



Designation: **F1960–23** **F1960 – 23a**

An American National Standard

Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing¹

This standard is issued under the fixed designation F1960; 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 cold expansion fittings and cross-linked (PEX) reinforcing rings for use with cross-linked polyethylene (PEX) plastic tubing in nominal tubing sizes of $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, and 3 in. that meet the requirements of Specification **F876** or **F3253** and for use with Polyethylene of Raised Temperature (PE-RT) pipe in nominal tubing sizes of $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, and 3 that meet the requirements of Specification **F2769**. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180 °F (82 °C). The system is comprised of a PEX reinforcing ring and a cold expansion fitting. Included are the requirements for materials, workmanship, dimensions, and markings to be used on the fitting components. The components covered by this specification are intended for use in residential and commercial, hot and cold, potable water distribution systems as well as building supply lines, sealed central heating, including under-floor-heating systems.

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.

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

1.4 *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

[A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts](#)

[B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines](#)

[B140/B140M Specification for Copper-Zinc-Lead \(Red Brass or Hardware Bronze\) Rod, Bar, and Shapes](#)

[B62 Specification for Composition Bronze or Ounce Metal Castings](#)

[B75/B75M Specification for Seamless Copper Tube](#)

[B140/B140M Specification for Copper-Zinc-Lead \(Red Brass or Hardware Bronze\) Rod, Bar, and Shapes](#)

[B283/B283M Specification for Copper and Copper-Alloy Die Forgings \(Hot-Pressed\)](#)

¹ This specification is under the jurisdiction of ASTM Committee **F17** on Plastic Piping Systems and is the direct responsibility of Subcommittee **F17.10** on Fittings. Current edition approved Feb. 1, 2023/April 1, 2023. Published February 2023/April 2023. Originally approved in 1999. Last previous edition approved in 2022/2023 as **F1960–22**; **F1960 – 23**. DOI: [10.1520/F1960-23](https://doi.org/10.1520/F1960-23); [10.1520/F1960-23A](https://doi.org/10.1520/F1960-23A).

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

- B371/B371M Specification for Copper-Zinc-Silicon Alloy Rod
- B453/B453M Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes
- B584 Specification for Copper Alloy Sand Castings for General Applications
- B927/B927M Specification for Brass Rod, Bar, and Shapes
- B967/B967M Specification for Copper-Zinc-Tin-Bismuth Alloy Rod, Bar and Wire
- 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
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
- D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D6358 Classification System and Basis for Specification for Poly (Phenylene Sulfide) (PPS) Injection Molding, Extrusion and Blow Molding Materials Using ISO Methods
- D6394 Classification System for and Basis for Specification for Sulfone Plastics (SP)
- F412 Terminology Relating to Plastic Piping Systems
- F876 Specification for Crosslinked Polyethylene (PEX) Tubing
- F877 Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems
- F2769 Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems
- F3253 Specification for Crosslinked Polyethylene (PEX) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems

2.2 ANSI Standard:

- B1.20 Pipe Threads General Purpose³
- B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
- B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

2.3 NSF Standards:

- NSF 14 for Plastic Piping Components and Related Materials⁴
- NSF 61 for Drinking Water System Components-Health Effects⁴

2.4 Manufacturers' Standardization Society Standards:

- SP-104 Wrought Copper Solder Joint Pressure Fittings⁵

2.5 ISO Standards:⁶

- ISO 9080 Plastics piping and ducting systems -- Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
- ISO 12162 Thermoplastics materials for pipes and fittings for pressure applications --Classification, designation and design coefficient

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 indicated.

3.1.2 *PEX reinforcing rings*—cross-linked polyethylene rings used to add contraction force around the cold expansion fittings.

4. Classification

4.1 This specification covers one class of cold expansion fittings with PEX reinforcing rings suitable for use with PEX tubing that meets the requirements of Specification **F876** or **F3253** and with PE-RT tubing that meets the requirements of Specification **F2769**.

