Designation: ~~F1871 – 20~~ F1871 – 24

Standard Specification for Folded/Formed ~~Poly (Vinyl~~ Poly-(Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation[1]

This standard is issued under the fixed designation F1871; 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, dimensions, workmanship, flattening resistance, impact resistance, pipe stiffness, extrusion quality, and a form of marking for folded/formed ~~poly (vinyl~~ poly-(vinyl chloride) (PVC) pipe for existing sewer and conduit rehabilitation.

1.2 ~~Pipe~~ Folded 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 and design calculations refer to Practice F1867.

1.3 This specification includes pipe made only from materials specified in Section 6. This specification does not include folded 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~~ values given in parentheses are mathematical conversions to SI units that are provided for information ~~only.~~only and are not considered standard.

1.5 There is no similar or equivalent ISO Standard.

1.6 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

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[1] This specification is under the jurisdiction of Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

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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**

D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D1600 Terminology for Abbreviated Terms Relating to Plastics (Withdrawn 2024)[3]
D1784 Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2152 Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D2444 Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
F412 Terminology Relating to Plastic Piping Systems
F1057 Practice for Estimating the Quality of Extruded Poly (Vinyl Chloride) (PVC) Pipe by the Heat Reversion Technique
F1867 Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation

2.2 *Federal Standard:*[4]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.3 *Military Standard:*[4]
MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, 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 value for modulus in tension as listed in 6.1.

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).

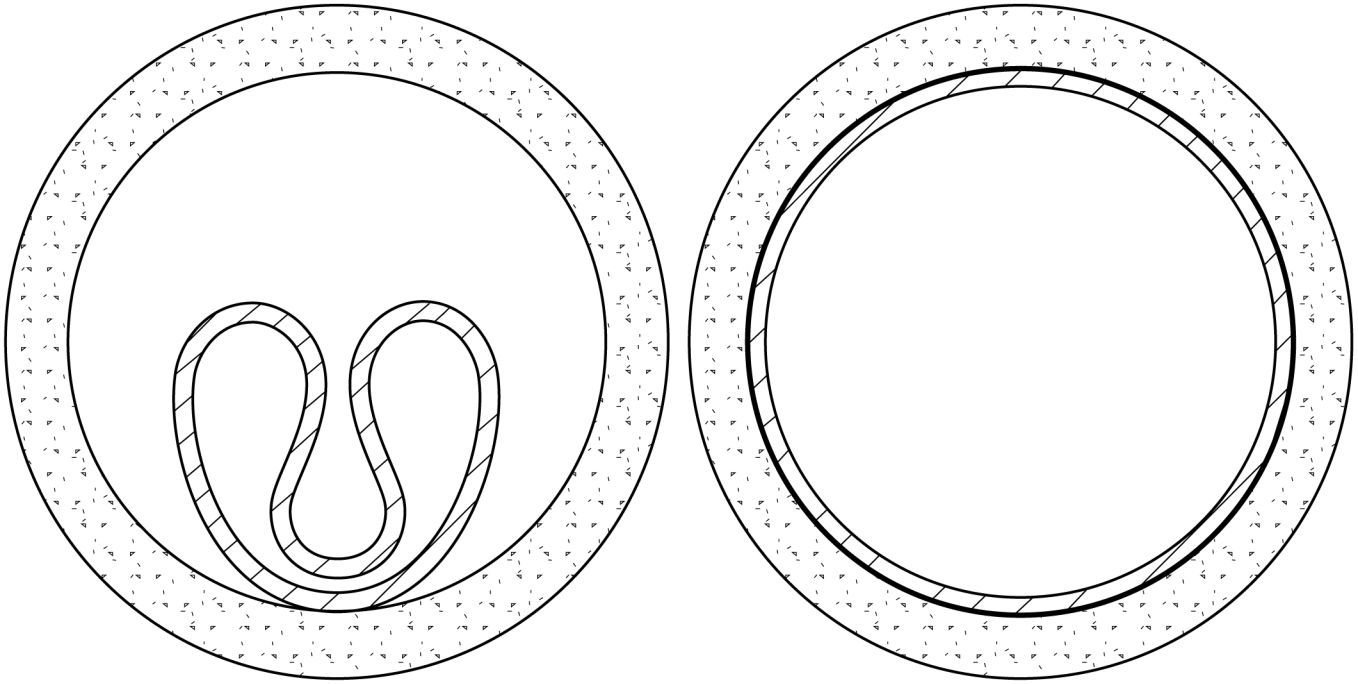
3.2.3 ~~*formed field*~~*rounded pipe sample, n*—A ~~formed field sample is formed when the folded pipe~~ folded pipe that has been inserted into a ~~mold~~ pipe mold and expanded with ~~steam heat and pressure, and, if required by the manufacturer, with a squeegee device or similar device to provide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

3.2.3.1 *Discussion—*
A "field sample" can be formed in the same manner as a rounded pipe sample.

