

TECHNICAL SPECIFICATIONS
FOR
INSULATED PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.1 The contractor shall supply insulated pipe and fittings with heat trace channels for use in water and forced sewage applications. The minimum service temperature range of all individual components and final products shall be -60° to 100°F unless otherwise specified. All pipe and fittings shall be capable of withstanding the cyclic freezing of water under its rated service pressure without breaks, leaks, gross deformities or impaired service characteristics. The pipe and fittings shall consist of an HDPE SDR 11 core pipe insulated with polyurethane insulation and protected with an outer jacket of either 16-gauge aluminum pipe or 175-mil HDPE, as specified in the bid schedule.

1.2 REFERENCES

A. The following specifications are referenced in this document and shall be considered integral to this specification:

2004 CSI Master Format number 33 11 00 (water utility distribution piping)

ASTM C17 Thermal transmission (guarded hot-plate apparatus)
ASTM C273 Shear properties of sandwich-core materials
ASTM C518 Thermal transmission (heat flow meter apparatus)
ASTM 01248 Polyethylene (PE) extrusion materials – wire and cable
ASTM 01621 Compressive properties of rigid cellular plastics
ASTM 02126 Response of rigid cellular plastic to thermal humid aging (thermal dimensional stability)
ASTM 02657 Heat Joining Polyolefin Pipe and Fittings
ASTM 02837 Obtaining pressure design basis for thermoplastic pipe products
ASTM 02842 Water absorption of rigid cellular plastics
ASTM 03350 Specification for Polyethylene plastic Pipe and Fittings Materials
ASTM E96 Water vapor transmission of rigid cellular plastics
ASTM E398 Water vapor transmission rate of sheet materials (dynamic relative humidity measurement)
ASTM F714 Polyethylene (PE) plastic pipe (SDR-PR) – based on outside diameter
AWWAC 901 Polyethylene Pressure Pipe and Fittings, 4-inch through 63-inch for Water Distribution and Transmission
NSF/ANSI-61 Drinking Water System Components – Health Effects
PPI TR-33* Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe
(*A gas pipe specification which is used industry-wide for all municipal and industrial PE pipe applications).

B. Unless otherwise noted herein or on the drawings, all fittings shall be constructed utilizing core pipe of the same Material, resin, and dimensions as that used for the core pipe of the straight lengths.

PART 2 PRODUCTS

2.1 CORE PIPE

- A. All core pipe shall be made of high-density polyethylene (HDPE) that conforms to all applicable provisions and requirements of the latest revision of AWWA C901 and AWWA C906 and, by inclusion, all appropriate standards referenced therein.
- B. The HDPE compounds utilized in the manufacture of products furnished under this specification shall be listed in PPI TR-4 and have a grade of PE34 with a minimum cell classification of PE 345444, composition class C {which specifies black (weather resistant) pipe containing not less than 2% carbon black} for PE 3408 materials, as defined in ASTM D3350. In conformance with AWWA C901 and AWWA C906, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1600 psi (PE3408) at a temperature of 73.4°F. All materials shall be evaluated, tested and certified for conformance with NSF- 61.
- C. All core HDPE pipe and fittings shall conform to standard iron pipe size outside dimensions (IPS), have a wall thickness meeting SDR 11, and have a minimum pressure rating of 160 psi according to ASTM D2837 at 73°F with a service rating of 0.5. All HDPE pipe shall be from straight sticks of pipe. Under no circumstances shall any coiled HDPE pipe be used to manufacture products furnished under this specification. All core sewer pipe shall be black, stamped with the appropriate SDR and ASTM designations.
- D. All HDPE pipe and fittings shall be homogeneous throughout, free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects, and shall be made of materials having the same chemical and physical characteristics. All HDPE pipe ends shall be free from chips, gouges, and other damage. All HDPE pipe and fittings shall be designed for direct pipe-to-pipe or pipe-to-fitting thermal butt fusion or electrofusion jointing, as shown on the drawings.
- E. All core HDPE fittings shall be manufactured to be as strong as or stronger than the pipe the fittings will be joined to, and shall maintain identical IPS outside dimension on stub-outs, and shall conform to the minimum pressure rating listed in section 2.1C. All fittings shall be manufactured from NSF-61 approved components. Tees may be fabricated using branch saddle sidewall fusion or molded fittings. All wyes shall be constructed using a prefabricated reinforced fitting constructed with thickened sidewalls and an inside diameter that matches SDR 11 pipe.
- F. All standard core elbows shall be fabricated using sweep bends. Sweep bends shall be seamless, manufactured in one continuous piece of SDR 11 HDPE pipe, with an angular tolerance of ± 2 degrees without reversion and a bend radius as specified in the following table. The elbows shall not be mitered and fused. All elbows must maintain normal outside diameters along their entire length within tolerance as per ASTM-F714 and be suitable for butt-welding or electrofusion. The outside surface of the elbows shall exhibit all the specified characteristics of the straight pipe and shall not have any blisters or other surface defects from the manufacturing process. All sweep bends shall be NSF-61 approved after manufacture of the final product. Tight radius 90 degree elbows shall be constructed with molded fittings rated at minimum pressure listed in sections 2.1C and shall be NSF-61 approved.

