Designation: F2928 – 13

Standard Practice for Specimens and Testing Conditions for Testing Polyethylene (PE) Pipe Butt Fusions Using Tensile and Hydrostatic Test Methods[1]

This standard is issued under the fixed designation F2928; 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 practice provides standardized sample butt fusion preparation, conditioning, and testing conditions for tension testing of specimens prepared from sample butt fusion joints or hydrostatic tests of sample butt fusion joints in accordance with:

1.1.1 Test Method D638, tension testing;

1.1.1.1 The preparation or use of tensile specimens other than Test Method D638 Type I through Type V is beyond the scope of this practice.

1.2 Test Method D1598, constant (sustained) hydraulic pressure testing;

1.3 Test Method D1599, short-term hydraulic pressure testing.

1.4 It is not within the scope of this practice to include plastic materials other than polyethylene or other tests for butt fusions. The exclusion of other plastic materials and other tests does not imply that other plastic materials are suitable or unsuitable for butt fusion, or that the tests cited herein are adequate or inadequate for qualitative characterization and for research and development of butt fusion joints, or that other tests do not have lesser, equal, or greater utility for such purpose.

1.5 The evaluation of test results and the determination of test result evaluation criteria are not within the scope of this practice. This practice is limited to standardized butt fusion test specimens and testing conditions for the comparison of test data from multiple parties.

1.6 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.

1.7 In this standard, text in parentheses, notes in the body of the standard and appendices are informational and non-mandatory. For tables in the body of the standard, table notes are mandatory.

1.8 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

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

F412 Terminology Relating to Plastic Piping Systems

F2620 Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

2.2 *PPI Standards:*[3]

PPI2 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-33 Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

3. Terminology

3.1 Definitions shall be in accordance with Terminology F412, Test Method D638, Test Method D1598, and Test

[1] This practice 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.

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

Method D1599 as applicable. Abbreviations shall be in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *failure, hydraulic, n*—any continuous loss of pressure with or without the transmission of test fluid through the body of the specimen under test.

3.2.2 *ductile failure, hydraulic, n*—the continuous loss of pressure through a break in the pipe specimen under test where localized expansion (deformation, elongation, necking down, or ballooning) of the pipe wall at the break is apparent.

3.2.3 *non-ductile failure, hydraulic, n*—the continuous loss of pressure through a break in the pipe specimen under test where localized expansion (deformation, elongation, necking down, or ballooning) of the pipe wall at the break is not apparent.

3.2.4 *pressure depletion, hydraulic, n*—a temporary loss of test sample source pressurization due to equipment or control failure, power loss, etc.

4. Summary of Practice

4.1 This practice specifies procedures for preparing sample butt fusions, preparing test specimens from sample butt fusions, sample and specimen conditioning, and requirements for testing sample butt fusions or specimens from sample butt fusions in accordance with Test Method D638, Test Method D1598, and Test Method D1599.

4.2 Alternate testing conditions for research, development or other purposes are allowed.

5. Significance and Use

5.1 This practice provides requirements for standardized preparation of sample butt fusions, preparation of specimens from sample butt fusions, and conditioning for testing in accordance with Test Method D638, Test Method D1598, or Test Method D1599. This practice is intended to improve the ability to reliably compare test results from multiple parties.

6. Sample Butt Fusions

6.1 *Sample Preparation*—Each sample butt fusion shall be at least two lengths of PE pipe that are joined together in accordance with a butt fusion joining procedure that has been selected by the parties involved. All pipe lengths in the sample butt fusion shall be the same length plus or minus five percent. The minimum pipe length shall be as specified in 7.1 or 8.1.2 or 9.1.2.

6.1.1 *Multiple Joint Sample Butt Fusions*—For Test Method D1598 or D1599, sample butt fusions containing multiple butt fusion joints shall be acceptable. The pipe length between butt fusion joints shall be the same length plus or minus five percent and shall not be less than the minimum pipe length specified in 8.1.2 or 9.1.2. The overall length of multiple joint sample butt fusions shall not exceed testing equipment capabilities.

