<table>
<thead>
<tr>
<th>ARTICLE</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.00</td>
<td>GENERAL</td>
<td>2305</td>
</tr>
<tr>
<td>23.01</td>
<td>MATERIALS PURCHASED FROM THE CITY</td>
<td>2305</td>
</tr>
<tr>
<td>23.02</td>
<td>CONSTRUCTION SERVICES PURCHASED FROM THE CITY</td>
<td>2305</td>
</tr>
<tr>
<td>23.03</td>
<td>CONTRACTOR SUPPLIED MATERIALS</td>
<td>2305</td>
</tr>
<tr>
<td>A.</td>
<td>REFERENCED STANDARDS</td>
<td>2305</td>
</tr>
<tr>
<td>B.</td>
<td>JOINT TYPES</td>
<td>2307</td>
</tr>
<tr>
<td>C.</td>
<td>GASKET MATERIAL</td>
<td>2309</td>
</tr>
<tr>
<td>D.</td>
<td>JOINT LUBRICANTS</td>
<td>2309</td>
</tr>
<tr>
<td>E.</td>
<td>DUCTILE IRON PIPE</td>
<td>2309</td>
</tr>
<tr>
<td>F.</td>
<td>PRESTRESSED CONCRETE CYLINDER PIPE</td>
<td>2309</td>
</tr>
<tr>
<td>G.</td>
<td>POLYVINYL CHLORIDE (PVC) PIPE</td>
<td>2310</td>
</tr>
<tr>
<td>H.</td>
<td>HIGH-DENSITY POLYETHYLENE (HDPE) PIPE</td>
<td>2310</td>
</tr>
<tr>
<td>I.</td>
<td>CURED-IN-PLACE PIPE (CIPP) LINING</td>
<td>2310</td>
</tr>
<tr>
<td>J.</td>
<td>CAST IRON AND DUCTILE IRON FITTINGS</td>
<td>2310</td>
</tr>
<tr>
<td>K.</td>
<td>ANCHORING COUPLINGS AND FITTINGS</td>
<td>2310</td>
</tr>
<tr>
<td>L.</td>
<td>RESTRAINT COLLARS FOR VALVES AND REDUCERS</td>
<td>2311</td>
</tr>
<tr>
<td>M.</td>
<td>POLYETHYLENE ENCASEMENT</td>
<td>2311</td>
</tr>
<tr>
<td>N.</td>
<td>COPPER SERVICE PIPE</td>
<td>2311</td>
</tr>
<tr>
<td>O.</td>
<td>SERVICE PIPE CONNECTORS</td>
<td>2311</td>
</tr>
<tr>
<td>P.</td>
<td>HYDRANT DRAIN MATERIAL</td>
<td>2311</td>
</tr>
<tr>
<td>Q.</td>
<td>AIR RELIEF VALVES</td>
<td>2312</td>
</tr>
<tr>
<td>R.</td>
<td>TRACER WIRE</td>
<td>2312</td>
</tr>
<tr>
<td>23.04</td>
<td>REMOVED MATERIALS</td>
<td>2313</td>
</tr>
<tr>
<td>A.</td>
<td>GENERAL</td>
<td>2313</td>
</tr>
<tr>
<td>B.</td>
<td>BASIS OF PAYMENT</td>
<td>2313</td>
</tr>
<tr>
<td>23.05</td>
<td>HANDLING AND STORAGE</td>
<td>2313</td>
</tr>
<tr>
<td>23.06</td>
<td>EXCAVATION AND BACKFILL</td>
<td>2314</td>
</tr>
<tr>
<td>23.07</td>
<td>INSTALLATION OF PIPE AND FITTINGS</td>
<td>2314</td>
</tr>
<tr>
<td>A.</td>
<td>GENERAL</td>
<td>2314</td>
</tr>
<tr>
<td>B.</td>
<td>CUTTING PIPE</td>
<td>2315</td>
</tr>
<tr>
<td>C.</td>
<td>PREVENTING CONTAMINATION</td>
<td>2315</td>
</tr>
<tr>
<td>D.</td>
<td>UTILITY CONFLICTS</td>
<td>2316</td>
</tr>
<tr>
<td>E.</td>
<td>CAST-IN-PLACE THRUST RESTRAINTS</td>
<td>2316</td>
</tr>
<tr>
<td>F.</td>
<td>TRACER WIRE</td>
<td>2317</td>
</tr>
<tr>
<td>G.</td>
<td>JOINTING PIPES</td>
<td>2317</td>
</tr>
<tr>
<td>H.</td>
<td>POLYETHYLENE ENCASEMENT</td>
<td>2319</td>
</tr>
<tr>
<td>I.</td>
<td>WATER MAIN SHUTDOWNS</td>
<td>2319</td>
</tr>
<tr>
<td>J.</td>
<td>BASIS OF PAYMENT</td>
<td>2321</td>
</tr>
</tbody>
</table>
# Chapter 23

## Water Mains

<table>
<thead>
<tr>
<th>Article</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.08</td>
<td>Installation of Valves and Hydrants</td>
<td>2321</td>
</tr>
<tr>
<td>A.</td>
<td>General</td>
<td>2321</td>
</tr>
<tr>
<td>B.</td>
<td>Basis of Payment</td>
<td>2323</td>
</tr>
<tr>
<td>23.09</td>
<td>Bentomat® CL Geosynthetic Clay Liner</td>
<td>2323</td>
</tr>
<tr>
<td>A.</td>
<td>General</td>
<td>2323</td>
</tr>
<tr>
<td>B.</td>
<td>Material</td>
<td>2323</td>
</tr>
<tr>
<td>C.</td>
<td>Indications for Use</td>
<td>2323</td>
</tr>
<tr>
<td>D.</td>
<td>Equipment</td>
<td>2324</td>
</tr>
<tr>
<td>E.</td>
<td>Bentonite Paste Preparation</td>
<td>2324</td>
</tr>
<tr>
<td>F.</td>
<td>Installation on Pipe</td>
<td>2324</td>
</tr>
<tr>
<td>G.</td>
<td>Installation at Sewer Crossing</td>
<td>2327</td>
</tr>
<tr>
<td>H.</td>
<td>Basis of Payment</td>
<td>2327</td>
</tr>
<tr>
<td>23.10</td>
<td>Temporary Hydrants and Blow-Off for Flushing and Disinfection</td>
<td>2328</td>
</tr>
<tr>
<td>A.</td>
<td>General</td>
<td>2328</td>
</tr>
<tr>
<td>B.</td>
<td>Basis of Payment</td>
<td>2328</td>
</tr>
<tr>
<td>23.11</td>
<td>Water Service Construction or Reconstruction</td>
<td>2328</td>
</tr>
<tr>
<td>A.</td>
<td>General</td>
<td>2328</td>
</tr>
<tr>
<td>B.</td>
<td>Basis of Payment</td>
<td>2329</td>
</tr>
<tr>
<td>23.12</td>
<td>Abandonment of Water Main</td>
<td>2330</td>
</tr>
<tr>
<td>A.</td>
<td>General</td>
<td>2330</td>
</tr>
<tr>
<td>B.</td>
<td>Basis of Payment</td>
<td>2330</td>
</tr>
<tr>
<td>23.13</td>
<td>Highway, Street and Railroad Crossing</td>
<td>2330</td>
</tr>
<tr>
<td>23.14</td>
<td>Testing</td>
<td>2331</td>
</tr>
<tr>
<td>23.15</td>
<td>Disinfection of the Completed Work</td>
<td>2332</td>
</tr>
<tr>
<td>23.16</td>
<td>Cold Weather Construction</td>
<td>2332</td>
</tr>
<tr>
<td>23.17</td>
<td>Substantial Completion</td>
<td>2332</td>
</tr>
<tr>
<td>23.18</td>
<td>Final Completion and Acceptance</td>
<td>2332</td>
</tr>
<tr>
<td>23.19</td>
<td>Guarantee</td>
<td>2332</td>
</tr>
</tbody>
</table>
## CHAPTER 23
### WATER MAINS

<table>
<thead>
<tr>
<th>ARTICLE</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.20</td>
<td>CATHODIC PROTECTION</td>
</tr>
<tr>
<td>A.</td>
<td>GENERAL</td>
</tr>
<tr>
<td>B.</td>
<td>SUBMITTALS</td>
</tr>
<tr>
<td>C.</td>
<td>DELIVERY, STORAGE AND HANDLING</td>
</tr>
<tr>
<td>D.</td>
<td>WARRANTY ON CONTRACTOR-PROVIDED MATERIALS</td>
</tr>
<tr>
<td>E.</td>
<td>APPROVED MATERIAL SUPPLIERS</td>
</tr>
<tr>
<td>F.</td>
<td>ELECTRICAL CONTINUITY PROVISIONS – FERROUS PIPE</td>
</tr>
<tr>
<td>G.</td>
<td>CORROSION MONITORING TEST STATIONS</td>
</tr>
<tr>
<td>H.</td>
<td>ELECTRICAL ISOLATION DEVICES</td>
</tr>
<tr>
<td>I.</td>
<td>GALVANIC ANODES</td>
</tr>
<tr>
<td>J.</td>
<td>WIRE, CABLE AND SPLICES</td>
</tr>
<tr>
<td>K.</td>
<td>EXOTHERMIC WELDS AND CONNECTION DEVICES</td>
</tr>
<tr>
<td>L.</td>
<td>INSTALLATION OF CATHODIC PROTECTION MATERIALS - GENERAL</td>
</tr>
<tr>
<td>M.</td>
<td>INSTALLATION OF CATHODIC PROTECTION MATERIALS – QUALITY CONTROL</td>
</tr>
<tr>
<td>N.</td>
<td>INSTALLATION OF ELECTRICAL CONTINUITY PROVISIONS – FERROUS PIPE</td>
</tr>
<tr>
<td>O.</td>
<td>INSTALLATION OF CORROSION MONITORING TEST STATIONS</td>
</tr>
<tr>
<td>P.</td>
<td>INSTALLATION OF ELECTRICAL ISOLATION DEVICES</td>
</tr>
<tr>
<td>Q.</td>
<td>INSTALLATION OF GALVANIC ANODES</td>
</tr>
<tr>
<td>R.</td>
<td>INSTALLATION OF WIRE, CABLE AND SPLICES</td>
</tr>
<tr>
<td>S.</td>
<td>INSTALLATION OF EXOTHERMIC WELDS AND CONNECTION DEVICES</td>
</tr>
<tr>
<td>T.</td>
<td>POST-INSTALLATION TESTING OF CATHODIC PROTECTION SYSTEMS</td>
</tr>
<tr>
<td>U.</td>
<td>BASIS OF PAYMENT</td>
</tr>
</tbody>
</table>
TABLE | TITLE
--- | ---
23.03 A | WEDGE REQUIREMENTS FOR RETAINER GLANDS
23.03 B | POLYETHYLENE ENCASEMENTS
23.03 C | HYDRANT DRAIN MATERIAL GRADATIONS
23.05 A | DUCTILE IRON PIPE STORAGE
23.07 A | MAXIMUM JOINT DEFLECTIONS (DUCTILE IRON PIPE ONLY)
23.07 B | MAXIMUM JOINT OPENINGS
23.07 C | WATER MAIN SHUTDOWN APPLICABLE FEE SCHEDULE
23.09 A | BENTOMAT GCL INSTALLATION GUIDE
23.14 A | WATER MAIN PRESSURE TESTING

DRAWING NO. | TITLE
--- | ---
CP-101 | SINGLE HORIZONTAL ANODE INSTALLATION
CP-102 | SINGLE VERTICAL ANODE INSTALLATION
CP-301 | CONTINUITY BONDING ACROSS DUCTILE IRON PIPE JOINT
CP-311 | CONTINUITY BONDING ACROSS VERTICAL GATE VALVE
CP-312 | CONTINUITY BONDING ACROSS BUTTERFLY VAVLE OR HORIZONTAL GATE VALVE
CP-321 | INSULATING RUBBER & TAPE WYE SPLICE FOR SACRIFICIAL ANODE CABLE CONNECTIONS
CP-322 | INSULATING RUBBER & TAPE BUTT SPLICE FOR SACRIFICIAL ANODE CABLE CONNECTIONS
CP-401 | EXOTHERMIC WELD PROCEDURE FOR FERROUS PIPE MATERIALS (HORIZONTAL ONLY)
CP-611 | ANODE TEST STATION (ATS)
CP-612 | ATS TERMINAL BOARD INSTALLATION DETAILS
CP-621 | CASING TEST STATION (CTS)
CP-622 | CTS TERMINAL BOARD INSTALLATION DETAILS
<table>
<thead>
<tr>
<th>DRAWING NO.</th>
<th>TITLE</th>
<th>DRAWING NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP-631</td>
<td>POTENTIAL TEST STATION (PTS)</td>
<td>2366</td>
</tr>
<tr>
<td>CP-632</td>
<td>PTS TERMINAL BOARD INSTALLATION DETAILS</td>
<td>2367</td>
</tr>
<tr>
<td>CP-641</td>
<td>FOREIGN CROSSING (OVER WM) TEST STATION (FTS)</td>
<td>2368</td>
</tr>
<tr>
<td>CP-642</td>
<td>FOREIGN CROSSING (UNDER WM) TEST STATION (FTS)</td>
<td>2369</td>
</tr>
<tr>
<td>CP-643</td>
<td>FTS TERMINAL BOARD INSTALLATION DETAILS</td>
<td>2370</td>
</tr>
<tr>
<td>CP-651</td>
<td>ISOLATION TEST STATION (ITS)</td>
<td>2371</td>
</tr>
<tr>
<td>CP-652</td>
<td>ITS TERMINAL BOARD INSTALLATION DETAILS</td>
<td>2372</td>
</tr>
<tr>
<td>CP-653</td>
<td>ISOLATION TEST STATION AT TAPPING SLEEVE (ITS-TAP)</td>
<td>2373</td>
</tr>
<tr>
<td>CP-691</td>
<td>FLUSH-MOUNTED ENCLOSURE FOR TEST STATION TERMINAL BOARD &amp; WIRES</td>
<td>2374</td>
</tr>
<tr>
<td>CP-692</td>
<td>POST-MOUNTED TEST STATION FOR TERMINAL BOARD &amp; WIRES</td>
<td>2375</td>
</tr>
<tr>
<td>CP-801</td>
<td>FLANGE ISOLATION KIT (FIK)</td>
<td>2376</td>
</tr>
<tr>
<td>CP-804</td>
<td>POLYVINYL CHLORIDE PIPE INSERT (PVPI)</td>
<td>2377</td>
</tr>
<tr>
<td>CP-805</td>
<td>HIGH DENSITY POLYETHYLENE PIPE INSERT (HDPI)</td>
<td>2378</td>
</tr>
<tr>
<td>CP-806</td>
<td>ISOLATION (BALL TYPE) CORPORATION STOP (ICS)</td>
<td>2379</td>
</tr>
<tr>
<td>CP-807</td>
<td>ISOLATION SERVICE FITTING (COPPER FLARE) FOR ¼&quot; TO 2&quot; PIPE (ISF)</td>
<td>2380</td>
</tr>
<tr>
<td>CP-808</td>
<td>ELECTRICAL ISOLATION DEVICES FOR METALLIC CASING SLEEVES</td>
<td>2381</td>
</tr>
<tr>
<td>CP-809</td>
<td>ELECTRICAL ISOLATION AT PIPE ENTRY WITHIN REINFORCED CONCRETE WALL</td>
<td>2382</td>
</tr>
</tbody>
</table>
CHAPTER 23
WATER MAINS

23.00 GENERAL

The Work covered in this chapter includes the materials, appurtenant devices, water services, installation and testing of water main construction and reconstruction.

23.01 MATERIALS PURCHASED FROM THE CITY

The Contractor shall purchase the following materials from the Lincoln Water System:

- Valves
- Valve boxes, rings and lids
- Fire hydrants

The above materials are available for inspection at the Lincoln Water System Service Center. The Contractor shall provide all labor and transportation for loading and hauling of said materials.

Water will be supplied to the Contractor in conformance with the General Conditions and Title 17 of the Lincoln Municipal Code.

All materials shall be billed to the Contractor at prices and rates established by the Public Works and Utilities Business Office. Contractors may obtain the current material prices from the Public Works and Utilities Business Office.

23.02 CONSTRUCTION SERVICES PURCHASED FROM THE CITY

The Contractor shall purchase the following services from the Lincoln Water System:

- Flushing and disinfection services and materials
- Water main tapping and abandonments
- Water main shutdowns
- Installation of hydrant extensions

All services shall be billed to the Contractor at prices and rates established by the Public Works and Utilities Business Office.

