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An American National Standard

Standard Specification for Fluoropolymer Resin Heat-Shrinkable Tubing for Electrical Insulation¹

This standard is issued under the fixed designation D2902; 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.

e¹ NOTE—Language was changed editorially in January 2013.

1. Scope-Scope*

- 1.1 This specification applies to flexible heat-shrinkable extruded tubing made from tetrafluoroethylene resin, copolymer of tetrafluoroethylene and hexafluoropropylene, and from perfluoroalkoxy resin for use as electrical insulation. This specification excludes crosslinked poly(vinylidene fluoride) and poly(vinylidene fluoride) copolymer which are covered under Specification D3144.
- Note 1—This standard is similar but not identical to IEC 60684-3-240 to -243.60684-3-240.
 - 1.2 The values stated in inch-pound units are to be regarded as the standard standard, except temperature, which shall be stated in degrees Celsius. Values The values given in parentheses are for information only. mathematical conversions to SI units that are provided for information only and are not considered standard.
 - 1.3 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

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

D638 Test Method for Tensile Properties of Plastics

D1711 Terminology Relating to Electrical Insulation

D2116 Specification for FEP Resin Molding and Extrusion Materials

D2671 Test Methods for Heat-Shrinkable Tubing for Electrical Use

D3144 Specification for Crosslinked Poly(Vinylidene Fluoride) Heat-Shrinkable Tubing for Electrical Insulation

D3307 Specification for Perfluoroalkoxy (PFA) Resin Molding and Extrusion Materials

D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials

D4895 Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion

E176 Terminology of Fire Standards

¹ This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.07 on Electrical Insulating Materials.

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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.

2.2 *IEC Standards*:³

60684-3-240 to -243IEC 60684-3-240 Flexible insulating sleeving, Part 3, sleeving - Part 3: Specifications for individual types of sleeving - Sheets 240 to 243: Heat-shrinkable PTFE sleeving

3. Terminology

- 3.1 Definitions:
- 3.1.1 For definitions pertaining to electrical insulation, refer to Terminology D1711.
- 3.1.2 For definitions pertaining to fire standards, refer to Terminology E176.
 - 3.1 Definitions:
- 3.1.1 For definitions pertaining to electrical insulation, refer to Terminology D1711.
- 3.1.2 For definitions pertaining to fire standards, refer to Terminology E176.

4. Classification

- 4.1 Type I—Tubing made from tetrafluoroethylene polymer (TFE) and capable of being heat shrunk at a temperature of 327°C [621°F].327 °C (621 °F).
- 4.2 Type II—Tubing made from a copolymer of tetrafluoroethylene and hexafluoropropylene (FEP) and capable of being heat shrunk at a temperature of 150°C [302°F].150 °C (302 °F).
- 4.3 Type III—Tubing made from perfluoroalkoxy resin (PFA) and capable of being heat shrunk at a temperature of 175°C [347°F].175 °C (347 °F).

5. Ordering Information

5.1 When ordering to this specification, the purchaser must state the size, and type of the required tubing.

6. Materials and Manufacture

- 6.1 The compound used in the manufacture of this tubing shall be modified fluoropolymer resin, and the finished compound shall be free of all foreign matter other than intended formulation additives as appropriate.
- 6.2 Type I tubing is normally made by paste extrusion. Type II and Type III tubings are normally made by melt extrusion. All types are expanded by mechanical means.

7. Chemical and Physical Property Requirements

- 7.1 The material shall conform to the chemical and physical property requirements specified in Table 1.
- 7.2 Every lot of material manufactured should be tested for dimensional requirements and restricted shrinkage. Other requirements shall be permitted to be tested less frequently or with a frequency agreed upon between seller and purchaser.

8. Dimensional Requirements

- 8.1 Type I material shall conform to the requirements specified in Table 3.
- 8.2 Type II and Type III materials shall conform to the requirements specified in Table 4.

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

TABLE 1 Chemical and Physical Property Requirements

Property		Requirement	
Порену	Type I	Type II	Type III
Restricted shrinkage, A Procedure B, 2000 V, 10 min	no cracking	no cracking	no cracking
testricted shrinkage, ^A procedure B, 2000 V, 10 min	no cracking	no cracking	no cracking
Specific gravity	2.13 to 2.18	2.12 to 2.20	2.13 to 2.20
ongitudinal change, max, %	+ 20	±15	±15
ongitudinal change, max, %	+20	±15	±15
ensile modulus at 200 % elongation, min, psi [MPa] Test Method D638	200<mark>0 [1</mark>3.8]	150<mark>0 [1</mark>0.3]	2500 [17.3]
2 in./min			
5 0 mm/min]			
ensile modulus at 200 % elongation, min, psi (MPa) Test Method D638	2000 (13.8)	1500 (10.3)	2500 (17.3)
in./min			
(50 mm/min)			
olume resistivity ^B , ohm-cm, at standard laboratory atmosphere, min	10¹⁶	10¹⁶	10¹⁶
blume resistivity, -cm, at standard laboratory atmosphere, min	10 ¹⁶	10 ¹⁶	10 ¹⁶
ielectric breakdown voltage, min kV:	<u>10</u>	<u></u>	10
5 ·			
Wall thickness:	0	0	0
Wall thickness 0.004 to 0.006 in.	8	8	8
0.004 to 0.006 in.	<u>8</u> 10	<u>8</u> 10	<u>8</u> 10
0.007 to 0.008 in.			
0.007 to 0.008 in.	<u>10</u>	<u>10</u>	<u>10</u>
	11.5	11.5	11.5
0.009 in.	<u>11.5</u>	<u>11.5</u>	<u>11.5</u>
0.010 to 0.011 in.	12.5	12.5	12.5
0.010 to 0.011 in.	12.5	12.5	12.5
0.012 to 0.014 in.	14.6	14.6	14.6
0.012 to 0.014 in.	14.6	14.6	14.6
0.015 in.	15	15	15
0.015 in.	15	15	15
0.016 to 0.019 in:	16.3	16.3	16.3
0.016 to 0.019 in.	16.3	16.3	16.3
	10.5	10.3	10.5 17
	tandatrds		
0.020 in. and larger	17	<u>17</u>	<u>17</u>
eat resistance: for 96 h followed by tests for tensile modulus at			
eat resistance for 96 h followed by tests for tensile modulus at			
00 %			
elongation, min, psi (MPa)			
Type I 350 ± 4°C [662 ± 7°F]	2000 [13.8]		
Type I—350 ± 4 °C (662 ± 7 °F)	<u>2000 (13.8)</u>		
Type II—250 ± 3°C [482 ± 6°F]		1500 [10.3]	
		1500 (10.3)	
Type III 275 ± 4°C [527 ± 7°F]			2500 [17.3]
Type III—275 \pm 4 °C (527 \pm 7 °F) catalog/standards/sist/49c8			2500 (17.3)
ow-temperature flexibility, - 55± 2°C [-67 ± °F]	no cracking	no cracking	no cracking
ow-temperature flexibility, -55 ± 2 °C (-67 ± °F)	no cracking	no cracking	no cracking
	no cracking	no cracking	no cracking
elting point:	007 : 1000		
Specification D4895	327 ± 10°C		
	- [621± 20°F]		
Specification D4895	327 ± 10 °C		
	(621 ± 20 °F)		
	(621 ± 20 °F)	270 ± 20 °C	
	(621 ± 20 °F)		
Specification D2116	(621 ± 20 °F)	270 ± 20 °C <u>[518 ± 40°F]</u> 270 ± 20 °C	
	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	
Specification D2116 Specification D2116	(621 ± 20 °F)	- [518 ± 40°F]	300 + 2°C
Specification D2116 Specification D2116	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	300 ± 2°C - [572 + 7°F]
Specification D2116 Specification D2116 Specification D3307 endotherm peak, min	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	- [572 ± 7°F]
Specification D2116 Specification D2116	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	$\frac{-[572 \pm 7^{\circ}F]}{300 \pm 2^{\circ}C}$
Specification D2116 Specification D3307 endotherm peak, min Specification D3307 endotherm peak, min	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	[572 ± 7°F] 300 ± 2 °C (572 ± 7 °F)
Specification D2116 Specification D3307 endotherm peak, min Specification D3307 endotherm peak, min	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	<u>[572 ± 7°F]</u> 300 ± 2 °C (572 ± 7 °F) 305 ± 3 °C
Specification D2116 Specification D3307 endotherm peak, min Specification D3307 endotherm peak, min Specification D3307	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	- [572 ± 7°F] 300 ± 2 °C (572 ± 7 °F) 305 ± 3 °C - [581± 5°F]
Specification D2116 Specification D2116 Specification D3307 endotherm peak, min	(621 ± 20 °F)	[518 ± 40°F] 270 ± 20 °C	<u>[572 ± 7°F]</u> 300 ± 2 °C (572 ± 7 °F) 305 ± 3 °C

