1 Scope

1.1 Purpose

The purpose of this specification is to provide standards for polyethylene (PE) line pipe suitable for use in conveying oil, gas and non-potable water in underground, above ground and slipeline applications for the oil and gas producing and gathering industries.

The standard does not propose to address all of the safety concerns associated with the design, installation or use of products suggested herein. It is the responsibility of the user of the standard to utilize appropriate health and safety considerations.

All pipe produced under this standard must utilize stress rated materials, but may be used in pressurized, non-pressure and negative pressure applications.

The technical content of this document provides requirements and guidelines for performance, design, materials inspection, dimensions and tolerances, marking, handling, storing and shipping.

1.2 Applications

1.2.1 Equipment

This specification covers polyethylene line pipe utilized for the production and transportation of oil, gas and non-potable water. The piping is intended for use in new construction, insertion renewal, line extension and repair, of both above ground and buried pipe applications. Specific equipment covered by this specification is listed as follows:

- polyethylene line pipe;
- polyethylene fittings.

1.2.2 Service Conditions

The standard service conditions for the API Spec15LE Standard Pressure Rating are as follows:

1. The hydrostatic design stress (HDS) is considered to be the maximum long-term stress for an indefinite time and is the basis for the pipe's standard pressure rating The standard pressure rating may be further adjusted to account for fluid service and temperature per the guidance in this standard. The design life is normally considered to be in excess of 50 years under these conditions.;
2. Typical service temperature is between –30 °F and 140°F
    a. If the service temperature is between -30 °F and 140 °F and is subject to temporatry excursions outside of this range, it is recommended to consult with the manufacturer for guidance.
    b. Design temperatures that exceed 140°F are allowable provided the material has an HDB per 5.1.1 established at the design temperature or higher. – See Annex C
3. The fluid environment is oil, gas and non-potable water – e.g. raw water, produced water, and brine;

Service conditions other than the standard API Spec 15LE conditions are discussed in Section 5—Design.

1.3 Unit Conversion

A decimal/inch system is the standard for the dimensions shown in this specification. Nominal sizes will continue to be shown as fractions. For the purposes of this specification, the fractions and their decimal equivalents are equal and interchangeable. For SI metric unit equivalents in millimeters (mm), multiply by

25.4 and round to 1 decimal place. Basic metric conversions are described in Annex A.

2 Normative References

The following referenced documents are indispensable for the application of this document. For date references, only the edition cited applies. For undated references, the latest edition of the referenced document applies (including any addenda/errata).

ANSI B16.5, *Pipe Flanges and Flanged Fittings move to Bibliography – not normative*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics move to Bibliography*

ASTM D792, *Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement move to Bibliography*

ASTM D1238, *Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometermove to bibliography*

ASTM D1505, *Standard Test Method for Density of Plastics by the Density-Gradient Techniquemove to bilbliography*

ASTM D1598, *Standard Test Method for Time-to Failure of Plastic Pipe Under Constant Internal Pressure*

ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittingsmove to bibliography unless intention was for it to be mandatory, then add language*

ASTM D1600, *Standard Terminology for Abbreviated Terms Relating to Plastics move to bibliography*

ASTM D1603, *Standard Test Method for Carbon Black Content in Olefin Plastics move to bibiography*

ASTM D2122, *Standard Test Method for Determining Dimensions of the Thermoplastic Pipe and Fittings*

ASTM D2290, *Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic by Split Disk Method Fittingsmove to bibliography unless intention was for it to be mandatory, then add language*

ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*

ASTM D2683, *Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter—Controlled Polyethylene Pipe and Tubing*

ASTM D2774, *Standard Practice for Underground Installation of Thermoplastic Pressure Pipingmove to bibliography*

ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials*

ASTM D3035, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter move to bibliography*

ASTM D3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*

ASTM D3350, *Standard Specification for Polyethylene Plastic Pipe and Fitting Materials*

ASTM D4218, *Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Techniquemove to bibliography*

ASTM F412, *Standard Terminology Relating to Plastic Piping Systems move to bibliography*

ASTM F714, *Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter*move to bibliography

ASTM F1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*

ASTM F1473, *Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins*move to bibliography

ASTM F2164 *Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure*move to bibliography

ASTM F2206, *Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock or Block Stock*

ASTM F2619, *Standard Specification for High-Density Polyethylene (PE) Line Pipe*move to bibliography?

ASTM F2620, *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*move to bibliography

ASTM F2786, *Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing).* bibliography

PPI TN-7, *Nature of Hydrostatic Stress Rupture Curves*

PPI TN-11, *Suggested Temperature Limits for the Operation and Installation of Thermoplastic Piping in Non-Pressure Applications*bibliography

PPI TN-13, *General Guidelines for Butt, Saddle and Socket Fusion of Unlike Polyethylene Pipes and Fittings*bibliography

PPI TR-3, *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Pipe Materials or Pipe*

PPI TR-4, *Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe*

PPI TR-9, *Recommended Design Factors for Pressure Applications of Thermoplastic Pressure Pipe Materials*

PPI TR-33, *Butt Fusion Joining of Polyethylene Gas Pipe*bibliography

PPI TN-38, *Bolt Torque for Polyethylene Flanged Joints*bibliography

PPI TR-41, *Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping*bibliography

*PPI TN-46, GUIDANCE FOR FIELD HYDROSTATIC TESTING OF HIGH DENSITY POLYETHYLENE PRESSURE PIPELINE:OWNER'S CONSIDERATIONS, PLANNING, PROCEDURES, AND CHECKLISTS*bibliography

U .S. DOT Title 49, *CFR* Part 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*bibliography

2.1 Requirements

Requirements of other standards included by reference in this specification are essential to the safety and interchangeability of the equipment produced.

2.2 Equivalent Standards

Standards referenced in this specification may be replaced by other international or national standards that

can be shown to meet or exceed the requirements of the referenced standard. Manufacturers who use other standards in lieu of standards referenced herein are responsible for documenting the equivalency of the standards. Where a standard is revised, the latest edition may be used on issue and shall become mandatory 6 months from the date of the revision.

3 Terms Definitions, Acronyms and Abbreviations

3.1 Terms and Definitions

3.1.1
acceptance criteria
Defined limits placed on characteristics of materials, products, or services.

3.1.2
adapters
Appurtenances that allow connecting components with different joining systems.

3.1.3
butt fusion
The fusing of polyethylene materials per a qualified procedure that entails squaring and aligning the pipe, heating the pipe ends to a specified temperature, pressurizing the two aligned ends together and allowing the resultant joint to cool.

3.1.4
cell classification
Applies to the use of ASTM D3350 in specifying the polyethylene material parameters. Polyethylene pipe and fitting materials are classified using Density, Melt Index, Flexural Modulus, and Tensile Strength at Yield, Slow Crack Growth Resistance, the Hydrostatic Design Basis (HDB) and an Ultraviolet (UV) stabilizer.

3.1.5
component
Any pressure line pipe, pipe connection, fitting, flange, adapter, reducer, or end of outlet connection covered by this specification.

