



# Standard Specification for Folded/Formatted Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation<sup>1</sup>

This standard is issued under the fixed designation F 1871; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers requirements and test methods for materials, dimensions, workmanship, flattening resistance, impact resistance, pipe stiffness, extrusion quality, and a form of marking for folded/formed poly (vinyl chloride) (PVC) pipe for existing sewer and conduit rehabilitation.

1.2 Pipe produced to this specification is for use in non-pressure sewer and conduit rehabilitation where the folded PVC pipe is installed into and then expanded to provide a close fit to the wall of the original conduit, forming a new structural pipe-within-a-pipe.

NOTE 1—For installation procedures refer to Practice F 1867.

1.3 This specification includes pipe made only from materials specified in Section 6. This specification does not include pipe manufactured from reprocessed, recycled, or reclaimed PVC.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are provided for information only.

1.5 The following precautionary statement pertains only to the test method portion, Section 11, 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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 There is no similar or equivalent ISO Standard.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics for Testing<sup>2</sup>
- D 638 Test Method for Tensile Properties of Plastics<sup>2</sup>
- D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position<sup>2</sup>

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<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

D 790 Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials<sup>2</sup>

D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>

D 1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds<sup>2</sup>

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings<sup>3</sup>

D 2152 Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion<sup>3</sup>

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading<sup>3</sup>

D 2444 Test Method for Determination of Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)<sup>3</sup>

F 412 Terminology Relating to Plastic Piping Systems<sup>3</sup>

F 1057 Practice for Estimating the Quality of Extruded Poly(Vinyl Chloride) (PVC) Pipe by Heat Reversion Technique<sup>3</sup>

F 1867 Practice for Installation of Folded/Formatted Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation<sup>3</sup>

2.2 Federal Standard:<sup>4</sup>

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

2.3 Military Standard:<sup>4</sup>

MIL-STD-129 Marking for Shipment and Storage

## 3. Terminology

3.1 *Definitions:* Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for poly(vinyl chloride) plastics is PVC.

3.1.1 The term TYPE A is not an abbreviation, but rather an arbitrary designation for PVC compounds with a minimum

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.04.

<sup>4</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

value for modulus in tension as listed in 6.1 and a maximum value as defined by cell limit 1 of Specification D 1784.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *folded pipe, n*—pipe that has been manufactured and calibrated round, then subsequently cooled and deformed into a folded shape for use in existing sewer and conduit rehabilitation (see Fig. 1).

3.2.2 *formed pipe, n*—A folded pipe that has been inserted into an existing sewer or conduit and expanded with steam heat and pressure, and, if required by the manufacturer, with a squeegee device or similar device to provide a close fit to the existing pipe (see Fig. 1).

3.2.3 *formed field sample, n*—A formed field sample is formed when the folded pipe has been inserted into a mold pipe and expanded with steam heat and pressure, and, if required by the manufacturer, with a squeegee device or similar device to provide a close fit to the mold pipe.

4. **Significance and Use**

4.1 This specification is for use by designers and specifiers, regulatory agencies, owners, and inspection organizations who are involved in the rehabilitation of non-pressure sewers and conduits. Modifications may be required, depending on specific job conditions to establish a project specification. The manu-

facturer of the product should be consulted for design and installation information. Industrial waste disposal lines should be installed only with the specific approval of the cognizant code authority, since chemicals not commonly found in drains and sewers and temperatures in excess of 140°F (60°C) may be encountered.