 $^{^{}A}$ For over-expanded sleeving, use a mandrel equal to the enclosable diameters (D+d)/2.

8.3 Tubing with non-standard dimensions shall be permitted to be supplied when agreed upon between purchaser and seller. Tubing with non-standard dimensions shall be considered to comply with this specification if the requirements of Table 1 are satisfied and the minimum recovered wall thickness equals or exceeds that of the identical or next largest as supplied size. The wall for sizes greater than the largest specified size shall be at least as thick as that of the largest specified size.

^B See Specification C618.



TABLE 2 Mandrel Sizes for Low-Temperature Flexibility Testing

Nominal Tubing Inside Diameter (max after unrestricted shrinkage)		Mandrel Diameter,		
in.	[mm]	in.	[mm]	
0.015 to 0.125	-[0.38 to 3.2]	0.3125 ± 0.002	[7.95± 0.06]	
0.126 to 0.250	- [3.3 to 6.3]	0.375 ± 0.003	$-[8.06\pm0.07]$	
0.251 to 1.000	[6.4 to 26]	0.437 ± 0.004	- [11.10± 0.10]	
1.001 to 2.000	- [27 to 50]	0.875 ± 0.005	$-[16.13 \pm 0.13]$	
2.001 to 3.000	- [51 to 75]	1.000 ± 0.005	$-[25.40 \pm 0.13]$	
3.001 to 4.000	[76 to 101]	$\frac{1.125 \pm 0.005}{}$	$-[28.58\pm0.13]$	

TABLE 2 Mandrel Sizes for Low-temperature Flexibility Testing

Nominal Tubing Inside Diameter (<u>Max After</u> <u>Unrestricted Shrinkage)</u>		Mandrel <u>Diameter</u>		
	in.	<u>(mm)</u>	in.	<u>(mm)</u>
	0.015 to 0.125	(0.38 to 3.2)	0.3125 ± 0.002	(7.95 ± 0.06)
	0.126 to 0.250	(3.3 to 6.3)	0.375 ± 0.003	(8.06 ± 0.07)
	0.251 to 1.000	(6.4 to 26)	0.437 ± 0.004	(11.10 ± 0.10)
	1.001 to 2.000	(27 to 50)	0.875 ± 0.005	(16.13 ± 0.13)
	2.001 to 3.000	(51 to 75)	1.000 ± 0.005	(25.40 ± 0.13)
	3.001 to 4.000	(76 to 101)	1.125 ± 0.005	(28.58 ± 0.13)

9. Workmanship

- 9.1 The heat-shrinkable tubing shall be homogeneous and free from flaws and defects and from foreign matter that have the potential to compromise its performance.
- 9.2 Type I tubing shall be furnished in clear (transparent milk white to tan) or in a color as agreed between purchaser and seller.
- 9.3 Type II tubing shall be furnished in clear (water white to transparent light blue) or in a color as agreed between purchaser and seller.
- 9.4 Type III tubing shall be furnished in clear (transparent water white) or in a color as agreed between the purchaser and seller.
- 10. Sampling indards.iteh.ai/catalog/standards/sist/49c85ba7-38aa-49e9-9c63-43d4690334a3/astm-d2902-21
- 10.1 A lot shall consist of all material manufactured from a single lot of resin at the same time and place.
- Note 2—In view of the batch nature of fluoropolymer resin extrusion involving relatively short runs, single lots of product have the potential to include different sizes or wall thicknesses or both.
- 10.2 Properties shall be permitted to be tested at any stage in processing when they are unaffected by subsequent processing.
- 10.3 Select a quantity of the product at random in accordance with Practice D3636 and Table 5 from each lot as defined in 10.1.
- 10.4 Statistical process control measurements shall be permitted to be used to demonstrate conformance in lieu of the sampling plan noted herein when the demonstrated process capability is greater than the specified AQL.

11. Tests and Retests

- 11.1 If the results of any test, except for attributes listed in Table 3 and 4 and Table 4, do not conform to the requirements prescribed in this specification, perform two additional tests on different specimens from the same lot. Nonconformance to or Table 4 requirements on the first inspection are cause for rejection.
 - 11.2 If either of the two additional tests fail, the purchaser has the option to reject the lot of material. Notice of nonconformance observed by the purchaser based on tests made according to this specification shall be reported to the manufacturer within 60 days from receipt of the material.