3.1.6
design factor

The design factor is used to reduce the hydrostatic design basis (HDB) determined according to ASTM D2837 and PPI TR-3 to arrive at the hydrostatic design stress (HDS) from which the design pressure is calculated. The design factor accounts for typical process variation, dimensional tolerances, and other sources of variability that can impact the long-term performance of high density polyethylene pipe. The design factor used in this standard for PE 4710 compounds is 0.63.*

Note: The design factor in this standard is not the inverse of the safety factor. The time to failure of HDPE at a particular temperature is related to stress through a power law relationship, i.e.: time to failure increases dramatically with a small reduction in stress.

3.1.7

dimension ratio

A ratio of the average specified outside diameter to the minimum specified wall thickness for outside diameter-controlled plastic pipe

3.1.8
eccentricity

The wall thickness variability as measured and calculated in accordance with ASTM D2122 Test Method in any diametrical cross section of the pipe shall be within 12 %. Wall thickness eccentricity range shall be measured in accordance with ASTM D2513, Section 6.5.1.3.

3.1.9

EDR—equivalent dimension ratio. The DR of the pipe to which the fitting is to be joined.

3.1.7
fittings
Tees, 90s, 45s and fittings manufactured by butt fusion welding of shape modified or mitered components prepared from molded fittings, sheet stock or block.

3.1.8
flanges
Face flanges with bolt hole circle per ANSI B16.5. Flanges and flange adapter as used in this specification, incorporates use of polyethylene flange adapter and metallic backup ring utilizing ANSI B16.5 bolt hole pattern.

3.1.9
Fluid Service Factor (FSF)
Factor applied to the Hydrostatic Design Stress (HDS) to account for the impact of the transported fluid on pipe performance.

3.1.10
Hydrostatic Design Basis (HDB)
The categorized Long-term Hydrostatic Strength (LTHS) in the circumferential or hoop direction for a given set of end use conditions, as established by ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials and PPI TR-3.*

3.1.11
Hydrostatic Design Stress (HDS)
The estimated maximum tensile hoop stress that can be applied continuously with a high degree of certainty that failure of the pipe will not occur. The HDS is a grade specific value that is determined by multiplying the HDB of a material at 73 °F with a design factor (DF), a multiplier of less than 1.0.

e.g. PE4710

HDB at 73 °F = 1600 psi

Design Factor = 0.63

HDS at 73 °F = 1600 psi * 0.63 = 1000 psi

3.1.12
lot number
Assignment of a unique code to each lot of manufactured pipe or fittings under the same conditions of production. Lot numbers are used to maintain production identification and traceability.

3.1.13
ovality
The maximum measured diameter, minus the minimum measured diameter, divided by the average measured diameter, times 100, expressed as a percentage:

3.1.14
Pipe Material Designation Code
A set of letters and numbers used to identify stress-rated thermoplastic compounds. The code consists of two or three letters which describe the type of material i.e. PE, PVC, PB, PEX, etc., per ASTM D1600. This

is followed by four numbers to describe material and physical properties in accordance with ASTM D3350 and PPI TR-4. Two of the numbers describe material properties according to the ASTM standard and two refer to pipe properties of HDS in water at 73 °F as listed in PPI TR-4. Where the Hydrostatic Design Stress is less than 1000 psi, a zero is used for the third number.

Eg. PE4710 where PE = Polyethylene

4 = Density (according to ASTM D3350)

7 = Slow Crack Growth Resistance (according to ASTM D3350)

10 = Hydrostatic Design Stress of 1000 psi at 73 °F in water

3.1.15
polyethylene plastics of raised temperature resistance (PE-RT)

a polyethylene plastic that has a categorized stress rating (HDB) above 140°F (60°C) in accordance with Test Method D2837.

3.1.16
reducers
Component fittings that allow two pipes of different diameters to be connected.

3.1.17
Short Term Hydrostatic Pressure (STHP)
The short term hydraulic failure pressure of pipe or fittings when subjected to the failure conditions of ASTM D1599, where the pressure is increased at a prescribed rate, under specific test conditions.

3.1.18
socket fusion
A joining process of polyethylene pipe and socket type polyethylene fittings manufactured per ASTM D2683. The preparation, heating, and fusion welding the pipe and fitting components shall be defined in a qualified procedure.

3.1.19
Standard Pressure Rating (PR)
The established maximum pressure that a fluid in the pipe can exert continuously with a high degree of certainty that failure in the pipe will not occur at a standard condition (i.e.: 73°F with water).

3.1.20
Temperature Service Factor (TSF)
Factor applied to the Hydrostatic Design Stress (HDS) to account for the impact of temperatures greater than the temperature at which the HDS is determined.

3.1.21
visual examination
Examination of parts and equipment for visible defects in material and workmanship.

3.1.22
working pressure
The maximum anticipated, sustained operating pressure applied to the pipe in actual service.

3.2 Acronyms and Abbreviations

ANSI	American National Standards Institute
API	American Petroleum Institute

ASTM	American International~~Society of Testing and Materials~~
DSF	Design Service Factor
DR	Dimension Ratio
HDB	Hydrostatic Design Basis
HDS	Hydrostatic Design Stress
LTHS	Long-term Hydrostatic Strength
PPI	Plastics Pipe Institute, Inc.

4 Purchasing Guidelines

4.1 General

Table 1 provides recommended guidelines for inquiry and purchase of API Spec 15LE pipe or fittings.

Pipe	
Specification	API 15LE
Material	HDPE
Pipe Material Designation Code	e.g. PE4710
Cell Classification	e.g. 445574C
Outside Diameter	Nominal OD (Project Specific)
Standard Dimension Ratio (DR)	Required (Project Specific)
Order Length	Available in Coils or Straight Lengths (Project Specific)
Fittings	
Molded Fittings (DR)	(Project Specific)
Fabricated Fittings Must Meet Pressure Rating of Pipe	(Project Specific)
Service	
Fluid Service	(Project Specific)
Internal Pressure	(Project Specific)
Design Temperature	(Project Specific)
Above Ground/Below Ground Application	(Project Specific)

Table 1—Purchasing General Guidelines

An important consideration for purchasing quality materials for application in oil and gas gathering is the selection of a quality vendor. Vendors should have an understanding of the necessary quality control testing and the capability to perform the testing required by standards.

Vendors should be able to provide records showing that a detailed QA/QC program is in place that meets or exceeds the testing required by API Spec 15LE.

Appropriate records of in-plant inspection and testing and quality control/quality assurance testing should be available to demonstrate that the manufacturer's piping products meet the requirements of this specification.

Vendors should have the ability to provide sound technical support for its products in field applications.

5 Design

5.1 Determination of Working Pressure

5.1.1 Hydrostatic Design Basis (HDB)

The HDB shall be established by the manufacturer in accordance with PPI TR-3 using ASTM D2837 methodology. Polyethylene materials meeting the requirements of this specification shall have their HDBs listed in PPI TR-4.

5.1.2 Hydrostatic Design Stress (HDS)

HDS is the maximum allowable hoop stress that can be applied continuously with a high degree of certainty that failure of the pipe will not occur when the pipe is subjected to long-term hydrostatic pressure. The HDS shall be determined by multiplying the HDB by the DF. This multiplier takes into account certain material performance requirements (according to PPI TR-3) and degrees of safety involved in thermoplastic piping manufacture and installation, and shall be either 0.5 or 0.63 depending on the material grade, as defined in PPI TR-3. Under conditions such as severe pressure cycling, higher temperature and aggressive chemical environments, additional design service factors (DSF) may be utilized.