23.03 CONTRACTOR SUPPLIED MATERIALS

A. REFERENCED STANDARDS

1. American National Standards Institute (ANSI). American Water Works Association (AWWA). Society of Cable Telecommunications Engineers (SCTE. All referenced standards shall be the latest revision thereof

   a. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings
   b. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems
   c. ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings
   d. ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
A. REFERENCED STANDARDS (Continued)

1. American National Standards Institute (ANSI) (Continued)
   
   e. ANSI/AWWA C115/A21.15 - Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges


   g. ANSI/AWWA C153/A21.53 - Ductile-Iron Compact Fittings for Water Service

   h. ANSI/AWWA C301 - Prestressed Concrete Pressure Pipe, Steel-Cylinder Type

   i. ANSI/AWWA C651 - Disinfecting Water Mains

   j. AWWA C800 – Underground Service Line Valves and Fittings

   k. ANSI/AWWA C900-16 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4" thru 60" for Water Transmission and Distribution

   l. AWWA C906-15 – Polyethylene (PE) Pressure Pipe and Fittings, 4" through 65"

   m. AWWA M28 – Rehabilitation of Water Mains

   n. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

   o. ANSI/SCTE 77 T15 – Specifications for Underground Enclosure Integrity


   a. A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

   b. A380 – Standard Practice for Cleaning, Descaling and Passivating of Stainless Steel Parts, Equipment and Systems


   d. A617 - Specifications for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.

   e. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings

   f. B88 - Specification for Seamless Copper Water Tube

   g. B584 – Standard Specification for Copper Alloy Sand Castings for General Applications

   h. D1248 – Specification for Plastic Molding and Extrusion Materials, Type 1, Class C, Grade 5

   i. F1216-09 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
A. REFERENCED STANDARDS (Continued)

2. American Society for Testing and Materials (ASTM) (Continued)
   j. **F477** - Standard Specification for Elastomeric Seals (Gaskets) for Joint Plastic Pipe
   k. **G97** – Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

3. National Association of Corrosion Engineers (NACE)
   a. **NACE SP0169** – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
   b. **NACE TM0497** – Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

4. Material and Construction Trade Standards
   b. Uni-Bell PVC Pipe Association, Installation Guide for PVC Pressure Pipe

B. JOINT TYPES

1. Push-on joints shall conform to the requirements of ANSI/AWWA C111/A21.11 for ductile iron pipe and “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe ASTM F477 for Polyvinyl Chloride Pipe.”

2. Mechanical joints shall conform to the requirements of ANSI/AWWA C111/A21.11. Bolts and nuts for mechanical joints shall be high-strength, low alloy steel as described in Paragraph 11-6.5 of ANSI A21.11.

3. Restrained push-on joints shall conform to the performance requirements as described in Section 11.9 of ANSI A21.11.

4. Special mechanical joints shall conform to the following:
   a. Swivel couplings (anchoring couplings) shall mean a standard plain end connection with an integrally cast compression gland and freely rotating bolt ring bearing on the compression gland, designed to mate with a standard mechanical joint connection and to prevent the joint from separating under pressure when all bolts are in place. Swivel couplings shall be similar to Tyler Pipe swivel adapter or U.S. Pipe rotatable mechanical joint gland. The rotatable bolt ring portion of swivel couplings shall be fabricated from ductile iron and shall have the letters “D.I.” or the words “Ductile Iron” cast in the bolt ring.
   b. Solid couplings shall mean a standard plain end connection with an integrally cast compression gland and bolt ring, designed to mate with a standard MJ bell and gasket. Solid couplings shall be similar to Tyler Pipe solid gland or U.S. Pipe integral mechanical joint gland.
B. JOINT TYPES (Continued)

c. All retainer glands shall utilize a wedge action principle or grip ring principle to fully restrain the fitting and pipe together. Wedge Action Retainer Glands shall be ductile iron with heat-treated ductile iron wedges and twist-off torque nut bolts. Ductile iron shall be per ASTM A536 grade 65-45-12. Wedges shall have a minimum hardness of 370 BHN. The gland shall allow for a minimum deflection of 3° and allow joint movement after installation. The gland shall be provided with torque limiting twist-off nuts with an additional fixed hex head to allow for removal and reinstallation of the gland. Twist-off torque nut bolts shall be coated or lubricated in a manner to prevent corrosion and premature twist-off of the torque limiting twist-off nuts. Additional requirements include:

<table>
<thead>
<tr>
<th>Specification Item</th>
<th>Ductile Iron Pipe</th>
<th>PVC Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Rating For 6&quot;-12&quot; Pipe</td>
<td>350 psi</td>
<td>305 psi (DR 14)</td>
</tr>
<tr>
<td>Pressure Rating For 16&quot; Pipe</td>
<td>350 psi</td>
<td>235 psi (DR 18)</td>
</tr>
<tr>
<td>Pressure Rating for 24&quot; and larger</td>
<td>250 psi</td>
<td>NA</td>
</tr>
<tr>
<td>Color</td>
<td>Black</td>
<td>Red</td>
</tr>
<tr>
<td>Acceptable Manufacturers</td>
<td>EBAA Iron Megalug Series 1100 Ford Uni-Flange Series 1400 STAR Stargrip 3000 SIGMA One-Lok SLD TYLER UNION TUFGRIP</td>
<td>EBAA Iron Megalug Series 2000PV STAR PVC Stargrip 4000E9408985 TYLER UNION TUFGRIP PVC FORD Uni-Flange Series 1500</td>
</tr>
</tbody>
</table>

Acceptable manufacturers are required to meet all stated specifications requirements. Failure to meet requirements shall be cause for rejection.

d. Mechanical Joint Restraint Adaptors for connection of MJ valves to MJ fittings and MJ fittings to MJ fittings shall be a bolt-through positive restraint mechanism meeting working pressure specifications of AWWA C153 for compact fittings and manufactured of ductile iron conforming to ASTM A536, 80-55-06. MJ adaptors shall connect standard mechanical joint fittings (AWWA C110 or C153) and valves at a linear distance not to exceed three (3) inches and without attachment to pipe. MJ adaptors shall be installed with standard styrene butadiene rubber (SBR) MJ gaskets conforming to the latest revision of AWWA C111 be supplied with an NSF 61, 7-mil. fusion bonded epoxy coating. The bolts and nuts shall be ASTM A193 Type 304 Stainless Steel Acceptable manufacturer shall be Foster Adaptor.

5. Flange connections shall conform to the requirements of ANSI B16.1 for 125-pound class and shall also conform to ANSI/AWWA C115/A21.15. The flange gaskets shall be 1/8" thick red rubber. The gasket shall be of the full face or inside bolt ring coverage styles. Bolts shall be sufficient length to expose 1/4" to 1/2" of the bolt beyond the outer face of the nut when the joint is fully assembled.
B. JOINT TYPES (Continued)

6. Precast concrete cylinder pipe joints shall conform to AWWA C301. The joint rings shall be galvanized steel. The external joint filler material shall be cement impregnated polyurethane foam in a closed loop form equal to Mar Mac Flex-Protex or shall be a cement mortar grout composed of 1 part Portland or mortar cement to 2 parts sand and sufficient water to flow easily. Joint diapers shall be heavy-duty cotton with wire or steel straps in the hem. Diapers shall be a minimum of 6" wide for all pipes 36" in diameter or smaller. All diapers for pipes larger than 36" shall be a minimum of 7" wide.

C. GASKET MATERIAL

All gaskets, with the exception of gaskets for flanged joints, shall be neoprene or other synthetic rubber. Natural rubber gaskets are not acceptable.

D. JOINT LUBRICANTS

All joint lubricants shall be a vegetable soap base or equal and shall be supplied by the pipe manufacturer. Lubricants shall be supplied in sterile, tightly sealed, small quantity containers. Any lubricant which has been contaminated with dirt or other foreign material shall be rejected.

E. DUCTILE IRON PIPE

Ductile iron pipe shall conform to the requirements of ANSI/AWWA C151/A21.51. All pipe shall be Class 52 unless otherwise specified. The cement mortar lining shall be standard weight and shall conform to the requirements of ANSI/AWWA C104/A21.4. Unless otherwise specified, all pipe shall be supplied in 18’ or 20’ lengths and shall have push-on type joints.

F. PRESTRESSED CONCRETE CYLINDER PIPE

Prestressed concrete cylinder pipe shall be manufactured in conformance with AWWA C301 and shall be designed in conformance with Appendix A or Appendix B of that Specification. Pressures and external loads used in design shall be as specified elsewhere in the Contract Documents.

The Contractor shall supply the following information for approval prior to delivery of the pipe and appurtenances:

1. Design Calculations
2. Proof of Design Test Results
3. Tabulated Layout Schedule
4. Affidavit of Compliance

Fine aggregate shall be clean natural sand. Artificial or manufactured sand shall not be used.

All branch outlets and other connections shall be of the joint type shown on the plans. Where projects are terminated without connecting to existing pipe, a mechanical joint bell adapter and mechanical joint plug shall be provided.

Adapter section shall be provided to connect to valves, fittings and existing pipe. All adapters, fittings and other specials shall be cement mortar lined.
G. POLYVINYL CHLORIDE (PVC) PIPE

Polyvinyl Chloride (PVC) pipe shall conform to AWWA C900-16. All pipe 12" in diameter or smaller shall be PVC 1120 DR 14 with O.D. conforming to that of ductile iron pipe unless otherwise specified. PVC pipe larger than 12" in diameter shall be PVC 1120 DR 18 conforming to that of cast iron pipe unless otherwise specified. Joints shall be push-on type with rubber compression ring joints conforming to “Standard Specification for Elastomeric Seals (Gaskets) for Joint Plastic Pipe” ASTM F477.

H. HIGH-DENSITY POLYETHYLENE (HDPE) PIPE

High-Density Polyethylene (HDPE) pipe may be used only upon review and approval of the Lincoln Water System. HDPE pipe shall conform to AWWA C906-15 and be a minimum Pressure Class DR11, Pipe Material Designation – PE 4710, with O.D. conforming to that of ductile iron pipe unless otherwise specified.

I. CURED-IN-PLACE PIPE (CIPP) LINING

Cured-in-place pipe (CIPP) lining may be used only upon review and approval of the Lincoln Water System. Liner material shall be a Class IV fully structural Cured-in-place pipe in accordance with AWWA M28, ASTM F1216-09, ASTM F1743-08 or ASTM F2019-03 with the exception that the liner thickness is in accordance with ASTM F1216-07a.

J. CAST IRON AND DUCTILE IRON FITTINGS

Cast iron and ductile iron fittings shall conform to the requirements of ANSI/AWWA C110/A21.10 and shall be supplied with a standard weight cement mortar lining conforming to ANSI/AWWA C104/A21.4 and all necessary glands, bolts, nuts and gaskets to complete a non-restrained mechanical joint fitting connection. Ductile iron compact fittings shall be in conformance with ANSI/AWWA C153/A21.53. All joints shall be mechanical joint bells unless otherwise provided in the Contract Documents.

Pressure ratings for fittings shall be a minimum of 250 p.s.i. water working pressure for 12" nominal diameter and smaller, based on the diameter of the largest bell. For fittings larger than 12" nominal diameter, a pressure rating of 150 p.s.i. shall be used unless otherwise specified.

K. ANCHORING COUPLINGS AND FITTINGS

Anchor couplings shall consist of a length of pipe with a solid coupling end connection and a swivel coupling end connection. Anchor couplings shall be similar to Tyler Pipe adapter swivel fittings or U.S. Pipe hydrant connection pieces.

Anchor elbows shall consist of 90° elbow with 2 swivel couplings, Anchor elbows shall be similar to the Tyler Pipe Swivel x Swivel 90° ELL swivel fittings.

Anchor pipe shall consist of a length of pipe with 2 swivel coupling end connections.

Swivel tees shall be cast to the requirements of ANSI A21.10 with mechanical joint run end connection and a swivel coupling on the branch connection. Swivel tees shall be similar to Tyler Pipe MJ x MJ x swivel tees or U.S. Pipe valve and hydrant tees.
23.03 CONTRACTOR SUPPLIED MATERIALS (Continued)

L. RESTRAINT COLLARS FOR VALVES AND REDUCERS

Restraint collars for valves and reducers when using PVC for water main construction shall be supplied and constructed in conformance to the applicable Lincoln Standard Plans or contract Special Provisions. Restraint collars for valves and reducers shall be considered subsidiary to PVC Water Main construction and are not measured or paid for as a separate fitting for purposes of this chapter.

M. POLYETHYLENE ENCASEMENT

Polyethylene encasement shall be Class C, black pigmented, 8 mils. thick, linear low density, polyethylene conforming to the requirements of ANSI/AWWA C105/A21.5. The encasement may be supplied in flat sheets or tubes at the Contractor's option. Tape used to repair or patch the encasement shall be manufactured from synthetic materials. Duct tape shall not be used for repairs. The tubes, measured when laid flat, and the flat sheets shall conform to TABLE 23.03 B – POLYETHYLENE ENCASEMENTS.

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter</th>
<th>Polyethylene Encasement Tube and Sheet Widths (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tube</td>
</tr>
<tr>
<td>6&quot;</td>
<td>20</td>
</tr>
<tr>
<td>8&quot;</td>
<td>24</td>
</tr>
<tr>
<td>12&quot;</td>
<td>30</td>
</tr>
<tr>
<td>16&quot;</td>
<td>37</td>
</tr>
<tr>
<td>24&quot;</td>
<td>54</td>
</tr>
<tr>
<td>30&quot;</td>
<td>67</td>
</tr>
<tr>
<td>36&quot;</td>
<td>81</td>
</tr>
<tr>
<td>48&quot;</td>
<td>108</td>
</tr>
<tr>
<td>54&quot;</td>
<td>121</td>
</tr>
</tbody>
</table>

N. COPPER SERVICE PIPE

Copper water service pipe shall be Type “K” seamless soft-drawn copper tubing which conforms to the “Specifications for Seamless Copper Water Tube”, ASTM Designation B 88.

O. SERVICE PIPE CONNECTORS

All copper service pipe connectors shall be fabricated from red brass. All copper supply and service pipe shall be joined by either flared-end connectors or brazed, non-lead, eutectic joints.

P. HYDRANT DRAIN MATERIAL

Hydrant drain material shall be clean, washed, hard, durable, uncoated and uniformly graded Class “A” gravel as specified by the Nebraska Department of Transportation. Gradation shall be as follows:
P. HYDRANT DRAIN MATERIAL (Continued)

**TABLE 23.03 C – HYDRANT DRAIN MATERIAL GRADATIONS**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>95</td>
<td>+/- 5</td>
</tr>
<tr>
<td>#4</td>
<td>78</td>
<td>+/- 4</td>
</tr>
<tr>
<td>#10</td>
<td>16</td>
<td>+/- 13</td>
</tr>
<tr>
<td>#200</td>
<td>3</td>
<td>+/- 3</td>
</tr>
</tbody>
</table>

Q. AIR RELIEF VALVES

Air relief valves shall be provided by the Contractor to conform to the size, type and configuration shown on the plans.

R. TRACER WIRE

All PVC water mains owned by the City of Lincoln shall be installed with a locator wire attached. The wire shall be direct bury 12 AWG solid steel core, copper clad wire with 30 mil, blue, HDPE insulator. Wire shall have a 30-volt rating with a minimum tensile break force of 380 pounds.

Approved manufacturer shall be Copperhead Industries, or equal. The wire shall be installed with as few splices as possible. Splices shall utilize end to end 3M DBR connectors, sealed with silicone sealant, aqua seal, or equal and covered with Scotch #33 electrical tape.
23.04 REMOVED MATERIALS

A. GENERAL

When called for on the plans and Contract Documents, the Contractor shall remove water main pipe and dispose of it.

When called for on the plans, the Contractor shall remove and reset water main valves, hydrants, and plugs at the location and grade as indicated on the plans. The Contractor shall exercise care in the removal and resetting of these items. Removal and Resetting of hydrants and valves will only be allowed in cases where the existing item was installed within the past 5 years, otherwise they shall be Removed and Salvaged. The Contractor shall thoroughly examine each appurtenance to ascertain whether it is in proper working condition; and if there is a question regarding the condition of the appurtenance, the Contractor shall contact the Lincoln Water System to exchange the item for one that is working.

When called for on the plans and Contract Documents, water main valves, hydrants, and plugs shall be removed and salvaged. The Contractor shall deliver the salvaged appurtenances to the Lincoln Water System Shop. Receipts for salvaged materials shall be delivered to the City’s Project Manager.

