SECTION 02653 - FABRICATED STEEL PIPE AND SPECIALS

City of San Diego, CWP Guidelines

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NTS: Typically this Section is used for intraplant piping. It may not require inclusion of Section 02600.

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing fabricated steel pipe, specials and connections to new and existing piping. Polyurethane and fusion bond epoxy lining and coating material shall be furnished only by an OWNER-approved manufacturer.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

[1.	Section 02600	Pipeline Construction]
2.	Section 09810	Polyethylene Tape Coating
3.	Section 15000	Piping components

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC), as specified in Section 01090 - REFERENCE STANDARDS.

1.4 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. Uniform Plumbing Code

1.5 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300

2.	ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
3.	ASTM A 36	Structural Steel
4.	ASTM A 47	Ferritic Malleable Iron Castings
5.	ASTM A 53	Pipe, Steel Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
6.	ASTM A 105	Forgings, Carbon Steel, for Piping Components
7.	ASTM A 106	Seamless Carbon Steel Pipe for High-Temperature Service
8.	ASTM A 197	Cupola Malleable Iron
9.	ASTM A 234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
10.	ASTM A 283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
11.	ASTM A 536	Ductile Iron Castings
12.	ASTM A 570	Hot-Rolled Carbon Steel Sheet and Trip, Structural Quality
13.	ASTM A 572	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
14.	ASTM D 16	Definition of Terms Relating to Paint, Varnish, Lacquer, and Related Products
15.	ASTM D 471	Test Method for Rubber Property - Effect of Liquids
16.	ASTM D 2240	Test Method for Rubber Property - Durometer Hardness
17.	ASTM D 4060	Test Method for Abrasion Resistance for Organic Coatings by the Taber Abraser
18.	ASTM D 4541	Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
19.	ASTM E 96	Test Method for Water Vapor Transmission of Materials
20.	AWWA C200	Steel Water Pipe 6 In. and Larger
21.	AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied

22.	AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
23.	AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
24.	AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines.
25.	AWWA C213	Fusion-Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipeline
26.	AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
27.	AWWA C602	Cement-Mortar Lining of Water Pipelines - 4-In. and Larger - In Place
28.	AWWA M11	Steel Pipe--A Guide for Design and Installation
29.	SSPC	Steel Structures Painting Council Specifications

1.6 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Certificates of Compliance with the indicated standards.

2. Detailed drawings showing layout and connections.

3. Calculations and drawings for anchorage (if any).

1.7 FACTORY INSPECTION AND TESTING

A. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture. This shall include costs for travel, meals, lodging, and car rental for [two] OWNER-designated inspectors for [ ] days required to complete such inspections or observations exclusive of travel days, if the place of manufacture, fabrication and factory testing is more than fifty (50) miles outside the geographical limit of the City. The CONTRACTOR shall not be responsible for salary or salary-related costs of the inspectors. The CONTRACTOR shall comply with the requirements of Section 01400.

B. **Product Testing**: Steel pipe and fittings shall be tested at the factory for compliance with the indicated standards.

C. **Witnesses**: The OWNER/CONSTRUCTION MANAGER will witness factory tests.

D. **Inspection:** Linings and coatings, except for cement mortar, shall be inspected electrically for continuity at the place of application.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Fabricated steel pipe and joints shall comply with SSPWC Sub-section 207-10.2.

2.2 PIPE MATERIALS

A. **Steel Pipe:** Steel pipe shall comply with ASTM A 53 (Type E or S), ASTM A 106 or AWWA C200; schedule 40 for pipe 10 inches diameter and smaller, and schedule 80 for pipe larger than 10 inches diameter, except as otherwise indicated.

B. **Steel Pipe Fabricated to Meet Requirements of AWWA C200:** Fabricated pipe shall comply with ASTM A 36, ASTM A 572 (Grade 42), ASTM A 570, (Grades 33 and 36), or ASTM A 283 (Grade D), except that ASTM A 53 and ASTM A 106 pipe shall be grade B, straight or spiral seam. Pipe shall have minimum wall thickness of 7 gauge for pipe 24 inches in diameter and smaller, and a minimum wall thickness of 1/4-inch for pipe larger than 24 inches diameter.

2.3 FITTINGS

A. Fittings shall comply with the following:

1. **Threaded Steel Fittings:** ASTM A 47, ASTM A 197 or ANSI B16.3.

2. **Forged Steel Fittings:** ASTM A 234, ASTM A 105 or ANSI B16.11.