PE pipe materials meeting the requirements of this specification are PE2708 and PE4710.

Materials designated as PE2708 meeting this specification have an HDB of 1,250 psi (8.3 MPa) for water at 73 °F(23 °C) and an HDB of either 1000 psi or 800 psi at 140°F. After applying a 0.63DF, the HDS at 73°F (23°C) will be 800 psi (5.5 MPa).

Materials designated as PE4710 meeting the requirements of this specification have an HDB of 1,600 psi (11.0 MPa) for water at 73°F (23°C) and an HDB of 1000 psi (6.9 MPa) for water at 140°F (60°C). After applying a 0.63 DF, the HDS at 73 °F (23 °C) will be 1000 psi (6.9 MPa).

5.1.3 Fluid Service Factor (FSF)

The FSF in Table 2 is a number equal to or less than 1.0 and is used to account for possible effects of the transported medium on the long-term performance of the piping. Table 2 provides FSF guidance values for some common applications.

Table 2—Fluid Service Factors (FSF)

Environment	Factor

Produced water, seawater, brine, process water and other oilfield water based fluids excluding oilfield water containing < 2 % liquid hydrocarbons[1]	1.0
Dry gas gathering (no associated hydrocarbon liquids)[2]	1.0
Dry gas gathering that is subject to US Federal Regulations[3]	See 49 CFR 192
Dry gas gathering that is subject to Canadian Federal Regulations[4]	1.0
Crude oil, multiphase fluids, wet natural gas and liquid hydrocarbons other oilfield based fluids with ≥ 2% liquid hydrocarbons.	0.5

[1] Water containing significant quantities of liquid hydrocarbons (> 2%) shall be treated as hydrocarbon liquids in this instance. For intermittent hydrocarbon levels above 2% contact manufacturer for guidance.

[2] Gas gathering in this standard refers to gas from a well or production source in a low population density area that is not subject to Department of Transportation, Office of Pipeline Safety, Title 49 *CFR* Part 192.

[3] Gas gathering application subject to Department of Transportation, Office of Pipeline Safety, Title 49 *CFR* Part 192.

[4] CSA Z662 Clause 13.3.

5.1.4 Temperature Service Factor (TSF)

For materials using HDS values determined at 73.4 °F to calculate MAOP and propose operation at a higher temperature, the TSFs in Table 3 should be applied to the HDS determined at 73.4 °F.

For polyethylene pipe with a service temperature greater than 80 °F, a Temperature Service Factor (TSF) is used in calculating the maximum pressure rating per section 5.1.5. Table 3 provides guidance though the user should consult with the manufacturer to confirm the TSF values in Table 3 are suitable for use with the manufacturer's PE compound.

Table 3—Temperature Service Factors

Service Temperature °F (°C)	PE 2708	PE4710
≤ 80 (27)	1.0	1.0
>80 – 90 (>27-32)	0.9	0.9
>90 – 100 (>32-38)	0.8	0.8

>100-110 (>38-43)	0.8	0.8
>110 – 120 (>43-49)	0.7	0.7
>120 – 130 (>49-54)	0.7	0.7
>130 – 140 (>54-60)	0.6	0.6
>140 (60)*		N/A

Note: Temperature Service Factors were derived using the interpolation formula in PE Handbook 2nd Ed, Chapter 3, Appendix A. based on PE4710 materials with an HDB of 1,000 psi @ 140F and PE 2708 materials with an HDB of 800 psi @ 140F. For PE2708 materials with an HDB of 1000 psi at 140°F contact the manufacturer. The calculated values are rounded to one decimal place.

* Consult Annex C and the manufacturer for specific design and service considerations for service temperatures above 140°F.

5.1.5 Standard Pressure Rating

The Standard Pressure Rating of a pipe is the design capacity to resist working pressure at the anticipated operating temperature with sufficient capacity to withstand associated positive pressure surges above working pressure. Standard Pressure Rating is calculated using the formula below:

$$P = \frac{2 \times HDS \times FSF \times TSF}{DR - 1}$$

or

where

P is the Standard Pressure Rating (psi);

HDS is the Hydrostatic Design Stress (psi) at 73.4° in water (See Section 5.1.2);

DR is the Dimension Ratio;

FSF is the Fluid Service Factor;

TSF is the Temperature Service Factor, if required by 5.1.4.

Standard Pressure Ratings at 73 °F		
DR (psi)	**PE2708**	**PE4710**
5.0	—	500

6.0	—	400
7.0	—	333
7.3	254	317
9	200	250
11	160	200
13.5	128	160
17	100	125
21	80	100
26	64	80
32.5	51	63

Table 4—Standard Pressure Ratings

The actual choice of design pressure for a particular application rests with the system designer. Design pressures for a particular application may vary from standard pressure ratings depending on actual application conditions. Additional design factors may be applied to systems operating under special or unusual conditions or when specified in Codes or Regulations or by the authority having jurisdiction. Users should consult the pipe manufacturer to confirm service factors and temperature factors and other information relating to pipe performance in various applications and application conditions.

5.1.6 External Collapse Rating

Guidelines on the collapse rating of polyethylene pipe are laid out in Annex B.

5.2 Dimensions and Tolerances

5.2.1 Size

Pipe manufactured to this specification shall comply with the dimensions and tolerances given in Table 5

In applications where special conditions or requirements dictate diameters, wall thicknesses or dimensions other than those listed in this table, if the pipe is manufactured from PE compounds meeting the requirements of this specification and the strength and design basis is the same, meeting all the requirements of this specification it shall be acceptable.

For diameters not shown in the table, the tolerance shall be the same percentage as that used in the table for the next smaller listed size.

5.2.2 Toe-in

The outside diameter when measured at the cut end of the pipe length shall not be more than 1.5 % smaller than the outside diameter specified in Table 5, when measured at any point within 1.5 pipe diameters or 11.8 in. (300 mm), whichever is less, to the cut end of the pipe length. Measurements shall be made using ASTM D2122 Test Method.

5.2.3 Eccentricity

The wall thickness variability as measured and calculated in accordance with ASTM D2122 Test Method in

any diametrical cross section of the pipe should not exceed 12 %.

5.2.4 Length

Pipe shall be furnished in cut lengths or coils as specified on the purchase order. Two pieces fused together to make a length are not acceptable. Measurements shall be made using ASTM D2122 Test Method.

5.2.5 Fittings

Fittings furnished for use with this specification shall meet requirements of specification ASTM D3261 for molded, machined, and assembled molded and/or machined butt-fusion fittings, ASTM F1055 for electrofusion fittings, ASTM F2206 for fabricated fittings and ASTM D2683 for socket fused fittings.

Fabricated, molded, and machined fittings shall meet the dimensional requirements of Table 5 at the welding/joint zone, and the testing requirements of the applicable standard. All fittings shall be Constant-OD EDR fittings, or Constant-ID EDR fittings, with either EDR matched to the DR and same working pressure rating as the pipeline itself. [1] EDR is defined in ASTM F2206: para 1.3.

Notes: [1] The Equivalent Dimension Ratio (EDR) of a fabricated fitting provides the same pressure rating in the fitting as the pressure rating of the DR of the pipe to which the fitting is to be joined.

