

**TECHNICAL SPECIFICATIONS  
FOR  
INSULATED GRAVITY SEWER PIPE AND FITTINGS**

***PART 1- GENERAL***

1.1 The contractor shall supply bell and spigot insulated pipe and fittings with heat trace channels for use in gravity sewer 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 17 core pipe insulated with polyurethane insulation and protected with an outer jacket of either 16-gauge aluminum pipe.

**1.2 REFERENCES**

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

2004 CSI Master Format No.33 31 00 (public sanitary utility sewerage piping)

|            |   |
|------------|---|
| ASTM C177  | Thermal transmission (guarded hot-plate apparatus)  |
| ASTM C273  | Shear properties of sandwich-core materials   |
| ASTM C518  | Thermal transmission (heat flow meter apparatus)  |
| ASTM D1248 | Polyethylene (PE) extrusion materials -wire and cable   |
| ASTM D1599 | Resistance to short-time hydraulic failure pressure of plastic pipe, tubing, and fittings               |
| ASTM D1621 | Compressive properties of rigid cellular plastics   |
| ASTM D1621 | Apparent density of rigid cellular plastics   |
| ASTM D1784 | Rigid PVC Compounds and CPVC Compounds  |
| ASTM D2128 | Response of rigid cellular plastics to thermal humid aging (thermal dimensional stability)              |
| ASTM D2657 | Heat Joining Polyolefin Pipe and Fittings   |
| ASTM D2837 | Obtaining pressure design basis for thermoplastic pipe products   |
| ASTM D2842 | Water absorption of rigid cellular plastics   |
| ASTM D3139 | Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals                                      |
| ASTM D3350 | 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 F477  | Elastomeric Seals (Gaskets) for Joining Plastic Pipe  |
| ASTM F714  | Polyethylene (PE) plastic pipe (SOR-PR) -based on outside diameter                                      |
| AWWA C901  | Polyethylene Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service                        |
| AWWA C906  | Polyethylene-Pressure Pipe and Fittings, 4-inch through 63-inch for Water Distribution And Transmission |
| PPI TR-33* | Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe   |

(\*A gas pipe specification which is used Industry-wide for municipal and industrial PE pipe applications.)

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

**PART 2 – PRODUCTS**

2.1 CORE PIPE

- A. Core pipe shall be made of high-density polyethylene (HDPE).
- 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. They shall have a PPI recommended Hydrostatic Design Basis (HD8) of 1600 psi (PE3408) at a temperature of 73.4°F.
- C. All pipe and fittings shall conform to standard iron pipe size outside dimensions (IPS), have a wall thickness meeting SDR 17, and have a minimum pressure rating of 100 psi according to ASTM 02837 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 core 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 sewer elbows shall be fabricated using sweep bends. Sweep bends shall be seamless, manufactured in one continuous piece of SDR 17 HDPE pipe, with an angular tolerance of plus or minus 2 degrees without reversion bend radius as specified in the table below. The elbows shall not be mitered and fused. All elbows must maintain normal outside diameters along their entire length without 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.

| Pipe Size<br>(Inches dia.) | Centerline<br>Radius (inches) |
|----------------------------|-------------------------------|
| 4                          | 13.0 – 15.0                   |
| 6                          | 19.0 – 21.0                   |
| 8                          | 22.0 – 26.0                   |
| 4" long radius             | 32                            |

- F. The manufacturer of core 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.
- G. Bell ends of all core pipe and fittings shall be fabricated with identical PVC push-on type sewer couplings. All PVC sewer couplings shall be manufactured in one piece of injection molded PVC compound meeting ASTM D1784. Couplings shall be Class 200 and conform to requirements of DR 21. Fittings shall be designed to withstand a minimum of 630 psi quick burst pressure at 73°F, tested in accordance with ASTM D1599. Bells shall be gasketed joints conforming to ASTM D3139 with gaskets conforming to ASTM F477.

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- H. The gaskets on push-on couplings shall be elastomeric, non-circular in cross-section, tapered on the inlet edge to prevent rollout when the pipe is coupled, and be not less than 1/4-inch square in the cross-sectional area. The groove in which the gasket is retained shall have sides that are perpendicular to the center line of the pipe.
- I. The spigot end of the core pipe shall be smoothly beveled to a 15 degree angle as shown in the drawings. The bevel shall reduce the wall thickness at the end of the pipe by 50 percent. The bell and spigot ends shall be free from chips, gouges, and other damage. The bell couplings shall not be ground, chipped, gouged, or damaged in any manner.

2.2 INSULATION

- A. Insulation between 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 cellular insulation completely fills the annular space between inner 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 <sup>2</sup> -°F |
| ASTM D1622        | Core Density Range  | 3.0 to 4.0 lbs/ft <sup>3</sup>             |
| ASTM 01621        | Minimum Compressive Strength<br>(parallel and perpendicular to pipe axis) | 35 psi                                     |
| ASTM D2842        | Maximum Water Absorption  | 0.05 lb/ft <sup>3</sup>                    |
| ASTM 02126        | Dimensional Stability<br>(Maximum Linear Change)                          | 1% at -20°F<br>3% at +100°F                |

- C. Exposed insulation faces at pipe end 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 the insulation with no deleterious effects to the insulation or coating. The coating shall be formulated for long-term service and retained flexibility over extended periods of exposure to sunlight, heavy precipitation, and saltwater spray within the service temperature range specified in Part 1. The strength of the coating's adhesive bond to the insulation 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 insulation rather than pull the balance of the coating off as a sheet.
- D. The end 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 OUTER JACKET

- A. Metal outer jackets for pipe and fittings shall be constructed of 16-gauge internal helical lock-seam corrugated aluminum pipe with an outside 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 –five head of water and the outside of the jacket shall present a relatively smooth, flat overall appearance. Standard corrugated culvert pipe is not acceptable.
- B. The outer jacket corrugations shall be 3/16-inch and 3/8-inch deep, as measured from the flat area between corrugations to the bottom of the corrugations 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 inside diameter as measured between the innermost portion of the corrugations, with a dimensional tolerance of  $\pm 1/2''$ .
- 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 section 2.3A.
- E. The Contractor shall provide company name and production date (month and date) on 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 tot the outer jacket.

