



Designation: F2905/F2905M – 24a

Standard Specification for Crosslinked Polyethylene (PEX) Line Pipe For Oil and Gas Producing Applications¹

This standard is issued under the fixed designation F2905/F2905M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers outside diameter controlled, pressure rated, metric-sized and inch-sized black or yellow crosslinked polyethylene (PEX) pipe made in pipe dimension ratios ranging from 6 to 17. Included are requirements and test methods for material, workmanship, dimensions, burst pressure, hydrostatic sustained pressure, stabilizer functionality, bent-pipe hydrostatic pressure, degree of crosslinking, chemical resistance, and minimum operating temperature. Requirements for pipe markings are also given. The pipe covered by this specification is intended for pressure or non-pressure oil and gas producing applications, such as conveying oil, dry or wet gas, gas gathering, multiphase fluids, and non-potable oilfield water. This specification does not cover piping for gas distribution applications.

1.2 This specification also includes requirements for joints made between PEX pipe and polyethylene electrofusion fittings (specified in Specifications [F1055](#) or [F3373](#)). Fittings to be used with PEX pipe manufactured to this Specification are in Specification [F2829/F2829M](#). Installation considerations are in [Appendix X3](#).

1.3 The text of this specification references notes, footnotes, and appendixes, which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

NOTE 1—Metric sized (SI units) pipe should only be joined with corresponding metric sized fittings, and inch sized pipe should only be joined with corresponding inch sized fittings. Inch sized fittings should not

be used for metric sized pipe, and metric sized fittings should not be used for IPS inch sized pipe.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- [D618 Practice for Conditioning Plastics for Testing](#)
- [D792 Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)
- [D1505 Test Method for Density of Plastics by the Density-Gradient Technique](#)
- [D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure](#)
- [D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings](#)
- [D1600 Terminology for Abbreviated Terms Relating to Plastics \(Withdrawn 2024\)³](#)
- [D1603 Test Method for Carbon Black Content in Olefin Plastics](#)
- [D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings](#)
- [D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe](#)
- [D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications](#)
- [D2765 Test Methods for Determination of Gel Content and](#)

¹ This specification is under the jurisdiction of ASTM Committee [F17](#) on Plastic Piping Systems and is the direct responsibility of Subcommittee [F17.68](#) on Energy Piping Systems.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

Swell Ratio of Crosslinked Ethylene Plastics

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

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

D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

F412 Terminology Relating to Plastic Piping Systems

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

F2023 Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Pipe, Tubing and Systems to Hot Chlorinated Water

F2619/F2619M Specification for High-Density Polyethylene (PE) Line Pipe

F2657 Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing

F2788/F2788M Specification for Metric and Inch-sized Crosslinked Polyethylene (PEX) Pipe

F2829/F2829M Specification for Metric- and Inch-Sized Fittings for Crosslinked Polyethylene (PEX) Pipe

F3373 Specification for Polyethylene (PE) Electrofusion Fittings for Outside Diameter Controlled Crosslinked Polyethylene (PEX) Pipe

2.2 *Federal Standard*.⁴

FED-STD-123 Marking for Shipment (Civil Agencies)

2.3 *Military Standard*.⁴

MIL-STD-129 Marking for Shipment and Storage

2.4 *ISO Standards*.⁵

ISO 1167 Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method ISO

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 14531-2 Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 2: Fittings for heat-fusion jointing

ISO 14531-3 Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)

ISO 18553 Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes,

fittings and compounds.

2.5 *PPI Standards*.⁶

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 Piping Materials or Pipe

PPI TR-4 PPI 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 and Design Coefficients for Thermoplastic Pressure Pipe

PEX Pipe Design Manual for Water, Oil, Gas & Industrial Applications

2.6 *American Petroleum Institute Standard*.⁷

API 15PX Specification for Crosslinked Polyethylene (PEX) Line Pipe

2.7 *Canadian Standard*.⁸

CSA B137.19 Crosslinked polyethylene (PEX) piping systems for gas services

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology **F412**, and abbreviations are in accordance with Terminology **D1600**, unless otherwise specified. The abbreviation for crosslinked polyethylene is PEX. Plastic pipe denotes a particular diameter schedule of plastic pipe that is outside diameter controlled.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *crosslinked polyethylene, n*—molecular chains chemically connected through irradiation with high-energy electron beams, or chemical agents such as organic peroxides or silanes.

