Designation: F1533 – 01 (Reapproved 2009)

Standard Specification for Deformed Polyethylene (PE) Liner[1]

This standard is issued under the fixed designation F1533; 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 requirements and test methods for materials of deformed PE liner intended for the rehabilitation of gravity flow and nonpressure pipelines. This application is for municipal sewage, storm water, industrial process liquids and effluents, conduit, and ducts. This renewal process involves installing a deformed liner into an existing pipeline, conduit, or duct, then reforming the liner with heat and pressure to fit tightly to the bore of the original pipeline, conduit, or duct.

1.2 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. In referee decisions, inch-pound units shall be used.

1.3 *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

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

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

F1248 Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe (Withdrawn 2007)[3]

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[4]

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[4]

3. Terminology

3.1 *Definitions:*

3.1.1 Unless otherwise indicated, definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600.

3.1.2 *deformed liner*—polyethylene pipe manufactured in a deformed shape that reduces the cross-sectional area for insertion and rehabilitation of nonpressure pipelines, conduits, and ducts. (See Fig. 1.)

3.1.3 *reformed liner*—a reformed pipe is a sample for test purposes formed when the deformed pipe has been inserted into a given casing pipe and rerounded with heat and pressure to fit snugly to the casing pipe taking a given cross-section, in accordance with Sections 5 and 6. (See Fig. 1.)

4. Materials

4.1 Material requirements are applicable only to materials prior to extrusion into the liner. Post-extrusion product requirements are presented in Section 6.

4.2 *Material Classifications*—Polyethylene materials allowable for use in the manufacture of polyethylene liner under this

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

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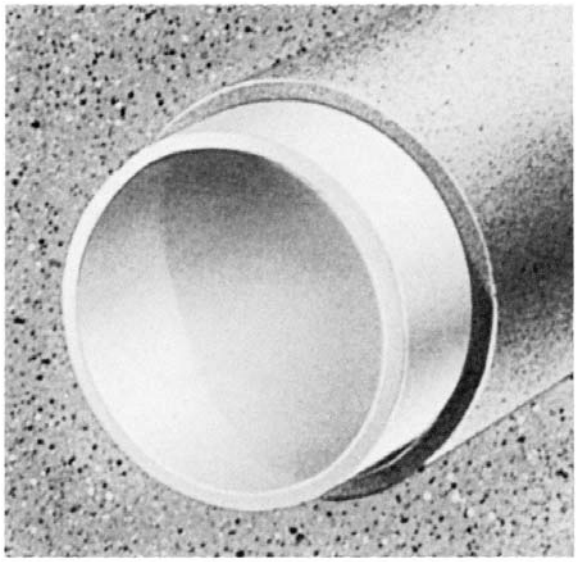
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

(*a*) *Deformed Pipe*



(*b*) *Reformed Pipe*

NOTE 1—This figure is intended only for clarification of terms specific to this specification and shows representative deformed and reformed pipe shapes. Other deformed pipe shapes may meet the general requirements of this specification.

FIG. 1 Deformed Pipe and Reformed Pipe—Clarification of Terms

specification shall have a Plastic Pipe Institute (PPI)[5] recommended Hydrostatic Design Basis in accordance with Table 1 and shall have a minimum classification in accordance with Specification D3350, as shown in Table 2.

4.3 *Rework Material*—Clean, rework material, meeting requirements in 4.2, and generated from the manufacturer's own pipe production, may be used by the same manufacturer, with material meeting requirements in 4.2 in any combination, as long as the liner produced meets all of the requirements of this specification for the pipe designated.

TABLE 1 Hydrostatic Design Basis of Pipe Materials

Thermoplastic Pipe Material Designation Code	Required Hydrostatic Design Basis
Pipe Designation	HDB, psi (MPa)
PE 3408	1600 psi at 73°F (11.03 MPa at 23°C)
PE 2406	1250 psi at 73°F (8.62 MPa at 23°C)

TABLE 2 Minimum D3350 Cell Classification Limits for Liner Materials[A]

Property Material	PE 2406	PE 3408
Density	2	3
Melt	3	4
Flexural modulus	4	5
Tensile strength	3	4
ESCR	3	3
HDB	3	4
Color and UV stabilizer	C or E	C or E

[A] Cell classification should be certified by the resin manufacturer per lot, as shipped to the pipe manufacturer.