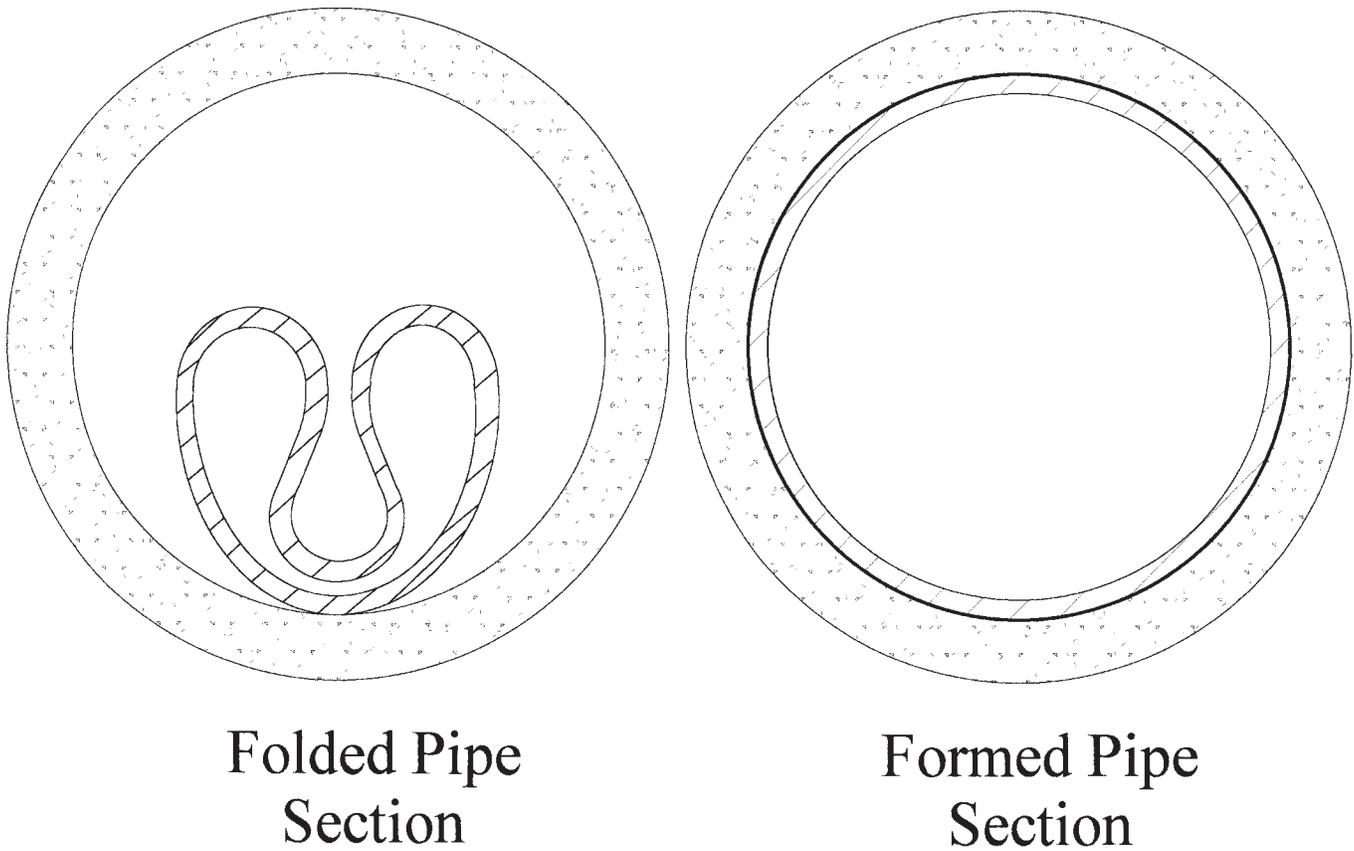
5. **Applications of Material**

5.1 The nominal folded PVC pipe sizes specified in Section 8 can be obtained for use in a range of original pipe inside diameters. Table 1 presents recommended ranges that are available for each nominal size.

6. **Materials and Manufacture**

6.1 *Basic Materials*—The pipe shall be made from virgin PVC compound meeting all the requirements for cell classification 12111 as defined in Specification D 1784 and with minimum physical properties as listed below:

Tensile Strength	Test Method D 638	3 600 PSI	(25 MPa)
Tensile Modulus	Test Method D 638	155 000 PSI	(1069 MPa)
Flexural Strength	Test Method D 790	4 100 PSI	(28 MPa)
Flexural Modulus	Test Method D 790	145 000 PSI	(1000 MPa)
Heat Deflection	Test Method D 648	115°F	(46°C)
Temperature tested at	(2 MPa)		
264 psi			



NOTE 1—This figure is intended only for clarification of terms specific to this specification, and shows a representative folded pipe shape. Other folded pipe shapes may meet the requirements of this specification.

FIG. 1 **Folded Pipe and Formed Pipe—Clarification of Terms**

**TABLE 1** Folded PVC Pipe Recommended Size Ranges of Use

NOTE—The minimum and maximum recommended existing pipe inside diameters shown are mean inside diameters along the pipe length and are not intended as absolute limits on localized dimensions. Consult the manufacturer for use of folded PVC pipe for sizes of existing pipe beyond the recommended ranges shown.

