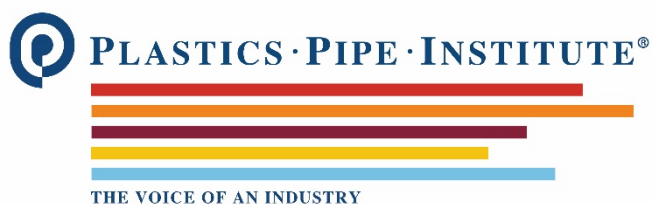


GUIDE TO HIGH-TEMPERATURE APPLICATIONS OF NON-POTABLE PEX PIPE AND TUBING SYSTEMS

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Foreword

GUIDE TO HIGH-TEMPERATURE APPLICATIONS OF NON-POTABLE PEX PIPE AND TUBING SYSTEMS

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 have shown their commitment to developing and improving quality products by assisting standards development 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 information to the end user regarding the additional evaluation that is required for PEX pipes to show its suitability for an anticipated lifetime in specific high-temperature applications.

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1.0 SCOPE

The intent of this Technical Note is to give guidance to the end user for determining appropriate design life calculations of crosslinked polyethylene (PEX) pipe and tubing in high-temperature applications, defined as operating temperatures above 180°F (82°C) for the purpose of this document. Not all PEX manufacturers allow operating conditions above 180°F for their tubing. Applications with such high-temperature exposures may include commercial hydronic distribution systems such as high-temperature radiator/baseboard piping, district heating piping, and certain types of waste heat systems.

The **Background** information in this Technical Note is provided to explain how PEX pipe and tubing, conforming to standards such as ASTM F876, ASTM F2788 and CSA B137.5, are suitable for typical applications such as hydronic radiant heating/cooling, hydronic distribution, snow and ice melting, and geothermal ground heat exchangers at operating temperatures up to and including 180°F.

Note 1: For PEX materials, “tubing” refers to products whereby the actual outside diameter (OD) is 1/8 inch larger than the nominal size and is described as copper tube size (CTS). Product standards ASTM F876 and CSA B137.5 apply to PEX tubing. “Pipe” refers to products whereby the actual OD matches that of steel pipe of the same nominal size and is described as iron pipe size (IPS), or products where the actual OD matches the nominal size. ASTM F2788 applies to PEX pipe. The terms “pipe” and “piping”, as well as “tube” and “tubing”, are used interchangeably in this document.

Note 2: See PPI TN-53 GUIDE TO CHLORINE RESISTANCE RATINGS OF PEX PIPES AND TUBING FOR POTABLE WATER APPLICATIONS for more information on the use of PEX tubing in hot chlorinated potable water applications.

2.0 BACKGROUND

It is a basic requirement for most plastic pressure pipes¹ to undergo a hydrostatic pressure test or tests to prove their long-term hydrostatic strength (LTHS) at various temperatures. “Hydrostatic” simply means constant water pressure inside a pipe or tubing. Hydrostatic testing involves testing multiple pipe specimens to ductile failure at various temperatures and pressures; when a data-set of failure times at multiple temperatures and pressures is collected, a ductile failure curve is plotted and evaluated mathematically. This provides a method to predict pipe endurance at the specific operating pressures for each temperature.

¹ The alternative to a long-term hydrostatic strength (LTHS) test is a long-term hydrostatic pressure strength (LTHS_p) test, usually applied to multi-layer or composite piping products.

Procedures for conducting long-term hydrostatic testing and evaluating the results were originally developed by PPI's Hydrostatic Stress Board (HSB) many decades ago. Today, these procedures are trusted to predict the long-term hydrostatic capabilities of crosslinked polyethylene (PEX) tubing, which achieves pressure ratings at various temperatures through extensive hydrostatic strength testing in accordance with the governing standards and policies such as ASTM D2837 and PPI TR-3.

The long-term hydrostatic strength of a specific PEX tubing is independent of any outside environmental factors which could cause tubing degradation or failure. Examples of environmental factors are oxidation of the tubing from excessive exposure to hot chlorinated water, excessive UV exposure or excessive thermal degradation. In North America, PEX tubing is required to establish its resistance to each type of oxidation through standardized testing and evaluation using test methods such as ASTM F2023 for hot chlorinated water oxidation, ASTM F2657 for UV exposure oxidation and mandatory requirements within ASTM F876 and ASTM F2788 for resistance to long-term high-temperature conditions.

This Technical Note will describe each of these test methods and evaluation techniques.

2.1 Evaluation Methods for Long-term Hydrostatic Strength (LTHS)

ASTM Test Method D2837 *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products* (originally published 1969) contains a procedure for obtaining a long-term hydrostatic strength category based on stress, referred to herein as the hydrostatic design basis (HDB). According to D2837, "The HDB is a material property and is obtained by evaluating stress rupture data derived from testing pipe made from the subject material." "The LTHS is determined by analyzing stress versus time-to-rupture (that is, stress-rupture) test data that cover a testing period of not less than 10,000 hours and that are derived from sustained pressure testing of pipe made from the subject material. The data are analyzed by linear regression to yield a best-fit log-stress versus log time-to-fail straight-line equation."

This method utilizes tubing specimens tested at constant temperatures (e.g. 73 °F, 180°F, 200°F [23°C, 82°C, 93°C]) with the linear log stress—log time regression line extrapolated to 100,000 hours (11 years). This extrapolated value is called the long-term hydrostatic strength (LTHS) and the categorized value of the LTHS is called the Hydrostatic Design Basis (HDB).

When data is analyzed and approved by the PPI's Hydrostatic Stress Board, these HDB values are published in 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*, which is available at www.plasticpipe.org. The hydrostatic design stress (HDS) is the product of the HDB and the design factor for water.