Designation: F3373 – 21

An American National Standard

Standard Specification for Polyethylene (PE) Electrofusion Fittings for Outside Diameter Controlled Crosslinked Polyethylene (PEX) Pipe[1]

This standard is issued under the fixed designation F3373; 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 specification covers polyethylene (PE 4710) electrofusion fittings for use with outside diameter-controlled crosslinked polyethylene (PEX) pipe, covered by Specifications F2788/F2788M, F2905/F2905M and F2968/F2968M. As stated in these PEX pipe standards, the PEX pipes joined to these PE 4710 electrofusion fittings have an HDB of 1250 psi or 1600 psi at 73 °F (23 °C) per Test Method D2837. Requirements for all metric-sized and inch-sized fittings for use with PEX pipe, made in accordance to these three pipe standards, are specified in Specification F2829/F2829M.

1.2 The maximum allowable operating temperature of electrofusion fittings made in accordance with this standard is limited to the highest temperature at which the HDB of the PE 4710 has been determined. When joined to PEX pipe having a higher temperature HDB, the maximum use temperature for the PE/PEX joint is limited to the elevated temperature HDB rating of the PE material in the fitting

NOTE 1—PEX and PE 4710 materials can have different elevated temperature ratings, and when joined together, the lower maximum elevated temperature rating will limit the maximum operating temperature. Per Table 1, the required PE 4710 material must have an HDB at 140 °F (60 °C), but may have an HDB at 180 °F (82 °C). PEX pipes generally have HDB ratings at 180 °F (82 °C) or 200 °F (93 °C) or both. When joined to PEX pipe, PE 4710 electrofusion fittings made in accordance with this standard may limit the maximum operating temperature to 140 °F (60 °C) where the PE 4710 material used does not have an optional higher temperature HDB rating.

1.3 Requirements for materials, workmanship, and qualification testing performance are included. The PE electrofusion fitting manufacturer shall assure that fittings produced in accordance with this specification comply with all the requirements of this specification. If a PEX pipe manufacturer deems that their pipe is suitable for joining to polyethylene (PE) electrofusion fittings, the PEX pipe manufacturer shall qualify their PEX pipe by testing joints made with these PE electrofusion fittings, and assuring that the joints meet the performance requirements of this specification.

1.4 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.

1.5 The following safety hazards caveat pertains only to the test method portion, Section 9, of this specification: *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.*

1.6 *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]

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

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F905 Practice for Qualification of Polyethylene Saddle-Fused Joints

F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings.

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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**

TABLE 1 Specification D3350 Classification Requirements and Properties of Polyethylene Electrofusion Fitting Materials

Physical Properties	Cell Classification and Properties for PE 4710 Material
Density	4
Melt Index	4
Flexural Modulus	>5
Tensile Strength	>5
Slow Crack Growth Resistance (Test Method F1473)	7
Hydrostatic Strength Classification	4
Specification D3350 Additive Code	C or E
Minimum HDB at 73 °F (23 °C), psi (MPa)	1600 (11.03)
Minimum HDS at 73 °F (23 °C), psi (MPa)	1000 (6.95)
Minimum HDB at 140 °F (60 °C), psi (MPa)	1000 (6.95)
Minimum HDB at 180 °F (82 °C), psi (MPa) – if applicable	800 (5.51)

F2788/F2788M Specification for Metric and Inch-sized Crosslinked Polyethylene (PEX) Pipe

F2829/F2829M Specification for Metric- and Inch-Sized Fittings for Crosslinked Polyethylene (PEX) Pipe

F2905/F2905M Specification for Crosslinked Polyethylene (PEX) Line Pipe For Oil and Gas Producing Applications

F2968/F2968M Specification for Crosslinked Polyethylene (PEX) Pipe for Gas Distribution Applications

2.2 *PPI Standards:*[3]

PPI TN-17 Crosslinked Polyethylene (PEX) Tubing Piping Materials or Pipe

PPI TR-3 HDB/HDS/PDB/SDB/MRS/CRS Policies - Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS), and Categorized Required Strength (CRS) Ratings for Thermoplastic

PPI TR-4 HDB/HDS/SDB/PDB/MRS/CRS Listed Materials, PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), Minimum Required Strength (MRS), Categorized Required Strength (CRS) Ratings for Thermoplastic Piping Materials or Pipe

2.3 *ISO Standards:*[4]

ISO 13954 Plastics pipe and fittings – Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal diameter greater than or equal to 90 mm

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *electrofusion, n*—a heat fusion joining process for fittings that have a heat source as an integral part of the fitting. Joining occurs when, in accordance with a specified procedure, electric energy is applied to the heat source during the procedure.