5. Materials and Manufacture

5.1 Cold expansion fittings shall be made from one of the following materials:

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>

⁴ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁵ Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.mss-hq.com>.

⁶ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

5.1.1 Brass:

5.1.1.1 *Machined Brass*—Machined brass fittings shall be made from material meeting the requirements of one of the following listed below:

Specification	Alloy
ASTM B16/B16M	UNS C36000
ASTM B140/B140M	UNS C31400
ASTM B371/B371M	UNS C69300, C69850
Standard EN 12164	CW614N
ASTM B453/B453M	UNS C35300
ASTM B927/B927M	UNS C27450, C27451
ASTM B967/B967M	UNS C49260, C49340

5.1.1.2 *Forged Brass*—Forged brass fittings shall be made from material meeting the requirements of Specification **B283/B283M**, Copper Alloy UNS Nos. C27450, C27451, C27453, C35330, C36500, C37700, C46400, C46500, C48600, C49260, C49340, C69300, or C69850.

5.1.1.3 *Cast Copper Alloys*—Cast copper alloy fittings shall be made from material meeting the requirements of Specification **B584**, Copper Alloy UNS Nos. C84400, C83800, C87850 or C89844 or C89836 or Specification **B62**, Copper Alloy UNS No. C83600, or Standard EN 1982, copper alloy EN Symbol CuSn4Zn6Pb3–C.

5.1.2 Sulfone:

5.1.2.1 *20 % Glass-Filled Polysulfone*—Polysulfone fittings produced using glass reinforcement shall be molded from polysulfone materials as specified in Specification Classification **D6394**. The polymers shall consist of polysulfone and glass fiber and meet the following line call out for additional properties (SP0110G20A30430).

5.1.2.2 *Unreinforced Sulfone Plastic (SP)*—Fittings shall be molded from sulfone plastic (SP) as specified in Specification Classification **D6394**. The material shall be unreinforced polysulfone (group 01, class 1, grade 2), or polyphenylsulfone (group 3, class 1, grade 2), or unreinforced polyphenylsulfone/polysulfone blends (group 04, class 1, grade 2) or reworked plastic in accordance with **5.1.2.3**.

5.1.2.3 Clean rework material of the same commercial designation, generated for the manufacturer’s own production may be used by the same manufacturer, provided the fittings meet all of the requirements of this specification. Rework material shall not be introduced at a ratio exceeding 25%.

5.1.3 Polyphenylene sulfide (PPS):

5.1.3.1 *Unreinforced Polyphenylene sulfide (PPS)*—Fittings shall be molded from unreinforced Polyphenylene sulfide (PPS) as specified in Specification Classification **D6358**. The polymers shall consist of PPS and meet the following line call out for additional properties (PPS0000B32240).

5.1.3.2 Clean rework material of the same commercial designation, generated for the manufacturer’s own production may be used by the same manufacturer, provided the fittings meet all of the requirements of this specification. Rework material shall not be introduced at a ratio exceeding 25 %.

NOTE 1—All wetted and pressure carrying polymeric materials used to manufacture the fittings should be suitable for the intended applications, that is, hot and cold potable water plumbing systems, in addition to the performance requirements of this specification. Those qualifying characteristics include but are not limited to an established hydrostatic design basis (HDB) in accordance with Test Method **D2837** or a minimum required stress (MRS) in accordance with ISO 9080/ ISO 12162 and a demonstration of resistance to the long-term effects of those chemicals normally found in water conveyed in these applications (for example, disinfectants such as sodium hypochlorite used in potable water) at the maximum temperature stated in this specification.

5.2 Reinforcing rings shall be made from PEX material meeting the performance requirements of **6.1**.

5.3 *Stainless Steel*—fittings shall be made from material meeting the requirements of Specification **A351/A351M**, stainless steel UNS No. J92800 or UNS J92600.

5.4 *Wrought Copper*—Wrought copper fittings shall be made from material meeting the requirements of Specification **B75/B75M** for one of the following coppers: copper UNS C10200, C10300, C10800, or C12200.

