STANDARD SPECIFICATION
SECTION 15061 STEEL TRANSMISSION PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes materials, design, fabrication, and testing of cement mortar lined and di-electric coated and/or cement-mortar coated welded steel pipe with special pieces in accordance with AWWA C200, C205, C208 and the following options and restrictions. Size range is 6- to 36-inch nominal pipe size.

1.02 PIPE IDENTIFICATION SYMBOLS

Interpret pipe identification symbols used on the Drawings as follows: S-30"-150 or S-30"-0.1875" designates type of pipe (steel); nominal pipe size (30 inches); and working pressure rating (Class 150) or pipe wall thickness (0.1875 inches).

1.03 SPECIALS

A special is defined as any piece of pipe other than a normal full length of straight pipe. This includes but is not limited to elbows, manhole sections, short pieces, reducers, adapter sections with special ends, sections with outlets, etcetera.

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Standard Drawings.

B. Record Drawings and Submittals: STD SPEC 01300.

C. Painting and Coating: STD SPEC 09900.

D. Polyethylene Tape Pipe Coating: STD SPEC 09957.

E. Corrosion Control for Buried Piping: STD SPEC 13110.

F. General Piping Requirements: STD SPEC 15050.

G. Flexible Pipe Couplings: STD SPEC 15122.

H. Pressure Testing of Piping: STD SPEC 15144.

I. Installation of Steel Transmission Pipe: STD SPEC 15251.

1.05 SUBMITTALS

A. Submit submittal packages in accordance with Standard Specification Section 01300.

B. Submit an affidavit of compliance with AWWA C200 and C205.

C. Submit detailed shop drawings for the pipe and specials showing:

1. Order of installation and closures with designation by piece number for each steel pipe and fabricated special to be furnished and installed.

2. Pipe station and centerline elevation at each change of grade and horizontal alignment.

3. Elements of curves and bends, both in horizontal and vertical alignment including elements of the resultant true angular deflections in case of combined curvature.

4. Pipe outside diameter, wall thickness, location of welded seams, and working pressure rating.

5. Locations of bulkheads for field hydrostatic testing of pipeline.

6. Locations of closures for length adjustment and for construction convenience.

7. Locations of valves, manholes, and other mechanical equipment.

8. Limits of each reach of field-welded joints, rubber gasket joints, and of concrete encasement.

9. Call out weld sizes and dimensions of thrust ring collars, grooved end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

D. Submit joint details.

E. Submit details of lining and coating.

F. Submit drawings of butt straps, couplings, and flanges.

G. Submit details of bulkheads and of their method of attachment to the pipeline.

H. Submit certificate that cement complies with ASTM C 150, designating type.

I. Submit certified copies of mill test reports on each heat from which steel is rolled.

J. Submit test reports on physical properties of rubber used in gaskets.

K. Submit welding procedure specifications (WPS) and procedure qualification records (PQR) for each welding process and welder qualification records (WQR) for each welder and welding operator.

L. Submit drawings of all pipes and specials to the District’s Representative for review. The Contractor and Engineer of Work shall both review and mark the review action taken, before submitting to District. Shop drawings shall be complete in all respects. If the shop drawings show any deviations from the requirements of the Drawings and Standard Specifications because of standard shop practices or other reasons, the deviations and the reasons therefore shall be set forth in the submittal packages.

M. Submit fabricator's quality control program results in one complete binder including all inspection reports, conducted tests, certified mill test reports, weld test coupon reports, welder qualification records, hydrostatic testing reports, shop testing reports, final

fabrication checklist for each special, and affidavit of compliance. The quality control program results shall document all phases of the fabrication process.

1.06 INSPECTION AND FIELD VERIFICATION

A. The District's Representative or his authorized representative will inspect materials, fabrication, and testing of pipes and specials at the manufacturer's plant.

B. Where new pipelines are to be connected to existing waterlines of the District, the Contractor shall verify in the field the location, elevation, pipe material, pipe outside diameter, and any other characteristics of the existing waterline before proceeding with the pipe fabrication or installation. This field verification shall be performed in the presence of the District's Representative. Adjust and align the new pipeline as necessary to meet the field conditions and provide all required material, labor, and equipment to make the connection.