[2] Fabricated fittings designed for full pressure service are joined by heat fusion and must be designed with additional thickness in the regions of geometrical miter-cuts as regions that are subject to localized stress risers. In cases where the fabricated fitting gore-pipe segments are not thickened, and have the same wall thickness as the pipeline, a fitting Geometric Strength Ratio (GSR) multiplier shall be defined and applied to each type fitting, to re-rate the fitting's effective pressure capacity, based on local stress intensification factors.

5.2.6 Ovality

The ovality of the pipe when exiting production line processing equipment but before coiling or packaging for shipment shall not exceed 5 % when measured in accordance with 6.5.3 of ASTM D2513 or 7.7 of ASTM F2619. Other factors such as installation, compaction, static soil loading, exposure to high ambient temperature and vehicular loads may increase ovality.

6 Process of Manufacture

6.1 General

Pipe furnished to this specification shall be produced by solid wall extrusion. Fittings shall be produced by one of the following processes: injection molding, forming, transfer molding, extrusion, machining, or fabrication.

Outside Diameter Nominal Size (in.)	Wall Thickness (in.)	(mm)	DR	(in.)	(mm)
0.5	0.840 ±0.004	21.34 ±0.10	11 9 7	0.076 + 0.009 0.093 + 0.011 0.120 + 0.014	1.93 + 0.22 2.36 + 0.28 3.05 + 0.36
0.75	1.050 ±0.004	26.67 ±0.10	11 9	0.095 + 0.011 0.117 + 0.014	2.41 + 0.28 2.97 + 0.36

			7	0.150 + 0.018	3.81 + 0.46
1	1.315 ±0.005	33.40 ±0.13	17	0.077 + 0.009	1.96 + 0.22
			13.5	0.097 + 0.012	2.46 + 0.30
			11	0.119 + 0.014	3.02 + 0.36
			9	0.146 + 0.018	3.97 + 0.46
			7.3	0.180 + 0.022	4.57 + 0.56
			7	0.188 + 0.023	4.78 + 0.58
			6	0.219 + 0.026	5.56 + 0.66
			5	0.210 + 0.025	5.33 + 0.64
1.25	1.660 ±0.005	42.16 ±0.13	21	0.079 + 0.009	2.01 + 0.24
			17	0.098 + 0.012	2.49 + 0.30
			13.5	0.123 + 0.015	3.12 + 0.38
			11	0.151 + 0.018	3.84 + 0.46
			9	0.184 + 0.022	4.67 + 0.56
			7.3	0.227 + 0.027	5.77 + 0.69
			7	0.237 + 0.028	6.02 + 0.72
			6	0.277 +0.033	7.03 + 0.84
			5	0.332 + 0.040	8.43 + 1.01
1.5	1.900 ±0.006	48.26 ±0.15	21	0.09 + 0.011	2.27 + 0.27
			17	0.112 + 0.013	2.84 + 0.34
			13.5	0.141 + 0.017	3.58 + 0.43
			11	0.173 + 0.021	4.39 + 0.53
			9	0.211 + 0.025	5.36 + 0.64
			7.3	0.260 + 0.031	6.60 + 0.79
			7	0.270 + 0.033	6.88 + 0.84
			6	0.317 + 0.038	8.05 + 0.96
			5	0.380 + 0.045	9.62 + 1.15
2	2.375 ±0.006	60.33 ±0.15	21	0.113 + 0.013	2.97 + 0.35
			17	0.140 + 0.017	3.56 + 0.43
			13.5	0.176 + 0.021	4.47 + 0.51
			11	0.216 + 0.026	5.49 + 0.66
			9	0.264 + 0.032	6.70 + 0.81
			7.3	0.325 + 0.039	8.25 + 0.99
			7	0.339 + 0.041	8.62 + 1.04

			6	0.395 + 0.048	10.03 + 1.21
			5	0.475 + 0.057	12.07 + 1.45
2.5	2.875 ±0.007	73.0 ±0.18	21	0.137 + 0.016	3.48 + 0.406
			17	0.169 + 0.020	4.29 + 0.508
			13.5	0.213 + 0.026	5.41 + 0.660
			11	0.261 + 0.031	6.63 + 0.787
			9	0.319 + 0.038	8.10 + 0.972
			7.3	0.394 + 0.047	10.00 + 1.200
			7	0.411 + 0.049	10.44 + 1.250
			6	0.479 + 0.575	12.17 + 1.460
			5	0.575 + 0.069	14.61 + 1.753
3	3.500 ±0.008	88.90 ±0.20	21	0.167 + 0.020	4.24 + 0.51
			17	0.206 + 0.025	5.23 + 0.64
			13.5	0.259 + 0.031	6.58 + 0.79
			11	0.318 + 0.038	8.08 + 0.97
			9	0.389 + 0.047	9.88 + 1.19
			7.3	0.479 + 0.058	12.17 + 1.47
			7	0.500 + 0.060	12.70 + 1.52
			6.0	0.583 + 0.070	14.81 + 1.78
			5	0.700 + 0.084	17.78 + 2.13
4	4.500 ±0.009	114.30 ±0.23	21	0.214 + 0.026	5.44 + 0.66
			17	0.265 + 0.032	6.73 + 0.81
			13.5	0.333 + 0.040	8.46 + 1.02
			11	0.409 + 0.049	10.39 + 1.24
			9	0.500 + 0.060	12.70 + 1.52
			7.3	0.616 + 0.074	15.65 + 1.88
			7	0.643 + 0.077	16.33 + 1.96
			6	0.750 + 0.090	19.05 + 2.29
			5	0.900 + 0.108	22.86 + 2.74
5	5.563 ±0.010	141.30 ±0.25	21	0.265 + 0.032	6.73 + 0.81
			17	0.328 + 0.039	8.33 + 0.99
			13.5	0.413 + 0.050	10.49 + 1.26
			11	0.506 + 0.061	12.85 + 1.54
			9	0.618 + 0.075	15.65 + 1.88

			7.3	0.762 + 0.091	19.35 + 2.32
			7	0.795 + 0.095	20.19 + 2.42
			6	0.927 + 0.111	23.55 + 2.83
			5	1.112 + 0.133	28.26 + 3.39
6	6.625 ±0.011	168.28 ±0.28	32.5	0.204 + 0.024	5.18 + 0.61
			26	0.255 + 0.031	6.48 + 0.79
			21	0.315 + 0.038	8.00 + 0.97
			17	0.390 + 0.047	9.91 + 1.19
			13.5	0.491 + 0.059	12.47 + 1.50
			11	0.602 + 0.072	15.29 + 1.83
			9	0.736 + 0.088	18.69 + 2.24
			7.3	0.908 + 0.109	23.06 + 2.77
			7	0.946 + 0.114	24.03 + 2.90
			6	1.104 + 0.133	28.04 + 3.36
			5	1.325 + 0.159	33.66 + 4.04
8	8.625 ±0.015	219.08 ±0.38	32.5	0.265 + 0.032	6.73 + 0.81
			26	0.332 + 0.040	8.43 + 1.02
			21	0.411 + 0.049	10.44 + 1.24
			17	0.507 + 0.061	12.88 + 1.55
			13.5	0.639 + 0.077	16.23 + 1.96
			11	0.784 + 0.094	19.91 + 2.39
			9	0.958 + 0.115	24.33 + 2.92
			7.3	1.182 + 0.142	30.02 + 3.61
			7	1.232 + 0.148	31.29 + 3.76
			6	1.438 + 0.173	36.53 + 4.38
			5	1.725 + 0.207	43.82 + 5.26
10	10.750 ±0.015	273.05 ±0.38	32.5	0.331 + 0.040	8.41+ 1.02
			26	0.413 + 0.050	10.49 + 1.27
			21	0.512 + 0.061	13.00 + 1.55
			17	0.632 + 0.076	16.05 + 1.93
			13.5	0.796 + 0.096	20.22 + 2.44
			11	0.977 + 0.117	24.82 + 2.97
			9	1.194 + 0.143	30.33 + 3.63
			7.3	1.473 + 0.177	37.41 + 4.50

