

San Antonio Water System Standard Specifications for Construction

ITEM NO. 815

**High Density Polyethylene (HDPE)
Pipe Installation Direct Bury for Water**

815.1 DESCRIPTION: This item shall consist of High Density Polyethylene Pipe and HDPE Tubing installation direct bury for water in accordance with these specifications and as directed by SAWS Inspector.

815.2 REFERENCE STANDARDS: Reference standards cited in this Specification Item No. 815 refer to the current reference standard published at the time of the latest revision date.

1. San Antonio Water System (SAWS):
 - a. SAWS Specifications for Water and Sanitary Sewer Construction
 - b. SAWS Materials Specifications
2. Texas Commission on Environmental Quality (TCEQ) Chapter 290 Rules and Regulations for Public Water Systems
3. American Society for Testing and Materials (ASTM) International:
 - a. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
 - b. ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
 - c. ASTM F 1290 Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
 - d. ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
 - e. ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
 - f. ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
 - g. ASTM D 2737 Standard Specification for Polyethylene (PE) Plastic Tubing
 - h. ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
 - i. ASTM D 2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
 - j. ASTM F 2880 Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4 in. to 65 in.

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- k. ASTM F 3124 Standard Practice for Data Recording the Procedure Used to Produce Heat Butt Fusion Joints
 - l. ASTM F 3183 Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
 - m. ASTM F 3190 Standard Practice for Heat Fusion Equipment (HFE) Operator Qualification on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings
 - n. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
 - o. ASTM D 3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
 - p. ASTM D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
4. American National Standards Institute (ANSI)/American Water Works Association (AWWA)
- a. ANSI/AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. (13 mm) Through 3 In. (76 mm) for Water Service
 - b. ANSI/AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 65 In. (1,650 mm), for Waterworks
 - c. ANSI/AWWA C651 Disinfecting Water Mains
5. AWWA American Water Works Association
- a. AWWA M55 Manual of Water Supply Practices, PE Pipe-Design and Installation
6. International Organization of Standardization (ISO)
- a. ISO9001
7. Plastics Pipe Institute, PPI
- a. PPI Handbook of Polyethylene Pipe – 2009 (2nd Edition)
 - b. PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE)
 - c. PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe (MAB-02)
 - d. Pipe PPI Material Handling Guide for HDPE Pipe and Fittings
 - e. PPI TR-33 Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
 - f. PPI TR-34 Disinfection of Newly Constructed Polyethylene Water Mains
 - g. PPI TR-38 Bolt Torque for Polyethylene Flanged Joints
 - h. PPI TN-42 Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects
8. National Sanitation Foundation (NSF)
- a. NSF 61: Drinking Water Components – Health Effects

815.3 SUBMITTALS: All submittals shall be in accordance with Engineer’s requirements and submittals shall be approved by the Engineer prior to delivery.

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1. Pipe resin used to produce HDPE pipe for this Project must be sampled, tested, and approved for use to assure compliance with ASTM cell classification requirements.
2. Resin vendor's certification characterizing the HDPE material and stating compliance with all requirements must accompany all raw material resins used in the manufacture of the pipe.
3. The pipe Manufacturer's responsibility includes testing in accordance with ASTM D3350 for pipe and HDPE tubing.
4. Certifications:
 - a. Per General Conditions section 5.12.2 all Contractor submittals for all pipe and other products or materials furnished under this specification shall be marked as reviewed and approved by Contractor for compliance with Contract Documents and the referenced standards.
 - b. The Manufacturer shall provide ISO 9001 Certificate by a third party.
 - c. Submit written verification that the pipe Manufacturer has been manufacturing ASTM F714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter pipe with similar design pressure and size as this Project for a minimum of ten (10) years.
 - d. Submit written verification that the pipe Manufacturer has been manufacturing ASTM D 2737 Standard Specification for Polyethylene (PE) Plastic Tubing with similar design pressure and size as this Project for a minimum of ten (10) years.
 - e. Submit written verification from the pipe Manufacturer demonstrating compliance with the production and delivery schedule of the pipe as indicated in the Contractor's preliminary CPM schedule.
 - f. Submit written verification from mechanical fitting Manufacturer that fitting is compatible with HDPE pipe and meets the requirements of this section.
5. Contractor shall submit Manufacturer's product data, installation recommendations, shop drawings, and certifications.
6. Shop Drawings:
 - a. Catalog Data Sheets for all materials confirming pipe, fittings, and other materials conform to requirements of this specification.
 - b. Pipe Supplier Information. Submit company name, contact name, and contact number.

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- c. Details of all piping systems components confirming that the pipe and fittings conform to the specified requirements.
 - d. The Contractor shall submit shop drawings of pipe, fittings, gaskets, hardware, flanges, appurtenances, special details sufficient to demonstrate compliance with these Specifications.
 - e. Fabrication drawings showing:
 - 1) Wall thickness.
 - 2) Pipe length.
 - 3) Pipe joint (i.e. fused, mechanical)
7. Testing Plan: Submit at least 30 days prior to testing and at minimum, include the following:
- a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Method of isolation. Method of isolation to be approved by the Engineer.
 - d. Method of conveying water from source to system being tested.
 - e. Hydrostatic leak testing.
 - 1) Submit a hydrostatic leak testing plan which includes equipment (pump, water meter, pressure regulating valve, pressure gauges, etc.), water handling procedures (supply and disposal), sequence and schedule by test section, and pressure test data. Must be per Specification Item No. 841 “Hydrostatic Testing Operations.”
 - 2) Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
8. Testing Reports:
- a. Furnish affidavit certified that all pipe meet the provisions of the specification and has been tested and submit reports in accordance with the applicable ASTMs and AWWA C901 and AWWA C906.
 - b. Reports include the following.
 - 1) Hydrostatic proof test reports.
 - 2) Sustained pressure test reports.
 - 3) Burst strength test reports.