PART 2 - MATERIALS

2.01 DESIGN CRITERIA

A. Obtain the following information from the Drawings:

1. Elevation of the pipe centerline and the completed ground.

2. Alignment of the pipeline.

3. Working pressure rating (psi) or pipe wall thickness. Working pressure is the maximum high water level (HWL) or maximum static head (HGL) of the pressure zone minus the pipe centerline elevation in feet divided by 2.31 feet per psi.

4. Nominal pipe size.

5. Location of single or double lap welded joints.

B. Field hydrostatic test pressure shall be as indicated in Standard Specification Section 15144, unless noted otherwise on the Drawings.

C. Steel Cylinder.

1. The following formula shall be used to determine the stress in the steel cylinder:

$$S = \frac{PD}{2T}$$

Where S = Stress, PSI
P = Working pressure rating, PSI
D = Actual outside diameter of steel cylinder, inches (not bell)
T = Wall thickness of steel cylinder, inches

2. Stress in steel cylinders shall not exceed 15,000 psi at the working pressure rating with no allowance for tensile strength of cement mortar, except that the following minimum cylinder thicknesses shall prevail:

Nominal Pipe Size (inches)	Minimum Thickness (inches)
6 to 10	0.1046
12 to 18	0.1345
20 to 27	0.1875
30 to 36	0.2500

3. Steel cylinder outside diameters for pipe 12 inches and smaller in nominal pipe size shall conform to the following:

Nominal Pipe Size (inches)	Steel Cylinder Outside Diameter (inches)
6	6.625
8	8.625
10	10.750
12	12.750

4. For larger pipes, the steel cylinder outside diameter shall meet the following minimum outside diameters:

Nominal Pipe Size (inches)	Steel Cylinder Outside Diameter (inches)
14	15.375
16	17.375
18	19.375
20	21.375
21	22.375
24	25.750
27	28.875
30	31.875
33	34.875
36	37.875

2.02 SPECIALS

A. Fabricated steel fittings shall comply with AWWA C208. For elbows, fabricate to a minimum centerline radius of 2.5 pipe diameters and provide the number of pieces as tabulated below:

Deflection Angle	Number of Pieces
0 to 22.5 degrees	2
22.6 to 45.0 degrees	3
45.1 to 67.5 degrees	4
67.6 to 90.0 degrees	5

B. Maximum circumferential stress at the working pressure rating shall not exceed 40 percent of the minimum yield stress.

C. Material for fabricated specials shall be the same as the pipe and may be from previously tested pipe manufactured in accordance with these specifications. Minimum wall thickness shall be equal to the thickest adjacent straight pipe, except that the following minimum wall thicknesses shall prevail for a special:

Nominal Pipe Size (inches)	Minimum Thickness (inches)
6 to 18	0.1345
20 to 27	0.1875
30 to 36	0.2500

D. Select the type of reinforcement for specials with outlets from the following:

$$R = \frac{\text{ID outlet}}{\text{ID main run x sin B}}$$

Where B = Angle between the longitudinal axis of the main run and the outlet

R	Type of Reinforcement
Maximum of 0.5	Collar Plate
Maximum of 0.7	Wrapper Plate
No limit	Crotch Plate

When outlets are located opposite each other in a special (i.e., a cross), the limiting values of “R” shall be 0.25 and 0.35, respectively. Use wrapper plate when the pipe main run is 21 inches and smaller, and “R” is larger than 0.7. Use crotch plate when the pipe main run is 24 inches and larger, and “R” is larger than 0.7.

E. Collar Plate Reinforcement.

1. For collar plate reinforcement, select an effective shoulder width "W" of a collar from the inside surface of the steel outlet to the outside edge of the collar, measured on the surface of the cylinder of the main run, such that:

$$W = (1/3 \text{ to } 1/2) \times \frac{\text{ID outlet}}{\sin B}$$

2. For collar plate reinforcement of tangential outlets, use:

$$\sin B = \sqrt{\frac{\text{OD outlet}}{\text{OD main run}}}$$

3. The minimum thickness "T" of the collar is determined by:

$$T = \frac{P \times \text{ID main run} \times \text{ID outlet} \times (2 - \sin B)}{4 \times F \times W \times \sin B}$$

Where P = Working pressure, PSI
F = Allowable stress at working pressure (40% of minimum yield)
B = As in paragraph 2.02, D.