			7	1.536 + 0.184	39.01 + 4.68
			6	1.792 + 0.215	45.51 + 5.46
			5	2.150 + 0.258	54.61 + 6.55
12	12.750 ±0.017	323.85 ±0.43	32.5	0.392 + 0.047	9.96 + 1.19
			26	0.490 + 0.059	12.45 + 1.50
			21	0.607 + 0.073	15.42 + 1.85
			17	0.750 + 0.090	19.05 + 2.29
			13.5	0.944 + 0.113	23.98 + 2.87
			11	1.159 + 0.139	29.44 + 3.53
			9	1.417 + 0.170	35.99 + 4.32
			7.3	1.747 + 0.210	44.37 + 5.33
			7	1.821 + 0.219	46.25 + 5.56
			6	2.125 + 0.255	53.98 + 6.48
			5	2.550 + 0.306	64.77 + 7.77
14	14.000 ±0.063	355.60 ±1.60	32.5	0.431 + 0.052	10.95 + 1.32
			26	0.538 + 0.065	13.67 + 1.65
			21	0.667 + 0.080	16.94 + 2.03
			17	0.824 + 0.099	20.93 + 2.51
			13.5	1.037 + 0.124	26.34 + 3.16
			11	1.273 + 0.153	32.33 + 3.89
			9	1.556 + 0.187	39.52 + 4.75
			7	2.000 + 0.240	50.80 + 6.10
			6	2.333 + 0.280	59.18 + 7.10
			5	2.800 + 0.336	71.12 + 8.53
16	16.000 ±0.072	406.40 ±1.83	32.5	0.492 + 0.059	12.50 + 1.50
			26	0.615 + 0.074	15.62 + 1.88
			21	0.762 + 0.091	19.35 + 2.31
			17	0.941 + 0.113	23.90 + 2.87
			13.5	1.185 + 0.142	30.10 + 3.61
			11	1.455 + 0.175	36.96 + 4.45
			9	1.778 + 0.213	45.16 + 5.41
			7	2.286 + 0.274	58.06 + 6.96
			6	2.667 + 0.320	67.74 + 8.13
			5	3.200 + 0.384	81.28 + 9.75

18	18.000 ±0.081	457.20 ±2.05	32.5	0.554 + 0.066	14.07 + 1.68
			26	0.692 + 0.083	17.58 + 2.11
			21	0.857 + 0.103	21.77 + 2.62
			17	1.059 + 0.127	26.90 + 3.23
			13.5	1.333 + 0.160	33.85 + 4.06
			11	1.636 + 0.196	41.55 + 4.98
			9	2.000 + 0.240	50.80 + 6.10
			7	2.571 + 0.309	65.30 + 7.85
			6	3.000 + 0.360	76.20 + 9.14
			5	3.600 + 0.432	91.50 + 10.98
20	20.000 ±0.090	508.00 ±2.29	32.5	0.615 + 0.074	15.62 + 1.88
			26	0.769 + 0.092	20.22 + 2.34
			21	0.952 + 0.114	24.18 + 2.90
			17	1.176 + 0.141	29.87 + 3.58
			13.5	1.482 + 0.178	37.64 + 4.52
			11	1.818 + 0.218	46.18 + 5.54
			9	2.222 + 0.267	56.44 + 6.78
			7	2.857 + 0.343	72.57 + 8.71
22	22.000 ±0.099	558.80 ±2.51	32.5	0.677 + 0.081	17.20 + 2.06
			26	0.846 + 0.102	21.49 + 2.59
			21	1.048 + 0.126	26.62 + 3.20
			17	1.294 + 0.155	32.87 + 3.94
			13.5	1.630 + 0.196	41.40 + 4.97
			11	2.000 + 0.240	50.80 + 6.10
			9	2.444 + 0.293	62.08 + 7.44
			7	3.143 + 0.377	79.83 + 9.58
24	24.000 ±0.108	609.60 ±2.74	32.5	0.738 + 0.089	18.75 + 2.25
			26	0.923 + 0.111	23.44 + 2.82
			21	1.143 + 0.137	29.03 + 3.48
			17	1.412 + 0.169	35.86 + 4.29
			13.5	1.778 + 0.213	45.16 + 5.420
			11	2.182 + 0.262	55.42 + 6.65
			9	2.667 + 0.320	67.74 + 8.13
			7	3.429 + 0.411	87.10 + 10.44

26	26.000 ±0.117	660.40 ±2.97	32.5	0.800	20.32
			21	1.238	31.45
			17	1.529	38.84
			13.5	1.925	48.90
			1	2.364	60.05
			9	2.889	73.38
28	28.000 ±0.126	711.20 ±3.20	32.5	0.862	21.89
			21	1.333	33.86
			17	1.647	41.83
			13.5	2.074	52.68
			11	2.545	64.64
			9	3.111	79.02
30	30.000 ±0.135	762.00 ±3.43	32.5	0.923	23.44
			21	1.428	36.27
			17	1.764	44.81
			13.5	2.222	56.44
			11	2.727	69.27
			9	3.333	84.66
32	32.000 ±0.144	812.80 ±3.66	32.5	0.985	25.02
			21	1.524	38.71
			17	1.882	47.80
			13.5	2.370	60.20
			11	2.909	73.89
34	34.000 ±0.153	863.60 ±3.89	32.5	1.046	26.57
			21	1.619	41.12
			17	2.000	50.80
			13.5	2.520	64.01
			11	3.091	78.51
36	36.000 ±0.162	914.40 ±4.11	32.5	1.108	28.14
			21	1.714	43.54
			17	2.112	53.65
			13.5	2.667	67.74
			11	3.273	83.13
42	42.000 ±0.189	1066.80 ±4.80	32.5	1.292	32.82

			21	2.000	50.80
			17	2.470	62.74
			13.5	3.111	79.02
48	48.000 ±0.216	1219.20 ±5.49	32.5	1.477	37.52
			26	1.846	46.89
			21	2.286	58.06
			17	2.824	71.73
			13.5	3.556	90.31
54	54.000 ±0.243	1371.60 ±6.17	32.5	1.662	42.22
			26	2.077	52.75
			21	2.571	65.31
			17	3.176	80.68

- Pipe dimensions and schedules listed are most commonly used by the oil and gas industries. Additional sizes and schedules are available. The complete list of sizes and schedules are listed in the following ASTM standards: ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*.

ASTM F2619, *Standard Specification for High-Density Polyethylene Line Pipe*. ASTM D3035, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.* ASTM F714, *Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter*.

