

**VALLECITOS WATER DISTRICT**  
**SECTION 15076 – CEMENT-MORTAR LINED AND COATED STEEL PIPE**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. This section includes materials, design, fabrication, testing, and installation of cement-mortar lined and/or cement-mortar coated welded steel pipe with special pieces in accordance with AWWA C200, C205, C208 and the following options and restrictions to be used in water transmission pipelines 16-inches and larger.
- B. A special is defined by any piece of pipe other than a normal full length straight section pipe. This includes, but is not limited to elbows, manhole sections, short pieces, reducers, tees, crosses, ellipsoidal dished heads, and adapter sections with special ends, sections with outlets, beveled sections, and etcetera.

**1.2 RELATED WORK SPECIFIED ELSEWHERE**

- A. All related work specified elsewhere, or in other codes or standards, will be as last revised, unless a specific date of issuance is called out in opposition to later revision date(s).
- B. Other sections of the Standard Specifications, not referenced below, shall also apply to the extent required for proper performance of this Work.
  - 1. Section 01300 - Submittals
  - 2. Section 02223 - Trenching, Backfilling, and Compacting
  - 3. Section 09900 - Painting and Coating
  - 4. Section 15000 - Piping Components
  - 5. Section 15041 - Disinfection of Piping
  - 6. Section 15042 - Hydrostatic Testing of Pressure Pipelines
  - 7. Section 15045 – Closed-Circuit Television (CCTV) Inspection
  - 8. Section 15050 - General Piping Requirements

**1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

- A. The following standards have been referenced in this Section:
  - 1. American National Standards Institute (ANSI)
    - a. B16.1 Cast Iron Pipe Flanges and Flanged Fittings
    - b. B16.5 Flanges and Flanges Hinges
    - c. B16.11 Forged Steel Fittings, Socket-Welding and Threaded

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- d. B16.47 Large Diameter Steel Flanges
- e. B36.10 Welded and Seamless Wrought Steel Pipe
- 2. American Society for Testing and Materials (ASTM)
  - a. A36 Structural Steel
  - b. A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  - c. A82 Steel Wire, Plain, for Concrete Reinforcement
  - d. A105 Forgings, Carbon Steel, for Piping Components
  - e. A106 Seamless Carbon Steel Pipe for High-Temperature Service
  - f. A181 Forgings, Carbon Steel, for General-Purpose Piping
  - g. A185 Steel Welded Wire Reinforcement, Plain, for Concrete
  - h. A216 Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
  - i. A234 Piping Fittings of Wrought Carbon Steel And Alloy Steel for Moderate and Elevated Temperatures
  - j. A283 Low and Intermediate Tensile Strength Carbon Steel Plates
  - k. A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products
  - l. A516 Pressure Vessel Plates, Heat-Treated Carbon-Manganese-Silicon Steel
  - m. A572 High Strength Low-Alloy Columbium-Vanadium Structural Steel
  - n. A1011 Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
  - o. A1018 Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled Carbon, Structural, High-Strength Low-Alloy Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.
  - p. C33 Concrete Aggregates

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- q. C40 Test method for Organic Impurities in Fine Aggregate for Concrete
  - r. C87 Test method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
  - s. C136 Method for Sieve Analysis of Fine and Coarse Aggregates
  - t. C150 Portland Cement
  - u. E94 Standard Guide for Radiographic Examination
  - v. E165 Practice for Liquid Penetrant Inspection Method
  - w. E709 Practice for Magnetic Particle Examination
  - x. E1032 Standard Test Method for Radiographic Examination of Weldments
3. American Society of Mechanical Engineers (ASME)
- a. AMSE Boiler and Pressure Vessel Code, Section VIII
  - b. ASME Boiler and Pressure Vessel Code, Section IX
4. American Water Works Association (AWWA)
- a. C200 Steel Water Pipe 6-Inch or Larger
  - b. C205 Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4-inches and Larger, Shop Applied
  - c. C207 Steel Pipe Flanges for Waterworks Services-Sizes 4 inches through 144-inches
  - d. C208 Dimensions for Fabricated Steel Water Pipe Fittings
  - e. M11 Steel Pipe Guide for Design and Installation
5. American Welding Society (AWS)
- a. D1.1 Structural Welding Code, Steel
6. American Society for Nondestructive Testing (ASNT)
- a. SMT-TC-1A, Recommended Practice

