

**SECTION 02XXX****HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS****PART 1 GENERAL****1.01 Scope of Work**

The Contractor shall provide solid wall high density polyethylene pipe (HDPE) and fittings which conform to AWWA, ASTM and other referenced documents listed in this specification with flanged and thermal butt fusion joints complete in place.

**1.02 Manufacturer Qualifications**

- A. Manufacturer shall maintain listing in PPI TR-4 PPI HSB Listing of Hydrostatic Design Basis Listed Materials and shall follow all policies and procedures listed in PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, as well as all applicable ASTM standards.
- B. HDPE pipe and fittings manufacturers and distributors shall be listed as current members of the Alliance for PE Pipe.
- C. Contractor shall have a minimum of 2 years recent experience installing HDPE pressure pipe and fittings for at least the specified pipe and fittings sizes and lengths and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least 2 years.
- D. All pipe and fittings of each material type must meet the same material class.
- E. The HDPE utility pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
- F. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

**1.03 Referenced Standards**

- A. American Water Works Association (AWWA) latest edition:
  - 1. AWWA C901 - Polyethylene Pressure Pipe and Tubing, ½ Inch Through 3 Inch for Water Service

2. AWWA C906 - Polyethylene Pressure Pipe and Fittings, 4 Inch Through 65 Inch for Water Distribution and Transmission
- B. American Society for Testing and Materials (ASTM) latest edition:
1. ASTM D638 – Tensile Method for Tensile Properties of Plastics
  2. ASTM D790 – Test Materials for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  3. ASTM D2122 – Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
  4. ASTM D2239 – Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
  5. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
  6. ASTM D2657 – Practice for Heat-Joining of Polyolefin Pipe and Fittings
  7. ASTM D2683 – Standard Specification for Socket Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
  8. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
  9. ASTM D2837 – Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
  10. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PE) Based on Controlled Outside Diameter
  11. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
  12. ASTM D3350-14 – Polyethylene Plastic Pipe and Fittings Material
  13. ASTM F412 – Standard Terminology Relating to Plastic Piping Systems
  14. ASTM F585 – Standard Guide for Insertion of Flexible Polyethylene Pipe Into Existing Sewers
  15. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
  16. ASTM F905 – Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
  17. ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
  18. ASTM F1056 – Standard Specification for Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
  19. ASTM F1290 – Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
  20. ASTM F2164 – Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
  21. ASTM F2206 – Fabricated Fittings for Butt-Fused Polyethylene Plastic Pipe
  22. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

23. ASTM F2786 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing)
  24. ASTM F3124 – Standard Practice for Data Recording the Procedure used to Produce Heat Butt Fusion Joints
  25. ASTM F3183 – Standard Practice for Guided Side Bend Evaluation of Polyethylene Pipe Butt Fusion Joint
  26. ASTM F3190 – Standard Practice for Heat Fusion Equipment (HFE) Operator Qualifications on Polyethylene (PE) and Polyamide (PA) Pipe and Fittings
- C. Plastics Pipe Institute (PPI) latest edition:
1. The Plastics Pipe Institute Handbook of Polyethylene Pipe
  2. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
  3. PPI TR-4 – PPI HSB Listing of Hydrostatic Design Basis, Hydrostatic Design Stresses, Pressure Design Basis, Strength Design Basis, Minimum Required Strength Ratings, and Categorized Required Strength for Thermoplastic Piping Materials or Pipe
  4. PPI – TR-33 – Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
  5. PPI – TN-34 – Installation Guidelines for Electrofusion Couplings 14” and Larger
  6. PPI – TN-36 – General Guidelines for Connecting HDPE Potable Water Pressure Pipes to DI and PVC Piping Systems
  7. PPI – TN-38 – Bolt Torque for Polyethylene Flanged Joints
  8. PPI – TN-44 – Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
  9. PPI – TN-45 – Mechanical Couplings for Joining Polyethylene Pipe
  10. PPI – TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner’s Considerations, Planning, Procedures, and Checklists
  11. PPI – TN-49 – Recommendations for AWWA C901 Service Tubes in Potable Water Applications
  12. PPI – TN-54 – General Guidelines for Squeezing Off Polyethylene Pipe in Water, Oil and Gas Applications
- D. Plastics Pipe Institute Municipal Advisory Board (MAB)
1. MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene Pipe
  2. MAB Generic Electrofusion Procedure for Field Joining of 14 Inch to 30 Inch Polyethylene Pipe
  3. MAB Model Specifications for PE 4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings

**1.04 SYSTEM DESIGN PARAMETERS**

- A. The HDPE system working pressure rating accommodates the normal operating pressure and the repetitive surges. The pressure rating applies at 73° F or less. Piping installed that may experience operating temperatures above 73° F shall be de-rated in accordance with manufacturer’s recommendation.
- B. Per AWWA 901 and C906, the repetitive surge pressure allowance is one half the pressure class of the pipe, and the occasional surge over pressure allowance is equal to the pressure class of the pipe. Allowable Total Pressure during Recurring Surge conditions equals 1.5 times the pipe’s pressure class. Allowable Total Pressure during Occasional Surge conditions equals 2.0 times the pipe’s pressure class.