4. Collars may be oval in shape or rectangular with rounded corners.

F. For wrapper plate reinforcement, use the above collar formula except that the wrapper is of thickness "T," its total width is (2W + ID outlet/sin B), and it extends entirely around the main pipe diameter portion of the steel special.

G. Base crotch plate design on Swanson, H.S. et. al., DESIGN OF WYE BRANCHES FOR STEEL PIPES, summarized in AWWA Manual M11 (Current Edition), Chapter 13.

H. Steel pipe used for outlets, 12 inches and smaller, shall be standard weight conforming to ASTM A 53 (Type E or S), Grade B. For flanged outlets, use a slip on flange, double welded, and match the flange of the connecting component.

I. At flanged outlets not indicated to be connected to valves or to other pipes, provide blind flanges with bolts, nuts, washers, and solid face gaskets.

2.03 STEEL FOR PIPE AND SPECIALS

Use steel conforming to ASTM A 36; ASTM A 283 Grade D; ASTM A 572 Grade 42 or 50; ASTM A 1011 Grade 33; or ASTM A 1018 Grade 33 with carbon content of 0.25% maximum. Use steel plate and sheet having a thickness with a maximum allowable variation of not more than 0.01-inch less than the minimum thickness specified.

2.04 CEMENT FOR INTERIOR MORTAR LINING

Use cement conforming to ASTM C 150, Type II.

2.05 CEMENT FOR EXTERIOR MORTAR COATING

Use cement conforming to ASTM C 150, Type II.

2.06 POLYETHYLENE TAPE PIPE COATING (DI-ELECTRIC COATED)

See Standard Specification Section 09957.

2.07 FLANGES

Use flanges conforming to AWWA C207, Class E or Class F; or ANSI B16.5, Class 150 or Class 300.

2.08 BOLTS, NUTS AND GASKETS FOR FLANGES

See Standard Specification Section 15050.

2.09 INSULATING FLANGE KITS

See Standard Specification Section 13110.

2.10 OUTLETS

For threaded outlets 3 inches and smaller, use a thredolet type per AWWA Manual M11 (Current Edition), Chapter 13. Outlets shall be 3000 pound WOG forged steel per ASTM A 105 or ASTM A 216, Grade WCB. Threads shall comply with ANSI B1.20.1, NPT. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or District approved equal. Do not use pipe couplings for outlets.

2.11 MECHANICAL CLAMP-TYPE COUPLINGS

A. Mechanical clamp-type couplings for grooved or shouldered end pipe shall be ductile iron, ASTM A 536 Grade 65-45-12. Bolts shall conform to ASTM A 183, 110,000 psi tensile strength. Gaskets shall be EPDM (ethylene propylene diene monomer) conforming to ASTM D 2000.

B. Couplings for pipe, 12-3/4 inches outside diameter and smaller, shall conform to AWWA C606 for flexible, square cut grooved joints in IPS steel pipe with weld-on grooved adapters. Couplings shall be Victaulic Style 77 or District approved equal.

C. Couplings for pipe, 15-3/8 inches outside diameter and larger, shall conform to AWWA C606 for shouldered end flexible joints with Type D special ends. Couplings shall be Victaulic Style 44 or District approved equal.

2.12 TYPE OF PIPE JOINTS

Joint ends of pipe sections shall be as indicated on the Drawings.

A. Rubber Gasket Joints: For pipes smaller than 24 inches, use a bell band or expanded bell and rolled groove spigot with rubber gasket. For pipes 24 inches and larger, use a carnegie shape spigot with matching bell. Attach spigot and bell with fillet weld on both the interior and exterior circumference of the pipe section.

B. Welded Joints: Use expanded bell with matching spigot to penetrate a minimum of 1-1/2 inches into the bell. The manufacturing tolerances stated in AWWA C200 do not apply and are hereby exceeded by the following. Joint tolerances shall not exceed a total of 1/8-inch on the diameter with the joint gap equalized around the perimeter.

C. Flanges: Use slip-on or ring type welded to the interior and exterior circumference of the pipe section. Use flanges for attaching pipe to valves, other appurtenances, or as shown on the Drawings.

