SECTION 33 11 20

HIGH DENSITY POLYETHYLENE (HDPE) WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes High Density Polyethylene (HDPE) pipe and fittings from 4-inch through 32-inch for potable water and reuse applications including distribution piping and horizontal directional drill (HDD).

1.2 REFERENCE STANDARDS

A. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. In the event of a conflict, the most stringent requirements prevail. Submit conflicts to the Owner in writing prior to purchase of materials.

B. ANSI/AWWA www.awwa.org

1. AWWA M55 Manual of Water Supply Practices, PE Pipe–Design and Installation
2. ANSI/AWWA C111/A21.11-12 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
3. AWWA C207-13 Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
4. ANSI/AWWA C651 Standard for Disinfecting Water Mains
5. ANSI/AWWA C800 Underground Service Line Valves and Fittings
6. ANSI/AWWA C901-08 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm) for Water Service
7. ANSI/AWWA C906-15 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm to 1,650 mm), for Waterworks

C. Plastics Pipe Institute, PPI www.plasticpipe.org

1. PPI Handbook of Polyethylene Pipe – 2009 (2nd Edition)
2. PPI TR-33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe
3. PPI TR-34 Disinfection of Newly Constructed Polyethylene Water Mains
4. PPI TR-41 Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping
5. PPI TN-34 Installation Guidelines for Electrofusion Couplings 14-inch and Larger
6. PPI TN-42 Recommended Minimum Training Guidelines for PE Pipe Butt Fusion Joining Operators for Municipal and Industrial Projects (2009)
7. Municipal Advisory Board Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe

D. NSF www.nsf.org

1. NSF / ANSI 61 Drinking Water System Components–Health Effects

E. ASTM www.astm.org

1. ASTM B 62 Standard Specification for Composition Bronze or Ounce Metal Castings

2. ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
3. ASTM D 2239 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR- PR) Based on Controlled Inside Diameter
4. ASTM D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
5. ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
6. ASTM D 2737 Standard Specification for Polyethylene (PE) Plastic Tubing
7. ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
8. ASTM D 3035 Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
9. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
10. ASTM D 3350-08 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
11. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR- PR) Based on Outside Diameter
12. ASTM F 905 Standard Practice for Qualification of Polyethylene Saddle-Fused Joints
13. ASTM F 1055 Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
14. ASTM F 1290 Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings
15. ASTM F 1412 Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
16. ASTM F 1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
17. ASTM F 1668 Standard Guide for Construction Procedures for Buried Plastic Pipe
18. ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
19. ASTM F 2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock
20. ASTM F 2620 Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

F. AASHTO (www.transportation.org)

1. AASHTO T-99 Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

G. International Organization for Standardization (www.iso.org)

1. ISO 12176-2 Plastics pipes and fittings -- Equipment for fusion jointing polyethylene systems
2. ISO/TR 13950 Plastics pipes and fittings -- Automatic recognition systems for electrofusion joints

1.3 SYSTEM DESIGN PARAMETERS

A. Surge Pressure

1. Per AWWA 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.
2. Table 1 gives the Pressure Class per AWWA C906, Pressure Rating and Allowable Total Pressure During Recurring and Occasional Surge for PE4710 pipe at 80°F or less.

Pipe Dimension Ratio (DR)	Pressure Class	Pressure Rating	Allowable Total Pressure During Recurring Surge	Allowable Total Pressure During Occasional Surge
DR 9	250 psi	250 psi	375 psi	500 psi

1.4 SUBMITTALS

A. Requirements

1. Submittals shall be in accordance with requirements in Submittals Section.
2. All submittals shall be reviewed by the Engineer or the City prior to delivery.
3. The Contractor shall submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications. This certification shall be in the form of a written document from the manufacturer attesting to the manufacturing process meeting the standards.
4. The Contractor shall submit shop drawings showing installation method and the proposed method and specialized equipment to be used.
5. Manufacturers recommended fusion procedures for the products.