6. General Requirements

6.1 *General*—All performance tests shall be performed on assemblies of fittings, PEX reinforcing rings and PEX or PE-RT tubing. Fittings and reinforcing rings shall meet the material and dimensional requirements of this specification. PEX tubing shall meet the requirements of Specification **F876** or **F3253**. PE-RT tubing shall meet the requirements of Specification **F2769**. Assembly of test specimens shall be in accordance with **10.1**. Each assembly shall contain at least two joints. Use separate sets of assemblies for each performance test requirement.

6.1.1 Fitting manufactured according to this specification and intended for use with PEX tubing meeting requirements of Specification **F876**, shall comply with the following performance requirements of Specification **F877**. When a section with an identical title appears in this specification, it contains additional requirements that supplement those found in Specification **F877**.

6.1.1.1 Requirements,

6.1.1.2 Test Methods, and

6.1.1.3 Retest and Rejection.

6.1.2 Fittings, manufactured according to this specification and intended for use with PE-RT tubing meeting the requirements of Specification **F2769**, shall comply with the following performance requirements of Specification **F2769**. When a section with an identical title appears in this Specification, it contains additional requirements that supplement those found in Specification **F2769**.

6.1.2.1 Requirements,

6.1.2.2 Test Methods, and

6.1.2.3 Retest and Rejection.

6.2 *Dimensions*—Any randomly selected fitting or fittings and PEX reinforcing rings shall be used to determine dimensions. Measurements shall be made in accordance with Test Method **D2122**, except determine diameter by making measurements at four locations spaced at approximately 45° apart around the circumference. Inspection and gauging of solder joint ends shall be accordance with ANSI B16.18, ANSI B16.22, or Manufacturers' Standardization Society SP-104.

7. Performance Requirements

7.1 *PEX Reinforcing Rings*:

7.1.1 *Density*—When determined in accordance with **11.1**, the PEX reinforcing rings shall have a density in the range from 926 to 940 kg/m³.

7.1.2 *Degree of Cross-linking*—When tested in accordance with **11.2**, the degree of cross-linking for PEX reinforcing rings shall be within the range from 70 to 89% inclusive.

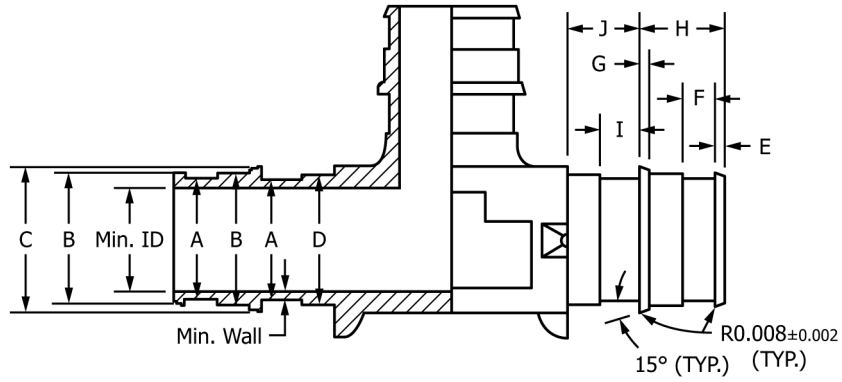
7.1.3 *Stabilizer Functionality*—The material used to make the PEX rings shall meet the stabilizer functionality requirements as defined in **11.3** of Specification **F876**.