D. Butt Strap Closures: Butt straps shall be the same thickness and material as the pipe wall but not less than 10 gage, at least 10 inches wide, rolled to fit the outside cylinder diameter in two half sections, and shall be centered over the plain ends of the pipe sections they are to join. Weld a 5-inch threaded, steel, standard half coupling or couplings to the interior and exterior of the top butt strap half section to provide access for mortar lining the inside of the joint. Provide two couplings for pipes 18 inches and larger. Provide a threaded steel plug for each half coupling.

E. Mechanical Clamp-Type Couplings: Use grooved or shouldered ends as determined by the outside diameter of the pipe and per AWWA C606. Prepare the pipe ends to properly engage with the specified dimensions of the coupling manufacturer for a correct fit.

F. Flexible Pipe Couplings: Use plain end pipe and provide joint harnesses where shown. Flexible pipe couplings and harnesses shall conform to Standard Specification Section 15122.

2.13 PAINTING AND COATING APPLIED IN SHOP

A. Wrap exterior surfaces of buried pipe with polyethylene tape pipe coating and apply cement mortar overcoat where shown on the Drawings as di-electric coated per Standard Specification Section 09957. Apply coating in shop.

B. Cement mortar coat buried pipe where shown on the Drawings. Apply coating in shop.

C. Coat the exposed bare steel surfaces of the spigot and bell ends of each pipe section per Standard Specification Section 09900, System No. 15 (prime coat only). Apply primer in shop to the interior and exterior surfaces to a 2-mil dry film thickness.

D. Coat inside surfaces of threaded outlets and blind flanges per Standard Specification Section 09900, System No. 5. Apply coating in shop.

E. Coat the grooved and shouldered ends of pipe to be in contact with mechanical clamp-type couplings per Standard Specification Section 09900, System No. 5. Apply coating in shop to the described surfaces to a maximum of 10 mils dry film thickness.

F. Coat the ends of plain end pipe where flexible pipe couplings are to be installed per Standard Specification Section 09900, System No. 5. Apply coating in shop.

PART 3 - EXECUTION

3.01 LENGTH OF PIPE SECTIONS

Provide pipe with a maximum length of 30 feet unless spreader beams are used in lifting the pipe sections at the third points, in which case lengths up to 40 feet can be used.

3.02 PIPE CYLINDER FABRICATION

A. Longitudinal and Girth Welds: Fabricate the pipe cylinder by full penetration butt welding with spiral seam or straight seam. Limit girth welds to two per pipe section with full penetration butt welds. Limit longitudinal welds to one seam for pipe diameters less than 30 inches and two seams for 30- to 36-inch diameters. Stagger longitudinal seams of adjacent shell courses. When using spiral seam, coil splices shall be a minimum of 2 feet away from the ends of the pipe cylinder.

B. Preparation on Edges: Machine or face the ends and edges of pipe sections for butt welds. Inspect sheared edges of plates or sheets over 1/4-inch in thickness for cracks. Do not use plates or sheets with edges containing cracks.

1. If the ends are faced with a cutting torch, removed irregularities and scale due to burning by grinding or chipping.

2. The dimensions and shape of the edges of the plates to be joined by welding and the gap between the plates shall be such as to allow thorough fusion and complete penetration, and the edges of plates shall be properly formed to accommodate the various welding conditions. Remove projecting burrs. Do not use hammering to shape the edges preparatory to welding.

3. Cut plates true to line so that the edges, when in position for welding, shall be straight, parallel, and in contact on longitudinal seams.

4. The maximum gap between the edges of plates prior to welding shall not be more than 1/16-inch.

C. Forming:

1. General:

a. Before rolling or forming longitudinal edges, plates shall be lap broken by a continuous rolling operation or be formed in a press having dies that are machined to the proper radius. The pressure exerted during the lap breaking operation shall be sufficient to secure a true and uniform curve at the edges of the plate. Roll or press form plates to the specified diameter.

b. Continually remove scale and other foreign matter accumulating on the plate during the rolling and forming operation by an air blast so that it will not be rolled or pressed into the surface of the plate. Keep the surfaces of breaker dies and

rolls clear of bits of metal or other accumulated materials during forming operations.

c. Form each section of pipe to a true circle of the specified diameter throughout its entire length so as to produce a finished pipe truly round and free from dents, kinks, and abrupt changes in curvature. The outside circumference of the finished pipe shall not be less than its design value and shall not exceed its design value by more than 0.4%.

d. Complete rolling and forming prior to making butt welds.

e. Do not heat or hammer for the necessary forming of angles.