B. Provide Product Data

1. Manufacturer
2. Dimension Ratio
3. Joint Types
4. Restraint, if required in Contract Documents
   a. Retainer glands
   b. Thrust harnesses
   c. Any other means of restraint

C. Lay schedule/drawing

1. Lay schedule is required for 24-inch and greater diameters
2. Schedule must be sealed by a Professional Engineer licensed in North Carolina and must include:
   a. Pipe class
   b. Fittings – bends, tees, services, connections, MJ adapters
   c. Stationing
   d. Transitions
   e. Joint deflection
3. Note that lay schedule does not need to indicate location of butt fusion joints, as these will be determined in the field based on available pipe lengths and field conditions

D. Provide Internal Stiffeners Data

E. Provide Mechanical Joint Adapters Data

F. Installer Qualifications

1. Provide certifications meeting requirements of section 3.1 for each installer. Keep certifications on project site available to Owner, Engineer, and Inspector.

G. Data Logger Records

1. Provide electronic data logger record to the inspector daily or on request of inspector.
2. Fusion Reports shall report manufacturer, component, component fusion-jointing parameters, assembly operation and joint identification, per ISO 12176-4, and the following fusion-jointing operation data:
    a. Temp-Compensated Fusion Time & Actual Fusion Time
    b. Resistance before & after fusion
    c. Hi and Low output voltage & output current during fusion
    d. Total Amp-Hours applied to fitting
    e. Input voltage and frequency before fusion
    f. High and Low input voltage and frequency during fusion
    g. Input waveform
    h. GPS position and quality
    i. Ambient temperature
    j. Heating iron face temperatures
    k. Fusion pressure
    l. Graphic representation of the fusion cycle.
3. Report shall comply with ISO 12176-2 requirements for traceability databases.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping Requirement

1. Ship and deliver pipe and fittings from manufacturer with dust plugs on pipe ends and fitting ends.

B. Storage and Handling Requirements

1. Handle the pipe in accordance with the PPI Handbook of Polyethylene Pipe (2nd Edition), Chapter 2 using approved strapping and equipment rated for the loads encountered. Do not use chains, wire rope, forklifts or other methods or equipment that may gouge or damage the pipe or endanger persons or property. Field storage is to be in compliance with AWWA Manual of Practice M55 Chapter 7.
2. If any gouges, scrapes, or other damage to the pipe results in loss of 10% of the pipe wall thickness, cut out that section or do not use. Damages resulting from improper delivery, storage, or handling are the responsibility of the Contractor, and no additional payment shall be allowed by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Only the pipe and tubing manufacturers as listed below are allowed. Other manufacturers may be considered as equals on a project basis.

1. Performance Pipe

2. Georg Fischer
3. JM Eagle
4. Driscoplex
5. WL Plastics

B. Only the electrofusion fittings manufacturers as listed below are allowed. Other manufacturers may be considered as equals on a project basis.

1. Agru America
2. Georg Fischer Central Plastics
3. Integrity Fusion Products
4. IPEX, Inc.
5. M.T. Deason Company
6. Nupi Americas
7. Plasson, USA
8. Strongbridge-Tega

C. Only the butt fusion fittings manufacturers as listed below are allowed. Other manufacturers may be considered as equals on a project basis.

1. ISCO
2. IPEX
3. Georg Fisher

D. Only the fusion equipment manufacturers as listed below are allowed. Other manufacturers may be considered as equals on a project basis.

1. McElroy

E. Any product that is not listed in this section is considered a substitution and shall be considered by the Engineer on a project basis.

2.2 HDPE PIPE AND TUBING DIMENSION REQUIREMENTS

A. HDPE Pipe and Tubing shall comply with the following dimension standards:

Diameter (inch)	Dimension Ratio	Outside Diameter Standard	Pipe Dimension Standard
3/4 through 1	SDR 9	Copper Tubing Size (CTS)	ASTM D 2737
1.25 though 3	DR 9	Iron Pipe Size (IPS)	ASTM D 3035
4 through 32	DR 9	Iron Pipe Size (IPS)	ASTM F 714

B. Section 2.3 of this specification further describes requirements for HDPE pipe.

C. Section 2.13 of this specification further describes requirements for HDPE tubing.

2.3 HDPE PIPE

A. For diameters from 1.25-inches through 3-inches, High Density Polyethylene (HDPE) pipe and fittings shall meet the requirements of AWWA C901.