B. BASIS OF PAYMENT

Water main pipe removed in conformance with these Specifications and accepted by the City’s Project Manager shall be measured and paid for at the contract unit price bid per linear foot for REMOVE WATER MAIN. Such payment shall be full compensation for all excavation, removal, backfill, disposal of excess materials, equipment, tools, labor and incidentals necessary to perform the Work called for.

Water main valves, hydrants and plugs removed and relayed, removed and salvaged, or removed in conformance with these Specifications and accepted by the City’s Project Manager shall be measured and paid for at the contract unit price bid per each for REMOVE AND SALVAGE _______, REMOVE AND RESET _______, or REMOVE _______. Such payment shall be full compensation for all excavation, removal of appurtenances and thrust blocking, bedding or foundation rock if required, resetting, loading of salvaged items, resetting valve box, backfill, materials, equipment, tools, labor and incidentals necessary to perform the Work.

23.05 HANDLING AND STORAGE

The Contractor shall protect all material from damage and handle material carefully in conformance with the manufacturer's recommendations. Equipment used to handle material such as slings, lifting lugs, hooks and other devices shall be designed to protect pipe, coatings, linings, joint elements, castings, valves, hydrants, and all other material.

Gaskets shall be protected from deterioration and stored out of direct sunlight for prolonged periods and in such a manner that they will not contact oils, fumes, solvents, and other materials and substances that attack rubber or synthetic rubber materials.

All hydrants and valves shall be protected so that latent water within the valves or hydrants will not freeze. The hydrants and valves shall be stored in such a manner that water will not enter drains and other openings. All butterfly valves shall be stored indoors. All resilient seated wedge valves shall be stored indoors or with the wedge in a raised position. All pipe, fittings, valves and hydrants shall be kept clean and protected from contamination by mud and dirt.
23.05 HANDLING AND STORAGE (Continued)

Prestressed concrete cylinder pipe shall not be stacked higher than allowed by the manufacturer's recommendations. PVC pipe shall not be stacked higher than 8’ or in conformance with manufacturer’s recommendations whichever is less. Ductile iron pipe shall not be stacked higher than allowed in TABLE 23.05 A – DUCTILE IRON PIPE STORAGE.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Number of Tiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>13</td>
</tr>
<tr>
<td>8&quot;</td>
<td>11</td>
</tr>
<tr>
<td>12&quot;</td>
<td>9</td>
</tr>
<tr>
<td>16&quot;</td>
<td>7</td>
</tr>
<tr>
<td>24&quot;</td>
<td>5</td>
</tr>
<tr>
<td>30&quot;</td>
<td>4</td>
</tr>
<tr>
<td>36&quot;</td>
<td>4</td>
</tr>
</tbody>
</table>

No direct measurement or payment for storage and handling of materials used in the construction of water mains will be made. The costs associated with the materials to be incorporated into the Work shall be considered subsidiary to the items for which direct payment is made.

23.06 EXCAVATION AND BACKFILL

Excavation and backfill for water mains and appurtenances shall conform to the requirements of Chapter 20 of these Specifications except as hereinafter modified for water main construction. Unless otherwise shown on the plans, modified by Special Provisions, or directed by the City’s Project Manager, all PVC pipe shall be embedded with approved materials to at least 6” above the top of the pipe.

23.07 INSTALLATION OF PIPE AND FITTINGS

A. GENERAL

The Contractor shall use the proper tools and equipment necessary to safely install all pipe, fittings and appurtenances to the lines and grades as shown on the plans. Installation of pipe and fittings shall be in conformance to manufacturer’s requirements and instructions except where otherwise provided in the specifications. Prior to beginning Work, the Contractor shall submit to the City’s Project Manager a copy of the manufacturer’s installation instructions for review and approval. The Contractor shall retain a copy of the installation instruction at the project site for reference during construction. PVC pipe shall be installed in strict conformance to the manufacturer’s requirements and instruction except that in no case shall PVC pipe be installed by bending the pipe.
23.07 INSTALLATION OF PIPE AND FITTINGS (Continued)

B. CUTTING PIPE

1. Ductile Iron Pipe

When nonstandard lengths of pipe are required to install valve and fittings, terminate lines, or make connections, the Contractor shall cut the pipe using an abrasive wheel, milling type cutter, or other approved mechanical cutter. Torch cutting shall be used only with specific permission of the City’s Project Manager and then only in strict conformance with the manufacturer's recommendations. After cutting, the Contractor shall bevel the ends of the pipe to approximate the manufactured bevel of a full length of pipe. Pipe which is not cut square or which has rough and jagged edges that might nick or cut gaskets shall be reworked to the approval of the City’s Project Manager.

2. Prestressed Concrete Cylinder Pipe

No cutting of prestressed cylinder pipe will be allowed. All pipe which does not fit or close shall be rejected and the rejected pipe removed from the job site.

3. PVC Pipe

PVC pipe shall be cut using carpenter, hack saws or abrasive wheel. Care shall be taken to make all cuts square and perpendicular to the longitudinal axis of the pipe. After cutting, the Contractor shall bevel the ends of the pipe to approximate the manufactured bevel of a full length of pipe. Pipe which is not cut square or which has rough and jagged edges that might nick or cut gaskets shall be reworked to the approval of the City’s Project Manager.

When 12” butterfly valves are called for on the plans for PVC pipe, the pipe ends shall be chamfered on the inside radius as detailed in the Lincoln Standard Plans so that the valve operates to a fully closed position.

C. PREVENTING CONTAMINATION

Existing valves and valves connecting the existing system to the new construction shall be operated only by the Lincoln Water System; except that the Contractor may operate those valves to fill the new mains for testing, only after notification of Lincoln Water System personnel.

The Contractor shall keep the pipe and appurtenances clean and free from tools, rags, dirt, mud, non-potable water, and other foreign materials and objects at all times during installation. If pipe laying is stopped or delayed for any reason, the Contractor shall seal the open ends of all pipes. Seals shall be capable of preventing the entry of water and other foreign material with the excavation completely full of water.

All pipes shall be jointed immediately after placement in the excavation. Bell-ends of pipe shall face in the direction of laying. The Contractor shall ensure that the pipe is not displaced after it is laid to the proper line and grade; and should the pipe become displaced the Contractor shall relay the pipe to the proper line and grade at no additional cost or expense to the City.
23.07 INSTALLATION OF PIPE AND FITTINGS (Continued)

D. UTILITY CONFLICTS

Where unforeseen conflicts between the water construction and existing utilities are discovered, the Contractor shall immediately notify the City’s Project Manager. Where the water main is to be constructed below or within 18” of a storm sewer pipe, the Contractor shall lay a full length of water main pipe centered on the sewer or such length as will provide the maximum possible separation of the joints in the water main from the sewer line. The Contractor shall also reconstruct any sanitary sewer with (1) 20’ length of C900 pressure pipe or equivalent, such that the maximum possible separation between the water main and the sewer pipe joints will result. The backfill material shall be select, low-permeability soil.

Where the water main is located below a sanitary sewer pipe, to prevent the possibility of contaminated wastewater reaching the potable water main, the entire space between the top of the water main up to the spring line (half way) of the sanitary sewer shall be back-filled with flowable fill. No granular fill shall be used. The extent along the water main shall be the entire length of pipe and fittings at the bottom of the excavation, and the extent along the sewer shall be to undisturbed earth. This flowable backfill shall be subsidiary to other items of work for which direct payment is made.

Where existing water mains are to be looped around another utility, the Contractor shall plan his Work so that disruptions to water service are minimized. The Contractor shall provide adequate personnel, equipment and materials necessary to complete the Work as quickly as possible. All necessary materials shall be on site, and where ever possible, the Contractor shall preassemble the entire looping configuration, including bends or offsets and restraint devices, before the water main will be scheduled for shutdown by Lincoln Water System. Service fees charged by the Lincoln Water System shall be considered subsidiary to the cost of looping the water main in the event of a utility conflict. Additional fees for extended shutdowns shall not be cause for additional compensation to the Contractor.

E. CAST-IN-PLACE THRUST RESTRAINTS

The Contractor shall construct concrete thrust blocks conforming to the requirements of the Lincoln Standard Plans at all locations shown on the plans or indicated by the City’s Project Manager. All thrust blocks shall be placed so that pipe and fitting joints will be accessible for repairs. The bearing face of all thrust blocks shall rest against undisturbed soil.

When the existing water mains must be reconstructed or looped, the Contractor shall restrain all fittings with ductile iron retainer glands installed in conformance with the manufacturer’s recommendations in addition to concrete thrust blocks, anchorages and/or gravity blocks.

Gravity block straps of the size and type specified in the Lincoln Standard Plans shall be State Steel type M1020, or equivalent, low carbon, low manganese, general purpose, merchant quality stainless steel that is suitable for forming and welding. All strap material not embedded in concrete shall be covered with polywrap or tape prior to backfilling.
F. TRACER WIRE

The Contractor shall install tracer wire (as per 23.03 P) directly to the top of the pipe between the 10 o’clock and 2 o’clock positions, with PVC pipe only. Tracer wire shall be secured to the main every 5’ with tape patches and shall be secured so that some slack can be taken out of the wire for valve and tap installations. Tracer wire shall be extended to the ground surface and terminated in conformance with the Standard Plans using a coil of excess wire at least 18" in length inside the valve box. For line valves and hydrant branch valves (branch less than 10’) the tracer wire shall be attached to the exterior of the valve box and inserted into the valve box 8" from the top of the box through a field drilled 1/2" hole. Tracer wire shall be installed with as few splices as possible. No bare wire shall be exposed, with the exception of 1" of wire to be stripped at the access loop for contact with tracing equipment. The two ends of the wire shall be knotted to prevent strain on the splice. Branch connections shall be made without cutting the main wire utilizing a connection clip and sealing the joint the same as splices. Tracer wires shall be tested by the Contractor for continuity after backfilling with a wire continuity tracing device. All wires failing to provide positive continuity for signal transmission shall be repaired or replaced at the Contractor’s expense.

After testing the ends, all tracer wires shall be sealed with heat shrink tape. Installation and testing of tracer wire shall be considered subsidiary to the installation of PVC pipe.

All water main reconstructions (loops for conflicting utilities) as shown on LSP 301 shall have tracer installed when using PVC pipe. When reconstruction is performed on ductile iron pipe or cast-iron pipe, tracer wire shall be terminated on both ends of the loop directly to the existing pipe using an exothermic welded connection, or a stainless steel Cathodi-Clamp™. Polyethylene encasement shall be (re)installed over the areas of the existing pipe where the tracer is terminated extending from a minimum of 2’ past the connection point of the new PVC pipe to a minimum of 2’ past the wire termination point on the existing water main.

G. JOINTING PIPES

1. General

All bells, gaskets, lubricants and appurtenances shall be kept clean. Gaskets shall be of the proper style for the pipe being laid. Joints shall be deflected after assembly.

2. Ductile Iron Pipe

Bell ends shall be protected during joining by approved methods. Maximum pipe joint deflections for push-on and mechanical jointed pipe shall conform to TABLE 23.07 A – MAXIMUM JOINT DEFLECTIONS.

3. PVC Pipe

PVC pipe shall be joined by inserting the spigot end of the pipe into the bell no further than marked by the manufacturer. Insertion on the PVC pipe further than the manufacturer’s mark shall require reassembly. Bell ends shall be protected during joining by approved methods. Maximum pipe joint deflections for PVC pipe shall confirm to the manufacturers recommended standards for the brand of pipe being installed.
G. JOINTING PIPES (Continued)

4. Mechanical Joints

Mechanical joints shall be assembled in strict conformance with the manufacturer's instructions and recommendations. Bolts on opposite sides of the joint shall be drawn up evenly to ensure even pressure around the gland and gasket. The Contractor shall tighten all retainer gland screw wedges according to manufacturer’s recommendations for each type of retainer gland and pipe material. Prior to final tightening, the Contractor shall make any necessary deflections. Deflections for DUCTILE IRON pipe shall not exceed those shown in TABLE 23.07 A – MAXIMUM JOINT DEFLECTIONS.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Push-on Joints</th>
<th>Mechanical Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deflection</td>
<td>Maximum Offset</td>
</tr>
<tr>
<td>6&quot;</td>
<td>4° 00'</td>
<td>17.0&quot;</td>
</tr>
<tr>
<td>8&quot;</td>
<td>4° 00'</td>
<td>17.0&quot;</td>
</tr>
<tr>
<td>12&quot;</td>
<td>4° 00'</td>
<td>9.5&quot;</td>
</tr>
<tr>
<td>16&quot;</td>
<td>2° 24'</td>
<td>9.5&quot;</td>
</tr>
<tr>
<td>24&quot;</td>
<td>2° 24'</td>
<td>9.5&quot;</td>
</tr>
<tr>
<td>30&quot;</td>
<td>2° 24'</td>
<td>9.5&quot;</td>
</tr>
<tr>
<td>36&quot;</td>
<td>2° 24'</td>
<td>9.5&quot;</td>
</tr>
<tr>
<td>48&quot;</td>
<td>1° 36'</td>
<td>6.5&quot;</td>
</tr>
<tr>
<td>54&quot;</td>
<td>1° 12'</td>
<td>5.0&quot;</td>
</tr>
</tbody>
</table>

5. Prestressed Concrete Cylinder Pipe Joints

The Contractor shall make all joints in prestressed concrete cylinder pipe in strict conformance with the manufacturer's instructions and recommendations. After placing the gasket on the spigot end of the pipe, the Contractor shall run a smooth round steel rod between the gasket and the spigot for one complete turn around the pipe and repeat in the opposite direction to ensure uniform stretching of the gasket.

After seating but prior to homing the pipe, the Contractor shall check the gasket for proper location using feeler gauges. Gaskets for pipes larger than 24" in diameter shall be checked from both the inside and outside of the pipe. Pipes shall be deflected where required after homing, according to the following:

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Maximum Joint Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;-36&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>48&quot;</td>
<td>1'</td>
</tr>
<tr>
<td>54&quot;</td>
<td>1'-1/8&quot;</td>
</tr>
</tbody>
</table>

The exterior joint recesses shall be filled with cement mortar. Cement mortar shall be rodded into diapir with a wire curved to conform to the radius of the pipe.
H. POLYETHYLENE ENCASEMENT

Polyethylene (PE) encasement shall be installed on all ductile and cast-iron water mains, water valves, fittings and water services using Method A or B as detailed in AWWA/ANSI C105/A21.5 except that the encasement shall consist of double wrapping. All pipe and fittings encased with PE shall be handled, repaired and installed in conformance to guidelines published by DIPRA. The Contractor shall double wrap and seal with tape all bolted connections, anchoring couplings, anchoring elbows, valves, and fire hydrants. Encasement for fittings and valves on PVC pipe shall extend a minimum of 18” past the joint. The Contractor shall ensure that hydrant drain holes are not blocked or covered. All water main and service valves shall be doubled wrapped, fully encased and sealed with tape around the valve stem operator underneath the operating nut.

The Contractor shall wrap all copper supply pipes from the tap extending 5’ away from any ductile or cast iron main, and shall repair all PE encasement at the tap location. Copper services connected to PVC water mains are not required to be encased, unless otherwise noted. All ductile iron fittings used on PVC water services shall be doubled wrapped.

I. WATER MAIN SHUTDOWN

The Lincoln Water System schedules and performs all shutdowns of the existing water system and corresponding interruptions of service to customers. Unless otherwise approved by the Engineer, the Contractor shall excavate areas of work prior to LWS scheduling shutdowns with customers to better assess the time required for the service interruption. In all cases the Contractor shall provide at least 48-hour notification for a request to interrupt service.

The Lincoln Water System also schedules and performs tapping, valve operation, and flushing and disinfection services, when required. In all cases the Contractor shall notify the Assistant Superintendent of Water Construction, or his representative, to provide for scheduling such services at least 48 hours prior to the time that they are needed. These services shall be scheduled only during City working hours.

Prior to LWS making the shutdown, the Contractor shall be fully prepared to perform the work in the most expedient manner possible. The Contractor shall have all necessary fittings, pipe, tools, and accessories available onsite and all parts/pieces necessary to complete the work must be preassembled to the extent possible to perform the work. If in the opinion of LWS, the City’s Project Manager or the Engineer that the contractor is not fully prepared to perform the work, a shutdown shall not be provided. The LWS reserves the right to charge the contractor a lump sum amount not to exceed $200 if the shutdown is cancelled due to lack of preparedness. This condition shall be not cause for claim of damages or additional compensation by the Contractor.

