



Designation: D2837 – 22

Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products¹

This standard is issued under the fixed designation D2837; 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 test method describes two essentially equivalent procedures: one for obtaining a long-term hydrostatic strength category based on stress, referred to herein as the hydrostatic design basis (HDB); and the other for obtaining a long-term hydrostatic strength category based on pressure, referred to herein as the pressure design basis (PDB). The HDB is based on the material's long-term hydrostatic strength (LTHS), and the PDB is based on the product's long-term hydrostatic pressure-strength (LTHS_p). The HDB is a material property and is obtained by evaluating stress rupture data derived from testing pipe made from the subject material. The PDB is a product specific property that reflects not only the properties of the material(s) from which the product is made, but also the influence on product strength by product design, geometry, and dimensions and by the specific method of manufacture. The PDB is obtained by evaluating pressure rupture data. 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 h 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. Using this equation, the material's mean strength at the 100 000-h intercept (LTHS) is determined by extrapolation. The resultant value of the LTHS determines the HDB strength category to which the material is assigned. The LTHS_p is similarly determined except that the determination is based on pressure versus time data that are derived from a particular product. The categorized value of the LTHS_p is the PDB. An HDB/PDB is one of a series of preferred long-term strength values. This test method is applicable to all known types of thermoplastic pipe materials and thermoplastic piping products. It is also applicable for any practical temperature and medium that yields

stress-rupture data that exhibit an essentially straight-line relationship when plotted on log stress (pound-force per square inch) or log pressure (pound-force per square in. gage) versus log time-to-fail (hours) coordinates, and for which this straight-line relationship is expected to continue uninterrupted through at least 100 000 h.

1.2 Unless the experimentally obtained data approximate a straight line, when calculated using log-log coordinates, it is not possible to assign an HDB/PDB to the material. Data that exhibit high scatter or a “knee” (a downward shift, resulting in a subsequently steeper stress-rupture slope than indicated by the earlier data) but which meet the requirements of this test method tend to give a lower forecast of LTHS/LTHS_p. In the case of data that exhibit excessive scatter or a pronounced “knee,” the lower confidence limit requirements of this test method are not met and the data are classified as unsuitable for analysis.

1.3 A fundamental premise of this test method is that when the experimental data define a straight-line relationship in accordance with this test method's requirements, this straight line may be assumed to continue beyond the experimental period, through at least 100 000 h (the time intercept at which the material's LTHS/LTHS_p is determined). In the case of polyethylene piping materials, this test method includes a supplemental requirement for the “validating” of this assumption. No such validation requirements are included for other materials (see [Note 1](#)). Therefore, in all these other cases, it is up to the user of this test method to determine based on outside information whether this test method is satisfactory for the forecasting of a material's LTHS/LTHS_p for each particular combination of internal/external environments and temperature.

NOTE 1—Extensive long-term data that have been obtained on commercial pressure pipe grades of polyvinyl chloride (PVC), polybutylene (PB), and cross linked polyethylene (PEX) materials have shown that this assumption is appropriate for the establishing of HDB's for these materials for water and for ambient temperatures. Refer to [Note 2](#) and [Appendix X1](#) for additional information.

1.4 The experimental procedure to obtain individual data points shall be as described in Test Method [D1598](#), which forms a part of this test method. When any part of this test

¹ This test method is under the jurisdiction of ASTM Committee [F17](#) on Plastic Piping Systems and is the direct responsibility of Subcommittee [F17.40](#) on Test Methods.

Current edition approved March 15, 2022. Published April 2022. Originally approved in 1969. Last previous edition approved in 2021 as D2837 – 21. DOI: 10.1520/D2837-22.

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

method is not in agreement with Test Method D1598, the provisions of this test method shall prevail.

1.5 General references are included at the end of this test method.

1.6 *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.*

1.7 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only and are not considered the standard.

NOTE 2—Over 3000 sets of data, obtained with thermoplastic pipe and piping assemblies tested with water, natural gas, and compressed air, have been analyzed by the Plastic Pipe Institute's (PPI) Hydrostatic Stress Board². None of the currently commercially offered compounds included in 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" exhibit knee-type plots at the listed temperature, that is, deviate from a straight line in such a manner that a marked drop occurs in stress at some time when plotted on equiscalar log-log coordinates. Ambient temperature stress-rupture data that have been obtained on a number of the listed materials and that extend for test periods over 120 000 h give no indication of "knees." However, stress-rupture data which have been obtained on some thermoplastic compounds that are not suitable or recommended for piping compounds have been found to exhibit a downward trend at 23 °C (73 °F) in which the departure from linearity appears prior to this test method's minimum testing period of 10 000 h. In these cases, very low results are obtained or the data are found unsuitable for extrapolation when they are analyzed by this test method.

Extensive evaluation of stress-rupture data by PPI and others has also indicated that in the case of some materials and under certain test conditions, generally at higher test temperatures, a departure from linearity, or "down-turn", may occur beyond this test method's minimum required data collection period of 10 000 h. A PPI study has shown that in the case of polyethylene piping materials that are projected to exhibit a "down-turn" prior to 100 000 h at 73 °F, the long-term field performance of these materials is prone to more problems than in the case of materials which have a projected "down-turn" that lies beyond the 100 000-h intercept. In response to these observations, a supplemental "validation" requirement for PE materials has been added to this test method in 1988. This requirement is designed to reject the use of this test method for the estimating of the long-term strength of any PE material for which supplemental elevated temperature testing fails to validate this test method's inherent assumption of continuing straight-line stress-rupture behavior through at least 100 000 h at 23 °C (73 °F).

When applying this test method to other materials, appropriate consideration should be given to the possibility that for the particular grade of material under evaluation and for the specific conditions of testing, particularly, when higher test temperatures and aggressive environments are involved, there may occur a substantial "down-turn" at some point beyond the data collection period. The ignoring of this possibility may lead to an overstatement by this test method of a material's actual LTHS/LTHS_p. To obtain sufficient assurance that this test method's inherent assumption of continuing linearity through at least 100 000 h is appropriate, the user should consult and consider information outside this test method, including very long-term testing or extensive field experience with similar materials. In cases for which there is insufficient assurance of the continuance of the straight-line behavior that is defined by the experimental data, the use of other test methods for the forecasting of long-term strength should be considered (see Appendix X1).

1.8 *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:³

D1243 Test Method for Dilute Solution Viscosity of Vinyl Chloride Polymers

D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 ISO Standard:

ISO 9080 Plastic Piping and Ducting Systems, Determination of Long-Term Hydrostatic Strength of Thermoplastics Materials in Pipe Form by Extrapolation⁴

2.3 Plastics Pipe Institute:²

PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), 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), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe

3. Terminology

3.1 Definitions:

3.1.1 *failure, n*—bursting, cracking, splitting, or weeping (seepage of liquid) of the pipe during test.

3.1.2 *hoop stress, n*—the tensile stress in the wall of the pipe in the circumferential orientation due to internal hydrostatic pressure.

3.1.3 *hydrostatic design basis (HDB), n*—one of a series of established stress values for a compound. It is obtained by categorizing the LTHS in accordance with Table 1.

3.1.4 *hydrostatic design stress (HDS), n*—the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied.

3.1.5 *long-term hydrostatic strength (LTHS), n*—the estimated tensile stress in the wall of the pipe in the circumferential orientation that when applied continuously will cause failure of the pipe at 100 000 h. This is the intercept of the stress regression line with the 100 000-h coordinate.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

² Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.