B. For diameters from 4-inches through 32-inches, HDPE pipe and fittings shall meet the requirements of AWWA C906.

C. The outside diameter of the pipe shall be based on the **Iron Pipe Size (IPS)** sizing system.

D. HDPE pipe shall be rated for use at a pressure class of 250 psi.

E. Polyethylene pipe shall be made from HDPE resin having a material designation code of PE4710 or higher.

F. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE445474C.

G. HDPE Pressure Pipe for potable water shall meet the requirements of NSF 61.

H. Pressure Pipe shall be approved by the Underwriter's Laboratory (UL) or Factory Mutual (FM).

I. Pipe Markings

1. Meet the minimum requirements of AWWA C901 or C906 as appropriate. Minimum pipe markings shall be as follows:
    a. Manufacturer's Name or Trademark and production record
    b. Nominal pipe size
    c. IPS
    d. Dimension Ratio (DR9)
    e. AWWA C901 or C906
    f. Seal of testing agency that verified the suitability of the pipe
    g. Resin type (PE4710)
2. Color identification to identify pipe service is required.
    a. Stripes or colored exterior pipe product shall be blue for potable water, or purple (lavender) for reclaimed water.
    b. Permanent identification of piping shall be provided by co-extruding multiple equally spaced color stripes into the pipe outside surface or by solid colored pipe shell.
    c. The striping material shall be the same material as the pipe material except for the color.
    d. Plain Black HDPE Pipe without color code markings may not be used.

J. Only smooth wall HDPE will be permitted.

K. Socket fusion is not allowed for pipes with diameter greater than 2-inch diameter.

2.4 HDPE BUTT FUSION FITTINGS

A. Butt Fusion Fittings shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.3.

B. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to or greater than the pipe unless otherwise specified on the plans.

1. Fabricated Fittings shall be Equivalent Dimension Ratio to DR9.
2. Pipe stock used to manufacture fabricated fittings shall meet requirements of AWWA C906 and meet the material designation code of PE4710.
3. Fabricated Fittings typically require a lower DR rating than the pipe to meet or exceed the pipe pressure rating. Calculate the difference for a fabricated fitting based on a published rerating percentage.
4. Fabricated bend and tee fittings shall have a minimum of 3 segments.
5. Fabricated bend fittings over 45 degrees through 90 degrees shall have a minimum of four segments.

6. Field fabricated fittings are not allowed.

C. All fittings shall meet the requirements of AWWA C906.

D. Markings for molded fittings shall comply with the requirements of ASTM D 3261.

1. Standard Designation (ASTM D 3261)
2. Manufacturer's name or trademark
3. Material designation (PE4710)
4. Date of manufacture or manufacturing code
5. Size
6. Dimension Ratio (example: DR11)

E. Fabricated fittings shall be marked in accordance with ASTM F 2206.

1. Standard Designation (ASTM F 2206)
2. Manufacturer's name or trademark
3. Material designation (PE4710)
4. Date of manufacture or manufacturing code
5. Size
6. Equivalent Dimension Ratio

2.5 HDPE ELECTROFUSION FITTINGS

A. Electrofusion Fittings shall be made of HDPE material with a minimum material designation code of PE4710 and with a minimum Cell Classification as noted in 2.3.

B. Electrofusion Fittings shall have a manufacturing standard of ASTM F 1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

C. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting.

D. Markings shall be according to ASTM F 1055.

1. Standard Designation (ASTM F 2206)
2. Manufacturer's name or trademark
3. Material designation (PE4710)
4. Date of manufacture or manufacturing code
5. Size
6. Equivalent Dimension Ratio

2.6 FLANGES AND MECHANICAL JOINT ADAPTERS (MJ ADAPTERS)

A. Flanges and Mechanical Joint Adapters shall have a material designation code of PE4710 or higher and a minimum Cell Classification as noted in 2.3.

B. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206.

C. The outside diameter of Flanges shall be based on Iron Pipe Size (IPS).

D. The MJ Adapters shall be based on Iron Pipe Size by Ductile Iron Pipe Size (IPS x DIPS).

E. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

F. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261.

1. Manufacturer's name or trademark
2. Material designation (PE4710)
3. Date of manufacture or manufacturing code
4. Size
5. Where recessed marking is used, take care not to reduce the wall thickness below the minimum specified.

G. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

H. Metal gland for MJ Adapter may be either AWWWA C110 (heavyweight) or AWWWA C153 (lightweight).

I. Low alloy steel bolts shall comply with AWWA C 111.4. Bolts, rods and hex nuts shall be manufactured from 304 stainless steel as per ANSI/ AWWA C111/A21.11.

J. Van-Stone style, metallic (including stainless steel), convoluted or flat-plate, back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C 207 Class 150 Series B, D, or E.

K. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The back-up ring, bolts, and nuts shall be protected from corrosion by a system such as coal-tar epoxy, galvanization, polyether, or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by the Engineer.

2.7 MECHANICAL JOINT WEDGE ACTION RESTRAINT

A. Mechanical Joint wedge action restraint shall only be allowed with specific permission of the Engineer in cases where an MJ Adapter is not feasible.

B. Mechanical Joint wedge action restraint shall be designed specifically for use on HDPE pipe.

C. The grip of the serrations shall increase as the hydrostatic pressure increases.

D. There shall be no additional tool required for installation other than the tools required to install standard sizes of hex nuts from 5/8"-1 1/8". The hex heads, bolts and rods shall be designed to tighten clockwise. The hex heads, bolts and rods shall be manufactured to allow for disassembly and re-installation of the restraint.

E. The gland halves shall be manufactured of high strength ductile iron in accordance with the ASTM A536 Standard, Grade 65-45-12.

F. Rods are manufactured from 304 stainless steel and hex nuts are manufactured from 316 stainless steel as per ANSI/ AWWA C111/A21.11.

G. The restraining gland shall comply with all applicable dimensions of ANSI/AWWA C111/A21.11 and shall be compatible with all bell and spigot (push-on) joint sockets of the standard.

H. Stiffening insert required.

2.8 SERVICE CONNECTIONS

A. Service connections shall be electrofusion saddles with sidewall fusion branch saddles, or tapping tees.

B. Electrofusion saddles shall be made from materials required in 2.5.

C. For sidewall fusion saddles, the size of the saddle shall be as indicated on the plans. The saddle can be made in accordance to ASTM D 3261 or ASTM F 2206. After installation, approximately ¼-inch of the PE pipe shall be visible beyond the saddle to confirm that proper surface preparation occurred. Saddle faces that do not provide ¼-inch of area beyond the saddle are not acceptable.

D. Tapping tees shall be made to ASTM D 3261 or D 2683.

E. Electrofusion saddles are the preferred method of service connections. Mechanical strap-on saddles can only be used where approved by the Engineer. The body of the mechanical saddle shall be stainless steel. The gasket material and design must be acceptable for PE pipe. Install mechanical strap-on saddles per the manufacturer's instructions.

2.9 PIPELINE MARKERS

A. Provide markers in accordance with Project Manual.

B. Detectable Warning Tape - 6-inch wide detectable warning tape - All force mains shall be clearly identified with blue plastic locator tape made specifically for that purpose. The tape shall be marked with black lettering clearly identifying the pipeline as sanitary sewer. The tape shall be Detectable Marking Tape.

C. Tracer wire - continuous AWG no. 12 gauge solid copper tracer wire with 30 mil thick blue HDPE insulation. Perform conductivity test on the tracer wire at final inspection.

D. Marker post material shall be high-performance fiberglass composite. Minimum 3-foot above ground. Manufactured by Carsonite or accepted equal.