8. Dimensions

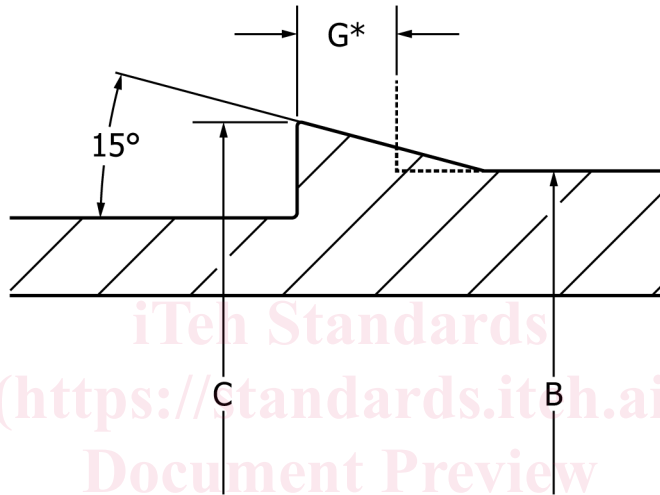
8.1 *Dimensions and Tolerances*—The dimensions and tolerances of fittings and PEX reinforcing rings shall be as shown in **Figs. 1 and 2**, and **Fig. 4** when measured in accordance with **6.2**.

8.1.1 *Alignment*—The maximum angular variation of any opening shall not exceed 1° off the true centerline axis.

8.1.2 *Fittings with Solder Joint Ends*—Solder joint ends shall be in accordance with ANSI B16.22, ANSI B16.18 or MSS SP-104.



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*Maximum width of dimension "G" allowed to transition to surface of dimension "B"

Brass, Stainless Steel and Wrought Copper Dimensions

Nominal Tubing Sizes	Min. Wall	Min. ID	A max min	B max min	C max min	D max min	E max min	F max min	G min	H max min	I max min	J max min
3/8	0.047	0.260	0.395 0.375	0.441 0.433	0.480 0.472	0.427 0.407	0.067 0.051	0.128 0.108	0.051	0.325 0.305	0.127 0.107	0.286 0.266
1/2	0.057	0.378	0.533 0.513	0.579 0.571	0.618 0.610	0.565 0.545	0.067 0.051	0.128 0.108	0.051	0.404 0.384	0.167 0.147	0.325 0.305
5/8	0.057	0.500	0.655 0.635	0.697 0.689	0.748 0.740	0.683 0.663	0.067 0.051	0.167 0.147	0.051	0.482 0.462	0.207 0.187	0.404 0.384
3/4	0.057	0.595	0.748 0.728	0.795 0.787	0.874 0.866	0.782 0.762	0.067 0.051	0.207 0.187	0.051	0.522 0.502	0.246 0.226	0.443 0.423
1	0.072	0.795	0.985 0.965	1.032 1.024	1.110 1.102	0.998 0.978	0.067 0.051	0.246 0.226	0.051	0.640 0.620	0.285 0.265	0.561 0.541
1 1/4	0.075	0.960	1.159 1.139	1.276 1.266	1.362 1.352	1.237 1.217	0.080 0.064	0.299 0.279	0.064	0.781 0.761	0.348 0.328	0.684 0.664
1 1/2	0.095	1.084	1.324 1.304	1.382 1.374	1.494 1.486	1.349 1.329	0.093 0.077	0.351 0.331	0.077	0.919 0.899	0.408 0.388	0.805 0.785
2	0.095	1.550	1.800 1.780	1.958 1.950	2.079 2.071	1.891 1.871	0.093 0.077	0.467 0.447	0.077	1.137 1.117	0.521 0.501	1.030 1.010
2 1/2	0.105	1.990	2.280 2.260	2.430 2.410	2.585 2.565	2.430 2.410	0.155 0.135	0.610 0.590	0.160	1.520 1.480	0.610 0.590	1.350 1.310
3	0.115	2.410	2.720 2.700	2.910 2.890	3.080 3.060	2.910 2.890	0.180 0.160	0.710 0.690	0.190	1.810 1.770	0.720 0.700	1.610 1.570

FIG. 1 Brass and Stainless Steel and Wrought Copper Insert Dimensions and Tolerances

8.1.3 *Tapered Threaded Ends*—Fitting threads shall be right-hand conforming to ANSI B1.20.1. They shall be taper threads (NPT).