If the proposed work involves 8” or larger water mains, any fittings to complete the installation or affects service to commercial or industrial customers, then a plan must be submitted to LWS for approval. The aforementioned plan shall indicate all fittings and dimensions of any pieces to be installed to complete the work causing the shutdown. The plan shall indicate the estimated time out of service, requested time for the shutdown, general description of how the work will be performed, required pumping equipment and the number of employees expected to perform the work.
I. WATER MAIN SHUTDOWNs (Continued)

The water main shall be excavated prior to the shutdown and the excavation prepared to make work conditions safe and clean. Where directed by LWS, the City’s Project Manager or the Engineer, the contractor shall use approved bedding material in the bottom of the excavation to provide a suitable work surface for ease of construction and to provide for sanitary conditions. These materials shall be compensated in accordance to applicable bid items.

Contractors shall be adequately equipped to pump drain water and anticipate some leakage of water past valves. Adequate pumping equipment shall be shall be a condition for approval of the shut-down plan.

There shall be no cost for a shut-down which interrupts water service for less than two (2) hours. For interruptions of water service lasting two (2) or more hours, the shut-down fees are as follows:

<table>
<thead>
<tr>
<th>Hours of Shutdown</th>
<th>Applicable Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2 hours</td>
<td>no charge</td>
</tr>
<tr>
<td>2 – 3 hours</td>
<td>$200</td>
</tr>
<tr>
<td>3 – 4 hours</td>
<td>$700</td>
</tr>
<tr>
<td>4 – 5 hours</td>
<td>$1,700</td>
</tr>
<tr>
<td>5 – 6 hours</td>
<td>$4,200</td>
</tr>
<tr>
<td>6 – 7 hours</td>
<td>$9,200</td>
</tr>
<tr>
<td>7 – 8 hours</td>
<td>$19,200</td>
</tr>
<tr>
<td>over 8 hours to 12 hours</td>
<td>$15,000 each additional hour</td>
</tr>
<tr>
<td>over 12 hours</td>
<td>$25,000 each additional hour</td>
</tr>
</tbody>
</table>

Example: Fee for water main shut down for 11.5 hours = $19,200 + $15,000 + $15,000 + $15,000 + $15,000 = $79,200

The shut down time shall be considered the time from when the water main has been isolated by the Lincoln Water System (LWS) to the extent possible up to the time that LWS is notified that work has been completed sufficiently to allow service to be restored. This cost shall not be reimbursable.
23.07 INSTALLATION OF PIPE AND FITTINGS

J. BASIS OF PAYMENT

WATER MAIN of the various sizes called for on the plans shall be measured and paid for at the contract unit price bid per linear foot for each different diameter required. Pipe shall be measured through fittings and valves. Such payment shall be full compensation for all excavation, backfill, pipe, bedding material, other materials, testing, equipment, tools, labor, and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

DUCTILE IRON PIPE WATER MAIN of the various types and sizes called for on the plans shall be measured and paid for at the contract unit price bid per linear foot for each different diameter required. Pipe shall be measured through fittings and valves. Such payment shall be full compensation for all excavation, backfill, pipe, other materials, testing, equipment, tools, labor and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

POLYVINYL CHLORIDE (PVC) WATER MAIN of the various types and sizes called for on the plans shall be measured and paid for at the contract unit price bid per linear foot for each different diameter required. Pipe shall be measured through fittings and valves. Such payment shall be full compensation for all excavation, backfill, pipe, bedding material, other materials, testing, equipment, tools, labor and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

All CAST IRON AND DUCTILE WATER MAIN FITTINGS, including ductile iron compact fittings, shall be measured separately and shall be paid for at the contract unit price bid per each for the various fittings called for in the proposal.

Glands, bolts, nuts and gaskets necessary to complete a non-restrained mechanical joint connection for water main fittings are considered accessory items to the connection. No direct payment shall be made for these items, but are considered subsidiary to CAST IRON AND DUCTILE IRON WATER MAIN FITTINGS for which payment is made.

RETAINER GLANDS of the various sizes called for to complete a restrained mechanical joint connection for water main fittings shall be counted and paid for at the contract unit price bid per each. All Work shall be in conformance with these Specifications and accepted by the City’s Project Manager.

23.08 INSTALLATION OF VALVES AND HYDRANTS

A. GENERAL

Immediately prior to installation, the Contractor shall inspect all valves and hydrants to ensure they are in good operating condition and free from defects. All valves shall be installed in such a manner that the operating nut and key will be in a vertical position. When the operator is located on the side of the valve, the Contractor shall install the valve with the operator located on the curb side of the valve.

All valve sizes should rest on support block with treated wood wedge(s) driven between the bottom of the valve and the support blocking. Valves 12” in diameter and larger shall be installed resting on one or more precast concrete support blocks 18” square and 4” thick which bear against undisturbed earth.
A. GENERAL (Continued)

The Contractor shall check the installation of all butterfly valves to be certain that the valve can be operated throughout its entire range of operation, and that it does not have contact with the inside edges of the pipe when operating.

Where tapping sleeves and valves are to be installed, the Contractor shall make all excavations to the dimensions required and provide all necessary trench protection. The Contractor shall provide precast concrete pads and other stabilizing materials under the tapping valves necessary to prevent rotation of the tapping sleeve on the main.

The Contractor shall provide and install a valve box over every valve operator. The valve box shall be installed plumb and centered over the operating nut and with the bottom of the box sufficiently lower than the operating nut to prevent the entry of soil. The top of the box shall be set flush with the final grade or paved surface. Valve box adjusting rings shall not be used to adjust valve boxes to grade. Valve boxes shall be stabilized to prevent out of alignment during compaction. Misaligned valve boxes shall be replaced during the warranty period.

Hydrants shall be set plumb, resting on precast concrete pads, 4” thick and 16” square. The support pads shall rest against undisturbed earth. The top of the flange on the hydrant shall be set to the grade shown on the plans. A hydrant of the length shown on the plans shall be used to attain this elevation. The Contractor shall make appropriate deflections or rotations in the tee and anchoring elbow, or use an anchoring offset, to meet this grade.

Fire hydrant barrel lengths shown on the plans are estimated and may not be sufficient dimensions for actual field conditions due to conflicting utilities and field modifications of water main profile. Contractors shall confirm actual hydrant barrel length required prior to construction so that hydrants are constructed in accordance to the LSP. This work shall be subsidiary to the water main construction.

Where a hydrant extension is necessary to meet the required grade, the hydrant extension shall be installed only by Lincoln Water System. Only one extension will be permitted on a hydrant. The Contractor shall remove and reset all hydrants which cannot be adjusted to grade with one extension. The Contractor shall notify the City’s Project Manager or that person’s representative when hydrant extensions are required.

The Contractor shall place a minimum of 0.75 cubic yards of hydrant drain material (as per 23.03 N) around the base of the hydrant to allow free ready drainage of the barrel. Polyethylene wrap shall be placed on top of the drainage gravel prior to the commencement of backfilling. Hydrant drain holes shall be kept open and clean at all times. Care should be exercised as to not block the drain holes with polyethylene wrap or concrete from backing blocks.

When obtaining hydrants from the Lincoln Water System, the Contractor shall determine and select the hydrant shoe configuration that best suits proper orientation of the steamer (large) nozzle perpendicular to the curb line. When required, adjustments to the final hydrant nozzle orientation shall be made by the Lincoln Water System with all applicable costs and fees assessed to the Contractor. These fees shall be considered subsidiary to the cost of installing the water main and shall not be cause for additional compensation by the Contractor.

Backfill shall be accomplished in conformance with the provisions of Chapter 20 of these Specifications, except that all backfill within 3’ of all hydrants and valve boxes shall be compacted using a mechanical hand tamper to 96% of maximum dry density as measured by AASHTO Method T-99.
23.08 INSTALLATION OF VALVES AND HYDRANTS (Continued)

B. BASIS OF PAYMENT

All VALVES of the various types and sizes indicated on the plans and actually installed shall be counted and paid for at the contract unit price bid per each. Such price shall include the valve, valve box, support blocks, other materials and labor necessary to install the valves, all equipment, tools, and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

All HYDRANTS installed, as shown on the plans or as directed, except temporary hydrants used for flushing or disinfection of the mains, shall be counted and paid for at the contract unit price bid per each for HYDRANT, COMPLETE, L=5.5’ or L=6.5’. Such price shall be full compensation for all loading, hauling, installation, thrust blocking, hydrant drain material, backfilling, labor, tools, materials, equipment and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

All HYDRANT EXTENSIONS necessary to adjust the hydrants to grade shall be counted and paid for at the contract unit price bid per each for HYDRANT EXTENSION, COMPLETE. Such price shall be full compensation for all installation costs charged by Lincoln Water System, hydrant extension kits, labor, tools, materials, equipment and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.

The unit price for HYDRANT EXTENSION, COMPLETE shall be an established unit price per each in the bid proposal.

23.09 BENTOMAT® CL GEOSYNTHETIC CLAY LINER

A. GENERAL

This work shall consist of installation of Bentomat ® CL Geosynthetic clay liner (GCL) on water pipe as specified on the plans.

B. MATERIAL

GCL shall be Bentomat ® CL Geosynthetic clay liner (GCL) as manufactured by CETCO and dry Bentonite granules shall be non-toxic, high swelling, low dust, granular, sodium bentonite used for sealing overlapped sections of geosynthetic clay liner around pipe. Acceptable brands are CETCO Volclay CG-50 (50 lb. bag) and BAROID granular bentonite (50 lb. bag) available at local horizontal directional drilling (HDD) supply companies.

C. INDICATIONS FOR USE

As specified on drawings, in Contract Specifications or as directed by the Engineer, GCL shall be installed in accordance with this Construction Standard on all water pipe in locations where it is impractical or unfeasible to obtain the required separation between the water main and existing or proposed sanitary or storm sewers per State of Nebraska Department of Health and Human Services Title 179 NAC 7.

The GCL shall be installed 360° around polyethylene encased pipe to create a second barrier between the pipe and the surrounding soil. For pipe that normally is not encased in polyethylene wrap (i.e. PVC, HDPE, etc), install one layer of polyethylene wrap prior to installing the GCL. All lumps of clay, mud, and so forth, on the pipe surface shall be removed prior to installation of the polyethylene encasement and GCL.
C. INDICATIONS FOR USE (Continued)

During installation, care shall be taken to prevent soil from becoming trapped between the polyethylene encased pipe and GCL.

The GCL shall be installed in a manner to provide a snug fit. Extra care shall be taken to completely cover and bridge irregular surfaces such as bell-spigot interfaces, bolted connections, and fittings. The GCL shall not be installed in locations where the surrounding soil is contaminated.

D. EQUIPMENT

Additional equipment needed for installation of GCL’s includes:
- Sharp Gasket Knife and spare blades
- Bentonite mastic and/or granular Bentonite paste made from dry powder sodium Bentonite
- Adhesive tape

Cutting GCL shall be performed using a sharp gasket knife. Frequent blade changes are recommended to avoid tearing of the geotextile components of the GCL.

The GCL shall be sealed around pipe joints, MJ hubs, flanges, bolts, nuts, valve bonnets, actuators, etc. using tape and bentonite past or bentonite mastic to seal GCL to these irregular surfaces.

E. BENTONITE PASTE PREPARATION

Bentonite paste shall be prepared immediately prior to installation of the GCL. Mix water with bentonite granules to form a paste with a consistency similar to peanut butter. Spread bentonite past on seams and folds before taping. If desired, bentonite paste may be spread with a trowel on polyethylene-wrapped pipe and fittings before wrapping with GCL.

F. INSTALLATION ON PIPE

The standard 15’ wide roll of GCL is similar to heavy carpeting for handling purposes. Unroll the 15’ roll of GCL and cut off the required amount needed to wrap around the outside diameter plus the required seam overlap on the bell end of MJ or RJ pipe. Refer to Table 23.09A below for the amount to cut from the roll.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>OD MJ/RJ BELL</th>
<th>CIRCUMFERENCE OF MJ/RJ BELL</th>
<th>MINIMUM SEAM OVERLAP ON MJ/RJ BELL</th>
<th>FEET TO CUT FROM 15’ WIDE ROLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6”</td>
<td>11.44”</td>
<td>35.94”</td>
<td>6”</td>
<td>4’</td>
</tr>
<tr>
<td>8”</td>
<td>13.97”</td>
<td>43.89”</td>
<td>6”</td>
<td>4’</td>
</tr>
<tr>
<td>12”</td>
<td>18.75”</td>
<td>58.90”</td>
<td>6”</td>
<td>6’</td>
</tr>
<tr>
<td>16”</td>
<td>23.22”</td>
<td>72.95”</td>
<td>6”</td>
<td>7’</td>
</tr>
<tr>
<td>24”</td>
<td>32.54”</td>
<td>102.23”</td>
<td>9”</td>
<td>10’</td>
</tr>
</tbody>
</table>

The GCL shall be wrapped around the pipe for the full length of the piping section, as indicated on project drawings or as directed by the Engineer, plus 2 additional feet. Therefore, if the section of pipe is longer than 13’, additional sections of GCL shall be cut off of the roll and installed on the pipe in an overlapped fashion until the required length of pipe plus the additional 1’ on each end has been wrapped.
F. INSTALLATION ON PIPE (Continued)

For example:

If a section of 12" diameter pipe to be covered with GCL is 20' long, two 6' long sections would be cut off the 15' wide GCL roll. These sections would be trimmed and overlapped a minimum of 1’ in the middle and 1’ on each end of the pipe section for a total distance of 22’, see Figure 1 and Figure 2. Seal the area where the two sections of GCL overlap with Bentonite paste and tape closed.
F. INSTALLATION ON PIPE (Continued)

Bring the sections of GCL up and around the circumference of the pipe overlapping the bell, barrel and spigot with a minimum of 6" to 9" as specified in Table 1. Take up the slack width at the top of the pipe as shown in Figure 3 to make a snug but not tight fit along the barrel of the pipe and/or surface of fitting, securing any folds in the GCL with tape. Folds shall be made, pasted and taped closed such that open area of fold does not collect back-fill material. Spread bentonite paste over folds and seams to seal wrap as needed prior to backfilling.

After folds and seams have been pasted and taped closed along the longitude of the pipe section the ends shall be pasted with bentonite and sealed with tape as shown in Figure 4.
G. INSTALLATION AT SEWER CROSSING

Bentomat® encasement at sewer crossing shall extend a minimum of 10’ beyond the outside edges of single sewers. At locations where multiple sewers are crossed, the encasement shall extend 10’ from the outside edge of the first sewer crossing to 10’ beyond the outside edge of the last sewer crossing. See Figure 4A.

H. BASIS OF PAYMENT

Bentomat® CL Geosynthetic clay liner (GCL) installed per this Chapter, as shown on the plans or as directed, shall be paid for at the contract unit price bid per Square Foot for BENTOMAT GEOSYNTHETIC CLAY LINING. Such price shall be full compensation for all loading and unloading, hauling, excavation, installation, backfilling, labor, tools, materials, equipment and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.
23.10 TEMPORARY HYDRANTS AND BLOW-OFF FOR FLUSHING AND DISINFECTION

A. GENERAL

Temporary hydrants and blow-offs shall be provided as shown on the plans or as determined by the Lincoln Water System to provide adequate discharge of water for preliminary and final flushing of the water main(s) in conformance to AWWA C651. The installation of temporary hydrants and blow-offs shall include any necessary protection of surrounding areas from damage caused by water erosion and any other provisions necessary for the conveyance of discharge water to protect downstream facilities or property.

B. BASIS OF PAYMENT

When called for in the proposal, payment for temporary hydrants and blow-offs used in conformance with these Specifications and accepted by the City’s Project Manager shall be made at the contract unit price bid per each for TEMPORARY HYDRANT AND BLOW-OFF. The Such payment shall be full compensation for installation of temporary hydrant and blow-off, necessary erosion protection, discharge water conveyance and downstream protection, removal of temporary hydrant and blow-off and any materials, equipment, tools, labor, or incidentals necessary to complete the work in conformance with the plans.

23.11 WATER SERVICE CONSTRUCTION OR RECONSTRUCTION

A. GENERAL

For the purpose of constructing or reconstructing all water supply and service lines, the Contractor shall comply with the provisions of Title 17 of the Lincoln Municipal Code. The Contractor shall cause all Work to be performed by a licensed plumber. All water services that are uncovered in the course of construction shall be inspected by the Lincoln Water System to assess their integrity and recommend replacement to customers when found to be in unsatisfactory condition. All water services that are reconstructed shall be inspected by the Lincoln Water System.