2.10 STIFFENING INSERT (STIFFENER)

A. Provide Stiffeners at each MJ adapter and coupling per Standard Details.

B. Stiffening inserts shall be specially designed for use on the inside of HDPE pipe in conjunction with AWWA C111 mechanical joints.

C. Provide stainless steel per ASTM 240, type 304 or 316.

D. Stiffener shall be manufactured within the pipe or MJ adapter by the factory.

E. Field installed stiffeners may be allowed upon approval of Charlotte Water inspector. Wedge style stiffeners are allowed.

F. Stiffener length must be sufficient to fully encompass the area of the pipe being restrained.

G. Inserts must be designed for underground pressurized fluid service and are pressure rated to match the pipe DR pressure rating, derated as appropriate for service temperature. Maximum test pressure limited to pipe rated pressure.

H. Stiffener design shall prevent movement causing fitting to slide or rotate on the pipe.

2.11 FLEX COUPLING RESTRAINT DEVICE

A. HDPE flex coupling restraint devices will be rated for minimum of 8,000 pounds of force.

B. Resin used to manufacture device shall meet requirements of ASTM 3350 with minimum cell classification of 445474C.

C. Device will include bar code and product label tag.

D. Device will install by electrofusion.

2.12 WALL ANCHOR

A. Butt fusion wall anchors, or force restraint collars, shall comply with requirements of DR9, Iron Pipe Size (IPS), minimum cell class 445474C, and meeting this specification's requirements for PE pipe except for striping.

2.13 HDPE TUBING

A. High Density Polyethylene (HDPE) tubing shall meet the requirements of AWWA C901.

B. HDPE tubing shall be rated for use at a pressure class of 250 psi.

C. Polyethylene tubing shall be made from HDPE resin having a material designation code of PE4710 or higher.

D. Tubing material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE445474C.

E. HDPE Pressure tubing for potable water shall meet the requirements of NSF 61.

F. Pressure tubing shall be approved by the Underwriter's Laboratory (UL) or Factory Mutual (FM).

G. Tubing Markings

1. Meet the minimum requirements of AWWA C901. Minimum pipe markings shall be as follows:
    a. Nominal pipe size
    b. Diameter Base (CTS or IPS)
    c. Dimension Ratio (DR11)
    d. Manufacturer's Name or Trademark
    e. Material Designation Code / Resin type (PE4710)
    f. AWWA pressure class
    g. Standard designation (AWWA C901)
    h. Seal of testing agency that verified the suitability of the pipe
2. Color identification to identify pipe service is required.
    a. Solid colored exterior pipe product shall be blue for potable water, or purple (lavender) for reclaimed water.
    b. Plain Black HDPE Pipe without color code markings may not be used.

H. Only smooth wall HDPE will be permitted.

I. Socket fusion is allowed for HDPE pipe from 1.25-inch through 2-inch diameter and tubing from 3/4-inch through 1-inch diameter.

2.14 COPPER FITTINGS

A. Fittings for copper tubing and polyethylene tubing shall be red brass containing 85% copper, 5% lead, 5% tin, and 5% zinc in conformance with ASTM B 62.

B. Fittings may be flared or compression as applicable, in accordance with AWWA C 800.

C. Compression fittings shall utilize a compression nut and/or split clamp with tightening screw.

D. Stab type fittings are not approved.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Only formally trained and certified fusion technicians may conduct fusions. Qualification of the fusion technician shall be demonstrated by certification in fusion training within the past year for the type of fusion, and size of the pipe, and on the specific equipment to be used on this project. Provide documentation showing current and up-to-date qualification of training obtained to fuse PE pipe in the appropriate sizes and equipment types for the job.

B. Training in accordance with ASTM F 6220 for butt fusion.

C. Training in accordance with ASTM F 1055 for electrofusion.

D. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.

E. Qualified technician has documented prior experience in performing HDPE pipe installations, head fusion procedures, and testing methods.