3.2.2 *multiphase fluid, n*—oil, gas, and water in any combination produced from one or more oil or gas wells, or recombined oil or gas well fluids that may have been separated in passing through surface facilities.

3.2.3 *oilfield water, n*—fresh or salt water transported by pipeline, regardless of purity or quality, from wells or surface locations for the purpose of providing water injection to underground reservoirs; or disposing of waste water from hydrocarbon or gas production, processing, or storage facilities.

3.2.4 *PEX pipe material designation code*—The PEX pipe material designation code shall consist of the abbreviation for crosslinked polyethylene (PEX) followed by four Arabic digits as shown in **Table 1**, and as defined in Terminology **F412** for PEX pipe materials.

3.2.5 *production run, n*—the continuous extrusion of pipe of a specific diameter, wall thickness and material compound.

⁶ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁷ Available from American Petroleum Institute (API), 200 Massachusetts Avenue, NW Suite 1100 Washington, DC 20001-5571, <http://www.api.org>.

⁸ Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, <http://www.csagroup.org>.

⁴ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁵ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

TABLE 1 PEX Pipe Material Designation Codes

PEX Pipe Material Designation Code	73 °F [23 °C] HDB Psi [MPa]	200 °F [93 °C] HDB Psi [MPa]
PEX 0006	1250 [8.62]	630 [4.34]
PEX 0007	1400 [9.66] ^A	630 [4.34]
PEX 0008	1600 [11.03]	630 [4.34]
PEX 0009	1800 [12.41]	630 [4.34]

^A The HDB category of 1400 psi has an LTHS range of 1340 to <1530 psi. The LTHS is determined in accordance with procedures of Test Method **D2837**.

3.2.6 *sample, n*—pipe or an element of pipe that represents a quantity of pipe and provides a specimen or specimens for testing.

3.2.7 *specimen, n*—pipe or an element of pipe that is subjected to test.

4. Pipe Classification

4.1 *General*—This standard covers PEX pipe that is pressure rated based on HDB at 73 °F [23 °C] and 200 °F [93 °C]. Pressure ratings for temperatures between 73 °F [23 °C] and 200 °F [93 °C] are determined by temperature interpolation in accordance with PPI TR-3.

4.2 *Classification*—PEX pipes are classified by their PEX pipe material designation codes as shown in **Table 1**.

4.3 *Operating Temperature Range*—The minimum operating temperature shall be in accordance with **6.11**. The maximum temperature for continuous operation shall be based on the highest temperature HDB in accordance with **5.2** and **Table 1**. The maximum temperature for intermittent operation shall require special design considerations and consultation with the pipe manufacturer and shall be consistent with the PPI “*PEX Pipe Design Manual for Water, Oil, Gas & Industrial Applications*.”

5. Materials

5.1 *General*—PEX pipes, meeting the requirements of this specification, are defined by means of (1) degree of crosslinking per **6.7**, and (2) long-term strength tests per Test Method **D2837** to determine HDB per **Table 1**. The HDB is a property of the PEX compound, which is used to make the PEX pipe.

5.2 *Basic Materials*—PEX pipe and fittings shall be made from PE compounds, which have been crosslinked by peroxides, azo compounds, or silane compounds in extrusion,

or by electron beam after extrusion, such that the pipe meets the performance requirements of Section **6**. The materials, procedure for mixing, and the process for crosslinking shall result in a product with Hydrostatic Design Basis ratings equal to or better than those shown in **Table 1**, when determined in accordance with procedures no less restrictive than those of Test Method **D2837**, and the PEX material shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis rating. See **Appendix X1** for additional information on PPI hydrostatic stress ratings.