TABLE 3 Dimensions, Type I—Lengths for Type I

As Constituted Affair I have shirthing Obstations					
As Supplied Inside Diameter, min, in. (mm)	After Unrestrict Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)	Stock Lengths, ft	Packaging	
As Supplied After Unrestrictive Shrinkage					
Inside Diameter, min, in. [mm]	Inside Diameter, max, in. [mm]	Wall Thickness, in. [mm]	— Stock Lengths	Packaging	
Heavy Wall					
- 0.166 [4.22]	0.130 [3.30]	$0.030 \pm 0.005 [0.76 \pm 0.13]$	3 ft to 1 ft min	straight lengths	
0.166 (4.22)	<u>0.130 (3.30)</u>	$\frac{0.030 \pm 0.005 (0.76 \pm 0.13)}{0.030 \pm 0.005 [0.76 \pm 0.13]}$	3 to 1, min 3 ft to 1 ft min	straight lengths	
- 0.250 [6.35] 0.250 (6.35)	0.193 [4.90] 0.193 (4.90)	$0.030 \pm 0.005 [0.76 \pm 0.13]$ $0.030 \pm 0.005 (0.76 \pm 0.13)$	3 to 1, min	straight lengths straight lengths	
- 0.333 [8.46]	0.257 [6.53]	0.030± 0.005 [0.76 ± 0.13]	3 ft to 1 ft min	straight lengths	
0.333 (8.46)	0.257 (6.53)	$0.030 \pm 0.005 (0.76 \pm 0.13)$	3 to 1, min	straight lengths	
- 0.415 [10.54]	0.320 [8.13]	0.030 ± 0.005 [0.76 ± 0.13]	3 ft to 1 ft min	straight lengths	
0.415 (10.54)	0.320 (8.13)	$0.030 \pm 0.005 (0.76 \pm 0.13)$	3 to 1, min	straight lengths	
- 0.498 [12.65]	0.383 [9.73]	$0.030 \pm 0.005 [0.76 \pm 0.13]$ $0.030 \pm 0.005 (0.76 \pm 0.13)$	3 ft to 1 ft min	straight lengths	
<u>0.498 (12.65)</u> - 0.580 [14.73]	<u>0.383 (9.73)</u> 0.448 [11.38]	$\frac{0.030 \pm 0.005 (0.76 \pm 0.13)}{0.030 \pm 0.005 [0.76 \pm 0.13]}$	3 to 1, min 3 ft to 1 ft min	straight lengths straight lengths	
0.580 (14.73)	0.448 (11.38)	$0.030 \pm 0.005 \ (0.76 \pm 0.13)$	3 to 1, min	straight lengths	
0.666 [16.92]	0.510 [12.95]	0.030± 0.005 [0.76 ± 0.13]	3 ft to 1 ft min	straight lengths	
0.666 (16.92)	0.510 (12.95)	$0.030 \pm 0.005 (0.76 \pm 0.13)$	3 to 1, min	straight lengths	
-0.748 [19.00]	0.572 [14.53]	$0.030 \pm 0.005 [0.76 \pm 0.13]$	3 ft to 1 ft min	straight lengths	
<u>0.748 (19.00)</u> 	<u>0.572 (14.53)</u> 0.637 [16.18]	$\frac{0.030 \pm 0.005 (0.76 \pm 0.13)}{0.030 \pm 0.005 [0.76 \pm 0.13]}$	3 to 1, min 3 ft to 1 ft min	straight lengths straight lengths	
0.830 (21.1)	0.637 (16.18)	$0.030 \pm 0.005 \ [0.76 \pm 0.13]$ $0.030 \pm 0.005 \ (0.76 \pm 0.13)$	3 to 1, min	straight lengths	
0.915 [23.2]	0.700 [17.78]	0.032± 0.006 [0.81 ± 0.15]	3 ft to 1 ft min	straight lengths	
0.915 (23.2)	0.700 (17.78)	$0.032 \pm 0.006 (0.81 \pm 0.15)$	3 to 1, min	straight lengths	
-1.000 [25.4]	0.764 [19.41]	0.040± 0.007 [1.02 ± 0.18]	3 ft to 1 ft min	straight lengths	
1.000 (25.4) 	<u>0.764 (19.41)</u> 0.891 [22.6]	$\frac{0.040 \pm 0.007 (1.02 \pm 0.18)}{0.045 \pm 0.007 [1.14 \pm 0.18]}$	3 to 1, min 3 ft to 1 ft min	straight lengths straight lengths	
1.170 (29.7)	0.891 (22.6)	$0.045 \pm 0.007 \ (1.14 \pm 0.18)$ $0.045 \pm 0.007 \ (1.14 \pm 0.18)$	3 to 1, min	straight lengths	
1.170 (23.7) 1.330 [33.8]	1.020 [25.9]	0.050± 0.008 [1.27 ± 0.20]	3 ft to 1 ft min	straight lengths	
1.330 (33.8)	1.020 (25.9)	$0.050 \pm 0.008 (1.27 \pm 0.20)$	3 to 1, min	straight lengths	
Standard Wall	116	eh Standa			
	0.027 [0.69]	0.012± 0.002 [0.30 ± 0.05]			
0.045 (1.14) 	0.027 (0.69) 0.032 [0.81]	$\frac{0.012 \pm 0.002 (0.30 \pm 0.05)}{0.012 \pm 0.002 [0.30 \pm 0.05]}$	3 ft min	spools	
0.050 (1.27)	0.032 (0.81)	$0.012 \pm 0.002 \ [0.30 \pm 0.05]$ $0.012 \pm 0.002 \ (0.30 \pm 0.05)$	3, min	spools	
- 0.055 [1.40]	0.039 [0.99]	0.016± 0.003 [0.41 ± 0.08]	3 ft min	spools	
0.060 [1.52]	0.043 [1.09]	0.016± 0.003 [0.41 ± 0.08]	3 ft min	spools	
0.055 (1.40)	0.039 (0.99)	$0.016 \pm 0.003 (0.41 \pm 0.08)$	3, min	spools	
- 0.065 [1.65]	0.049 [1.24]	0.016± 0.003 [0.41 ± 0.08]	3 ft min	spools	
	0.054 [1.37] 0.043 (1.09)	$0.016 \pm 0.003 [0.41 \pm 0.08]$ $0.016 \pm 0.003 (0.41 \pm 0.08)$	3 ft min 3, min	spools spools	
- 0.085 [2.16]	0.061 [1.55]	0.016± 0.003 [0.41 ± 0.08]	3 ft min	spools	
0.065 (1.65)	0.049 (1.24)	$0.016 \pm 0.003 (0.41 \pm 0.08)$	3, min	spools	
0.093 [2.36] al US-II	10 10 10 (11 <u>E 1)</u>				
	en.al/ca 0.067 [1.70] dards/s	0.016± 0.003 [0.41 ± 0.08]	O IL IIIIII	a3/astm-C _{spools} 2-21	
0.076 (1.93)	0.054 (1.37)	$\frac{0.016 \pm 0.003 [0.41 \pm 0.08]}{0.016 \pm 0.003 (0.41 \pm 0.08)}$	3, min	a3/astm=0 _{spools} 2=21 spools	
0.110 [2.79]	0.067 [1.70] dards/s 0.054 (1.37) 0.072 [1.83]	0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08]	3, min 3 ft min	a3/astm=0 _{spools} 2 1 spools spools	
0.110 [2.79] 0.085 (2.16)	0.067 [1.70] dards/s 0.054 (1.37) 0.072 [1.83] 0.061 (1.55)	$\frac{0.016 \pm 0.003 [0.41 \pm 0.08]}{0.016 \pm 0.003 (0.41 \pm 0.08)}$	3, min	as/astm-ospools spools spools spools	
0.110 [2.79]	0.067 [1.70] dards/s 0.054 (1.37) 0.072 [1.83]	0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08)	3, min 3 ft min 3, min	spools spools spools straight lengths spools	
0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79)	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83)	0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08)	3, min 3 ft min 3, min 3 ft, 2 ft, 1 ft 3, min 3, min	spools spools straight lengths spools spools spools	
0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56]	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26]	0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08]	3, min 3, min 3, min 3, min 3, tt, 2 ft, 1 ft 3, min 3, min 3, min 3, tt, 2 ft, 1 ft	spools spools spools straight lengths spools spools spools spools spools	
	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03)	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08]	3, min 3, min 3, min 3, min 3, min 3, t, 2 t, 1 ft 3, min 3, min 3, t, 2 t, 1 ft 3, 2, 1	spools spools spools spools straight lengths spools spools spools straight lengths straight lengths straight lengths	
	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56]	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08]	3, min 3, t, 2 t, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt	spools spools spools spools straight lengths spools spools spools straight lengths straight lengths straight lengths	
	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03)	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08]	3, min 3, min 3, min 3, min 3, min 3, t, 2 t, 1 ft 3, min 3, min 3, t, 2 t, 1 ft 3, 2, 1	spools spools spools spools straight lengths spools spools spools straight lengths straight lengths straight lengths	
	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.112 [2.84] 0.101 (2.56)	0.016± 0.003 [0.41± 0.08] 0.016± 0.003 [0.41± 0.08]	3, min 3, tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1	spools spools spools spools straight lengths spools spools spools spools spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08]	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.112 [2.84] 0.101 (2.56) 0.124 [3.15]	0.016± 0.003 [0.41 ± 0.08] 0.016 ± 0.003 (0.41 ± 0.08) 0.016± 0.003 (0.41 ± 0.08)	3, min 3, t, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt 3, 2, 1 3 tt, 2 tt, 1 tt	spools spools spools spools spools straight lengths spools spools spools spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57)	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84)	$\begin{array}{c} 0.016\pm0.003 \ [0.41\pm0.08] \\ 0.016\pm0.003 \ [0.41\pm0.0$	3, min 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1	spools spools spools spools spools spools straight lengths spools spools spools straight lengths	
