

High-Temperature PE4710 (PE-RT) Pipe and Fittings for Pressure Piping Systems

Model specification for Pipeline Elevate-RT™ PE4710 (PE-RT) pipe in raw water, process water, wastewater, district heating and cooling, oil and gas gathering, and chemical or corrosive service at operating temperatures up to 180°F.

The specifier may adopt part or all of this model specification. The specifier is responsible for confirming that each part adopted is appropriate for the intended service, and for editing bracketed and blank entries to suit the project. See the notice at the end of this document.

PART 1 – GENERAL

1.1 SCOPE

This specification covers the material, manufacturing, joining, installation, and testing requirements for high-density polyethylene (HDPE) PE4710 raised-temperature-resistance (PE-RT) pipe and fittings used in pressure piping systems operating at temperatures up to and including 180°F (82°C). All work shall be performed in accordance with this specification, the engineered plans, and the manufacturer's published recommendations.

1.2 DESCRIPTION

- A.** Furnish, install, and test the PE-RT piping system as indicated herein and as shown on the Drawings, including pipe, fittings, fabrications, transition connections, and appurtenances.
- B.** The primary installation methods addressed are direct burial by open cut and trenchless pull-in installation. The means and methods, including testing for acceptance, shall conform to the standards referenced herein, with the intent of providing a leak-free, fully self-restrained piping system for the Owner.
- C.** Pipeline construction shall be performed in accordance with engineered plans and drawings prepared under the direction of a professional engineer.
- D.** A licensed and bonded contractor shall perform pipeline construction work. The Contractor shall secure all necessary permits before commencing construction.
- E.** All work shall be inspected by an authorized representative of the Owner, who shall have authority to halt construction where this specification or standard construction practice is not being followed. Written notice shall be issued ordering construction to cease until all deficiencies are corrected.

1.3 REFERENCED STANDARDS

- A.** The standards and documents listed in Appendix D are incorporated by reference and made part of this specification to the extent referenced.
- B.** Unless otherwise specified, a reference to a standard means the latest published edition and revision in effect at the bid date of the project.

- C. In the event of conflict, the requirements of the project specification shall prevail.

1.4 SYSTEM DESIGN PARAMETERS

- A. Pipe shall be furnished in dimension ratio DR shown on the Drawings. Outside diameters shall be based on the IPS sizing system in accordance with ASTM F714 and ASTM D3035, or ASTM F2619. Standard sizes, wall thicknesses, and weights are listed in Appendix B.
- B. The maximum working pressure rating is based on a hydrostatic design stress (HDS) of 1,000 psi at 73°F, derived from a hydrostatic design basis (HDB) of 1,600 psi at 73°F per ASTM D2837 using the 0.63 design factor recommended by PPI TR-4. The elevated-temperature rating is independently substantiated by an HDB of 800 psi at 180°F per ASTM D2837 and PPI TR-3.
- C. The maximum operating pressure at service temperature shall be determined per the ASTM F2619 Appendix relationship, using the temperature service factor and fluid service factor below. Design pressures for each DR and temperature are tabulated in Appendix C.
- D. System design shall account for surge and cyclic pressures, fatigue, thermal expansion and contraction, external loads, and chemical or hydrocarbon exposure. Refer to PPI TR-9 for design service factors and to the PPI *Handbook of Polyethylene Pipe*, 2nd ed., Chapter 3 for additional design guidance.

PRESSURE-STRESS RELATIONSHIP PER ASTM F2619 APPENDIX

$$P_T = 2 \times HDS \times S_F \times S_T \div (DR - 1)$$

P _T	Maximum operating pressure at temperature T, psig
HDS	Hydrostatic design stress at 73°F = 1,000 psi for PE4710
S _T	Temperature service factor — see Table 1
S _F	Fluid service factor — see Table 2
DR	Pipe dimension ratio, OD ÷ minimum wall thickness

TABLE 1 — TEMPERATURE SERVICE FACTOR, S_T

Service temperature	<80°F (27°C)	100°F (38°C)	120°F (49°C)	140°F (60°C)	160°F (71°C)	180°F (82°C)
S _T	1.00	0.84	0.73	0.63	0.55	0.50

TABLE 2 — FLUID SERVICE FACTOR, S_F

Service fluid	S _F
Water, brine, dry gas gathering	1.0
Liquid hydrocarbons (>2%) — wet natural gas and liquid hydrocarbons; continuous exposure to produced water containing >2% liquid hydrocarbons; gas condensates	0.5

Continuous-use temperature. For long-term design (50 years and greater), 140°F is considered the maximum continuous-use temperature for typical PE4710 design. Pipeline Elevate-RT™ has a D2837-substantiated 180°F HDB that supports continuous operation to 180°F. Short-term and intermittent operating temperatures above 180°F may be acceptable provided the appropriate temperature service factor is applied. Other considerations also affect maximum use temperature; the specifier shall contact Pipeline Plastics for design recommendations at these elevated temperatures.

