CROSSLINKED POLYETHYLENE (PEX) PIPE & TUBING SYSTEMS

PPI TN-17

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Foreword

This technical note was developed and published with the technical help and financial support of the members of the Plastics Pipe Institute (PPI). These members are committed to developing and improving quality products by assisting independent standards and user organizations in the development of standards, and also by developing design aids and reports to help engineers, code officials, specifying groups, contractors and users.

The purpose of this technical note is to provide general information on crosslinked polyethylene (PEX) pipe and tubing, how it is manufactured, and in what applications it can be used.

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The Plastics Pipe Institute, Inc.

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CROSSLINKED POLYETHYLENE (PEX) PIPE & TUBING SYSTEMS

1.0 INTRODUCTION

The successful use of crosslinked polyethylene (PEX) systems throughout the world in numerous applications, along with the capabilities of PEX pipe and tubing in cold- and hot-water pressure piping environments, have generated significant interest and growth in the usage in these materials across North America.

To answer common questions about PEX materials from installers, designers, builders, engineers and specifiers, as well as the public, this technical note provides an overview of PEX properties and capabilities, the applications and benefits of PEX, and the technical requirements for PEX systems. Several product standards are listed as references.

2.0 PEX DEFINITION

PEX is the acronym for Crosslinked Polyethylene.

2.1. Formal Definition

Crosslinked Polyethylene is a polyethylene material which has undergone a change in molecular structure using a chemical or a physical process whereby a majority of the polymer chains are chemically linked.

Crosslinking of polyethylene into PEX for pipe and tubing results in improved properties such as elevated temperature strength and performance, chemical resistance, flexibility, and resistance to slow crack growth.

2.2. Explanation

PEX is a modified polyethylene material, typically high-density polyethylene (HDPE), which has undergone a change in the molecular structure using a chemical or a physical process whereby the majority of the polymer chains are permanently linked to each other.

This crosslinking of the polymer chains results in improved performance properties such as elevated temperature strength, flexibility, chemical resistance, environmental stress crack resistance (ESCR), resistance to slow crack growth (SCG), toughness, and abrasion resistance. Crosslinking also makes PEX a “semi-thermoset” polymer, providing excellent long-term stability.

3.0 CROSSLINKING IMPROVES THE PROPERTIES FROM HDPE

Below is a table summarizing the property changes from HDPE to PEX materials in general:

Table 1: Summary of Property Changes from HDPE to PEX Materials

Property	Change from HDPE to PEX	Benefit
Tensile Yield Strength @ 73°F (23°C) Tensile Yield Strength @ 180°F (82°C)	Typically Unchanged Typically Increases	PEX is suitable for both low- and elevated-temperature applications
Elongation at Break	Unchanged or Increases	Improved flexibility to withstand installation stresses while resisting tensile deformation
Environmental Stress Crack Resistance	Increases	Greater resistance to environmental hazards. Improved toughness and abrasion resistance.
Resistance to Slow Crack Growth	Increases	Greater resistance to environmental hazards such as scratches. Improved toughness and abrasion resistance.
Creep Resistance	Increases	Improved stability over long-term pressurization and loads. The traditional HDPE stress curve "knee- point" is typically eliminated.
Hydrostatic Design Basis (HDB): HDB @ 73°F (23°C) HDB @ 180°F (82°C)	 Typically Unchanged Increases	HDB is an evaluation of the long-term hoop strength of the material, and is used to develop its pressure ratings. PEX is suitable for both low- and elevated-temperature applications.
Hydrocarbon Permeation	Unchanged	Similar performance
Chemical Resistance *	Typically Increases	Similar or improved performance
** The chemical resistance of thermoplastics is complex and is generally a function of the polymer's resistance to applied load, temperature, and environment. See PPI TR-19 Chemical Resistance of Plastic Piping Materials.*		

4.0 ELEVATED TEMPERATURE CAPABILITIES

In general, 140°F (60°C) is the typical maximum service temperature for thermoplastic HDPE pressure pipe applications. With PEX, however, the in-service temperature is at least 180°F (82°C) and sometimes as high as 200°F (93°C)[1]. PEX tubing is also tested to ensure that short-term exposure to a temperature of 210°F (99°C) at an internal pressure of 150 psig is also tolerated.