	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 (2.84) 0.137 [3.30]	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 (0.41 ± 0.08) 0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08]	3, min 3, 2, 1	spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57)	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84)	$\begin{array}{c} 0.016\pm0.003 \ [0.41\pm0.08] \\ 0.016\pm0.003 \ [0.41\pm0.0$	3, min 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1 3, 2, 1	spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57) -0.210 [5.33] 0.200 (5.08) -0.230 [5.84] 0.210 (5.33)	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.141 [3.58] 0.130 (3.30)	0.016±0.003 [0.41±0.08] 0.016±0.003 [0.41±0.08] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10]	3, min 3, 2, 1	spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57) -0.210 [5.33] 0.200 (5.08) -0.230 [5.84] 0.210 (5.33) -0.240 [6.10]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.141 [3.58] 0.130 (3.30) 0.158 [4.01]	0.016±0.003 [0.41±0.08] 0.016±0.003 [0.41±0.08] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10]	3, min 3, t, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft 3, 2, 1 3 ft, 2 ft, 1 ft	spools spools spools spools spools spools straight lengths spools spools spools spools spools straight lengths	
0.110 [2.79] 0.085 (2.16) 0.120 [3.05] 0.093 (2.36) 0.110 (2.79) 0.140 [3.56] 0.120 (3.05) 0.160 [4.06] 0.140 (3.56) 0.180 (4.57] 0.160 (4.06) 0.200 [5.08] 0.190 (5.08) 0.200 (5.08) 0.200 (5.08) 0.210 (5.33) 0.200 (5.33) 0.203 (5.84] 0.210 (5.33)	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.114 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58)	$\begin{array}{c} 0.016\pm0.003 \ [0.41\pm0.08] \\ 0.020\pm0.004 \ [0.51\pm0.10] \\ 0.020\pm0.004 \ [0.51\pm0.1$	3, min 3, 2, 1	spools spools spools spools spools spools spools straight lengths spools spools spools spools straight lengths	
0.110 [2.79] 0.085 (2.16) 0.120 [3.05] 0.093 (2.36) 0.110 (2.79) 0.140 [3.56] 0.120 (3.05) 0.160 [4.06] 0.140 (3.56) 0.180 [4.57] 0.160 (4.06) 0.200 [5.08] 0.200 (5.08) 0.200 (5.08) 0.230 [5.84] 0.210 (5.33) 0.200 [5.84] 0.210 (5.33) 0.200 [5.84]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.112 (3.15) 0.114 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52]	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.020± 0.004 [0.51 ± 0.10] 0.020± 0.004 [0.51 ± 0.10]	3, min 3, 2, 1	spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57) -0.210 [5.33] 0.200 (5.08) -0.230 [5.84] 0.210 (5.33) -0.240 [6.10] 0.230 (5.84) -0.290 [7.37] 0.240 (6.10)	0.067 [1.70] 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.890 [2.03] 0.067 (1.70) 0.072 (1.83) 0.067 (1.70) 0.072 (1.83) 0.080 [2.03] 0.080 (2.03) 0.101 [2.56] 0.080 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.130 [3.30] 0.141 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52] 0.158 (4.01)	0.016±0.003 [0.41±0.08] 0.016±0.003 [0.41±0.08] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10]	3, min 3, 2, 1	spools straight lengths	
0.110 [2.79] 0.085 (2.16) 0.120 [3.05] 0.093 (2.36) 0.110 (2.79) 0.140 [3.56] 0.120 (3.05) 0.160 [4.06] 0.140 (3.56) 0.180 [4.57] 0.160 (4.06) 0.200 [5.08] 0.200 (5.08) 0.200 (5.08) 0.230 [5.84] 0.210 (5.33) 0.200 [5.84] 0.210 (5.33) 0.200 [5.84]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.089 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.112 (3.15) 0.114 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52]	0.016± 0.003 [0.41 ± 0.08] 0.016± 0.003 [0.41 ± 0.08] 0.020± 0.004 [0.51 ± 0.10] 0.020± 0.004 [0.51 ± 0.10]	3, min 3, 2, 1	spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 [4.57] 0.160 (4.06) -0.200 [5.08] 0.180 (4.57) -0.210 [5.33] 0.200 (5.08) -0.230 [5.84] 0.210 (5.33) -0.240 [6.10] 0.230 (5.84) -0.290 [7.37] 0.240 (6.10) -0.310 [7.87] 0.290 (7.37) -0.370 [9.40]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.141 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52] 0.158 (4.01) 0.198 [5.03] 0.178 (4.52) 0.224 [5.69]	0.016±0.003 [0.41±0.08] 0.016±0.003 [0.41±0.08] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10]	3, min 3, 2, 1	spools straight lengths	
0.110 [2.79] 0.085 (2.16) 0.120 [3.05] 0.093 (2.36) 0.110 (2.79) 0.140 [3.56] 0.120 (3.05) 0.160 [4.06] 0.140 (3.56) 0.180 [4.57] 0.160 (4.06) 0.200 [5.08] 0.180 (4.57) 0.210 [5.33] 0.200 (5.08) 0.230 [5.84] 0.210 (5.33) 0.200 [5.84] 0.210 (5.33) 0.200 [5.84] 0.210 (5.33) 0.200 [7.37] 0.240 [6.10] 0.230 [5.84) 0.290 [7.37] 0.240 (6.10) 0.310 [7.87]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 [2.84] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.114 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52] 0.158 (4.01) 0.198 [5.03] 0.198 (5.03)	0.016± 0.003 [0.41± 0.08] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10]	3, min 3, 2, 1	spools straight lengths	
0.110 [2.79] 0.085 (2.16) 0.120 [3.05] 0.093 (2.36) 0.110 (2.79) 0.140 [3.56] 0.120 (3.05) 0.160 [4.06] 0.140 (3.56) 0.180 [4.57] 0.160 (4.06) 0.200 [5.08] 0.180 (4.57) 0.210 [5.33] 0.200 (5.08) 0.230 [5.84] 0.210 (5.33) 0.200 [5.84] 0.210 [5.37] 0.240 [6.10] 0.230 [5.84] 0.290 [7.37] 0.240 (6.10) 0.310 [7.87] 0.290 [7.37) 0.370 [9.40] 0.310 [7.87) 0.390 [9.91]	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.087 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.101 (2.56) 0.112 [2.84] 0.101 (2.56) 0.124 [3.15] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.141 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52] 0.158 (4.01) 0.198 [5.03] 0.194 [5.03] 0.194 [5.03]	0.016±0.003 [0.41±0.08] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10] 0.020±0.004 [0.51±0.10]	3, min 3,	spools spools spools spools spools straight lengths spools straight lengths	
-0.110 [2.79] 0.085 (2.16) -0.120 [3.05] 0.093 (2.36) 0.110 (2.79) -0.140 [3.56] 0.120 (3.05) -0.160 [4.06] 0.140 (3.56) -0.180 (4.57) 0.160 (4.06) -0.200 [5.08] 0.180 (4.57) -0.210 [5.33] 0.200 (5.08) -0.230 [5.84] 0.210 (5.33) -0.240 [6.10] 0.230 (5.84) -0.290 [7.37] 0.240 (6.10) -0.310 [7.87] 0.290 (7.37) -0.370 [9.40] 0.310 (7.87)	0.067 [1.70] 0.054 (1.37) 0.054 (1.37) 0.072 [1.83] 0.061 (1.55) 0.080 [2.03] 0.067 (1.70) 0.072 (1.83) 0.080 [2.26] 0.080 (2.03) 0.101 [2.56] 0.089 (2.26) 0.112 [2.84] 0.101 (2.56) 0.112 [2.84] 0.112 (2.84) 0.130 [3.30] 0.124 (3.15) 0.114 [3.58] 0.130 (3.30) 0.158 [4.01] 0.141 (3.58) 0.178 [4.52] 0.158 (4.01) 0.198 [5.03] 0.198 (5.03)	0.016± 0.003 [0.41± 0.08] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10] 0.020± 0.004 [0.51± 0.10]	3, min 3, 2, 1	spools straight lengths	

