Designation: D1599 – 18

Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings[1]

This standard is issued under the fixed designation D1599; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the resistance of thermoplastic pipe, tubing and fittings, and reinforced thermosetting pipe and reinforced thermoplastic pipe to hydraulic pressure in a short time period. Procedure A is used to determine burst pressure of a specimen if the mode of failure is to be determined. Procedure B is used to determine that a specimen complies with a minimum burst requirement.

NOTE 1—Reinforced thermoplastic pipe is a three-layer construction consisting of a thermoplastic core layer around which is wound a continuous helical reinforcement layer. A protective thermoplastic cover layer is applied over the reinforcement. For design and pressure, the thermoplastic core and cover layers are not considered hoop stress bearing elements. All of the hoop stress is taken up by the reinforcement layer.

1.2 This test method is suitable for establishing laboratory testing requirements for quality control purposes or for procurement specifications.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *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.*

1.5 *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]

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D3517 Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe

D3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

3. Summary of Test Method

3.1 This test method consists of loading a specimen to failure, or a predetermined minimum level, in short-time interval by means of continuously increasing internal hydraulic-pressure while immersed in a controlled-temperature environment.

4. Significance and Use

4.1 This test method establishes the short term hydraulic failure pressure of thermoplastic pipe, tubing and fittings, and reinforced thermosetting pipe, and reinforced thermoplastic pipe. Data obtained by this test method are of use only in predicting the behavior of pipe, tubing, and fittings under conditions of temperature, time, method of loading, and hoop stress similar to those used in the actual test. They are generally not indicative of the long-term strength of thermoplastic or reinforced thermosetting resin pipe, tubing, and fittings, and reinforced thermoplastic pipe.

4.2 Procurement specifications utilizing this test method may stipulate a minimum and maximum time for failure other than the 60 to 70 s listed in 9.1.3. Either the internal hydraulic pressure or the hoop stress may be listed in the requirements.

NOTE 2—Many thermoplastics give significantly different burst strengths depending on the time to failure. For instance, significant differences have been observed between failure times of 65 and 85 s.

[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.

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[2] 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.

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

4.3 This test method is also used as a short-term pressurization validation procedure, where the specimens are pressurized to a predetermined minimum pressure requirement.

5. Failure

5.1 Any instantaneous or rapid loss of pressure shall constitute failure.

5.2 Any visible passage of fluid through the wall of the specimen shall constitute failure.

5.3 Any loss of pressure that interrupts the continuous and uniform pressure increase, described in 9.1.3, shall constitute failure.

5.4 Leakage at the end closure or fracture of the specimen in the immediate vicinity of the end closure shall be considered as an invalid test item, not a failure.

6. Apparatus

6.1 *Constant-Temperature Bath*—A water bath or other fluid bath equipped so that uniform temperature is maintained throughout the bath. This may require agitation. If an air or other gaseous environment is used, provisions shall be made for adequate circulation. Unless otherwise stated, the tests shall be conducted at 73± 3.6 °F (23 ± 2 °C). The tolerance on other test temperatures shall be 3.6 °F (± 2 °C). Fluid environments that chemically attack the specimens shall not be used unless this effect is being studied. In that case, the purpose of the test shall be included in the report.

NOTE 3—Reinforced thermosetting resin pipe and fittings may show increasing failure pressures as temperature is raised above 73.4 °F (23 °C) in this test.

6.2 *Pressurizing System*—A device capable of applying an essentially continuously increasing internal hydraulic pressure to the test specimen. Suggested equipment for this test may include the following:

6.2.1 *Nitrogen Supply (Cylinder Gas)* with a pressure regulator and hydraulic accumulator, or

6.2.1.1 *Pump,* capable of applying essentially continuously increasing internal hydraulic pressure to the test specimen.

6.3 *Pressure Indicating System:*

6.3.1 *Pressure Gauges*—When used, mechanical pressure gauges shall have a precision within 1 % of full-scale deflection with a maximum indicating hand.

