

SPECIFICATIONS - DETAILED PROVISIONS
Section 15061 - Steel Cylinder Water Pipe

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SECTION 15061
STEEL CYLINDER WATER PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

Contractor to furnish steel pipe as hereinafter described.

- A. Types of Steel Pipe
 - 1. Cement mortar lined and cement mortar coated steel pipe (CML&C). This type of pipe is to be used in steel pipeline construction unless otherwise specified.
 - 2. Pre-tensioned concrete cylinder pipe.
 - 3. Cement mortar lined and coal-tar enamel coated and wrapped steel pipe.
 - 4. Cement mortar lined and asphalt coated and wrapped steel pipe.
- B. Pipe Class or Working Pressure shall be 150 psi unless otherwise specified. This specification includes all classes and specific tables for Class 100, 150, and 200 psi.
- C. Nominal Pipe Diameter shall mean the approximate inside diameter of the cement mortar lining.
- D. Fabricated Steel Plate Specials, defined as bends, wyes, reducers, outlets, and other pipe structures.

1.02 QUALITY ASSURANCE

Includes the requirements of this specification and the requirements of the latest revision of the following standards as applicable. Unless specifically stated otherwise, the most stringent requirement will govern when there is a conflict.

- A. AWWA C-200. American Water Works Association (AWWA) C-200 standard for steel water pipe 6 inches and larger.
- B. AWWA C-203. AWWA C-203 coal-tar protective coatings for hot applied enamel and tape.

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- C. AWWA C-205. AWWA C-205 cement mortar lining and coating. Section 5.5.4 wire mesh: When wire mesh is used as the reinforcement for the coating, it shall have a minimum of 1/2" coating over the wire mesh.
- D. AWWA C-208. Standard dimensions for steel water pipe fittings.
- E. AWWA C-303. Reinforced concrete pressure pipe – steel cylinder type, pre-tensioned.
- F. ASTM C-150. Portland Cement.
 - 1. Type II Cement.
 - 2. Type V Cement.
- G. ASTM A-234. Piping fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures.
- H. ASTM-A-615-GR40. Deformed and plain billet-steel bars for concrete reinforcement.
- I. AWWA Manual M-11. Design and installation of steel pipe.
- J. Standard Drawing B-288. EMWD standard drawing for steel plate flanges.
- K. ASTM D-2240. Rubber property - durometer hardness.

1.03 SUBMITTALS

- A. Pipe Layout Drawings. Pipe (36 inches and larger) shall be fabricated to adhere to the contract construction drawings. The Contractor shall submit pipe layout drawings for approval by the Engineer when the pipe layout varies from the alignment or grade shown on the contract drawings. These drawings shall be the same scale as the contract drawings. The District will allow the manufacturer to utilize a set of reproducible contract drawings to reflect the proposed deviations from the planned grades. Departures from line and grade within the following parameters will be permitted in the manufacture of the pipe to allow the use of joint pulls to effect changes of alignment:
 - 1. Horizontal alignment shall be within 4 inches of the alignment shown on the contract drawings.
 - 2. In vertical alignment, depth may be reduced 1 inch or increased 4 inches if the following minimum vertical clearances between outside diameters of other facilities are maintained and no additional highpoints are created :
 - a) 1 foot vertical clearance between sewer and water pipelines.

- b) 0.5 foot vertical clearance between all other facilities except when specifically shown otherwise on the contract drawings.
3. Horizontal location of the vertical P.I. may deviate by 0.5 feet.

(Pipe smaller than 36 inch may be straight run pipe with horizontal and vertical bends fabricated to conform to construction drawings and welded to straight run pipe with butt straps per Standard Drawing B-304 or other approved full welded joint connections.)

Proposed departures in excess of these limits must be approved by the Engineer prior to initiation of layout drawings.

Computer printouts will be accepted in lieu of layout drawings except for such proposed departures.

- B. Fabricated Steel Plate Specials. Fabricated steel plate specials submittals shall be approved prior to fabrication. The dimensions shall conform to AWWA C-208 except as modified herein or as otherwise shown on the plans.
- 1. Pipe Outlets. The measurement from the outside of pipe to the face of flange shall be 12" unless otherwise shown. Outlets shall be designed per AWWA Manual M-11, and design of stiffner plates shall follow the nomograph method.