2. Minimum Radius: Do not use any forming process in which the plates are bent or otherwise formed during any stage of the process to a curvature of appreciably smaller radius than the radius of curvature corresponding to the specified diameter of the pipe.

3. Forming Bells:

a. Shape the bells to accommodate the spigot penetration. Form the bell on an expanding press or by being thrust axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to a round bell of required diameter and shape, avoiding injurious reduction in plate thickness at any point, and avoiding impairment of the physical properties of any part of the plate.

b. Do not use any process in which the bell is formed by rolling.

c. Bells for mitered pipe shall be normal to the axis of the adjacent course of the adjoining pipe, and the axis of any such bell shall be parallel to the axis of such adjacent course.

D. Preparation for Welding:

1. Fit Up:

a. Take special care in the layout of joints in which fillet welds are to be used in order to ensure the fusion of the weld material at the bottom of the fillet. Prior to welding, fit the plates closely; and during welding, hold them firmly together.

b. Tack weld or clamp in place the edges of butt joints in proper alignment and hold throughout the welding process. Do not use dogs, clips, lugs, or equivalent devices welded to the steel plate for the purpose of forcing it into position.

2. Cleaning:

a. Prior to welding, clean the surfaces of plates and members to be welded by an automatic process of all scale and rust for a distance of not less than 1-inch and of all oil or grease for a distance of not less than 3 inches from the welding edge and on both sides of the plates in the case of butt joints.

b. Remove grease or oil with lye or other solvent. Do not use kerosene or any heavier petroleum solvent.

c. Blasting and other cleaning shall preferably be done prior to any tack welding of the plates. Should inspection indicate a greater amount of porosity at the tack welds than in the remainder of the welds, sandblast the tack welds prior to automatic welding.

d. When it is necessary to deposit metal over a previously welded surface, remove any scale, slag, or welding flux thereon by a roughing tool, chisel, air chipping hammer, or other means to prevent inclusion of impurities in the weld metal.

3. Aligning: Where butt-welded joints are used, take particular care in aligning the edges to be joined so that complete penetration and fusion at the bottom of the joint is accomplished. The offset in abutting edges shall not exceed 1/16-inch at circumferential and spiral seams and shall not exceed 1/32-inch at longitudinal seams.

E. Fabrication of Specials: Fabricate specials from previously hydrostatically tested straight pipe sections.

3.03 WELDING

A. Material and Objective:

1. Perform welding by skilled welders who have had experience in the method and materials to be used. Welding operators shall be qualified under the standard qualification procedures of the ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications. Any welder or welding operator performing work shall have been qualified for the process involved within the past three years.

2. Perform welding by an unvarying arc-welding process, which excludes the atmosphere during the process of deposition and while the metal is in a molten state. The size and type of electrode used, the current and voltage required, and the type of wire and flux to be used for automatic processes shall be subject to review by the District's Representative.

3. Do not use rusted or damaged electrodes. Sift used flux from automatic welders free of fines and coarse pieces and remove mill scale before reusing.

4. Welds shall be of uniform composition, neat, smooth, full strength, and ductile. Make welds with a technique which will ensure uniform distribution of load throughout the welded section with a minimum tendency to produce eccentric stress or distortion in the weld or in the adjacent metal.

5. Make all welds in such manner and on such time schedule as to avoid residual internal stresses in the welded joints and stresses due to temperature changes in the completed pipe sections. Weld longitudinal seams before girth seams.

B. Quality of Welds:

1. There shall be no greater evidence of oxidation in the metal of the weld than in the metal of the unwelded plate. Welded joints shall be of a type that will produce complete fusion of the plates and shall be free from unsound metal, pinholes, and cracks.

2. The finish of welded joints shall be reasonably smooth and free from grooves, depressions, burrs, and other irregularities. There shall be no valley or undercut in the center or edges of any weld.

3. Any pipe section which shows irregularities in shape after welding may be rerolled to make it cylindrical, but in no case shall it be reformed by hammering, and in no event shall reforming be permitted of pipe sections which after welding are found to have abrupt changes in curvature at longitudinal seams, unless such welds are subsequently removed and rewelded following the reforming operation.