3.2 INSTALLATION

A. GENERAL

1. Install pipe, fittings, specials, and appurtenances as specified herein, as specified in AWWA M55, and in accordance with the pipe manufacturer's recommendations with the intention of providing a leak-free system to the Owner.
2. Excavate and backfill trenches in accordance with the Project Manual.

B. PIPE HANDLING

1. At the close of each operating day, when work is stopped for more than 30 minutes, or when the trench is unsupervised:
    a. Keep the pipe clean and free of debris, dirt, animals, and trash – during and after the laying operation.
    b. Effectively seal the open end of the pipe using a gasketed night cap.

C. JOINING METHODS

1. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations.
2. Saddle fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or PPI TR-41 or the fitting manufacturer's recommendations and PPI TR-41.
3. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end.
4. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion requires an electric source , a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used.

D. MECHANICAL

1. Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with this specification.
2. Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
3. Mechanical coupling shall be made by qualified technicians.

E. JOINT RECORDING

1. Butt Fusion: The butt fusion equipment must be capable of reading and storing the input parameters and the fusion results for later download to a record file.
2. Electrofusion: The electrofusion equipment must be capable of reading and storing the input parameters and the fusion results for later download to a record file.
3. The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

F. INSTALLATION

1. Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.
2. Lay pipe with blue stripe within 45-degrees either side of crown, if pipe has blue stripe.
3. Pipe embedment - Embedment material shall be fine aggregate defined as:
   a. Granular and free flowing
   b. Generally meets or exceeds the limits on deleterious substances per Table 1 for fine aggregate according to ASTM C 33
   c. Reasonably free of organic material
   d. Gradation:

Sieve Size	**Percent Retained**
1 inch	0
3/8 inch	0-10
#30	25-60
#100	95

4. Compact backfill per ASTM D 698 and AASHTO T-99 as modified by NCDOT to 85% of maximum density or 95% maximum density within a road right-of-way. Compact the top 12-inches below the road sub-grade to 100% of maximum density within a road right-of-way.

G. MARKER INSTALLATION

1. See Standard Detail for placement requirements for detectable tape and tracer wire.

3.3 SITE QUALITY CONTROL

A. LEAK TESTING

1. Hydrostatic leakage testing is recommended and shall comply with AWWA C651, ASTM F 2164, ASTM F 1412, AWWA Manual of Practice M55 Chapter 9, and PPI Handbook of Polyethylene Pipe Chapter 2 (2nd Edition). If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.
2. Prior to scheduling a test with the inspector, preform a pre-test to confirm compliance.

3. Contractor shall perform hydrostatic and leakage tests in accordance with North Carolina state requirements.
4. Installed main shall be adequately anchored with a covering of at least 6-inches of initial backfill, if installed by an open trench method. The joints and fittings, particularly flange connections shall be left uncovered for visual leak inspection.
5. Leak tests of HDPE water system shall be conducted in accordance with ASTM F2164. The pipeline should be slowly filled with potable water and all trapped air bled off. The main should undergo a hydrostatic pressure test using pressure at the lowest elevation in the system at 150 psi. The pressure shall be maintained constant for 4-hour period by adding makeup water. After 4-hour period is completed, the pressure shall remain steady within 5% (7.5 psi) of a target 150 psi test pressure for one hour.
6. The total test time should not exceed 8 hours. If the pipeline has to be retested – the pipe must be depressurized and allowed to "relax" for at least 8 hours before the next testing sequence.
7. The pressure shall be maintained constant for 4-hour period by adding makeup water. After 4-hour period is completed, test the pressure at the lowest point.
8. Test pressure for one hour. Pressure should remain steady at 1.5 times the working pressure, but not more than the design pressure of the pipe (e.g. 200 psi for DR 11). Pressure must remain within 5% of a target test pressure for one hour.
9. In fused polyethylene water piping system no leakage shall be present. If leakage is observed at a fusion joint, complete rupture may be imminent. The Contractor shall move all personnel away from the joint and depressurize the main. Leaks, failure, or defective construction shall be promptly repaired by the Contractor at the Contractor's sole expense.
10. Payment for pressure and leakage testing shall be considered included in the price paid per linear foot for water main installation.
11. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