3. **Fabricated Steel Fittings:** AWWA C208

4. **Grooved Fittings:** Full-flow cast fittings, or segmentally welded fittings with grooves or shoulders designed and fabricated for standard grooved-end piping.

5. **Cast Fittings:** Ductile iron conforming to ASTM A 536 or malleable iron conforming to ASTM A 47.

2.4 PIPE LINING

A. Where indicated, pipe linings shall comply with the following:

B. **Cement Mortar:** Pipe and fittings shall be centrifugally lined with cement mortar complying with AWWA C205. If the special cannot be lined centrifugally, it shall be lined by hand in compliance with AWWA C602. Fittings and specials larger than 24 inches, not fabricated from centrifugally formed straight sections, shall require 2-inch by 4-inch WO.5 x WO.5 gage self-furring wire mesh reinforcement for hand-applied lining. The wire mesh shall be positioned approximately in the center of the lining. The wires spaced 2 inches on centers shall run circumferentially around the pipe with the fabric securely fastened to the pipe. Splices shall be lapped 4 inches and the free ends tied or looped to assure continuity.

Surfaces shall be prepared in accordance with SSPC-SP 10 for Near White Blast Cleaning, and the lining shall be applied as recommended by the manufacturer.

C. **Glass Lining:** Pipe and fittings shall be glass lined with a vitreous material to a minimum thickness of 10 mils. Pipe and fittings shall have all internal welds ground smooth and voids and slag holes ground out, rewelded and ground smooth. Glass lining shall provide continuous coverage when tested by a low voltage holiday detector.

2.5 PIPE COATING

A. Where indicated, pipe coatings shall comply with the following:

1. **Coal-Tar Enamel Coating:** Coal-tar protective coating shall be a multi-layer coal-tar enamel fibrous glass mat and mineral glass felt wrap conforming to ANSI/AWWA C203 except as indicated below:

a. Coating Conditions

(1). Pipe surfaces shall be prepared by solvent cleaning (SSPC-SP1) followed by blasting to at least Commercial Blast Cleaning (SSPC-SP6) conditions.

(2). Pipe temperatures shall be at least 85 degrees F.

b. Primer shall be type B.

c. Coal-Tar Enamel: Specially processed coat-tar pitch combined with inert filler, having no asphalt or petroleum of natural origin, of Type 1, applied hot.

d. Glass Fiber Wrap: Non-woven, either reinforced or non-reinforced, glass fiber mat uniformly impregnated with material compatible with coat-tar enamel.

e. Coal-Tar Enamel: Second coat matching the first.

f. Glass fiber or mineral felt outer wrap.

g. Whitewashing, latex painting, or kraft paper.

h. Coating Thickness: Primer plus coal-tar enamel shall be 3/32 inch thick, plus or minus 1/32 inch.

i. Continuity Testing: The entire coated surface of the pipe shall be electrically tested for continuity. Inspection voltage shall be calculated as:

$$V = 1250[T]^{½}$$

Where: V = Test voltage, volts
T = Total coating system thickness, mils

2. **Prefabricated Tape Coating**: Tape coating shall be in accordance with Section 09810. Holiday testing shall be calculated from:

$$V = 1250[T]^{½}$$

Where: V = Test voltage, volts
T = Total tape coating system thickness, mils

2.6 FUSION-BONDED EPOXY COATING AND LINING

A. **General:** Except as described below, the material system for the exterior and interior of fabricated steel pipe and specials shall be in accordance with ANSI/AWWA C213.

B. **Minimum Pipe Diameter:** The minimum pipe diameter for application of an internal lining shall be 8 inches for welded joint pipe, and 4 inches for gasketed joint pipe.

C. **Maximum Temperature:** This material system shall be able to withstand a maximum service temperature of 190^{0}F.

D. **Thickness:** The powder shall be applied to the preheated pipe at a uniform cured thickness. The minimum nominal uniform cured thickness of the applied material shall be as follows:

1. Interior, 16 mils
2. Exterior, 14 mils
3. Maximum thickness shall be determined by the applicator based on the roughness of the pipe so as to obtain a holiday free product. Lining and coating thickness for pipe joints shall be compatible with dimensional tolerances.

E. **Field-Welded Joints:** The repair of field-welds shall be per Section 3.5 of ANSI/AWWA C213, EXCEPT that Subsection 3.5.3 shall not be used for the internal repair. After joint repair the joint shall be tested for continuity per Subsection G.2 below.