Table 1 gives the Pressure Class per AWWA C906, Pressure Rating and Allowable Total Pressure during Recurring and Occasional Surge for PE4710 pipe at 73°F or less.

<b>Table 1</b>				
<b>Pressure Class per AWWA C906 for PE 4710 at 73° F or Less</b>				
<b>Pipe Dimension Ratio (DR)</b>	<b>Pressure Class (psi)</b>	<b>Pressure Rating (psi)</b>	<b>Allowable Total Pressure During Recurring Surge (psi)</b>	<b>Allowable Total Pressure During Occasional Surge (psi)</b>
DR 9	250	250	375	500
DR 11	200	200	300	400
DR 13.5	160	160	240	320
DR 17	125	125	187.5	250
DR 21	100	100	150	200
DR 26	80	80	120	160

**1.05 Submittals**

- A. Contractor shall submit information detailing the manufacturer’s experience requirements to satisfy the requirements of this specification.
- B. Submit pipe catalog information confirming that pipe, fittings, joints, and other materials conform to the requirements of the specifications.
- C. Affirmation that product shipped meets or exceeds the standards set forth in this specification. This shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards.
- D. Submit manufacturers recommended fusion procedures for the products.

## PART 2 PRODUCTS

### 2.01 Polyethylene Pipe, Fittings and Accessories

- A. Polyethylene pipe and fittings 4-65 inch diameter shall be in accordance with AWWA C906-15, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
- B. Polyethylene pipe ½ - 3 inch diameter for main line piping shall be polyethylene pipe (not tubing) in accordance with AWWA C901, material designation code of PE4710, all applicable ASTM standards and be listed on the PPI TR-4 HSB Listing of Hydrostatic Design Basis Listed Materials.
- C. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE4710, all applicable ASTM standards and shall be listed in current versions of PPI TR-4. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All fittings shall meet the requirements of AWWA C901, C906 and all applicable ASTM standards. Markings for molded fittings shall comply with the requirements of ASTM D3261. Fabricated fittings shall be marked in accordance with ASTM F2206. Socket fittings shall meet ASTM D2683. Fabricated fittings shall be manufactured using a DataLogger to record fusion time, pressure and temperature, and shall be marked with a unique joint identifier that corresponds to the joint report. A graphic representation of the time and pressure data for all fusion joints made producing fittings shall be maintained for a minimum of five years as part of quality control and will be available upon request of owner. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F2620.
- D. Electrofusion fittings shall be made of HDPE material with a minimum material designation code of PE4710 and meet ASTM F1055. Electrofusion fittings shall have a pressure rating equal to the pipe unless otherwise specified on the project documents. All electrofusion fittings shall be suitable for use as pressure conduits and have nominal burst values of four times the working pressure rating of the fitting. Marking of electrofusion fittings shall comply with the requirements of ASTM F1055. All electrofusion fittings shall be properly stored in compliance with the manufacturer's recommendation.
- E. If saddle fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM F2620 or PPI TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190.

- F. If socket fusion is used to fuse branch saddles, tapping tees and other HDPE fittings onto the wall of the main pipe, it shall be done in accordance with ASTM D2683 or the fitting manufacturer's recommendations. Socket fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past two years on the equipment to be utilized on this project in accordance with ASTM F3190. All equipment used for socket fusion should comply with ASTM F1056 and manufacturer's recommendations.
- G. Flanges and Mechanical Joint Adapters (MJ) shall have a minimum material designation code of PE4710 and meet all applicable AWWA and ASTM standards. Flanged and MJ adapters can be made to ASTM D3261 or machined in compliance with ASTM F2206. Flanges and MJ adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ adapters shall be per ASTM D3261. Fabricated (including machined) flange adapters shall be marked per ASTM F2206. Installation of all Flanged adapters shall follow the guidelines of the Plastics Pipe Institute TN-38.
- H. Glands, bolts, and gaskets shall be manufactured in accordance with AWWA C153. Bolts and nuts shall be grade 2 or higher.