1.4 SUBMITTALS

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- A. The following shall be submitted in accordance with the Standard Specifications:
1. Submit an affidavit of compliance with AWWA C200, C205, C208.
  2. Submit detailed shop drawings for the pipe and specials showing:
    - a. Materials of construction, including references to industry standards being met (i.e. ASTM, ANSI, AWWA, etc.).
    - b. Order of installation and closures with designation by piece number for each steel pipe and fabricated special to be furnished and installed.
    - c. Pipe station and invert elevation at each change of grade and horizontal alignment.
    - d. Elements of curves and bends, both in horizontal and vertical alignment including elements of the resultant true angular deflections in case of combined curvature.
    - e. Pipe outside diameter, wall thickness, lining and coating thickness, location of welded seams, and working pressure rating.
    - f. Locations of bulkheads for field hydrostatic testing of pipeline. Testing against valves shall not be permitted.
    - g. Locations of closures, including cut-to-fit allowances, for length adjustment and for construction convenience.
    - h. Locations and laying lengths of valves, meters, manholes, and other mechanical equipment which determine piping dimensions.
    - i. Limits of each reach of field-welded joints, rubber gasket joints, and of concrete encasement.
    - j. Call out weld sizes and dimensions of thrust ring collars, grooved end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.
    - k. Paint primer type and thickness where joints and other cement-mortar holdbacks occur.
  3. Submit joint details. Include insulting joints.
  4. Submit details of lining and coating.
  5. Submit drawings of butt straps, couplings, and flanges.
  6. Submit details of bulkheads and of their method of attachment to the pipeline.

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7. Submit calculations supporting the sizing of reinforcing collar plates, wrapper plates or crotch plates, supporting selected wall thickness of pipe and specials, and supporting welded joint design and joint welding details.
8. Submit certificate that cement complies with ASTM C150, designating type.
9. Submit certified copies of mill test reports on each heat from which steel is rolled.
10. Submit test reports on physical properties of rubber used in gaskets.
11. Certification of dye penetrant shop-weld testing.
12. Document and certify by pipe mark number that cement mortar lining thickness measurements meet the requirements as specified herein for each pipe, fitting, and pipe special.
13. 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.
14. Shop drawings of all pipes and specials shall be submitted to the District Engineer or their designee for review. The Contractor and Engineer shall both review and mark the review action taken, before submitting to the District. Shop drawings shall be complete in all respects. If the shop drawings show any deviations from the requirements of the Approved Plans and specifications because of standard shop practices or other reasons, the deviations and the reasons therefore shall be set forth in the District approves Submittal Form.
15. 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.
16. Installation Schedule
17. Shop and field welder qualification certificates and records for each welder, including a reference list of three completed buried pipeline welding projects.
18. Inspection reports and field tests results for all field welding.
19. Certificates of welding rods used for field welding.

**1.5 QUALIFICATIONS OF MANUFACTURERS**

- A. Only manufacturers who manufacture a complete lined and coated pipe can be qualified for this work. All pipe manufacturing operations shall be performed at the same location for all pieces of pipe. Supervisors of cement-mortar coating operations shall have at least two

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years' continuous recent experience in the application of cement-mortar coating systems for steel pipe.

- B. Welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by independent local, approved testing agency not more than six months before commencing work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

**1.6 INSPECTION AND FIELD VERIFICATION**

- A. The District Engineer 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, 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. The field verification shall be performed in the presence of the District Engineer or their designee. 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.
- C. When required by the District, the Contractor shall provide a certified and qualified welding inspector at no cost to the District. Contractor is responsible for performing Quality Control in accordance with AWS D1.1 requirements during installation and welding operations.

**1.7 CERTIFICATIONS**

- A. Certifications: Furnish a certified affidavit of compliance for all pipe and other products, materials, or related work upon delivery to the jobsite, provided under this Section, as specified in ANSI/AWWA C200, C205, C206, and C602, respectively, and the following supplemental requirements:
  - 1. Compliance with the additional requirements included in the Standard Specifications.
  - 2. Physical and chemical properties of all steel.
  - 3. Hydrostatic test reports.
  - 4. Results of production weld tests.
  - 5. Sand, Cement, and mortar tests.
  - 6. Rubber gasket tests.
  - 7. All materials are NSF approved for use with potable water.
  - 8. All welds were performed in conformance with these Standard Specifications.

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- B. All expenses incurred in making samples or collecting data for certification of tests shall be borne by the Contractor at no increased cost to the District.