Pipe outlets shall also be provided for chlorination corp stops, air valve assemblies, services, and other appurtenances required by the contract drawings. Brass plugs shall be provided for installation upon later removal of the chlorination corp stops.
 - 2. Bends
 - a) The radius of bends shall be a minimum of 2½ times the pipe diameter unless specified otherwise.
 - b) Bends may be welded to adjacent pipe sections.
 - c) Bends shall conform to the following table:

2-piece	0° - 30°
3-piece	30° - 45°
4-piece	45° - 67½°
5-piece	67½° - 90°

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- C. Rubber Gaskets. Test results showing the properties of the material used in the rubber gaskets shall be submitted by the Contractor if requested by the Engineer.
- D. Pipe Design. Pre-tensioned concrete cylinder pipe reinforcing steel shall be computed as follows:

$$A_s = \frac{6 P_w D_y}{f_s}$$

Where:

A_s = Total cross-sectional area of circumferential steel (cylinder plus bar reinforcement) --- sq. in./ft. of pipe

P_w = Pressure Rating (Class) --- psi

D_y = Inside diameter of steel cylinder – inches

f_s = Average circumferential stress in psi in the steel cylinder and bar reinforcement when the section is subjected to working pressure

and

f_s = is not to exceed 16500 psi nor 50% of the specified minimum yield strength of the steel used in the cylinder. Bar reinforcement shall not be greater than 60% of the total area of circumferential reinforcement.

1.04 DELIVERY

Pipe and material shall be furnished, delivered and strung along the trench site.

- A. Internal bracing adequate for handling and transportation shall be installed as soon as practical after the application of cement mortar lining. All bracing shall remain in the pipe until installation and backfilling are completed.
- B. Gasket material shall be furnished with the pipe for storage in a cool, well ventilated place and protected from direct sunlight.

1.05 JOB CONDITIONS

Pipe and materials shall not be fabricated, stored, or installed in climatic conditions that will adversely affect the quality of the finished pipeline project.

1.06 ALTERNATIVES

Pipe for projects that are federally funded, in part or whole, shall also meet or exceed federal requirements:

- A. Steel pipe shall conform to federal specification SS-P-385A for cement mortar lined and reinforced cement mortar coated pipe.
- B. Pre-tensioned concrete cylinder pipe shall conform to federal specification SS-P-381B.

PART 2 - PRODUCTS

2.01 MATERIALS

For all steel manufactures outside the United States, the Contractor shall submit to the District, for its approval, a certified letter stating that the steel meets or exceeds the following: all of the requirements of AWWA C-200, the applicable ASTM Standards, and this Specification, and provide certified physical and chemical test results. The manufacturer of the steel cylinder shall be responsible for all requirements of these specifications. Manufacturers must be per EMWD's "approved materials list".

- A. Cement Mortar Lined Steel Pipe Cylinder
 - 1. Steel thickness shall be at least 12 ga. (0.1046").
 - 2. Steel thickness shall be determined from the pressures imposed (Class) and the design stress of the steel. Design stress is defined as one-half (½) of the allowable minimum yield stress of the steel.
 - 3. Steel pipe shall conform to the following table which includes minimum diameters and minimum thicknesses for various classes and nominal diameters. Note: Plate thickness is based on steel with a yield stress of 33,000 psi and a design stress equal to 50% of the yield stress (16,500 psi).

Nominal Pipe Diameter	Minimum Cylinder Diameter	Class 200 Min. Cylinder Plate Thickness	Class 150 Min. Cylinder Plate Thickness	Class 100 Min. Cylinder Plate Thickness
4"	4-1/2" O.D.	0.1046"	0.1046"	0.1046"
6"	6-5/8" O.D.	0.1046"	0.1046"	0.1046"
8"	8-5/8" O.D.	0.1046"	0.1046"	0.1046"
12"	12-3/4" O.D.	0.1046"	0.1046"	0.1046"
14"	15-1/4" O.D.	0.1046"	0.1046"	0.1046"
16"	17-3/8" O.D.	0.1046"	0.1046"	0.1046"
18"	19-3/8" O.D.	0.1160"	0.1046"	0.1046"
20"	21-3/8" O.D.	0.1280"	0.1046"	0.1046"
21"	22-3/8" O.D.	0.1340"	0.1046"	0.1046"
24"	25-3/8" O.D.	0.1519"	0.1143"	0.1046"

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Nominal Pipe Diameter	Minimum Cylinder Diameter	Class 200 Min. Cylinder Plate Thickness	Class 150 Min. Cylinder Plate Thickness	Class 100 Min. Cylinder Plate Thickness
27"	28-3/8" O.D.	0.1699"	0.1278"	0.1046"
30"	31-3/8" O.D.	0.1879"	0.1413"	0.1046"
33"	34-3/8" O.D.	0.2058"	0.1548"	0.1046"
36"	37-3/8" O.D.	0.2238"	0.1684"	0.1126"
39"	40-3/8" O.D.	0.2418"	0.1819"	0.1216"
42"	43-3/8" O.D.	0.2597"	0.1954"	0.1306"
45"	46-7/8" O.D.	0.2807"	0.2111"	0.1412"
48"	49-7/8" O.D.	0.2987"	0.2247"	0.1502"
54"	55-7/8" O.D.	0.3346"	0.2517"	0.1683"

4. Cylinder shall conform to AWWA C-200.
5. Cement mortar lining shall conform to AWWA C-205.
6. Separate joint rings, if used, shall conform to Section 2.6, AWWA C-303.