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- 4) Stress Regression Testing
 - c. Other reports may be requested by the Engineer.
9. Fusion Information: Submit the following prior to performing any work.
 - a. Written fusion procedures, including procedures for cold weather work if needed.
 - b. Certification from pipe Manufacturer that Contractor is qualified to join, lay, and handle pipe.
 - c. Butt fusion shall be performed by personnel certified by McElroy (or Engineer approved equal) in large diameter pipeline fusion.
 - d. Fusion operators shall be qualified per PPI TN-42 and ASTM F3190.
 - e. The person performing the fusing of HDPE pipe and HDPE tubing shall have received training in the fusing of HDPE pipe and HDPE tubing in accordance with the recommendations of the pipe Manufacturer and the fusing equipment supplier.
 - f. Provide a statement from pipe Manufacturer that personnel responsible for fusing the pipe have been trained and qualified.
 - g. The Contractor shall maintain records of trained personnel and shall certify that training was received not more than 12 months before commencing construction.
 - h. The Contractor shall also submit details of welding/fusing procedures and equipment to be used.
 - d. Data Logger specification and sample report.
 - e. Fusion machine specification and maintenance log: At a minimum, reports shall include for each fusion machine fusion operator, time, date, heater temperature, pressure, and station number of joint.
 - f. Listing for all fusion operators to be used for the work must be approved by the Engineer at least two weeks prior to the start of work.
 - g. Contractor to submit shop drawings and fusion information together as a complete package, in a timely manner for review prior to start of work.
10. Detail drawings indicating type, number, and other pertinent details of the slings and other methods proposed for pipe support and handling during manufacturing, transport, and installation.
11. All pipe handling equipment and methods shall be acceptable to the Engineer.
12. Pipe Manufacturer's Written Quality Assurance/Quality Control Program.

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13. Field Service Representative Resume.

815.4 MATERIALS: The materials for High Density Polyethylene Pipe (HDPE) and HDPE tubing for Water Supply Lines shall conform to the following requirements:

1. HDPE pipe with 4" to 65" diameter shall be PE4710 solid wall pipe and fittings that are in conformance with ASTM F714, AWWA C901 and C906, and NSF 61 requirements stated herein.
2. Pipe 6-inch and larger diameter shall be a minimum of DR 11 (pressure rating of 200 psi) and Ductile Iron Pipe Size (DIPs) outside diameter.
3. Pipe and Fitting Manufacture: All pipe and fittings will be high density polyethylene pipe and made of virgin material.
4. No rework except that obtained from the manufacturer's own production of the same formulation will be used.
5. The pipe and fitting produced from this resin will have a minimum cell Classification of 445574 C under ASTM D3350.
6. For potable water applications, the cell classification shall be 445574C-CC3.
7. The value for the Hydrostatic Design basis will not be less than 1,600 psi at 73°F per ASTM D2837.
8. Pipe will have ultraviolet protection for a minimum of three (3) years.
9. The hydrostatic design stress (HDS) rating for water at 73°F shall not be less than 1,000 psi that shall be listed in PPI TR-4 in the name of the pipe manufacturer.
10. Pipe and Fitting Quality: All pipes and fittings shall be free of visible cracks, holes, foreign material, foreign inclusions, blisters, or other deleterious or injurious faults or defects.
11. Pipe and fittings shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
12. Cuts or gouges, per AWWA M55 are acceptable up to 10% of wall thickness. Cuts or gouges in excess of 10% of wall thickness must be removed by cutting the damaged section from the pipe string and butt fusing the ends.
13. Pipe Marking: Each length of pipe shall be clearly marked with pipe manufacturer, pipe size, pipe class, production code, material designation and other relevant identifying information.
14. Stripe along the length of pipe shall be blue in color to identify the pipe as potable water. **Stripe shall be extruded in the pipe every 120° – painted on stripes are not acceptable.**
15. Fittings:
 - a. When butt fusion is not possible, polyethylene pipe shall be connected by electrofusion coupling. Electrofusion couplings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in section 815.4.
 - b. Electrofusion Fittings shall be manufactured in accordance with ASTM F1055.

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- c. All electrofusion fittings shall be suitable for use as pressure conduits and shall be pressure rated equal to the pressure rating of the pipe to which it is joined.
 - d. Markings shall be according to ASTM F1055. Acceptable manufacturers are included in SAWS' Approved Products List (APL).
 - e. Polyethylene pipe and mechanical fittings shall be connected by means of a polyethylene flange adapter or polyethylene mechanical joint adapter with backup ring.
 - f. The polyethylene adapter shall meet the same material requirements as the HDPE pipe. Approved manufacturers for mechanical or flanged joint adapters are included in SAWS' APL.
 - 1) Provide MJ adapters with kit, manufactured in accordance with ASTM D3261. The adapter kit shall include the following:
 - i. Rubber gasket
 - ii. MJ backup ring
 - iii. Corrosion resistant – Cor Blue bolts and nuts
 - 2) Provide flanged adapters with kit, manufactured in accordance with ASTM D3261. The adapter kit shall include the following:
 - i. Metallic back-up rings (Van-Stone style lap joint flanges) shall have a radius on the inside diameter of the bore so as to be compatible with HDPE flanges. Back up ring shall have a bolt pattern that will mate with AWWA C207 Class D (or B or E), ASME/ANSI B 16.5 Class 50, ASME/ANSI B 16.1 Class 125, or ASME/ANSI B16.47 Series A.
 - ii. Flange adapters shall meet the dimensional and material requirements of ASTM F2880.
 - g. Mechanical fittings shall meet Specification Item No. 836 “Grey-Iron and Ductile-Iron Fittings” except as modified herein.
 - h. Pipe connection fittings shall be meet or exceed the pressure requirements of the HDPE pipe and shall be certified by the fitting manufacturer as suitable for use with HDPE pipe.
 - i. Stiffener inserts shall be used for all fittings and connections to HDPE pipe unless specifically not recommended by the fitting and pipe manufacturers. Stiffeners shall be 304 stainless steel.
 - j. Stiffener shall be wedge type design or solid design as recommended by fitting manufacturer for the size of pipe.
 - k. Mechanical fittings that do not provide restraint against pull-out or push-off are prohibited.
 - l. Flange adapters for connection to butterfly valves shall be factory beveled to permit clearance of butterfly valve disc.
 - m. Bevel shall not result in pressure rating less than requirements of the pipe to be connected to.
16. Flex restraints or integral pipe collars for restraint shall be designed by the pipe or