1.5 SUBMITTALS

- A.** Affirmation from the manufacturer that the product shipped meets or exceeds the requirements of the standards set forth in this specification, in the form of a document attesting that the manufacturing process meets those standards, with associated test reports confirming compliance.
- B.** Current Certificate of Compliance and evidence of ISO 9001 registration from an independent registrar, upon request.
- C.** Product data sheet, cell classification, and PPI TR-4 listing for the resin and pipe as manufactured.
- D.** Manufacturer's recommended butt fusion, saddle fusion, and electrofusion joining procedures for the specified product and wall thicknesses.
- E.** Fusion technician training records and qualification certificates, dated not more than 12 months before commencing construction.
- F.** The Owner reserves the right, at its own cost, to conduct an in-plant audit and observe extruding and molding facilities.

1.6 DELIVERY, STORAGE, AND HANDLING

- A.** Handle and store pipe in accordance with the PPI *Handbook of Polyethylene Pipe*, Chapter 2, using approved strapping and equipment rated for the loads encountered. Chains, wire rope, and forklift methods that may gouge or damage the pipe, or endanger persons or property, shall not be used.
- B.** A receiving inspection shall be performed at delivery, and any shipping damage shall be reported to the manufacturer within seven days. Pipe or fittings with gouges or scrapes equal to or greater than 10% of the wall thickness, or with other damage or manufacturing defects, shall be rejected. Additional grounds for rejection include incorrect markings, incorrect DR, and wrong sizing standard.
- C.** Where pipe is stored outdoors for extended periods, stack in accordance with the manufacturer's recommendations and protect from mechanical damage. Black pipe with 2% minimum carbon black requires no additional protection from ultraviolet exposure.

PART 2 – PIPE AND FITTINGS

2.1 QUALIFICATION OF MANUFACTURERS

The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by this specification. Production facilities shall be open for inspection by the Owner or its authorized representative. The pipe and fitting manufacturer shall be certified to the current edition of ISO 9001 and shall maintain a documented quality management system defining product specifications and manufacturing and quality assurance procedures that assure conformance with customer and applicable regulatory requirements.

2.2 APPROVED MANUFACTURER AND PRODUCT

APPROVED MANUFACTURER

Pipeline Plastics, LLC — Westlake, Texas

APPROVED PIPE

Pipeline Elevate-RT™ PE4710 (PE-RT) Pipe**2.3 MATERIALS**

- A.** PE-RT material used for the manufacture of pipe and fittings shall be PE4710 high-density polyethylene meeting the ASTM D3350 cell classification PE445574C, and shall be listed in the name of the pipe manufacturer in PPI TR-4 with a standard-grade HDB rating of 1,600 psi at 73°F and 800 psi at 180°F per ASTM D2837 and PPI TR-3.
- B.** Pipeline Elevate-RT™ is manufactured using Dow Chemical INTREPID™ 2499 bimodal polyethylene resin. Substitution of resin shall not be permitted without written approval of the Engineer.
- C.** The compound shall contain a stabilizer system suitable for high oxidative environments. Where required by the service, a CC3 oxidative-resistance rating per ASTM D3350 shall be specified.
- D.** Color and UV stabilization shall be code (C) black with 2% minimum carbon black per ASTM D3350.
- E.** Nominal physical properties of the compound are listed in Appendix A. Nominal values are typical results; they are not guaranteed and are not intended for use as product specification or engineering design values.
- F.** Where the piping system conveys potable water, materials shall be certified to NSF/ANSI/CAN 61.
[Specifier to delete if not applicable.]

2.4 PIPE

- A.** Pipe shall be manufactured in accordance with ASTM F714, ASTM D3035, ASTM F2619, and API 15LE as applicable to the size and sizing system specified.
- B.** Dimensions and tolerances shall meet the requirements of the applicable manufacturing standard. Inside diameters and weights per foot listed in Appendix B may vary within manufacturing tolerances.
- C.** Pipe shall be furnished in straight lengths or coils as shown on the Drawings. Pipe shall be free of visible cracks, holes, foreign inclusions, blisters, and other deleterious defects.
- D.** Standard sizes are 2 in. through 42 in. IPS in DR 7 through DR 32.5 as tabulated in Appendix B. Other sizes are available; the specifier shall confirm availability with the manufacturer.

2.5 MARKING

Pipe shall be marked in accordance with ASTM D3035 (1"-3") or ASTM F714, ASTM F2619, and API 15LE as applicable. Markings shall include the manufacturer's name or trademark, nominal size, dimension ratio, material designation code PE4710 PE-RT, the applicable standard designations, production record code, and date of manufacture. Markings shall be legible and permanent until time of installation. Stripes shall be co-extruded into the pipe outside surface; stripes printed or painted on the outside surface shall not be acceptable. Gray or silver stripe is specified.