All water supply or service lines which are to be looped or reconstructed shall be constructed of Type “K” seamless soft-drawn copper tubing or ductile iron pipe.

The Contractor shall place all reconstructed water services or looped water services so as to provide a minimum cover of 4’. Minimum lateral clearance from structures open to the weather, such as storm sewer inlets, shall be 3’.

All other clearance shall be a minimum of 6”.

Looping a water service shall consist of the reconstruction of a water service across the width of the excavation for the facility being built or within 5’ of said excavation. When the break in the service line is within 5’ of either the tap or the curb stop, the Contractor shall loop the service pipe from the tap or curb stop to the opposite side of the excavation and only 1 joint will be allowed. When the break in the service line is beyond 5’ from the tap or curb stop, the Contractor shall loop only that portion of service within the excavation and 2 joints will be allowed. All joints shall be located at or near the edges of the excavation and in no case shall the joints be positioned beneath other pipes or structures.

When a service constructed of lead, galvanized steel, pitted copper, or other material considered unacceptable according to Title 17 of the Lincoln Municipal Code requires looping or reconstruction, the entire service from tap to curb stop shall be replaced.
23.11 WATER SERVICE CONSTRUCTION OR RECONSTRUCTION (Continued)

A. GENERAL (Continued)

When a water service which does not conflict with the Work is damaged by the Contractor, it must be repaired or replaced at the expense of the Contractor to the City’s Project Manager’s satisfaction. Copper service pipe in good condition may be repaired, all other unacceptable service materials shall be replaced from tap to curb stop.

When a service is replaced to the corporation tap, a new tap may be required. No tap shall be allowed to remain which is smaller than 3/4”.

New curb stops and boxes may be required when the service is reconstructed to the curb stop. Such curb stop may be ordered to be replaced if inoperable or obsolete. All curb stops and boxes shall be supplied by the Lincoln Water System at no cost to the Contractor.

All corporation taps, labor and equipment required to replace taps will be supplied by the Lincoln Water System to the Contractor at no cost. The Contractor shall be responsible for all excavation, boring, backfilling, installation of curb stops and boxes, sod, pavement, and other incidentals necessary to complete the looping or reconstruction.

All water services crossing or paralleling a new main shall be transferred to the new main if the main is 16” or smaller.

Any tap removed from service shall be immediately abandoned at the main by the Lincoln Water System at no cost to the Contractor, unless the main is to be abandoned as part of the Work of the contract. The Contractor shall be responsible for excavation, backfill, sod, pavement and other incidentals necessary to complete the abandonment.

Whenever a water service is reconstructed that provides fire protection (fire service), the Contractor shall obtain the necessary Underground Fire Sprinkler Permit through the City’s Building and Safety Department, Bureau of Fire Prevention. The Contractor shall comply with the requirements of the permit and anticipate and arrange any necessary inspections of the fire service reconstruction.

B. BASIS OF PAYMENT

When the items of Work stated below do not appear as bid items in the proposal form, all Work necessary for the looping or reconstruction of water services shall be paid for as an Extra Work item.

When the items of Work stated below are included in the proposal form, the payment shall be as follows:

COPPER WATER SERVICE PIPE or DUCTILE IRON WATER SERVICE PIPE of the various sizes called for shall be measured and paid for at the contract unit price bid per linear foot. Such payment shall be full compensation for all materials, tools, equipment, and labor including the licensed plumber, excavation, backfill, sod, clean-up and incidentals necessary to install the pipe in a manner acceptable to the City’s Project Manager.

Boring for water service pipe shall be measured and paid for at the contract unit price per linear foot for BORING FOR ___” WATER SERVICE PIPE. Such payment shall be full compensation for all labor, materials, equipment, tools and incidentals necessary to produce the bore hole ready to receive the water service pipe, as accepted by the City’s Project Manager. Water service pipe to be placed in the bore hole shall be paid for as provided above.
23.11 WATER SERVICE CONSTRUCTION OR RECONSTRUCTION (Continued)

B. BASIS OF PAYMENT (Continued)

LOOP WATER SERVICE shall be measured and paid for at the contract unit price bid per each. This payment shall be full compensation for all labor, equipment, excavation, backfill, tools, incidentals, and materials except pipe, necessary to complete the Work in a manner acceptable to the City’s Project Manager.

CONSTRUCT OR RECONSTRUCT WATER SERVICE shall be measured and paid for at the contract unit price bid per each. Such payment shall be full compensation for all labor, tools, and materials, except pipe and materials supplied by the City, equipment, excavation, backfill and incidentals necessary to complete the Work in a manner acceptable to the City’s Project Manager.

23.12 ABANDONMENT OF WATER MAIN

A. GENERAL

When existing water mains are shown to be abandoned in place on the plans, the Contractor shall plug each end of the abandoned water main segment with a sleeve and plug or concrete after all services have been connected to the new water main for that section.

When existing water valve boxes are shown to be abandoned in place on the plans and the proposed water main is in service with service lines reconnected, the Contractor shall turn the valves to the off position, remove 1 or more feet of the top section of the valve box, fill with sand, and cap or plug with concrete.

B. BASIS OF PAYMENT

ABANDONMENT OF WATER MAIN shall be measured and paid for at the contract lump sum amount. Such payment shall be full compensation for all labor, tools, and materials necessary to complete the Work in a manner acceptable to the City’s Project Manager.

23.13 HIGHWAY, STREET AND RAILROAD CROSSING

Highway, street and railroad crossings shall be constructed as indicated on the plans and as specified in the respective permits issued, if applicable. The City will obtain all necessary permits. Pipe encasement shall be constructed in conformance with Chapter 20 of these Specifications.
23.14 TESTING

The Contractor shall furnish all gauges, pumps and other equipment necessary to perform all of the acceptance tests and shall provide all assistance necessary or required by the City’s Project Manager to verify the test results. No test shall be conducted until all thrust blocking has attained sufficient strength to resist any thrusts imposed by the test pressures applied.

The Contractor shall carefully fill the main or mains to be tested with water from the existing water distribution system. The Contractor shall bleed all air from pipes, valves, fittings and hydrants during filling operations. All corporation stops required to expel air shall be installed by the Lincoln Water System. The Contractor shall provide and backfill all excavations required to install corporation stops. All air taps will be abandoned by the Lincoln Water System personnel after testing is completed.

The Contractor shall pump water into the system to raise the pressure to the level indicated in the table below at the lowest elevation in the section being tested. The Contractor shall maintain the test pressure, within +/- 5 (psi), during the entire test period. The pressure testing period shall be a minimum of 2 hours. The Contractor shall carefully measure all water added to the system during that period. The rate of water added per 1,000 feet of pipeline shall not exceed maximum allowable rate as shown in TABLE 23.14 A – WATER MAIN PRESSURE TESTING.

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Maximum Allowable Rate (gallons/hour)</th>
<th>Test Pressure (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot;</td>
<td>0.57</td>
<td>200</td>
</tr>
<tr>
<td>8&quot;</td>
<td>0.76</td>
<td>200</td>
</tr>
<tr>
<td>12&quot;</td>
<td>1.15</td>
<td>200</td>
</tr>
<tr>
<td>16&quot;</td>
<td>1.32</td>
<td>150</td>
</tr>
<tr>
<td>24&quot;</td>
<td>1.99</td>
<td>150</td>
</tr>
<tr>
<td>30&quot;</td>
<td>2.48</td>
<td>150</td>
</tr>
<tr>
<td>36&quot;</td>
<td>2.98</td>
<td>150</td>
</tr>
<tr>
<td>48&quot;</td>
<td>3.97</td>
<td>150</td>
</tr>
<tr>
<td>54&quot;</td>
<td>4.47</td>
<td>150</td>
</tr>
</tbody>
</table>

When the pipeline being tested contains sections of various diameters, the allowable losses shall be the sum of the computed allowable losses for each size. Where sections are isolated for testing, the allowable losses will be computed for the length of sections being isolated.

During the test period, the ground surface along the length of the section being tested shall be examined for leakage. All detected leaks shall be repaired regardless of the test results.

In the event that the test requirements are not met, the Contractor shall locate and repair all defects at his own expense. Following the repairs, the tests shall be repeated until the test result requirements are met.

Pressure testing shall not be measured or paid for directly. Testing shall be considered subsidiary to those items for which direct payment is made.
23.15 DISINFECTION OF THE COMPLETED WORK

The Contractor shall keep the Work clean during construction to facilitate disinfection. All excavation and backfill required to install chlorination taps shall be provided by the Contractor.

For water mains 24" and smaller, the Contractor shall provide for the scheduling of the flushing and disinfection by the Lincoln Water System at least 24 hours in advance of the time that those services are desired. All costs of disinfection, including tests, shall be billed to and paid for by the Contractor.

For water mains 30" and larger, the Contractor shall provide a flushing and disinfection plan to the City’s Project Manager for review and approval that is in conformance to the Special Provisions or the requirements specified in AWWA C651. This plan shall include the method and disinfectant to be used in disinfection process, the concentration of disinfectant to be used, the method of neutralization of the disinfectant prior to discharge into open channels or storm sewer systems. The documented results of the bacteriological tests shall be provided to the City’s Project Manager with a copy to the Lincoln Water System.

Flushing and disinfection will be repeated at the Contractor's expense until bacteriological tests conducted by the Lincoln Water System indicate the system is properly disinfected.

The Work required to disinfect the system shall not be measured for direct payment. Disinfection shall be considered subsidiary to those items for which direct payment is made.

23.16 COLD WEATHER CONSTRUCTION

All construction performed in cold weather or during periods where frost penetration of the soil exceeds 6" shall be in conformance with Chapter 20 of these Specifications.

23.17 SUBSTANTIAL COMPLETION

Water main Work shall be considered substantially complete when all pipe is laid, all hydrants, valves, fittings and appurtenances installed and operable, backfill complete, testing complete and accepted, disinfection complete, tap holes backfilled, water services connected, paving, sidewalks and driveways replaced, final clean-up and park space finished.

23.18 FINAL COMPLETION AND ACCEPTANCE

The project shall be considered eligible for final acceptance by the City when all required Work is complete and accepted by the City’s Project Manager, including all Work associated with existing water main abandonment, valve box grade adjustments, required grade adjustments to hydrants including installation of hydrant extensions in conformance to these specifications, required adjustments to hydrant nozzle orientation, seeding and/or sodding, and correction of all deficiencies found as a result of testing and/or final inspection by the City’s Project Manager.

23.19 GUARANTEE

At any time during the two-year guarantee period, and within the time period allowed, the Contractor shall correct any defect in material or workmanship which has been brought to his attention. Such items shall include but not be limited to trench settlement including subsequent pavement damage, pipe leaks, damage to polyethylene encasement, hydrants out of plumb, hydrants which drain improperly, valve boxes out of plumb or offset from center of operating nut, or service line leaks.
23.20 CATHODIC PROTECTION

A. GENERAL

When called for on the plans and Contract Documents, the Contractor install cathodic protection for Ductile iron water mains having a diameter of greater than or equal to 12-inches (and their smaller appurtenances such as lateral connections to existing water mains and/or fire hydrants) that are installed using open-trench excavations and driven and bored casings. This shall not apply to water mains installed via horizontal directional drilling.

B. SUBMITTALS

1. Product Data

Submit manufacturer’s specifications, recommendations, and installation instructions for each of the following main product categories and all applicable product subheadings specified in this Specification:

a. Electrical Continuity Provisions for Ferrous Pipe (Materials and Testing Procedure)
b. Corrosion Monitoring Test Stations, Buried Reference Electrodes and Calibrated Wire Shunts
c. Electrical Isolation Devices
d. Galvanic Anodes
e. Wire, Cable, and Splices
f. Exothermic Welds and Connection Devices

Manufacturer’s product submittals shall be incorporated into a single document to demonstrate that the items have been properly coordinated by the CONTRACTOR as a unit.

a. A notation shall be made on each shop drawing submitted as to the item’s specific use by the appropriate Article-Paragraph referenced in this Specification.
b. Multiple or incomplete submittals furnished by the CONTRACTOR may be rejected.

2. Quality Assurance

a. Furnish the services of an individual certified by NACE International® as a Level CP2 Corrosion Technician to monitor compliance with this Specification and to ensure that the cathodic protection system components conform to this Specification.
b. Submit the CP Technician’s qualifications and prior experience before installation of any cathodic protection components.
c. After the cathodic protection system has been installed, field commissioning of the cathodic protection system will be performed by the CP Technician furnished by the CONTRACTOR for review and approval by the CITY OF LINCOLN’S CP Specialist.

C. DELIVERY, STORAGE AND HANDLING

Manufacturers shall provide adequate care to protect cathodic protection materials from damage during handling, storage, hauling, and installation.
D. WARRANTY ON CONTRACTOR-PROVIDED MATERIALS

All Contractor-provided materials shall be guaranteed for a period of one year. The one-year period shall commence at the time of the final installation of all components by the Contractor and after the system has been tested and properly adjusted for operation by Lincoln Water System’s Corrosion Engineer.

E. APPROVED MATERIAL SUPPLIERS

The following list of suppliers is provided for the CONTRACTOR’s convenience in procuring the material required by this Specification. It shall remain the CONTRACTOR’s responsibility to ensure that the materials furnished meet the physical descriptions and performance characteristics listed herein.

1. Subject to meeting the requirements of this Specification, cathodic protection materials are available from the following manufacturers-suppliers:
   b. BK Corrosion, LLC, (713-225-0349).
   c. T. Christy Enterprises, (800-258-4583).

F. ELECTRICAL CONTINUITY PROVISIONS – FERROUS PIPE

Insulated Stranded Copper Cable

1. The quantity and gauge of continuity bond cables required for each pipe joint shall be as shown on the CP Installation Detail Drawings included hereinafter in this Specification.
   a. The CONTRACTOR, at his option, may install the largest gauge of continuity bond cable for all pipe sizes provided that the weld shots do not damage the pipe wall or its interior lining.

2. Bond cables shall be factory-made with formed copper sleeves installed at both ends of the bond cable using the manufacturer’s proper-sized hammer dies.

3. Bond cables shall be fabricated by the same manufacturer as the exothermic weld equipment used to connect the cable to the structure.

4. Cable shall be constructed of stranded copper equipped with a high molecular weight polyethylene insulation. Insulation shall conform to ASTM D1248 – Specification for Plastic Molding and Extrusion Materials, Type 1, Class C, Grade 5 and be configured as follows:
   a. No. of Strands: 7
   b. Outer Jacket Thickness: 0.110 inches
   c. Length: 18 inches (min.)

5. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:
   a. Continental Industries (918-627-5210), thermOweld® Jumper Bonds.
   b. ERICO Products, Inc. (440-248-0100), Cadweld® Bonds – Formed Terminal.
G. CORROSION MONITORING TEST STATIONS

1. Non-Metallic Post-Type Test Stations

   a. Monitoring stations shall be a non-metallic post-type station mounted on a non-metallic conduit post. Test station shall be furnished with a capped terminal board equipped with wire/cable binding posts to permit ready access and shall be constructed as follows:

      (1) Terminal Board: Polycarbonate plastic (clear).
      (2) Test Station Cap: Polycarbonate plastic (color coded by test station type).
      (3) Conduit Post: UV stabilized polyethylene (white).
      (4) Binding Posts: Nickel-plated marine brass (6 minimum).
      (5) Shorting Bars: Nickel-plated copper.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Tinker & Rasor Company (909-890-0700), Model T-3.

2. Flush-Mounted Test Station Enclosures

   a. Test station shall be contained in a heavy-duty, polymer concrete, flush-to-grade utility enclosure able to withstand incidental traffic and constructed as follows:

      (1) The open bottom body shall be constructed of polymer concrete having a minimum compressive strength of 87 MPa.
      (2) The cover shall be constructed of polymer concrete having a non-skid surface and shall cover the body of the enclosure. Cover shall be capable of withstanding a minimum of 20,000 pounds without failure in accordance with the requirements ANSI/SCTE 77/T15 applications.
      (3) Cover shall have a minimum of two hex-capped stainless-steel hold-down bolts placed at opposite corners and shall be labeled “CP TEST” in minimum 1” high letters.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Oldcastle Polymer, Model 1324-12
      (2) New Basis, Inc. (951-787-0600) Model PCA132412S.
G. CORROSION MONITORING TEST STATIONS (Continued)

3. Prepackaged Cu-CuSO₄ Reference Electrodes
   a. Description: Cu-CuSO₄ electrodes shall be used for soil environments to provide a stable electrical benchmark from which to measure the cathodic protection system’s effectiveness. Electrodes shall be constructed as follows:

   (1) Element: Copper rod encapsulated in a proprietary backfill electrolyte containing high purity copper sulfate crystals and a chloride ion trap to prevent contamination of the electrolyte.
   (2) Service life of the reference electrode shall be no less than 20 years.
   (3) Lead Wire: No. 14 RHH-RHW (yellow) stranded copper wire. Lead wire shall be sufficiently long to reach its termination point without splicing.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Borin Manufacturing, Inc. (310-822-1000) Model SRE-007-CUY.
      (2) GMC Electrical, Inc. (909-947-6016) Model CU-1-UGPC.