TABLE 3 Continued

		TABLE 3 Continued		
As Supplied	After Unrestr	ictive Shrinkage	0	5
nside Diameter, min, in. (mm)	Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)	Stock Lengths, ft	Packaging
- 0.430 [10.92]	0.278 [7.06]	0.020± 0.004 [0.51 ± 0.10]	3 ft, 2 ft, 1 ft	straight lengths
0.410 (10.41)	0.260 (6.60)	$0.020 \pm 0.004 \ (0.51 \pm 0.10)$	3, 2, 1	straight lengths
0.450 [11.43]	0.311 [7.90]	0.020± 0.004 [0.51 ± 0.10]	3 ft , 2 ft, 1 ft	straight lengths
0.430 (10.92)	0.278 (7.06)	$0.020 \pm 0.004 (0.51 \pm 0.10)$	3, 2, 1	straight lengths
0.470 [11.94]	0.329 [8.36]	$0.020 \pm 0.004 [0.51 \pm 0.10]$	3 ft , 2 ft, 1 ft	straight lengths
0.450 (11.43)	0.311 (7.90)	$0.020 \pm 0.004 (0.51 \pm 0.10)$	3, 2, 1	straight lengths
0.470 [11.94]	0.347 [8.81]	0.020± 0.004 [0.51 ± 0.10]	3 ft , 2 ft, 1 ft	straight lengths
0.470 (11.94)	0.329 (8.36)	$0.020 \pm 0.004 (0.51 \pm 0.10)$	<u>3, 2, 1</u>	straight lengths
0.470 (11.94)	0.347 (8.81)	$0.020 \pm 0.004 (0.51 \pm 0.10)$	3, 2, 1	straight lengths
0.470 [11.94]	0.334 [8.48]	$0.025 \pm 0.005 [0.64 \pm 0.13]$	3 ft, 1 ft min	straight lengths
<u>0.470 (11.94)</u>	0.334 (8.48)	$0.025 \pm 0.005 (0.64 \pm 0.13)$	3, 1, min	straight lengths
- 0.560 [14.22]	0.339 [8.61]	$0.025 \pm 0.005 [0.64 \pm 0.13]$	3 ft, 1 ft min	straight lengths
<u>0.560 (14.22)</u>	<u>0.339 (8.61)</u>	$0.025 \pm 0.005 (0.64 \pm 0.13)$	<u>3, 1, min</u>	straight lengths
- 0.655 [16.64]	0.462 [11.73]	$0.025 \pm 0.005 [0.64 \pm 0.13]$	3 ft, 1 ft min	straight lengths
<u>0.655 (16.64)</u>	0.462 (11.73)	$0.025 \pm 0.005 (0.64 \pm 0.13)$	<u>3, 1, min</u>	straight lengths
 0.750 [19.05]	0.524 [13.31]	$0.025 \pm 0.005 [0.64 \pm 0.13]$	3 ft, 1 ft min	straight lengths
<u>0.750 (19.05)</u>	<u>0.524 (13.31)</u>	$0.025 \pm 0.005 (0.64 \pm 0.13)$	<u>3, 1, min</u>	straight lengths
- 0.930 [23.6]	0.655 [16.64]	$0.030 \pm 0.005 [0.76 \pm 0.13]$	3 ft, 1 ft min	straight lengths
0.930 (23.6)	0.655 (16.64)	$0.030 \pm 0.005 (0.76 \pm 0.13)$	<u>3, 1, min</u>	straight lengths
- 1.125 [28.6]	0.786 [20.0]	$0.035 \pm 0.006 [0.89 \pm 0.15]$	3 ft, 1 ft min	straight lengths
1.125 (28.6)	0.786 (20.0)	$0.035 \pm 0.006 \ (0.89 \pm 0.15)$	3, 1, min	straight lengths
- 1.310 [33.3]	0.911 [23.1]	$0.035 \pm 0.006 [0.89 \pm 0.15]$	3 ft, 1 ft min	straight lengths
1.310 (33.3)	<u>0.911 (23.1)</u>	$0.035 \pm 0.006 (0.89 \pm 0.15)$	<u>3, 1, min</u>	straight lengths
- 1.500 [38.1]	1.036 [26.3]	$0.035 \pm 0.006 [0.89 \pm 0.15]$	3 ft, 1 ft min	straight lengths
1.500 (38.1)	<u>1.036 (26.3)</u>	$0.035 \pm 0.006 \ (0.89 \pm 0.15)$	<u>3, 1, min</u>	straight lengths
in Wall				
0.034 [0.86]	0.015 [0.38]	$0.009 \pm 0.002 [0.23 \pm 0.05]$	3 ft min	spools
- 0.038 [0.97]	0.018 [0.46]	$0.009 \pm 0.002 [0.23 \pm 0.05]$	3 ft min	spools
0.034 (0.86)	0.015 (0.38)	$0.009 \pm 0.002 (0.23 \pm 0.05)$	3, min	spools
0.046 [1.17]	0.022 [0.56]	$0.009 \pm 0.002 [0.23 \pm 0.05]$	3 ft min	spools
 0.050 [1.27]	0.027 [0.69]	0.010 ± 0.002 [0.25 \pm 0.05]	3 ft min	spools
0.038 (0.97)	0.018 (0.46)	$0.009 \pm 0.002 (0.23 \pm 0.05)$	3, min	spools
	0.032 [0.81]	0.010 ± 0.002 [0.25 ± 0.05]	3 ft min	spools
0.046 (1.17)	0.022 (0.56)	$0.009 \pm 0.002 (0.23 \pm 0.05)$	3, min	<u>spools</u>
0.060 [1.52]	0.039 [0.99]	0.012 ± 0.003 [0.30 \pm 0.08]	3 ft min	spools
-0.065 [1.65]	0.043 [1.09]	$0.012\pm0.003[0.30\pm0.08]$	3 ft min	spools
0.050 (1.27)	0.027 (0.69)	$0.010 \pm 0.002 (0.25 \pm 0.05)$	3, min	spools
-0.076 [1.93]	0.049 [1.24]	$0.012 \pm 0.003 [0.30 \pm 0.08]$	3 ft min	spools
0.055 (1.40)	0.032 (0.81)	$0.010 \pm 0.002 (0.25 \pm 0.05)$	3, min	spools
-0.085 [2.16]	0.054 [1.37]	$0.012 \pm 0.003 [0.30 \pm 0.08]$	3 ft min	spools
0.060 (1.52)	0.039 (0.99)	$0.012 \pm 0.003 (0.30 \pm 0.08)$	3, min 3 ft min	spools
	0.061 [1.55] eh.a/ca 0.043 (1.09) dards	0.012± 0.003 [0.30 ± 0.08]	e9-9c63-3, min 469033	4a3/astm-spools