3.2.2 *fusion interface, n*—the surface in the heat fusion process where the plastic materials of the products being joined bond together.

3.2.3 *fusion zone length, n*—the total length of the melted material in the fitting cross-section under evaluation.

4. Materials and Manufacture

4.1 *Material requirements*—PE 4710 compounds suitable for use in the manufacture of electrofusion fittings under this specification shall meet the classification requirements of Specification D3350 as shown in Table 1, and shall meet the Specification D3350 requirements for brittleness temperature, thermal stability and tensile elongation. The material compound shall also have HDB and HDS ratings at 73 °F (23 °C) and HDB ratings at 140 °F (60 °C) or higher in accordance with Test Method D2837 and PPI TR-3 policies, and these PE material compounds shall be listed by a listing agency, such as PPI in TR-4, as PE4710 in accordance with policies and procedures no less restrictive than those in PPI TR-3.

4.2 *Additive Classes*—PE 4710 compounds meeting Specification D3350 code C, shall have 2.0 to 3.0 percent carbon black. PE 4710 compounds meeting Specification D3350 code E shall be colored with UV stabilizer.

4.3 *Rework Material*—Clean polyethylene material that met 4.1 and 4.2 before processing, free of any wire or contaminants, and generated from the fitting manufacturer's own production, shall be acceptable for use by the same manufacturer, provided that the fittings produced conform to the requirements of this specification. Rework material shall be blended with virgin material that complies with 4.1 and 4.2.

4.4 *Heating Mechanism*—The heat mechanism shall be of materials and design not detrimental to the performance of the fitting or the pipe to which it is intended to be joined. Heating mechanisms, such as wires or materials other than polyethylene, shall not exit the fitting in an area exposed to internal pressure. Heat mechanisms shall be of a design that ensures that wire terminations are toward the outer edges of the fusion zone length and away from the pressure containing area. Examples of acceptable and unacceptable wire terminations are shown in Figs. 1-5.

5. Performance Requirements

5.1 The following requirements are for electrofusion fitting joint designs, single or dual coil, and body designs that have been joined using the fitting manufacturer's recommended joining procedures. Each PE electrofusion fitting body size, body design and joint design shall meet the requirements in this section when joined to PEX pipe that complies with Specification F2788/F2788M, F2905/F2905M or F2968/F2968M. Fittings intended for use in the distribution of natural gas or liquid petroleum gas shall also meet the requirements of Specification F2968/F2968M.