B. Pre-tensioned Concrete Cylinder Pipe

1. Shall conform to the following table:

**PRE-TENSIONED CONCRETE CYLINDER PIPE
WORKING PRESSURE**

Nominal Pipe Diameter	Cylinder Diameter	Class 200		Class 150		Class 100	
		Plate Thickness	Total Area (sq."/ft)	Plate Thickness	Total Area (sq."/ft)	Plate Thickness	Total Area (sq."/ft)
12"	12-3/4" O.D.	12ga.	1.485	12ga.	1.485	12ga.	1.485
14"	15-1/4" O.D.	12ga.	1.485	12ga.	1.485	12ga.	1.485
16"	17-3/8" O.D.	12ga.	1.485	12ga.	1.485	12ga.	1.485
18"	19-25/32" O.D.	12ga.	1.485	12ga.	1.485	12ga.	1.485
20"	21-25/32" O.D.	12ga.	1.584	12ga.	1.485	12ga.	1.485
21"	22-25/32" O.D.	12ga.	1.657	12ga.	1.485	12ga.	1.485
24"	25-3/4" O.D.	12ga.	1.873	12ga.	1.495	12ga.	1.495
27"	28-25/32" O.D.	12ga.	2.093	12ga.	1.570	12ga.	1.525
30"	31-7/8" O.D.	12ga.	2.318	12ga.	1.737	12ga.	1.555
33"	34-7/8" O.D.	12ga.	2.536	12ga.	1.902	12ga.	1.585
36"	37-7/8" O.D.	12ga.	2.755	12ga.	2.066	12ga.	1.615
39"	40-7/8" O.D.	12ga.	2.973	12ga.	2.230	12ga.	1.645
42"	43-7/8" O.D.	11ga.	3.191	12ga.	2.393	12ga.	1.675
45"	46-7/8" O.D.	11ga.	3.409	12ga.	2.557	12ga.	1.704

Nominal Pipe Diameter	Cylinder Diameter	Class 200		Class 150		Class 100	
		Plate Thickness	Total Area (sq."/ft)	Plate Thickness	Total Area (sq."/ft)	Plate Thickness	Total Area (sq."/ft)
48"	49-7/8" O.D.	10ga.	3.628	11ga.	2.720	11ga.	1.915
54"	55-7/8" O.D.	9ga.	4.063	11ga.	3.048	11ga.	2.032

12 ga. = .1046 = 1.255 square inch/ft.

11 ga. = .1196 = 1.435 square inch/ft.

10 ga. = .1345 = 1.614 square inch/ft.

9 ga. = .1495 = 1.794 square inch/ft.

2. Rod reinforcing shall conform to ASTM A615 GR40, and the minimum diameter shall be 7/32".
3. Shall conform to AWWA C-303.

C. Coatings

1. Pre-tensioned concrete cylinder pipe shall be coated per AWWA C-303 except the cement shall be Type II or Type V.
2. Cement mortar lined steel pipe shall be cement mortar coated unless specified otherwise.

a) Cement Mortar Coating

- (i) Shall be a minimum of 3/4" thick.
- (ii) Shall either be Type II or Type V cement, unless specifically stated on the plans or in the Special Conditions.
- (iii) Shall be one type of cement; i.e., Type II & V shall not be mixed together.
- (iv) Shall meet or exceed AWWA C-205 requirements.
- (v) Shall be of adequate thickness to provide required rigidity and corrosion protection.

b) Coal-Tar Enamel Coated and Wrapped Coating shall conform to AWWA C-203

- (i) Type B primer shall be used.
- (ii) Coal-tar enamel may be Type I or Type II.
- (iii) Wrapping shall be a single layer of glass mat or 15-pound coal tar saturated asbestos felt.
- (iv) The coating shall be whitewash.