9. Workmanship, Finish, and Appearance

9.1 The fittings shall be made from compounds that are homogeneous throughout. The sealing surfaces of the insert shall be smooth and free of foreign material. The fitting walls shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye and that affect wall integrity.

10. Assembly

10.1 *Cold Expansion Joints*—Fittings shall be joined to PEX or PE-RT tubing by the contraction of the expanded tubing and reinforcing ring over the insert of the cold expansion fitting. Fittings and PEX reinforcing rings shall meet the dimensional and material requirements of this standard. PEX tubing shall meet the requirements of Specification **F876** or **F3253**. PE-RT tubing shall meet the requirements of Specification **F2769**.

10.2 *Expansion Tool*—The expansion tool shall expand the PEX tubing and reinforcing ring to a maximum inside diameter as listed in **Table 1**. The expanded tubing shall be round to ensure uniform contraction of the tubing around the cold expansion fitting. The expansion tool shall be inspected for wear according to the manufacturer’s instructions.

10.3 *Procedure:*

10.3.1 *Assembly of Connections*—Refer to manufacturers written installation instructions.

11. Reinforcing Ring Testing Methods

11.1 *Density*—Determine the density of the reinforcing ring material in accordance with Test Method **D1505**, or Test Method **D792**, using three specimens.

11.2 *Degree of Cross-Linking*—Determine the degree of cross-linking in accordance with Test Method **D2765**, Method B except for the following: during sample preparation, place a reinforcing ring in a lathe with automatic feeding. Shave a strip approximately 0.004 in.-thick that consists of the full thickness of the ring. For the purpose of this specification, the degree of cross-linking (*V*) is defined as 100 % minus the extract percent = *V*.

11.3 *Stabilizer Functionality Test*—The PEX reinforcing ring material shall be evaluated for stabilizer functionality by one of the two methods described in this section.

11.3.1 *Significance*—This test need only be performed for original validation of a PEX reinforcing ring compound.

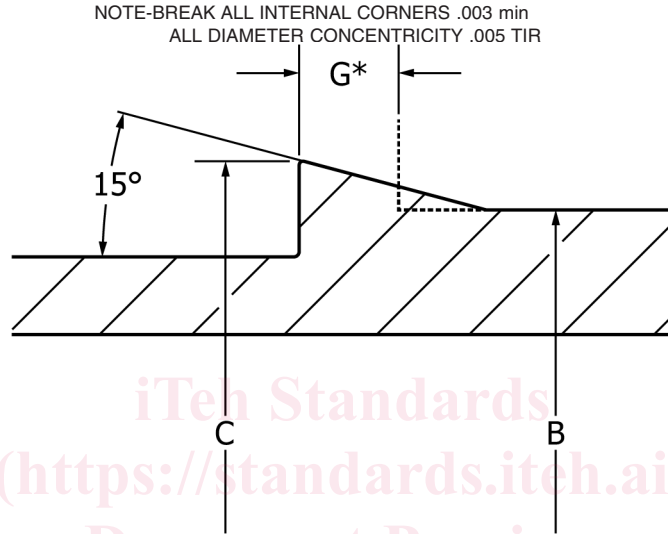
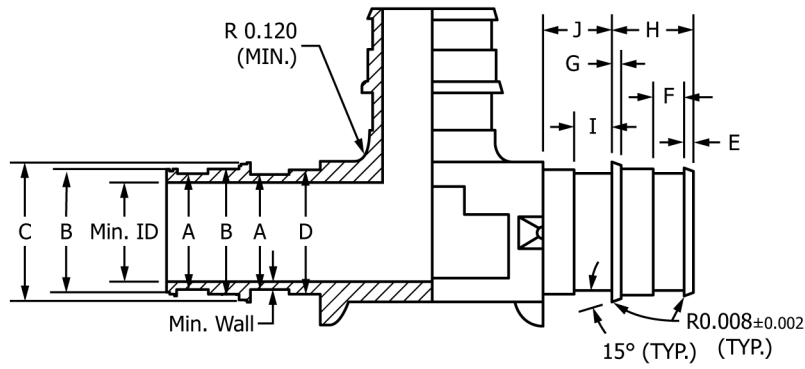
11.3.2 *Method 1:*

11.3.2.1 The material used to make the PEX reinforcing rings shall meet the stabilizer functionality requirements of Specification **F876**.

