Designation: F 894 – 98a

An American National Standard

Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe[1]

This standard is issued under the fixed designation F 894; 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, ring stiffness, flattening, joint systems, and a form of marking for large diameter, 10 to 120 in. (250 to 3050 mm), inside diameter based polyethylene (PE) pipe of profile wall construction and with butt-fused, bell and spigot, and other mechanical joints for use in low pressure and gravity flow applications, such as for sewers and drains.

NOTE 1—Pipe produced to this specification should be installed in accordance with Practice D 2321 and with the manufacturer's recommendations.

NOTE 2—For purposes of this specification, low pressure is defined as 50 ft (15.2 m) of water column or less.

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

1.3 The following safety hazards caveat pertains only to the test method portion, Section 8, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings[3]

D 2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity–Flow Applications[3]

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Pipe Loading[3]

D 2657 Practice for Heat Joining of Polyolefin Pipe and Fittings[3]

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials[3]

D 3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals[3]

D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials[4]

F 412 Terminology Relating to Plastic Piping Systems[3]

F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe[3]

F 585 Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers[3]

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[5]

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[5]

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 polyethylene is PE.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *closed profile (CP)*—a profile wall pipe wall construction that presents essentially smooth internal and external surfaces.

3.2.2 *extrusion welding*—a joining technique that is accomplished by extruding a molten polyethylene bead between two prepared surface ends.

3.2.3 *open profile (OP)*—a profile wall pipe wall construction that presents an essentially smooth internal surface with a ribbed or corrugated external surface.

3.2.4 *profile wall*—a pipe wall construction that presents an essentially smooth surface in the waterway but includes ribs or other shapes, which can be either solid or hollow, that help brace the pipe against diametrical deformation (see Fig. 1).

[1] This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.04.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

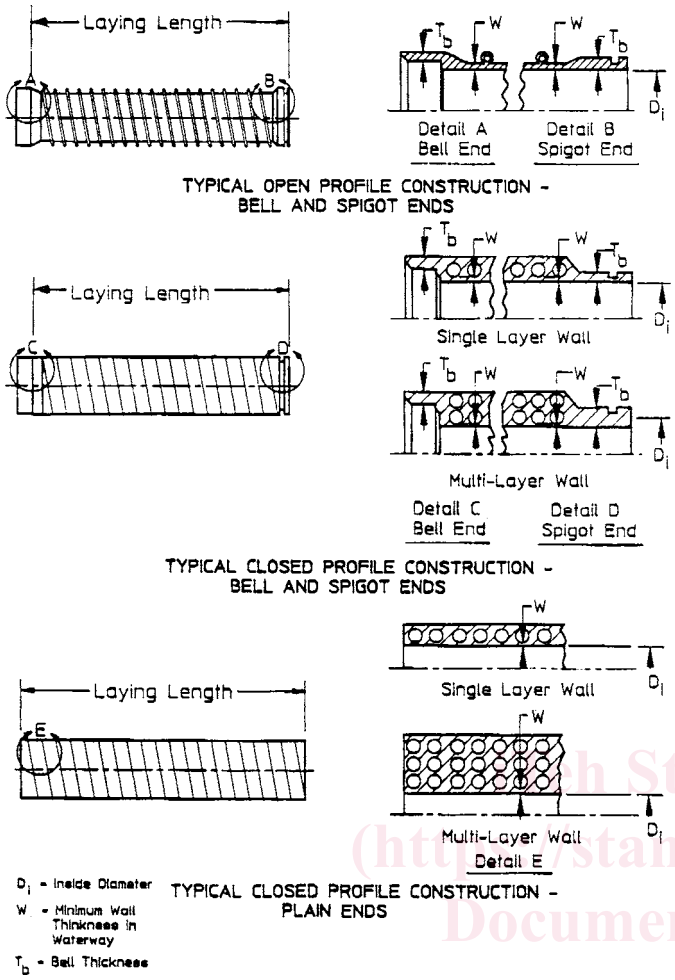

FIG. 1 Typical Construction of Profile Wall PE Pipe

3.2.5 *ring stiffness constant (RSC)*—the value obtained by dividing the parallel plate load in pounds per foot of pipe length, by the resulting deflection, in percent, at 3 % deflection. The ring stiffness constant (RSC) that is used in this specification to classify pipe is a measure of the pipe's deformation resistance to diametrical point loading, such as is experienced during handling and installation. A pipe should resist these loads sufficiently well to allow its installation to prescribed deflection limits.