### 2.4 HEAT TRACE CHANNEL

- A. Heat trace channels shall be fully enclosed, in direct contact with the Inner core pipe for its entire length, and there shall be no intrusion of foam between the heat trace channel and the core pipe unless otherwise specified. Spacers shall be used to offset the channel at the spigot ends, as shown in the drawings. All channel spacers shall be constructed from urethane or extruded polystyrene.
- 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-inches to 1-inch high within the finished product after insulation is cured. Heat trace channels shall be installed as shown on the drawings. The heat trace channel shall be flush with the insulation face of the pipe with a tolerance of -1/8-inch, with ends cleanly cut, square, smooth, and free from burrs or other protrusions that could interfere with installation of the heat trace in the field.
- C. Heat trace channels installed along angular bends of fittings shall be constructed with 1 1/2-inch diameter PVC Liquid tight flexible, non-metallic conduit. Conduit material shall be non-conductive 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 and sunlight resistance. A transition fitting shall be installed on all ends of heat trace

channel that results in a half-moon channel flush with 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.

## **PART 3 - EXECUTION**

### 3.1 MANUFACTURING AND DIMENSIONAL TOLERANCES

- A. Allowable offset of the centerline of the outer jacket and core pipe shall be not more than 1/4-inch at the pipe ends. Elsewhere along pipe lengths the centerline off-set shall not be greater than 3/8-inch.
- B. The minimum temperature of all components used to manufacture pipe end 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 table in section 2.1E with a tolerance of  $\pm 2$  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  $\pm 2$  degrees.
- E. The spigot end of the core pipe shall extend beyond the face of the insulation a distance of 1-3/4-inches plus the insertion depth of the push-on coupling  $\pm 1/4$ -inch. The insertion depth shall be defined as the distance between the outside edge of the coupling and the coupling center stop.
- F. The outer jacket shall be cut in one pass perpendicular to the length of the jacket  $\pm 1$  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 end 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 the relief deviance of  $\pm 1/4$ -inch across the face.

### 3.2 FABRICATED FITTINGS

- A. All fusion joints 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 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.
- C. All fabricated fittings shall have all internal fusion beads removed in such a manner as to result in a continuously smooth flow path inside the pipe per the requirements of the International Plumbing Code Section 704.2 and 706.2, and the Alaska Department of Environmental Conservation 18 AAC 72.040(b)(4)(C).

*TECHNICAL SPECIFICATIONS FOR INSULATED GRAVITY SEWER PIPE AND FITTINGS (cont.)*

3.3 INSULATING

- A. All Federal and State regulations governing 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 only (not straight pipe) may be manufactured using one insulation injection for each open end of the fitting. In no case shall the jacket of either straight pipe or fittings be drilled to perform, monitor, or inspect the injection.
- C. The maximum allowable void size is 0.05 in<sup>3</sup> (for reference, as 3/8-inch cube is 0.05in<sup>3</sup>).
- 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 be flush with the insulation faces at each end of the pipe with a tolerance of -1/8-inch, 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 to produce insulation-to-insulation separation when a sample is tested in shear as described in section 2c1.
- B. The 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 10% of the minimum wall thickness shall be cause for rejection.

3.5. PRODUCTION TESTING AND INSPECTION

- A. Only finished pipe length and fittings that meet the requirements of these specifications and drawings shall be used for destructive testing. 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 core elbow and fitting extensions shall be examined before the 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 center line) between the fused ends must not exceed 10% of the pipe minimum wall thickness.

TECHNICAL SPECIFICATIONS FOR INSULATED GRAVITY SEWER PIPE AND FITTINGS (cont.)

4) The width of the combined two beads for SDR 17 pipe shall be as follows:

| <u>Pipe Dia.</u> | <u>Minimum Bead Width</u> | <u>Maximum Bead Width</u> |
|------------------|---------------------------|---------------------------|
| 4"               | 3/16-inch                 | 3/8-inch                  |
| 6"               | 1/4-inch                  | 1/2-inch                  |
| 8"               | 15/16-inch                | 9/16-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 insulation face alignment and relief profile, and alignment and smoothness of core pipe ends.
- c. **INSULATION INTEGRITY:** Completed pipe and fitting ends shall be inspected for voids in excess of 0.05 in<sup>3</sup> 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 Part 2.1, "Inner Core Pipe."

## 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 and finished per the specifications in this document to allow Owner use of that pipe section.
- 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 in 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 this 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 show 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 15psi and insulation-to-insulation (or insulation-to-insulation pipe surface film) separation or tearing.

*TECHNICAL SPECIFICATIONS FOR INSULATED GRAVITY SEWER PIPE AND FITTINGS (cont.)*

- 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 center line 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-inch 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.
- D. All bundles and crates will be clearly marked:

**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 inspection, the product packing will be inspected to see that all specifications listed in section 3.5 have been met. Should any of the packing fail to meet the specifications, the Contractor shall re-pack the pipe to meet the specifications.

END OF SPECIFICATION