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

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

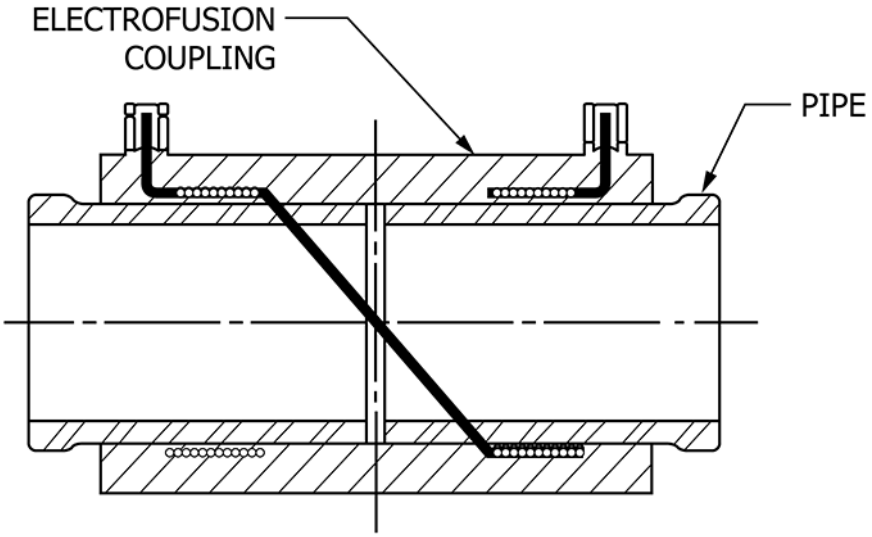

FIG. 1 Correct Wire Termination Coupling–Single Coil

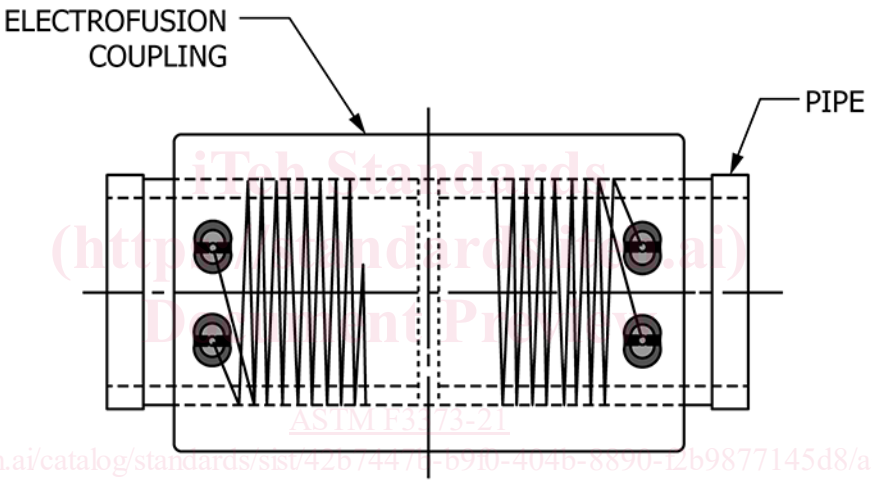

FIG. 2 Correct Wire Termination Coupling–Dual Coil

5.1.1 Any revisions to the electrofusion fitting body or joint design or processing by the manufacturer after the initial testing requires retesting to ensure these requirements can still be met.

NOTE 2—The user of these PE electrofusion fittings should contact the PEX pipe manufacturer to assure that joints between these PE electrofusion fittings and their type of PEX pipe meet the performance requirements of this specification.

5.1.2 Assemblies shall be limited to operating at the highest temperature at which the PE material used to make the fitting has an HDB rating per 4.1.

5.1.3 It is not intended that every PE electrofusion body design and body size be tested for compliance with these requirements. In general, testing the smaller and larger fitting configurations that are not more than 3 standard sizes different (such as NPS 2 to NPS 6) shall be acceptable for determining compliance of the intermediate sizes in the range. However, in determining the similarity or difference between various body designs (coupling, elbow, cross, wye, etc) resistance to internal pressure stress concentrations, and resistance coil design and size shall be taken into account.

NOTE 3—For example, internal pressure fitting body stress concentrations between a coupling and a wye may differ significantly; whereas, internal pressure stress concentrations between a tee and a saddle may be similar. Likewise a single or dual coil design may be suitable for some body designs but not others, and scaling may be affected by outlet size.

5.1.4 Saddle fittings shall be joined in accordance with manufacturer's recommendations to PEX main pipe. The PEX main pipe shall be perforated through the saddle branch outlet in accordance with manufacturer's recommendations to the maximum perforation hole size recommended and shall be tested with branch outlet(s) joined using the manufacturer's procedure to lengths of PEX pipe material for which the manufacturer recommends the use of his fitting. Lengths of PEX pipe joined to saddle fitting outlets shall be in accordance with 8.3.1.