2.6 FITTINGS AND CUSTOM FABRICATIONS

- A. General.** All fittings and custom fabrications shall be PE4710 (PE-RT) with a minimum cell classification as specified in Section 2.3.A, and shall be pressure rated for the same internal pressure rating as the mating pipe at the design service temperature. Fittings shall be rated for the specified operating temperature; the specifier shall verify the fitting manufacturer's elevated-temperature rating.
- B. Molded fittings.** Molded fittings shall be manufactured, tested, and marked in accordance with ASTM D3261, and manufactured from the same PE4710 (PE-RT) as specified in Section 2.3.A. Where the required molded fitting is not available in the project-specified DR, a thicker-wall molded fitting may be used to maintain the pressure rating, and the spigot ends shall be modified by the fitting manufacturer or approved representative to match the DR and nominal OD of the pipe being installed. The manufacturer shall submit samples from each molded fitting production lot to x-ray inspection.
- C. Fabricated fittings.** Fabricated fittings shall be manufactured, tested, and marked in accordance with ASTM F2206 and shall be made by heat fusion joining of machined shapes cut from pipe, polyethylene sheet stock, or molded fittings manufactured from the same material as specified in Section 2.3.A. Where a thicker wall is used to maintain the pressure rating, fitting ends shall be machined by the fitting manufacturer or approved representative to match the DR and nominal OD of the pipe being installed.
- D. Electrofusion fittings.** Electrofusion fittings shall be manufactured and marked in accordance with ASTM F1055 and shall have a pressure rating equal to the mating pipe unless otherwise shown on the Drawings. Electrofusion fittings shall remain in original factory packaging until installation; fittings not in original packaging shall be rejected. The fitting manufacturer's temperature rating shall be verified for service above 140°F.
- E. Flange adapters and back-up rings.** Flange adapters shall conform to ASTM F2880 and shall be made with sufficient through-bore length to be clamped in a butt fusion machine without a stub-end holder. Sealing surfaces shall be machined with a series of small v-shaped grooves (serrations). Back-up rings shall be pressure rated equal to or greater than the mating pipe, with the bore chamfered or radiused to clear the flange adapter radius. Flange bolts shall be SAE J429 Grade 2 or Grade 5 with corresponding heavy-hex nuts, or as specified by the Owner. Refer to PPI TN-38 for bolt torque.
- F. Mechanical joint adapters.** MJ adapters shall be manufactured from the same material as specified in Section 2.3.A made in accordance with ASTM D3261, with a pressure rating equal to the pipe to which they are joined. MJ adapters 4 in. through 16 in. may be provided with optional stainless steel stiffeners on request; MJ adapters 14 in. and larger shall be provided with heavy-duty back-up ring kits; all MJ adapters 18 in. and larger shall be provided with stainless steel stiffeners. Accessories shall include AWWA C110 metal glands, high-strength low-alloy bolts and nuts with fluoropolymer finish or stainless steel as specified by the Owner, and gaskets as specified by the Owner and rated for the service temperature and fluid.
- G. Elastomeric components.** Gaskets, seals, and other elastomeric components shall be selected for compatibility with the service fluid, disinfectant regime, and design service temperature. Elastomers rated only for ambient service shall not be used in lines operating above 100°F.

2.7 COMPLIANCE TESTS

In case of conflict with the manufacturer's certifications, the Contractor, Engineer, or Owner may request retesting by the manufacturer, or may have retests performed by an outside testing service. All retesting shall be at the requestor's expense and shall be performed in accordance with this specification.

PART 3 – JOINING

3.1 TRAINING AND INSPECTION

- A. Refer to ASTM F3190, ASTM F3565, and PPI MAB-01, MAB-02, and MAB-06 for recommended training and inspection of butt fusion, sidewall fusion, socket fusion, and electrofusion joints. All equipment shall be inspected and all personnel training requirements completed and verified before commencing construction.
- B. Each fusion technician shall be qualified to make the specific joint required. Qualification shall be demonstrated by evidence of training within the previous 12 months on the equipment and pipe sizes to be used on the project, and shall include successful destructive testing of prepared joints. The Contractor shall maintain records of trained personnel.
- C. Upon request and at the requestor's expense, training personnel from the manufacturer or its representative shall be made available.
- D. Installation of the pipe shall be observed by trained inspectors on a full-time basis, or as specified.

3.2 JOINING METHODS

Pipe and fittings shall be joined by heat fusion, electrofusion couplings, mechanical joint adapters, or flange connections in accordance with the manufacturer's recommendations and this specification. Unless otherwise shown on the Drawings, and except for connections to dissimilar piping materials, all joints shall be fused. Fusion parameters for Pipeline Elevate-RT™ shall follow ASTM F2620 and PPI TR-33 and TR-41 as recommended by the manufacturer.