5.0 METHODS OF CROSSLINKING HDPE INTO PEX

Polyethylene can be crosslinked using several technologies or methods. All methods create links or bonds between the single chains of HDPE to form a three-dimensional molecular matrix. The number of links between the polyethylene molecules determines the crosslink density and is an important factor in determining the physical properties of the material.

The three most common methods of crosslinking polyethylene for pipe and tubing are:

5.1. Peroxide Method

This method employs organic peroxides that, when heated, generate reactive free radicals that splice HDPE chains together during extrusion. This is sometimes referred to as the *PEX-a Process*.

5.2. Silane Method

This method involves grafting a reactive silane molecule to the backbone of the polyethylene. This is sometimes referred to as the *PEX-b Process*.

5.3. Electron Beam Method

This method involves subjecting the extruded HDPE pipe to a dose of high-energy electrons. This is sometimes referred to as the *PEX-c Process*.

NOTE 1: These letter designations are not related to any type of performance rating system. PEX pipe and tubing produced by each of the three methods must meet the same technical requirements as specified in the relevant PEX standards (e.g., ASTM F876, ASTM F2788, CSA B137.5).

Other crosslinking methods are also in commercial use. Although each method of crosslinking may produce slightly different pipe characteristics, all PEX pipe and tubing is required to meet or exceed the minimum requirements of the standard/s to which the product is listed.

[1] *See PPI TN-52 Guide to High-temperature Applications of Non-Potable PEX Pipe and Tubing Systems*

6.0 TYPICAL CONFIGURATIONS OF PEX TUBING OR PIPING SYSTEMS

PEX pipe and tubing are commonly manufactured and supplied in both coils and straight lengths. It is more typical for smaller diameter products (i.e., less than 1 inch nominal) to be supplied in coils, while larger diameter products (i.e., 1 inch nominal and greater) are typically supplied in straight lengths of various lengths, per the customer preference.

In the PEX industry, “tubing” typically refers to PEX products where the actual outside diameter (OD) is 1/8 inch (0.125”) larger than the nominal size, the same as copper tube sizes (CTS) – see ASTM F876 and CSA B137.5.

“Pipe” typically refers to PEX products where the actual OD matches the that of steel pipe of the same nominal size, otherwise known as Iron Pipe Sizing (e.g., 4 inch IPS), or products in which the actual OD matches the nominal size directly (e.g., 63 mm) – see ASTM F2788 and F2968. In both cases, specified tolerances apply, as per relevant standards.

6.1. PEX Tubing

PEX tubing is available in nominal tubing sizes from 1/4 to 4 inch. The wall thickness is based upon standard dimensional ratio (SDR) 9 values, which yield standard hydrostatic pressure ratings of 160 psi at 73°F (1105 kPa at 23°C) and 100 psi at 180°F (690 kPa at 82°C). Additionally, some PEX tubing products are rated for operation of 80 psi at 200°F (550 kPa at 93°C)[1]. Consult the specific PEX manufacturer’s literature and listings for appropriate pressure ratings. PEX tubing is sold in coils and straight lengths.

PEX tubing products are approved in plumbing and mechanical building codes for applications such as hot- and cold-water distribution, radiant floor heating, snow & ice melting, water service lines, and fire protection (i.e., residential sprinklers).

A wide selection of fittings constructed of metal or polymer is available for PEX tubing. PEX fittings are also subject to specific product specifications and standardized test requirements. See Section 13.0 of this document.

6.2. PEX Pipe

PEX pipe is available in metric pipe sizes of DN 16 to DN 1000 (approximate outside diameters of 16 mm to 1005 mm) and inch pipe sizes NPS 3 to NPS 54 (approximate outside diameters of 3.5 in. to 54 in.). Several standard dimensional ratio (SDR) values apply to PEX pipe, controlling the wall thickness.