5.2 *Pressure Requirements:*

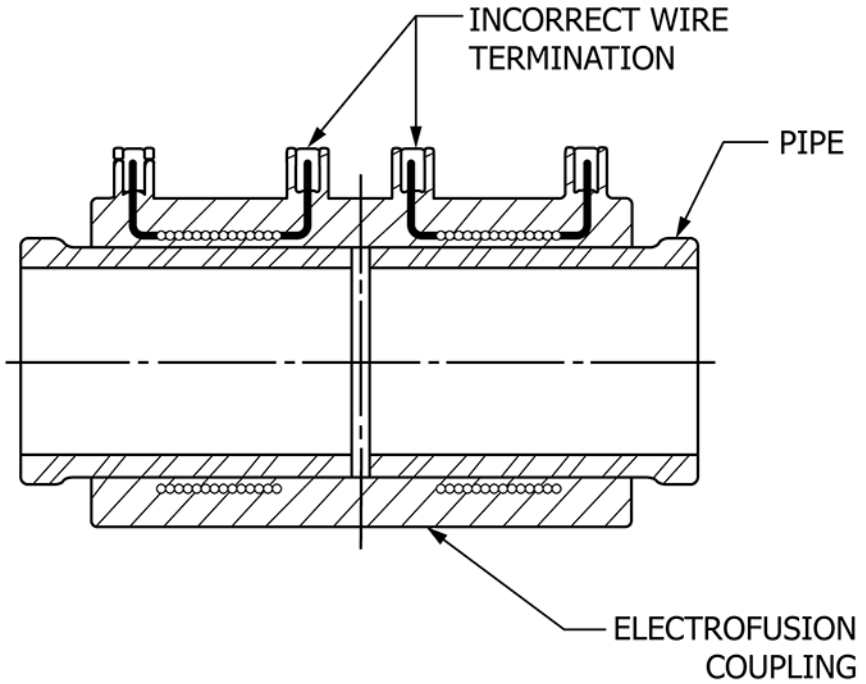

FIG. 3 Incorrect Wire Termination Coupling–Dual Coil

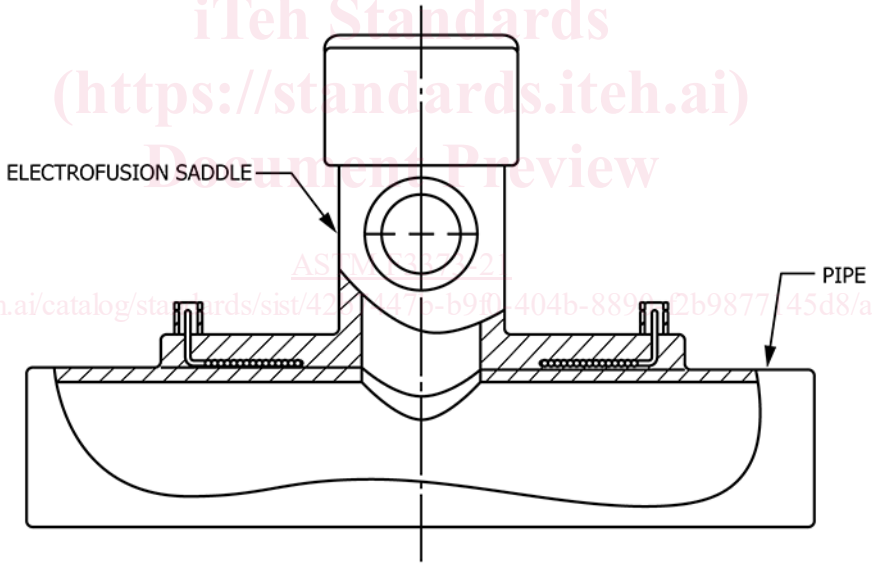

FIG. 4 Correct Wire Termination–Saddle Fitting

5.2.1 *Minimum Hydraulic Burst Pressure*—To test the PE electrofusion fitting, the fitting manufacturer shall use PEX pipe having a 1600 psi HDB. The fitting and fused joint shall not fail when tested in accordance with 9.1. The minimum hydraulic burst pressure at 73 °F (23 °C) of the test specimen shall be 2900 psi (20 MPa).

5.2.2 *Sustained Pressure*—To test the PE electrofusion fitting, the fitting manufacturer shall use PEX pipe having a 1600 psi HDB. The fitting and fused joint shall not fail when tested in accordance with 9.2 at t. The test pressure, minimum time-to-failure, and test temperature in accordance with Table 2. Where the controlling pipe standard requires testing at multiple temperatures, sustained pressure testing shall only be performed at the highest test temperature, not to exceed 180 °F (82 °C). If a pipe standard is not specified, or does not contain test requirements, the test pressure, minimum time-to-failure and test temperature shall be as shown in Table 2.