- A. **Butt fusion.** Joints between plain-end pipes and fittings shall be made by butt fusion in accordance with ASTM F2620. Prior to fusion, the pipe shall be clean and ends cut square. Field equipment shall secure and precisely align the pipe ends and shall be capable of recording fusion parameters. Fusion quality data shall meet ASTM F3124 and shall be provided to the Owner, who will review the records within seven days and identify any joint indicated for replacement. External and internal beads shall not be removed unless specifically required in project plans.
- B. **Butt fusion of unlike wall thickness.** Butt fusion shall be performed between pipe ends, or pipe ends and fitting outlets, having the same outside diameter and differing by not more than one standard DR – for example DR 13.5 to DR 17, or DR 11 to DR 13.5. Transitions greater than one DR shall be made with a transition nipple, by mechanical means, or by electrofusion. Refer also to ASTM F2620, Section X1.4.
- C. **Saddle (sidewall) fusion.** Joints between the main and saddle branch fittings shall be made by saddle fusion in accordance with ASTM F2620 by qualified technicians. Refer to ASTM F905 for qualification of saddle-fused joints.
- D. **Socket fusion.** Molded socket fusion fittings shall be used only for joining pipe 2 in. and smaller, in accordance with ASTM F2620.
- E. **Electrofusion.** Electrofusion joining shall be performed in accordance with the fitting manufacturer's recommended procedure and ASTM F1055, ASTM F3565, PPI MAB-01, and MAB-02. The installer shall remove oxidation from the pipe OD and maintain clean surfaces on both pipe and fitting. The assembly shall remain clamped until the required cooling time has elapsed.
- F. **Cold and inclement weather.** For fusing at ambient temperatures below 32°F, or in snow, rain, or high wind, refer to PPI MAB-08 and the manufacturer's recommendations.

- G. Mechanical connections.** Mechanical connection of PE-RT to valves, pumps, and other equipment shall use flanges, MJ adapters, or devices manufactured for use with HDPE, in conformance with AWWA M55, Chapter 6. Per MAB-04, stiffeners shall be used with all mechanical connections. Mechanical couplings shall be recommended by their manufacturer for use on HDPE at the required pressure rating and service temperature, shall incorporate an internal stiffener, and shall be fully self-restrained. When joining by other means, the installation instructions of the joining device manufacturer shall be observed.
- H. Branch connections.** Branch connections to the main shall be made with saddle fittings fused per Section 3.2.C, electrofusion branch fittings, or tees.

PART 4 – INSTALLATION

4.1 GENERAL

Installation shall be in accordance with ASTM D2774, ASTM F1668, AWWA M55, the manufacturer's recommendations, and this specification. All necessary precautions shall be taken to ensure a safe working environment in accordance with applicable safety codes and standards. Installation is recommended to follow the PPI *Handbook of Polyethylene Pipe*, 2nd ed.

4.2 EXCAVATION, FOUNDATION, AND BEDDING

- A.** Trench excavations shall conform to the plans and drawings as authorized in writing by the Engineer and in accordance with all applicable codes. The Contractor shall remove excess groundwater. Where necessary, trench walls shall be shored or reinforced.
- B.** Pipe shall be laid on grade on a stable foundation. The trench bottom may undulate, but significant irregularities shall be leveled or filled with compacted embedment. Where the trench bottom is uniform and the soil stable, foundation or bedding may be omitted at the discretion of the Engineer. Unstable or unsuitable trench bottom soils shall be removed and replaced with a 6 in. foundation or bedding of compacted Class I material to pipe bottom grade.
- C.** Care shall be taken when placing, moving, or removing trench boxes, sheeting, shoring, or bracing to prevent disturbance of the pipe and embedment soils. Any voids or disturbance shall be refilled and re-compacted.

4.3 PIPE HANDLING

When lifting with slings, only wide fabric choker slings of sufficient rated capacity shall be used to lift, move, or lower pipe and fittings. Wire rope and chain are prohibited. Slings shall be inspected before use; worn or damaged equipment shall not be used.

4.4 EMBEDMENT AND FINAL BACKFILL

- A.** Embedment material shall be Class I, II, III, or IV soil as defined by AWWA M55; bedding material shall be Class I or Class II. Class V soils are not recommended. Engineered embedment soil type and particle size shall be in accordance with ASTM D2774.
- B.** Maximum particle size in the embedment shall not exceed the values in Table 3.

- C.** Embedment shall be placed and compacted in lifts not exceeding 6 in. to at least 90% Standard Proctor Density (ASTM D698), to a minimum of 6 in. above the pipe crown. Care shall be taken to ensure the haunch areas below the springline are completely filled and free of voids. For shallow, non-traffic applications and at the discretion of the Engineer, compactable native trench material may be used, placed in lifts not exceeding 6 in. and compacted to at least 85% Standard Proctor Density.
- D.** Final backfill shall be placed and compacted to finished grade. Native soils may be used provided they are free of debris, stones, boulders, clumps, and frozen clods larger than 8 in. in their largest dimension. Where final backfill is beneath a paved surface, crossing pipeline, or waterway, soil shall be placed in lifts and compacted to 95% or greater (ASTM D698), or as required by the Owner or permitting agency.