4. Calibrated Wire Shunts
   a. Description: Color-coded calibrated wire shunts shall be used to connect the cathodic protection system’s anode header cable and structure return connection circuits.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Tinker & Rasor Company (909-890-0700), 0.01-ohm wire shunt with yellow mounting plate rated at 8 amps.

H. ELECTRICAL ISOLATION DEVICES

1. Plastic Pipe Inserts (PPI): In soils not known to be contaminated with hydrocarbons, PPI shall be constructed as shown on the CP Installation Detail Drawings included hereinafter in this Specification.

   a. High Density polyethylene Pipe Inserts (HDPI) shall meet the requirements for Type III, Grade P345 Polyethylene Material as defined in ASTM Specification D-1248 (PE 3408). The minimum pressure class/SDR rating acceptable shall be Class 200/SDR 11. The pipe shall have an outside diameter matching the ductile iron pipe to which it is connected.

   b. Mechanical joint anchor fittings shall be used to transition from ductile iron to HDPE or PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress the pipe will pull apart before the fitting will pull out and the pipe will blow before the fitting will rupture under pressure.
H. ELECTRICAL ISOLATION DEVICES (Continued)

2. Flange Isolation Kit (FIK) Assemblies: In soils not known to be contaminated with hydrocarbons, FIK shall be constructed as shown on the CP Installation Detail Drawing included hereinafter in this Specification. Provide FIK assemblies matching the pressure rating of the pipe.

   a. FIK assemblies shall be certified by an independent certification agency to meet the requirements of the NSF-61 Standard and shall consist of the following components:

      (1) Flange Gasket Retainer: Full-faced (Type E) G-10 Epoxy Glass.
      (2) Sealing Elements: Ethylene propylene diene monomer (EPDM) quad O-Rings.
      (3) Isolation Sleeves: 1/32-inch thick G-10 Epoxy Glass.
      (4) Isolation Washers: Double 1/8-inch thick G-10 Epoxy Glass.
      (5) Backup Washers: Double 1/8-inch thick Type 304 Stainless Steel.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) GPT, Inc. (303-988-1242) Model LineBacker®.
      (2) Lamons® (713-222-0284) Model IsoGuard™.

3. Petrolatum Tape-Wrap Encapsulation of Buried FIK

   a. All buried FIK shall be encapsulated in a three-part cold-applied petrolatum tape coating consisting of a primer, profiling mastic, and a low-temperature petrolatum tape.

      (1) Primer:

         (a.) Solids Content: 100%
         (b.) Specific Gravity: 1.08
         (c.) Specific Volume: 26 cubic inches/pound
         (d.) Flash Point: > 356 °F
         (e.) Coverage: 10-22 sq. ft./pound

      (2) Profiling Mastic:

         (a.) Solids Content: 100%
         (b.) Specific Gravity: 0.605
         (c.) Specific Volume: 46 cubic inches/pound
         (d.) Flash Point: 356 °F
         (e.) Coverage: Varies by application

      (3) Low-Temperature Petrolatum Tape:

         (a.) Thickness: 46 mils
         (b.) Maximum Service Temperature: 122 °F
         (c.) Roll Width: 2 inches to 12 inches
         (d.) Roll Length: 33 feet
         (e.) Coverage with 55% Overlap: 87 sq. ft. of tape per 100 sq. ft. of pipe
23.20 CATHODIC PROTECTION (Continued)

H. ELECTRICAL ISOLATION DEVICES (Continued)

3. Petrolatum Tape-Wrap Encapsulation of Buried FIK (Continued)

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:


4. Electrically Isolating Corporation Stops

a. Electrically isolating corporation stops shall be constructed as follows:

(1) All brass construction conforming to AWWA Standard C800 (ASTM B-62 and ASTM B-584).
(2) Solid one-piece tee-head and stem with EPDM O-ring in stem.
(3) Ball-style valve with molded EPDM seat to support fluorocarbon-coated brass ball.
(4) Factory-assembled nylon insulator installed between the body assembly and flared copper/nut service line. Individual or field-installed threaded nylon or plastic components are not acceptable.
(5) All threaded components must be metal. Entire assembly threads secured with adhesive to prevent unintentional disassembly and to render unit leak resistant to 300 psi working pressure.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following, no substitutions:

(1) Mueller Company (770-206-4200), Model N35000N Insulated Ball Corporation Assembly.
(2) A.Y. McDonald (800-292-2737), Model 74701B Corporation Stop with #74755DB Copper Flare x Female Copper Flare Dielectric Bushing.

5. Casing Spacers

a. Carrier pipe shall be contained within each steel casing sleeve by the use of casing isolation spacers.

(1) Configuration:

(a.) Carrier pipe shall be positioned such that the carrier rests near the bottom of the casing pipe and the height of the risers and runners shall be sized to provide a bottom clearance not less than one-half inch between the casing pipe and the extreme outside diameter of the any joint bell of the carrier pipe and a top clearance of three-fourths inch minimum.

(2) Band Sections:

(a.) Casing spacer shall be a two-piece shell per carrier pipe and made from T304 stainless steel of a minimum 14-gauge thickness.
H. ELECTRICAL ISOLATION DEVICES (Continued)

5. Casing Spacers (Continued)

(2) Band Sections: (Continued)

(b.) Each shell section shall be lined with a 0.090" thick, ribbed PVC extrusion with a retaining section that overlaps the edges of the shell and prevents slippage.

(c.) PVC Liner shall have a hardness of 85-90 durometer.

(d.) Bearing surfaces (runners) shall be ultra-high molecular weight polyethylene (UHMW) to provide abrasion resistance and a low coefficient of friction (0.12).

(3) Runners:

(a.) The runners shall be attached to the support risers at appropriate positions to properly support the carrier pipes within the casing pipe and to ease installation.

(b.) The runners shall be mechanically bolted to the spacer.

(4) Risers:

(a.) Risers shall be MIG welded to the shell, where applicable.

(b.) Risers shall be made of T304 stainless steel of a maximum 10 gauge with bolt heads welded to the inside of the risers for strength.

(c.) Bottom risers 6" and over in height shall be reinforced. All reinforcing plates shall be 10-gauge T304 stainless steel and shall be MIG welded to mating parts.

(d.) All weldments shall be fully chemically passivated in accordance with ASTM A380.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

(1) Cascade Waterworks Manufacturing Co. (800-426-4301), Model CCS.

(2) Advance Products and Systems, Inc. (337-233-6116), Model SSI.


6. Pipe Penetration Sleeve Seals

a. Isolating sleeve seals shall be modular mechanical type constructed of expanding, interlocking links shaped to continuously fill and seal the annular space between the carrier pipe and the sleeve or opening, and shall be constructed as follows:

(1) Links: Synthetic rubber.

(2) Fasteners: Zinc-coated steel.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

(1) GPT, Inc. (303-988-1242) Model Link-Seal®.

(2) Advance Products and Systems, Inc. (337-233-6116), Model Innerlynx®.
23.20 CATHODIC PROTECTION (Continued)

H. ELECTRICAL ISOLATION DEVICES (Continued)

7. Casing End Seals

a. Casing end seals shall be wrap-around style and shall be constructed as follows:

(1) Annulus Wrapping: 1/8-inch thick neoprene rubber.
(2) Hold-down Banding: 1/2-inch wide Type 304 SS worm gear banding.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

(1) GPT, Inc. (303-988-1242) Model S Pull-On End Seal.
(2) Advance Products and Systems, Inc. (337-233-6116), Model AM End Seal.

I. GALVANIC ANODES

1. Magnesium Anodes

a. Description: Magnesium anodes shall be capable of delivering a minimum efficiency of 500 amp-hours per pound of magnesium and shall have the following metallurgical analysis:

b. Quality Assurance: Furnish spectrographic analysis for assurance of chemical composition and ASTM G97 for verification of electro-chemical properties on samples from each heat or batch of anodes supplied for this project.

c. Metallurgy:

(1) Aluminum: 0.01% (max.)
(2) Manganese: 0.50% - 1.3%
(3) Copper: 0.02% (max.)
(4) Nickel: 0.001% (max.)
(5) Iron: 0.03% (max.)
(6) Other (each): 0.05% (max.)
(7) Other (total): 0.30% (max.)
(8) Magnesium: Balance

d. Packaged Magnesium Anode Backfill: Completely surround the anode ingot in backfill without voids. Provide magnesium anodes packaged within a cotton sack in a special chemical backfill having the following proportions:

(1) Ground Hydrated Gypsum: 75%
(2) Powdered Bentonite: 20%
(3) Anhydrous Sodium Sulfate: 5%
(4) Provide backfill with a grain size such that 100% is capable of passing a 20-mesh screen and 50% is retained by the 100-mesh screen.
I. GALVANIC ANODES (Continued)

1. Magnesium Anodes (Continued)

   e. Anode Lead Wire

      (1) The standard lead wire for a magnesium anode shall be at least 10 feet in length of No. 12 AWG solid copper wire with Type TW (red) thermoplastic insulation

      (2) Lead Wire Connection to Anode Core

         (a.) Magnesium anodes shall be cast with a minimum 20-gauge galvanized steel core.  
         (b.) One end of the anode shall be recessed to expose the core for silver-soldering the lead wire. 
         (c.) The silver-soldered lead wire connection and anode recess shall be filled with an electrical potting compound before packaging.

      (3) Magnesium Anode Physical Parameters

<table>
<thead>
<tr>
<th>Anode Weight (#)</th>
<th>Nominal Package Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Anode</td>
<td>Pkg’d Anode</td>
</tr>
<tr>
<td>48</td>
<td>98</td>
</tr>
<tr>
<td>Length</td>
<td>38</td>
</tr>
<tr>
<td>Diameter</td>
<td>8.0</td>
</tr>
</tbody>
</table>

   f. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Mesa Products, Inc., (918-627-3188).  
      (2) BK Corrosion, LLC, (713-225-0349).  
      (3) T. Christy Enterprises, (800-258-4583).

2. Zinc Anodes

   a. Description: Zinc anodes shall be capable of delivering a minimum efficiency of 335 amp-hours per pound of zinc.

   b. Quality Assurance: Furnish spectrographic analysis for assurance of chemical composition for verification of electro-chemical properties on samples from each heat or batch of anodes supplied for this project.

   c. Metallurgy:

      (1) Aluminum: 0.005% (max.)  
      (2) Cadmium: 0.003% (max.)  
      (3) Iron: 0.0014% (max.)  
      (4) Lead: 0.003% (max.)  
      (5) Copper: 0.002% (max.)  
      (6) Zinc: Balance
I. GALVANIC ANODES (Continued)

2. Zinc Anodes (Continued)

d. Packaged Zinc Anode Backfill: Completely surround the anode ingot in backfill without voids. Provide Zinc anodes packaged within a cotton sack in a special chemical backfill having the following proportions:

(1) Ground Hydrated Gypsum: 75%
(2) Powdered Bentonite: 20%
(3) Anhydrous Sodium Sulfate: 5%
(4) Provide backfill with a grain size such that 100% is capable of passing a 20-mesh screen and 50% is retained by the 100-mesh screen.

e. Zinc Anode Lead Wire

(1) The standard lead wire for a Zinc anode shall be at least 10 feet in length of No. 12 AWG solid copper wire with Type TW (red) thermoplastic insulation.

(2) Lead Wire Connection to Anode Core

(a.) Zinc anodes shall be cast around a centralized ¼-inch diameter electro-galvanized mild steel rod core.

(b.) Lead wire shall be silver-soldered to the rod core.

(c.) Wrap soldered connection with two half-lapped layers of rubber tape followed by two half-lapped layers of vinyl tape.

f. Zinc Anode Physical Parameters

<table>
<thead>
<tr>
<th>Anode Weight (#)</th>
<th>Nominal Package Dimensions (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Anode</td>
<td>Pkg’d Anode</td>
</tr>
<tr>
<td>60</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Length</td>
</tr>
<tr>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>

g. Subject to meeting the requirements of this Special Provision, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

(1) Mesa Products, Inc., (918-627-3188).
(2) BK Corrosion, LLC, (713-225-0349).
(3) T. Christy Enterprises, (800-258-4583).
23.20 CATHODIC PROTECTION (Continued)

J. WIRE, CABLE AND SPLICES

1. Anode Header Cable and Structure Return Connection (Direct Burial)

   a. High molecular weight polyethylene insulated stranded copper cable shall be used for all underground portions of the cathodic protection system’s anode header cable and structure return connection circuits. Insulation shall conform to ASTM D1248 – Specification for Plastic Molding and Extrusion Materials, Type 1, Class C, Grade 5.

   b. The DC cables shall be sized as follows:

      (1) No. of Strands: 7
      (2) Outer Jacket: 0.110" thickness
      (3) Anode Header Cable: No. 8 AWG (red)
      (4) Structure Return Connection: No. 8 AWG (blue)

2. Test Wires for CP System Monitoring (Direct Burial)

   a. Cross-linked polyethylene (XLPE) Type RHW-2 and USE-2 for use at 600 volts or less shall be used for all underground structure connections as part of the CP system’s monitoring circuit. Wire insulation shall conform to NEC for direct burial, general-purpose applications at a maximum continuous operating temperature of 90 degrees C in either wet or dry locations.

   b. The test wires shall be configured as follows:

      (1) Conductors shall be Class B stranded annealed uncoated copper per UL Standard 854 and 44.
      (2) Primary Insulation: 0.045" thickness
      (3) Gauge and Structure Color Code: #12 AWG (colors as shown on drawings)

   c. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Graybar Electric Company (800-472-9227)
      (2) Omni Cable Corp. (800-292-6664)
      (3) Kris-Tech Wire (315-339-5268)

3. Compression Crimp Splice Connectors

   a. All underground spliced connections used within the DC cathodic protection circuit shall be made through the use of copper compression crimp connectors.

      (1) The proper size connectors shall be used in accordance with the manufacturer’s recommendations.
      (2) Connectors shall be crimped with a hand tool capable of delivering a minimum of 9000 pounds of compressive force.

   b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

      (1) Burndy LLC-US (800-346-4175).
23.20 CATHODIC PROTECTION (Continued)

J. WIRE, CABLE AND SPLICES (Continued)

4. Splice Encapsulation

a. All underground spliced connections used within the DC cathodic protection circuit shall be sealed with rubber and plastic tape contained within a waterproof coating.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

(1) 3M Electrical Products (1-888-364-3577) - Scotch Brand 23 Rubber Splicing Tape.
(2) 3M Electrical Products (1-888-364-3577) - Scotch Brand 33+ Vinyl Electrical Tape.
(3) 3M Electrical Products (1-888-364-3577) - Scotchkote Electrical Coating.

K. EXOTHERMIC WELDS AND CONNECTION DEVICES

1. All connections used within the DC cathodic protection system circuit shall be by exothermic welds.

a. The proper size welders, metal charges, and wire sleeves shall be used in accordance with the manufacturer’s recommendations. Do not mix different manufacturers’ products.

   (1) When connecting to horizontal ductile iron or cast-iron structures, use a maximum of 32-gram weld metal charge and furnaces designated specifically for cast iron.
   (2) When connecting to horizontal carbon steel structures, use a maximum of 25-gram weld metal charge and furnaces designated specifically for carbon steel.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

   (1) Continental Industries (918-627-5210), Model thermOweld®.
   (2) ERICO Products, Inc. (440-248-0100), Model Cadweld®.

2. Coating of Wire and Cable Connections to Structures

a. A pre-fabricated plastic sheet with an igloo-shaped dome and entry tunnel filled with an oil- and gas-resistant elastomeric rubber and a primer-less elastomeric tape for bonding directly to the structure.

b. Subject to meeting the requirements of this Specification, acceptable manufacturer’s products which may be incorporated into the work include the following or an approved equal:

   (1) Continental Industries (918-627-5210), Model thermOcap® PC.
   (2) Chase Corporation (781-332-0700), Model Royston Handy Cap® IP.
L. INSTALLATION OF CATHODIC PROTECTION MATERIALS - GENERAL

Examine the areas and conditions under which cathodic protection materials are to be installed and notify RESIDENT PROJECT REPRESENTATIVE in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

Drawings: Install all cathodic protection components and equipment according to the following CP Installation Detail Drawings included hereinafter in this Specification.