Pipe Size (inches dia.)	Centerline Radius (inches)
<u>2</u>	<u>6.0 – 9.0</u>
<u>3</u>	<u>9.0 - 11.0</u>
<u>4</u>	<u>13.0 – 15.0</u>
<u>6</u>	<u>19.0 – 21.0</u>
<u>8</u>	<u>22.0 – 26.0</u>

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G. The manufacturer of fabricated fittings supplied under this specification shall establish and qualify heat fusion procedures conforming to PPI TR-33 and ASTM D2657 and all fusion must be performed by a qualified operator factory-certified in the use of the specific equipment employed to construct the fittings.

2.2 INSULATION

A. Insulation between core pipe and outer jacket of all pipe and fittings shall be low-density rigid closed-cell urethane foam with a nominal thickness as shown on the drawings. It shall be applied and cured in strict accordance with the manufacturer's recommendations and good commercial practices such that the resulting insulation completely fills the annular space between core pipe and outer jacket and is free of defects affecting its intended purpose.

B. Urethane foam shall exhibit the following properties and characteristics specified by the referenced ASTM tests below:

ASTM C518 or C177	Maximum K-factor, as produced	0.15 to 0.17 btu-in/hr-ft-F ft
ASTM D1622	Core Density Range	3.0 to 4.0 lbs/ft
ASTM D1621	Minimum Compressive Strength (Parallel and perpendicular to pipe axis)	35 psi
ASTM D2842	Maximum Water Absorption	0.05 lb/ft ³
ASTM D2126	Dimensional Stability (Maximum Linear Change)	1% at -20°F 3% at +100°F

C. Exposed urethane foam faces at pipe and fitting ends shall be coated to protect against physical abuse, UV exposure during shipping and storage, and against water intrusion in service. The coating shall be suitable for direct application over urethane foam with no deleterious effects to the foam or coating. The coating shall be formulated for long-term service and retained flexibility over extended periods of exposure to sunlight, harsh weather, and saltwater spray. The strength of the adhesive bond of the coating to the foam shall be greater than the tensile strength of the coating. In the event the coating is nicked or an edge is rolled up in handling, the coating that has been dislodged shall tear free from the coating still adhering to the foam rather than pull the balance of the coating off as a sheet.

D. The coating shall be applied and cured in strict accordance with the manufacturer's recommendations and good commercial practice such that the finished product is free of defects affecting its intended purpose.

E. The coating material shall exhibit the following properties and characteristics:

ASTM E398 or E96	Maximum Water Vapor Permeance:	1.0 perm
	Dry Film Thickness Range:	15 to 63 mils

2.3 METAL OUTER JACKET

A. Metal outer jackets for pipe and fittings shall be constructed of 16-gauge internal helical lock-seam corrugated aluminum pipe with a nominal diameter as shown on the drawings. Aluminum alloy material shall be 3004-H34 with a 7072 coating on the outside of the jacket or 5052-H32. All helical seams shall be continuous, tightly locked and folded. The outer jacket of all pipe and fittings shall be watertight under a five-foot head of water and the outside of the jacket shall present a relatively smooth, flat overall appearance. Standard corrugated culvert pipe is not acceptable.

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- B. The outer jacket corrugations shall be between 3/16-inch and 3/8- inch deep as measured from the flat area between corrugations to the bottom of the corrugation on the outside of the jacket and shall be spaced no more than 2-2/3-inches apart and formed diagonally around the pipe, resulting in not less than 2 nor more than 10 complete corrugations crossing the pipe's circumference at a given cross-section.
- C. The nominal diameter shall be the inside diameter as measured between the innermost portion of the corrugations, with a dimensional tolerance of + 1/2"
- D. All joints in the aluminum outer jacket fabricated around fittings shall be welded with a continuous bead, resulting in a finished jacket that is watertight per the requirements of sections 2.3A.
- E. The Contractor shall provide company name date (month and year) on the outer jacket of each pipe and fitting. Information shall be stamped onto an aluminum plate with 1/8-inch to 1/4-inch high lettering, and the plate shall be riveted onto the jacket with a minimum of 4 aluminum rivets. The plate shall be secured to the jacket within 8" of one end of the jacket.
- F. All surfaces of the outer jacket, including end-cuts and welds, shall be finished such that no jagged edges exist that could cause personal injury.
- G. The interior of the jacket shall be free of oils, grease, or other residue that could interfere with the adhesion of insulation to the outer jacket.