TABLE 3 – ALLOWABLE MAXIMUM PARTICLE SIZE IN EMBEDMENT

Pipe diameter	Maximum particle size
4 in. and smaller	≤ ½ in.
6 in. and 8 in.	≤ ¾ in.
10 in. through 16 in.	≤ 1 in.
18 in. and larger	≤ 1½ in.

4.5 RESTRAINT, ANCHORAGE, AND APPURTENANCES

- A.** Systems joined by heat fusion, electrofusion, flanges, and MJ adapters are fully self-restrained and do not require external joint restraints or thrust block anchors. Reinforced concrete anchor blocks shall be installed where PE-RT connects to unrestrained pipe. Refer to AWWA M55.
- B.** Connections to other pipe materials, valves, and appurtenances shall be made by mechanical joints, flanges, or transition fittings, and shall be restrained and supported independently. A stiffener shall be installed in the bore of the PE-RT pipe where an OD compression mechanical coupling is used and where connecting plain-end pipe to a mechanical joint pipe, fitting, or appurtenance. External clamp and tie-rod restraint shall be installed where PE-RT is connected to the socket of a mechanical joint component, except where an MJ adapter is used.
- C.** All appurtenances shall be independently supported and shall not rely on the pipeline or its connections for support.
- D.** Mechanical joint and flange connections shall be installed per the manufacturer's recommended procedure. Adapters and flanges shall be centered and aligned to the mating component before assembling and tightening bolts; in no case shall gland or flange bolts be used to draw a connection into alignment. Bolt threads and nuts shall be lubricated and flat washers used under the nuts. Bolts shall be evenly tightened according to the manufacturer's tightening pattern and torque steps. Four hours after initial assembly, flange connections shall be re-tightened to the target torque. For pipe 14 in. and larger, and for environmentally sensitive or critical pipelines, a second re-torque shall be performed after an additional 4 to 24 hours.
- E.** Per ASTM D2774, connections shall be protected where a buried branch or service pipe is joined to a service saddle, branch saddle, or tapping tee on a main, and where pipes enter or exit casings or walls. The area surrounding the connection shall be embedded in properly placed, compacted backfill, preferably in combination with a protective sleeve or other structural support, to protect against shear and bending loads.

4.6 LARGE-DIAMETER FABRICATED FITTINGS

Not more than one plain-end connection of a 16 in. IPS or larger fabricated directional fitting shall be butt fused to the end of a pipe length before placing the assembly into the trench. Remaining fitting connections shall be made in the trench by butt fusion, flange, or other means per Section 3.2. Handling, lifting, moving, or lowering a 16 in. IPS or larger fabricated fitting connected to more than one pipe length is prohibited. Fitting damage caused by improper handling shall be corrected by the installing Contractor at its expense.

4.7 COLD (FIELD) BENDING

The Contractor shall not bend pipe to fit a trench at a radius less than the values in Table 4.

TABLE 4 – MINIMUM LONG-TERM COLD BENDING RADIUS

Pipe DR	Minimum cold bending radius (long-term)
DR 9 and lower	20 × pipe OD
DR 11 – DR 13.5	25 × pipe OD
DR 17 – DR 21	27 × pipe OD
Fitting or flange within the bend	100 × pipe OD

4.8 THERMAL EXPANSION AND CONTRACTION

The coefficient of thermal expansion of Pipeline Elevate-RT™ is approximately 1.0×10^{-4} in./in./°F. Above-grade, in-casing, and partially restrained runs shall be designed to accommodate expansion and contraction between the installation temperature and the design service temperature range. Buried, fully restrained, and properly embedded pipe develops thermal stress rather than movement; the Engineer shall evaluate end-restraint loads at connections to rigid structures and appurtenances, particularly in lines operating above 140°F.

4.9 TRENCHLESS INSTALLATION

- A. Per ASTM F1804, the Contractor shall determine and document the maximum proposed pull-in length and pull-in force for the DR and diameter to be installed. Pull-in lengths shall not exceed the documented maximum for that DR and diameter.
- B. Before pulling, rollers or other approved devices shall be placed beneath the pipe to avoid damage and reduce drag. Sharp pavement corners at the launch pit shall be protected with rollers or pads.
- C. A commercially available load limiter (weak link) approved by the Engineer shall be used between the puller and the pipe. Per ASTM F1804 and the PPI *Handbook of Polyethylene Pipe*, the maximum safe pull stress at 73°F shall not exceed 1,400 psi for a ½ to 1 hour load duration, 1,300 psi for 12 hours, or 1,250 psi for 24 hours. Safe pull stress shall be reduced for pull-in at elevated pipe or ground temperatures.
- D. For horizontal directional drilling refer to ASTM F1962, MAB-07, and the PPI *Handbook of Polyethylene Pipe*, Chapter 12; for sliplining refer to ASTM F585 and Chapter 11; for pipe bursting refer to MAB-05 and Chapter 16.