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- fitting manufacturer and suitable for fusing to the HDPE pipe.
17. The size and number of the flex restraints or size of the pipe collar (width and diameter) shall be as designed by the manufacturer to accommodate the loads indicated in the plans.
 18. HDPE tubing 3-inch and smaller shall be HDPE conforming to the latest edition of ANSI/AWWA C901 and ANSI/NSF Standard 61.
 - a. HDPE tubing shall be copper tube size (CTS), DR.9
 - b. Mechanical fittings for service HDPE tubing shall be compression type.
 - c. Stainless steel inserts shall be used at connections to brass fittings as recommended by the fitting manufacturer.
 - d. Splicing of the HDPE tubing shall not be allowed.
 - e. HDPE tubing color shall be blue or black with a blue stripe.
 - f. HDPE tubing Marking: HDPE tubing shall be marked in accordance with the standards to which it is manufactured. Include nominal size, DR, manufacturer's name or trademarks, materials designation code, date of manufacturer, pressure rating, and mark of certifying agency (ASTM and NSF).
 19. Service connection fittings to distribution or transmission main shall be mechanical saddles and shall meet SAWS' Material Specifications 110-30 "Service Saddles" except as modified herein.
 20. Saddles shall be designed for use on HDPE piping to maintain a pressurized seal with the HDPE main regardless of change in pipe diameter due to temperature or pressure and shall be engineered to prevent sliding or rotation movement.
 21. Clamps and Gaskets: Clamps shall be stainless steel and shall meet the requirements SAWS' Material Specifications 100-32 "Standard/Wide Range Repair and Tap Clamps".
 22. Furnish full circle, universal clamp couplings with a minimum 3/16-inch-thick neoprene, grid-type gasket. Select clamps to fit outside diameter of pipe.
 23. Use minimum clamp length of 30 inches for replacement pipes O.D. of 10.75 inches (10inch nominal) or greater and 18 inches for replacement pipe O.D. less than 10.75 inches.
 24. Tracer wire shall be utilized for location and taped directly to the pipe.
 - a. Tracer wire shall be properly spliced at each end connection and each service connection.
 - b. Tracer wire shall be adequately wrapped and protected at each splice location in accordance with manufacturer recommendations.
 - c. No bare tracer wire shall be accepted.
 - d. Wire shall also come up to the top of valve extensions and fire hydrant stems, as directed by the Inspector.
 - e. Tracer wire shall be utilized for location purposes and taped directly to the top of pipe.
 - f. Tracer wire shall be of solid core (14 gauge insulated), and shall be taped

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- to the main in minimum of 10 inch increments.
- g. Detection Tape shall not be used in-lieu of tracer wire.
25. Detection Tape – Detection Tape shall be 12 inches wide with repeating black lettering as follows “BURIED POTABLE WATER LINE BELOW”. Lettering shall be a minimum of 1-inch; aluminum foil core; 0.5 mil thick; encased in a protective inert plastic jacket; 5,000 psi minimum tensile strength; 2.5 lbs/inch per 1,000 feet minimum weight, colored blue.
- a. Detection Tape shall be installed once backfill has been placed and compacted to at least 12 inches above the top of pipe and not more than 18 inches above the top of pipe.

815.5 QUALITY CONTROL AND ASSURANCE:

- 1. Manufacturer’s Qualifications
 - a. Manufacturer shall have a minimum of ten (10) years recent experience producing HDPE pressure pipe and fittings for at least the specified sizes and lengths and shall be able to submit documentation of at least five (5) installations in satisfactory operation for at least five (5) years.
 - b. HDPE pipe and fittings manufacturers and distributors shall be listed as current members of the Plastics Pipe Institute (PPI).
- 2. Fusion Contractor Qualification Requirements
 - a. Fusion shall be performed by a work force that is experienced and certified in the performance of the related work.
 - b. The fusion contractor shall be certified by the pipe or fitting manufacturer to have been trained and approved in the fusion of the HPDE products and shall have a minimum of five (5) years total experience with the product.
 - c. The Contractor shall submit such certification as required in Section 815.3.
- 3. Onsite Observation:
 - a. Pipe Supplier: The pipe and fitting supplier(s) shall provide the services of an experienced, competent, and authorized field service representative who is acceptable to the SAWS to be onsite for the initial installation of pipe and fittings.
 - 1) The field service representative shall have a minimum of five (5) years of experience and practical knowledge installing HDPE pipe with joints and fittings of the type to be furnished.
 - 2) The resume of the field service representative shall be submitted in accordance with the requirements of this section.

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- b. Pipe Inspections: The Engineer and Inspector reserve the right to inspect pipes. Such inspection shall in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications. Approval of the products or tests is not implied by the Engineer's decision not to inspect the manufacturing, testing, or finished pipes
- c. For budgeting purposes, assume up to 16 hours on site will be required for the pre-installation and initial installation of pipe and fittings. Additional periodic site visits will be at the request and discretion of the Owner.
 - 1) SAWS for a minimum of one periodic site visit and a maximum of three periodic site visits.
 - 2) Assume each additional periodic site visit will require 8 hours on site. The field service representative duties shall include, but not be limited to, the following:
 - i. Observe the installation and fusion of the pipe and fittings.
 - ii. Report any concerns to the SAWS.
 - iii. Answer questions and provide assistance to the SAWS and the Contractor.
 - 3) Submit copies of all field reports and test results.
- d. Field tests
 - 1) Butt Fusion Joint Tests: Joint Tests shall be performed with McElroy's "Guided Side-Bend Tester" or Engineer approved equal test equipment meeting the requirements of ASTM F3183.
 - 2) Testing procedures shall be as recommended by the test apparatus manufacturer and ASTM F3183 and shall be performed for all fusion operators intended to be used on the project.
 - 3) Joint shall be prepared, fused, and tested in the presence of the SAWS Inspector and the Engineer.
 - 4) Contractor shall perform Joint Tests whenever a fusion operator whose work has not yet been Joint Tested performs a fusion for the first time and randomly as requested by SAWS at the expense of the Contractor.
 - 5) Contractor should assume one (1) joint test for every 20 fusion joints.

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- 6) If fusion joint test fails, then additional joint tests in excess of one (1) test for every 20 fusion joints shall be at the expense of the Contractor.
- 7) Electrofusion Joint Tests: Contractor's fusion operator shall demonstrate successful electrofusion coupling technique through a joint integrity test.
- 8) Test shall be in accordance with ASTM F 1055 and shall be performed on a 16" or larger electrofusion coupling.
- 9) Joint shall be prepared and fused in the presence of the SAWS' Inspector and the Engineer.
- 10) Contractor shall perform an additional Electrofusion Joint Test for any additional fusion operators whose work has not yet been joint tested.
- 11) Hydrostatic Pressure and Leakage Tests: Hydrostatic testing shall be in accordance with this Specification Section 815.7 - Hydrostatic Testing and Disinfection.