1. Drawing No. CP-101: Single Horizontal Anode Installation
2. Drawing No. CP-102: Single Vertical Anode Installation
3. Drawing No. CP-301: Continuity Bonding across Ductile Iron Pipe Joint
4. Drawing No. CP-311: Continuity Bonding across Vertical Gate Valve
5. Drawing No. CP-312: Continuity Bonding across Butterfly Valve or Horizontal Gate Valve
6. Drawing No. CP-321: Insulating Rubber & Tape Wye Splice for Sacrificial Anode Cable Connections
7. Drawing No. CP-322: Insulating Rubber & Tape Butt Splice for Sacrificial Anode Cable Connections
8. Drawing No. CP-401: Exothermic Weld Procedure for Ferrous Pipe Material (Horizontal Only)
9. Drawing No. CP-611: Anode Test Station (ATS)
10. Drawing No. CP-612: ATS Terminal Board Installation Details
11. Drawing No. CP-621: Casing Test Station (CTS)
12. Drawing No. CP-622: CTS Terminal Board Installation Details
13. Drawing No. CP-631: Potential Test Station (PTS)
14. Drawing No. CP-632: PTS Terminal Board Installation Details
15. Drawing No. CP-641: Foreign Crossing (Over WM) Test Station (FTS)
16. Drawing No. CP-642: Foreign Crossing (Under WM) Test Station (FTS)
17. Drawing No. CP-643: FTS Terminal Board Installation Details
18. Drawing No. CP-651: Isolation Test Station (ITS)
19. Drawing No. CP-652: ITS Terminal Board Installation Details
20. Drawing No. CP-653: Isolation Test Station at Tapping Sleeve (ITS-TAP)
22. Drawing No. CP-692: Post-Mounted Test Station for Terminal Board & Wires
23. Drawing No. CP-801: Flange Isolation Kit (FIK)
24. Drawing No. CP-804: Polyvinyl Chloride Pipe Insert (PVPI)
25. Drawing No. CP-805: High Density polyethylene Pipe Insert (HDPI)
26. Drawing No. CP-806: Isolation (Ball Type) Corporation Stop (ICS)
27. Drawing No. CP-807: Isolation Service Fitting (Copper Flare) for ¾" to 2" Pipe (ISF)
28. Drawing No. CP-808: Electrical Isolation Devices for Metallic Casing Sleeves
29. Drawing No. CP-809: Electrical Isolation at Pipe Entry with Reinforced Concrete Wall
23.20 CATHODIC PROTECTION (Continued)

M. INSTALLATION OF CATHODIC PROTECTION MATERIALS – QUALITY CONTROL

1. CONTRACTOR’s Quality Control System

Implement a quality control system monitored to ensure that the standards for materials, workmanship, construction, and functional performance established by this Specification are adhered to throughout the course of the Work.

2. CONTRACTOR’s Technical Assistance

The CONTRACTOR shall have access (via telephonic assistance) from cathodic protection system material suppliers throughout the duration of the Work.

N. INSTALLATION OF ELECTRICAL CONTINUITY PROVISIONS – FERROUS PIPE

1. General: Factory-made cable bonds shall be installed across all non-welded ferrous pipe joints except as follows:

   a. Pipe joints that are specifically required to be electrically isolated.

   b. Bond around all valves - do not connect cable bonds to valve housing.

2. Method:

   a. Inspect each bond cable to ensure a continuous electrical conductor with no cuts or tears in the cable insulation.

   b. Attach bond cable to water main by the exothermic welding process in accordance with the manufacturer’s instructions.

   c. Do not use any exothermic weld equipment that is either damp or wet.

   d. Cover all exothermic welds with a pre-fabricated, igloo-shaped, domed-plastic elastomeric rubber cover as described in this Specification.

3. Post-Installation Visual Inspection: Inspect all electrical continuity bond cable connections by visually examining each exothermic weld connection for strength and suitable coating prior to backfilling.

4. Post-Installation Continuity Testing: CONTRACTOR shall use the following procedure to verify all bonded pipe joints are electrically continuous prior to backfilling. All data shall be documented for the job record and submitted each day to the CITY OF LINCOLN and also summarized and submitted to the CITY OF LINCOLN at the completion of the project.

   a. Measure the electrical potential at each side of selected bonded connections with a portable copper/copper-sulfate reference electrode (CSE) and a digital voltmeter having at least 10 mega-ohm input impedance.

   b. Place the CSE into the soil within 18-inches of the bonded connection and do not move the CSE.

   c. Connect the red meter lead to the CSE and the black meter lead to the pipe (not the cable). Ensure a secure direct contact to the pipe by using an awl or similar tool.
23.20  CATHODIC PROTECTION (Continued)

N. INSTALLATION OF ELECTRICAL CONTINUITY PROVISIONS – FERROUS PIPE (Continued)

4. Post-Installation Continuity Testing (Continued)
   
   d. Measure and record the DC voltage between the CSE and the pipe on EACH side of the bonded connection.

   e. The two DC voltage readings must be identical to indicate an acceptable connection.

5. Acceptance Criterion: If, in the opinion of the CITY OF LINCOLN, any exothermic weld is deficient, the CONTRACTOR shall remove and replace the deficient welded connection at no expense to the City of Lincoln.

6. Backfilling of Bond Cables:
   
   a. Perform backfilling that will prevent damage to the bond cables and connections to the water main.

   b. If construction activity damages a bond cable, the CONTRACTOR shall remove and replace the bond cable at no expense to the CITY OF LINCOLN.

O. INSTALLATION OF CORROSION MONITORING TEST STATIONS

1. General: Install the required number of test stations at the locations shown or as directed by the CITY OF LINCOLN.

2. Reference Electrode
   
   a. Keep permanent reference electrodes dry and protect from freezing before installation.

   b. Remove plastic or paper shipping bags from around the reference electrode prior to installation.

   c. Place reference electrode in native soil within 12 to 36 inches of the water main.

3. Test Wires
   
   a. Provide test station lead wires that are continuous with no cuts or tears in the insulation covering the conductor.

   b. Attach test leads to the water main by the exothermic welding process.

   c. Connect all test station wires to one side of the terminal board using the test station manufacturer’s standard binding posts at the locations shown on the Plans.

   d. Install wire shunt plate and shorting bars to the opposite side of terminal board from the incoming wires.

   e. Install wire shunt plate last to permit easy removal from terminal board without having to disassemble other test station wire and cable connections.
23.20 CATHODIC PROTECTION (Continued)

O. INSTALLATION OF CORROSION MONITORING TEST STATIONS (Continued)

4. Terminal Board and Test Stations within Flush-Mounted Enclosure:
   a. Route all test station wires through the mounting pipe and run to an area along the water main that will not accumulate standing water or allow the test station to be silted over.
   b. Install the test station terminal board on top of the mounting pipe and extend the pipe vertically to allow at least 24" below bottom of the enclosure.
   c. Install the top of test station head and color-coded cap to allow a minimum separation of 1" from the underside of the enclosure cover. Permanently mark as-built pipeline stationing number on test station cap or mounting post.
   d. Set the top of the enclosure flush to final grade outside of vehicular traffic areas and support with a minimum 6" gravel base to support and drain the inside of the enclosure.
   e. Fasten the two hold-down bolts of the enclosure lid but do not over tighten.
   f. Thoroughly backfill and compact the soil surrounding the enclosure to prevent settling and voids.
   g. Drive a vertical 12-inch long steel rebar flush into the ground and immediately alongside the enclosure to facilitate locating with a magnetic sensing device.

5. Terminal Board and Test Stations on Mounting Post:
   a. Route all test station wires through the mounting pipe and run to an area along the water main that will not accumulate standing water.
   b. Install the test station terminal board on top of the mounting pipe and extend the pipe vertically to a height of at least 36" to 42" above final grade.
   c. Install the top of test station head and color-coded cap. Permanently mark as-built pipeline stationing number on test station cap or mounting post.
   d. Thoroughly backfill and compact the soil surrounding the mounting post to prevent settling and voids.
   e. Install CITY OF LINCOLN-supplied bollard/post in areas with high vegetation that could obscure test station’s PE mounting post.
   f. Affix CITY OF LINCOLN-supplied adhesive identification label to test station’s mounting pipe.
23.20 CATHODIC PROTECTION (Continued)

O. INSTALLATION OF CORROSION MONITORING TEST STATIONS (Continued)

6. Post-Installation Backfilling

a. Protect test leads during the backfilling operation to avoid damage to the wire insulation and integrity of the conductor.

b. Protect permanent reference electrode during backfilling to avoid damage to the electrode and its lead wire.

c. If, in the opinion of the CITY OF LINCOLN, the installation of the test station wires or the reference electrode is deficient, the CONTRACTOR shall remove and replace these components at no expense to the City of Lincoln.

P. INSTALLATION OF ELECTRICAL ISOLATION DEVICES

1. General: Install the required number of electrical isolation devices at the locations shown on the CP Installation Schedule provided hereinafter in this Specification or as directed by the CITY OF LINCOLN. The water main intended for cathodic protection shall be electrically isolated at the following locations:

a. At all copper water service laterals at the corporation stop.

b. At all metallic casing sleeves beneath street or rail crossings.

c. At all connections to existing metallic water mains or at connections to new water mains that are not intended for cathodic protection.

2. Casing Isolation Testing:

a. After casing spacers are installed but prior to grouting of the casing annulus, perform electrical isolation test to verify that casing and carrier pipes are electrically separated as follows:

(1) Measure and record the DC voltage difference between the casing and the carrier pipes using a digital voltmeter having at least 10 mega-ohm input impedance.

(2) If the DC voltage difference is not greater than zero DC millivolts, remove electrical connection between the casing and carrier pipes to provide electrical separation and repeat the electrical isolation test. Do not grout the casing annulus until a DC voltage difference of greater than zero DC millivolts is measured and recorded.

3. Flange Isolation Kit (FIK) Procedure:

a. Inspect the gasket kit and verify that the material is as specified and that the material is not damaged.

b. Clean the bolting materials. Apply lubricant or anti-seizing compound to all threads required for alignment with nuts and nut facings.
P. INSTALLATION OF ELECTRICAL ISOLATION DEVICES (Continued)

3. Flange Isolation Kit (FIK) Procedure: (Continued)

   c. Align flange faces so that they are parallel and concentric with each other and within 0.010 inch without external loading or springing.

   d. Line up bolt holes by driving two tapered drift pins in opposite directions to each other into two diametrically opposite bolt holes.

   e. Insert insulating sleeves into bolt holes. Sleeves must slide in easily; if not, flanges must be realigned. Do not force sleeves into bolt holes.

   f. Assemble studs/bolts as follows:

      (1) Run one nut on each stud so that two full threads are showing beyond the nut.
      (2) Slide steel backup washer onto stud and insert into bolt hole. If flange requires two-sided insulation, add an insulating washer after the steel washer.
      (3) From the opposite end of the stud, place an insulating washer, steel backup washer, and a nut; tighten by hand.
      (4) Torque the first two studs at diametrically opposite locations to a maximum of 30 percent of the final torque value in a star pattern.
      (5) Repeat star-torquing pattern at each bolt by increasing torque to 50-60 percent of final value.
      (6) Continue torquing all studs in a star pattern using the specified torque setting (100 percent) until there is no further rotation of the nuts.

   g. Acceptance

      (1) Immediately after a FIK has been installed in accordance with the manufacturer’s specifications, the CONTRACTOR will perform an electrical isolation test using a radio frequency isolating test meter to verify the flange will not permit current flow across it.
      (2) If, in the opinion of the CITY OF LINCOLN, the FIK is shorted, the CONTRACTOR shall remove and replace the isolation gasket or bolt sleeves/washers at the CONTRACTOR’s expense.

   h. Sealing Buried Isolation Flanges

      (1) After any buried FIK has been tested and found to be 100 percent effective, the entire isolator shall be encapsulated in a three-part, non-toxic, petrolatum tape wrap before burial.
      (2) Encapsulation shall completely cover both flange sides and shall extend a minimum of six inches beyond the ends of all flange bolt heads and nuts.
Q. INSTALLATION OF GALVANIC ANODES

1. General: Install the required number of anodes at the locations shown on the CP Installation Schedule provided hereinafter in this Specification or as directed by the CITY OF LINCOLN.

2. Method

   a. Remove plastic or paper shipping bags from around prepackaged anodes prior to installation.

   b. Install in the manner and at the dimensions from the water main as shown on the CP Installation Details. Field modifications shall be made only with the approval of the CITY OF LINCOLN.

   c. Handle galvanic anodes in such a manner to avoid damaging anode materials and wire connections.

   d. Attach anode lead wire to insulated header cable or route lead wire directly to pipe or test station as required.

   e. Splices are not permitted within the length of a factory-fabricated anode lead wire.

   f. Install prepackaged anodes with compacted backfill material, such that no voids exist between the anode material and the backfill.

   g. In soils that do not exhibit any signs of moisture content or granular soils that have no cohesive strength, pour 5 gallons of water over the anode after backfilling and tamping have been completed to a point about 6 inches above the anode. After the water has been absorbed by the earth, backfilling shall be completed to the ground surface level.

R. INSTALLATION OF WIRE, CABLE AND SPLICES

1. Install underground wires, cables, and connections at a minimum 36 inches below final grade with a minimum separation of 6 inches from other underground structures.

2. Seal splices against water penetration as follows:

   a. Clean and then wrap with a minimum of two half-lapped layers of rubber electrical tape.

   b. Apply two half-lapped layers of plastic electrical tape.

   c. Cover with a fast-drying electrical sealant.
23.20 CATHODIC PROTECTION (Continued)

S. INSTALLATION OF EXOTHERMIC WELDS AND CONNECTION DEVICES

1. All exothermic welding shall be performed in accordance with the manufacturer’s recommendations for welding equipment, weld metal charge size, and applicability to the structure. Do not use exothermic weld equipment if the graphite mold is wet.

2. Structure Surface Preparation
   a. All bare metal shall be free of dust, dirt, grease, oil and other foreign matter.
   b. Practical removal shall be by either power or hand wire brushing.
   c. Grinding or filing shall remove sharp edges or burrs.

3. Installation of Elastomeric Cover over Exothermic Welds
   a. Clean the pipe surface which is to be covered by removing all moisture, dirt, grease and other contaminants.
   b. The weld areas shall be no more than warm to the touch before applying the elastomeric cover.
   c. Remove the release paper from the back of the mastic pad. Avoid touching the exposed elastomeric tape.
   d. Apply the mastic pad to the structure by firmly pressing on all edges making sure that the tunnel area of the plastic dome completely covers the lead wire entering the exposed copper of the connection.
   e. Push the dome of the plastic weld cap firmly over the exothermic weld area and the wire entering the weld cap.

T. POST-INSTALLATION TESTING OF CATHODIC PROTECTION SYSTEMS

1. General: CITY OF LINCOLN will provide services of a NACE-certified CP Specialist for periodic field inspections and technical oversight of the CONTRACTOR’s commissioning services of the cathodic protection system in accordance with the following NACE International® reference standard and standard test method:

2. After installation of the cathodic protection system, field tests including the following items will be performed by the CP Technician furnished by the CONTRACTOR:
   a. Take photographs of each test station – both of the terminal board and also the surrounding landscape for future identification and locating.
   b. Verify that each test station wire is attached to the appropriate structure using the proper color code.
T. POST-INSTALLATION TESTING OF CATHODIC PROTECTION SYSTEMS

2. After installation of the cathodic protection system, field tests including the following items will be performed by the CP Technician furnished by the CONTRACTOR: (Continued)

c. Measure cathodic protection data at each test station as follows:

   (1) Red Cap Anode Test Station: ON S/S potentials of the pipeline using the buried reference electrode and a portable Cu-CuSO₄ reference cell. Momentarily disconnect the anode(s) from the circuit and record Instant-Off S/S potentials of the pipeline using the buried reference electrode and a portable Cu-CuSO₄ reference cell. Measure the total current through the anode circuit via the TS shunt.

   (2) Orange Cap Isolation Test Station: Structure-to-soil potentials of the pipeline and the foreign structure (across the FIK) using the buried Cu-CuSO₄ reference electrode and a portable reference cell.