## 2.02 Pipeline Identification

- A. All polyethylene pipe shall be marked in accordance with the standards to which it is manufactured.
- B. All polyethylene pipe shall be black, and shall contain a continuous colored stripe, 2 inches wide, located at no greater than 90 degree intervals around the pipe. Stripes shall be impregnated or molded into the pipe by the manufacturer. Application of the stripes after manufacture is not acceptable. Stripe color shall be:
  - 1. Potable Water Mains - blue stripes
  - 2. Reclaimed Water Mains - purple stripes
  - 3. Force Mains - green stripes
  - 4. Sanitary Sewer - green stripes
  - 5. Storm Sewer - no stripes required
- C. Grey or white polyethylene without stripes may be used for gravity or storm sewer applications as approved by the Owner or Engineer.
- D. All black polyethylene without stripes may be used for any installation in the interest of expediting delivery or reducing the cost of installation as approved by the Owner or Engineer.

## PART 3 EQUIPMENT

### **3.01 Data Logger**

- A. A data logger shall be used to record and document all butt fusion process. The data logger must be compatible and outfitted with an electronic data recording device. A digital report or printout for all fusion joints made that complies with, but is not limited to, ASTM F3124 must be delivered to the Owner upon request and at the completion of the project. All hydraulic fusion must be recorded and able to produce a graphic representation of the time and pressure data. All manual fusion must be recorded with, but not limited to, Joint ID, Operator Name and ID, Pipe information, and Heater Plate Temperature. The recording unit shall be a DataLogger 6 as manufactured by McElroy Manufacturing, Inc, or newer model or approved equivalent.
- B. The Owner or Engineer may approve not implementing use of a DataLogger on small diameter pipe, 6 inches or less.

## **PART 4 EXECUTION**

### **4.01 Delivery, Storage and Handling of Materials**

- A. Contractor is required to inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, or other defects shall be rejected and removed from the job site without delay.

### **4.02 Pipe Joining**

- A. High density polyethylene pipe shall be heat fused and pressure tested as per manufacturer's guidelines before installation. During assembly and prior to installation, pipe must be laid out in such a way as to minimize interference to pedestrian and vehicular traffic.
- B. Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out, discarded and the pipe rejoined.
- C. Each butt fusion shall be recorded and logged by a datalogger affixed to the fusion machine. Joint data shall be submitted as part of the as-built documentation.
- D. Mechanical joining – in areas as to which auxiliary or final connections are to be made and the continuous pipe section will not be installed, the polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections or mechanical couplings designed for joining polyethylene pipe or for joining polyethylene pipe to another pipe material. Mechanical couplings shall be fully pressure rated and fully thrust restrained and installed in accordance with manufacturer's recommendations.



#### 4.03 Pressure and Leakage Testing

##### A. Summary of Practice of Pressure and Leakage Testing

1. The section of the piping to be tested is isolated from other parts of the system and properly restrained in order to prevent failure of both the test section and the existing system connected to the test section. Isolated sections of the test section are vented to the atmosphere in order to ensure compressible gases do not remain within the hydraulic test section. The test section is filled with liquid, raised to the test pressure, and allowed to stabilize. The system is then inspected for leakage and the pressure is relieved. Any required repairs or replacements are then performed while the pipe is depressurized.
2. There is no leakage allowance, as properly made heat-fusion joints of HDPE do not leak. However, if any defects or leaks are revealed, they should be corrected and the pipeline retested after a minimum 24 hour recuperation period between tests. Total testing conducted on a section of pipeline shall not exceed eight hours within a 24 hour period.
3. An expansion allowance is allowed as HDPE will expand slightly due to elasticity and Poisson effects. The amount of make-up water (expansion allowance) will vary because expansion is not linear. This procedure compensates for expansion with an initial expansion phase followed by a testing phase as to which the test pressure is reduced suspending expansion. Expansion or contraction due to Poisson effects may disjoin other non-restrained joints, such as bell and spigot joints, so measures must be taken to fully restrain the test section.

##### B. Style of Testing

1. Conduct hydrostatic pressure testing of installed polyethylene pipe in accordance with ASTM F2164, Standard Field Leak Testing of Polyethylene Pipe and Crosslinked Polyethylene Piping Systems Using Hydrostatic Pressure.
2. It is not recommended to conduct pneumatic leak testing on HDPE in accordance with ASTM F2786, Standard Practice for Leak Testing of Polyethylene Piping Systems Using Gaseous Media Under Pressure (Pneumatic Leak Testing.)