815.6 CONSTRUCTION

1. General. Installation shall be in accordance with ASTM D2774, AWWA M55, Specification Item No. 812 "Water Main Installation," and as specified in this Specification.
 - a. No pipe shall be installed where the interior or exterior surfaces show damage that may jeopardize the integrity of the pipe as determined by the SAWS' Inspector.
 - b. Such damaged pipe shall be replaced with a new undamaged pipe.
 - c. All pipe damaged prior to end of construction shall be replaced at Contractor's expense.
2. Transportation, Unloading, and Storage:
 - a. Contractor's activities will comply with the requirements of this section.
 - b. Transport, handle, and store pipe and fittings as recommended by Manufacturer.
 - c. Contractor to notify SAWS' Inspector a minimum of 4 hours prior to the delivery and unloading of pipe.
 - d. SAWS' Inspector may choose to be present at time of delivery.
 - e. Contractor is not to unload pipe until SAWS' Inspector is present or has informed Contractor to proceed with unloading.
 - f. During loading, transportation, and unloading, every precaution should be taken to prevent damage to the pipe.

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- g. If new pipe and fittings become damaged before or during installation, it shall be repaired as recommended by the Manufacturer or replaced as required by the SAWS' Inspector at the Contractor's expense, before proceeding further.
- h. All pipe and accessories shall be loaded and unloaded by lifting with hoists or by skidding in order to avoid shock or damage.
- i. Proper facilities shall be provided for lowering sections of pipe into trenches.
- j. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.
- k. Protect the pipe from sharp edges when overhanging the bed of a truck or trailer by placing a smooth, rounded protecting strip on the edge of the bed.
- l. The load should be anchored securely to prevent slippage.
- m. Lengths of small-diameter, lightweight pipe can be unloaded manually.
- n. Dragging the pipe into place is NOT permitted.
- o. Pipe handled on skidways shall not be rolled or skidded against pipe on the ground.
- p. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or interior of the pipe.
- q. The joints shall be handled near the middle with wide web slings and bars.
- r. The use of chains, end hooks or cable slings that may scar the pipe are not permitted.
- s. Slings for handling the pipe shall not be located at butt-fused joints.
- t. All pipe and fittings shall be subjected to visual inspection at time of delivery and before they are lowered into the trench to be laid.
- u. Joints or fittings that do not conform to these specifications will be rejected and must be removed immediately by the Contractor.
- v. Materials, if stored, shall be kept safe from damage.
- w. The Contractor shall be responsible for all security, damage and loss of pipe.
- x. The interior of the pipe as well as all sealing surfaces of mating components (i.e. flange faces) shall be kept free from dirt or foreign matter at all times.
- y. The open ends of all sections of joined and/or installed pipe (not in service) shall be plugged to prevent animals or foreign material from entering the pipe line or pipe section.
- z. The practice of stuffing cloth or paper in the open ends of the pipe will not be permitted.
- aa. Where possible, the pipe shall be raised and supported at a suitable distance from the open end such that the open end will be below the level of the pipe at the point of support.
- bb. Where necessary due to ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
- cc. Pipe shall be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe.

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- dd. The expansion and contraction caused by uneven heating by the sunlight shall be prevented by restraining the racks.
- 3. Cleaning: Before placement of pipe in the trench, all pipe and fitting shall be thoroughly cleaned of any foreign substance that may have collected thereon and shall be kept clean at all times thereafter.
- 4. Openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
- 5. Placement:
 - a. HDPE mains shall be laid to the depth shown in the contract documents.
 - b. Pipe shall be laid directly on the imported bedding material.
 - c. No blocking shall be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe.
 - d. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid.
 - e. Initial backfill shall be consolidated to a point 12 inches above installed pipeline.
 - f. In addition, the compaction and other requirements shall be as specified in Specification Item No. 804 "Excavation, Trenching and Backfill."
 - g. **All pipes in place must be approved by the Inspector before backfilling.**
 - h. Pipe shall be protected from lateral displacement by pipe embedment material installed as specified in Specification Item No. 804 "Excavation, Trenching, and Backfill."
 - i. Pipe shall not be laid in water or under unsuitable weather or trench conditions, and shall be protected against entry of foreign matter
 - j. Lay the pipe so that no high or low points other than those on the plans are introduced.
 - k. To prevent high points or low points along the pipeline, the general slope of the pipeline shall not be changed between vertical angle points.
 - l. When pipe is to be connected to existing pipe, the terminus of the existing pipe shall be field located prior to fabricating new pipe.
 - m. The Contractor shall submit any required alignment adjustments to the Engineer for acceptance.
 - n. The Contractor shall make any required field alignment adjustments to allow proper fit-up of pipe in conformance with tolerances specified.
 - o. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades.
 - p. Whenever pipe laying is stopped, the open end of the line shall be closed with an inflatable pipe plug end board or other water tight seal to keep water and debris from entering the interior of the pipe.
 - q. Any standing water shall be removed from the trench before the inflatable pipe plug or end board is removed.
 - r. Laying Lengths:

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- 1) Maximum pipe laying lengths shall be limited to the requirements of the City of San Antonio Street Cut permit. Contractor shall comply with City of San Antonio Street Cut permit
 - 2) All trenches must be closed at end of day with an all-weather surface or steel plate.
 - 3) Open trenches during non-working hours are not permitted.
 - s. When the HDPE pipe has been placed in the trench and backfilled, the Contractor shall leave the end sections exposed to allow for expansion and contraction of the pipe. After 24 hours or once the pipe has reached ambient temperatures of the existing ground (trench), the end section(s) can be connected to the fitting or existing pipe.
6. Cutting Pipe:
- a. Cutting shall be in accordance with the pipe Manufacturer's recommendations.
 - b. Cuts shall be smooth, straight, and at right angle to the pipe axis.
 - c. After cutting, the end of the pipe shall be dressed to remove all roughness and sharp corners.
7. Jointing:
- a. All HDPE pipe shall be joined to itself by the heat fusion process per ASTM F2620 and ASTM F1290 which produces homogeneous, leak tight joints or by mechanical coupling.
 - b. Sections of HDPE pipe shall be joined above ground into continuous lengths by the thermal butt fusion method.
 - c. Socket fusion, extrusion welding, and hot gas welding will not be acceptable.
 - d. Contractor shall minimize use of mechanical couplings to join the plain ends of HDPE pipe and shall plan work stoppage to coincide with locations of mechanical fittings indicated in the plans where possible.
 - e. Use of other than butt fusion or electrofusion shall be in accordance with the Contractor's approved fusion plan or as approved by the Engineer.
 - f. If in ditch butt fusion or electrofusion cannot be utilized, mechanical couplings shall be from SAWS' APL and approved for use with HDPE by manufacturer, but must be approved by SAWS prior to installation.
 - g. Jointing of pipe and mechanical fittings shall be performed in accordance with the instructions and recommendations of the pipe and fitting Manufacturer.
 - h. Mechanical and flanged fittings shall be installed in accordance with the fitting manufacturer's recommended procedures.
 - i. Stainless steel stiffener inserts shall be utilized at all fittings.
Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33.
 - j. All fusion joints shall be made in compliance with the pipe or fitting Manufacturer's recommendations.