B. CLEANING AND DISINFECTING

1. After installation and pressure testing, disinfect water line according to AWWA C651.
2. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection shall be a minimum of 12 hours and should not exceed 24 hours.
3. Lab samples shall be collected and analyzed by Charlotte Water laboratories.
4. Dechlorinate with sodium bisulfate prior to release. Any water discharged to the ground surface shall not exceed 0.2 ppm of free chlorine.
5. Upon completion, the system should be thoroughly flushed with fresh water, and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

C. DISINFECTION AND BACTERIOLOGICAL TESTING

1. Newly installed potable water pipelines require disinfection in accordance with ANSI/AWWA C651/B301. The disinfection should take place after the initial flushing and after the completion of the pressure testing.
2. Air is to be exhausted from each high point, dead end, branch run, and hydrant run. The chlorinated water shall be removed prior to samples being collected for bacteriological testing.
3. After flushing to remove sediment and other foreign matter, and after testing for leaks, Contractor shall disinfect the main by the addition and thorough dispersion of a chlorine

solution in concentrations sufficient to produce a chlorine residual of at least 50 milligrams per liter (or ppm) in the water throughout the distribution system.

4. Injection of liquid chlorine solution shall be used to disinfect HDPE water mains. The disinfecting solution should not contain more than 12 percent of active chlorine. Prolonged exposure to highly concentrated disinfection chemicals may damage the inside surface of HDPE pipe and is to be avoided.
5. The chlorine solution shall remain in contact with interior surfaces of the water system for a period of 24-hours. Then the water system shall be flushed with fresh water from an approved water source until the chlorine solution is dispelled.
6. Before bacteriological testing samples are taken, each hydrant run, branch run, and dead end shall be thoroughly flushed to clear foreign matter and until the residual chlorine concentration is less than one part per million.
7. The Contractor shall measure residual chlorine concentrations by using a color comparator test that is witnessed and approved by the Inspector. After the chlorine concentration is less than 1 ppm, samples shall be gathered and tests conducted according to the provisions of AWWA C651-92, at the expense of the Contractor, by a laboratory approved by the Engineer.
8. Samples shall be taken at representative points as required to thoroughly test the installed main.
9. The Contractor will be required to perform two consecutive 24-hour apart Coliform tests. Testing laboratory used by the Contractor shall be State Certified and provide QA/QC report. The new facilities shall remain isolated and out of service until satisfactory test results have been obtained that meet the requirements of Charlotte Water and the North Carolina Department of Environment and Natural Resources – Public Water Supply Section and the Engineer has accepted the results as indicative of the bacteriological condition of the new water main. If unsatisfactory or doubtful results are obtained from the initial sampling, the chlorination process shall be repeated until acceptable test results are obtained. The bacteriological test takes at least 48 hours for results to be conclusive.
10. Individual new water services will be flushed thru the angle meter stop after connection to the new water main.
11. Payment for disinfecting water mains shall be considered included in the price paid per linear foot for water main installation.
12. Disposal of chlorinated water shall comply with all federal, state, and local regulatory requirements. Disposal directly to the storm drain system without removal of chlorine is strictly prohibited. No discharge into the storm drain system shall be allowed during rain. Upon termination of the flushing, any standing water in the gutter shall be removed by sweeping it to the nearest storm drain catch basin. Flushing of chlorinated water directly into the sanitary sewer system will only be allowed with the written approval of the Charlotte Water.
13. New water mains must be tied-in into water distribution system within 24 hours following the Engineer’s acceptance of the bacteriological tests’ results or the Contractor will be required to repeat flushing, disinfection, and bacteriological testing procedures at the Contractor’s expense. The new pipe, connections, and fittings must be kept clean and swabbed with a 5% solution of hypochlorite before installation.

END OF SECTION

Revision Log		
DATE	NAME	SUMMARY OF CHANGE