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An American National Standard

Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems[1]

This standard is issued under the fixed designation F2389; 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.

~~ε[1] NOTE—9.1 was editorially corrected in July 2008.~~

1. Scope

1.1 This specification establishes requirements for polypropylene (PP) piping system components made to metric sizes and IPS schedule 80 sizes, and pressure rated for water service and distribution supply (see Appendix X1). Included are criteria for materials, workmanship, dimensions and tolerances, product tests, and marking for polypropylene (PP) piping system components such as pipe, fittings, valves, and manifolds.

1.2 The components governed by this specification shall be permitted for use in water service lines, hot-and-cold water distribution, hydronic heating, and irrigation systems.

1.3 The pipe and fittings produced under this specification shall be permitted to be used to transport industrial process fluids, effluents, slurries, municipal sewage, etc. The user shall consult the manufacturer to determine whether the material being transported is compatible with the polypropylene piping system and will not affect the service life beyond limits acceptable to the user.

1.4 *Units*—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 *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 requirements prior to use.*

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1505 Test Method for Density of Plastics by the Density-Gradient Technique
D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
D1600 Terminology for Abbreviated Terms Relating to Plastics
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2749 Symbols for Dimensions of Plastic Pipe Fittings
D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D4101 Specification for Polypropylene Injection and Extrusion Materials
F412 Terminology Relating to Plastic Piping Systems
F2023 Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water

2.2 *International Organization for Standardization (ISO) Standards:*

ISO 3127 Thermoplastic Pipes—Determination of Resistance to External Blows—Round the Clock Method[3]
ISO 4065 Thermoplastics Pipes—Universal Wall Thickness Table[3]
ISO 9080 Plastics Piping and Ducting Systems—Determination of the Long-Term Hydrostatic Strength of Thermoplastics Materials in Pipe Form by Extrapolation[3]
ISO 15874-2:2002 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 2: Pipes[3]

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water.

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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] Available from the International Organization for Standardization (ISO) 1, rue de Varembé, Case postale 56 CH-1211 Geneva 20, Switzerland.~~

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

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ISO 15874-3:2002 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 3: Fittings[3]
ISO/TS 15874-7 Plastics Piping Systems for Hot and Cold Water Installations—Polypropylene (PP)—Part 7: Guidance for the Assessment of Conformity[3]

2.3 *NSF International Standards:*

NSF/ANSI 14 Plastics Piping System Components and Related Materials[4]
NSF/ANSI 61 Drinking Water System Components—Health Effects[4]

2.4 *European Norm:*

prEN 10226-1 Pipe Threads Where Pressure Tight Joints are Made on the Threads—Part 1: Designation, Dimensions and Tolerances[5]

2.5 *American Society of Mechanical Engineers (ASME) Standard:*

B1.20.1 Pipe Threads, General Purpose, Inch[6]

2.6 *Plastic Pipe Institute (PPI) Technical Report:*

TR-4 PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials[7]

3. Terminology

3.1 *Definitions*:

3.1.1 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 *polypropylene random copolymer (PP-R)*, *n*—a propylene plastic containing not more than 50 % of another olefinic monomer (or monomers), having no functional group other than the olefinic group, copolymerized with the propylene.

3.2.1.1 *Discussion*—This term is also used for finished compound which comprises the PP-R resin and additives such as colorants, UV inhibitors, and stabilizers. Polypropylene random copolymers containing more than one additional monomer are often referred to as "terpolymers."

3.2.2 *plastic-to-metal transition fittings*, *n*—a fitting designed to provide a means of connection between the PP piping system and metal piping systems such as steel pipe and copper tubing. The fittings include a means of taking into account the differences in thermal expansion of the materials and maintaining a pressure-tight seal over the intended use temperature range.

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4. Classification

4.1 *General*—This specification covers PP piping systems made from PP materials (PP-R) in various dimension ratios and pressure ratings.

4.2 *Thermoplastic Pipe Series and Schedule*—This specification covers PP pipe made in schedule 80 IPS sizes and metric sizes in accordance with ISO 4065.

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5. Materials and Manufacture

5.1 The pipe and fittings shall be polypropylene material of type PP-R. Clean rework material, of the same PP-R resin generated from the manufacturer's own pipe or fitting production, shall be permitted to be used provided the pipe or fittings produced meet all requirements of this specification.

