

Specification for Crosslinked Polyethylene (PEX) Line Pipe

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Contents

	Page
1 Introduction	1
1.1 Purpose	1
1.2 Scope	1
1.3 Service Conditions	1
2 Normative References	2
2.1 General	2
2.2 Requirements	3
2.3 Equivalent Standards	3
3 Definitions and Abbreviations	4
3.1 Definitions	4
3.2 Abbreviations	5
4 Design	6
4.1 Long-term Strength	6
4.2 Fluid Service Factors	6
4.3 Determining the Maximum Working Pressure	7
4.4 External Service Environment	10
4.5 Dimensions and Tolerances	10
5 Process of Manufacture	15
5.1 General	15
5.2 Pipe Compound	15
5.3 Pipe Compound Requirements	15
5.4 Finish and Workmanship	17
6 Fittings	17
6.1 General	17
6.2 Electrofusion Fittings	17
6.3 Metallic Fittings	17
6.4 PEX Fittings	17
7 Quality Management Program	18
7.1 General	18
7.2 Quality Records Retention	18
7.3 Quality Control Tests	18
8 Product Marking	19
8.1 Manufactured Pipe	19
9 Handling, Storage, and Installation	20
9.1 Storage	20
9.2 Handling	20
9.3 Installation	20
10 Integrity Management	20
Annex A (informative) API Monogram Program—Use of the API Monogram by Licensees	21
Annex B (informative) External Pressure Rating (Collapse Pressure)	25
Annex C (informative) Interpolation of the HDB	26
Annex D (normative) Calculation of Pressure Ratings for Pipe Sizes Not Listed in this Standard	27

Contents

	Page
Annex E (informative) Purchasing Guidelines	29
Annex F (informative) Installation	30
Annex G (informative) Integrity Management	35
Bibliography	36
Tables	
1 Fluid Service Factors (FSF)	7
2 Standard Pressure Ratings (psi) of PEX Pipe Using the HDB Method of Design at Various Temperatures for Nonchemically Aggressive Fluids	7
3 Working Pressure (psi) of PEX Pipe Using the HDB Method of Design at Various Temperatures for Multiphase Fluids, Wet Natural Gas, and Liquid Hydrocarbons	8
4 Standard Pressure Ratings (psi) of PEX Pipe Using the DIN 16892/3 Method of Design at Various Temperatures for Most Fluids	9
5 Maximum Working Pressure (psi) of PEX Pipe Using the DIN 16892/3 Method of Design at Various Temperatures for Multiphase Fluids, Wet Natural Gas, and Liquid Hydrocarbons	9
6 Inch Dimensions and Tolerances Based on Outside Diameters	10
7 Metric Dimensions and Tolerances Based on Outside Diameters	14
8 Test Description and Frequency for PEX Pipe	19
E.1 Purchasing General Guidelines	29

Specification for Crosslinked Polyethylene (PEX) Line Pipe

1 Introduction

1.1 Purpose

The purpose of this specification is to provide standards for crosslinked polyethylene (PEX) line pipe suitable for use in conveying oil, gas, and nonpotable water in underground, aboveground, and reliner applications for the oil and gas producing industries.

This specification 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 utilizes pressure-rated materials 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 Scope

This specification covers PEX line pipe utilized for the production and transportation of oil, gas, and nonpotable water. The piping is intended for use in new construction, structural, pressure-rated liner, line extension, and repair of both aboveground and buried pipe applications. Specific equipment covered by this specification is listed as follows:

- a) PEX line pipe;
- b) fittings.

1.3 Service Conditions

The standard service conditions for the API 15PX standard pressure rating are as follows:

- a) Standard pressure ratings in non-chemically-aggressive fluids;
- b) Service temperature range: -50 °C (-58 °F) to 95 °C (203 °F);

NOTE Applications above 95 °C (203 °F) require special design consideration.

- c) The fluid environment is oil, gas, and nonpotable water and combinations thereof (see Table 1);
- d) Axial loads shall include end loads due to pressure only;
- e) Service conditions other than the standard API 15PX conditions are discussed in Section 5.