Folded Pipe Nominal Outside Diameter, in. (mm)	Recommended Existing Pipe Inside Diameter Range, in. (mm)		Resulting Installed DR Range		
	Min	Max	DR 26	DR 32.5	DR 41
4 (102)	3.6 (91)	4.1 (104)	24-27	31-38	
6 (152)	5.7 (145)	6.1 (155)	25-27	31-38	
8 (203)	7.6 (193)	8.2 (208)	25-27	31-38	
9 (229)	8.6 (218)	9.2 (234)	25-27	31-38	
10 (254)	9.5 (241)	10.2 (259)	25-27	31-38	
12 (305)	11.6 (295)	12.6 (320)	25-27	31-38	
15 (381)	14.5 (368)	15.4 (391)	25-27	31-38	
18 (457)	17.6 (447)	18.2 (462)			40-42

6.1.1 Compounds meeting the above minimum properties that have different cell classifications because one or more properties are greater than those of the specified compounds are also acceptable, except modulus in tension shall not exceed 280 000 psi.

6.2 *Rework Material*—Clean rework material from this type of pipe, generated from the manufacturer’s own production may be used by the same manufacturer, provided that the rework material meets all the requirements of 6.1 and that the pipe produced meets all the requirements of this specification.

**7. Other Requirements**

7.1 *Pipe Flattening*—There shall be no evidence of splitting, cracking, or breaking when the rounded pipe is tested in accordance with 11.3.

7.2 *Pipe Impact Strength*—The impact strength of rounded pipe shall not be less than the values given in Table 2 when tested in accordance with 11.4.

NOTE 2—This test is intended only for use as a quality control test, not as a simulated service test.

7.3 *Pipe Stiffness*—Pipe stiffness values for the rounded pipe shall comply with Table 3, when tested in accordance with 11.5.

7.4 *Extrusion Quality*—The extrusion quality of the pipe shall be evaluated by both of the following test methods.

7.4.1 *Acetone Immersion*—The pipe shall not flake or disintegrate when tested in accordance with 11.6.1.

7.4.2 *Heat Reversion*—The extrusion quality shall be estimated by heat reversion method in accordance with 11.6.2.

**TABLE 2** Minimum Impact Strength at 73°F (23°C)

Pipe Size, in. (mm)	Impact Strength, ft-lbf (J)	
4 (102)	150	(203)
6 (152)	210	(284)
8 (203)	210	(284)
9 (229)	220	(299)
10 (254)	220	(299)
12 (305)	220	(299)
15 (381)	220	(299)
18 (457)	220	(299)

**TABLE 3** Minimum Pipe Stiffness at 5 % Deflection

Pipe Size, in. (mm)	Pipe Stiffness, psi (kPa)		
	DR 26	DR 32.5	DR 41
4(102)–18(457)	41(281.9)	22(151.3)	11(75.6)

7.5 *Flexural Properties*—Flexural modulus of elasticity values for the rounded pipe shall comply with 6.1.

**8. Dimensions, Mass, and Permissible Variations**

8.1 *Formed Pipe Diameter*—The average outside diameter of the formed pipe shall meet the requirements given in Table 4 with a tolerance of plus or minus 1.0 % when measured in accordance with 11.2.1.

8.2 Formed Pipe wall thickness of the rounded pipe, when measured in accordance with 11.2.2, shall not be less than the values specified in Table 4.

**9. Workmanship, Finish, and Appearance**

9.1 The formed pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.

**10. Sampling**

10.1 The formed pipe sample preparation shall involve the unfolding and expansion of a folded pipe sample within a split pipe mold with an inside diameter equal to the nominal outside diameter as shown in Table 4. A folded pipe sample of sufficient length, 10 ft (3 m) maximum, to complete the testing requirements shall be inserted into the split pipe mold and secured at the ends. The assembly shall then be placed in an enclosed chamber for heating. Ambient pressure steam shall be applied to the chamber for at least a 15-minute period at a minimum temperature of 220°F (104°C). While maintaining the minimum 220°F temperature, the folded pipe shall then be formed by applying internal steam pressure at 5 psig (34 kPa) for a period of 2 minutes. While maintaining the 5 psig internal pressure, transition to air pressure and cool the sample to 100°F (38°C) or less. Remove the rounded sample from the mold for testing.

10.2 The frequency of sampling shall be as agreed upon by the purchaser and the seller.

10.3 Initial and retest samples shall be drawn from the same production shift.

**TABLE 4** Formed Pipe Dimensions

Nominal Outside Diameter, in. (mm)	Minimum Wall Thickness, in. (mm)		
	DR 26	DR 32.5	DR 41
4.00 (102)	0.154 (3.91)	0.123 (3.12)	
6.00 (152)	0.231 (5.87)	0.185 (4.70)	
8.00 (203)	0.308 (7.82)	0.246 (6.25)	
9.00 (229)	0.346 (8.79)	0.277 (7.04)	
10.00 (254)	0.385 (9.78)	0.308 (7.82)	
12.00 (305)	0.462 (11.73)	0.369 (9.37)	
15.00 (381)	0.576 (14.63)	0.462 (11.73)	
18.00 (457)			0.439 (11.15)

## 11. Test Methods

11.1 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of  $73.4 \pm 3.6^{\circ}\text{F}$  ( $23 \pm 2^{\circ}\text{C}$ ) and  $50 \pm 5\%$  relative humidity, with test specimens conditioned in accordance with Procedure A of Test Methods D 618, unless otherwise specified in the test methods or in this specification.