The Dimension Ratio (DR) is the specified diameter divided by the minimum wall thickness

Table 5—Dimension and Tolerances Based on Outside Diameters

6.2 Materials

Polyethylene materials approved for use in the manufacture of pipe and fittings under this specification shall be classified in accordance with ASTM D3350. Cell classifications values for materials meeting the requirements of this specification are included in Table 6.

Resins and compounds meeting the material requirements and cell classifications of this standard shall have HDB and HDS ratings listed in PPI TR-4. An HDB listing at 140 °F in PPI TR-4 is required.

An HDB listing at a temperature above 140°F in PPI TR-4 is required for design temperatures above 140°F. The PE-RT designation applies to PE materials that have an established HDB at 180°F (82.2°C) listed in PPI TR-4.

6.3 Rework Material

Rework material is acceptable to manufacture pipe and fittings in accordance with this specification as part of a blend with virgin material compound meeting 6.2. Rework material shall be polyethylene material compound from the manufacturer's own pipe or fitting production that met 6.2 as virgin material compound. Rework material shall have the same D3350 cell classification and property value or material designation code per Table 6 as the virgin material compound in the blend. Pipe containing rework material shall meet the requirements of this specification.

6.3.1 The manufacturer shall have procedures for ensuring that rework material is clean before use

and shall have procedures for tracing rework material from its initial processing as virgin material through the manufacturer's rework process to ensure that material blends containing rework material comply with this section. Testing rework material for compliance with Table 6 classification and properties is not required.

6.4 Fittings

Fittings furnished for use with this specification shall meet requirements of specification ASTM D3261 for butt-fused fittings, ASTM F2206 for fabricated fittings, ASTM F1055 for electrofusion fittings, ASTM D2683 for socket fused fittings and this API specification for dimensional requirements. Material and resins shall meet the Cell Classifications listed in Table 6.

	Material Designation Code	
Physical Property	PE2708	PE4710
Density	2	4
Melt Index	3	4
Flexural Modulus	4	5
Tensile Strength	3	≥ 5
Slow Crack Growth Resistance (PENT)	7	7
Hydrostatic Strength Classification	3	4
Color and Ultraviolet (UV) Stabilizer[1]	C or E	C or E

[1]Color and UV stabilizers shall meet either Class C or Class E as defined in ASTM D3350. Class C compounds shall contain a minimum 2 % to 3.0 % carbon black. Class E compounds shall contain an antioxidant compound adequate for outdoor storage unprotected in sunlight for a minimum of 24 months.

Table 6—Cell Classifications According to ASTM D3350

6.5 Finish and Workmanship

6.5.1 Pipe Ends

Pipe ends shall be plain and squared.

6.5.2 Finish

The interior and exterior of the pipe shall be uniform in finish without voids, cracks, crazing, foreign

inclusions or deep scratches.

6.5.3 Workmanship

Cut pipe ends shall be clean without ledges, shaving tails, burrs or cracks.

The interior of the pipe shall be blown or washed clean of cuttings and shavings.

7 Quality Program

The adoption of an external quality management system by a manufacturer is not a necessity to meet the requirements of this standard. It is, however, desirable for manufacturers to conform their quality program to meet an internationally recognized quality management system.

7.1 Quality Manual

The manufacturer shall maintain a quality manual that adequately describes the quality program. The quality program shall confirm that sufficient quality records are maintained to demonstrate conformance to requirements and verify effective product manufacturing to the requirements of this standard and to any related mentioned standards. Quality records shall remain legible, readily identifiable and retrievable for a period of not less than 10 years or as specified by an external quality system.

7.2 Quality Control Tests

7.2.1 Conditioning

Test specimens shall be conditioned at 73.4 ±3.6 °F (23 ±2 °C) prior to testing for a minimum of 1 hour in water or 4 hours in air at 73.4 ±3.6 °F (23 ±2 °C).

7.2.2 Quality Control Testing

Samples for quality control testing shall be conditioned in accordance with 7.2.1 or in accordance with ASTM D2122. This applies to test methods covering the determination of diameter, wall thickness, and length dimensions of pipe and fittings.

Polyethylene pipe materials may undergo dimensional change near cut ends due to internal residual stresses. When this condition is noted, care shall be taken to make measurements at a location that is not affected by the toe-in effect.

7.2.3 Pipe Requirements and Frequency

7.2.3.1 Physical Properties

7.2.3.1.1 Elevated Temperature Sustained Pressure tests shall be conducted for each material designation code listed in Table 6 used at the facility. The test shall be conducted per ASTM D1598.

7.2.3.1.2 Elevated temperature testing of product materials and extrusion technique qualification shall be performed when a polyethylene pipe material designation is first used in a manufacturing facility to manufacture pipe or tubing and semi-annually thereafter, such that the tests generally represent a first half or a second half of the annual production at the facility.

7.2.3.1.3 The test sample shall consist of three specimens of a generally representative pipe or tubing size produced at the manufacturer's facility using a material designation code from Table 6. Select one Table 6 material to test at one Table 7 condition for all three specimens using water as the testing medium per ASTM D1598.

7.2.3.1.4 Passing results are (1) non-failure for all three specimens at a time equal to or greater than the "minimum average time before failure," or (2) not more than one ductile specimen failure and the average time before failure for all three specimens shall be greater than the specified "minimum average time before failure" for the selected Table 7 condition. For Table 7, Condition 1 through 5: If more than one ductile failure occurs before the "minimum average time before failure," it is permissible to conduct one

retest at a Table 7 condition of lower stress and longer “minimum average time before failure” for the material designation code. For Table 7, Condition 6, no retest is possible. Brittle failure of any specimen in the test sample when tested at Table 7, Condition 1 through 6 constitutes failure to meet this requirement.

7.2.3.1.5 Except as provided in items a, b, c and d above, if the results of any test(s) do not meet the requirements of this specification, the test(s) may be conducted again in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirement of the specification by such means as omitting tests that are a part of the specification, substituting or modifying a test method, or by changing the specification limits. In retesting, the product requirements of this specification shall be met, and the test methods designated in the specification shall be followed. If, upon retest, failure occurs, the quantity of the product represented by the test(s) does not meet the requirements of this specification.

7.2.3.2 Test Description and Frequency for Pipe

The following tests shall be conducted per the prescribed frequencies indicated in Table 8.

Table 7—Elevated Temperature Sustained Pressure Test Requirements

		PE2708,		PE4710	
Condition	**Test Temperature**	**Test Pressure Hoop Stress**	**Minimum Average Time Before**	**Test Pressure Hoop Stress**	**Minimum Average Time Before**
	°F (°C)	psi (kPa)	Failure (Hours)	Psi (kPa)	Failure (Hours)
1	176 °F (80 °C)	670 (4620)	170	750 (5170)	200
2	176 °F (80 °C)	650 (4480)	340	730 (5035)	400
3	176 °F (80 °C)	630 (4345)	510	705 (4860)	600
4	176 °F (80 °C)	610 (4210)	680	685 (4725)	800
5	176 °F (80 °C)	590 (4070)	850	660 (4550)	1000
6	176 °F (80 °C)	580 (4000)	1000	640 (4415)	1200

Table 8—Test Description and Frequency for Pipe

Test Description	Frequency	Minimum Requirements

Outside Diameter (per ASTM D2122)	Once/hour or once/coil, whichever is less frequent.	Must meet dimensions specified in Table 6.
Wall Thickness (per ASTM D2122)	Once/hour or once/coil, whichever is less frequent.	Must meet dimensions specified in Table 6.
Short term Burst Pressure (per ASTM D1599) (for sizes 12 in. and less)	At beginning of production then once weekly during production run and after any major process interruption	Failures must be ductile and must occur between 60 and 70 seconds.
Apparent Ring Tensile Strength (per ASTM D2290) (may be substituted for the Short Term Burst Pressure Test for pipe sizes larger than 4 in.)	At beginning of production then once weekly during production run and after any major process interruption	Minimum apparent tensile strength must be 2520 psi for PE2708 and 2900 psi for PE4710.
Carbon Content	At start up and once every 24 hours.	Ash range is 2.0 % to 3.0%
Ovality (per ASTM F2619)	Once per production run.	Not to exceed 5 % per 5.2.6.