6.2 Sample butt fusions shall be conditioned to the test temperature in accordance with Table 1.

NOTE 1—Butt fusion procedures such as Practice F2620 require cooling the fusion joint to ambient temperature before pulling, installation or rough handling. Conditioning in this practice is intended to stabilize test samples to test temperature. Additional conditioning time may be necessary when testing at temperatures significantly above or below 73°F (23°C), or when samples have been temporarily stored at temperatures significantly above or below test temperature.

6.3 Each sample butt fusion shall be marked, labeled, tagged or otherwise identified so that information relating to the sample butt fusion joint such as date, time, operator, location, joining procedure, pipe material, etc., and testing results will be cross-referenced and documented.

6.3.1 Each Test Method D638 tension test specimen shall be marked, labeled, tagged or otherwise identified so that information relating to the tension test specimen such as date, time, operator, location, joining procedure, pipe material, etc., and testing results will be crossreferenced and documented.

7. Tension Testing

7.1 *Tension Test Specimen Preparation*—Prepare sample butt fusions in accordance with Section 6 and 7.1.1. Prepare tension test specimens from the sample butt fusions in accordance with 7.1.3 – 7.1.5 .

7.1.1 The minimum pipe length on each side of the butt fusion shall be at least 6-in (152 mm) so that the sample butt fusion is at least 12-in (305 mm) in overall length.

7.1.2 For pipe smaller than 1-in (25 mm) outside diameter, each sample butt fusion shall be cut longitudinally in half. For pipe 1-in (25 mm) outside diameter and larger, each sample butt fusion shall be cut longitudinally into quadrants.

7.1.3 Depending on pipe wall thickness and the Test Method D638 specimen type, tension test specimens are prepared from all or parts of the pipe wall. Where wall thickness exceeds the thickness of the chosen Test Method D638 specimen type, pipe wall is machined away to achieve the thickness specified for the Test Method D638 specimen type.

NOTE 2—Where the thickness of the Test Method D638 specimen type spans all or most of the pipe wall thickness, equal amounts of inside wall

TABLE 1 Minimum Sample Butt Fusion Conditioning Time

	Minimum Conditioning Time in Medium at Test Temperature	
Pipe Wall Thickness[A]	Circulating water per Practice D618, Procedure D	Circulating air per Practice D618, Procedure A
≤1-in (≤25 mm)	1 h	4 h
>1 in (250 mm) to ≤2.5 in (64 mm)	2 h	8 h
>2.5 in (64 mm) to ≤4 in (102 mm)	3 h	12 h
>4 in (102 mm)	4 h	16 h

[A] For butt fusions between unequal wall thickness pipes, use the greater wall thickness of the two pipes.

thickness and outside wall thickness are removed to achieve the required specimen thickness.

7.1.3.1 From each sample butt fusion half or quadrant, machine Type I, II, III, IV or V test specimens in accordance with Test Method D638. (Note 3) The butt fusion shall be in the center of the test specimen gauge length. The center shall be half the gauge length plus or minus five percent of the gauge length. Pipe wall curvature shall be ignored.

NOTE 3—Tension test specimens should be the same type. Tension testing results from different tension specimen types may not be comparable. The specimen type should be determined by agreement among the involved parties.

7.1.3.2 For pipe wall thickness less than or equal to Test Method D638 tension specimen thickness, machine tension test specimens using the full wall thickness. Pipe wall curvature in the gauge area shall be ignored. Machining to remove pipe wall curvature in the grip area is permissible.

7.1.3.3 For pipe wall thickness greater than Test method D638 tension specimen thickness but less than three times tension specimen thickness, and where the parties have not determined a specific wall area such as outside, middle or inside wall for testing, specimens shall be prepared from the center of the pipe wall. Machine Type I, II, III, IV or V tension test specimens, and for the length of the tension test specimen, remove equal amounts of material from the pipe outside surface and the pipe inside surface so that the tension test specimen gauge area thickness is from the center of the pipe wall.

7.1.3.4 For pipe wall thickness greater than three times specimen thickness, section the pipe wall into one-third sections, for example, outer one-third, middle one-third, and inner one-third, and prepare tension test specimens from the outer, middle, and inner pipe wall.