5.3 *Tensile Strength Requirements for Coupling Type Joints Up to NPS 8*—The fitting or the pipe to fitting joint made on pipe shall not fail when tested in accordance with 9.3. Specimens shall be subjected to a tensile stress that causes the pipe to yield to an elongation no less than 25 % or causes the pipe to break outside the joint area. Tensile tests must be made

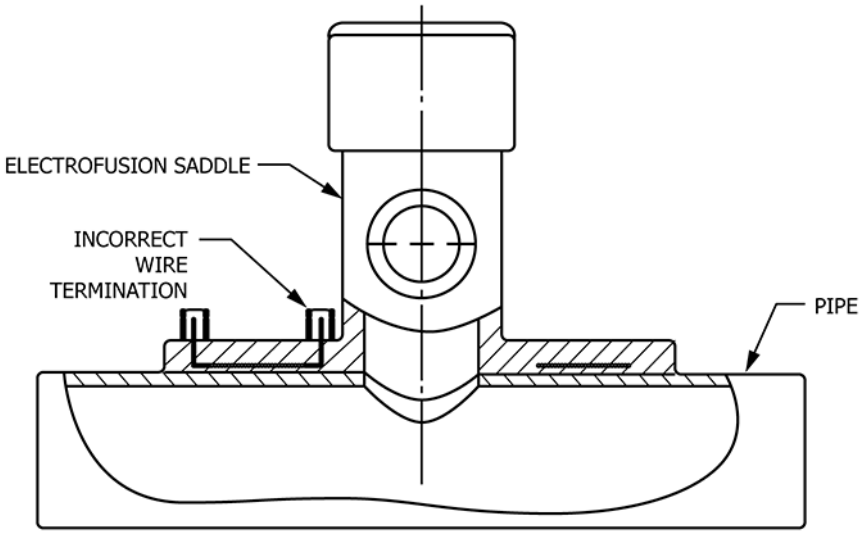

FIG. 5 Incorrect Wire Termination Saddle–Single Coil

TABLE 2 Sustained Pressure Test Requirements

Condition	PEX with HDB of 1600 psi at 73 °F (23 °C)		
	Test Temperature °F (°C)[A]	Test Hoop Stress psi	Minimum Average Time Before Failure Hours
1	176 (80)	750 (5170)	200
2	176 (80)	640 (4415)	1200

[A]Test temperature tolerance ± 4 °F (± 2 °C). Test pressure tolerance ± 5 psi (± 35 kPa); test pressure hoop stress values are rounded to the nearest 5 psi or 5 kPa. Table 2 conditions are based on PE validation requirements per PPI TR-3 with Condition 2 being 85 % of Condition 1 hoop stress and six times greater minimum average time before failure.

on specimens as joined, not on straps cut from the specimen. Yielding must be measured only in the pipe, independent of the fitting or joint.

5.3.1 Equipment needed to conduct full-scale tensile tests for sizes larger than NPS 8 is not readily available; therefore, tensile tests for these sizes shall be tested in accordance with Annex A2. The tests performed in Annex A2 also qualify the fitting design for the joint crush test portion of 5.5.

5.4 *Impact Resistance (Saddle Type Joints Only)*—The joint made on the specimen shall not fail when impacted with a force sufficient to break the body or other portion of the specimen. Tests of 500 ft-lb or higher impact with no failures noted shall be considered as a "pass" impact test. The device for testing and the methods shall be as defined in Practice F905.

5.5 *Joint Integrity Tests—(Couplings and Saddle Type Joints)*—The joint made on the specimen shall meet the requirements in 9.4 and 9.5 of this specification, when tested in accordance with 9.4.

5.5.1 Equipment needed to perform crush testing to the procedure described in 9.4.1 for NPS 8 and larger is not readily available, or can be hazardous to operate safely; therefore, an optional alternative to crush tests for coupling-type joints 8 IPS and larger is included as mandatory information in Annex A2. Tests performed in Annex A2 qualify the fitting design in lieu of the joint crush test portion of 9.4.1. All other performance requirements in Section 5 and 9.4.1 shall be satisfied by testing to the requirements using the methods described in Section 9.