7.2.4 Fittings Requirements and Frequency

7.2.4.1 Fittings

The following tests shall be conducted per the prescribed frequencies as outlined in Table 9.

7.2.4.2 Retest and Rejection

Failure of two of the six specimens tested constitutes failure in the test. Failure of one of the six specimens tested is cause for retest of six additional specimens. Failure of one of six specimens tested in retest constitutes failure in the test.

Table 9—Fittings Requirements and Frequency

Test Description	Frequency	Minimum Requirements
Socket Fittings		
Socket Entrance Dia. (ASTM D2122)	Once per hour or 1 per 10 fittings, whichever is less frequent. Fittings must meet all applicable dimensions of ASTM D2683.	
Socket Bottom Dia. (ASTM D2122)		
OOR for Socket Entrance and Bottom Diameters		

Inner Diameter (ASTM D2122)		
Wall thickness (Socket fitting) (ASTM D2122)	Once per cavity at the beginning of each production setup.	Must be 125 % of the minimum wall thickness of pipe to which it is designed to be joined.
Knit-line integrity: Either, or a) Crush Test (ASTM D2513) b) Ring Tensile (ASTM D2290) c) Short term Burst (ASTM D1599)	Once at start-up and at the beginning of each change in production.	Fitting must exhibit no separation of knit line.
Butt Fittings—Molded		
Outside Diameter (ASTM D2122)	Once per hour or 1 per 10 molded pieces, whichever is less frequent.	Fittings must meet all applicable dimensions of ASTM D3261and ASTM D2683.
Wall Thickness (butt fitting) (ASTM D2122)		
Knit-line Integrity: Either, or a) Crush Test (ASTM D2513) b) Ring Tensile (ASTM D2290) c) Short term Burst (ASTM D1599)	Once at start-up and at the beginning of each change in production.	Fitting must exhibit no separation of knit line.
Butt Fittings—Fabricated		
Outside Diameter (ASTM D2122)	Once per hour or 1 per 10 pieces, whichever is less frequent.	Fitting must meet all applicable dimensions of Table 6 of this specification.
Wall Thickness (butt fitting) (ASTM D2122)		
Visual Inspection of Fusion Beads	Every fitting.	As described in manufacturers QA/QC procedure (API Spec Q1 or ISO 9001:2000).
Misalignment	Visual per fitting.	Must fall within O.D Tolerance of pipe.
All Fittings		
Short Term Burst (ASTM D1599) @ 73 °F	1st and every 50th fitting of each size.	60 s to 70 s
PE2708		2520 psi
and PE4710		2900 psi

When the pipe or fittings fail to meet the specification requirements of any test, additional tests shall be made on the products produced, back to the previous acceptable results. The pipe or fittings produced in the interim that do not pass the requirements shall be rejected.

7.2.5 Failure

Pipe failure is identified as failure to meet the applicable requirements listed in Tables 7, 8, and 9.

7.3 Inspection and Rejection

7.3.1 Purchaser Inspection

Receiving Inspection:

- Visually inspect all incoming product to verify that the paperwork accurately identifies the load being delivered.
- The descriptions and items on the packing list should describe the items being ordered.
- The Bill of Lading generally describes the order as the number of packages received from the manufacturer.
- The packing list, the order acknowledgement list and the Bill of Lading should all be in agreement before the shipment is accepted.

Receiving Report:

- The Bill of Lading should not be signed until it is acknowledged that the order was received in good condition.
- Any damage, missing packages, etc. should be noted on the Bill of Lading at the time.
- Shipping problems in delivery such as damaged pipe or fittings, missing parts or packages, document discrepancies, incorrect product, etc. should be noted on the Bill of Lading and the manufacturer should be notified immediately. Discrepancies should be noted and documented to the appropriate vendor.
- If they are not in agreement, provisions should be made for discrepancies.

7.3.2 Injurious Defects

Injurious defects are those that adversely affect the service life of the pipe such as foreign inclusions, kinks, visible cracks, or contamination with foreign materials and any other defects and imperfections reducing the wall thickness below minimum tolerance listed in Table 5.

8 Equipment Marking

8.1 General

Pipe manufactured in conformance with this specification shall be marked by the manufacturer as specified.

- Pressure rating markings are prohibited.
- The required print line markings on pipe shall be legible, visible and permanent. The permanency of the marking shall be such that it can only be removed by physically removing part of the pipes wall thickness. The marking shall not reduce the pipes wall thickness to less than the minimum value required for the pipe or tubing. It should not have an effect on the long term strength of the pipe and it should not provide channels for leakage when elastomeric gasket compression fittings are used to make joints.
- The print string on each length of pipe or fitting shall include in any sequence:
- manufacturer’s name, Product’s name or trademarks;
- Spec 15LE;
- additional standards optional (e.g. ASTM D2513 or ASTM F2619)
- size

- Dimension Ratio (SDR);
- Material Designation Code (PE2708, PE4710);
- a. PE-RT pipes shall also include PE-RT in the print string;
- color and UV stabilizer (C or E);
- date of manufacture (e.g. 16 Mar 06);
- manufacturer's lot number or markings for traceability to materials utilized;
- additional markings, except pressure ratings, as agreed upon between manufacturer and purchaser, are not prohibited.

9 Handling, Storage and Installation

9.1 Storage

Polyethylene pipe products are protected against deterioration from exposure to ultraviolet light and weathering effects. Color and black products are typically compounded with antioxidants, thermal stabilizers, and UV stabilizers. Color products use sacrificial UV stabilizers that absorb UV energy, and are eventually depleted. In general, non-black products should not remain in unprotected outdoor storage for more than 2 years, however, some manufacturers may allow longer unprotected outside storage. Black products contain at least 2 % carbon black to protect the material from UV deterioration. Black products are generally suitable for unlimited outdoor storage and for service on the surface, above grade or buried. In the case of striped products, the manufacturer should be consulted for storage lifetime recommendations in excess of 2 years.

The size and complexity of any particular project will determine the pre-installation storage requirements. For some projects, several storage or staging areas along the right-of-way may be appropriate, while a single location may be suitable for another job. The site and its layout should provide protection against physical damage to pipe, fittings and any pipeline components. General requirements are for the area to be of sufficient size to accommodate piping materials, to allow room for handling equipment to get around them, and to have a relatively smooth, level surface free of stones, debris, or other material that could damage pipe or components, or interfere with handling. Pipe may be placed on 4-in. wide wooden dunnage, evenly spaced at intervals of 4 ft or less.