2 Normative References

2.1 General

This specification includes by reference, either in total or in part, the most current issue of the following standards:

API 15S, *Spoolable Reinforced Plastic Line Pipe*

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

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

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

ASTM D2122¹, *Standard Test Method for Determining Dimensions of the Thermoplastic Pipe and Fittings*

ASTM D2765, *Standard Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics*

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

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

ASTM F2905/F2905M, *Standard Specification for Black Crosslinked Polyethylene (PEX) Line Pipe, Fittings and Joints for Oil and Gas Producing Applications*

ASTM F3203, *Standard Test Method for Determination of Gel Content of Crosslinked Polyethylene (PEX) Pipes and Tubing*

ASTM F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*

ASTM F2657, *Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing*

ASTM D4364, *Standard Practice for Performing Outdoor Accelerated Weathering Tests of Plastics Using Concentrated Sunlight*

DIN 16892², *Crosslinked polyethylene (PE-X) pipes —General requirements, testing*

ISO 527-1³, *Determination of Tensile Properties*

ISO 1167, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure -- Test method*

¹ ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19248, www.astm.org

² German Institute for Standardization, Am DIN-Platz, Burggrafenstrabe 6, 10787 Berlin, Germany, www.din.de.

³ International Organization for Standardization, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, www.iso.org.

ISO 10147, *Pipes and fittings made of crosslinked PEX (PE-X) — Estimation of the degree of crosslinking by determination of the gel content*

ISO 13477, *Thermoplastics pipes for the conveyance of fluids – Determination of resistance to rapid crack propagation (RCP) -- Small-scale steady-state test (S4 test)*

ISO 14531-1, *Plastics pipes and fittings – Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels - Metric series – Specifications – Part 1: Pipes*

ISO 18553, *Method for assessment of the degree of pigment or carbon black dispersion in polyethylene pipes, fittings and compounds*

ISO 3126, *Plastics piping systems – Plastics components – Determination of dimensions*

ISO 9001, *Quality management systems – Requirements*

ISO 9080, *Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO TS 29001, *Petroleum, petrochemical and natural gas industries – Sector-specific quality management systems – Requirements for product and service supply organizations*

ISO/IEC 17020, *Conformity assessment – Requirements for the operation of various types of bodies performing inspection*

ISO/IEC 17065, *Conformity assessment – Requirements for bodies certifying products, processes and services*

PPI TR-3⁴, *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, *PPI 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*

2.2 Requirements

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

2.3 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 six months from the date of the revision.

⁴ Plastics Pipe Institute, 105 Decker Court, Suite 825, Irving, TX 75062, plasticpipe.org.

3 Definitions and Abbreviations

3.1 Definitions

3.1.1

adapters

Appurtenances that allow connecting components with different joining systems.

3.1.2

component

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

3.1.3

crosslinking

The formation of a three-dimensional polymer by means of interchain reactions resulting in changes in physical properties.

NOTE PEX materials used in the manufacturing of PEX line pipe may be crosslinked by a number of industry-proven means. These include:

- a) peroxide crosslinking (PEX-a);
- b) silane crosslinked (PEX-b);
- c) irradiation (PEX-c).

3.1.4

design service factor (DSF)

A safety factor applied to the hydrostatic design basis (HDB) to calculate the standard pressure rating of the pipe.

3.1.5

design coefficient

A coefficient with a value greater than 1 that takes into consideration service conditions as well as properties of the components of a piping system other than those represented in σ_{LPL} .

NOTE 1 When used with the DIN 16892/3 design method.

NOTE 2 See ISO 12162 for information regarding the minimum permissible service (design) coefficient for PEX pipes.

3.1.6

dimension ratio (DR)

The ratio of a pipe's outside diameter to its wall thickness.

3.1.7

ittings

A piping component used to join or terminate sections of pipe or to provide changes of direction or branching in a pipe system.

3.1.8

flanges

Appurtenances incorporating a PEX flange adapter and metallic backup ring with ANSI B16.5 bolt hole pattern.

NOTE Metallic flange couplers for field installations and PEX face flanges used as internal diameter adapters are also covered by this specification.

3.1.9

fluid service factor (FSF)

Factor applied in the determination of the maximum working pressure 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 hoop direction as established by ASTM D2837.

3.1.11

material designation code

A set of letters and numbers consisting of the abbreviation for the type of plastic (PEX) followed by four Arabic numerals—two to describe the short-term properties, in accordance with the ASTM standard being referenced, and two to designate the hydrostatic design stress when tested in water at 23 °C (73 °F) in units of 100 psi, with any decimal figures dropped.

3.1.12

maximum working pressure

The maximum anticipated, sustained pressure applied to the pipe in actual service when the fluid service factor (FSF) and temperature service factor (TSF) are considered.

3.1.13

minimum required strength (MRS)

The categorized lower prediction limit (LPL) of the long-term hydrostatic strength at 20 °C (68 °F) determined in accordance with ISO 9080 and ISO 12162.