4. Back chipping on both automatic and hand welding, whether for repairs or preparation of the groove for the original weld, are subject to inspection by the District's Representative before being filled with weld metal. Do not make butt welds prior to the completion of the rolling and forming. Grind butt welds for both hand and automatic welding to sound metal before welding the reverse side.

C. Longitudinal Joints:

1. Longitudinal joints shall be double butt welded by a fully automatic welding process, using welding heads which permit visual investigation of the deepest point of penetration of the first pass and which permit backfilling of extensive repair cuts by the automatic process. Use starter and runoff plates for longitudinal weld. The first pass on longitudinal welds shall be on the inside of the pipe and shall accomplish at least 75 percent of the complete penetration.

2. Joint welds shall be continuous for the full length of the seam, and shall be built up uniformly at the center of the weld to form a reinforcement on both sides of the plate. The bead on the outside of the pipe shall have a height of at least 1/16-inch and no more than 3/32-inch and a minimum width of at least one and one-half times the thickness of the plate; provided that in any case the weld and penetration shall be of sufficient width so that both edges to be joined shall be entirely involved in the weld, regardless of a possible inaccuracy in the line of travel of the automatic electrode. Where the welding method permits a considerable deviation in the line of travel of the welding head, place a scribed line parallel to and at a fixed distance from the edges of the plates prior to welding so that the location of the welding bead with regard to the plate joints may be readily checked.

3. Where welding on small pipe is done from one side only, remove the bead on the inside of the pipe by chipping so that the finished weld on the inside of the pipe will be practically flush with the plates. The inside bead will in no case be required to be larger than the outside bead but shall be of sufficient size so that, upon its removal, the inside fusion lines and any defects near the under surface of the weld metal will be exposed.

4. If complete penetration and reinforcement on both sides of butt-welded joints are not satisfactorily accomplished, when the welding is done from one side, then chip out the reverse side to the extent necessary to secure a clean surface of the originally deposited weld metal and make an automatic welding pass on the reverse side. The bead on the inside of the pipe shall be not more than 1/16-inch in height and the width of the bead shall be not less than 3/8-inch with smoothly tapered edges. Before making the second weld, chip out the underside of the first weld with a round-nosed tool until entirely solid and clean metal is reached.

5. Welding shall be subject to the requirement that there shall be no valley, groove, or undercut along the edge of or in the center of the weld, and that the deposited metal shall be fused smoothly and uniformly into the plate surface at the edges of the joint.

6. If the normal welding process is interrupted for any reason, take special care when welding is resumed to get full penetration and thorough fusion between the weld metal and the plates and the weld metal previously deposited. Where welding is interrupted by faulty machine operation, chip back the weld to where the presence of solid, clean metal indicates correct machine operation before resuming welding operations.

D. Shop Circumferential Joints and Spiral Seam Joints: Shop circumferential and spiral seam joints shall be double butt welded. The details of shop circumferential and spiral seam joints shall conform to the requirements for longitudinal joints as given above. Circumferential joints in bends and welded fabricated fittings need not be made by automatic welding methods.

E. Defects: Completely chip out porosity and cracks, trapped welding flux, or other defects in the welds in a manner which will permit proper and complete repair by welding. Repair defective welds by hand welding. Where the defect is so extensive as to make a hand repair impractical, use automatic welds.

F. Equipment: In welding by an automatic process, both the rate of deposition of weld metal and the rate of travel of the electrode shall be automatically controlled. Use the submerged arc welding process for automatic welding.

3.04 SHOP TESTING

A. General: After completion of fabrication and welding in the shop, and prior to the application of any lining or coating, test each component according to the following requirements.

B. Shop Test Requirements:

1. Perform tests of production welds in accordance with AWWA C200 for each heat of steel used. A guided-bend test specimen shall be considered as having passed only if no crack or other open defect exceeding 1/8-inch measured in any direction is present in the weld metal or heat affected zone of the base material after the bending. A tension test specimen shall be considered as having passed only if failure occurs in the base metal at a stress in excess of the minimum specified tensile strength. There shall be at least one set of welding tests as described in AWWA C200, Section 3.3.5 for each 1,000 linear feet of spiral seam weld in addition to tests specified in Section 3.3.6 of the same standard.