5.2 For pipe compound, the melt flow rate (MFR) shall not exceed 10.8 grain/10 min (0.7 g/10 min), when tested in accordance with D1238 using conditions of 4.76 lbm (2.16 kg) at 446°F (230°C).

5.3 The density of the unreinforced, natural color PP material shall not exceed 56.9 lbm/ft^3 (912 kg/m^3), when tested in accordance with Test Method D1505 or Test Method D792.

5.4 *Minimum Required Strength (MRS)*—The PP material used in the pipe and fittings shall have an MRS value of 1160 psi (8.0 MPa) or 1450 psi (10.0 MPa) based on testing in accordance with ISO 9080 and classification of the lower confidence limit (σ_{LCL}) at 50 years in accordance with ISO 12162.

5.5 *Categorized Required Strength ($CRS_{\theta,t}$)*—The PP material used in the pipe and fittings shall have a $CRS_{\theta,t}$ value of 280 psi (1.93 MPa) based on testing in accordance with ISO 9080 and classification of the lower confidence limit (σ_{LCL}) at 180°F (82°C) and 50 years.

5.6 *Minimum Pressure Rating*—The minimum pressure rating of the pipe shall be 160 psi (1.1 MPa) at 73°F (23°C) and 100 psi (0.69 MPa) at 180°F (82°C) for hot-and-cold distribution and 160 psi (1.1 MPa) at 73°F (23°C) for cold water service.

5.7 *Threads*—Fittings shall be permitted to be threaded by use of metal inserts molded into the fitting.

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[4] Available from the Deutsches Institut für Normung, Burgrafenstrasse 6, 10787 Berlin, Germany.
[5] Available from NSF International, 789 Dixboro Road, Ann Arbor, MI, 48105.
[5] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.
[6] European Committee for Standardization, 36, rue de Stassart, B-1050 Brussels.
[7] Available from the Plastics Pipe Institute, 1825 Connecticut Ave. N.W., Suite 630, Washington, DC 20009.
[7] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

5.7.1 Metal threads shall be constructed of brass or stainless steel inserts molded into the fitting.

5.7.2 Threads shall not be molded or fabricated directly into the polypropylene plastic.

5.8 The piping compound shall be permitted to include colorants, antioxidants, reinforcing materials and additives necessary for the finished product. The modified material and finished product shall meet all requirements of this specification.

NOTE 1—The Plastics Pipe Institute (PPI) publishes listings of minimum required strength (MRS) and categorized required strength ($CRS_{\theta,t}$) ratings for thermoplastic piping materials in Technical Report No. 4 (TR-4). ISO/TS 15874-7 provides guidance on evaluating the effect of additives on long-term strength of the pipe and fittings material.

6. Workmanship, Finish and Appearance

6.1 The pipe and fittings shall be free of visible cracks, holes, foreign inclusions, blisters and other known injurious defects. The pipe and fittings shall be uniform in color, opacity, density and other physical properties.

7. Dimensions and Tolerances

7.1 *Pipe Dimensions*—Pipe dimensions shall meet the requirements in 7.1.1 and 7.1.2.

7.1.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 1 (IPS Sch. 80), or Tables 2 and 3 (metric series), when measured in accordance with Test Method D2122. For diameters not shown in these tables, the tolerance shall be the same percentage of outside diameter as those for the closest listed diameter.

7.1.2 *Wall Thicknesses*—The wall thicknesses and tolerances shall be as shown in Table 1, or Tables 2 and 3, when measured in accordance with Test Method D2122. For wall thicknesses (DR's) not shown in these tables, the minimum wall thickness shall be as calculated using the DR and outside diameter, and the tolerance on the wall thickness shall be the same percentage of the calculated minimum wall thickness as for the closest listed minimum wall thickness.

7.1.3 *Threaded Pipe*—Pipe covered by this specification shall not be threaded.

7.2 *Fittings Dimensions*—Fittings dimensions shall meet the requirements in 7.2.1 through 7.2.4.

7.2.1 *Threads*—Taper threads for joining fittings shall comply with the requirements of ASME B1.20.1 for NPT metal thread inserts or prEN 10226-1 for metric threads. Threads used by the manufacturer to join component parts of a fitting together shall meet the manufacturer's specifications.