PART 5 – TESTING

5.1 FUSION QUALITY

The Contractor shall be responsible for field set-up and operation of the fusion equipment and for the fusion

procedure used by its operators on site. Quality controls for fusion joint quality shall include operator training in identifying a properly made fusion; where applicable, equipment to record and document key fusion parameters for comparison against recommended guidelines; field testing of trial joints; and hydrostatic testing. The Contractor at its expense shall make all necessary corrections to equipment, set-up, operation, and procedure, and shall re-make rejected fusions.

5.2 FUSION PROCESS QUALIFICATION

The Contractor shall verify field fusion quality by preparing and testing a trial fusion matching the diameter and wall of each pipe being installed. The trial fusion shall cool completely before testing. A bend-back test per ASTM F2620 shall be used for wall thicknesses less than 1 in.; a guided side bend test per ASTM F3183 shall be used for wall thicknesses of 1 in. and larger. This verification shall be done at the beginning of the project to qualify the procedure, equipment, and operator. If equipment or operator changes, then qualification shall be performed again before any further fusions are completed. Additional fusion quality checks can be requested.

5.3 LEAK TESTING

- A.** Hydrostatic leak testing shall be conducted in accordance with ASTM F2164. Pneumatic pressure testing is prohibited. Appropriate safety considerations shall be observed at all times, and the Contractor is responsible for the safety of its personnel during testing and repair.
 - B.** Test pressure shall be a minimum of 1.5 times the working pressure of the piping system, or a maximum of 1.5 times the pipe pressure rating at the test temperature, and shall not exceed the capacity of the lowest-rated or lowest-elevation component in the test section.
 - C.** Where the line has been operating at elevated temperature, the test section shall be allowed to cool to ambient before testing, and the pressure rating at the test temperature shall be used to establish the test pressure.
 - D.** In a fused PE-RT piping system, no leakage is allowed.
 - E.** If the test fails, the test section shall be depressurized, repaired, and allowed to relax for at least eight hours before beginning the next test sequence.
 - F.** Leaks, failures, or defective construction shall be promptly repaired by the Contractor at its sole expense.
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PART 6 – CLEANING AND COMMISSIONING

- A.** After installation and pressure testing, the system shall be flushed with clean water to remove debris and construction residue before being placed in service.
- B.** Where the system conveys potable water, cleaning and disinfection shall be in accordance with AWWA C651 using solutions of liquid disinfectants, not powders or tablets. Refer to PPI TR-34. Following verification of disinfection, all mains, laterals, and service pipes shall be thoroughly flushed with potable water and retested to verify that residual chlorine has been reduced to concentrations suitable for consumption. [Specifier to delete if not applicable.]
- C.** Lines intended for elevated-temperature service shall be brought up to operating temperature gradually in accordance with the system design, and connections at rigid structures shall be observed during the initial thermal cycle.

- D.** Record drawings shall show installed alignment, depth of cover, DR, fitting locations, and the locations of all service connections tied to existing property lines.

APPENDIX A – NOMINAL PHYSICAL PROPERTIES

Property	Nominal value	Test method
Density	0.960 g/cm ³	ASTM D1505
Melt index (MI), 190°C / 2.16 kg	0.1 g/10 min	ASTM D1238
High load melt index, 190°C / 21.6 kg	7 – 14 g/10 min	ASTM D1238
PENT	>10,000 hours	ASTM F1473
Tensile stress at yield	3,500 psi	ASTM D638
Tensile stress at break	4,500 psi	ASTM D638
Elongation at break	>500 %	ASTM D638
Flexural modulus	150,000 psi	ASTM D790
Brittleness temperature	<-103 °F	ASTM D746
Hardness	62 Shore D	ASTM D2240
Vicat softening temperature	256 °F	ASTM D1525
Coefficient of thermal expansion	1.0 × 10 ⁻⁴ in/in/ °F	ASTM D696
Cell classification	PE445574C	ASTM D3350
Hydrostatic design basis	1,600 psi @ 73°F; 800 psi @ 180°F	ASTM D2837

Nominal values are typical results. They are not guaranteed and are not intended for use as a product specification or as engineering design values.

APPENDIX B – STANDARD IPS SIZES, WALL THICKNESSES, AND WEIGHTS

Pressure ratings shown in the header are for water at temperatures up to 80°F per ASTM F714. Inside diameters and weights may vary within manufacturing tolerances. These tables represent standard sizes; other sizes are available.