- 0.110 [2.79]		$\frac{0.012 \pm 0.003 (0.30 \pm 0.08)}{0.012 \pm 0.003 [0.30 \pm 0.08]}$	3, min 3 ft min	4a3/aSUTF Cspools 2-21
0.076 (1.93)	0.067 [1.70] 0.049 (1.24)	$0.012 \pm 0.003 \ [0.30 \pm 0.08]$ $0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, min	spools
- 0.120 [3.05]	0.049 (1.24) 0.072 [1.83]	$\frac{0.012 \pm 0.003 (0.30 \pm 0.08)}{0.012 \pm 0.003 [0.30 \pm 0.08]}$	3 ft, 2 ft, 1 ft	straight lengths
0.085 (2.16)	0.054 (1.37)	$0.012 \pm 0.003 \ [0.30 \pm 0.00]$ $0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, min	spools
0.140 [3.56]	0.034 (1.37) 0.080 [2.03]	0.012 ± 0.003 (0.30 ± 0.08) 0.012± 0.003 [0.30 ± 0.08]	3 ft, 2 ft, 1 ft	straight lengths
				0 0
0.093 (2.36)	0.061 (1.55)	$0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, min	spools
<u>0.110 (2.79)</u> 	<u>0.067 (1.70)</u> 0.089 [2.26]	$\frac{0.012 \pm 0.003 (0.30 \pm 0.08)}{0.012 \pm 0.003 [0.30 \pm 0.08]}$	<u>3, min</u> 3 ft, 2 ft, 1 ft	<u>spools</u> straight lengths
0.120 (3.05)	0.072 (1.83)	$0.012 \pm 0.003 \ [0.30 \pm 0.08]$ $0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, 2, 1	straight lengths
0.120 (3.05) 	0.072 (1.65) 0.101 [2.56]	$\frac{0.012 \pm 0.003 (0.30 \pm 0.08)}{0.012 \pm 0.003 [0.30 \pm 0.08]}$	3 ft, 2 ft, 1 ft	straight lengths
0.140 (3.56)	0.080 (2.03)	$0.012 \pm 0.003 \ [0.30 \pm 0.08]$ $0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, 2, 1	straight lengths
0.140 (3.36) 0.191 [4.85]	0.000 (2.03) 0.112 [2.84]	0.012 ± 0.003 (0.30 ± 0.08) 0.012± 0.003 [0.30 ± 0.08]	3 ft, 2 ft, 1 ft	straight lengths
0.150 (3.81)	0.089 (2.26)	$0.012 \pm 0.003 \ [0.30 \pm 0.08]$ $0.012 \pm 0.003 \ (0.30 \pm 0.08)$	3, 2, 1	straight lengths
0.150 (3.61) 	0.069 (2.26) 0.124 [3.15]	$\frac{0.012 \pm 0.003 (0.30 \pm 0.08)}{0.015 \pm 0.004 [0.38 \pm 0.10]}$	3, 2, 1 3 ft, 2 ft, 1 ft	straight lengths
0.170 (4.32)	0.101 (2.56)	$0.012 \pm 0.003 \ (0.30 \pm 0.10)$	3, 2, 1	straight lengths
0.170 (4.32) - 0.215 [5.46]	0.130 [3.30]	0.015 ± 0.003 (0.30 ± 0.08) 0.015± 0.004 [0.38 ± 0.10]	3 ft, 2 ft, 1 ft	straight lengths
0.191 (4.85)	0.112 (2.84)	$0.012 \pm 0.003 \ (0.30 \pm 0.10)$	3, 2, 1	straight lengths
0.191 (4.65) 0.240 [6.10]	0.112 (2.64) 0.141 [3.58]	0.015 ± 0.003 (0.30 ± 0.08) 0.015± 0.004 [0.38 ± 0.10]	3 ft, 2 ft, 1 ft	straight lengths
0.205 (5.21)	0.124 (3.15)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	3, 2, 1	straight lengths
0.205 (5.21) 	0.124 (3.13) 0.158 [4.01]	$\frac{0.015 \pm 0.004 (0.38 \pm 0.10)}{0.015 \pm 0.004 [0.38 \pm 0.10]}$	3, 2, 1 3 ft, 2 ft, 1 ft	straight lengths
0.215 (5.46)	0.130 (3.30)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	3, 2, 1	straight lengths
0.215 (5.46) - 0.302 [7.67]	0.130 (3.30) 0.178 [4.53]	0.015 ± 0.004 (0.38 ± 0.10) 0.015± 0.004 [0.38 ± 0.10]	3 ft, 2 ft, 1 ft	straight lengths
0.240 (6.10)	0.178 [4.53] 0.141 (3.58)			straight lengths straight lengths
0.240 (6.10) 		$0.015 \pm 0.004 (0.38 \pm 0.10)$	3, 2, 1	straight lengths
	0.198 [5.03]	0.015 ± 0.004 (0.38 ± 0.10)	3 ft, 2 ft, 1 ft	0 0
<u>0.270 (6.86)</u> - 0.370 [9.40]	<u>0.158 (4.01)</u> 0.224 [5.69]	$\frac{0.015 \pm 0.004 (0.38 \pm 0.10)}{0.015 \pm 0.004 [0.38 \pm 0.10]}$	3, 2, 1 2 ft 2 ft 1 ft	straight lengths
	U.ZZ4 13.091	$0.015 \pm 0.004 [0.38 \pm 0.10]$	3 ft, 2 ft, 1 ft	straight lengths straight lengths
		$0.015 \pm 0.004 (0.00 \cdot 0.40)$		Straight lengths
0.302 (7.67)	0.178 (4.53)	$\frac{0.015 \pm 0.004 (0.38 \pm 0.10)}{0.015 \pm 0.004 [0.38 \pm 0.10]}$	3, 2, 1	
0.302 (7.67) 	0.178 (4.53) 0.249 [6.32]	$0.015 \pm 0.004 \ [0.38 \pm 0.10]$	3 ft , 2 ft, 1 ft	straight lengths
0.302 (7.67) 	0.178 (4.53) 0.249 [6.32] 0.198 (5.03)	$\frac{0.015 \pm 0.004 \left[0.38 \pm 0.10\right]}{0.015 \pm 0.004 \left(0.38 \pm 0.10\right)}$	3 ft, 2 ft, 1 ft 3, 2, 1	straight lengths straight lengths
0.302 (7.67) 	0.178 (4.53) 0.249 [6.32]	$0.015 \pm 0.004 \ [0.38 \pm 0.10]$	3 ft , 2 ft, 1 ft	straight lengths