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- k. Fusion joints shall be made by qualified fusion technicians per ASTM F3190.
 - 1) A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F3190.
- l. Considerations should be given to and provisions made for adverse weather conditions, such as cold air temperatures, precipitation, or wind, which is accepted by the Engineer.
- m. For 6” and larger pipe sizes, the pipe butt fusion machine shall be a self-contained hydraulic fusion machine capable of butt fusing HDPE pipe.
- n. The carriage must be removable from the chassis for in-ditch use.
- o. The machine must be compatible with an electronic data recording device.
- p. Accessories will include all butt fusion inserts for the specified range of pipe sizes, a pyrometer kit for checking the surface temperature of the heater, extension cord (25' minimum), and hydraulic extension hoses (minimum of four).
- q. The butt fusion machine will be by McElroy, or Engineer approved equivalent.
- r. The butt-fused joint will be true alignment and will have uniform roll back beads resulting from the use of proper temperature and pressure.
- s. The joint surfaces will be smooth.
- t. The fused joint will be watertight and will have tensile strength equal to that of the pipe.
- u. All joints will be subject to acceptance by the Inspector prior to installation.
- v. All defective joints will be cut out and replaced at no cost to SAWS.
- w. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than 10% of the wall thickness, will not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above.
- x. Pipe having defects that in the opinion of the Inspector indicate the pipe may be damaged, faulty, substandard, improperly manufactured, or have other defects as listed herein, will be discarded and not used.
- y. Defects warranting pipe rejection include the following: concentrated ridges, discoloration, excessive spot roughness, and pitting; insufficient or variable wall thickness; pipe damage from bending, crushing, stretching or other stress; pipe damage that impacts the pipe strength, the intended use, the internal diameter of the pipe, internal roughness characteristics; or any other defect of manufacturing or handling.
- z. All fusions shall be made with fusion equipment equipped with a Data Logger.
- aa. Submit Data Logger reports to SAWS' Inspector for each previous day's pipe fusion.

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bb. Fusion Data Recording:

- 1) The device shall be capable of meeting the requirements of ASTM F 3124, “Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints in Plastic Piping Systems or Fittings”. The device, or combination of devices, shall record the following variables of each fused joint:
 - i. Heater surface temperature immediately before inserting the heater plate. Alternatively, the heater plate may be measured with a pyrometer and entered into the weld record.
 - ii. Gauge pressure during the initial heat cycle.
 - iii. Gauge pressure and elapsed time during the heat-soak cycle.
 - iv. Heater removal (dwell) time.
 - v. Gauge pressure and elapsed time during the fusing/cool cycle.
 - vi. Drag pressure.
 - vii. Pipe diameter and wall thickness.
 - viii. Type of HDPE material (Specification and Classification) and Manufacturer.
 - ix. Fusion Machine Identification.
- 2) The device shall record the operator, a unique operator ID number, the date and time of each weld.
- 3) Records showing the device is up to date on all required calibration should be available for presentation when requested.
 - i. All fusion welds should be traceable to the report (via operator and weld ID) with permanent paint marker/pen only, next to fusion weld.
 - ii. When requested prior to commencement of work, a weld location map may be requested by the SAWS’ Inspector or SAWS’ representative.
 - iii. All joining procedures shall be acceptable to SAWS’ Engineer.
 - iv. Threaded or solvent cement joints and connections are not permitted.
 - v. All equipment and procedures will be used in strict compliance with the manufacturer's recommendations.
 - vi. Fusing will be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

8. Electrofusion:

- a. Electrofusion joining shall be done in accordance with the manufacturers recommended procedure, ASTM F 1290, PPI TN 34, PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE), and PPI Municipal Advisory Board (MAB) Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene (PE) Pipe (MAB-02).

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- b. The process of electrofusion requires an electric source, commonly called an electrofusion processor that has wire leads and a method to read electronically (by laser) or otherwise input the barcode of the fitting.
 - c. The electrofusion processor must be capable of reading and storing the input parameters and the fusion results for later download to a record file.
 - d. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project and successful demonstration of jointing procedures through a destructive test as indicated in this specification
 - e. Contractor shall perform electrofusion in strict conformance with MAB procedures.
 - f. Contractor shall prepare ditch as required to allow adequate space for preparatory work and cleaning.
 - g. Inspector may reject any electrofusion coupling installation which lacks witness marks for stab depth or lacks evidence of proper cleaning and scraping prior to fusing.
9. Fusion Operators:
- a. The Contractor of the fusion machine operator is responsible for the fusion joint quality of the fusion weld made by that individual.
 - b. The Contractor is responsible for documenting all qualification and training records of that individual.
 - c. All HDPE fusion equipment operators shall be qualified to the procedure used to perform pipe joining.
 - d. Fusion equipment operators shall have current, formal training on all fusion equipment employed on the project.
 - e. When the fusion machine operator is employed by the HDPE pipe and fusion machine supplier, the supplier shall maintain an ISO 9001 Certified Quality Management System.
10. Flange Installation:
- a. Flange connections shall be installed in accordance with the Manufacturer's recommended procedure.
 - b. Flanges shall be centered and aligned to the mating component before assembling and tightening bolts.
 - c. In no case shall flange bolts be used to draw the connection into alignment.
 - d. Bolt threads shall be lubricated, and flat washers should be used under the nuts.
 - e. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the Manufacturer.
 - f. At least 1 hour after initial assembly, flange connections shall be re-tightened following the tightening pattern and torque step recommendations of the Manufacturer.
 - g. Connections shall be retightened a second time after at least 4 hours in accordance with Manufacturer's recommendations.
 - h. The final tightening torque shall be as recommended by the gasket Manufacturer.