6.3.2 *Pressure Transducers*—When used, pressure transducers shall have a precision with 1% of full-scale deflection. The system shall have the capability to save the maximum test pressure for retrival and display after the completion of the test.

6.3.3 The pressure indicating apparatus (gauge or pressure transducer) shall be located in the test system at a location such that it only indicates pressure on the specimen and does not indicate pressure built up by water flowing in the supply lines to the specimen.

NOTE 4—The pressure indicating apparatus (gauge or pressure transducer) should be equipped with a pressure surge protection device.

NOTE 5—When testing materials such as Polyolefins that change in volume greatly before rupture, a large diameter water supply line or location of the gauge on the specimen should be used to eliminate erroneous readings caused by the pressure drop in the water supply line.

6.4 *Timing Device*—Stop watch or equivalent.

6.5 *Specimen End Closures:*

6.5.1 *Pipe or Tubing*—Either free-end or restrained-end closures, that will withstand the maximum test pressures, may be used. Closures shall be designed so that they do not cause failure of the specimen. Free-end closures shall be used for referee tests.

NOTE 6—Free-end closures fasten to the specimen so that internal pressure produces longitudinal tensile stresses in addition to hoop and radial stresses in the pipe wall. Restrained-end closures rely on a rod through the specimen or an external structure to resist the end thrust. Stresses in the wall of restrained-end specimens act in the hoop and radial directions only. Because of this difference in loading, the expected hoop stress at failure in free-end specimens of solid-wall thermoplastic pipes are approximately 11 % lower than in restrained-end specimens. The test results will reflect this difference in test method.

6.5.2 *Fittings*—Caps and plugs for fittings shall not extend beyond the bottom thread or the bottom of the socket.

NOTE 7—For purposes of determining the ultimate rupture strength of fittings, a metal band not extending more than one third of the threaded or socket depth, may be used: When the mode of failure of a piping system is to be determined, no reinforcement shall be used.

7. Test Specimen

7.1 *Pipe or Tubing:*

7.1.1 *Specimen Size*—For pipe sizes of 6 in. (150 mm) or less, the specimen length between the end closures shall be not less than five times the outside diameter of the pipe, but in no case less than 12 in. (300 mm). For larger sizes, the minimum length shall be not less than three times the outside diameter, but in no case less than 30 in. (760 mm).

7.1.2 *Sample Size*—Unless otherwise specified five specimens shall be tested.

7.1.3 *Measurements*—Dimensions shall be determined in accordance with Test Method D2122 or Practice D3567.

7.2 *Fittings:*

7.2.1 *Specimen Size*—Specimens shall consist of complete fittings without alteration.

7.2.2 *Sample Size*—Unless otherwise specified five specimens shall be tested.

7.2.3 *Specimen Surface*—All surfaces of the specimens shall be free of visible flaws, scratches, or other imperfections, except for the usual marks common on good extrusions and molding, unless these imperfections are being investigated, in which case the purpose shall be included in the report along with a description of the imperfections.

7.3 *Systems (Pipe, Fittings, and Joints):*

7.3.1 Systems shall be prepared from pipe and fittings meeting the requirements of 7.1 and 7.2, unless otherwise specified.

7.3.2 The pipe and fittings shall be joined as recommended by the manufacturer using solvent cement, heat fusion, or other techniques. When solvent cements are used they shall meet the requirements of the relevant solvent cement specification.

8. Conditioning

8.1 Test specimens shall be conditioned at the test temperature for a minimum of 1 h in a liquid bath or 16 h in a gaseous

medium before pressurizing, unless otherwise specified. Unless otherwise agreed upon, the test temperature shall be 73 ± 3.6 °F (23 ± 2 °C) for thermoplastic pipe. For thermosets, test at 73 ± 3.6 °F (23 ± 2 °C) or at maximum rated temperature depending on intended service.