**PART 2 – PRODUCTS**

2.1 DESIGN CRITERIA

- A. Obtain the following information from the Approved Plans:
1. Elevation of pipe invert and 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. Normal pipe size. The nominal diameter or inside diameter of the pipe and other fabricated steel sections as shown on the Approved Plans is the clear diameter of the lined pipe after the application of the interior mortar lining.
  5. Location of single or double lap welded and butt-welded joints.
- B. Field hydrostatic test pressure shall be as indicated in the Standard Specifications, unless noted otherwise on the Approved Plans.
- 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  
               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 thickness shall prevail:

Nominal Pipe Size (inches)	Minimum Thickness (inches)
6 to 12	0.1875
14 to 36	0.2500
> 36	TBD (0.3125 min)

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3. Steel cylinder outside diameters for pipe twelve inches (12”) 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 pipe larger than twelve inches (12”) in nominal diameter, the steel cylinder outside diameter shall meet the following minimum dimensions:

Nominal Pipe Size (inches)	Steel Cylinder Outside Diameter (inches)
14	15.375
16	17.375
18	19.375
20	21.875
24	25.875
27	28.875
30	31.875
33	34.875
36	37.875

**2.2 SPECIALS**

- A. Fabricated steel fittings shall comply with AWWA C208. For elbows, unless otherwise noted, 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 thickness shall prevail for a special.

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

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

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

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

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

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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  $(2W + ID \text{ outlet} / \sin B)$ , and it extends 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, twelve-inches (12”) and smaller, shall be standard weight conforming to ASTM A53 (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 gaskets in accordance with the Standard Specifications.

2.3 STEEL FOR PIPE AND SPECIALS

- A. Use steel conforming to ASTM A36, ASTM A283 Grade D, ASTM A1011 SS Grade 36, ASTM A1018 SS Grade 36 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.

2.4 CEMENT FOR INTERIOR MORTAR LINING

- A. Use cement conforming to ASTM C150, Type II.

2.5 CEMENT FOR EXTERIOR MORTAR COATING

- A. Use cement conforming to ASTM C150, Type II.

2.6 FLANGES

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

2.7 BOLTS, NUTS, WASHERS, AND GASKETS FOR FLANGES

- A. Bolts, nuts, washers, and gaskets for flanges shall be per the Standard Specifications.

2.8 INSULATING FLANGE SETS

- A. Install insulating flange sets as shown in the Approved Plans, and per the Standard Specifications.

2.9 OUTLETS

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- A. For threaded outlets three inches (3”) and smaller, use a Thredolet type per AWWA Manual M11 (Current Edition), Chapter 13. Outlets shall be 3000 pound WOG forged steel per ASTM A105 or ASTM A216, Grade WCB. Threads shall comply with ANSI B1.20.1, NPT. Do not use pipe couplings for outlets.
- B. Threaded insulating bushings as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved in accordance with the Standard Specifications.

**2.10 MECHANICAL CLAMP-TYPE COUPLINGS**

- A. Mechanical clamp-type couplings for grooved or shouldered end pipe shall be per the Standard Specifications.
- B. Couplings for pipe, twelve three fourths-inches (12-3/4”) 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, fifteen three eighths-inches (15-3/8”) 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.

**2.11 TYPE OF PIPE JOINTS**

- A. Joint ends of pipe sections shall be as indicated on the Approved Plans.
- B. Welded joints: Use expanded bell with matching spigot to penetrate a minimum of two and a half inches (2-1/2”) 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 an eighth inch (1/8”) on diameter with the joint gap equalized around the perimeter. Lap joints prepared for field welding shall be in accordance with ANSI/AWWA C200 and 206. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Unless otherwise approved by the District Engineer, bell ends shall be formed by an expanding press or by the pipe being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. The ends shall not be rolled. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
- C. Flanges: Use slip-on or ring-type welded to the interior and exterior circumference of the pipe section. Weld-neck flanges (conforming to ANSI B16.5) shall be provided for piping 4-inches in diameter and smaller to connect to flanged valves, fittings and equipment. Slip-on or weld-neck flanges shall be provided for piping 4-inches in diameter. Flanges shall match the connecting flanges on adjacent fitting, valve or piece of equipment.
- D. Butt Strap Closures: Butt straps shall be the same thickness and material as the pipe wall, at least ten inches (10”) 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 joint. Weld a six inch (6”) threaded, steel, standard half-coupling or couplings to the interior and exterior of the tip butt strap half-section to provide access for mortar lining the inside of the joint.

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Provide two couplings for pipes eighteen-inches (18”) to thirty inches (30”) at the 2 and 10-o’clock position. 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 Couplings: Use plain end pipe and provide joint harness where shown. Flexible couplings and harness shall conform to Approved Material List, latest edition.