4. Classifications and Uses

4.1 *Uses*—The requirements of this specification are intended to provide pipe suitable for underground or overground gravity and low pressure drainage of sewer, surface water, and industrial waste.

NOTE 3—Industrial waste disposal lines should be installed only upon the specific approval of the governing code, or other authority, and after determining the suitability of the product under the anticipated environment, temperature, and other end-use conditions. Users should consult the manufacturer for the required product information.

4.2 *Classifications*—This specification covers PE profile wall pipe products made in four standard ring stiffness constant (RSC) classifications, namely 40, 63, 100, and 160. These are referred to as RSC 40, RSC 63, RSC 100, and RSC 160.

NOTE 4—Other RSC classifications may be supplied, as agreed upon between the purchaser and the manufacturer, provided that such product complies in every other respect with the applicable dimensional tolerances and testing requirements of this specification.

4.3 *Joining Systems*:

4.3.1 *Bell and Spigot, Gasketed Type*—Seal is affected by a gasket compressed between the spigot and billed ends of the pipe (see Fig. 2).

4.3.2 *Bell and Spigot, Extrusion Weld Type*—Seal is affected by extrusion welding of the bell and spigot pipe ends (see Fig. 2).

4.3.3 *Heat Fusion*—Heat fusion joints are in accordance with Practice D 2657. Seal is affected by joining molten pipe ends under controlled temperature and pressure (see Fig. 3).

4.3.4 *Plain End Extrusion Weld*—Seal is effected by extrusion welding prepared plain ends of the pipe (see Fig. 4).

4.3.5 *Other*—Where these connections are impractical or undesirable because of space, layout, or other requirement, joining methods such as flanging, restrained integral connectors, and others may be used. Methods proposed should be evaluated by the engineer for suitability.

5. Materials

5.1 *Base Materials*—The pipe shall be made of PE plastic compound meeting the requirements of cell classification PE 334433C (or E) or higher cell classification in accordance with Specification D 3350. The material shall have an established hydrostatic design basis (HDB) of not less than 1250 psi (8.6 MPa) for water at 73.4°F (23°C) determined in accordance with Test Method D 2837.

NOTE 5—A source of hydrostatic design basis (HDB) recommendations for commercial thermoplastic pipe materials is the Plastics Pipe Institute. These are developed on the basis of Test Method D 2837 and additional requirements. A listing of recommended HDB's and the criteria for development may be obtained from the Plastics Pipe Institute, a Division of the Society of the Plastic Industry, Suite 600K, 1801 K Street, NW, Washington, DC 20006-1301.

5.2 *Other Pipe Materials*—Materials other than those specified under base materials may be used as part of the profile construction, for example, as a core tube to support the shape of the profile during processing, provided that these materials are compatible with the base PE material, are completely