6.3. Coatings and Barriers

Some PEX tubing and pipes are available with specific coatings or barriers for specific purposes, such as resistance to oxygen diffusion, ultraviolet (UV) resistance, color-coding, etc. The specific performance of these coatings or barriers should be discussed with the PEX manufacturer to ensure the correct PEX material is used for the application.

NOTE 2: Consult model, national, and local codes (or "applicable local codes") and the authority having jurisdiction (AHJ) when selecting the type of PEX pipe or tubing and components for specific applications. Also, consult the PEX manufacturer for specific approvals, recommendations, and limitations.

7.0 TYPICAL APPLICATIONS FOR PEX TUBING AND PIPE

7.1. PEX tubing is typically used in the following applications:

- Potable water service pipes
- Residential potable cold- and hot-water distribution systems,
- Commercial potable cold- and hot-water distribution systems
- Residential (i.e., NFPA 13D) fire protection systems
- Hydronic distribution piping (hot and cold water for space conditioning)
- Hydronic radiant heating and cooling, using warm or chilled fluids
- Outdoor snow and ice melting
- Outdoor turf conditioning
- Ice rink surface piping and subsurface heating
- Freezer-slab protection (keeping subfloors below freezer slabs from freezing)
- Warm- and hot-water radiator connection piping
- Hot-water baseboard convector piping
- Chilled water piping
- District heating and cooling pipelines
- Geothermal ground loop heat exchangers
- Building services piping
- Compressed air distribution
- Specialized industrial and mining applications

NOTE 3: PEX is typically *not* used for refrigerant line piping or medical gas applications.

7.2. PEX pipe is typically used in the following applications:

- Potable water pipes (underground)
- Natural gas distribution (underground)
- Oil and gas gathering
- Chilled water piping
- District heating and cooling pipelines
- Compressed air distribution
- Specialized industrial and mining applications

PEX is a unique material that provides many opportunities for new applications.

Please discuss your application with any PEX manufacturer to determine if PEX is the material of choice for the specific application.

8.0 THE ADVANTAGES OF PEX SYSTEMS

For potable water applications, PEX plumbing systems offer the following advantages over competing materials as documented in the ***"Design Guide for Residential PEX Water Supply Plumbing Systems"*** published by PPI, PPFA, and the Home Innovation Research Lab (please refer to that "Guide" for additional details):

- Safety of potable water and long-term reliability
- Resistant to corrosion and deposits (i.e., no mineral build-up)
- Resistant to common disinfectants (e.g., chlorine and chloramines)
  - See PPI TN-53 and PPI Statement A
- No flame used for joining; compression-style fittings
- Speed and ease of installation with professional appearance
- Cost effectiveness, lower installed cost than metal piping materials
- Energy efficiency through reduced heat transfer
  - See PPI TR-48
- Elevated temperature capability
- Long-term hydrostatic strength stability
- Erosion resistance
  - See PPI TN-26
- Durability and toughness
- Flexibility, even at cold temperatures
- Resistance to freeze-break damage
  - See PPI TR-52
- Resistance to most chemicals found on construction sites
- Noise and water hammer resistance (pressure surge absorption)
- Light weight, easy to transport

For other applications, these same advantages apply for PEX systems.

Additional distinct advantages may be found in other applications, depending on the traditional material used as the basis for comparison.

9.0 SUSTAINABILITY

PEX pipe and tubing systems are considered to be more sustainable solutions for piping systems than traditional metal materials, for multiple reasons:

- No mining operations for the ore
- Lower cost to the environment for production
- Low energy cost to produce PEX as compared with copper
- Smooth wall, excellent flow characteristics reduce pumping costs
- Proven long life and durability provides value
- Light weight of PEX reduces transportation costs
- Flexibility can dampen water hammer, reducing pressure spikes
- PEX does not add minerals to drinking water
- PEX systems protect health and safety

10.0 CODE ACCEPTANCE OF PEX SYSTEMS

PEX plumbing systems are approved by all major building codes, including (but not limited to) the: *International Residential Code, International Plumbing Code, National Standard Plumbing Code, Uniform Plumbing Code,* and the *National Plumbing Code of Canada*.