### 11.2 Formed Pipe Dimensions:

11.2.1 *Pipe Diameters*—Measure the outside diameter of the pipe in accordance with the applicable section of Test Method D 2122. Either a tapered sleeve gage or a vernier circumferential wrap tape accurate to  $\pm 0.001$  in. ( $\pm 0.02$  mm) may be used.

11.2.2 *Wall Thickness*—Measure the wall thickness in accordance with the applicable sections of Test Method D 2122. Make sufficient readings, a minimum of six, to ensure that the minimum thickness has been determined. Use a cylindrical anvil tubing micrometer accurate to  $\pm 0.001$  in. ( $\pm 0.02$  mm).

11.3 *Pipe Flattening*—Flatten three specimens of rounded pipe, 6 in. (152 mm) long, between parallel plates in a suitable press until the distance between the plates is 40 % of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 minutes. Remove the load and examine the specimens for evidence of splitting, cracking, or breaking.

11.4 *Impact Resistance*—Determine the impact resistance of the rounded pipe in accordance with the applicable section of Test Method D 2444, using a 20-lb (9 kg) Tup A and the flat plate Holder B. Test six specimens each 6 in. (152 mm) long at the impact levels given in Table 2. All shall pass. If one fails, test another six specimens. Eleven passes out of 12 tested shall be acceptable.

11.5 *Pipe Stiffness*—Determine the pipe stiffness for rounded pipe specimens using Test Method D 2412. Test three specimens, each 6 in. (152 mm) long. The pipe stiffness of each specimen at 5 % deflection shall equal or exceed the minimum value listed in Table 3.

### 11.6 Extrusion Quality:

11.6.1 *Acetone Immersion*—Tests shall be run in accordance with Test Method D 2152 on rounded samples, every production lot run. This procedure is used for determining the extrusion quality of extruded PVC plastic pipe as indicated by reaction to immersion in anhydrous acetone. It is applicable only for distinguishing between unfused and properly fused PVC.

11.6.2 *Heat Reversion*—Tests shall be run in accordance with Practice F 1057 on rounded pipe samples, every production lot run. The rounded pipe shall not exhibit any of the effects listed in the suggested Interpretation of Results in Practice F 1057.

11.6.3 *Flexural Properties*—Tests shall be run on rounded pipe samples in accordance with Test Method D 790, Method I, Procedure A, every production lot run.

## 12. Inspection

12.1 Inspection of the material shall be made as agreed upon by the purchaser and the seller as part of the purchase contract.

## 13. Retest and Rejection

13.1 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 met, and the test methods designated in the specification shall be followed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

## 14. Certification

14.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser that the material 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. Each certification so furnished shall be signed by an authorized agent of the manufacturer, the individual responsible for performing the tests.

## 15. Product Marking

15.1 Pipe in compliance with this specification shall be clearly marked as follows at intervals of 5 ft. (1.5 m) or less.

15.1.1 Manufacturer's name or trademark and code,

15.1.2 Nominal outside diameter,

15.1.3 The PVC cell classification, for example "12111,"

15.1.4 The legend, "DR XX Folded PVC Pipe,"

15.1.5 This designation "Specification \_\_\_\_\_," and

15.1.6 Length marker and linear distance label, for example: "1000 ft" ("304.8m").

## 16. Packaging

16.1 The full length and wall thickness of the folded PVC pipe is heated and coiled onto a reel in a continuous length for storage and shipping. The minimum diameter of the reel drum or core shall be 48 in. (1219 mm).

## 17. Quality Assurance

17.1 When the product is marked with this designation, F 1871, 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.

## 18. Keywords

18.1 installation, underground; plastic pipe, thermoplastic; poly (vinyl chloride) (PVC) plastic pipe; rehabilitation, trenchless technology

## 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 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 United States Federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for United States 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 that will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motors 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 S1.2—The inclusion of United States Government procurement requirements should not be construed as an indication that the United States Government uses or endorses the products described in this document.

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