7.2.2 *Laying Lengths*—Laying lengths shall be in accordance with the manufacturer's specifications.

7.2.3 *Socket-fused Fittings*—Dimensions for socket-fused fittings shall be in accordance with Tables 4 and 5 (IPS Sch 80) or Tables 6 and 7 (metric series). Socket depth shall be measured from the face of the socket entrance to the face of the pipe stop at the socket bottom.

7.2.4 *Electrofusion Fittings*—Dimensions for electrofusion fittings shall be in accordance with manufacturer's specifications.

7.2.5 *Valves and Flanges*—Dimensions for valves and flanges shall be in accordance with the manufacturer's specifications.

8. Requirements

8.1 *Longitudinal Reversion*—When tested in accordance with ISO 15874-2, at the conditions given in Table 8, the mean relative change in pipe length shall not exceed 2 %.

8.2 *Melt Flow Rate (MFR) of Pipe and Fittings*—When tested in accordance with D1238, the MFR of specimens taken from the finished pipe or fittings shall be within 30 % of the MFR of the compound used to produce the pipe or fitting. Two specimens shall be tested, and both shall pass.

8.3 *Impact Strength*—When tested in accordance with ISO 3127, 9 of 10 specimens shall pass at the impact level specified in Table 9 at a test temperature of 32 ± 2°F (0 ± 1°C).

8.4 *Thermal Stability and Oxidative Induction Time (OIT)*—Pipe and fittings shall meet the requirements of 8.4.1–thermal stability by hydrostatic testing, and 8.4.2–oxidative induction time.

8.4.1 When tested in accordance with Test Method D1598, pipe and fittings shall not fail at the pressure corresponding to the pipe circumferential stresses and times given in Table 10. If an assembly fails at a joint, the fitting material shall be permitted to be retested in pipe form.

8.4.2 The oxidative induction time (OIT) shall be determined on pipe and fittings in accordance with Test Method D3895. Two specimens shall be tested and the average OIT of the two shall be at least 80 % of the OIT of the virgin material compound. For

TABLE 1 IPS Schedule 80 OD and Wall Thickness

Nominal Pipe Size	Average Outside Diameter, OD, in.		Tolerance on OD, in.		Out-of-roundness (max–min)		Minimum Wall Thickness, in.		Tolerance on Wall Thickness, in.	
½	0.840	(21.34)	±0.004	(±0.10)	0.015	(0.38)	0.147	(3.73)	+0.020	(+0.51)
¾	1.050	(26.67)	±0.004	(±0.10)	0.020	(0.51)	0.154	(3.91)	+0.020	(+0.51)
1	1.315	(33.40)	±0.005	(±0.13)	0.025	(0.64)	0.179	(4.55)	+0.021	(+0.53)
1-½	1.900	(48.26)	±0.006	(±0.15)	0.030	(0.76)	0.200	(5.08)	+0.024	(+0.61)
2	2.375	(60.33)	±0.006	(±0.15)	0.035	(0.89)	0.218	(5.54)	+0.026	(+0.66)
3	3.500	(88.90)	±0.008	(±0.20)	0.040	(1.02)	0.300	(7.62)	+0.036	(+0.91)
4	4.500	(114.30)	±0.009	(±0.23)	0.050	(1.27)	0.337	(8.56)	+0.040	(+1.02)
6	6.625	(168.28)	±0.011	(±0.28)	0.050	(1.27)	0.432	(10.97)	+0.052	(+1.32)