2.4 HDPE OUTER JACKET

- A. HDPE jacket shall be high-density polyethylene, conforming to ASTM D-1248 and the specification standards listed above for the HDPE core pipe. The wall thickness shall be a minimum of 175 mils thick. The jacket size shall be as specified on the drawings. Joints in the HDPE outer jacket for fittings shall be butt fused wherever possible and extrusion welded where required. The outer jacket shall be finished to produce a watertight covering.
- B. All joints in the aluminum outer jacket fabricated around fittings shall be welded with a continuous bead, resulting in a finished jacket that is watertight per the requirements of sections 2.3A

2.5 HEAT TRACE CHANNEL

- A. Heat trace channels shall be fully enclosed, in direct contact with the core pipe for its entire length, and there shall be no intrusion of insulation between the heat trace channel and the core pipe unless otherwise specified.
- B. Heat trace channels for all straight lengths of pipe shall be made of PE or ABS material and shall be half- moon shaped with inside dimensions of 1-1/2-inches to 1-3/4-inches wide by 3/4-inch to 1-inch high and installed as shown on the drawings. The heat trace channel shall extend 2-inches past the insulation face of the pipe, with ends cleanly cut, square, smooth, and free from burrs or other protrusions that could interfere with installing the heat trace in the field, as shown in the drawings.

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- C. Heat trace channels installed along angular bends of fittings shall be constructed with 1-1/2 inch diameter flexible, liquid tight PVC non-metallic conduit. Conduit material shall be nonconductive and non-corrosive, with a smooth interior surface that will maintain the internal diameter in tight radius bends. Conduit material shall be UL listed for outdoor use. A transition fitting shall be installed on all ends of heat trace channel that results in a half-moon
- D. channel protruding from the insulation face as specified for straight pipe channel. All transition fittings shall be constructed with smooth interiors, free from burrs or other protrusions that could interfere with installing the heat trace in the field, as shown in the drawings.
- E. Pieces of half-moon heat trace channel to fit within the joint area (jumpers) shall be provided with each piece of pipe and with each fitting. The jumpers must be sized to slip snugly over the outside of the specified straight pipe heat trace channel with an overlap of not less than 1 %-inches on each side after a typical field fusion of individual lengths of pipe.

. 2.6. GLYCOL TRACE CHANNEL

- A. Glycol trace channels shall be fully enclosed and constructed of PE or ABS material with a minimum thickness of 0.10-inch. The Channel shall be in direct contact with the core pipe for its entire length and there shall be no intrusion of insulation between the heat trace channel and the core pipe unless otherwise specified.
- B. The glycol trace channel shall be oval-shaped and sized 6-5/8 inch by 3-1/4 inch to allow adequate interior space to conveniently pull two each 2-inch SDR-11 HDPE pipes within the channel. Channels used in fittings shall be mitered and fused together to create a channel that follows the curvature of the fitting.

PART 3: EXECUTION

3.1 MANUFACTURING AND DIMENSIONAL TOLERANCES

- A. Allowable offset of the centerline of the outer jacket and inner core pipe shall be not more than 1/4-inch at the pipe ends. Elsewhere along pipe lengths the centerline offset shall not be greater than 3/8-inch. Allowable offset of the centerline of the glycol channel and core pipe shall be not more than 3/8-inches.
- B. The minimum temperature of all components used to manufacture pipe and fittings shall be 50°F at the start of fabrication. The fabricated pipe shall be placed in a facility maintained at a temperature of 50°F or greater for a minimum of 12 hours after fabrication.
- C. All elbows shall have a bend radius as specified in the drawings with a tolerance of ± 2 degrees without reversion. All elbows must maintain normal outside diameters along their entire length without tolerance as per ASTM-F714.
- D. All branches of fabricated fittings must lie in a single plane with a maximum deviation of + 2 degrees.
- E. The length of core pipe protruding from the insulation on the ends shall be 12 inches $\pm 1/4$ -inch. The inner core pipe ends shall be smooth and oriented perpendicularly to the inner core pipe longitudinal axis $\pm 1/8$ -inch.