**2.12 PAINTING AND COATING**

- A. Cement and mortar coat all buried pipe where shown on the Approved Plans. Apply coating in shop.
- B. Coat the exposed bare steel surfaces of the spigot and bell ends of each pipe section per the Standard Specifications, System No. 15 (prime coat only). Apply primer in shop to the interior and exterior surfaces to a 2-mil dry film thickness.
- C. Coat inside surfaces of threaded outlets and blind flanges per the Standard Specifications, System No. 5. Apply coating in shop.
- D. Coat the grooved and shouldered ends of pipe to be in contact with mechanical clamp-type couplings per the Standard Specifications, System No. 5. Apply coating in shop to the described surfaces to a maximum of 10-mils dry film thickness.
- E. Coat the ends of plain end pipe where flexible pipe couplings are to be installed per the Standard Specifications, System No. 5. Apply coating in shop.

**PART 3 – EXECUTION**

**3.1 LENGTH OF PIPE SECTIONS**

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

**3.2 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 up to thirty inches (30”) and two seams for thirty inches (30”) to thirty six inch (36”) diameters. Stagger longitudinal seams of adjacent shell courses. When using spiral seam, coil splices shall be a minimum of two feet (2’) away from the ends of the pipe cylinder.
- B. Preparation of Edges: Machines or face the ends and edges of pipe sections for butt welds. Inspect sheared edges of plates or sheets over a fourth inch (1/4”) in thickness for cracks. Do not use plates or sheets with edges containing cracks.

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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 one sixteenth inch (1/16").

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

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as to stretch the steel plate beyond its elastic limit to a round bell of required diameter and shape, avoiding injurious reduction in plate 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 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 surface of plates and members to be welded by an automatic process of all scale and rust for a distance of not less than one inch (1") and of all oil or grease for a distance of not less than three inches (3") 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:

- a. 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 one

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sixteenth inch (1/16") at the circumferential and spiral seams and shall not exceed one thirty second inch (1/32") at longitudinal seams.

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

**3.3 SHOP 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 Engineer of their designee.
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
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 re-welded following the reforming operation.

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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 Engineer or their designee 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 one sixteenth inch (1/16") and no more than three thirty second inch (3/32") 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 one sixteenth inch (1/16") in height and the width of the bead shall be not less than three eighth inch (3/8") 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.

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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 the weld metal and the rate of travel of the electrode shall be automatically controlled. Use the submerged arc welding process for automatic welding.

3.4 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 the 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 one eighth inch (1/8") 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 back-gouge and completed weld of all manual process groove welds by the liquid penetrant method. Test completed fillet welds by the liquid penetrant method.

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5. Any production weld or manual process weld that appears to be of poor quality as determined by the District Engineer or their designee 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 testing, 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 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 re-welding, 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 and defects in the welds disclosed by the radiographs. Submit all radiographs and the notation of areas for repair to the District Engineer or their designee 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 Engineer or their designee for review.

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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, re-welding the chipped section, and retesting. Drill and tap the necessary test holes, and plug weld holes after testing.
8. Liquid Penetrant Test: Conform to the requirements specified in ASTM E165, 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, re-weld, 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 E709, using the wet particle technique. Chip out all defects, re-weld, and retest the section affected until it shows no leaks or other defects.

**3.5 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 the 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 three fourth inch (3/4”) on the outside of the curve. Minimum interior joint space shall be half inch (1/2”).
  2. For welded joints, do not pull joint to exceed the minimum overlap of the assembled bell and spigot lap joint or more than one half inch (1/2”) on the outside of the curve. Minimum overlap of the assembled joint shall be one inch (1”) or 3 times the pipe wall thickness, whichever is greater per AWWA C206. Minimum interior joint space shall be one fourth-inch (1/4”). Maximum interior joint space shall be two inches (2”).
- 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. From 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

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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.

3.6 THICKNESS OF INTERIOR MORTAR LINING

- A. 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 10	3/8
12 through 18	1/2
20 through 36	3/4

3.7 THICKNESS OF EXTERIOR MORTAR COATING

- A. Conform to AWWA C205 except provide three-quarter inch (3/4") 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.

3.8 PRODUCT MARKING

- A. Plainly mark each length of straight pipe and each special at the bell end to identify the date of manufacture and 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.

3.9 INSTALLATION

- A. Delivery and Temporary Storage of Pipe
1. 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 twenty four inches (24") in diameter and larger prior to loading.
  2. Limit onsite pipe storage to a maximum of one week. Place the pipe in the numerical order in which it is to be installed and secure it from rolling. Support the pipe on wooden blocks, sandbags, mounds of sand, or other suitable supports. Place the supports at about the one quarter point from the pipe ends. Do not roll or drop the pipe on the ground or allow the pipe to fall from the pipe trailer trucks.
  3. Place plastic caps over the ends of the pipes and specials. Replace caps damaged during shipment to the project site. Do not remove the plastic caps placed over the ends until the pipe is ready to be placed in the trench. Plastic caps may be opened temporarily to spray water inside the pipe for moisture control. Replace plastic caps damaged during shipment.