TABLE 3 Continued

		TABLE 3 Continued		
As Supplied	After Unrestri	ctive Shrinkage	0. 11	5
Inside Diameter, min, in. (mm)	Inside Diameter, max, in. (mm)	Wall Thickness, in. (mm)	Stock Lengths, ft	Packaging
Thin Wall				
- 0.430 [10.92]	0.278 [7.06]	0.015± 0.004 [0.38 ± 0.10]	3 ft, 2 ft, 1 ft	straight lengths
0.390 (9.91)	0.249 (6.32)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	3, 2, 1	straight lengths
0.450 [11.43]	0.311 [7.90]	0.015± 0.004 [0.38 ± 0.10]	3 ft , 2 ft, 1 ft	straight lengths
<u>0.410 (10.41)</u>	0.260 (6.60)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	<u>3, 2, 1</u>	straight lengths
- 0.470 [11.94]	0.329 [8.36]	$0.015 \pm 0.004 \ [0.38 \pm 0.10]$	3 ft, 2 ft, 1 ft	straight lengths
0.430 (10.92)	0.278 (7.06)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	3, 2, 1	straight lengths
	0.347 [8.81]	$0.015 \pm 0.004 [0.38 \pm 0.10]$	3 ft, 2 ft, 1 ft	straight lengths
0.450 (11.43)	0.311 (7.90) 0.300 [10.13]	$0.015 \pm 0.004 (0.38 \pm 0.10)$	3, 2, <u>1</u> 3 ft, 2 ft, 1 ft	straight lengths
 0.560 [14.22] 0.470 (11.94)	0.399 [10.13] 0.329 (8.36)	$0.015 \pm 0.004 [0.38 \pm 0.10]$ $0.015 \pm 0.004 (0.38 \pm 0.10)$	3, 2, 1	straight lengths straight lengths
0.470 (11.94)	0.347 (8.81)	$0.015 \pm 0.004 (0.00 \pm 0.10)$ $0.015 \pm 0.004 (0.38 \pm 0.10)$	3, 2, 1	straight lengths
0.560 [14.22]	0.399 [10.13]	0.020± 0.005 [0.51 ± 0.13]	3 ft, 2 ft, 1 ft	straight lengths
0.560 (14.22)	0.399 (10.13)	$0.015 \pm 0.004 \ (0.38 \pm 0.10)$	3, 2, 1	straight lengths
0.655 [16.64]	0.462 [11.73]	0.018± 0.005 [0.46 ± 0.13]	3 ft , 2 ft, 1 ft	straight lengths
0.560 (14.22)	0.399 (10.13)	$0.020 \pm 0.005 \ (0.51 \pm 0.13)$	<u>3, 2, 1</u>	straight lengths
- 0.655 [16.64]	0.462 [11.73]	$0.020 \pm 0.005 [0.51 \pm 0.13]$	3 ft, 2 ft, 1 ft	straight lengths
0.655 (16.64)	0.462 (11.73)	$0.018 \pm 0.005 (0.46 \pm 0.13)$	3, 2, 1	straight lengths
0.750 [19.05]	0.524 [13.31]	$0.018 \pm 0.005 [0.46 \pm 0.13]$	3 ft, 2 ft, 1 ft	straight lengths
0.655 (16.64)	0.462 (11.73)	$0.020 \pm 0.005 (0.51 \pm 0.13)$	3, 2, 1	straight lengths
0.750 [19.05] 0.750 (19.05)	0.524 [13.31] 0.524 (13.31)	$0.020 \pm 0.005 [0.51 \pm 0.13]$ $0.018 \pm 0.005 (0.46 \pm 0.13)$	3 ft, 2 ft, 1 ft 3, 2, 1	straight lengths straight lengths
0.730 (19.03) 	0.524 (15.51) 0.655 [16.64]	0.010 ± 0.005 (0.40 ± 0.13) 0.020± 0.005 [0.51 ± 0.13]	3 ft, 2 ft, 1 ft	straight lengths
0.750 (19.05)	0.524 (13.31)	$0.020 \pm 0.005 (0.51 \pm 0.13)$	3, 2, 1	straight lengths
- 0.930 [23.6]	0.655 [16.64]	0.025± 0.005 [0.64 ± 0.13]	3 ft, 2 ft, 1 ft	straight lengths
0.930 (23.6)	0.655 (16.64)	$0.020 \pm 0.005 (0.51 \pm 0.13)$	3, 2, 1	straight lengths
1.125 [28.6]	0.786 [20.0]	0.025± 0.005 [0.64 ± 0.13]	3 ft, 2 ft, 1 ft	straight lengths
<u>0.930 (23.6)</u>	<u>0.655 (16.64)</u>	$0.025 \pm 0.005 \ (0.64 \pm 0.13)$	<u>3, 2, 1</u>	straight lengths
- 1.125 [28.6]	0.786 [20.0]	$0.030 \pm 0.006 [0.76 \pm 0.15]$	3 ft , 2 ft, 1 ft	straight lengths
1.125 (28.6)	0.786 (20.0)	$0.025 \pm 0.005 (0.64 \pm 0.13)$	$\frac{3, 2, 1}{3}$	straight lengths
1.125 (28.6)	0.786 (20.0)	$0.030 \pm 0.006 (0.76 \pm 0.15)$	<u>3, 2, 1</u>	straight lengths
2.0:1 Shrink Factor	0.000 [0.50]	0.010 : 0.000 [0.05 : 0.05]	4 4 4	atraight langtha
 0.039 [1] 0.039 (1)	0.020 [0.50] 0.020 (0.50)	$\begin{array}{c} 0.010 \pm 0.002 \ [0.25 \pm 0.05] \\ 0.010 \pm 0.002 \ (0.25 \pm 0.05) \end{array}$	S.iteh 4ti)	straight lengths straight lengths
- 0.059(1) - 0.059[1.5]	0.030 [0.75]	0.010 ± 0.002 (0.25 ± 0.05)	4 ft	straight lengths