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- F. The outer jacket shall be cut in one pass perpendicular to the length of the jacket ± 1 degree. The coupling on bell ends shall be perpendicular to the length of the jacket ± 1 degree and flush with the jacket end with a tolerance of $-1/8$ -inch. No part of the coupling shall protrude beyond the end of the jacket as determined by placing a straight-edge across the jacket at any two points. The bell end of the coupling shall be flush with the insulation and outer jacket. Before coating, the plane of the exposed insulation face at bell and spigot ends shall be perpendicular to the centerline axis of the outer jacket $\pm 1/8$ -inch. The insulation profile of the coated ends shall not exceed a relief deviance of $+ 1/2$ -inch across the face.

3.2 FABRICATED FITTINGS

- A. All fusion joints used in fabricated fittings shall be documented by a computer that records pressure and temperature applied at each fused joint. Computer printouts and electronic data for each fitting shall be made available to the owner upon request. The contractor shall ensure that each joint is fused at the temperature and pressure recommended by the pipe manufacturer in order to achieve the maximum pressure rating for that joint.
- B. All fittings for each project shall be labeled with a unique identifier that corresponds with the fusion computer printouts for each fitting.

3.3 INSULATING

- A. All Federal and State regulations applicable to the type of insulation and its use shall be strictly adhered to.
- B. Insulation shall be placed into the pipe by a single injection application. Fittings may be manufactured using one insulation injection for each open of the fitting. In no case shall the jacket be drilled to perform, monitor, or inspect the injection.
- C. The maximum allowable void size is 0.05 in³ (for reference, a 3/8-inch cube is .05 in³).
- D. Insulation and chemicals shall be prevented from coming in contact with the end or inside of the exposed core pipe.
- E. The heat trace channel shall be secured to the outside of the core pipe, parallel to the pipe axis, and prior to the insulating. The channel shall protrude 2-inches past the insulation faces at each end of the pipe or fitting, be free of insulation residue and foreign substances, and open to the minimum cross section specified throughout.
- F. The glycol trace channel shall be secured to the outside of the core pipe, parallel to the pipe axis, and prior to the insulating. The channel shall be flush with the insulation faces at each end of the pipe or fitting, be free of insulation residue and foreign substances, and open to the minimum cross section specified.

3.4 CORE PIPE/INSULATION BOND

- A. Core pipe and fittings shall be bonded to the insulation with minimum shear bond strength of 15 psi, or in such a manner as to produce foam-to-foam separation when a sample is tested in shear.
- B. The inner core pipe surface preparation will be performed in a manner that does not leave foreign material imbedded in the plastic. Gouges or scratches in the pipe surface that exceed the tolerance specified by the pipe manufacturer for the pipe pressure rating shall be cause for rejection.

3.5 PRODUCTING TESTING AND INSPECTION

- A. Only finished pipe lengths and fittings that meet the requirements of these specifications and drawings shall be used for destructive testing. Should any product fail to meet the visual quality control specifications listed below, that product shall be either re-built to meet the specifications or rejected. Only those products that meet all visual quality control specifications shall be considered final products suitable for receipt by the owner or for laboratory or other destructive testing.

1. VISUAL QUALITY CONTROL:

- a. FUSION JOINTS: All fusion joints on elbow and fitting extensions shall be examined before the inner core pipe assembly is foamed into the outer jacket. Elbow and fitting extension fusion joints shall meet all the requirements of the pipe manufacturer and the following minimum requirements:
 - 1) On both sides, the double bead shall be rolled over to the surface and be uniformly rounded and consistent in size throughout the entire circumference of the joint.
 - 2) The gap between the two beads must not be below the fusion surface throughout the entire circumference of the joint.
 - 3) The displacement (perpendicular to the pipe centerline) between the fused ends must not exceed 10% of the pipe minimum wall thickness
 - 4) The width of the combined two beads for SDR 11 pipe shall be as follows:

Pipe Dia.	Minimum Bead Width	Maximum Bead Width
2" pipe	3/16-inch	5/16-inch
3" pipe	9/32-inch	3/8-inch
4" pipe	5/16-inch	7/16-inch
6" pipe	3/8 - inch	9/16-inch
8" pipe	1/2-inch	11/16-inch

- 5) Both beads of each fusion joint shall be of a uniform size and shape. The ratio of the difference in individual bead widths divided by the total width of both beads shall not exceed 10%.
- b. DIMENSIONAL TOLERANCE: Each length of pipe and each fitting will be examined by the Contractor for off-set tolerances, insulation cut-back distances, exposed foam face alignment and relief profile, and alignment and smoothness of inner core pipe ends.
- c. INSULATION INTEGRITY: Completed pipe and fitting ends shall be inspected for voids in excess of 0.05 in³ or discontinuities by the Contractor prior to coating. Any glazing left on the uncoated pipe end from the forms used during the foaming operation shall be removed before coating.
- d. HDPE CARRIER PIPE: The surface of the HDPE carrier pipe shall be free of nicks, cuts, or gouges as outlined in Section 2.1 of this document.