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11. Connections with Existing Piping:
 - a. Connections between new work and existing piping shall be made using connections as shown on Drawing Series DD-812.
 - b. To minimize effects from temperature shrinkage, connections to existing piping shall only be made after pipeline is backfilled and pipeline has reached ambient temperature of the existing ground (trench).
 - c. Connection to existing piping shall only be made after concrete anchor reaction blocks have been in place at least seven (7) days.
 - d. Contractors shall coordinate connection so that SAWS Inspector is in attendance during connection installation and testing. Each connection with an existing pipe shall be made at a time and under conditions that will least interfere with service to customers, and as authorized by SAWS.
 - e. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.
 - f. Special care shall be taken to prevent contamination of potable water lines when dewatering, cutting into, and making connections with existing pipe.
 - g. Trench water, mud, and other contaminating substances shall be kept out of the lines.
 - h. The interior of all pipe, fittings, and valves installed in connections to existing piping shall be thoroughly cleaned and then swabbed in accordance with the requirements of AWWA C651.
 - i. Connections to existing piping shall be fully restrained in accordance with Manufacturer's recommendations.
12. Direct Burial:
 - a. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D 2321 or ASTM D 2774 for pressure systems and AWWA Manual of Practice M55 Chapter 8. The Design Window identified in AWWA M55 Chapter 5 (page 65 of 2006 version) shall be considered acceptable design and installation conditions.
 - b. Pipe embedment and bedding – Embedment/bedding material should be as specified in Specification Item No. 804 “Excavation, Trenching and Backfill.” Initial backfill shall be mechanically consolidated as specified in Specification Item No. 804 “Excavation, Trenching and Backfill.”
 - c. Secondary backfill should be as specified in Specification Item No. 804 “Excavation, Trenching, and Backfill.”
13. Valves:
 - a. Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation.
 - b. The Contractor shall adjust stem packing and operate each valve prior to installation to insure proper operation.
 - c. Valves (body and seat) shall not be subjected to test pressures greater than valve Manufacturer's recommendation.

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- d. Valves shall be installed so that the valve stems are plumb and in the location show on Drawings.
 - e. Verify clearance of valve disc rotation with inside of flange adapter on HDPE pipe.
 - f. Provide factory beveled flange adapter as needed to provide free clearance of the valve disc.
14. Pipe Deflection:
- a. The minimum allowable bending radius shall be not less than the radius shown in the Drawings.
15. Concrete Encasement:
- a. Concrete encasement shall be installed as indicated on the drawings.
 - b. Concrete and reinforcing steel shall be as specified in the Contract Documents.
 - c. All pipes to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.
16. Reaction Anchorage and Blocking:
- a. All fittings on HDPE pipe shall be mechanically restrained.
 - b. Fittings shall meet requirements of Specification Item No. 836 “Grey-Iron and Ductile-Iron Fittings” as modified in this section.
 - c. Concrete anchor blocking shall be keyed into undisturbed earth on each side of the pipe as shown in the Contract Drawings and Drawing Series DD-839 and shall be installed so that all joints are accessible for repair.
 - d. The dimensions of concrete reaction blocking shall be as indicated on the drawings or as directed by the Engineer.
17. Cold Weather Protection:
- a. No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation.
 - b. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
18. Sunlight Protection:
- a. Pipe shall be protected from extended exposure to sunlight, shall be kept as cool as possible during installation.
 - b. Pipe shall be covered with backfill immediately after installation.
 - c. Allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.
19. HDPE Service Installation:

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- a. HDPE water service installation shall be in accordance with the requirements of Specification Item No. 824 “Service Supply Lines” except as modified herein.
- b. Service supply line connections to mains shall be angled at 10 to 20 degrees or as recommended by HDPE tubing manufacturer to reduce stress at the connection to the corporation stop.
- c. Service lines shall be continuous from corporation stop to the meter set.
- d. HDPE service line shall be snaked loosely through the trench.
- e. Use stainless steel inserts at connection to fittings.
- f. Install tracer wire along HDPE service similar to tracer wire for HDPE main.
- g. Terminate wire neatly in 12” long (minimum) coil in meter box.
- h. HDPE tubing approved manufacturers are listed in SAWS’ APL.

815.7 HYDROSTATIC TESTING AND DISINFECTION:

1. Hydrostatic Testing:
 - a. Prior to pressure test of newly installed main, insure all fittings within test section have been installed correctly and restrained against movement.
 - b. All concrete anchor blocks shall have been installed a minimum of seven (7) days prior to pressurizing the line.
 - c. Pressure test the installed main per ASTM F2164 as outlined herein.
 - d. The hydrostatic leak test procedure consists of filling, an initial expansion phase, a test phase, and depressurizing.
 - e. There are two alternatives for the test phase.
 - f. Filling – Flush the main in accordance with Specification Item No. 841 “Hydrostatic Testing Operations.”
 - g. No valve in SAWS’s water distribution system shall be operated by the Contractor without prior permission of the Inspector.
 - h. The Contractor shall notify the SAWS’ Inspector when a valve is to be operated and shall only operate the valve in the presence of the SAWS’ Inspector.
 - i. Initial Expansion Phase – Gradually pressurize the test section to test pressure and maintain test pressure for three (3) hours.
 - j. During initial expansion phase, polyethylene pipe will expand slightly.
 - k. Additional water will be required to maintain pressure. It is not necessary to monitor amount of water added during the initial expansion phase.

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- l. If test pressure cannot be attained, or if it takes an unreasonably long time to reach test pressure, discontinue test and verify there are no faults with test equipment or pipeline before proceeding.
- m. Hydrostatic Test - Test pressures shall be in accordance with Specification Item No. 841 “Hydrostatic Testing Operations.”
- n. At the discretion of SAWS, the test method used may be either a Monitored Make-up Water Test or a Non-Monitored Make-up Water Test.
 - 1) Monitored Make-up Water Test
 - i. This alternative is applicable when the test pressure is 150% of the system design pressure.
 - ii. Immediately following the initial expansion phase, monitor the amount of make-up water required to maintain test pressure for one (1), two (2), or three (3) hours.
 - iii. If the amount of make-up water needed to maintain test pressure does not exceed the amount in Table 815-1, no leakage is indicated.
 - 2) Non-monitored Make-up Water Test
 - i. Immediately following the initial expansion phase, reduce test pressure by 10 PSI and stop adding additional water.
 - ii. If the test pressure remains steady (within 5% of the target value) for one (1) hour, no leakage is indicated.
- o. Total time allotted for test shall not exceed 8 hours.
- p. If successful test cannot be completed in this period, then the test section must be depressurized and allowed to relax for a minimum of 8 hours before retest.
- q. Re-test after repair.
- r. Retest per the requirements of this specification.
- s. Manifest shall be filled out with all pressure test results.