Size	OD		DR 7	DR 9	DR 11	DR 13.5	DR 17	DR 21	DR 26	DR 32.5
Pressure rating, psi			335	250	200	160	125	100	80	63
2"	2.375	Wall	.339	.264	.216	—	—	—	—	—
		ID	1.656	1.816	1.917	—	—	—	—	—
		lb/ft	0.948	0.767	0.643	—	—	—	—	—
3"	3.500	Wall	.500	.389	.318	—	—	—	—	—
		ID	2.440	2.676	2.825	—	—	—	—	—
		lb/ft	2.058	1.663	1.394	—	—	—	—	—
4"	4.500	Wall	.643	.500	.409	.333	—	—	—	—
		ID	3.137	3.440	3.633	3.793	—	—	—	—
		lb/ft	3.400	2.751	2.307	1.914	—	—	—	—
6"	6.625	Wall	.946	.736	.602	.491	.390	—	—	—
		ID	4.619	5.064	5.348	5.585	5.799	—	—	—
		lb/ft	7.373	5.961	4.994	4.151	3.354	—	—	—
8"	8.625	Wall	1.232	.958	.784	.639	.507	.411	.332	.265
		ID	6.013	6.593	6.963	7.271	7.549	7.754	7.922	8.062
		lb/ft	12.50	10.11	8.468	7.035	5.689	4.658	3.808	3.066
10"	10.750	Wall	1.536	1.194	.977	.796	.632	.512	.413	.331
		ID	7.494	8.218	8.678	9.062	9.409	9.665	9.873	10.049
		lb/ft	19.42	15.70	13.16	10.93	8.830	7.247	5.905	4.772
12"	12.750	Wall	1.821	1.417	1.159	.944	.750	.607	.490	.392
		ID	8.889	9.747	10.293	10.748	11.160	11.463	11.710	11.918
		lb/ft	27.32	22.09	18.51	15.38	12.43	10.19	8.315	6.709
14"	14.000	Wall	2.000	1.556	1.273	1.037	.824	.667	.538	.431
		ID	9.760	10.702	11.302	11.801	12.254	12.587	12.858	13.087
		lb/ft	32.93	26.63	22.31	18.54	14.98	12.29	10.03	8.092
16"	16.000	Wall	—	1.778	1.455	1.185	.941	.762	.615	.492
		ID	—	12.231	12.916	13.487	14.005	14.385	14.695	14.956
		lb/ft	—	34.77	29.15	24.21	19.58	16.05	13.08	10.56
18"	18.000	Wall	—	2.000	1.636	1.333	1.059	.857	.692	.554
		ID	—	13.760	14.531	15.173	15.755	16.183	16.532	16.826
		lb/ft	—	44.02	36.90	30.64	24.76	20.31	16.57	13.36
20"	20.000	Wall	—	2.222	1.818	1.481	1.176	.952	.769	.615
		ID	—	15.289	16.145	16.859	17.506	17.981	18.369	18.695
		lb/ft	—	54.35	45.54	37.83	30.58	25.08	20.44	16.49
22"	22.000	Wall	—	—	2.000	1.630	1.294	1.048	.846	.677
		ID	—	—	17.760	18.545	19.256	19.779	20.206	20.565
		lb/ft	—	—	55.10	45.78	37.00	30.32	24.75	19.98
24"	24.000	Wall	—	—	2.182	1.778	1.412	1.143	.923	.738
		ID	—	—	19.375	20.231	21.007	21.577	22.043	22.434
		lb/ft	—	—	65.59	54.48	44.02	36.08	29.44	23.77
26"	26.000	Wall	—	—	—	1.926	1.529	1.238	1.000	.800
		ID	—	—	—	21.917	22.758	23.375	23.880	24.304
		lb/ft	—	—	—	63.94	51.67	42.35	34.57	27.89
28"	28.000	Wall	—	—	—	2.074	1.647	1.333	1.077	.862
		ID	—	—	—	23.603	24.508	25.173	25.717	26.174

Size	OD	DR 7	DR 9	DR 11	DR 13.5	DR 17	DR 21	DR 26	DR 32.5	
Pressure rating, psi		335	250	200	160	125	100	80	63	
30"	30.000	lb/ft	—	—	—	74.18	59.93	49.12	40.10	32.33
	30.000	Wall	—	—	—	2.222	1.765	1.429	1.154	.923
		ID	—	—	—	25.289	26.259	26.971	27.554	28.043
		lb/ft	—	—	—	85.16	68.81	56.39	46.02	37.11
32"	32.000	Wall	—	—	—	1.882	1.524	1.231	.985	
	32.000	ID	—	—	—	28.009	28.770	29.391	29.913	
		lb/ft	—	—	—	—	78.27	64.16	52.37	42.26
34"	34.000	Wall	—	—	—	2.000	1.619	1.308	1.046	
	34.000	ID	—	—	—	29.760	30.568	31.228	31.782	
		lb/ft	—	—	—	—	88.37	72.43	59.10	47.69
36"	36.000	Wall	—	—	—	2.118	1.714	1.385	1.108	
	36.000	ID	—	—	—	31.511	32.366	33.065	33.652	
		lb/ft	—	—	—	—	99.08	81.21	66.28	53.46
42"	42.000	Wall	—	—	—	—	2.000	1.615	1.292	
	42.000	ID	—	—	—	—	37.760	38.575	39.260	
		lb/ft	—	—	—	—	—	110.54	90.18	72.78

APPENDIX C – MAXIMUM OPERATING PRESSURE VS. TEMPERATURE

Maximum operating pressures in psig for Pipeline Elevate-RT™ PE4710. Source pressure ratings in the <80°F column are per the Pipeline Elevate-RT™ technical data sheet. Refer to TechNote 210 and PPI TR-9 for design factors.