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**B. Handling of Pipe**

1. Lift pipes and specials with mechanical equipment using spreader beams or 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 directly bearing on the pipe. Lift pipes at two points, at approximately a third (1/3) to a fourth (1/4) of the pipe length from the pipe ends.
2. For pipes twenty four inches (24") in diameter and larger, maintain internal braces placed in pipes until backfilling is complete. Where the pipe is to be concrete encased, do not remove internal braces until the concrete has set hard and the subsequent backfill has been completed.
3. Measure each pipe and special to check the laying length against the tabulated layout schedule for fabrication accuracy. Mark the required stab depth of the spigot end around the circumference of each pipe and special prior to joint assembly.
4. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective damage or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench.

**C. Sanitation of Pipe Interior**

1. During laying operations, do not place tools, clothing, or other materials in the pipe. Keep the interior of the pipe clean as the pipeline construction progresses. The purpose of maintaining a clean interior is to aid in the passage of the bacteriologic quality testing after disinfection.
2. When pipe laying is not in progress, including the noon, hour, close the ends of the installed pipe with a plug to deter entry of vermin, children, dirt, and storm water.

**D. Installing Pipe in Trench**

1. Trenching, Backfilling, and Compacting, Shoring, and Dewatering shall be in accordance with the Standard Specifications.
2. Lay pipes uphill if the grade exceeds 10 percent.
3. Place and compact the pipe base material (imported sand).
4. Cut a depressing to accommodate the pipe bell, external joint filler form, and polyethylene encasement at valves and flanges; and spaces to permit removal of the pipe handling slings.
5. Handle pipe and specials in a manner to avoid any damage to the pipe or coatings. Do not drop pipe or specials into trenches under any circumstances.
6. Lay each pipe and special in the order and position shown on the tabulated layout schedule. Lower the pipe onto the pipe base and install it to line and grade along its

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full length on firm bedding except at the bell and at the sling depressions. Laying tolerances for the installed pipe shall not vary greater than 0.3-foot horizontally, or greater than 0.1-foot vertically from the alignment and elevations shown on the tabulated layout schedule.

7. When installing pipe with beveled joints or mitered bends at the bell end, do not deviate the pipe top mark by more than two inches (2") from the vertical line passing through the pipe center.
8. Do not cut or modify a fabricated steel special in the field. Notify the District Engineer or their designee immediately in the event of interferences with the installation of adjoining components.
9. For all pipes, regardless of diameter, the District will require that the Contractor provide closed-circuit television (CCTV) inspection in accordance with the Standard Specifications of the completed interior mortar joints in the installed pipe at an interval of approximately nine hundred and sixty feet (960') or less. This inspection will be reviewed by the District Engineer or their designee. No additional pipe will be allowed to be installed in the trench until the interior joints have been inspected and repaired. An interior joint will be considered a failed joint when cement mortar does not fill the gap 100 percent between the adjacent mortar linings of the two joined pipes. All failed joints will be repaired by cutting out the joint and installing a butt strap closure. The inspection equipment shall be capable of providing distance readings; high quality visual transmission to the monitor; tape recordings; brightness, contrast, and focus adjustments; 360-degree camera head rotation within a 90-degree plane from the longitudinal centerline of the pipe; and remote operation.
10. For pipes twenty four inches (24") in diameter and larger, the amount of pipe to be laid and assembled in a trench shall be limited to a distance of approximately three hundred and twenty feet (320'). No additional pipe will be allowed to be installed in the trench until the other related operations of pipeline construction are completed. Other operations include, but are not limited to, joint welding or bond wires, grouting of exterior pipe joints, backfilling and compacting, removal of internal braces, completion of interior joints, and inspection by the District Engineer or their designee. The intent of this limitation is to provide a safe environment for the construction and inspection of the pipeline. The interior of the pipeline is considered a confined or enclosed space having a limited means of egress which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere.
11. All ferrous metal pipes and all pipes specified or shown on the Approved Plans to be cathodically protected shall be completed in accordance with the Approved Plans and specifications.
12. Warning and locator tape shall be installed on all pipelines per the Standard Specifications.

E. Installing Polyethylene Encasement

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1. Wrap buried valve and flanges with polyethylene material per the Standard Specifications. Repair polyethylene material damaged during construction.