F. **Blast Cleaning:** The pipe surfaces to be covered in the plant shall be blast-cleaned with steel grit to achieve a near white surface conforming to SSPC-SP10 or NACE TM-01-70 grade NACE No. 1.

G. **Continuity Tests**

1. Interior of pipe shall be electrically inspected for continuity at 2100 volts prior to exterior coating. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe 20 inches O.D. or smaller, or one per 2 linear feet of pipe over 20 inches O.D., the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.

2. Exterior of pipe shall be electrically inspected for continuity at 1965 volts prior to storage . At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe length for pipe smaller than 14 inches O.D., or one per 25 square feet of surface area for pipe 14 inches in O.D. and larger, the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of the ANSI/AWWA C213 specifications.

H. **Coating Repair and Field Touch-Up:** If gasketed joint pipe is used, exothermic weld connections for the installation of bond cables across joints of the pipeline for cathodic protection shall be repaired and touched-up with 3M-312 material or equal.

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NTS: The DESIGN CONSULTANT shall prepare a list of candidate manufacturers for the proposed coating/lining material from which list the OWNER will select and approve the fusion bond epoxy manufacturer for the project.

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I. **Fusion Bond Epoxy Manufacturers:**

1. [ ]
2. [ ]
3. [or equal]

J. **Qualifications, Approval, and Documentation of Fusion Bond Epoxy Manufacturers**

1. **Qualifications:** The fusion bond epoxy manufacturer shall have a record of at least one application of the proposed coating/lining material on a successfully performing fabricated steel pipe installation of comparable size and complexity constructed in the recent past.

2. Approval

a. Bidders shall submit the name and documented qualifications of the manufacturer proposed for the fusion bond epoxy material. The OWNER will review and approve the proposed selection.

b. Documentation to be submitted CONTRACTOR

(1) Documentation of at least one fabricated steel pipe project constructed in the recent past and successfully performing under similar service conditions.

(2) The name, telephone number, and address of the owner and completion date and location for the project listed above.

(3) The name, telephone number, and address of the firm which applied the fusion bond epoxy in the project listed above.

(4) Descriptive literature, including Material Safety Data Sheet, for the proposed material.

2.7 POLYURETHANE COATING AND LINING

A. **Material:** Polyurethane material shall be a 1 to 1 polyol resin to isocyanate resin 2-component mixture, of Type V according to ASTM D 16.

B. **Performance:** Coating and lining shall have the following properties:

1.	Impact Resistance	no less than 80 inch pounds when tested according to ASTM G14 for 40-mil thickness
2.	Adhesion	no less than 2,000 psi when tested according to ASTM D4541
3.	Hardness	65 (plus or minus 5), Shore D, at 70 degrees F, when tested according to ASTM D 2240.
4.	Abrasion Resistance	less than 100 mg weight loss per 1,000 revolutions of a CS-17 wheel when tested according to ASTM D 4060
5.	Chemical Resistance	less than 5 percent weight change after 90 days tested according to ASTM D 543 (1O% H_2SO_4, 10% HCL, 30%NaOH, H_2S, raw sewage)
6.	Permeability	less than 0.0005 perm inches when tested according to ASTM E 96
7.	Dielectric Strength	no less than 200 volts per mil of coating

8.	Coal Tar Content	zero percent
9.	Fillers	less than 30 percent

C. **Application Conditions**

1. Pipe surfaces shall be prepared by solvent washing (SSPC-SP1) followed by near white blast (SSPC-SP10) with an angular profile of at least 2.5 microns.

2. Pipe temperatures shall be at least 5 degrees F warmer than the dewpoint in the area of the application equipment. Pipe shall be warmed if necessary.

3. Material components shall be stored at temperatures warmer than 50 degrees F and shall not be stored longer than 6 months. Older components shall not be used.

D. **Thicknesses:** Material shall have the following minimum nominal thicknesses:

1.	Pipe Interior	40 mils
2.	Pipe Exterior	25 mils
3.	Sealing Areas on Spigot and Bells	8 mils. Thicker material which does not compromise joint tightness may be accepted

4. Factory Testing

   a. The entire pipe surface coated and lined with polyurethane shall be tested at 200 volts per mil for holidays after curing. Every holiday shall be repaired as indicated below.

   b. Entire pipe surface shall be inspected visually. Pipe with sharp protuberances or significant sags, dimples, or curtains will not be accepted.

   c. The CONSTRUCTION MANAGER will select one section of pipe from each lot of 20 sections for thickness testing by the CONTRACTOR. Tests shall be made by a Type 1 magnetic thickness gage. The CONSTRUCTION MANAGER will designate locations for spot measurements taken at the points of an equilateral triangle 3 inches on a side: the triangles shall be located at both ends, in the middle, and at the midpoints of each half of the pipe, plus 5 randomly-selected individual points.