NOTE In this standard, the equivalent MRS value is defined by reference curves in DIN 16892 and has a value of 9.5 MPa.

3.1.14

out of roundness

The maximum measured outside diameter, minus the minimum measured outside diameter, divided by the average measured outside diameter, times 100, expressed as a percentage.

3.1.15

standard pressure rating

The established maximum pressure that nonaggressive fluids such as water can exert continuously with a high degree of certainty that failure in the pipe will not occur.

3.2 Abbreviations

ANSI American National Standards Institute

API American Petroleum Institute

ASTM American Society for Testing Materials

CSA Canadian Standards Association

DIN Deutsch Institute for Norms

DN nominal diameter

DR	dimension ratio
FSF	fluid service factor
HDB	hydrostatic design basis
ISO	International Standards Organization
LPL	lower prediction limit
MRS	minimum required stress
NPS	nominal pipe size
PEX	cross-linked polyethylene
PE	polyethylene
PPI	Plastics Pipe Institute, Inc.
QA	quality assurance
QC	quality control
RCP	rapid crack propagation
TSF	temperature service factor
UV	ultraviolet

4 Design

4.1 Long-term Strength

The long-term strength shall be measured with water as the internal pressurizing medium. Either the HDB or DIN 16892/3 long-term strength shall be used to establish the maximum working pressure of a PEX pipe.

The design process shall include the effects of the internal and external chemical environment on the long-term strength, which comprises the DSF for the HDB method or the design coefficient when using the DIN 16892/3 method; the operating temperature; and the chemical environment that is included in the FSF. The design process shall also include consideration of the installation method.

4.2 Fluid Service Factors

The FSFs in Table 1 shall be used to compensate for possible effects of the transported fluid on the long-term performance of the piping and for the hazardous nature of some applications.

Table 1—Fluid Service Factors (FSF)

Environment	Factor	HDB	DIN 16892/3
Produced water, seawater, brine, process water, and other oilfield water-based fluids, excluding oilfield water containing > 2 % liquid hydrocarbons ¹	1.0	Table 2	Table 4
Dry gas gathering (no associated hydrocarbon liquids) ²	1.0	Table 2	Table 4
Dry gas gathering that is subject to Canadian Federal Regulations ³	1.0	Table 2	Table 4
Multiphase fluids, wet natural gas, and liquid hydrocarbons	0.5	Table 3	Table 5
¹ Water containing significant quantities of liquid hydrocarbons (> 2 %) shall be treated as liquid hydrocarbon. 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 U.S. Department of Transportation, Office of Pipeline Safety, Title 49 CFR Part 192. ³ CSA Z662 Clause 13.3.			

4.3 Determining the Maximum Working Pressure

4.3.1 To Use the HDB Pressure Rating System:

4.3.1.1 Determine the FSF to determine whether to use Table 2 or Table 3.

4.3.1.2 Select the appropriate HDB based on the anticipated operating temperature and the material designation code as shown in the appropriate rows of Table 2 if FSF is 1.0 or Table 3 if FSF is 0.5.

4.3.1.3 Find the DR for the pipe in the column headings in Tables 2 or 3.

4.3.1.4 The value for the maximum working pressure in water service is at the intersection of the DR column and the HDB row in Table 2, and includes the application of a DSF of 0.71.

4.3.1.5 The value for the maximum working pressure for multiphase fluids, wet natural gas, and liquid hydrocarbons is at the intersection of the DR column and the HDB row in Table 3, and includes the application of a DSF of 0.71.

Table 2—Standard Pressure Ratings (psi) of PEX Pipe Using the HDB Method of Design at Various Temperatures for Nonchemically Aggressive Fluids

Temperature °C (°F)	Material Designation Code	HDB (psi)	Maximum Working Pressures (psig) for the Indicated DR				
			DR 7.4	DR 9	DR 11	DR 13.6	DR 17
23 (73)	PEX xx06	1250	277	222	178	141	111
	PEX xx08	1600	355	284	227	180	142
60 (140)	PEX xx06	800 ¹	178	142	114	90	71
	PEX xx08	1000 ¹	222	178	142	113	89
82 (180)	PEX xx06 PEX xx08	800	178	142	114	90	71
93 (200)	PEX xx06	630	140	112	89	71	56
	PEX xx08	800	178	142	114	90	71
NOTE For the working pressure of multiphase fluids, wet natural gas, and liquid hydrocarbons, refer to Table 3.							
¹ HDB was interpolated using the HDB values at 23 °C (73 °F) and 82 °C (180 °F) for the grades with the indicated material designation code.							