TABLE C.1 – WATER, BRINE, AND DRY NATURAL GAS ($S_F = 1.0$)

DR	<80°F	100°F	120°F	140°F	160°F	180°F
7	335	280	240	210	180	165
9	250	210	185	160	140	125
11	200	170	145	125	110	100
13.5	160	135	115	100	90	80
17	125	105	90	80	70	60
21	100	85	75	65	55	50
26	80	65	60	50	45	40
32.5	63	55	45	40	35	30

TABLE C.2 – >2% LIQUID HYDROCARBONS: CRUDE OIL, PRODUCED WATER, WET NATURAL GAS ($S_F = 0.5$)

DR	<80°F	100°F	120°F	140°F	160°F	180°F
7	165	140	120	105	90	80
9	125	105	90	80	70	60
11	100	85	70	60	55	50
13.5	80	65	55	50	45	40
17	60	50	45	40	35	30
21	50	40	35	30	25	25
26	40	30	30	25	20	20
32.5	30	25	20	20	15	15

For long-term design of 50 years and greater, 140°F is considered the maximum continuous-use temperature for general PE4710 design; Pipeline Elevate-RT™ carries a D2837-substantiated 180°F HDB supporting continuous operation to 180°F. There are many considerations required in the course of a piping system design, and these values should not be construed as approval of any specific design.

APPENDIX D — REFERENCED DOCUMENTS

ASTM INTERNATIONAL

D638	Tensile Properties of Plastics
D698	Laboratory Compaction Characteristics of Soil Using Standard Effort
D2837	Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
D2774	Underground Installation of Thermoplastic Pressure Piping
D3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
D3261	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for PE Pipe and Tubing
D3350	Polyethylene Plastics Pipe and Fittings Materials
F585	Insertion of Flexible Polyethylene Pipe into Existing Sewer
F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
F905	Qualification of Polyethylene Saddle-Fused Joints
F1055	Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled PE Pipe and Tubing
F1473	Notch Tensile Test to Measure the Resistance to Slow Crack Growth (PENT)
F1668	Construction Procedures for Buried Plastic Pipe
F1804	Determining Allowable Tensile Loads for Polyethylene Gas Pipe During Pull-In Installation
F1962	Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit
F2164	Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure
F2206	Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet, Plate or Block Stock
F2619	Polyethylene (PE) Line Pipe
F2620	Heat Fusion Joining of Polyethylene Pipe and Fittings
F2880	Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe
F3124	Data Recording the Procedure Used to Produce Heat Butt Fusion Joints in Plastic Piping
F3183	Guided Side Bend Testing of Butt Fusion Joints
F3190	Heat Fusion Joining Procedure Qualification of Polyethylene Pipe and Fittings
F3565	Electrofusion Joining Procedure Qualification

PLASTICS PIPE INSTITUTE

Handbook	Handbook of Polyethylene Pipe, 2nd ed.
TR-3	Policies and Procedures for Developing HDB, HDS, SDB, PDB and MRS Ratings
TR-4	Listing of HDB, HDS, SDB, PDB and MRS Ratings for Thermoplastic Piping Materials or Pipe
TR-9	Design Service Factors for Plastic Pipe
TR-33	Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe
TR-34	Disinfection of Newly Constructed Polyethylene Water Mains
TR-41	Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping
TN-38	Bolt Torque for Polyethylene Flanged Joints
MAB-01/02	Generic Electrofusion Procedures for Field Joining of Polyethylene Pipe
MAB-03	Model Specifications for PE4710 Buried Potable Water Service, Distribution and Transmission Pipes and Fittings
MAB-04	Basic HDPE Repair Options
MAB-05	Guidelines for PE4710 Pipe Bursting of Potable Water Mains
MAB-06	Guidelines for HDPE Pipeline Inspection
MAB-07	Guidelines for Use of Mini-Horizontal Directional Drilling
MAB-08	Guidelines for Fusing HDPE Pipe in Cold and Inclement Weather

AWWA

C110	Ductile-Iron and Gray-Iron Fittings
C651	Disinfecting Water Mains
M55	PE Pipe — Design and Installation

OTHER

API 15LE	Polyethylene Line Pipe (PE)
ISO 9001	Quality Management Systems — Requirements
NSF 61	NSF/ANSI/CAN 61 Drinking Water System Components — Health Effects
SAE J429	Mechanical and Material Requirements for Externally Threaded Fasteners
TechNote 210	Pipeline Elevate-RT™ Maximum Operating Temperature and Pressure, Pipeline Plastics, LLC

NOTICE

This model specification is intended as a guide to support the designer of piping systems. The specifier may adopt part or all of it, and is responsible for ensuring that all parts used are appropriate for the intended purpose and for editing bracketed and blank entries to suit the project.

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