      (1) No single spot measurement shall be less than 75 percent of the indicated minimum nominal thickness.

      (2) The average of three spot measurements from any triangle shall not be less than 80 percent of the indicated minimum nominal thickness.

(3) The average of all spot measurements on a pipe shall not be less than the indicated minimum nominal thickness.

d. Sections of pipe selected by the CONSTRUCTION MANAGER for thickness testing will also be tested by the CONSTRUCTION MANAGER for delamination by scoring and prying with a pocket knife.

e. If the tested pipe complies with the thickness criteria above and shows no sign of delamination by knife test, all pipe in the lot of 20 will be considered as complying with requirements and the tested pipe may be repaired for installation. If the tested pipe fails either test, five additional sections from the same lot will be tested in similar fashion, and if all five pass all tests, then the lot, except for the pipe which failed, will be considered in compliance. If any of the additional sections fail, the entire lot will be considered non-compliant and shall not be used.

5. Coating and Lining Repair of Holidays and Cut Ends

a. Holidays and cut ends shall be repaired by solvent cleaning, roughening with coarse sand paper, and application of brushable 2-component material recommended by the manufacturer for such purposes. Overlap the acceptable coating and lining at least one inch in all directions. Mix repair material and apply in accordance with the manufacturer's recommendation.

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NTS: The DESIGN CONSULTANT shall prepare a list of candidate manufacturers for the proposed coating/lining material from which list the OWNER will select and approve the polyurethane manufacturer for the project.

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E. **Polyurethane Manufacturers**

1. [ ]
2. [ ]
3. [or equal]

F. **Qualifications, Approval, and Documentation of Polyurethane Manufacturers**

1. **Qualifications:** The polyurethane manufacturer shall have a record of at least one application of the proposed coating/lining material on a successfully performing fabricated steel pipe installation of comparable size and complexity constructed in the recent past.

2. Approval

a. Bidders shall submit the name and documented qualifications of the manufacturer proposed for the polyurethane material. The OWNER will review and approve the proposed selection.

b. Documentation to be submitted CONTRACTOR

(1) Documentation of at least one steel pipe project constructed in the recent past and successfully performing under similar service conditions.

(2) The name, telephone number, and address of the owner and completion date and location for the project listed above.

(3) The name, telephone number, and address of the firm which applied the polyurethane in the project listed above.

(4) Descriptive literature, including Material Safety Data Sheet, for the proposed material.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pipe shall be installed in accordance with AWWA M11, Chapter 16.

Sleeve-type pipe couplings shall be installed in accordance with AWWA M11.

Pipe lining and coatings at field joints shall comply with Section 09800.

Buried couplings and valves shall be field coated complying with Section 09800.

3.2 TESTING

A. Hydrostatic Testing shall comply with Section 4 of AWWA C600.

B. All exterior surface coatinags shall be inspected electrically immediately before the pipe is lowered into the trench, following the same requirements for factory inspection procedure and voltage indicated above for the protective material. All holidays shall be repaired before the pipe is placed.

3.3 CORROSION CONTROL

A. **Joint Bonding/Test Stations:** Joints shall be bonded in accordance with the details indicated. The pipe shall be cleaned to bare bright metal at the point where the bond is installed. The pipe manufacturer shall be responsible for determining and implementing a suitable procedure and schedule for installation of bonding—field versus factory versus combination—in a manner that the corrosion resistance of the lining and coating is not degraded by the bonding process. It may involve welding joint bonding pads, or welding the bonding wires in the factory before applying the lining and coating specified and/or may involve patching impaired areas in the factory or the field. In addition, test stations shall be installed where shown.

B. **Bonding and Electrical Continuity:** All unwelded pipe joints shall be bonded for electrical conductivity in accordance with the details indicated. The CONTRACTOR shall furnish all materials required for joint bonding and test station installations. 2½"x 2"x 3/8" thick steel pads similar to the pipe material shall be welded on both ends of the pipe prior to lining and coating. Following welding of the bond wires to the pipe, the exterior coating shall be repaired per Section 15025.

[C. **Cathodic Protection:** Cathodic protection shall be provided in accordance with Section 15025. Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided as indicated.]

** END OF SECTION **