   (3) Blue Cap Casing Test Station: Structure-to-soil potentials of the pipeline and the casing using the buried reference electrode and a portable Cu-CuSO₄ reference cell.


   (5) White Cap Foreign Test Station: Structure-to-soil potentials of the pipeline and the foreign structure using the buried reference electrode and a portable Cu-CuSO₄ reference cell. Note any DC interference to the pipeline.

d. Determine the effectiveness of each accessible electrical isolation device.

e. Prepare and submit a summary report to the CITY OF LINCOLN and RESIDENT PROJECT REPRESENTATIVE containing a description of the structures intended for protection, a description of the cathodic protection systems, and a tabulation/analysis of the data versus NACE International® performance standards.

3. Final Acceptance: Assist the CITY OF LINCOLN’s CP Specialist after energizing and commissioning of the cathodic protection system to ensure that deficiencies are corrected prior to acceptance by the RESIDENT PROJECT REPRESENTATIVE.

a. The costs for any additional field tests or inspections by the CITY OF LINCOLN’s CP Specialist that result from either material or installation deficiencies will be charged to the CONTRACTOR at direct cost with no mark-up and deducted from the CONTRACTOR’s final pay application for the project.

b. The cathodic protection system installation will be deemed acceptable for full payment only after being tested by the CONTRACTOR’s CP Technician and determined to meet the minimum performance criterion established in this Specification by the CITY OF LINCOLN’S CP Specialist.

U. BASIS OF PAYMENT

All Cathodic Protection components installed per this Chapter, as shown on the plans or as directed, shall be paid for at the contract unit price bid per Lump Sum for CORROSION CONTROL SYSTEM. Such price shall be full compensation for all loading and unloading, hauling, excavation, installation, backfilling, labor, tools, materials, equipment and incidentals necessary to complete the Work in conformance with these Specifications and as accepted by the City’s Project Manager.
SPECIAL HORIZONTAL ANODE INSTALLATION

 Limits of Trench Excavation (nominal 2D + 24"

 Water Utility Std. Standard Pipe Bedding/Backfill

 60" (min. sep. as practical)

 Pre-Packaged Anode in Pocketed Trench (Backfilled with minimum 12" of Native Soil)

 3" (min.)

 Undisturbed Earth/Rock

 Section A-A

 Plan View

 Exothermic Weld
 Anode Connection (See Dwg. CP-401)

 Insulated Copper Wire to Anode

 A

 A

 2020 City of Lincoln Standard Specifications
 CHAPTER 23 – WATER MAINS
DRAWING NO. CP-102
SINGLE VERTICAL ANODE INSTALLATION

Section A-A

Plan View

** Surrounded with Clay/Native Soil (no aggregate)
* Protect anode wire by backfilling at min. 36" depth

8" - 10" dia. augered hole down to bottom pipe invert
Spoils to Grade
Connect Anode Lead Wire* to Pipe
Pre-Packaged Sacrificial Anode**
Undisturbed Earth/Rock

~60" separation distance
Exothermic Weld Anode Connection (See Dwg. CP-401)
Insulated Copper Wire to Anode*

2020 City of Lincoln Standard Specifications
CHAPTER 23 – WATER MAINS
DRAWING NO. CP-301
CONTINUITY BONDING ACROSS DUCTILE IRON PIPE JOINT

<table>
<thead>
<tr>
<th>Pipe Joint Bonding Information</th>
<th>Pipe Dia. (in.)</th>
<th>Pipe Mat’l</th>
<th>Continuity Bond</th>
<th>Min. Cable Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 24</td>
<td>DIP</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1G to 24</td>
<td>DIP</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10 to 14</td>
<td>DIP</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>6 to 8</td>
<td>DIP</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

Refer to City of Lincoln Special Provisions for material and installation requirements

Note: Bonding across water main valves shall be as shown on CP-311 and CP-312

Exothermic Weld Connections (See Dwg. CP-401)

Insulated Copper Bond Cable(s)

Factory-Applied Cement Mortar Lining

Joint Sealing Gasket

Pipe I.D.
DRAWING NO. CP-312
CONTINUITY BONDING ACROSS BUTTERFLY VALVE OR HORIZONTAL GATE VALVE

Plan View - Gate Valve

Plan View - Butterfly Valve
Crimp Splice Procedure

Remove approximately 1" of cable insulation to expose clean copper conductors. Join the conductors by inserting them equidistance into the compression connection sleeve. Crimp conductors firmly in place using a crimping tool that requires a complete crimp before the tool can be removed. A minimum of 2 equally-spaced crimp indents is required. Test the crimped connection by pulling on the cables.

Suggested Splice Sealing Procedure

Roughen the cable insulation 2" beyond the end of the exposed conductors. Ensure the entire surface over which the tape will be applied is clean using a lint-free cloth. Do not use solvents. Fill voids with insulating putty tape as required. Apply a high-voltage rubber tape half lapped over all bare conductors. Tape should be tensioned as recommended by the manufacturer. Half-lap tape to produce a uniform buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered approximately 1 inch over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Coat the entire tape wrap with a brush-applied electrical sealant.
DRAWING NO. CP-322
INSULATING RUBBER & TAPE BUTT SPLICE FOR SACRIFICIAL ANODE CABLE CONNECTIONS

Note: "Splinting" the entire connection before burial to minimize wire stress is recommended.

Crimp Splice Procedure

Remove at least 1" of cable insulation to expose clean copper conductors. Join the conductors by inserting them equidistance into the compression connection sleeve. Crimp conductors firmly in place using a crimping tool that requires a complete crimp before the tool can be removed. A minimum of 3 equally-spaced crimp indents is required. Test the crimped connection by pulling on the cables.

Suggested Splice Sealing Procedure

Roughen the cable insulation 2" beyond the end of the exposed conductors. Ensure the entire surface over which the tape will be applied is clean using a lint-free cloth. Do not use solvents. Fill voids with insulating putty tape as required. Apply a high-voltage rubber tape half lapped over all bare conductors. Tape should be tensioned as recommended by the manufacturer. Half-lap tape to produce a uniform buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered approximately 1 inch over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Coat the entire tape wrap with a brush-applied electrical sealant.
1. Clean a small square area at the top dead center of the pipe. Use a grinder or flat file to expose bright shiny metal.

2. Strip off about 1" of insulation from stranded/solid copper wires or stranded copper cables.

3. Slip on a copper weld sleeve to #10 AWG wire and smaller test wire and to #2 AWG or #4 AWG stranded copper bond cables.

4. Place the weld furnace directly over the copper wire or cable and while holding firmly in place, ignite flash powder with a flint igniter. After cooling, remove all slag from the top of the weld metal.

5. Apply cold-applied mastic/cap to cover all exposed copper and bare pipe metal prior to backfilling.

Do not use exothermic weld equipment if the graphite furnace is wet. Follow manufacturer’s specific instructions for storage, handling, and use.
DRAWING NO. CP-611
ANODE TEST STATION (ATS)

Section A-A

Plan View

**Backfilled with min. 12" Native Soil

* Install all test station types (specified as either post- or flush-type) within 35' of buried reference electrode
CLEAR Polycarbonate Terminal Board w/RED screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

#12 AWG (Blue) to New Water Main
Shunt Resistor (opposite side to wires)
Shorting Bar (opposite side to wires)
#8 AWG (Red) to Anode(s)
#8 AWG (Blue) to New Water Main
#14 AWG (Yellow) to Reference Electrode

Connector Ring

3.5" dia.(nominal) White PE Pipe

Side 1: Wire and Cable Binding Post Connections
Side 2: Shunt & Shorting Bar Connections
Terminal Board Cover Removed
DRAWING NO. CP-621
CASING TEST STATION (CTS)

Test Station Post

Trench Backfill

Insulated Copper Test Wire, n=wire code (See Dwg. CP-622)

36"

Casing End Seal

Pipe Bedding

Undisturbed Earth

Elevation

Exo. Weld Connections (See Dwg. CP-401)

36" max.

Limit of Excavation

Test Station Post

Casing Sleeve

Reference Electrode

Plan View

* Install all test station types (specified as either post- or flush-type) within 35' of buried reference electrode
CLEAR Polycarbonate Terminal Board w/BLUE screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

#12 AWG (Blue) to New Water Main
#12 AWG (White) to Casing
#14 AWG (Yellow) to Reference Electrode

Connector Ring
3.5" dia. (nominal) White PE Pipe
Elevation

Plan View

* Install all test station types (specified as either post- or flush-type) within 35' of buried reference electrode
CLEAR Polycarbonate Terminal Board w/GREEN screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

#12 AWG (Blue) to New Water Main
#14 AWG (Yellow) to Reference Electrode

Locking Ring
Connector Ring

3.5" dia.(nominal) White PE Pipe
DRAWING NO. CP-641
FOREIGN CROSSING (OVER WM) TEST STATION (FTS)

Elevation

Plan View

* Install flush test station enclosure within 35' of buried reference electrode
Test Station* Inside Flush Enclosure

Insulated Copper Test Str. Wires

n-wire code (See Dwg. CP-643)

New Water Main

12" min. separation to new WM

Pipe Bedding

Undisturbed Earth

Existing Foreign Pipeline (depth varies)

Elevation

Limit of Excavation

Exo. Weld Connections

(See Dwg. CP-401)

Flush Enclosure

Reference Electrode installed directly over foreign pipeline

Existing Foreign Pipeline

Plan View

* Install flush test station enclosure within 35' of buried reference electrode
CLEAR Polycarbonate Terminal Board w/WHITE screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

#8 AWG (Blue) to New Water Main
#12 AWG (Blue) to New Water Main
#14 AWG (Yellow) to Reference Electrode

Connector Ring
3.5" dia (nominal) White PE Pipe
DRAWING NO. CP-651
ISOLATION TEST STATION (ITS)

Test Station Post*

Trench Backfill

Insulated Copper Test Stn. Wires
n=wire code (See Dwg. CP-652)

36"

Ex. Water Main

New WM

Undisturbed Earth

Pipe Bedding

Elevation

Limit of Excavation

Exo. Weld Connections
(See Dwg. CP-401)

36" max.

Buried Electrical Isolator

Reference Electrode

Plan View

* Install all test station types (specified as either post- or flush-type) within 35' of buried reference electrode
CLEAR Polycarbonate Terminal Board w/ORANGE screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

#12 AWG (Blue) to Upstream/New Water Main
#12 AWG (White) to Downstream/Existing Water Main
#14 AWG (Yellow) to Reference Electrode

Connector Ring

3.5" dia. (nominal) White PE Pipe
This Detail Applies Only to Conn. to Ex. WM at Tap Sleeve

CLEAR Polycarbonate Terminal Board w/ORANGE screw-on cover (not shown)
Front Side: 1/4-20 Binding Posts
Backside: 1/4-20 hex nuts on 1/4-20 x 1" screws w/lock washer & fiber washer

1. #12 AWG (Blue) to New DIP Water Main
2. #12 AWG (White) to Existing Water Main
3. #14 AWG (Yellow) to Reference Electrode
4. #12 AWG (Black) to Ductile Iron Valve Housing
5. #12 AWG (Black) to Ductile Iron Valve Housing
6. #12 AWG (Black) to Ductile Iron Valve Housing
7. #8 AWG (White) to Existing Water Main
8. #8 AWG (White) to Existing Water Main
9. Not Used

Connector Ring
3.5" dia. (nominal) White PE Pipe

Test Station Inside Flush Enclosure**

Valve Operator Extension Shaft Housing & Pad

Install Flange Isolation Kit* (see also Dwg. CP-801)

Install Reference Electrode at spring line of pipe within 12" to 36" of valve housing

*FL-FL connection required at this point

**Install flush test station enclosure within 35' of buried reference electrode
DRAWING NO. CP-691
FLUSH-MOUNTED ENCLOSURE FOR TEST STATION TERMINAL BOARD & WIRES

- Polycarbonate Cover (color varies by TS type)
- (CLEAR) Polycarbonate Terminal Board (refer to individual test station wiring diagrams)
- Terminal Board (shown w/o cover and wire terminations)
- Connector Ring
- 3.5" dia. (nominal) x 60" L White PE Pipe
- 3/8" hex hold-down bolt (typ. for 2)
- 23.25" L x 13.75" W x 2" th. Polymer Concrete Cover
- 25" L x 15.5" W x 12" H Polymer Conc. Enclosure
- CP Wire & Cable Entry contained within PE pipe
- 6" Gravel Base to Support & Drain Enclosure
DRAWING NO. CP-801
FLANGE ISOLATION KIT (FIK)

Flange Side A          Flange Side B

Single-Side Isolation

Type F Ring Gasket

Type E Full Face Gasket

Two-Side Isolation

Note: ANSI-AWWA companion flanges are required. FIK cannot be installed on M.J. joints.

Required Information to Properly Size a Flange Isolation Kit

- Flange Spec.
- Flange Size
- Flange Rating
- Flange O.D.
- Flange I.D.
- Bolt Circle Ø
- Qty. Bolt Holes
- Flange Bolt Ø
- Bolt Hole Ø
- Flange Thickness (A)
- Flange Thickness (B)
**DRAWING NO. CP-804**

**POLYVINYL CHLORIDE PIPE INSERT (PVPI)**

Ex. WM w/o CP — Plastic Pipe* — New DIP w/CP

12" to 36"

EBAA Iron Series 3800 Restrained Pipe Coupling (or approved equal)

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>PVC Pipe Specification*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C900 PVC</td>
</tr>
<tr>
<td>Minimum</td>
<td>4</td>
</tr>
<tr>
<td>Maximum</td>
<td>12</td>
</tr>
</tbody>
</table>
DRAWING NO. CP-806
ISOLATION (BALL TYPE) CORPORATION STOP (ICS)

COMPONENT LIST FOR BALL CORP VALVE LLB ASSEMBLY CG X CS

<table>
<thead>
<tr>
<th>MARK</th>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
<th>ASTM</th>
<th>ALLOY or TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BODY</td>
<td>BRASS</td>
<td></td>
<td>CAST LOW LEAD ALLOY</td>
</tr>
<tr>
<td>2</td>
<td>D-RING</td>
<td>RUBBER</td>
<td>D-2000</td>
<td>EP</td>
</tr>
<tr>
<td>3</td>
<td>STEM</td>
<td>BRASS</td>
<td></td>
<td>CAST LOW LEAD ALLOY</td>
</tr>
<tr>
<td>4</td>
<td>BALL</td>
<td>BRASS</td>
<td></td>
<td>CAST LOW LEAD ALLOY</td>
</tr>
<tr>
<td>5</td>
<td>GASKET</td>
<td>RUBBER</td>
<td>D-2000</td>
<td>NITRILE</td>
</tr>
<tr>
<td>6</td>
<td>D-RING</td>
<td>RUBBER</td>
<td>D-2000</td>
<td>EP</td>
</tr>
<tr>
<td>7</td>
<td>END PIECE</td>
<td>BRASS</td>
<td></td>
<td>CAST LOW LEAD ALLOY</td>
</tr>
<tr>
<td>8</td>
<td>D-RING</td>
<td>RUBBER</td>
<td>D-2000</td>
<td>NITRILE</td>
</tr>
<tr>
<td>9</td>
<td>INSULATED TAIL PC.</td>
<td>BRASS w/NYLON</td>
<td></td>
<td>CAST LOW LEAD ALLOY</td>
</tr>
<tr>
<td>10</td>
<td>COUP. NUT</td>
<td>BRASS</td>
<td>B-62</td>
<td>ALLOY C83600</td>
</tr>
<tr>
<td>11</td>
<td>TUBE NUT</td>
<td>BRASS</td>
<td>B-62</td>
<td>ALLOY C83600</td>
</tr>
</tbody>
</table>

MUELLER MODEL N35000N SHOWN (other models are similar)
Follow the manufacturer's installation instructions.
Do NOT to tighten across the dielectric bushing.
NOTE: These fittings are NOT field serviceable.

A.Y. McDonald Model 747-55DB Shown (other manufacturers' products are similar)
Casing Isolator and Casing End Seal

1. Stainless Steel Band Casing Isolator w/Dielectric Runners
2. Wrap-Around Casing Boot End Seal (pipe not req'd to be centered)

Note: Ductile Iron Pipe is shown - casing isolators for welded steel pipe are similar
Flange Isolation Kit
(See Dwg. CP-801**)

Water Stop &
Anchor Collar

Cast-In Place
Wall Sleeve*

Pipe Penetration
Sleeve Seal

Wall

* Wall may be cored as an alternative to using wall sleeve
** Do not ground pipe between FIK and wall