6. Dimensions and Permissible Variations

6.1 Dimension and tolerances of electrofusion fittings must be such that heat fusion is possible to outside diameter (OD) controlled PEX pipes that comply with Specifications F2788/F2788M, F2905/F2905M and F2968/F2968M, such that the joints will satisfy the performance requirements in Section 5.

6.2 Because of the varying designs for electrofusion fittings, the actual spread of dimensions may be quite different from manufacturer to manufacturer. A table of dimensions and tolerances encompassing these differences would be meaningless and without value and, therefore, is omitted from this specification.

6.3 The manufacturer shall furnish to the user the electrical resistance, critical dimensions, and tolerances of his fittings. This information must include at least the following dimensions and tolerances:

6.3.1 Inside diameter of each electrofusion joint connection,

6.3.2 Operating temperature joining limits, and

6.3.3 Operating pressure limits of the fitting.

NOTE 4—There are other items that fall beyond the scope of this specification, which would be of interest to the user for proper application of the fittings and is recommended as additional information to be furnished. A few of these are: *(1)* maximum pipe out of round allowed at joint area; *(2)* minimum/maximum pipe SDR capability of the fitting, and *(3)* for saddles intended for use on a live main, the maximum allowable line pressure when making the joint.

7. Workmanship, Finish, and Appearance

7.1 The manufacture of these fittings shall be in accordance with good commercial practice so as to produce fittings meeting the requirements of this specification.

7.2 The fittings shall be homogeneous throughout, except where a heating coil or electrical connectors are incorporated, and free of cracks, holes, foreign inclusions, or injurious

defects such as gouges, dents, cuts, etc. The fittings shall be as uniform as commercially practicable in opacity, density, and other physical properties. Any heating coils, connecting cables, connectors, and related electrical power source shall be designed to prevent electrical shock to the user.

8. Specimen Preparation

8.1 *Conditioning:*

8.1.1 Unless otherwise specified, condition the specimens (pipe and fittings) prior to joining at the minimum pipe temperature allowable for fusion as recommended by the manufacturer, for not less than 16 h and make the fusion joint at that temperature for those tests where conditioning is required.

8.1.2 Unless otherwise specified, condition the specimens (pipe and fittings) prior to joining at the maximum pipe temperature allowable for fusion as recommended by the manufacturer, for not less than 16 h and make the fusion joint at that temperature for those tests where conditioning is required.

8.1.3 After conditioning per 8.1.1 and 8.1.2, condition specimens at 73 °F ± 4 °F (23 °C ± 2 °C) for not less than 16 h prior to testing.

8.2 *Test Conditions*—Conduct the tests at the Standard Laboratory Temperature of 73 °F ± 4 °F (23 °C ± 2 °C) unless otherwise specified.

8.3 *Preparation of Specimens for Testing:*

8.3.1 Prepare test specimens so that the minimum length of unreinforced PEX pipe on one side of any fitting is equal to three times the diameter of the pipe, but in no case less than 12 in. (304 mm). It is permissible to test multiple fittings together provided they are separated by a minimum distance equal to three times the diameter of the pipe, but in no case less than 12 in. (304 mm).

8.3.2 Using the manufacturer's recommended joining procedures, fuse all fitting outlets with to the appropriate size pipe.

8.3.3 Saddle fitting specimens conditioned per 8.1.2 for quick burst testing per 9.1 or sustained pressure testing per 9.2, shall be joined to pipe that is under pressure. Before, during and after joining, the pipe shall be pressurized to no less than the maximum allowable operating pressure of the pipe system or fitting, whichever is lowest, when being prepared for those tests. The pipe shall be left under pressure for a time period not less than recommended by the manufacturer for cooling in the field prior to testing. It shall be acceptable to join saddle joint specimens for mechanical/destructive type tests such as impact per 5.4 or crush tests per 9.4, or specimens conditioned for cold temperature joining per 8.1.1, may be made on pressurized or unpressured pipe.

9. Test Methods

9.1 *Minimum Hydraulic Burst Pressure Test:*

9.1.1 Select four fittings at random and prepare specimens in accordance with Section 8. From the four specimens, condition two specimens each in accordance with 8.1.1 and 8.1.2 and 8.1.3.