5. Sampling

5.1 Reformed pipe sample preparation shall involve the rounding of a deformed pipe sample within a split pipe mold with an inside diameter equal to the nominal outside diameter shown in Table 3. A deformed pipe sample of sufficient length (10 ft maximum) to complete the testing requirements shall be inserted into the split pipe mold and secured at the ends. The ends shall have threaded nipples for applying steam with a pressure gage having steam discharge piping. The assembly shall be placed in an enclosed chamber for heating. Ambient pressure steam shall be applied to the chamber for at least a 15-min period at a minimum temperature of 200°F. The temperature shall be elevated to 250°F and the pipe shall be reformed by applying 14.5 psig for a period of 2 min. The pressure shall be increased to a maximum of 26 psig for an additional period of 2 min. While maintaining the 26-psig internal pressure, transition to air pressure and cool to 100°F or less. Remove the reformed sample from the mold for testing.

TABLE 3 Dimensions and Tolerances

Nominal Outside Diameter, in.[A]	Outside Diameter Tolerances[B]	Minimum Wall Thickness, in.			
		DR17	DR24	DR26	DR32.5
3.00	+0.00, –0.015	0.176	0.124	0.115	. . .
4.00	+0.00, –0.015	0.234	0.166	0.153	. . .
6.00	+0.00, –0.015	0.352	0.249	0.230	0.184
8.00	+0.00, –0.020	0.469	0.332	0.306	0.245
10.00	+0.00, –0.020	0.587	0.416	0.384	0.307
12.00	+0.00, –0.025	0.704	0.499	0.461	0.368
15.00	+0.00, –0.050	0.879	0.623	0.575	0.460
18.00	+0.00, –0.060	1.055	0.748	0.690	0.552

[A] The reformed pipe permits variance of nominal outside diameter during installation of –0.4 to +3.4 % to match existing pipe inside diameter. The larger variance may increase the DR value. Existing inside pipe diameters outside this range will necessitate special sizes.

[B] The listed outside diameter tolerances are provided for manufactured liner pipe.

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

Safety precautions shall be provided during the test procedure, that is, during application of steam and pressure.

5.2 A reformed pipe sample as returned from the job site using the job site reforming process shall be considered acceptable for testing purposes. Sample length shall be a minimum of 6 in. (153 mm).

5.3 The frequency of sampling shall be agreed upon between the purchaser and the seller.

6. Requirements and Test Methods

6.1 *Workmanship*—The deformed liner shall be essentially uniform in color, opacity, and other properties. There shall be no evidence of splits, cracks, crazing, kinks, or breaks.

6.2 *Dimensions:*

6.2.1 *Outside Diameter*—The outside diameter shall be as shown in Table 3 when measured in accordance with Test Method D2122 on liner samples taken from the production line before deforming. A dimensional check shall be made at least once every 12 h during production.

6.2.2 *Wall Thicknesses*—The wall thickness shall be as shown in Table 3 when measured in accordance with Test Method D2122. Use of a properly calibrated ultrasonic thickness tester is also permitted under this specification. Make sufficient readings, a minimum of eight, equally spaced around the circumference to ensure that the thickness has been determined.

6.3 *Special Sizes*—Where existing system conditions or special local requirements make other diameters or dimensions necessary, other sizes or dimension ratios, or both, shall be acceptable for engineered applications when mutually agreed upon between the purchaser and manufacturer, if the deformed liner is manufactured from plastic compounds meeting the material requirements of this specification, and the strength and design requirements are calculated on the same basis as those used in the specification. For diameters not shown in Table 3, the tolerance shall be the same percentage as used for diameters shown in Table 3. Minimum wall thickness shall be calculated by dividing the minimum diameter by the dimension ratio.