PEX heating/cooling systems are approved by the *International Residential Code, International Mechanical Code, Uniform Mechanical Code, Uniform Solar, Hydronic, and Geothermal Code,* and by CSA B214 *Installation Code for Hydronic Heating Systems* (Canada).

PEX systems are also recognized by certain codes for water service lines, chilled water piping, geothermal heat exchangers and more, with specific requirements. An example of other codes includes ASME B31.9 *Building Services Piping*.

NOTE 4: Consult local codes when selecting the type of PEX pipe or tubing and components for specific applications. Also consult the PEX manufacturer for specific approvals, recommendations, and limitations.

11.0 PEX MATERIAL DESIGNATION CODES

Unlike thermoplastic PE material designation codes, the first two digits of the PEX material designation code are not used to describe its short-term properties. Instead:

- **The first digit** of the PEX material designation code is for chlorine resistance when tested in accordance with ASTM F2023 and evaluated in accordance with ASTM F876 (tubing) or F2788 (pipe):
    - A digit “1” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 25% of the time at 140°F (60°C) and 75% of the time at 73°F (23°C).
    - A digit “3” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 50% of the time at 140°F (60°C) and 50% of the time at 73°F (23°C).
    - A digit “5” indicates the PEX tubing has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 100% of the time at 140°F (60°C).
    - A digit “0” indicates it does not meet this requirement or it has not been tested.

- **The second digit** of the PEX material designation code is used to indicate the level of UV resistance for the PEX material when tested in accordance with ASTM F2657 and evaluated in accordance with ASTM F876:
    - A digit “1” indicates the PEX tubing has been tested and meets the F876 requirement for minimum UV resistance of 1 month.
    - A digit “2” indicates the PEX tubing has been tested and meets the F876 requirement for minimum UV resistance of 3 months.

- A digit “3” indicates the PEX tubing has been tested and meets the F876 requirement for minimum UV resistance of 6 months.
- A digit “0” indicates it does not meet any minimum UV resistance requirement or it has not been tested.

- **The last two digits** of the PEX material designation code represent the PPI recommended Hydrostatic Design Stress at 73°F (23°C) divided by one hundred. PEX pipe and tubing materials use a Design Factor of 0.5.

An example of this pipe material designation code is as follows:

- **PEX 1106** is a crosslinked polyethylene (the PEX abbreviation is in accordance with ASTM D1600)
  - The first digit of “**1**” indicates that this material has been tested and meets the F876 requirement for minimum chlorine resistance at the end use condition of 25% of the time at 140°F (60°C) and 75% of the time at 73°F (23°C).
  - The second digit of “**1**” indicates that this material has been tested and meets the F876 requirement for minimum UV resistance of 1 month.
  - The third and fourth digits of “**06**” indicates that this material has a 630 psi maximum recommended HDS (0.5 design factor) at 73°F (23°C).

12.0 TECHNICAL QUALIFICATION REQUIREMENTS FOR PEX

In order to qualify a PEX tubing or piping product for commercial market use, a manufacturer’s piping system must be evaluated and approved to one or more of the following industry standards, depending on the application and the jurisdiction:

- API Spec 15PX - *Specification for Crosslinked Polyethylene (PEX) Line Pipe*
- ASTM F876 - *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*
- ASTM F877 - *Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems*
- ASTM F2023 – *Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Pipe, Tubing and Systems to Hot Chlorinated Water*
- ASTM F2657 - *Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing*
- ASTM F2788 – *Standard Specification for Metric- and Inch-sized Crosslinked Polyethylene (PEX) Pipe*
- ASTM F2829 - *Standard Specification for Metric- and Inch-Sized Crosslinked Polyethylene (PEX) Pipe Systems*
- ASTM F2968 - *Standard Specification for Crosslinked Polyethylene (PEX) Pipe for Gas Distribution Applications*
- AWWA C904 *Crosslinked Polyethylene (PEX) Pressure Tubing, ½ in. Through 3 in. for Water Service*
- CSA B137.5 - *Crosslinked Polyethylene Tubing Systems for Pressure Applications*
- NSF/ANSI 14 – *Plastics Piping System Components and Related Materials* (for both potable water and radiant floor heating applications)