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- c) Asphalt Coated and Wrap Coating shall use
 - (i) Asphalt primer.
 - (ii) Asphalt (hot applied).
 - (iii) Mica surfaced 15-pound pipeline felt.
- d) Field painting shall be used on above-ground installation as shown on the drawings
- e) Bare metal shall be coated with a suitable primer for its intended use

D. Steel Plate Specials

- 1. Shall be constructed of steel plate, thickness computed from the greater of the following criteria, unless a still greater requirement is shown on the drawings or stated in the special conditions:
 - a) Thickness not less than 3/16"; or
 - b) Thickness as determined from the formula

$$T \geq \frac{D \times P}{2 \times 12,500}$$

Where:

T = wall thickness in inches

D = inside diameter of steel cylinder in inches

P = design pressure (class) in pounds per square inch

- 2. Schedule 30 or heavier steel pipe in standard diameters may be used in lieu of above paragraph "2.01, D1" for outlets that are 12" and smaller diameter (12.75", 10.75", 8.625", 6.625" and 4.5" outside diameters).
- 3. Steel welding fittings conforming to the requirements of ASTM Designation A-234 may be used when available in suitable sizes.
- 4. Cement mortar lining meeting AWWA C-205 except handwork reinforcement shall be 2"x 4" No. 12 welded wire fabric.
- 5. Coating meeting the requirements of straight pipe.

6. Stiffner plates, when required, designed per the nomograph method of AWWA Manual M-11.
 7. Reinforced steel collar pads designed for the specified pressure where needed.
 8. Materials meeting or exceeding AWWA C-200 requirements.
- E. Rubber Ring Gaskets
1. Shore durometer hardness range shall be in the range of 50-55 in accordance with ASTM D-2240.
 2. Compound shall conform to the requirements of Section 2.8 AWWA C-303.

2.02 MIXES

All mixes shall conform to the applicable reference sections.

2.03 FABRICATION OF PIPE

- A. Steel cylinder pipe shall be fabricated in accordance with:
1. AWWA C-200 for cement mortar lined steel pipe.
 2. AWWA C-303 for pre-tensioned steel cylinder steel pipe.
- B. Cement mortar lining process shall be followed with sealing each pipe end with a waterproof cover prior to carefully moving the pipe section. The pipe sections shall be cured under sprinklers or by other processes approved by the Engineer.
- C. Coatings shall be applied after the exterior of the pipe is thoroughly cleaned and free from all loose mill scale and rust.
1. Cement mortar coating shall be applied pneumatically or by impaction resulting in a dense uniform coating that adheres tightly to the pipe.
 2. Coal-tar enamel and wrapped coating shall be applied in accordance with AWWA C-203.
 3. Asphalt coating and wrapping.
 - a) Shall be applied after pipe is fabricated and hydrostatically tested.
 - b) Asphalt primer.

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- (i) Shall be applied to clean-dry surfaces to produce a suitable bond between the metal and subsequent coating of asphalt.
 - (ii) Shall be uniform and free from bare spots.
 - (iii) Shall be protected from rain and fog during and between applications.
- c) Hot asphalt shall be applied after the primer has completely hardened and with, or immediately preceding, the wrapping material in sufficient quantity to form a bead on the exposed edge of wrap.
 - d) Wrapping material shall be spirally wrapped under tension to ensure complete coverage, 3/4" lap at edge, no wrinkles and buckles, and complete cementing to the pipe with hot asphalt.
 - e) Coating and wrapping shall be omitted at each end for a sufficient distance to permit the making of field joints. All exposed bare metal shall be coated with a suitable primer.

D. Joints

- 1. All pipes shall have rubber gasket joints unless otherwise shown.
 - a) The steel area in the bell shall not be less than the area in an equivalent length of pipe barrel.
 - b) Rubber gasket ends formed integrally with the steel cylinder shall be formed either by sizing with a machined swage or die, or by rolling per AWWA C-200.
 - c) Separate rubber gasket joint rings shall be formed per requirements of Section 3.3 of AWWA C-303.
- 2. Ends that are not rubber gasket, including but not limited to weld bells, plain ends, grooved ends, and butt straps shall conform to AWWA C-200 where applicable, and to the construction drawings.
- 3. Flanges shall conform to Eastern Municipal Water District standard drawing B-288.

E. Steel Plate Specials shall conform to approved shop drawings and shall be fabricated in a shop approved for that purpose by the Engineer.

- 1. Each special shall have a mark on the top and bottom corresponding to the true vertical axis.