9. Procedure

9.1 *Procedure A:*

9.1.1 Attach the end closures to the specimen and fill it completely with test fluid which is maintained at the test temperature. Attach specimen to the pressuring device, making certain no gas is entrapped when using liquids. The specimen shall be completely immersed in the conditioning medium.

9.1.2 Condition the specimen as specified in 8.1.

9.1.3 Increase the pressure uniformly and continuously until the specimen fails, measuring the time with a stop watch. If failure time is less than 60 s, reduce the rate of loading and repeat the test. The time to failure for all specimens shall be between 60 and 70 s.

9.1.4 Record the pressure and time-to-failure.

NOTE 8—If additional data can be obtained by continued pressurization after failure (as defined in Section 5), it is the tester's prerogative to do so but is beyond the scope of this method.

9.2 *Procedure B:*

9.2.1 Prepare the test specimen in the same way as described in Procedure A (9.1.1 to 9.1.2).

9.2.2 Increase the pressure uniformly and continuously, measuring the time. To determine that the specimen complies with a minimum burst requirement the specimen shall burst between 60 and 70 s, or the minimum burst pressure shall be reached or exceeded between 60 and 70 s.

10. Calculation

10.1 Calculate the pipe hoop stress as follows:

$$S = P(D - t)/2t \text{ for outside diameter controlled pipe}$$

or

$$S = P(d + t)/2t \text{ for inside diameter controlled pipe}$$

where:

S = hoop stress, psi (or MPa),
P = internal pressure, psi (or MPa),
D = average outside diameter, in. (or mm). For reinforced thermosetting pipe, outside diameter shall not include nonreinforced covers,
d = average inside diameter, in. (or mm), and
t = minimum wall thickness, in. (or mm). For reinforced thermosetting pipe use minimum reinforced wall thickness.

NOTE 9—An alternative method for calculating the hoop stress of reinforced pipe is given in the Annex of Specification D3517.

11. Report

11.1 The report shall include the following:

11.1.1 Complete identification of the specimens, including material, manufacturer's name and code number, type, source, and previous history.

11.1.2 Procedure used, either A or B.

11.1.3 Pipe dimensions, including nominal size, minimum wall thickness, and average outside diameter. For reinforced thermosetting pipe and reinforced thermoplastic pipe, wall thickness and outside diameter shall be reinforced dimensions only. Unreinforced thicknesses shall also be reported. For fittings, report nominal size and schedule, or pressure rating.

11.1.4 Type of end closure used, that is, free or restrained,

11.1.5 Number of specimens tested.

11.1.6 Test temperature.

11.1.7 Test environment, including conditioning time.

11.1.8 Purpose of the tests. Refer also to 6.1 and 7.2.3.

11.1.9 Failure pressure and failure time (Procedure A or B) or minimum pressure reached and time to reach minimum pressure (Procedure B) for each specimen.

11.1.10 For pipe, calculate the average maximum stress and the standard deviation.

11.1.11 Type of failure for Procedure A (bursting, cracking, splitting, weeping, leaking).

11.1.12 Date of test.

12. Precision and Bias[3]

12.1 *Precision*[3]—Based on a mini laboratory round-robin conducted on 2-in. (50.8 mm) medium density polyethylene pipe, the precision (one standard deviation) of this test method for medium density polyethylene pipe is as follows:

12.1.1 Within-laboratory, ± 3 % (repeatability).

12.1.2 Between-laboratory, ± 6 % (reproducibility).

12.2 *Bias*—Data obtained using this test method are believed to be reliable, since accepted techniques of analysis are used. However, because no referee method is available, no bias statement can be made.

13. Keywords

13.1 burst pressure; plastic fittings; plastic pipe; plastic tubing; short-term hydrostatic pressure

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F17-1038.

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (D1599 – 14$^{\varepsilon 1}$) that may impact the use of this standard.

(1) Revised 1.1, 4.1, and 11.1.3.

(2) Note 1 was added.