2. Test each straight pipe section in the shop by the hydrostatic test method.

3. Inspect all welds in the expanded portion of the pipe bell in accordance with the magnetic particle test.

4. Test backgouge and completed weld of all manual process groove welds by the liquid penetrant method. Test completed fillet welds by the liquid penetrant method.

5. Any production weld or manual process weld that appears to be of poor quality as determined by the District's Representative shall be subjected to 100 percent

radiographic testing. One hundred percent ultrasonic testing may be used in lieu of 100 percent radiographic testing.

6. After shop fabrication, retest each pipe section with a mitered bend or reducer. Test the mitered or butt joints by 100 percent radiographic testing.

7. After shop fabrication, retest each pipe section with an attached outlet. Test the collar or wrapper with the soap and compressed air method. Test the outlet by the liquid penetrant method.

8. Test each slip-on or ring type flange welded to the pipe by the liquid penetrant method and with the soap and compressed air method.

C. Test Methods:

1. Shop Hydrostatic Test: Vent air from the pipe section before the test pressure is applied. Hold the test pressure on each section for a sufficient length of time to permit inspection of all joints.

2. Use the following hydrostatic test pressure for testing straight pipe sections:

$$P = \frac{2ST}{D}$$

Where P = Hydrostatic test pressure, PSI
S = Stress, PSI, use 75% of the minimum yield point of the steel
T = Wall thickness of the steel pipe section to be tested in inches
D = Actual outside diameter of the steel pipe section to be tested in inches

3. When subjected to the above hydrostatic test pressure, the pipe shall show no leaks, distortion, or other defects. Repair any leaks or other defects which develop during the hydrostatic test by chipping out and rewelding, after which the repaired section shall again be tested until it shows no leaks or other defects.

4. Test Bulkheads: Furnish and attach suitable dished heads and blind flanges for making the hydrostatic tests, and after completion of the tests, remove the heads and properly restore the ends of the sections.

5. Radiographic Test: Make the radiographs in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels. Repair defects in the welds disclosed by the radiographs. Submit all radiographs and the notation of areas for repair to the District's Representative for review.

6. Ultrasonic Test: Make the ultrasonic tests in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels. Repair defects in the welds disclosed by ultrasonic testing. Prepare a report of the ultrasonic testing and submit to the District's Representative for review.

7. Soap and Compressed Air Test: Use compressed air at maximum 40-psi pressure into the joint, and while the joint is under pressure, swab every portion of every welded seam forming a part of the joint with a heavy soap solution or a commercial

bubble-producing leak test fluid. Examine for leakage. Repair any defects disclosed by the test by chipping out, rewelding the chipped section, and retesting. Drill and tap the necessary test holes, and plug weld the holes after testing.

8. Liquid Penetrant Test: Conform to the requirements specified in ASTM E 165, Method B. The materials used shall be either water washable or nonflammable. Products: "Spotcheck" by the Magnaflux Corporation or "Met-L-Check Flaw-Findr" by the Met-L-Check Company. Chip out all defects, reweld, and retest the section affected until it shows no leaks or other defects.

9. Magnetic Particle Test: Magnetic particle test shall conform to the requirements specified in ASTM E 709, using the wet particle technique. Chip out all defects, reweld, and retest the section affected until it shows no leaks or other defects.

D. Pipe Fit Up at Flexible Pipe Couplings:

1. The following procedures shall be witnessed and accepted by the District's Representative in order to verify that the pipes are appropriately sized where the pipes are to be joined by a flexible coupling.

2. Obtain the specifications and fabrication tolerances for the specific flexible pipe coupling to be used. Deliver this information and the flexible pipe coupling to the pipe manufacturer. See Standard Specifications Section 15122. At each location where a flexible pipe coupling is to be installed, fabricate the pipe to a tolerance that will ensure proper fit of the flexible pipe coupling per the coupling manufacturer's requirements.

3. After fabrication of the pipe sections and application of the required coatings on the pipe, assemble the two pipe ends and the flexible coupling in the shop in the same alignment and configuration as the pipe will be assembled in the field. Check for ease of assembly and any evidence of an inadequate seal between the pipe and flexible pipe coupling.

4. If any evidence of inadequate seal is observed, repair the pipe in a manner acceptable to the District's Representative. Repeat the assembly and repair process until satisfactory results are achieved. If excessive repairs to the pipe are needed, the District's Representative may require, at his sole discretion, that a new section of pipe be fabricated.