5.3 *PEX Pipe Material Designation Code*—The PEX material meeting the requirements of this specification shall be designated PEX 0006, PEX 0007, PEX 0008, or PEX 0009.

5.3.1 The first digit of the pipe material designation code is the chlorine resistance and the second digit is the UV resistance. The last two digits are the hydrostatic design stress (HDS) for water at 73 °F (23 °C) in units of 100 psi with any decimal figures dropped. The HDS is equal to the Hydrostatic Design Basis (HDB) times the design factor (DF)

$$\text{HDS} = \text{HDB} \times \text{DF} \quad (1)$$

Where the HDS code contains less than two figures, a zero is used before the number. Thus, a complete material designation code for PEX pipe consists of the three letters “PEX” and four digits, as shown in the Pipe Material Designation Code Cells chart (see **Table 2**).

5.3.2 *Example 1*—PEX pipe marked with the pipe material designation code PEX 1006 is a PEX pipe meeting the chlorine resistance requirement of cell 1 for 25 % of the time at 140 °F (60 °C) and 75 % of the time at 73 °F (23 °C), no UV resistance requirement of cell 0, and having an HDS for water at 73 °F (23 °C) of 630 psi, which is cell 06 (HDB of 1250 psi times 0.5 design factor) as follows:

Pipe material designation code			
Material	PEX		
Chlorine resistance (75 % at 73 °F and 25 % at 140 °F)	1		
UV Resistance	0		
HDS at 73 °F (23 °C) (630 psi)		0	6

5.3.3 *Example 2*—PEX pipe marked with the pipe material designation code PEX 5308 is a PEX pipe meeting the chlorine resistance requirement cell 5 for 100 % of the time at 140 °F (60 °C), UV resistance requirement cell 3 of 6 months, and having an HDS for water at 73 °F (23 °C) of 800 psi, which is cell 8 (HDB of 1600 psi times 0.5 design factor) as follows:

TABLE 2 Pipe Material Designation Code Cells

Property	Standard	0	1	2	3	4	5	6	7	8	9
Chlorine Resistance	F2023	Not tested or rated	75 % at 73 °F (23 °C) and 25 % at 140 °F (60 °C)	Reserved	50 % at 73 °F (23 °C) and 50 % at 140 °F (60 °C)	Reserved	100 % at 140 °F (60 °C)	...	...	...	...
UV Resistance	F2657	Not tested or rated	1 month	3 months	6 months	...	...	...	...	...	...
HDS for water at 73 °F (23 °C)	D2837	...	...	...	...	...	...	630	...	800	...



Pipe material designation code

Material	PEX
Chlorine resistance (100 % at 140 °F)	5
UV Resistance	3
HDS at 73 °F (23 °C) (800 psi)	0 8

5.4 **Density**—When determined in accordance with 7.5, the PEX base resin, without carbon black, shall have a minimum average density of 0.926 g/cm³.

5.5 **Color:**

5.5.1 PE compounds used to make black PEX pipe shall contain well dispersed carbon black as a colorant.

5.5.2 PE compounds used to make yellow PEX pipe shall contain a yellow pigment as a colorant.

5.6 **UV Protection:**

5.6.1 Black pipe with or without yellow stripes shall be stabilized and protected against deterioration from unprotected UV exposure for not less than 10 years. Yellow pipe shall be stabilized and protected against deterioration from unprotected UV exposure for not less than 3 years.

5.6.2 If the carbon black content is less than 2.0%, the pipe shall be tested in accordance with Test Method F2657, Practice D2565 or ISO 14531-1 Annex C. After PEX pipe has been weathered, it shall meet the thermal stability, 95 °C hydrostatic strength (for stress values, use 536 psi (3.7 MPa) for PEX 0006, 598 psi (4.1 MPa) for PEX 0007, 681 psi (4.7 MPa) for PEX 0008, or 768 psi (5.3 MPa) for PEX 0009), and elongation at break requirements of ISO 14531-1 Table 8.