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 manufacturer 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)~~140 °F (60 °C) may be encountered.

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.



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

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

5. Applications of Material

5.1 The nominal ~~folded~~rounded 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.~~Additional sizes and/or DR's may be accommodated; consult the manufacturer.

6. Materials and Manufacture

6.1 *Basic Materials*—The folded pipe shall be made from virgin PVC compound meeting all the requirements for cell classification 12111 or 32111 as defined in Specification D1784 and with minimum physical properties as listed below:

Tensile Strength	Test Method D638	3 600 PSI	(25 MPa)
Tensile Modulus	Test Method D638	155 000 PSI	(1069 MPa)
Flexural Strength	Test Method D790	4 100 PSI	(28 MPa)
Flexural Modulus	Test Method D790	145 000 PSI	(1000 MPa)
Heat Deflection Temperature tested at 264 psi	Test Method D648 (2 MPa)	115 °F	(46 °C)

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.

6.2 *Rework Material*—Clean rework material from this type of pipe, generated from the ~~manufacturer's~~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 rounded pipe produced meets all the requirements of this specification.

7. Other Requirements (Typically Evaluated on Rounded Pipe Samples)

7.1 *Pipe Flattening*—There shall be no evidence of splitting, cracking, or breaking when the rounded pipe is tested in accordance with 11.4.

7.2 *Pipe Impact ~~Strength—~~Resistance*—The impact ~~strength~~resistance of rounded pipe shall not be less than the values ~~given~~specified in Table ~~2~~1 when tested in accordance with 11.5.

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

~~NOTE 1—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 35~~	~~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~~	~~34-36~~	
~~9 (229)~~	~~8.6 (218)~~	~~9.2 (234)~~	~~25-27~~	~~31-38~~	~~34-36~~	
~~10 (254)~~	~~9.5 (241)~~	~~10.2 (259)~~	~~25-27~~	~~31-38~~	~~34-36~~	
~~12 (305)~~		~~11.6 (295)~~	~~12.6 (320)~~	~~25-27~~	~~31-38~~	~~34-36~~
~~15 (381)~~	~~14.5 (368)~~	~~15.4 (391)~~	~~25-27~~	~~31-38~~	~~34-36~~	
~~18 (457)~~	~~17.6 (447)~~	~~18.2 (462)~~			~~34-36~~	~~40-42~~

TABLE 1 Minimum Impact Resistance at 73 °F (23 °C)

Nominal Rounded Pipe Size, NPS	Impact Energy (J)
Inch/Pound Units	
4	150
6-8	210
8-48	220
Nominal Rounded Pipe Size, DN	Impact Energy (J)
SI (Metric) Units	
100	204
150–200	284
225–1200	299

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 32, when tested in accordance with 11.6.

7.4 *Extrusion Quality*—The adequacy of fusion and the extrusion quality of the rounded pipe shall be evaluated by ~~both of~~ the ~~following test methods.~~test methods specified in 7.4.1 and 7.4.2, respectively.

7.4.1 *Acetone Immersion*—The pipe shall not flake or disintegrate when tested in accordance with 11.7.1.

7.4.2 *Heat Reversion*—The pipe extrusion quality shall be estimated by heat reversion method in accordance with 11.7.2.

7.5 *Flexural Properties*—Flexural modulus of elasticity values for the rounded pipe shall comply with 6.1 when tested in accordance with 11.7.3.

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 2 Minimum Pipe Stiffness at 5 % Deflection

Inch/Pound Units

Nominal Rounded Pipe Size NPS	Pipe Stiffness, psi (lb/in/in)									
	DR 26	DR 32.5	DR 35	DR 41	DR50	DR60	DR69	DR77	DR86	DR103
4	41	22	...	...	...	...	...	...	...	...
6	41	22	...	...	...	...	...	...	...	...
8	41	22	16.5	...	...	...	...	...	...	...
9	41	22	16.5	...	...	...	...	...	...	...
10	41	22	16.5	...	...	...	...	...	...	...
12	41	22	16.5	11	...	...	...	...	...	...
15	41	22	16.5	11	4.5	...	...	...	...	...
18	...	...	16.5	11	4.5	...	...	...	...	...
21	...	...	...	11	4.5	3.1	...	...	...	...
24	...	...	...	...	4.5	3.1	1.8	...	...	...
27	...	...	...	...	...	3.1	1.8	1.1	...	...
30	...	...	...	...	...	3.1	1.8	1.1	0.8	...
36	...	...	...	...	...	...	1.8	1.1	0.8	0.5
42	...	...	...	...	...	...	...	1.1	0.8	0.5
48	...	...	...	...	...	...	...	...	0.8	0.5