**F. Assembling Pipe Joints**

1. Clean the ends of the pipe to be joined of foreign material.
2. For rubber gasket joints, apply a food grade and biodegradable lubricant to the inside of the bell of the pipe in the trench and to the rubber gasket and spigot groove of the pipe to be installed. Stretch the rubber gasket into the groove of the spigot end of the pipe to be inserted and distribute it uniformly around the circumference. Immediately lower the pipe to be installed into the trench and, without tilting the pipe, entire its spigot into the bell of the pipe in the trench. Use come-a-longs or pipe jacks to drive spigot end home horizontally. Maintain joint recess recommended by pipe manufacturer for made-up joint.
3. For field-welded joints and pipes smaller than twenty four inches (24") in diameter, lower the pipe to be installed into the trench. Slightly tilt up the pipe to be installed and enter its spigot into the top portion of the bell of the pipe in the trench. Continue to lower the pipe to be installed and push the spigot end into the bell horizontally to the marked stab depth on the spigot. Maintain a minimum fourth inch (1/4") to maximum two inch (2") joint space.
4. For field-welded joints and pipes twenty four inches (24") in diameter and larger, lower the pipe to be installed into the trench. Slightly tilt up the pipe to be installed and enter its bell onto the top portion of the spigot of the pipe in the trench. Continue to lower the pipe to be installed and push the bell onto the spigot horizontally to the marked stab depth on the spigot. Maintain a minimum fourth inch (1/4") to maximum two inch (2") joint space for welded joints.

**G. Installing Pipe in Vaults**

1. Install pipe in vaults without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Provide temporary supports and place the assembled piping at the correct grade and position in the vault.
2. Provide pipe supports per the Standard Specifications or as shown on the Approved Plans.
3. Link seal assemblies shall be installed at all pipe penetrations in accordance with the Standard Specifications.

**H. Installing Flanged Joints**

1. Flanged joints shall be installed per the Standard Specifications.

**I. Installing Insulating Flange Sets**

1. Insulating flange sets as shown in the Approved Plans shall be installed per the Standard Specifications.

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J. Installing Mechanical Clamp-Type Couplings

1. Install mechanical Clamp-Type couplings in accordance with the manufacturer's recommendations and the Standard Specifications.

K. Installing Flexible Pipe Couplings

1. Install flexible pipe couplings and joint harnesses where shown per the manufacturer's recommendations.

L. Field Welded Joints

1. Field welding shall be completed and inspected by the District Engineer's designee or an approved welding inspector prior to the application of cement mortar to the interior joint and cement grout to the exterior joint.
2. Provide single or double welded lap joints and butt strap closures where indicated on the Approved Plans. The minimum overlap of the assembled lap joint shall be one inch (1") or 3 times the pipe wall thickness, whichever is greater per AWWA C206.
3. Field welding shall be in accordance with AWWA C206. Welder's qualifications shall be in accordance with AWWA C206 Section 4.4. Any welder performing work shall have been qualified for the process involved within the past three years. Welders shall present a copy of their certification and references to the District Engineer or their designee prior to performing any field welding.
4. If joint faying surfaces are rusted or pitted where weld metal is to be deposited, clean them by wire brushing or abrasive blast cleaning.
5. Provide a two inch (2") minimum overlap for the butt strap on each of the adjoining pipe ends. Butt weld the longitudinal seams of the butt strap before completing the circumferential fillet welds. The longitudinal seams of the butt strap shall be offset from the pipe seams by a minimum of three inches (3"). Do not install butt straps with angular deflections.
6. To apply a fillet weld to the exterior joint of lap welded pipe or butt strap closures, deposit weld material in successive layers. Minimum size of fillet weld shall be equal to the steel cylinder thickness. Complete each pass around the entire circumference of the pipe before commencing the next pass. Use electrodes recommended by the pipe fabricator. Do not deposit more than an eighth inch (1/8") of throat thickness per pass. The minimum number of passes or beads in the completed weld shall be as follows:

Steel Cylinder Thickness (inches)	Fillet Weld Minimum Number of Passes
0.2500 and Less	2