11.3.3 *Method 2:*

11.3.3.1 *Test Samples*—Six (6) samples shall be tested. A test sample shall consist of a reinforcing ring produced from the PEX compound to be qualified, a piece of PEX tube of the same nominal size as the test reinforcing ring with a minimum length of 6 in. and meeting the requirements of Specification **F876** or **F3253** and a fitting of the same nominal size as the test reinforcing ring which complies with this specification (ASTM F1960). The PEX tube and sample reinforcing ring shall be assembled onto the F1960 fitting using tools and procedures recommended by the reinforcing ring manufacturer.

11.3.3.2 *Test Conditions*—The assembled samples shall be exposed continuously in a hot air oven for 3000 hours at a temperature of 248 °F (± 3.6 °F) or for 8000 hours at a temperature of 230 °F (± 3.6 °F). The samples shall be suspended in the oven by the tube. The reinforcing ring samples shall not touch each other or the oven.



*Maximum width of dimension "G" allowed to transition to surface of dimension "B"

Sulfone and Polyphenylene Sulfide Dimensions

Nominal Tubing Sizes	Min. Wall	Min. ID	A max min	B max min	C max min	D max min	E max min	F max min	G min	H max min	I max min	J max min	Max Flash and Mismatch
3/8	0.047	0.268	0.402 0.382	0.441 0.433	0.480 0.472	0.427 0.407	0.067 0.051	0.128 0.108	0.051	0.325 0.305	0.128 0.108	0.306 0.266	0.005
1/2	0.057	0.385	0.540 0.520	0.579 0.571	0.618 0.610	0.565 0.545	0.067 0.051	0.128 0.108	0.051	0.404 0.384	0.167 0.147	0.345 0.305	0.005
5/8	0.057	0.494	0.648 0.628	0.697 0.689	0.748 0.740	0.683 0.663	0.067 0.051	0.167 0.147	0.051	0.482 0.462	0.207 0.187	0.424 0.384	0.005
3/4	0.057	0.590	0.755 0.735	0.795 0.787	0.874 0.866	0.782 0.762	0.067 0.051	0.207 0.187	0.051	0.522 0.502	0.246 0.226	0.463 0.423	0.005
1	0.072	0.788	0.992 0.972	1.032 1.024	1.110 1.102	0.998 0.978	0.067 0.051	0.246 0.226	0.051	0.640 0.620	0.286 0.266	0.581 0.541	0.005
1 1/4	0.075	0.970	1.159 1.139	1.276 1.266	1.362 1.352	1.237 1.217	0.080 0.064	0.299 0.279	0.064	0.781 0.761	0.348 0.328	0.704 0.664	0.005
1 1/2	0.095	1.084	1.328 1.308	1.382 1.374	1.494 1.486	1.349 1.329	0.093 0.077	0.351 0.331	0.077	0.919 0.899	0.408 0.388	0.825 0.785	0.005
2	0.128	1.484	1.800 1.780	1.958 1.950	2.079 2.071	1.891 1.871	0.093 0.077	0.467 0.447	0.077	1.137 1.117	0.521 0.501	1.050 1.010	0.005
2 1/2	0.175	1.850	2.280 2.260	2.430 2.410	2.585 2.565	2.430 2.410	0.155 0.135	0.610 0.590	0.160	1.520 1.480	0.610 0.590	1.350 1.310	0.005
3	0.210	2.220	2.720 2.700	2.910 2.890	3.080 3.060	2.910 2.890	0.180 0.160	0.710 0.690	0.190	1.810 1.770	0.720 0.700	1.610 1.570	0.005

FIG. 2 Sulfone and Polyphenylene Sulfide Insert Dimensions and Tolerances