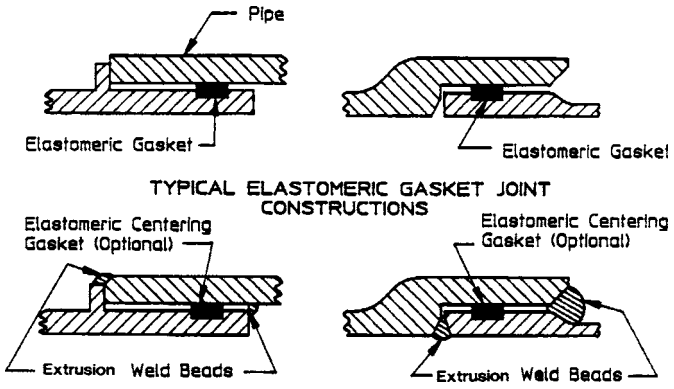

FIG. 2 Typical Extrusion Weld Joint Constructions

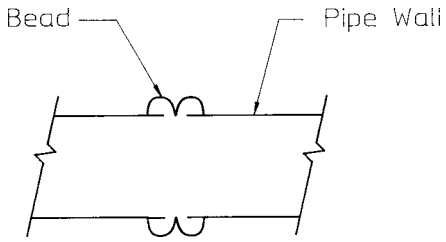

FIG. 3 Heat Fusion

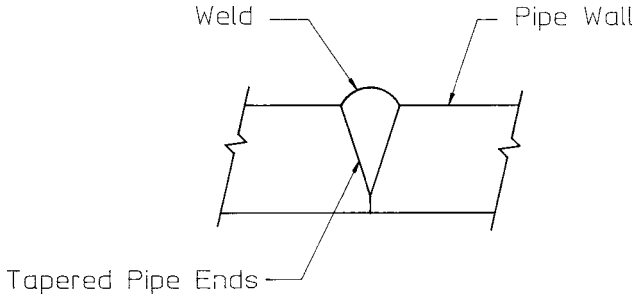

FIG. 4 Extrusion Weld

encapsulated in the finished product, and in no way compromise the performance of the PE pipe products in the intended use. Examples of suitable materials include polyethylene and polypropylene.

5.3 *Rework Material*—Clean rework PE material generated from the manufacturer's own pipe production may be used by the same manufacturer provided the pipe produced meets all the requirements of this specification. Rework material of the type described in 5.2, may only be used to make product if it has been shown to be compatible with the base PE material and allows the production of pipe that meets all the requirements of this specification.

5.4 *Gaskets*—Elastomeric gaskets shall comply with the requirements specified in Specification F 477.

5.5 *Lubricant*—The lubricant used for assembly of gasket joints shall have no detrimental effect on the gasket or on the pipe.

5.6 *Thermal Welding Material*—The material used for thermally welding the pipe material shall meet the requirements established for the base material.

6. Joining System

6.1 *Bell and Spigot* (See Fig. 2):

6.1.1 The pipe ends shall consist of integrally formed bell and spigot, one of which is designed to accommodate a gasket, which when assembled forms a watertight seal by the radial compression of the gasket between the spigot and the bell ends. Alternatively, the pipe ends may act as either spigot or bell to an externally supplied coupling.

6.1.2 The joint shall be designed to avoid displacement of the gasket when it is assembled in accordance with the manufacturer's recommendations.

6.1.3 The assembly of the gasket joints shall be in accordance with the manufacturer's recommendations.

6.2 *Bell and Spigot Thermal Weld Type*:

6.2.1 The pipe ends shall consist of an integrally formed bell and spigot which, when assembled, come together to form an interface between bell and spigot, such that it is suitable for permanent sealing by thermal welding using the extrusion welding process, in accordance with the manufacturer's recommended procedure. Alternatively, the pipe ends may act as either spigot or bell to an externally supplied coupling.

6.2.2 Permanently sealed joints may be effected by welding from inside the pipe or outside, or both.

6.2.3 The assembly of the welded joints shall be in accordance with the manufacturer's recommendations.

6.3 *Heat Fusion* (See Fig. 3):

6.3.1 The pipe ends shall be plain and suitable for machine facing to square.

6.3.2 The assembly of the joint shall be in accordance with Practice D 2657 and the manufacturer's recommendations.

6.4 *Extrusion Welding Plain End* (See Fig. 4):

6.4.1 The pipe ends shall be chamfered as for welding.

6.4.2 Permanently sealed joints may be effected by welding from inside the pipe or outside, or both.

6.4.3 The assembly of the welding joints shall be in accordance with the manufacturer's recommendations.

7. Requirements

7.1 *Workmanship*—The pipe shall be essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be matte or semi-glossy in appearance and be free of chalking, sticky, or tacky material. Slight lines and mold marks (see Note 6) are permissible provided that they do not result in variation of the inside diameter of more than ⅛ in. (3.2 mm) from that obtained on adjacent unaffected portions of the surface, and provided that such pipe meets all of the test requirements set forth in this specification. Apart from the built-in voids and hollows associated with some profile wall designs, the pipe walls shall be free of cracks, blisters, foreign inclusions, or other defects that are visible to the naked eye and that may affect the wall integrity. Bloom or chalking may develop in pipe exposed to direct rays of the sun (ultraviolet radiant energy) for extended periods and consequently the above requirements do not apply to pipe after extended exposure to direct rays of sun.

NOTE 6—Processes currently available for the production of pipe meeting this specification involve tools or molds that may leave small parting lines or flash marks on the surface of the pipe. These are typical of any molding process and in no way affect the performance of the pipe.