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TABLE 2 Metric Sizes OD

Nominal Size	Outside Diameter, OD					
	Minimum Average OD, in.		Maximum Average OD, in.		Maximum Out-of-roundness, in.	
16	0.630	(16.0)	0.642	(16.3)	0.016	(0.4)
20	0.787	(20.0)	0.799	(20.3)	0.016	(0.4)
25	0.984	(25.0)	0.996	(25.3)	0.016	(0.4)
32	1.260	(32.0)	1.272	(32.3)	0.020	(0.5)
40	1.575	(40.0)	1.591	(40.4)	0.020	(0.5)
50	1.969	(50.0)	1.988	(50.5)	0.024	(0.6)
63	2.480	(63.0)	2.504	(63.6)	0.024	(0.6)
75	2.953	(75.0)	2.980	(75.7)	0.039	(1.0)
90	3.543	(90.0)	3.579	(90.9)	0.039	(1.0)
110	4.331	(110.0)	4.370	(111.0)	0.039	(1.0)
125	4.921	(125.0)	4.969	(126.2)	0.051	(1.3)
~~140~~	~~5.512~~	~~(140.0)~~	~~5.563~~	~~(141.3)~~	~~0.063~~	~~(1.6)~~
140	5.512	(140.0)	5.563	(141.3)	...	...
~~160~~	~~6.299~~	~~(160.0)~~	~~6.358~~	~~(161.5)~~	~~0.063~~	~~(1.6)~~
160	6.299	(160.0)	6.358	(161.5)	...	...
~~200~~	~~7.874~~	~~(200.0)~~	~~7.953~~	~~(202.0)~~	~~0.079~~	~~(2.0)~~
200	7.874	(200.0)	7.953	(202.0)	...	...
~~250~~	~~9.842~~	~~(250.0)~~	~~9.941~~	~~(252.5)~~	~~0.098~~	~~...~~
250	9.842	(250.0)	9.941	(252.5)	...	...
~~280~~	~~11.023~~	~~(2.0)~~	~~11.142~~	~~(283.0)~~	~~...~~	~~...~~
280	11.023	(280.0)	11.142	(283.0)	...	...
315	12.401	(315.0)	12.528	(318.2)	...	...
355	13.976	(355.0)	14.118	(358.6)	...	...

those materials which require final blending at the extruder (masterbatch/resin), the 80% OIT requirement shall be based on the OIT of the pipe sample which has also passed the hydrostatic testing of 8.4.1or a pipe sample of the same formulation containing no rework.

NOTE 2—Initial qualification of changes to materials that have met the requirements of this section may be evaluated based on limited hydrostatic testing and comparison of OIT values.

8.5 *Hydrostatic Pressure Tests*—When tested in accordance with 9.1, at the hoop stresses and temperatures given in Table 11, assemblies of pipe and fittings shall not fail during the test period specified.

8.6 *Thermocycling*—Plastic-to-metal transition fittings, intended to be used at temperatures above 113°F (45°C) shall not separate or leak during or after being thermocycled 1000 times between the temperatures of 60°F and 180°F (16°C and 82°C). Transition fittings which meet the thermal cycling requirements of ISO 15874-5 for the intended application class are exempt from this requirement. Fittings shall be assembled with pipe per the manufacturer's instructions, and tested in accordance with 9.2.

8.7 *Oxidative Stability in Potable Chlorinated Water Applications*—PP piping intended for use in the transport of potable water shall have a minimum extrapolated time-to-time failure of 50 years when tested and evaluated in accordance with 9.3.

9. Test Methods

9.1 *Hydrostatic Tests*—Test assemblies in accordance with Test Method D1598, at the hoop stresses and temperatures given in Table 11. An assembly shall consist of at least 4 pipe specimens and 6 fitting joints. For testing valves, the assembly shall include at least 3 valves in the shut-off position (seat test) and 3 valves in the open or partially open position (shell test). Assemblies used in testing of manifolds shall include a minimum of 6 of each type of manifold connection.

9.1.1 *Assembly Procedure*—The assemblies shall be made in accordance with the manufacturer's recommended joining procedures and equipment.

9.2 *Thermocycling Test Method for Transition Fittings*:

9.2.1 *Apparatus*—A nitrogen or air source capable of maintaining a nominal internal pressure of 100 ± 10 psi (690 ± 69 kPa) on the specimens is required. The immersion system shall consist of two water reservoirs controlled at 60 ± 3.6°F (16 ± 2°C) and 180 ± 3.6°F (82 ± 2°C). The specimens shall be cycled from one reservoir to the other or the hot and cold water shall be alternately cycled over the test specimens automatically and returned to the proper reservoir.

9.2.2 *Sampling and Specimen Preparation*—Select at random six specimens of the type and size of plastic-to-metal transition fittings to be tested. Assemble the fittings with suitable lengths of pipe or tubing and attach to a common manifold. Assemble strictly in accordance with the instructions of the fitting manufacturer. Close the specimen assembly with any suitable end closures that allow "free-end" mounting and will not leak under the thermocycling conditions, and connect the specimen assembly to the pressure source.