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TABLE 815-1			
MAKEUP WATER ALLOWANCE TABLE			
Make-Up Water Allowance for Test Phase, Monitored Make-Up Water (U.S. Gallons/100 feet of Pipe)			
Nominal Pipe Size (in)	1-Hour Test	2-Hour Test	3-Hour Test
6	0.3	0.6	0.9
8	0.5	1.0	1.5
12	1.1	2.3	3.4
16	1.7	3.3	5.0
20	2.8	5.5	8.0
24	4.5	8.9	13.3
30	6.3	12.7	19.2

2. Disinfection
 - a. Disinfection shall be performed by SAWS in accordance with the requirements of Specification Item No. 847 “Disinfection,” except as modified herein.
 - b. Contractor shall provide connections for disinfection as required in the Drawings and Specification Item No. 847 “Disinfection.”
 - c. The disinfection chemical solution shall not exceed 12% active chlorine.
 - d. The duration of the test should not exceed 24 hours.

815.8 MEASUREMENT:

1. HDPE Pipe will be measured by linear foot for each size and DR as follows:
 - a. Measurements will be formed from the center line intersection of runs and branches of tees to the end of the valve of a dead end run.
 - b. Measurement will also be between the center line intersection of runs and branches of tees.
 - c. Where the branch is plugged for future connection, the measurement will include the entire laying length of the branch or branches of the fitting.
 - d. The measurement of each line of pipe of each size will be continuous and shall include the full laying lengths of all fittings and valves installed between the ends of each line except the laying length of reducers will be divided equally between the connected pipe sizes.
 - e. Lines leading to a tapping connection with an existing main will be measured to the center of the main tapped.

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2. HDPE Water Service Supply Lines will be measured by the unit for each size and type as follows:
 - a. Relay Short Service will be measured by the unit of the various types and sizes of each service line relayed.
 - b. Relay Long Service will be measured by the unit of the various types and sizes of each service line relayed.
 - c. Relocate Short Service will be measured by the unit of the various types and sizes of each service line relocated.
 - d. Relocate Long Service will be measured by the unit of the various types and sizes of each service line relocated.
 - e. New Short Service will be measured by the unit of the various types and sizes of each new service line installed.
 - f. New Long Service will be measured by the unit of the various types and sizes of each new service line installed.
 - g. New Un-metered Short Service will be measured by the unit of the various type and sizes of each new un-metered service line installed.
 - h. New Un-metered Long Service will be measured by the unit of the various type and sizes of each new un-metered service line installed.

815.9 PAYMENT:

1. Payment of HDPE pipe installed will be made at the unit price bid per linear foot of pipe of the various sizes and DRs installed by the open cut method.
2. Such payment shall also include excavation, selected embedment material, backfill, compaction, hauling, and disposition of surplus excavated material, including existing pipe, fittings, appurtenances to abandoned (where specified or show in the contract documents.), testing as per required by ASTMs and this specification.
3. HDPE Water Service Supply Lines:
 - a. Payment for a Relay Short Service will be made at the unit of the various types and sizes of each service line relayed.
 - 1) Such payment shall also include trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line relay.
 - 2) Connection of service to the existing meter and adjustment of the meter, meter box.
 - b. Payment for Relay Long Service will be made at the unit of the various types and sizes of each service line relayed.
 - 1) Such payment shall also include trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type

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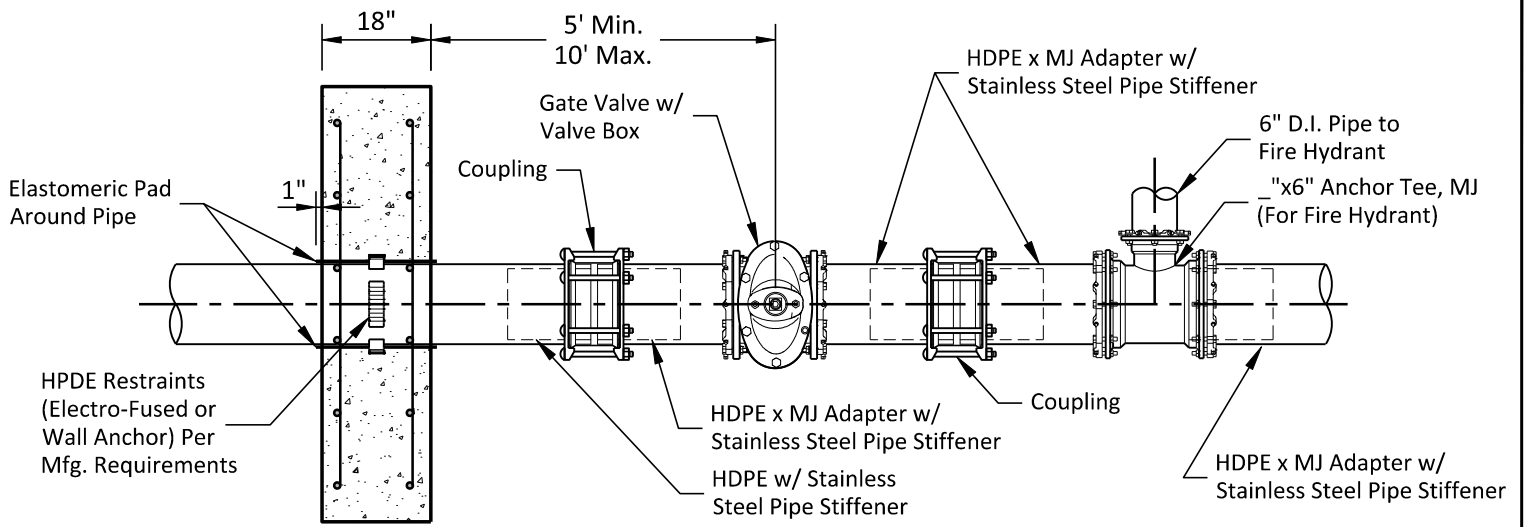
- encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line relay,
- 2) Connection of service to the existing meter and adjustment of the meter, meter box.
- c. Payment for Relocate Short Service will be made at the unit of the various types and sizes of each service line relocated.
- 1) Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line relocate.
- d. Payment for Relocate Long Service will be made at the unit of the various types and sizes of each service line relocated.
- 1) Such payment shall also include trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line relocate.
- e. Payment for Reconnect Long Service will be made at the unit of the various types and sizes of each service line relocated.
- 1) Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line reconnection.
- f. Payment for New Short Service will be made at the unit of the various types and sizes of each new service line installed.
- 1) Such payment shall also include excavation, new meter box trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the service line reconnection.
- g. Payment for New Long Service will be made at the unit of the various types and sizes of each new service line installed.
- 1) Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials,

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sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the new service line reconnection.