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Greater than 0.2500

3

7. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.
8. In lieu of exterior welded joints, the interior may be welded where the pipe diameter is greater than twenty four inches (24"). Backfill to one foot over the top of pipe except at the joints. Complete the interior weld prior to filling the outside joint recess with cement mortar.
9. Welding Procedures, Welding Qualifications, and Testing:
  - a. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1. Field welders shall be proficient in the welding processes required for pipe 6G in accordance with AWS standards. Field welders shall have a reference list of completing three buried pipeline welding projects in the last five years. If work is to be performed on rod wrapped concrete cylinder pipe, field welder shall provide references for performing such work in the past to the satisfaction of the District Engineer or their designee.
  - b. For field welding, if required by the District Engineer or their designee, the welder qualification testing shall be performed at the site. Previous qualifications will not be accepted. The Contractor shall obtain the services of an independent testing laboratory to perform the welder qualification onsite. Copies of all test data and certifications shall be provided to the District Engineer or their designee. All costs for welder qualification testing shall be at no increased cost to the District.
  - c. Upon completion of each field-welded joint, the welding operator shall mark his regularly assigned identification number and the last two numbers of the year in which the work was completed to a specific joint. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round nose types, are used.
  - d. All field lap welds will be inspected by magnetic particle or dye penetration methods. Field butt welds will be inspected in accordance with the requirements of API 1104 by the radiographic method and the acceptance criteria of API 1104. Magnetic particle testing is not required for seal welds.
  - e. The Contractor shall inform the District Engineer or their designee before completed weld joints are to be backfilled so that the joint may be inspected. The Contractor shall assume all costs of exposing backfilled joints for inspection when backfilling preceded the inspection.

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- f. Personal performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors in accordance with AWS QCI, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.
- g. The District Engineer or their designee, at their discretion, may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein. Except as otherwise specified herein, all costs for the independent testing laboratory to inspect and field test welds will be paid for by the Contractor. If the weld is defective, the inspection costs shall be paid for by the Contractor. Defective welds shall be repaired and retested at the Contractor's expense.
- h. Test reports of all laboratory tests shall be submitted as provided in the inspection and field verification section.
- i. All weld testing and inspection described herein shall be performed by the Contractor at no additional cost to the District.

**M. Pipeline Closure Assemblies**

- 1. Use pipeline closure assemblies (butt straps) to unite sections of pipeline laid from opposite directions and to adjust the field length of the pipeline to meet structures, other pipelines, and points established by design stations.
- 2. Center the shaped steel butt straps over the ends of the pipe sections they are to join and provide a minimum of two inches (2") of overlap on the pipe ends. Weld the butt straps to the outside of the pipes with complete circumferential fillet welds equal in size to the thinnest part being joined and on the inside where indicated. Butt weld the longitudinal seams of the butt strap before completing the circumferential fillet welds.
  - a. Where butt straps are to be installed with no interior access available, perform welding from the outside of the pipe only. Butt strap shall include six inch (6") threaded, steel, standard half coupling or couplings, i.e. hand holes. One hand hole shall be installed for pipe 16" diameter pipe and smaller. Two hand holes shall be installed for pipe 18" to 24" diameter. Prepare the longitudinal seams of the butt strap for a single-groove, full penetration butt weld. Use an interior backing plate in the gap for the full width of the joint. Provide carbon steel plates equal to the thickness of the pipe wall by one inch (1") wide by the width of the joint. Fillet weld the backing plates to each interior side of the bottom half of the butt strap. Each backing plate shall project a half inch (1/2") above the longitudinal seams are complete, then the circumferential fillet welds at each end of the butt strap can be completed.
  - b. Where butt straps are to be installed with interior access available, perform welding from both the inside and outside of the pipe. Prepare the outside longitudinal seams of the butt strap for a single-groove, full penetration

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butt weld. Use an interior backing plate in the gap for the full width of the joint minus one inch (1"). Provide carbon steel plates equal to the thickness of the pipe wall by one inch (1") wide by the width of the joint minus one inch (1"). Fillet weld the backing plates to each interior side of the bottom half of the butt strap. Each backing plate shall project a half inch (1/2") above the longitudinal seam of the bottom half of the butt strap and be centered in the longitudinal length of the butt strap. Once the butt welds of the outside longitudinal seams are complete, then the outside circumferential fillet welds at each end of the butt strap can be completed. When the outside welds are complete, fillet weld around the inside backing plate and then complete the inside circumferential fillet welds at each end of the butt strap.

3. Cement mortar line closure assemblies to a mortar thickness equal to the adjoining pipe sections. Clean the inside steel surfaces by wire brushing or power brushing. Apply a cement and water wash coat prior to applying the cement mortar. Where the joint width exceeds four inches (4"), place welded wire fabric reinforcement in two inch (2") by four inch (4") pattern of No. 13 gage over the exposed steel. Install the fabric so that the wire on the two inch (2") spacing run circumferentially around the pipe. Crimp the wires on the steel surface. Pack the cement mortar into the recess of the joint and steel trowel finish to match the adjoining pipes.
4. Apply welded wire fabric reinforcement and cement mortar to the inside face of the closure plug. Thread plug into coupling once cement mortar is dry and seal weld.
5. Cement mortar coat the exterior of closure assemblies. Clean the outside steel surfaces of the butt strap and adjoining pipes by wire brushing or power brushing. Apply cement and water wash coat to the steel surfaces and allow to dry. Wrap welded wire fabric reinforcement or expanded metal lath around the exposed steel and secure in place. Crimp the metal wires of the fabric or the metal lath at four inch (4") spacing around the pipe to support the fabric or lath three eighths inch (3/8") from the exposed steel surface. Trowel cement mortar over the exposed steel surfaces in a two-coat application. Apply the scratch coat and four (4) hours later the finish coat. The finish coat may be applied sooner if the scratch coat is hard and self-supporting. The cement mortar coating shall be equal in thickness to the adjacent coatings and have no voids, cracks, or blisters. Keep the coating moist by sprinkling or spraying with water to retard drying while curing.