5.6.3 If the carbon black content is greater than 2.0 % and less than 3.0 % as measured by Test Method D1603 or Test Method D4218, the UV exposure time requirement of 5.6.2 is not applicable. This is consistent with ISO 14531-1 Table 8. The carbon black shall be well dispersed, and have the correct type (furnace) and particle size (40 nm or less), such as N550. To demonstrate good carbon black dispersion the PEX pipe shall meet the ISO 14531-1 dispersion requirement of less than or equal to grade 3 when measured in accordance with ISO 18553, or in accordance with an equivalent ASTM test method for carbon black dispersion, such as Test Method D5596.

5.7 **Rework Material**—PEX rework shall not be used in the manufacture of PEX pipes and fittings made in accordance to this specification.

6. **Requirements**

6.1 **Workmanship**—The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other defects. The pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

6.2 **Out-of Roundness**—The maximum out-of roundness requirements shown in Table 3 and Table 4 for pipe apply to the average measured diameter in accordance with 7.4.1.

6.3 **Dimensions and Tolerances:**

6.3.1 **Outside Diameters**—The outside diameters and tolerances shall be as shown in Table 3 or Table 4, when measured in accordance with 7.4 and 7.4.1.

TABLE 3 Metric-sized Outside Diameters and Tolerances for PEX Pipe

Pipe Size	Average Outside Diameter	Tolerances for Average Diameter	Out-of-Roundness
mm	mm	mm	mm
16	16.15	±0.15	1.2
20	20.15	±0.15	1.2
25	25.15	±0.15	1.2
32	32.15	±0.15	1.3
40	40.20	±0.20	1.4
50	50.20	±0.20	1.4
63	63.20	±0.20	1.5
75	75.25	±0.25	1.6
90	90.30	±0.30	1.8
110	110.35	±0.35	2.2
125	125.40	±0.40	2.5
140	140.45	±0.45	2.8
160	160.50	±0.50	3.2
180	180.55	±0.55	3.6
200	200.60	±0.60	4.0
225	225.70	±0.70	4.5
250	250.75	±0.75	5.0
280	280.85	±0.85	9.8
315	315.95	±0.95	11.1
355	356.10	±1.10	12.5
400	410.20	±1.20	14.0
450	451.35	±1.35	15.6
500	501.50	±1.50	17.5
560	561.70	±1.70	19.6
630	631.90	±1.90	22.1

TABLE 4 Inch-sized Outside Diameters and Tolerances for PEX Pipe

Pipe Size	Outside Diameter	Tolerances or Outside Diameter ±
in.	in.	in.
3	3.500	.016
4	4.500	.020
5	5.563	.025
6	6.625	.030
8	8.625	.039
10	10.750	.048
12	12.750	.057
14	14.000	.063
16	16.000	.072
18	18.000	.081
20	20.000	.090
22	22.000	.099
24	24.000	.108
26	26.000	.117
28	28.000	.126
30	30.000	.135
32	32.000	.144
34	34.000	.153
36	36.000	.162
42	42.000	.189
48	48.000	.216
54	54.000	.243

6.3.2 **Wall Thickness**—The wall thickness and tolerances shall be as shown in Table 5 or Table 6, when measured in accordance with 7.4 and 7.4.2.

6.4 **Sustained Pressure 73 °F [23 °C]**—The PEX pipe shall not fail in less than 1000 h when tested in accordance with 7.6. For PEX 0006 the stress shall be 1320 psi [9.1 MPa], for PEX 0007 the stress shall be 1450 psi [10.0 MPa], for PEX 0008 the stress shall be 1650 psi [11.3 MPa], and for PEX 0009 the stress shall be 1870 psi [12.9 MPa]. Piping intended for use at temperatures of 100 °F [38 °C] and higher shall be tested at