6.4 Environmental stress crack resistance (ESCR) materials allowable for use in the manufacture of liner under this specification shall meet the minimum requirements specified in Table 2. Test specimens required for testing in accordance with Test Method D1693 shall be prepared from material meeting the requirements of 4.2 or 4.3 in any combination.

6.5 *Tensile Strength and Tensile Elongation*—Samples shall be tested for tensile strength at yield and elongation at break per cell classification values. Tests shall be performed in accordance with Test Method D638 on a Type IV tensile test specimen cut from the production liner sample. Test the specimen at a speed of 2 in./min. Tensile strength and elongation shall be checked at least once per production lot run.

6.6 *Flexural Modulus*—Flexural modulus shall be checked at least once per production lot run per 6.6.1 or 6.6.2.

6.6.1 Test specimens shall be machined from the wall of the resin lot run, in accordance with the requirements of 5.1. Samples shall be tested for flexural modulus in accordance with Test Method D790 using Method 1, Procedure B and a 2 in. (50 mm) test span.

6.6.2 Test specimens shall be sections of pipe as removed from the production line before deforming or sections of pipe that have been reformed in accordance with 5.1 or 5.2. Cell Classification value shall be verified by measuring the pipe stiffness at 5% deflection per Test Method D2412, and calculating the corresponding flex modulus for the pipe section per Test Method D2412.

6.7 *Conditioning:*

6.7.1 *Referee Testing*—When conditioning is required for referee tests, condition the specimens in accordance with Procedure A of Practice D618 at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h before test. Conduct tests under the same conditions of temperature and humidity, unless otherwise specified.

6.7.2 *Quality Control Testing*—Unless otherwise specified, condition the specimens for a minimum of 24 h before test in air or 4 h in water at 73.4 ± 3.6°F (23 ± 2°C). Test the specimens at 73.4 ± 3.6°F without regard to relative humidity.

6.8 *Test Conditions*—Conduct tests other than those for routine quality control purposes in the Standard Laboratory Atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the referenced test method or in this specification. In cases of disagreement, retesting shall be conducted with the temperature and relative humidity tolerances limited to ±1.8°F (1°C) and ±2 %, respectively.

6.9 *Retest and Rejection*—If the results of any test(s) do not meet the requirements of this specification, the test(s) may be conducted again in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirement of the specification by such means as omitting tests that are a part of the specification, substituting or modifying a test method, or by changing the specification limits. In retesting, the product requirements of this specification shall be followed. If upon retest failure occurs, the quantity of product represented by the test(s) shall be rejected.

6.10 The requirements in 6.1, 6.2, 6.5, and 6.6 are intended for initial product qualification, and as routine quality control requirements to be performed during every production run and shall meet Table 2 value range. The requirements in 6.4 are intended to qualify product as meeting this specification, and are to be performed by the pipe supplier, and certified accordingly.

7. Certification

7.1 When specified in the purchase order or contract, the pipe producer's certification shall be furnished to the purchaser that the deformed liner was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

8. Marking

8.1 Markings shall be applied to the exposed end of each deformed liner coil in such a manner that they remain legible during normal handling, shipment, and storage. Markings may be stenciled on the outside of the liner.

8.2 *Markings*—Each deformed liner coil in compliance with this specification shall be clearly marked by the manufacturer with the following information: this designation, ASTM F1533; the nominal outside diameter in inches or special size in inches, DR-XX, and approximate coil length; the standard material designation code (PE3408 or PE2406); the manufacturer's name, trade name, or trademark; and the manufacturer's production code, from which plant location, machine, and date of manufacture can be identified.

9. Packaging

9.1 Unless otherwise specified, deformed liner shall be coiled. Coil lengths shall be specified by the purchaser. Coils shall be securely banded in layers, and layer to layer. Only nonmetallic banding shall come in contact with the liner. Metallic banding may be used, provided a protective material is placed between the metallic banding and the liner. Liner coils shall be packaged for shipment by commercial carrier.

10. Quality Assurance

10.1 When the product is marked with this designation, F1533, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

These requirements apply *only* to Federal/Military procurement, not domestic sales or transfers.

S1. *Responsibility for Inspection* —Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for U.S. Government Procurement:*

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.2—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.