2. LABORATORY TESTING:

- a. Laboratory testing as identified in section 2.2B shall be conducted to verify the quality of the finished product. The density and K-factor shall be measured on insulation specimens of the appropriate size and under the specified conditions as set forth in the applicable ASTM test. Insulation specimens shall be retrieved by cutting a 12-inch section of insulated pipe from a production sample. The remaining length shall be trimmed to the dimensional tolerances of this specification to allow owner use of that pipe section.

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- b. Should the Contractor choose to test the "K" factor as outlined in ASTM C518, the testing apparatus shall be calibrated within 24 hours of the test using a calibration standard certified accurate by the National Bureau of Standards (NBS). The "K" factor test sample shall be removed from the insulated pipe, prepared for testing, and left open to the atmosphere at 70°F for a minimum of 24 hours prior to testing.
- c. In addition to the testing identified I section 2.2B, the following tests shall be performed to verify the quality of the finished product:
 - 1) Core pipe/insulation bond:
 - a) Two 6-inch lengths of cured insulated pipe shall be cut from one uncoated insulation face end of completed pipe length. The remaining length shall be trimmed according to the dimensional tolerances of the specification and coated to allow owner use of that pipe section.
 - b) One specimen shall be tested at +70°F. The other specimen shall be brought to -60°F in 4 hours or less, and remain there for at least 24 hours before testing. Acceptance will be indicated by a minimum shear bond strength of 15 psi and insulation –to-insulation (or insulation-to-insulation pipe surface film) separation or tearing.
 - c) Testing shall be conducted as indicated on the attached drawing labeled “Core pipe/insulation bond test setup.”

3.6 PACKING

- A. The core pipe spigot ends of all pipe and fittings shall be capped with PE pipe caps (Caplugs, or approved equal) and the plugs taped to the pipe with black electrical tape (such as 3M #33+) or other approved tape after final inspection and prior to shipment. Duct tape shall not be used to secure the PE pipe caps to the pipe spigot ends.
- B. Pre-insulated pipe shall be packed in bundles with a maximum gross weight of 4,000 pounds per bundle unless otherwise specified by the Owner. The end geometry of each bundle shall be rectangular. Each layer of pipe within the bundle including the bottom layer shall rest upon a minimum of 3 each 4-inch x 4-inch cross cleats banded to that individual layer using 1-1/4-inch steel strapping. All cleats shall feature a 45-degree stop block at least nominal 4-inches high by 4-inches long fastened securely to both ends of the cleats to prevent the pipe from rolling off the cleat when the banding is cut. The outer cross cleats shall be installed between 1 to 2-feet from the insulation face of the pipe ends with the middle cleat centered on the bundle. In addition, 1-1/4-inch steel straps shall securely fasten all the layers together to form a complete bundle. Bundles 5 pipes wide by 5 pipes high are recommended.
- C. All fittings and couplings shall be packaged in crates sheathed with minimum 1/2 inch sheathing not to exceed 4 ft x 4 ft x 8 ft. Minimum nominal 2-inch x 3-inch framing members shall be installed in all corners of the crate and fastened securely to the sheathing. On crates longer than 6-feet, framing members shall be installed along the shorter centerline of all the 4 long panels. The framing members shall be securely fastened to each other and to the sheathing. For crates 4-feet long or less, 2 each 4-inch x 4-inch cleats shall be installed on the bottom edges of the crate to provide for forklift handling. For crates longer than 4-feet, 3 cleats shall be installed, with the middle cleat centered on the crate. These cleats shall be fastened through the bottom sheathing and also banded to the crate with 1-1/4" wide steel bands that wrap around the entire crate. The crates shall be designed to stack 3 crates high, provide protection to the contents during rough oceans, air freight transport, and on-site handling without damage.

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D. All bundles and crates will be clearly marked per the following:

ANTHC
Village Name
Supplier's Name

3.7 FINAL INSPECTION

A. After completion of the quantity of pipe and fittings contracted for, the Owner may perform a final inspection at the fabrication point. The certified results of all required laboratory tests made during production by the Contractor shall be made available in report form at this time. During the final inspections, the product packing will be inspected to see that all specifications listed in sections 3.6 have been met. Should any of the packing fail to meet the specifications, the Contractor shall re-pack the pipe to meet specifications.

END OF SPECIFICATION