2. Outlets, including wyes, shall be built into the wall of the pipe.
3. Fabricated steel fittings of suitable design shall be welded to the cylinder before the exterior coating is placed around the fittings.
4. Cement mortar lining shall meet the requirements of straight pipe with the provisions that handwork lining reinforcement shall be positioned approximately in the center of the lining. The wires spaced 2" on center shall extend circumferentially around the pipe. The fabric shall be securely fastened to the pipe. Splices shall be lapped 4" and the free ends tied or looped to ensure continuity.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Notification of Manufacture. Unless specifically waived, EMWD Inspection Department shall be notified at least 48 hours prior to commencement of the manufacture of pipe.
- B. Hydrostatic Testing. Steel cylinders shall be hydrostatically tested to a stress equal to 75% of the minimum yield point of the steel. Certification of all cylinders is required by the District.
- C. Specials. Specials shall be bulkheaded and tested prior to lining and coating of weld seams at one-and-one-half (1½) times the design pressure (class). Dye penetrant process may be used on all untested welds in lieu of hydrostatic testing if the straight pipe used in fabricating the special has passed a hydrostatic test of 75% of the yield point. All defective welds including pinholes and porous welds shall be chipped out, rewelded, and retested.
- D. Soap and Compressed Air Test
 1. All double-welded lap joints, butt-strap joints, and other joints susceptible to this test shall be tested by the soap and compressed air method as hereinafter described. After completion of the shop hydrostatic test of the pipe sections the soap and compressed air test also may be used instead of hydrostatic testing of welded joints in the steel manhole outlets, which are attached to steel-plate sections.

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2. As soon as practicable after the welding of each joint to be tested by the soap and compressed air test has been completed, the Contractor shall subject each joint to a soap test by forcing compressed air, at approximately 40 pounds pressure per square inch, into each said joint and, while the joint is under pressure, every portion of every welded seam forming a part of the joint shall be swabbed with a heavy soap solution or an approved, commercial, bubble producing leak test fluid and shall be carefully examined for leakage. The Contractor shall repair any defects disclosed by the test by chipping out and rewelding the chipped section, after which the same test shall again be applied. The Contractor shall provide all apparatus and materials for making the tests, shall drill and tap the necessary holes and shall plug weld the holes after testing.
- E. Rubber Gaskets. Rubber gaskets shall be subject to inspection and/or testing by the Engineer. All unsatisfactory gaskets shall be immediately replaced at no expense to the District.
- F. Manways. All 30" diameter and larger pipe shall have 24" diameter or larger access manways within 750 feet of any interior point of the pipeline.
1. Manways shall consist of 24" diameter outlets with 24" blind flanges.
 2. Manways shall have a maximum spacing of 1500 feet on center. At valve installations, manways shall be located on both sides of each valve a maximum of 35 feet.
 3. Outlets or bumped heads that provide an equal or larger opening than a 24" manway may be used for pipe access.
 4. Manway locations shall be selected to minimize impact to traffic, and shall be approved by EMWD prior to pipe fabrication.

3.02 INSTALLATION

- A. Preparation. Internal bracing, in addition to the bracing used for handling and transportation of the pipe, shall be installed when required to ensure maximum permissible deflections are not exceeded during laying, backfill, and compaction.
- B. Pipe Zone Density. Relative compaction in pipe zone III as shown on standard drawing B-286B shall be in accord with the manufacturer's recommendation. All pipe bid for this project shall meet EMWD's minimum standards as set forth in Section 15061 herein. The Contractor, in conjunction with the pipe manufacturer, will indicate in the space provided and attached hereto as part of the bid forms, the pipe zone compaction to be constructed, the mortar thickness - both lining and coating - and the trench slope construction.

- C. Diapers shall be impervious if available.
1. Width of diapers, where used, shall be sufficient to allow cupping of the diaper for increased thickness of the joint mortar. Recommended minimum diaper widths:
 - a) 20" dia. pipe and larger: 12"
 - b) 12" - 18" dia. pipe: 10"
 - c) 10" dia. pipe and smaller: 9"
 2. Mortar placement shall be from one side of the diaper, to allow the mortar to flow around the bottom and up the opposite side of the pipe, to preclude the possibility of any voids inside the diaper.
- D. Curing operations shall begin immediately after completion of joint mortaring.
1. Immediate backfill should follow the completion of the joint mortaring operation where possible. Care must be taken to immediately wet down and consolidate the backfill, to avoid draining the moisture from the mortar through porous diapers into dry backfill soil, or disturbing the mortar set by subsequent compaction of the backfill.
 2. Completed-joint mortar to be exposed to the sunlight where backfill will not take place until after the mortar has hardened must be kept continually moist during the curing period to prevent cracking of the curing mortar.

END OF SECTION 15061

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