- 2) New Meter box template
- h. Payment for New Un-metered Short Service will be made at the unit of the various type and sizes of each new un-metered service line installed.
- 1) Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the un-metered service line reconnection.
 - 2) New Meter box template
- i. Payment for New Un-metered Long Service will be made at the unit of the various type and sizes of each new un-metered service line installed.
- 1) Such payment shall also include excavation, trench excavation protection, hauling and disposition of surplus excavated materials, sand backfill, cutting pavement and surface structures of all type encountered and replacement with all type specified, and HDPE tubing and fittings of the various sizes used in the un-metered service line reconnection.
 - 2) New Meter box template.

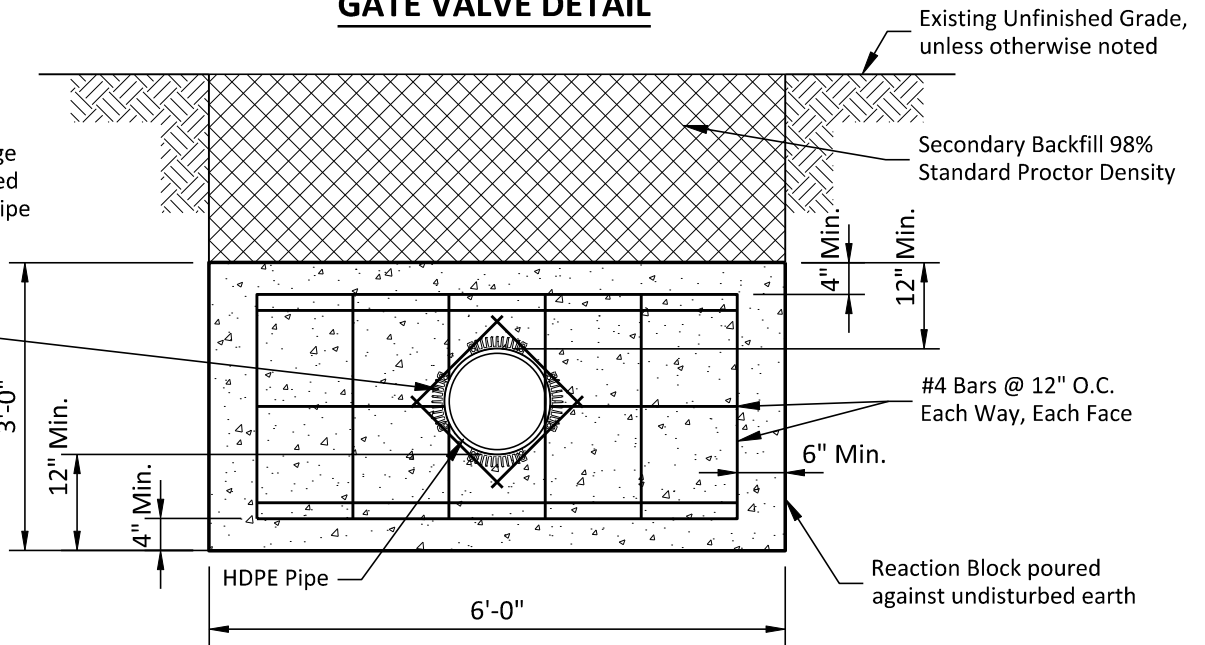
- End of Specification -



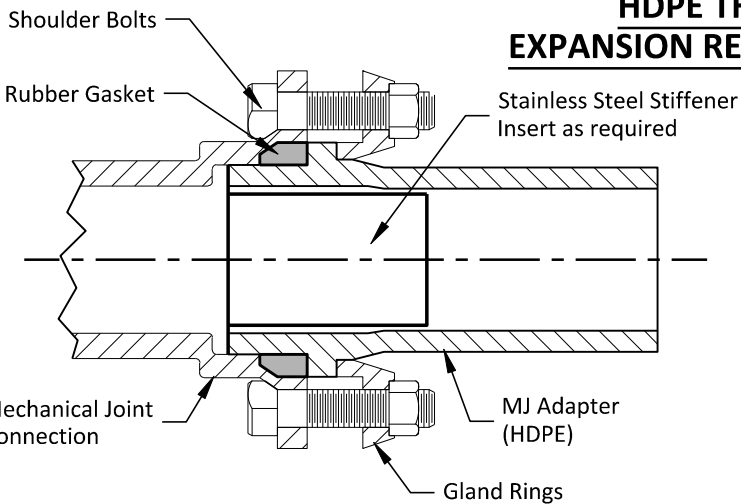
GATE VALVE DETAIL

NOTE:
Reaction Block and Flange Connection to be installed at all D.I. Pipe to HDPE Pipe Connections

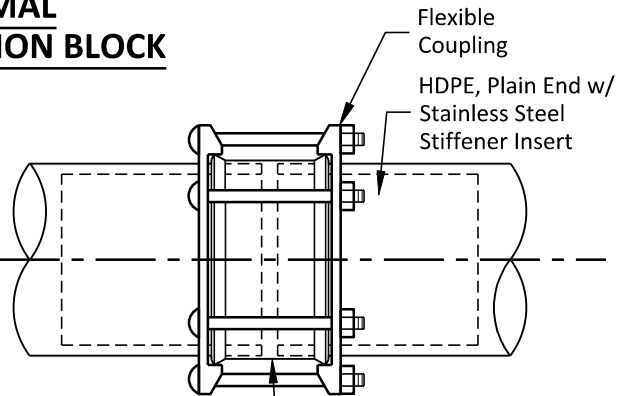
HDPE Restraints (Electro-Fused or Wall Anchor) Per Mfg. Requirements



HDPE THERMAL EXPANSION REACTION BLOCK



HDPE M.J. ADAPTER



HDPE FLEXIBLE COUPLING (RESTRAINED) DETAIL