7.2 *Pipe Dimensions:—*

7.2.1 *Diameter* The average inside diameter of the pipe, including the diameter in integral spigot sections where present, shall meet the requirements given in Table 1 or Table 2, when measured in accordance with 8.4.1.

7.2.2 *Pipe Wall Thickness*—The minimum wall thickness of the waterway of the pipe (see Fig. 1) shall meet the requirements given in Table 1 or Table 2, when measured in accordance with 8.4.2.

7.2.3 *Bell and Spigot Wall Thickness*—With the exception of the tapered lead-in section, where present, the minimum wall thickness in the bell of the pipe (see Fig. 1) shall meet the values specified in Table 1 or Table 2. The minimum wall thickness of the thinnest section of the spigot shall not be less than that established for the pipe waterway.

TABLE 1 Open Profile Pipe Dimensions and Tolerances

Nominal Pipe Size, in. (mm)	Average Inside Diameter, in. (mm)	Tolerance on Average Inside Diameter, in. (mm)	Min Wall Thickness in Pipe Waterway, *W*				Min Bell Thickness, *Tb*, in. (mm)
			RSC 40, in. (mm)	RSC 63, in. (mm)	RSC 100, in. (mm)	RSC 160, in. (mm)	
18 (460)	18.00 (457.2)	±0.38 (9.65)	0.18 (4.57)	0.18 (4.57)	0.18 (4.57)	0.22 (5.59)	0.70 (17.78)
21 (530)	21.00 (533.4)	±0.38 (9.65)	0.18 (4.57)	0.18 (4.57)	0.18 (4.57)	0.24 (6.10)	0.70 (17.78)
24 (610)	24.00 (609.6)	±0.38 (9.65)	0.18 (4.57)	0.18 (4.57)	0.22 (5.59)	0.24 (6.10)	0.70 (17.78)
27 (690)	27.00 (685.8)	±0.38 (9.65)	0.18 (4.57)	0.18 (4.57)	0.24 (6.10)	0.24 (6.10)	0.70 (17.78)
30 (760)	30.00 (762.0)	±0.38 (9.65)	0.18 (4.57)	0.22 (5.59)	0.24 (6.10)	0.26 (6.60)	0.70 (17.78)
33 (840)	33.00 (838.2)	±0.38 (9.65)	0.18 (4.57)	0.24 (6.10)	0.24 (6.10)	0.30 (7.62)	0.95 (24.13)
36 (910)	36.00 (914.4)	±0.38 (9.65)	0.18 (4.57)	0.24 (6.10)	0.26 (6.60)	0.30 (7.62)	1.05 (26.67)
42 (1070)	42.00 (1066.8)	±0.42 (10.67)	0.24 (6.10)	0.24 (6.10)	0.30 (7.62)	0.38 (9.65)	1.15 (29.21)
48 (1220)	48.00 (1219.2)	±0.48 (12.19)	0.24 (6.10)	0.26 (6.60)	0.30 (7.62)	0.38 (9.65)	1.25 (31.75)
54 (1370)	54.00 (1371.6)	±0.54 (13.72)	0.24 (6.10)	0.30 (7.62)	0.38 (9.65)	0.42 (10.67)	1.25 (31.75)
60 (1520)	60.00 (1524.0)	±0.60 (15.24)	0.26 (6.60)	0.30 (7.62)	0.38 (9.65)	0.52 (13.21)	1.30 (33.02)
66 (1680)	66.00 (1676.4)	±0.66 (16.76)	0.30 (7.62)	0.38 (9.65)	0.42 (10.67)	0.67 (17.02)	1.30 (33.02)
72 (1830)	72.00 (1828.8)	±0.72 (18.29)	0.30 (7.62)	0.38 (9.65)	0.42 (10.67)	0.90 (22.86)	1.30 (33.02)
78 (1980)	78.00 (1981.2)	±0.78 (19.81)	0.30 (7.62)	0.38 (9.65)	0.52 (13.21)	0.90 (22.86)	1.35 (34.29)
84 (2130)	84.00 (2133.6)	±0.84 (21.34)	0.38 (9.65)	0.42 (10.67)	0.67 (17.02)	0.90 (22.86)	1.35 (34.29)
90 (2290)	90.00 (2286.0)	±0.90 (22.86)	0.38 (9.65)	0.42 (10.67)	0.90 (22.86)	0.95 (24.13)	1.35 (34.29)
96 (2440)	96.00 (2438.4)	±0.96 (24.38)	0.38 (9.65)	0.52 (13.21)	0.90 (22.86)	0.95 (24.13)	1.35 (34.29)
108 (2740)	108.00 (2743.2)	±1.08 (27.43)	0.42 (10.67)	0.67 (17.02)	0.90 (22.86)	0.95 (24.13)	1.35 (34.29)
120 (3050)	120.00 (3048.0)	±1.20 (30.48)	0.52 (13.21)	0.67 (17.02)	0.90 (22.86)	0.95 (24.13)	1.35 (34.29)