9.2.3 *Procedure*—Pressure the specimen assembly with nitrogen to 100 ± 10 psi (690 ± 69 kPa). Immerse in 60 ± 3.6°F (16 ± 2°C) water to determine if there are any initial leaks. All leaks shall be eliminated before the thermocycling test is started. Thermally cycle the specimen assembly between 60 ± 3.6°F (16 ± 2°C) and 180 ± 3.6°F (82 ± 2°C) by means of immersion in water using the test cycle given in Table 12. For sizes greater than 1-½ in. (40 mm), shorter dwell times shall be permitted if

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TABLE 3 Metric Sizes Wall Thickness

Nominal Size	Minimum Wall Thickness											
	DR = 17.6		DR = 17		DR = 11		DR = 7.3		DR = 6		DR = 5	
	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.	Min Wall, in.	Tolerance, in.
16	... ...	... ...	... ...	... ...	0.071 (1.8)	+0.020 (+0.50)	0.087 (2.2)	+0.020 (+0.50)	0.106 (2.7)	+0.020 (+0.50)	0.130 (3.3)	+0.020 (+0.50)
20	... ...	... ...	... ...	... ...	0.075 (1.9)	+0.009 (+0.23)	0.110 (2.8)	+0.013 (+0.34)	0.134 (3.4)	+0.016 (+0.41)	0.161 (4.1)	+0.019 (+0.49)
25	... ...	... ...	... ...	... ...	0.091 (2.3)	+0.011 (+0.28)	0.138 (3.5)	+0.017 (+0.42)	0.165 (4.2)	+0.020 (+0.50)	0.201 (5.1)	+0.024 (+0.61)
32	... ...	... ...	... ...	... ...	0.114 (2.9)	+0.014 (+0.35)	0.173 (4.4)	+0.021 (+0.53)	0.213 (5.4)	+0.026 (+0.65)	0.256 (6.5)	+0.031 (+0.78)
40	... ...	... ...	... ...	... ...	0.146 (3.7)	+0.017 (+0.44)	0.217 (5.5)	+0.026 (+0.66)	0.264 (6.7)	+0.032 (+0.80)	0.319 (8.1)	+0.038 (+0.97)
50	... ...	... ...	... ...	... ...	0.181 (4.6)	+0.022 (+0.55)	0.272 (6.9)	+0.033 (+0.83)	0.327 (8.3)	+0.039 (+1.00)	0.398 (10.1)	+0.048 (+1.21)
63	... ...	... ...	... ...	... ...	0.228 (5.8)	+0.027 (+0.70)	0.339 (8.6)	+0.041 (+1.03)	0.413 (10.5)	+0.050 (+1.26)	0.500 (12.7)	+0.060 (+1.52)
75	... ...	... ...	... ...	... ...	0.268 (6.8)	+0.032 (+0.82)	0.406 (10.3)	+0.049 (+1.24)	0.492 (12.5)	+0.059 (+1.50)	0.594 (15.1)	+0.071 (+1.81)
90	... ...	... ...	... ...	... ...	0.323 (8.2)	+0.039 (+0.98)	0.484 (12.3)	+0.058 (+1.48)	0.591 (15.0)	+0.071 (+1.80)	0.713 (18.1)	+0.086 (+2.17)
110	... ...	... ...	... ...	... ...	0.394 (10.0)	+0.047 (+1.20)	0.594 (15.1)	+0.071 (+1.81)	0.720 (18.3)	+0.086 (+2.20)	0.870 (22.1)	+0.104 (+2.65)
125	... ...	... ...	... ...	... ...	0.449 (11.4)	+0.054 (+1.37)	0.673 (17.1)	+0.081 (+2.05)	0.819 (20.8)	+0.098 (+2.50)	0.988 (25.1)	+0.119 (+3.01)
140	... ...	... ...	... ...	... ...	0.500 (12.7)	+0.060 (+1.52)	0.756 (19.2)	+0.091 (+2.30)	0.917 (23.3)	+0.110 (+2.80)	1.106 (28.1)	+0.133 (+3.37)
160	... ...	... ...	... ...	... ...	0.575 (14.6)	+0.069 (+1.75)	0.862 (21.9)	+0.103 (+2.63)	1.047 (26.6)	+0.126 (+3.19)	1.264 (32.1)	+0.152 (+3.85)
200	... ...	... ...	... ...	... ...	0.716 (18.2)	+0.083 (+2.1)	1.079 (27.4)	+0.122 (+3.1)	1.311 (33.3)	+0.154 (+3.9)	1.575 (40.0)	+0.181 (+4.6)
250	... ...	... ...	... ...	... ...	0.894 (22.7)	+0.102 (+2.6)	1.346 (34.2)	+0.157 (+4.0)	1.642 (41.7)	+0.189 (+4.8)	1.968 (50.0)	+0.220 (+5.6)
280	0.626 (15.9)	+0.071 (+1.8)	0.653 (16.6)	+0.075 (+1.9)	1.000 (25.4)	+0.110 (+2.8)	... ...	... ...	... ...	... ...	... ...	... ...
315	0.705 (17.9)	+0.079 (+2.0)	0.736 (18.7)	+0.083 (+2.1)	1.126 (28.6)	+0.122 (+3.1)	... ...	... ...	... ...	... ...	... ...	... ...
355	0.791 (20.1)	+0.091 (+2.3)	0.831 (21.1)	+0.094 (+2.4)	1.268 (32.2)	+0.138 (+3.5)	... ...	... ...	... ...	... ...	... ...	... ...