5. Before disassembling the parts, mark the parts so that they can be re-assembled in the same orientation in the field.

6. Before any final acceptance by the District's Representative, test, and repair as necessary, any damages to the pipe coatings and linings caused by the fit-up procedure.

3.05 ALIGNMENT CRITERIA

A. For horizontal and vertical curve alignment, use straight or beveled pipe of normal or one-half normal lengths pulled partially open on one side of the joint or use pipes with a welded mitered bend of up to 10 degrees next to the bell end. Design pipes with a bend in excess of 10 degrees as a special. Do not use angular deflections at butt strap joints.

B. Deflection by Pulled Joints:

1. For rubber gasket joints, do not pull joint more than one-half of the watertight extensibility provided by the bell and spigot design or more than 3/4-inch on the outside of the curve. Minimum interior joint space shall be 1/2-inch.

2. For welded joints, do not pull joint to exceed the minimum overlap of the assembled bell and spigot lap joint or more than 1/2-inch on the outside of the curve. Minimum overlap of the assembled joint shall be 1-inch or 3 times the pipe wall thickness, whichever is greater per AWWA C206. Minimum interior joint space shall be 1/4-inch.

C. Deflection By Beveled Joints: For welded joints only, use pipe sections having beveled bell ends for curves and angles in the alignment which cannot be accomplished using the maximum allowable deflection by pulled joints. Beveled pipe sections used in curved alignment shall be of standard length except when shorter sections are required to fit the radius of curvature in which case all sections shall be of equal length. Do not bevel spigot ends. The beveled end of a pipe shall not have a deflection from a plane perpendicular to the pipe axis exceeding 5 degrees. Form the bell end perpendicular to the plane of the beveled end, so there is no loss of lap joint tolerance. Do not pull beveled joints.

D. Deflection By Mitered Bends: For rubber gasket joints and welded joints, use pipe sections with welded mitered bends of up to 10 degrees next to the bell end for curves and angles which cannot be accomplished using the maximum allowable deflections by pulled or beveled joints. Pipe sections with mitered bends used in curved alignment shall be of standard length except when shorter sections are required to fit the radius of curvature in which case all sections shall be of equal length.

3.06 THICKNESS OF INTERIOR MORTAR LINING

Conform to AWWA C205 except provide minimum thickness of mortar lining over steel cylinder and steel specials as follows:

Nominal Pipe Size (inches)	Lining Thickness (inches)
6 through 12	5/16
14 and 16	1/2
18 through 36	3/4

3.07 THICKNESS OF EXTERIOR MORTAR COATING OVER METALSURFACES

Conform to AWWA C205 except provide 1-1/4 inches minimum thickness of mortar coating over all metal surfaces, except at flanges. Coating within one bolt length of a flange shall be held to 50 percent of the above thickness.

3.08 PROTECTIVE COATING ON PIPE ENDS WITH MORTAR LINING AND COATING

Coat the exposed bare steel surfaces of the spigot and bell ends of each pipe section in the shop. Apply primer to the interior and exterior steel surfaces to a 2-mil dry film thickness.

3.09 POLYETHYLENE TAPE PIPE COATING WITH MORTAR ARMOR COAT

Where it is shown on the Drawings that polyethylene tape coating with mortar armor coat is to be used on the exterior of the pipe and specials, see Standard Specification Section 09957.

3.10 PRODUCT MARKING

Plainly mark each length of straight pipe and each special at the bell end to identify the proper location of the pipe item by reference to the layout schedule. For beveled joints and mitered bends at the bell end, show the degree of bevel or miter and the point on the circumference to be laid uppermost.

3.11 SHIPPING AND HANDLING

A. When loading pipes and specials for shipment to the project site, use wooden stringers between pipe layers and secure the load with padded chains or ribbon binders. Place internal braces for pipes 24 inches in diameter and larger prior to loading.

B. Lift pipes and specials for loading with wide nylon straps, wide canvas or padded slings, wide padded forks, and skids designed to prevent damage to the pipes and specials. Do not use cable slings or chains.

C. Place plastic caps over the ends of the pipes and specials. Replace caps damaged during shipment to the project site.

D. Do not drop, roll, or damage the pipes and specials.

3.12 INSTALLATION

See Standard Specification Section 15251.

END OF SECTION