NOTE 4—Where greater wall thickness and specimen type permit, additional specimens from between the inner and middle wall and from between the middle and outer wall (for example, one-fifth thickness sections) may be prepared to provide additional data.

7.1.4 Tension test specimen machining shall produce smooth surfaces in the gauge length area. Machining tool marks in the distance between the grips (see Test Method D638, Fig. 1) shall be parallel to the long axis of the tensile specimen. Machining tool marks in the distance between the grips that are not parallel to the long axis of the tensile specimen shall be smoothed with abrasive paper (No. 00 or finer). Finish sanding strokes shall be made in a direction that is parallel to the long axis of the tension test specimen. Fusion bead removal during specimen machining shall be acceptable. There shall be no indented printline pipe markings in the tension test specimen gauge area.

7.1.5 *Fusion beads*—The presence or absence of fusion beads on tensile specimens shall be by agreement among the parties making and testing the joints. All tensile specimens for a test set shall be consistent with both, one outside or one inside, or no fusion beads.

7.2 *Tension Test Specimen Conditioning*—Tension test specimens shall be conditioned in air in accordance with Practice D618, Procedure A for not less than 4 hours at the testing temperature without regard to humidity, or in water in accordance with Practice D618, Procedure D for not less than one hour at the testing temperature.

7.3 *Testing*—Tension test specimens shall be tested in accordance with Test Method D638. Unless otherwise specified, the test shall be conducted at 73°F (23°C), and the grip separation rate shall be 2 in/min (50 mm/min). Testing at an alternate temperature or grip separation rate shall be by agreement among the parties making and testing the joints.

7.3.1 *Gauge area measurement*—Measure the width and thickness of the tension test specimen in the gauge area to the nearest 0.001 in (0.025 mm) using a measuring device such as a micrometer caliper. Measurements shall be taken at both sides of the fusion, excluding fusion beads if present, and the smaller measurement shall be used to calculate the cross section of the gauge area. Calculate and record the gauge area cross section by multiplying the minimum width and thickness measurements.

7.3.2 Record the load and extension curve of the specimen

7.3.3 Record the load and extension at the yield point and the load and extension at the moment of specimen separation.

7.3.3.1 If testing is discontinued before specimen separation, record the load and extension at the moment the test is discontinued.

7.4 *Calculations and Report:*

7.4.1 Calculate tensile strength at yield by dividing the maximum load in pounds-force (newtons) by the gauge area cross section. Report the results in pounds-force per square inch (pascals) to three significant figures for tensile strength at yield and tensile strength at break. If there is no apparent yielding, report tensile strength at separation and indicate that separation was without apparent yielding.

7.4.2 If the specimen separates, calculate tensile strength at separation by dividing the maximum load in pounds-force (newtons) by the gauge area cross section. Report the results in pounds-force per square inch (pascals) to three significant figures for tensile strength at separation. If there is no apparent yielding, report tensile strength at separation and indicate that separation was without apparent yielding.

7.4.3 Percent elongation calculations. (Note 5.)

7.4.3.1 Calculate percent elongation at separation, or if the test is discontinued before separation, calculate percent elongation and report that the test was discontinued before separation.

7.4.3.2 If elongation occurs over the entire gauge length (both sides of the fusion joint), divide the extension length by the tensile specimen gauge length and multiply by 100.

7.4.3.3 If elongation occurs on one side of the fusion joint, divide the extension length by half the tensile specimen gauge length and multiply by 100.

NOTE 5—Per Test Method D638, percent elongation is the change in gauge length relative to the original specimen gauge length, expressed as a percent. Because wall thickness may vary on each side of the fusion joint, elongation may occur on one side of the fusion, or uniformly or non-uniformly on both sides of the fusion, or uniformly through the entire reduced area. Elongation may extend beyond the reduced area into the grip area of the tension specimen. If testing is stopped before specimen separation, elongation may not be at break. A full description of tension specimen elongation should be provided when reporting elongation results.