SI (Metric) Units

Nominal Rounded Pipe Size DN	Pipe Stiffness, psi (kPa)									
	DR 26	DR 32.5	DR 35	DR 41	DR50	DR60	DR69	DR77	DR86	DR103
100	283	152	...	...	...	...	...	...	...	...
150	283	152	...	...	...	...	...	...	...	...
200	283	152	114	...	...	...	...	...	...	...
225	283	152	114	...	...	...	...	...	...	...
250	283	152	114	...	...	...	...	...	...	...
300	283	152	114	76	...	...	...	...	...	...
375	283	152	114	76	31	...	...	...	...	...
450	...	...	114	76	31	...	...	...	...	...
525	...	...	...	76	31	21	...	...	...	...
600	...	...	...	...	31	21	12	...	...	...
675	...	...	...	...	...	21	12	7.6	...	...
750	...	...	...	...	...	21	12	7.6	5.5	...
900	...	...	...	...	...	...	12	7.6	5.5	3.4
1050	...	...	...	...	...	...	...	7.6	5.5	3.4
1200	...	...	...	...	...	...	...	...	5.5	3.4

8. Dimensions, Mass, and Permissible Variations

8.1 *~~Formed~~Rounded Pipe Diameter*—The average outside diameter of the ~~formed~~rounded pipe shall meet the requirements given in Table ~~4~~3 ~~with a tolerance of plus or minus 1.0 %~~ when measured in accordance with 11.3.1.

8.2 *Rounded Pipe Wall Thickness*—~~Formed Pipe~~The pipe wall thickness of the rounded ~~pipe, when measured in accordance with~~ pipe ~~11.3.2,~~ shall not be less than the values specified in Table 4 when measured in accordance with 11.3.2.

9. Workmanship, Finish, and Appearance

9.1 The ~~formed~~ folded, formed, and/or rounded 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~~rounded pipe sample preparation shall involve the unfolding and ~~expansion~~expanding 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) minimum, 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~~ 15-min at a minimum temperature of ~~220 °F (104 °C).~~200 °F (93 °C). While maintaining the minimum ~~220 °F (104 °C)~~200 °F (93 °C) temperature, the folded pipe shall then be formed by applying internal steam pressure at 5 psig (34 kPa) minimum for a period of at least 2 minutes. While maintaining the 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.

11. Test Methods

11.1 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of ~~73.4 ± 3.6 °F (23~~73 °F ± 4 °F (23 °C ± 2 °C)

~~TABLE 4 Formed Pipe Dimensions~~

~~Nominal Outside Diameter, in. (mm)~~	~~Minimum Wall Thickness, in. (mm)~~			
~~DR 26~~	~~DR 32.5~~	~~DR 35~~	~~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)~~	~~0.229 (5.8)~~	
~~9.00 (229)~~	~~0.346 (8.79)~~	~~0.277 (7.04)~~	~~0.257 (6.5)~~	
~~10.00 (254)~~	~~0.385 (9.78)~~	~~0.308 (7.82)~~	~~0.286 (7.3)~~	
~~12.00 (305)~~	~~0.462 (11.73)~~	~~0.369 (9.37)~~	~~0.343 (8.7)~~	
~~15.00 (381)~~	~~0.576 (14.63)~~	~~0.462 (11.73)~~	~~0.429 (10.9)~~	
~~18.00 (457)~~				~~0.439 (11.15)~~

TABLE 3 Rounded Pipe Dimensions (Inch/Pound and SI (Metric) Units)

Nominal Rounded Pipe Size	Recommended Pipe Outside Diameter Range, in.		Nominal Rounded Pipe Size	Recommended Pipe Outside Diameter Range, mm	
NPS	Min	Max	DN	Min	Max
4	3.6	4.1	100	91	104
6	5.7	6.1	150	145	155
8	7.6	8.2	200	193	208
9	8.6	9.2	225	218	234
10	9.5	10.2	250	241	259
12	11.6	12.6	300	295	320
15	14.5	15.4	375	368	391
18	17.6	18.2	450	447	462
21	20.4	21.2	525	517	539
24	23.3	24.2	600	591	616
27	26.2	27.3	675	665	693
30	29.1	30.3	750	739	770
36	34.9	36.4	900	887	924
42	40.7	42.4	1050	1035	1077
48	46.6	48.5	1200	1183	1231