N. Connection to Existing Waterlines

1. Where new pipelines are to be connected to existing steel waterlines, the Contractor shall verify in the field location, elevation, pipe material, pipe outside diameter, and any other characteristics of the existing waterline before proceeding with the installation. Where rod wrapped concrete cylinder pipe exists, weld the reinforcing rod wrap to the cylinder wall of the pipe for a sufficient distance to anchor the rod wrap from the movement at the point of connection. Do not cut or damage the rod wrap under any circumstances and do not cut the concrete cylinder pipe until the rod wrap has been anchored. This field verification shall be performed in the presence of the District Engineer or their designee.

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- O. Installing Corrosion Control Components
1. Install bond wires, anodes, and test stations in accordance with the Approved Plans and specifications.
- P. Completing Interior Mortar Joints for Pipes Smaller than 24-Inches in Diameter
1. Butt Strap Assembly Method:
    - a. The interior of joints shall be completed as described elsewhere in this specification for pipeline closures using a butt strap with hand holes.
    - b. Upon approval by the District, hand holes can be fabricated onto the spigot end of the pipe for the purposes of completing the interior joint. The centerline of the hand hole shall be a minimum of sixteen inches (16") from the spigot end of the pipe. The hand hole shall not be welded directly onto the joint, on the bell end of the pipe, or within the bell deformation zone as determined by the pipe manufacturer.
    - c. After backfill operations are complete, joints shall be inspected and repaired per the procedures outlined in Section 3.10, D, 9.
- Q. Completing Interior Mortar Joints for Pipes 24-Inches in Diameter and Greater.
1. Backfill the trench before applying the interior lining at joints. Joints shall be lined immediately after backfilling and at no time shall the completion of the lining be further than three hundred and twenty feet (320') behind pipe laying.
  2. Do not remove the internal braces until backfilling has been completed or until the concrete encasement and subsequent backfill are completed.
  3. Working inside the pipe, remove foreign substances which adhere to the steel joint rings, clean them, and pack cement mortar into each joint. Finish the surface with a steel trowel to match the adjoining pipes.
  4. Remove by sweeping excess mortar and other construction debris from the pipe interior as the pipeline construction progresses.
- R. Completing Exterior Pipe Joints Where Cement-Mortar Coated
1. Fill exterior joint recess with cement grout using a fabric form placed around the joint and secured with steel straps. At the option of the Contractor, a rapid set cement grout may be used to shorten the set up time before backfilling.
  2. Pour and rod the grout from one side only until it is visible on the opposite side.
- S. Trench Backfill
1. Provide sufficient space along each side of the pipe and trench wall to observe that the pipe zone material (imported sand) fills all the spaces below pipe spring line.

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2. Start the backfilling operations specified in the Standard Specifications after completing the exterior pipe joints and the cement grout has cured for 24-hours or is hard enough to be self-supporting as determined by the District Engineer or their designee.
3. No exterior pipe joint shall be backfilled until it has been inspected by the District Engineer or their designee.
4. Until the pipeline is filled with water, install bulkheads and apply moisture inside the bullheaded portions in a manner that will effectively prevent the drying out of the mortar lining.
5. After the pipe zone has been backfilled and compacted, place the warning/identification tape on the compacted zone material and center over the pipe. Run tape continuously along the trench and tie ends of tape together. Wrap tape around the valve box extension pipes and continue along pipe.

T. Painting and Coating

1. Coat exterior surfaces of bare steel pipe in vaults per the Standard Specifications, System No. 10. Apply finish coat in the field.
2. Coat exterior surfaces of mechanical clamp-type couplings and flexible pipe couplings the same as the adjacent pipes.
3. Do not paint or coat exposed insulating flange sets in vaults. Sets shall be electrically non-conductive and any paint on the washers and nuts will prevent the proper function of the set.

U. Pressure Testing and Disinfection

1. Hydrostatic pressure testing and disinfection requirements shall be in accordance with the Standard Specifications.

**\*\*END OF SECTION\*\***