0.059(1.5)	0.030 (0.75)	$0.010 \pm 0.002 \ (0.25 \pm 0.05)$		straight lengths
- 0.098 [2.5]	0.049 [1.25]	0.010± 0.002 [0.25 ± 0.05]	eview 4/t	straight lengths
0.098 (2.5)	0.049 (1.25)	$0.010 \pm 0.002 (0.25 \pm 0.05)$		straight lengths
0.138 [3.5]	0.069 [1.75]	0.010 ± 0.002 [0.25 ± 0.05]	4 4 ft	straight lengths
0.138 (3.5)	<u>0.069 (1.75)</u>	$0.010 \pm 0.002 \ (0.25 \pm 0.05)$	<u>4</u> 4 ft	straight lengths
- 0.197 [5]	0.098 [2.5]	$0.010 \pm 0.002 \ [0.25 \pm 0.05]$		straight lengths
0.197 (5)	0.098 (2.5)	$0.010 \pm 0.002 (0.25 \pm 0.05)$	9e9-9c63-4 4t 14690334a3/as	straight lengths
nup s 0.276 [7] dands. It	en.a/cat <mark>o.138 [3.5]</mark> ndards/	$0.020 \pm 0.004 \ [0.50 \pm 0.10]$		straight lengths
0.276 (7)	0.138 (3.5)	$0.020 \pm 0.004 (0.50 \pm 0.10)$	<u>4</u> 4 ft	straight lengths
	0.197 [5.0]	0.020 ± 0.004 (0.50 ± 0.10)	4 π	straight lengths
0.594 (10) - 0.512 [13]	<u>0.197 (5.0)</u> 0.256 [6.5]	$\frac{0.020 \pm 0.004 (0.50 \pm 0.10)}{0.020 \pm 0.004 [0.50 \pm 0.10]}$	<u>4</u> 4 ft	straight lengths straight lengths
0.512 (13)	0.256 (6.5)	$0.020 \pm 0.004 \ [0.50 \pm 0.10]$ $0.020 \pm 0.004 \ (0.50 \pm 0.10)$	4	straight lengths
- 0.827 [20]	0.394 [10.0]	$\frac{0.020 \pm 0.004 + (0.00 \pm 0.10)}{0.020 \pm 0.004 + (0.50 \pm 0.10)}$	<u>4</u> 4 ft	straight lengths
0.827 (20)	0.394 (10.0)	$0.020 \pm 0.004 \ (0.50 \pm 0.10)$	4	straight lengths
1.024 [26]	0.512 [13.0]	0.030 ± 0.004 [0.75 ± 0.10]	4 -tt	straight lengths
1.024 (26)	0.512 (13.0)	$0.030 \pm 0.004 \ (0.75 \pm 0.10)$	<u>4</u>	straight lengths
Very Thin Wall				
	0.027 [0.69]	$0.006 \pm 0.002 [0.15 \pm 0.05]$	3 ft spools	
-0.055 [1.40]	0.032 [0.81]	$0.006\pm0.002 [0.15\pm0.05]$	3 ft	spools
0.050 (1.27)	0.027 (0.69)	$0.006 \pm 0.002 (0.15 \pm 0.05)$	<u>3</u> 3 ft	spools
- 0.060 [1.52] 0.055 (1.40)	0.039 [0.99]	$\frac{0.006 \pm 0.002 \left[0.15 \pm 0.05\right]}{0.006 \pm 0.002 \left(0.15 \pm 0.05\right)}$	ઇ I દ ૧	spools
<u>0.055 (1.40)</u> 	<u>0.032 (0.81)</u> 0.043 [1.09]	$\frac{0.006 \pm 0.002 (0.15 \pm 0.05)}{0.006 \pm 0.002 [0.15 \pm 0.05]}$	<u>3</u> 3 ft	<u>spools</u> spools
0.060 (1.52)	0.039 (0.99)	$0.006 \pm 0.002 \ (0.15 \pm 0.05)$ $0.006 \pm 0.002 \ (0.15 \pm 0.05)$	3	spools
- 0.076 [1.93]	0.039 (0.39) 0.049 [1.24]	0.006 ± 0.002 (0.13 ± 0.03) 0.006± 0.002 [0.15 ± 0.05]	<u>3</u> 3 ft	spools
0.065 (1.65)	0.043 (1.09)	$0.006 \pm 0.002 (0.15 \pm 0.05)$	<u>3</u>	spools
- 0.085 [2.16]	0.054 [1.37]	$\frac{0.006 \pm 0.002}{0.006 \pm 0.002} = \frac{0.15 \pm 0.05}{0.05}$	3 ft	spools
0.076 (1.93)	0.049 (1.24)	$0.006 \pm 0.002 \ (0.15 \pm 0.05)$	<u>3</u>	spools
0.093 [2.36]	0.061 [1.55]	$0.006 \pm 0.002 \ [0.15 \pm 0.05]$	3 ft, 2 ft, 1 ft	straight lengths
0.085 (2.16)	0.054 (1.37)	$0.006 \pm 0.002 \ (0.15 \pm 0.05)$	<u>3</u>	spools
-0.110 [2.79]	0.067 [1.70]	0.006± 0.002 [0.15 ± 0.05]	3 ft, 2 ft, 1 ft	straight lengths
0.093 (2.36)	0.061 (1.55)	$0.006 \pm 0.002 (0.15 \pm 0.05)$	3, 2, 1	straight lengths
- 0.120 [3.05]	0.072 [1.83]	0.008± 0.002 [0.20 ± 0.05]	3 ft, 2 ft, 1 ft	straight lengths
<u>0.110 (2.79)</u> 	<u>0.067 (1.70)</u> 0.080 [2.03]	$\frac{0.006 \pm 0.002 (0.15 \pm 0.05)}{0.008 \pm 0.002 [0.20 \pm 0.05]}$	3, 2, <u>1</u> 3 ft, 2 ft, 1 ft	straight lengths straight lengths
0.120 (3.05)	0.072 (1.83)	$0.008 \pm 0.002 \ (0.20 \pm 0.05)$ $0.008 \pm 0.002 \ (0.20 \pm 0.05)$	3, 2, 1	straight lengths
- 0.150 (3.81)	0.072 (1.03) 0.089 [2.26]	0.008 ± 0.002 [0.20 ± 0.05]	3 ft, 2 ft, 1 ft	straight lengths
0.140 (3.56)	0.080 (2.03)	$0.008 \pm 0.002 (0.20 \pm 0.05)$	3, 2, 1	straight lengths
			<u></u>	