9.1.2 Test the specimens in accordance with Test Method D1599.

9.1.3 Failure of the fitting or joint shall constitute specimen failure. The test equipment, procedures, and failures definitions shall be as specified in Test Method D1599.

9.1.4 Failure of any one of the four specimens shall constitute failure of the test. Failure of one of the four specimens tested is cause for retest of four additional specimens, joined at the failed specimen's joining temperature. Failure of any of these four additional specimens constitutes a failure of the test.

9.2 *Sustained Pressure Test:*

9.2.1 Select four fittings at random and prepare specimens in accordance with Section 8 of this specification. From the four specimens, condition two specimens each in accordance with 8.1.1 and 8.1.2 and 8.1.3.

9.2.2 Test the specimens in accordance with Test Method D1598. The assemblies are to be subjected to pipe fiber stresses and minimum test periods in accordance with the requirements of Table 2 for the pipe material type being tested with the electrofusion fitting.

9.2.3 Failure of the fitting or joint shall constitute specimen failure.

9.2.4 Failure of any one of the four specimens shall constitute failure of the test. Failure of one of the four specimens tested is cause for retest of four additional specimens, joined at the failed-specimens-joining temperature. Failure of any of these four additional specimens constitutes a failure of the test.

9.3 *Tensile Strength Test (Coupling Only):*

9.3.1 Select four fittings at random and prepare specimens in accordance with Section 8 with the exception that it is permissible, on pipe sizes above 4 in. (102 mm) IPS, if limits of tensile machine will not allow 25 % elongation with pipe specimens of three-pipe diameters, to test with free pipe lengths of 20 in. (304 mm) minimum. From the four specimens, condition two specimens each in accordance with 8.1.1, 8.1.2 and 8.1.3.

9.3.2 Test the specimens using the apparatus of Test Method D638. Test at a pull rate of 0.20 in. (5.0 mm) per min, ± 25 %.

9.3.3 Failure of the fitting or joint as defined in 5.3, shall constitute specimen failure.

9.3.4 Failure of any one of the four specimens shall constitute failure of the test. Failure of one of the four specimens tested is cause for retest of four additional specimens, joined at the failed specimens joining temperature. Failure of any of these four additional specimens constitutes a failure of the test.

9.4 *Joint Integrity Tests*—Illustrations of joint crush tests for couplings and saddles are offered in 9.4.1 and 9.4.2 as test methods that are useful as an evaluation of bonding strength between the pipe and fitting. Alternately, the fusion evaluation test (FET) offered in 9.4.3 and 9.4.4 may be used in lieu of the crush test. Similar test evaluations as specified in the contract or purchase order and as agreed upon by the purchaser and manufacturer are of equal value in performing such evaluations and may be substituted with such agreement.

9.4.1 *Joint Crush Test (Coupling Only):*

9.4.1.1 Select four fittings at random and prepare specimens in accordance with Section 8. From the four specimens, condition two specimens each in accordance with 8.1.1, 8.1.2, and 8.1.3.

NOTE 5—It is permissible to utilize in joint integrity testing, specimens from the quick-burst tests conducted in 9.1 after visually determining that neither the joint area nor the pipe segment to be crushed was a part of the failure mode in the quick-burst test.

9.4.1.2 Slit joints longitudinally as illustrated in Fig. 6 as near the centerline of the pipe as practical. Pipe lengths extending out of the socket may be cut back to a minimum of 3 in. (76 mm) for ease of placing in a vise.

9.4.1.3 Place each specimen half in a vise such that the outermost wire of coil is within 1.250 in. ± 0.125 in. (32 mm ± 3 mm) of vise jaws, with the jaws closing only on the pipe portion of the specimen (Fig. 7).

9.4.1.4 Tighten the jaws of the vise on the pipe until the inner walls of the pipe meet (Fig. 8). Repeat crush test on both halves and each end of specimen, at all ends, where a joint exists.

9.4.1.5 Separation of the fitting from the pipe at the fusion interface constitutes a failure of the test. Some minor separation at the outer limits of the fusion heat source up to 15 % of the fusion length may be seen. This does not constitute a failure. Ductile failure in the pipe, fitting, or the wire insulation material, is acceptable as long as the bond interface remains intact.