TABLE 2 Closed Profile Pipe Dimensions and Tolerances

Nominal Pipe Size, in. (mm)	Average Inside Diameter, in. (mm)	Tolerance on Average Inside Diameter, in. (mm)	Min Wall Thickness in Pipe Waterway, *W*, All RSC, in. (mm)	Min Bell Thickness, *Tb*, in. (mm)
10 (250)	10.0 (254.0)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
12 (300)	12.0 (304.8)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
15 (380)	15.0 (381.0)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
18 (460)	18.0 (457.2)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
21 (530)	21.0 (533.4)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
24 (610)	24.0 (609.6)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
27 (690)	27.0 (685.8)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
30 (760)	30.0 (762.0)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
33 (840)	33.0 (838.2)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
36 (910)	36.0 (914.4)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
40 (1020)	40.0 (1016.0)	±0.38 (9.65)	0.18 (4.57)	0.5 (12.7)
42 (1070)	42.0 (1066.8)	±0.42 (10.67)	0.18 (4.57)	0.5 (12.7)
48 (1220)	48.0 (1219.2)	±0.48 (12.19)	0.18 (4.57)	0.5 (12.7)
54 (1370)	54.0 (1371.6)	±0.54 (13.72)	0.18 (4.57)	0.5 (12.7)
60 (1520)	60.0 (1524.0)	±0.60 (15.24)	0.18 (4.57)	0.6 (15.2)
66 (1680)	66.0 (1676.4)	±0.66 (16.76)	0.18 (4.57)	0.6 (15.2)
72 (1830)	72.0 (1828.8)	±0.72 (18.29)	0.18 (4.57)	0.6 (15.2)
78 (1980)	78.0 (1981.2)	±0.78 (19.81)	0.18 (4.57)	0.6 (15.2)
84 (2130)	84.0 (2133.6)	±0.84 (21.34)	0.18 (4.57)	0.7 (17.8)
90 (2290)	90.0 (2286.0)	±0.90 (22.86)	0.18 (4.57)	0.7 (17.8)
96 (2440)	96.0 (2438.4)	±0.96 (24.38)	0.18 (4.57)	0.7 (17.8)
108 (2740)	108.0 (2743.2)	±1.08 (27.43)	0.18 (4.57)	0.7 (17.8)
120 (3050)	120.0 (3048.0)	±1.20 (30.48)	0.18 (4.57)	0.8 (20.3)

7.2.4 *Laying Length*—Standard pipe laying length, measured from the bottom of the bell to the tip of the spigot (see Fig. 1), shall be 20 ft (6.1 m) when measured in accordance with Test Method D 2122. Other laying lengths shall be as agreed upon between the purchaser and the manufacturer. The tolerance on the laying length shall be ±2 in. (50 mm). For pipe with an integral bell, the pipe laying length is measured from the bottom of the bell to the tip of the spigot.

7.3 *Ring Stiffness Constant*—Ring stiffness constant (RSC) for the pipe between bell and spigot sections shall comply with the minimum values given in Table 3, when tested in accordance with 8.5.1 or with the corresponding values established by statistical correlation, developed by the manufacturer and agreed by the purchaser, when measured in accordance with 8.5.2. However, in cases of disagreement the pipe shall comply with the values in Table 3, when tested in accordance with

TABLE 3 Minimum Ring Stiffness Constant (RSC) Values

Nominal Pipe Classification	RSC (lb/ft of Length)
40	36
63	56
100	90
160	144