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TABLE 4 IPS Sch 80 Socket-weld Fittings

Nominal Size	Socket Entrance, A						Socket Bottom, B					
	Average, in.		Tolerance on Average, in.		Maximum Out-of-roundness, in.		Average, in.		Tolerance on Average, in.		Maximum Out-of-roundness, in.	
½	0.840	(21.34)	±0.010	(±0.25)	0.012	(0.30)	0.794	(20.17)	±0.005	(±0.13)	0.012	(0.30)
¾	1.050	(26.67)	±0.010	(±0.25)	0.012	(0.30)	1.000	(25.40)	±0.007	(±0.18)	0.012	(0.30)
1	1.311	(33.30)	±0.010	(±0.25)	0.016	(0.41)	1.258	(31.95)	±0.007	(±0.18)	0.012	(0.30)
1-½	1.898	(48.21)	±0.012	(±0.30)	0.016	(0.41)	1.830	(46.48)	±0.007	(±0.18)	0.015	(0.38)
2	2.383	(60.53)	±0.012	(±0.30)	0.016	(0.41)	2.308	(58.62)	±0.007	(±0.18)	0.015	(0.38)
3	3.513	(89.23)	±0.012	(±0.30)	0.040	(1.02)	3.427	(87.05)	±0.010	(±0.25)	0.020	(0.51)
4	4.522	(114.86)	±0.015	(±0.38)	0.040	(1.02)	4.417	(112.19)	±0.010	(±0.25)	0.020	(0.51)
6	6.656	(169.06)	±0.032	(±0.81)	0.050	(1.27)	6.512	(165.40)	±0.012	(±0.30)	0.040	(1.02)

TABLE 5 IPS Sch 80 Socket-weld Fittings

Nominal Size	Socket depth, C				Wall Thickness			
	Min, in.		Max, in.		Socket, E, Min, in.		Body, F, Min, in.	
½	0.835	(21.21)	0.865	(21.97)	0.147	(3.73)	0.185	(4.70)
¾	0.960	(24.38)	0.990	(25.15)	0.154	(3.91)	0.195	(4.95)
1	1.085	(27.56)	1.115	(28.32)	0.179	(4.55)	0.225	(5.72)
1-½	1.335	(33.91)	1.365	(34.67)	0.200	(5.08)	0.250	(6.35)
2	1.460	(37.08)	1.490	(37.85)	0.218	(5.54)	0.275	(6.99)
3	1.830	(46.48)	1.860	(47.24)	0.300	(7.62)	0.375	(9.53)
4	2.205	(56.01)	2.235	(56.77)	0.337	(8.56)	0.420	(10.67)
6	2.955	(75.06)	2.985	(75.82)	0.432	#####	0.540	(13.72)