9.4.1.6 Failure of any one of the four specimens shall constitute failure of the test and is cause for retest of four additional fittings, joined at the same temperature as the failed specimens. Failure of any of these four additional specimens constitutes a failure of the test.

9.4.2 *Saddle Crush Test (Not Full-Wrap Design):*

9.4.2.1 Select four fittings at random and prepare specimens in accordance with Section 8. From the four specimens, condition two specimens each in accordance with 8.1.1 and 8.1.2 (see 9.4).

9.4.2.2 PEX Pipe lengths extending from saddle joint may be cut back clear up to the outer edges of the saddle for convenience of handling, if desired, however, it is not necessary. The length of the PEX pipe extending beyond the saddle is not important to this test (Fig. 9).

9.4.2.3 Place the specimen in vise jaws as shown in Fig. 10, such that vise jaws are within ½ in. of saddle bottom and the jaws will close only on the pipe portion of the specimen. Saddle designs incorporating a bottom half saddle will need the bottom half removed for this test. Saddle designs incorporating a full-wrap single piece saddle are to be tested as in 9.4 socket type joints (Fig. 7 and Fig. 8).

9.4.2.4 Tighten the jaws of the vise on the pipe until the inner walls of the pipe meet (Fig. 11).

9.4.2.5 Separation of the fitting from the pipe at the fusion interface constitutes a failure of the test. Some minor separation at the outer limits of the fusion heat source up to 15 % of the fusion length may be seen. This does not constitute a failure. Ductile failure in the pipe, fitting, or the wire insulation material, is acceptable as long as the bond interface remains intact.

9.4.2.6 Failure of any one of the four specimens shall constitute failure of the test and is cause for retest of four additional fittings, joined at the same temperature as the failed specimens. Failure of any of these four additional specimens constitutes a failure of the test.

9.4.3 *Fusion Evaluation Test (FET) of Couplings:*

9.4.3.1 Select four fittings at random and prepare specimens in accordance with Section 8. From the four specimens, condition two specimens each in accordance with 8.1.1 and 8.1.2 and 8.1.3.

9.4.3.2 A band saw with a locking guide and a blade restricted to cutting plastic is recommended for obtaining the FET samples. Slit the coupling in the order of cuts as illustrated in Fig. 12. First, radially cut the coupling in half along the centerline of the joint. Pipe extending from the fittings may be cut back to about 1 in. from the fitting edge. Cut FET specimens approximately 1⁄16 in. wide from each joint half. A minimum of four FET strips shall be cut from one half of the coupling and spaced approximately 90° apart.

9.4.3.3 Grip an FET specimen in a vise or clamping device as shown in Fig. 13 so that the bond line between the pipe and fitting is at least 1⁄16 in. from the edges of the clamping device. Flex the specimen four times 90° in both directions. Pliers may be used in lieu of a vise as long as the entire length of the fusion is flexed.

9.4.3.4 Separation of the specimen along the bond line constitutes failure of the specimen. Some minor separation at the outer limits of the fusion heat source may be seen or there may be voids between wires. This does not constitute failure as long as the voids do not exceed the limits of 9.5. Ductile failure in the pipe, fitting, or the wire insulation material is acceptable as long as the bond interface remains intact.

9.4.3.5 Failure of any one of the four joints shall constitute failure of the test and is cause for retest using four additional fittings joined at the same conditions as the failed joint

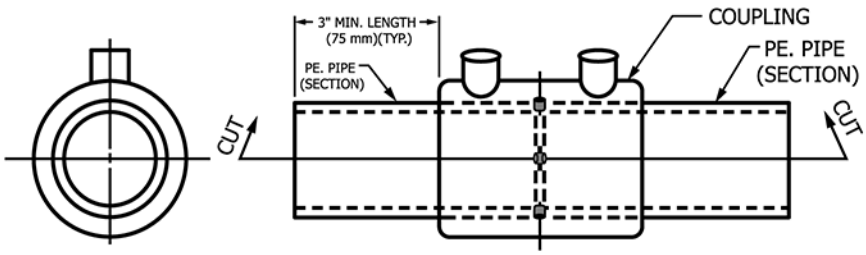

FIG. 6 Preparation of Coupling Specimen for Crush Test