Coiled pipe is best stored as received in silo packs. Individual coils may be removed from the silo pack without disturbing the stability of the package. Coils may be stored either on edge or stacked flat one on top of the other, but in either case, they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surfaces.

Pipe received in bulk packs or strip loads should be stored in the same package. If the storage area is flat and level, bulk packs or strip load packs may be stacked evenly upon each other to an overall height of about 6 ft, for less flat or less level terrain the maximum stacking height should be limited to about 4 ft.

9.2 Handling

Polyethylene piping materials are lightweight compared to similar piping materials made of steel but larger pieces and components can be heavy. Lifting and handling equipment must have adequate rated capacity to lift and move components from the truck to onsite or temporary storage. Equipment such as a forklift, a crane, a side boom tractor, or an extension boom crane is used for unloading.

When using a forklift, or forklift attachments on equipment such as articulated loaders or bucket loaders, lifting capacity must be adequate at the load center on the forks. Before lifting or transporting the load, forks should be spread as wide apart as practical, forks should extend completely under the load, and the load should be as far back on the forks as possible. Care should be taken not to damage the load with the forks.

9.3 Installation

See Plastics Pipe Institute (PPI) Handbook of Polyethylene Pipe, 2nd Edition for detailed installation information.

Annex A

(informative)

API Monogram

Annex B

(informative)

Conversions

U.S. Customary units are in all cases preferential and shall be the standard in this specification.

LENGTH	**1** inch (in.)	= **25.4** millimeters (mm) exactly
PRESSURE	**1** pound per square inch (psi)	= **0.06894757** Bar • **1** Bar = **100** kilopascals (kPa)
STRENGTH **OR** STRESS	**1** pound per square inch (psi)	= **0.006894757** Megapascals (MPa)
MASS	**1** pound (lb)	= **0.4535924** kilograms (kg)
TEMPERATURE	To convert degree Fahrenheit (°F) to degrees Celsius (°C):	ºC = **5/9** (ºF – **32**)
IMPACT ENERGY	**1** foot-pound (ft-lb)	= **1.3558181** Joules (J)
TORQUE	**1** foot pound (ft-lb)	= **1.3558181** Newtonmeters (Nm)

Annex C

(Informative)

Design Temperatures above 140°F

A.1. Operating Temperatures Utilizing a PE-RT

For short-term minor excursions above 140°F utilizing standard PE4710 materials, the pipe manufacturer should be consulted for guidance. For sustained elevated temperature operating conditions up to 180°F, a PE-RT compound can be utilized. The PE-RT designation applies to compounds that have an established HDB at 180°F (82.2°C) listed in PPI TR-4

A.2 Temperature Service Factor

For service temperature greater than 140 °F, a Temperature Service Factor (TSF) should be used in calculating the pressure rating per section 5.1.4. Table 3 provides guidance though the user should consult with the manufacturer to confirm the TSF values in Table 3 are suitable for use with the manufacturer's PE compound for the service conditions.

Temperature Service Factors in Table A.2.1 were derived using the interpolation formula in PPI Handbook of Polyethylene Pipe, 2nd Ed, Chapter 3, Appendix A. and based on PE 4710 PE-RT compound with an HDB of 1600 psi at 73.4°F and an HDB of 800 psi @ 180°F. The pipe manufacture should be contacted for PE pipe manufactured with compounds with other HDB values to establish appropriate TSFs.

Service Temperature °F (°C)	PE-RT
>140 – 150 (>60 - 66)	0.6
>150 - 160 (>66-71)	0.6
>160-170 (>71 – 77)	0.5
>170-180 (>77- 82)	0.5

Table A.2.1: PE-RT TSFs for compounds with an HDB of 1600 psi at 73.4°F and 800 psi at 180°F.

A.3 Marking

Per marking requirements in section 8.1, pipe manufactured from a PE-RT compound should include "PE-RT" in the print line

Annex D

(Informative)

Cold Temperature Applications

In cold temperature gas and multi-phase fluid service applications – It may be advisable to test for resistance to failure by RCP in accordance with the procedures set forth in ISO 13477 (S4 Test) or ISO 13478 (Full Scale Test (FST). Refer to ASTM D2513-16a, sect.4.9 and consult the pipe manufacturer regarding the applicability of RCP test results across diameters or SDR's, or both.

Annex E

(informative)

External Pressure Rating (Collapse Pressure)

In certain applications, polyethylene pipe may be subjected to a "negative pressure" external pressure that could cause the collapse of the pipe. A "negative pressure" situation Net external pressure exists where the external loading pressure on the pipe is greater than the internal pressure in the pipe., which can result in pipe collapse if the external hydraulic pressure exceeds the flattening buckling resistance of the pipe. Unconstrained pipe wall buckling is a consideration where the pipe is not supported by embedment or when embedment provides little or no support. PE pipe confined in a dense embedment material such as properly buried PE pipes will have greater resistance to external pressure. Flattening Unconstrained buckling resistance should be considered for some gravity flow lines, vacuum lines, submerged lines and any line where the internal pressure is less than the static external hydraulic load in unconstrained pipe. Flattening Unconstrained buckling resistance is usually not a consideration for properly buried PE pipe or where the end of the line is open to an external water environment. Open ended lines are pressure balanced and the static head in a full pipe crossing a water body will usually be the same or higher that the water height above the pipeline.

A few examples of external pressure on unconstrained pipe include:where negative pressure situations may occur are as follows.

- A pipeline operating under vacuum – typically evaluated for vacuum resistance independent of soil embedment support.
- Above or below ground gravity flow lines where column separation occurs in the liquid flow resulting in a vacuum load.
- A vacuum line—An underwater pipeline - a water suction For instance a pipeline submerged 23 ft in a lake (equivalent to 10 psi external loading) and is operating under a partial vacuum of 5 psi. The net negative external pressure is 15 psi.
- A water line going over a hill. The velocity of the water flow down the hill can exceed the velocity of the water coming up the hill and cause a "negative pressure" siphoning or reduced internal pressure to occur.
- An ungrouted slipline installation with groundwater in the annular space

Excessive external pressure or nor net internal vacuum pressure can cause pipe flattening or collapse. The maximum external load is determined not by material strength but by the pipe's stiffness. The pipe will flatten if the bending moment due to the load exceeds the resisting moment due to the elastic stresses in the pipe. The critical external pressure above which round unconstrained pipe will flatten or collapse can be estimated by using Love's Equation:

x f_O

where

P_{CR} is the critical flattening buckling pressure, lb/in.^{2};

E is the elastic modulus, lb/in.^{2};

μ is Poisson's ratio;

(0.45 for polyethylene under long-term stress);

(0.35 for polyethylene under short-term stress);

DR is the pipe Dimension Ratio.

f_O = pipe ovality compensation factor

Where q is the ovality (e.g. q = 0.03 for 3% ovality)

An appropriate safety factor should be applied when using this equation for design. If short-term modulus is used in the calculation, a safety factor of 3 would be typical. If a long-term value of modulus is available, this may be reduced to 1.5.The designer should compare the critical buckling pressure to the actual anticipated pressure and apply a safety factor commensurate with his assessment of the application. Safety factors in the range of 2 are common, but specific circumstances may warrant a higher or lower value.

For above ground lines, increased temperatures will decrease the pipe's collapse resistance and in buried lines, pipe deflection will reduce flattening buckling resistance.