- NSF/ANSI/CAN 61 - *Drinking Water System Components - Health Effects* (for potable water applications only)
- NSF/ANSI 372 - *Drinking Water System Components – Lead Content*
- 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*

The text in sections 12.1 through 12.14 explains these referenced technical standards using the abstracts and summaries of those standards as published by API, ASTM, AWWA, CSA, NSF, and PPI, respectively, with permissions as shown. The content below is used with permission of each of the publishing organizations and is subject to change.

12.1. API Spec 15PX *Specification for Crosslinked Polyethylene (PEX) Line Pipe*

This specification covers PEX line pipe utilized for the production and transportation of oil, gas, and non-potable 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.

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

This specification covers crosslinked polyethylene (PEX) tubing that incorporates an optional polymeric inner, middle or outer layer and that is outside diameter controlled, made in nominal SDR9 tubing dimension ratios except where noted, and pressure rated for water at three temperatures (see Appendix 1). Included are requirements and test methods for material, workmanship, dimensions; burst pressure, hydrostatic sustained pressure, excessive temperature and pressure, environmental stress cracking, stabilizer functionality, bent tube hydrostatic pressure, oxidative stability in potable chlorinated water, UV resistance, and degree of crosslinking.

The components covered by this specification are intended for use in, but not limited to, residential and commercial, hot- and cold-potable water distribution systems, reclaimed water, fire protection, municipal water service lines, radiant heating and cooling systems, hydronic distribution systems, snow and ice melting systems, geothermal ground loops, district heating, turf conditioning, compressed air distribution and building services pipe, provided that the PEX tubing covered herein complies with applicable code requirements.

12.3. ASTM F877 *Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems*

This specification covers requirements, test methods, and marking requirements for system components when tested with nominal SDR9 crosslinked polyethylene tubing as a system. Systems are intended for 100 psi (0.69 MPa) water service up to and including a maximum working temperature of 180°F (82°C). Requirements and test methods are included for materials, workmanship, dimensions and tolerances, burst pressure, hydrostatic sustained pressure, excessive temperature and pressure, corrosion resistance, and thermocycling tests. The components covered by this specification are intended for use in, but not limited to, residential and commercial hot and cold potable water distribution systems or other applications such as reclaimed water, fire protection, municipal water service lines, radiant heating and cooling systems, hydronic distribution systems, snow and ice melting systems, geothermal ground loops, district heating, turn conditioning, compressor air distribution, and building services pipe.

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

This test method describes the general requirements for evaluating the long-term, chlorinated water, oxidative resistance of cross-linked polyethylene (PEX) pipe or tubing produced in accordance with PEX specifications, such as Specification F876 or Specification F2788/F2788M by exposure to hot, chlorinated water. This test method outlines the requirements of a pressurized flow-through test system, typical test pressures, test-fluid characteristics, failure type, and data analysis. The oxidizing potential of the test-fluid specified in this test method exceeds that typically found in potable water systems across the United States.

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NOTE 5: Other known disinfecting systems (e.g. chlorine dioxide, ozone, and chloramines) are currently used for protection of potable water; however, free chlorine is the most common system in use today. Chloramines have been tested in comparison to free chlorine by PPI utilizing ASTM Test Method F2023 and found to be significantly less aggressive to PEX tubing. See PPI Statement A for more details. Disinfecting systems other than chlorine and chloramines have not been evaluated by this method.

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

This test method describes the procedure for exposing crosslinked polyethylene (PEX) tubing produced in accordance with Specification F876 to natural (sunlight) ultraviolet (UV) radiation and evaluating the effects of the exposure. This test method outlines the requirements for specimen size and preparation, exposure orientation, minimum UV exposure energy, post exposure testing and reporting.