TABLE 6 Metric Series Socket-weld Fittings

Nominal Size	Socket Entrance, A						Socket Bottom, B					
	Minimum Average Diameter, in.		Maximum Average Diameter, in.		Maximum Out-of-roundness, in.		Minimum Average Diameter, in.		Maximum Average Diameter, in.		Maximum Out-of-roundness, in.	
16	0.598	(15.20)	0.610	(15.50)	0.016	(0.40)	0.594	(15.10)	0.606	(15.40)	0.016	(0.40)
20	0.756	(19.20)	0.768	(19.50)	0.016	(0.40)	0.748	(19.00)	0.760	(19.30)	0.016	(0.40)
25	0.953	(24.20)	0.965	(24.50)	0.016	(0.40)	0.941	(23.90)	0.957	(24.30)	0.016	(0.40)
32	1.224	(31.10)	1.240	(31.50)	0.020	(0.50)	1.217	(30.90)	1.232	(31.30)	0.020	(0.50)
40	1.535	(39.00)	1.551	(39.40)	0.020	(0.50)	1.528	(38.80)	1.543	(39.20)	0.020	(0.50)
50	1.925	(48.90)	1.945	(49.40)	0.024	(0.60)	1.917	(48.70)	1.937	(49.20)	0.024	(0.60)
63	2.437	(61.90)	2.461	(62.50)	0.024	(0.60)	2.425	(61.60)	2.445	(62.10)	0.024	(0.60)
75	2.925	(74.30)	2.949	(74.90)	0.039	(1.00)	2.878	(73.10)	2.902	(73.70)	0.039	(1.00)
90	3.516	(89.30)	3.539	(89.90)	0.039	(1.00)	3.461	(87.90)	3.484	(88.50)	0.039	(1.00)
110	4.307	(109.40)	4.331	(110.00)	0.039	(1.00)	4.240	(107.70)	4.264	(108.30)	0.039	(1.00)
125	4.898	(124.40)	4.921	(125.00)	0.039	(1.00)	4.827	(122.60)	4.850	(123.20)	0.039	(1.00)

TABLE 7 Metric Series Socket-weld Fittings

Nominal Size	Socket Depth, C				Wall Thickness			
	Min, in.		Max, in.		Socket, E, Min, in.		Body, F, Min, in.	
16	0.524	(13.30)	0.622	(15.80)	0.121	(3.06)	0.161	(4.08)
20	0.571	(14.50)	0.669	(17.00)	0.145	(3.69)	0.194	(4.92)
25	0.630	(16.00)	0.728	(18.50)	0.167	(4.25)	0.223	(5.67)
32	0.713	(18.10)	0.811	(20.60)	0.212	(5.38)	0.282	(7.17)
40	0.807	(20.50)	0.906	(23.00)	0.256	(6.50)	0.341	(8.67)
50	0.925	(23.50)	1.024	(26.00)	0.335	(8.50)	0.446	(11.33)
63	1.079	(27.40)	1.177	(29.90)	0.413	(10.50)	0.551	(14.00)
75	1.181	(30.00)	1.319	(33.50)	0.492	(12.50)	0.656	(16.67)
90	1.299	(33.00)	1.496	(38.00)	0.591	(15.00)	0.787	(20.00)
110	1.457	(37.00)	1.732	(44.00)	0.723	(18.38)	0.965	(24.50)
125	1.575	(40.00)	1.850	(47.00)	0.822	(20.88)	1.096	(27.83)

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it has been demonstrated that the shorter time is sufficient to achieve the test temperature at the internal surface of the fitting. Upon completion of the 1000 cycles, immerse the specimen assembly in 60 ± 3.6°F (16 ± 2°C) water to determine if there are any leaks.

9.2.4 *Interpretation of Results*—Any evidence of leakage at any one of the transition fittings or separation of any transition fitting from the pipe or tubing constitutes a failure of this test.

9.3 *Oxidative Stability in Potable Chlorinated Water Applications*—The test shall be conducted, and the extrapolated time-to-failure shall be determined in accordance with Test Method F2023. The test fluid shall be reverse-osmosis (RO) or deionized (DI) water prepared in accordance with 9.1.1 of Test Method F2023.