##### C. Equipment to be used during testing

1. Non-HDPE components, such as end caps, valves, etc., that are used to isolate the test section from other parts of the system in order to perform the test are required to be rated for pressures equal to or greater than the test pressure applied to the test section. These non-HDPE components must be properly restrained while conducting the pressure test.
2. Air release valves must be installed at the high points of the test section to



allow for the release of any air or gases within the pipe prior to performing the required hydraulic pressure testing.

3. Pumping equipment used to pressurize the test section during the pressure testing should be of adequate capacity to fill, pressurize and test the section within the allotted time for the test.
4. A pressure monitoring gage is recommended to be connected to the test section at the lowest point to ensure the highest pressure is recorded within the test section. The combination of pump pressure and pressure at higher elevations will be recorded at the lowest point of the test section. Constant monitoring of the pressure during testing is required. A datalogger with a pressure recording transducer can be attached to the pressure gage to record pressure readings during the test. Additional gauges capturing the quantity of water used to fill prior to initial pressure testing and make up water during testing are required.

D. Safety

1. Take the necessary safety precautions to ensure the test is conducted safely during the entirety of the testing period. Persons operating near the test string should be familiar with pressure testing and understand the safety precautions necessary to perform the test safely.
2. The test section should be supervised at all times during pressure testing.
3. Failure of the HDPE pipe string may result in sudden, violent, uncontrolled and dangerous movement of the system piping, components or parts of the components.

E. Restraint against movement

1. Measures should be taken to ensure all parts and components of the pipe section under pressure testing should be restrained from movement either through the use of partial backfill or adequate above ground restraint methods.

F. Pre-test preparation and set-up

1. HDPE pipe materials are rated at temperatures of 73°F or less. Pressure testing at higher temperatures will require de-rating of the pipe and fittings in accordance with the manufacturer's recommendations.
2. Prior to testing, all heat fusion joints are to be completely cooled and allowed to cool beyond the required rough handling time.
3. The pipe string and components required to be tested should be flushed, pigged or otherwise cleaned to remove dirt and debris that may damage parts or components involved in the pressure testing.

G. Maximum test pressures

1. The maximum test pressure of should not exceed the Owner's or Engineer's recommendations.
2. System operating pressures often refer to the actual pressure that the municipal water and wastewater pipeline systems experience during actual operation.
3. System design pressures often refer to the pressure rating of the HDPE pipeline that will be installed within the municipal water and wastewater pipeline system. HDPE pipe utilized in municipal water and wastewater systems often have higher rated design pressures than the operating pressures of the pipe systems they are installed within.
4. System operating and system design pressures are not always equal. It is necessary to establish if there is a difference between system operating and system design pressures. The Owner or Engineer will make a determination if the system operating pressure or system design pressures will be used to perform pressure and leakage tests on the pipe string.
5. The maximum test pressure for HDPE shall not exceed 1.5 times the system design pressure when lower pressure rated components or devices are not present. The maximum test pressure for HDPE shall not exceed the pressure rating of the lowest pressure rated components when they are present.

#### H. Test duration

1. The test duration required to pressurize, stabilize, hold test pressure and depressurize shall not exceed 8 hours. If retesting is necessary, the test section shall be depressurize for a minimum of 8 hours prior to restarting.
2. Prior to pressurizing, all components must be inspected to be in proper working conditions, all components of the test section shall be vented to atmosphere and all low pressure lines not part of the test section shall be disconnected from the test section.

#### I. Execution

1. The test section shall be filled slowly with liquid and all air is purged from the system. It is important to take steps to ensure all air is purged from the system. The flow velocity of liquid within the test section should not exceed the capacity of air to be purged from the system or the allowable design velocity of the pipe.
2. The test section should be allowed to come to temperature equilibrium between the pipe string and the fluid within the pipe.
3. When the test section is filled with fluid and purged with air, the pressure within the test section shall be gradually increased to the required test pressure. Make-up water should be allowed to fill the test section to maintain the required pressure due to expansion of the test section.
4. Once the pipe has stabilized, the pressure should be reduced 10 psi and the pressure monitored for 1 hour. The pressure should not be increased nor makeup water added to the test section during the observation period.

5. If not leakage occurs or if the internal pressure remains within 5% of the test phase pressure, the pressure test has passed.
6. All records kept during pressure testing shall be provided to the Owner and Engineer.

J. Post test submittals

1. All records kept during pressure testing shall be provided to the Owner and Engineer.
2. Pressure test reports shall include the test liquid, backflow prevention devices, if used, weather conditions and ambient temperature at site of testing, test pressure, types of test gauges, location of test gauges including location distances and elevations, gauge calibration records, test pressures recorded, any adjustments made such as makeup water, etc, description of leaks or failures, date and time, and operator performing the pressure test.

**END OF SECTION**