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12.6. ASTM F2788 *Standard Specification for Metric- and Inch-sized Crosslinked Polyethylene (PEX) Pipe*

This specification covers crosslinked polyethylene (PEX) pipe that is outside diameter controlled in metric pipe sizes of DN 16 to DN 1000 (approximate outside diameters of 16 mm to 1005 mm) and inch pipe sizes NPS 3 to NPS 54 (approximate outside diameters of 3.5 in. to 54 in.), made in nominal pipe dimension ratios, and pressure rated for water at three temperatures (see Appendix X1). Included are requirements and test methods for material, workmanship, dimensions, burst pressure, hydrostatic sustained pressure, excessive temperature- pressure, environmental stress cracking, stabilizer functionality, bent-pipe hydrostatic pressure, oxidative stability in potable chlorinated water, degree of crosslinking, and minimum operating temperature. Requirements for pipe markings are also given. The pipe covered by this specification is intended for pressure applications, such as, industrial and general-purpose pipelines, potable water pipelines, and fire–extinguishing pipelines.

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12.7. ASTM *F2829 Standard Specification for Metric- and Inch-Sized Crosslinked Polyethylene (PEX) Pipe Systems*

This specification covers performance requirements, test methods, and marking requirements for metric- and inch-sized fittings for use with Specification F2788/F2788M, F2905/F2905M, and F2968/F2968M PEX pipe. The following performance requirements are described for the fittings – 73°F (23°C) hydrostatic strength, 176°F (80°C) hydrostatic strength, short-term internal pressure resistance, resistance to tensile loads, cohesive resistance for electrofusion fittings at both the minimum and maximum recommended temperatures, impact resistance for saddle fittings, and leak tightness and pull out tests for mechanical fittings. The metric- and inch-sized components covered by this specification are intended for the above-ground and buried pressure piping applications, such as

industrial and general-purpose pipelines, potable water pipelines up to 140 °F [60 °C], and fire–extinguishing pipelines.

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12.8. ASTM F2968 *Standard Specification for Crosslinked Polyethylene (PEX) Pipe for Gas Distribution Applications*

This specification covers outside diameter controlled, metric-sized and inch-sized black or yellow crosslinked polyethylene (PEX) pipe, made in pipe dimension ratios ranging from 6 to 17, and pressure rated for gas distribution. 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, minimum operating temperature and squeeze-off. Requirements for pipe markings are also given. The pipe covered by this specification is intended for buried gas distribution and gas transmission pressure piping applications.

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12.9. AWWA C904 *Crosslinked Polyethylene (PEX) Pressure Pipe, ½ in. Through 3 in. for Water Service*

This standard describes crosslinked polyethylene (PEX) pressure tubing made from material having a standard PEX material designation code of PEX 1306, or higher, according to ASTM F876 and intended for use as underground potable water, reclaimed water, and wastewater service lines in sizes ½ in. through 3 in. that conform to a standard dimension ratio of SDR9. Tubing may include an optional polymeric outer layer. Included in this standard are criteria for classifying PEX plastic tubing materials, and a system of nomenclature, requirements, and test methods for materials and tubing. Methods of markings are given.

12.10. CSA B137.5 *Crosslinked Polyethylene Tubing Systems for Pressure Applications*

This Standard specifies requirements for crosslinked polyethylene (PEX) tubing systems that comprise tubing and fittings. Tubing covered by this Standard is made in Standard Dimensional Ratio 9 (SDR 9). Systems are pressure rated at three temperatures: 1105 kPa at 23°C, 690 kPa at 82°C, and 550 kPa at 93°C, with a maximum working pressure of 690 kPa at 82°C. Systems are intended for use in potable water distribution systems or other applications, including municipal water service lines, reclaimed water distribution, radiant panel heating and cooling systems, hydronic baseboard heating systems, snow and ice melting heating systems, building services piping, compressed air distribution, and ground source geothermal systems, provided that the PEX tubing systems

covered herein comply with the applicable code requirements. Residential and commercial systems are included.

