

Specification for Polyethylene Line Pipe (PE)

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Specification for Polyethylene Line Pipe (PE)

1 Scope

1.1 Purpose

This specification covers polyethylene line pipe (PE) utilized for the production and transportation of oil, gas, mixed-phase fluids, and non-potable water. The piping is intended for use in new construction, insertion renewal, line extension, and repair of both aboveground and buried pipe applications.

1.2 Service Conditions

The standard service conditions for the API 15LE standard pressure rating are as follows.

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 standard conditions but may vary depending on actual operating conditions.

Typical service temperature is between -30°F and 140°F .

If the service temperature is between -30°F and 140°F and is subject to temporary excursions outside of this range, it is recommended to consult with the manufacturer for guidance. See Annex A.

For sustained, long-term (e.g. 50 years) elevated design temperatures that exceed 140°F , see Annex A.

The fluid environment is oil, gas, mixed-phase fluids, and non-potable water, e.g. raw water, produced water, and brine.

2 Normative References

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

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

ASTM D1598 ¹, *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 Fittings*

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

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 Pipe*

ASTM D2513, *Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings*

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

¹ ASTM International, PO Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428. www.astm.org

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

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

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 Plastics Pipe and Fittings Material*

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

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

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

ASTM F2206, *Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)*

ASTM F2619/F2619M, *Standard Specification for High-Density Polyethylene (PE) Line Pipe*

ISO 9001², *Quality management systems — Requirements*

PPI TR-3³, *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe*

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

U.S. DOT Title 49, CFR Part 192⁴, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1.1

acceptance criteria

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

3.1.2

butt fusion

A process 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.

² International Organization for Standardization, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, www.iso.org.

³ Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75062, www.plasticpipe.org.

⁴ Department of Transportation. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov/fdsys.

3.1.3**component**

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

3.1.4**design factor****DF**

A number between zero and one used to reduce the hydrostatic design basis (HDB) to arrive at the HDS from which the design pressure is calculated.

NOTE 1 The DF accounts for typical process variation, dimensional tolerances, and other sources of variability that can impact the long-term performance of high-density polyethylene pipe.

NOTE 2 The DF 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.

3.1.5**dimension ratio****DR**

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

3.1.6**eccentricity**

The wall thickness variability as measured and calculated in accordance with ASTM D2122 test method in any diametrical cross section of the pipe.

3.1.7**equivalent dimension ratio****EDR**

The dimension ratio (DR) of the pipe to which the fitting is to be joined.

3.1.8**fittings**

A piping system component used to join or terminate sections of pipe or to provide changes in direction or branching in a pipe system, e.g. tees, 90s, 45s, and fittings manufactured by butt fusion welding of shape modified or mitered components prepared from molded fittings, sheet stock, or block.

3.1.9**fluid service factor****FSF**

Factor applied to the 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 in the circumferential or hoop direction for a given set of end use conditions, as established by ASTM D2837.

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.

NOTE The HDS is a grade specific value that is determined by multiplying the HDB of a material at 73 °F with a DF, a multiplier of less than 1.0.

EXAMPLE

PE4710

HDB at 73 °F = 1600 psi

DF = 0.63

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

3.1.12**lot number**

A unique code assigned to each lot of manufactured pipe or fittings under the same conditions of production.

NOTE 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.

EXAMPLE

PE4710 where PE = polyethylene

4 = density (according to ASTM D3350)

7 = slow crack growth resistance (according to ASTM D3350)

10 = HDS of 1000 psi at 73 °F in water

3.1.15**short-term hydrostatic pressure**

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.

3.1.16**standard pressure rating**

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 73 °F with water.

3.1.17**temperature service factor****TSF**

Factor applied to the HDS to account for the impact of temperatures greater than the temperature at which the HDS is determined.

3.1.18**working pressure**

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

3.2 Acronyms and Abbreviations

DR	dimension ratio
EDR	equivalent dimension ratio
FSF	fluid service factor
HDB	hydrostatic design basis
HDPE	high density polyethylene
HDS	hydrostatic design stress
MAOP	maximum allowable operating pressure
OOR	out of roundness
PE	polyethylene line pipe
PENT	Pennsylvania edge-notched tensile test
PPI	Plastics Pipe Institute
RCP	rapid crack propagation
SDR	standard dimension ratio
TSF	temperature service factor
UV	ultraviolet

4 Design**4.1 Determination of Working Pressure****4.1.1 Hydrostatic Design Basis (HDB)**

The HDB shall be established by the pipe manufacturer in accordance with ASTM D2837 and PPI TR-3, and the compound shall be listed in PPI TR-4.

4.1.2 Design Factor (DF)

The DF used in this standard for PE2708 and PE4710 compounds is 0.63 @ 73 °F as recommended by the PPI (Plastics Pipe Institute) Hydrostatic Stress Board and published in PPI TR-4.