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12.11. 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*

This technical report presents the policies and procedures used by the HSB (Hydrostatic Stress Board) of the PPI (Plastics Pipe Institute) to develop recommendations of estimated long-term hydrostatic strength for commercial thermoplastic piping materials. Recommendations are published in PPI technical report TR-4 *PPI Listing of Hydrostatic Design Basis, and Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe.*

Listings are developed from data submitted to the HSB by the manufacturer. These data are obtained according to the basic method outlined in ASTM D1598, “Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.” The general method used to evaluate the data is described in ASTM D2837, “Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials,” with additional requirements as specified in PPI TR-3.

TR-3 and TR-4 also provide the recommended pipe material designation codes for PEX materials. See Section 11.0 for details on PEX Material Designation Codes.

12.12. NSF/ANSI 14 *Plastics Piping System Components and Related Materials*

This standard establishes minimum physical, performance, quality assurance, marking, and record keeping requirements for plastic piping components and related materials.

Extracted, with permission, from NSF/ANSI 14 Plastics Piping System Components and Related Materials*, copyright NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105. A copy of the complete standard may be purchased from NSF International, www.nsf.org*

12.13. NSF/ANSI/CAN 61 *Drinking Water System Components - Health Effects*

This standard is intended to cover specific materials or products that come into contact with drinking water, drinking water treatment chemicals, or both. The primary focus of the standard is on contaminants or impurities imparted indirectly to drinking water.

PEX tubing used in the transport of potable water must be marked “POTABLE” or have the seal of a lab that has evaluated the tubing against the requirements of NSF/ANSI/CAN Standard 61.

Extracted, with permission, from NSF/ANSI/CAN 61 Drinking Water System Components - Health Effects*, copyright NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105. A copy of the complete standard may be purchased from NSF International, www.nsf.org*

12.14. NSF/ANSI 372 *Drinking Water System Components – Lead Content*

This standard establishes procedures for the determination of lead content based on the wetted area of products. This standard applies to any drinking water system component that conveys or dispenses water for human consumption through drinking or cooking.

Extracted, with permission, from NSF/ANSI 372 Drinking Water System Components – *Lead Content, copyright NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105. A copy of the complete standard may be purchased from NSF International, www.nsf.org*

13.0 PEX FITTINGS

Several PEX tubing manufacturers have developed a unique fitting system, but each of these joining technologies must deliver the same minimum performance as specified in PEX system standards ASTM F877 and CSA B137.5. Many of these fitting systems are also described in their own ASTM standard specifications, covering everything from acceptable materials and dimensions to assembly procedures and performance testing.

The method of connection should comply with the tubing manufacturer’s recommendations and instructions. Fittings are regulated to comply with performance and material criteria from recognized standards. They should be marked by a certified third-party agency such as CSA, IAPMO, ICC, NSF, UL, or other third-party testing and listing agency.

It is the responsibility of each PEX tubing manufacturer to test and certify their tubing with each of the fitting systems that they chose to recommend for use with their tubing, when tested as a system according to the standard ASTM F877 or CSA B137.5. Then, the tubing manufacturer indicates the certified fitting system/s that they recommend for use with their tubing on the print line (markings). Not every PEX tubing manufacturer allows their tubing to be used with every fitting. Consult your tubing manufacturer for acceptable methods.

PEX fitting product standards include, but are not limited to:

- ASSE Standard 1061 *Performance Requirements for Push-Fit Fittings*
- ASTM F877 *Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems*
- ASTM F1055 *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*
- ASTM F1807 *Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*
- ASTM F1960 *Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*
- ASTM F2080 *Standard Specification for Cold-Expansion Fittings With Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe*
- ASTM F2159 *Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*
- ASTM F2434 *Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Crosslinked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Tubing*
- ASTM F3347 *Standard Specification for Metal Press Insert Fittings With Factory Assembled Stainless Steel Press Sleeve For SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*
- ASTM F3348 *Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*

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