Designation: D 3295 – 97

Standard Specification for PTFE Tubing[1]

This standard is issued under the fixed designation D 3295; 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 PTFE tubing manufactured from PTFE resin produced from dispersion specified in Specification D 4895.

NOTE 1—PTFE tube and rod manufactured from resin specified in Specification D 4894 are covered in Specification D 1710.

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

1.3 The following hazard caveat pertains only to the test method portion, Section 8, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 There is currently no published ISO standard relating to this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

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

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[2]

D 883 Terminology Relating to Plastics[2]

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 1675 Test Method for Polytetrafluoroethylene Tubing[4]

D 1710 Specification for Polytetrafluoroethylene (PTFE) Basic Shapes, Rod, and Heavy-Walled Tubing[2]

D 1898 Practice for Sampling of Plastics[2]

D 3892 Practice for Packaging/Packing of Plastics[5]

D 4894 Specification for Polytetrafluoroethylene Granular Molding and Ram Extrusion Materials[6]

D 4895 Specification for Polytetrafluoroethylene Resin Produced From Dispersion[6]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[6]

3. Terminology

3.1 *Definitions:*

3.1.1 The terminology given in Terminology D 883 is applicable to this specification.

3.2 *Description of Term Specific to This Standard:*

3.2.1 *lot*—a collection of units of product from which a sample is to be drawn and inspected to determine conformance with the acceptability criteria, and is to be accepted or rejected as a whole. It may differ from a collection of units designated as a lot for other purposes, for example, production, shipment, etc.

4. Classification

4.1 This specification provides for two types of PTFE tubing differentiated by size schedule as follows:

4.1.1 *Type I*—Tubing based upon the American Wire Gage (AWG) sizes.

4.1.2 *Type II*—Tubing based upon fractional inch sizes.

4.2 The types are further differentiated in accordance with increasing wall thicknesses as follows:

4.2.1 *Grade A*—Tubing having walls tabulated in Table 1 listed as light-weight wall.

4.2.2 *Grade B*—Tubing having walls of greater thickness than Class A listed as thin wall.

4.2.3 *Grade C*—Tubing having walls tabulated in Table 2 listed as standard wall.

4.2.4 *Grade D*—Tubing having walls tabulated in Table 3 listed as chemical tubing.

4.2.5 *Grade E*—Tubing having walls tabulated in Table 2and Table 3 listed as heavy wall.

4.3 A one-line system may be used to specify materials covered by this specification. The system uses predefined cells

[1] This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.12).

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

[3] *Annual Book of ASTM Standards*, Vols 08.01 and 08.04.

[4] *Annual Book of ASTM Standards*, Vol 10.01.

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

[6] *Annual Book of ASTM Standards*, Vol 14.02.

***A Summary of Changes section appears at the end of this standard.**

TABLE 1 Dimensions and Tolerances for Type I PTFE Tubing, mm (in.) (Grades A and B)

AWG Size	Inside Diameter		Grade A		
			Lightweight Wall		
	min	max	nom	min	max
30	0.25 (0.010)	0.38 (0.015)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
28	0.33 (0.013)	0.46 (0.018)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
26	0.41 (0.016)	0.53 (0.021)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
24	0.51 (0.020)	0.66 (0.026)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
22	0.64 (0.025)	0.81 (0.032)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
20	0.81 (0.032)	1.01 (0.040)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
19	0.91 (0.036)	1.12 (0.044)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
18	1.02 (0.040)	1.25 (0.049)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
17	1.14 (0.045)	1.37 (0.054)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
16	1.30 (0.051)	1.55 (0.061)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
15	1.45 (0.057)	1.70 (0.067)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)
14	1.65 (0.064)	1.88 (0.074)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
13	1.83 (0.072)	2.08 (0.082)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
12	2.06 (0.081)	2.31 (0.091)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
11	2.31 (0.091)	2.57 (0.101)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
10	2.59 (0.102)	2.85 (0.112)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
9	2.90 (0.114)	3.15 (0.124)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
8	3.28 (0.129)	3.58 (0.141)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)
7	3.66 (0.144)	4.01 (0.158)	0.20 (0.008)	0.15 (0.005)	0.25 (0.011)
6	4.12 (0.162)	4.52 (0.178)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
5	4.62 (0.182)	5.03 (0.198)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
4	5.18 (0.204)	5.69 (0.224)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
3	5.82 (0.229)	6.33 (0.249)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
2	6.55 (0.258)	7.06 (0.278)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
1	7.34 (0.289)	7.90 (0.311)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
0	8.26 (0.325)	8.81 (0.347)	0.25 (0.012)	0.22 (0.009)	0.38 (0.015)
AWG Size	Inside Diameter		Grade B		
			Thin Wall		
	min	max	nom	min	max
30	0.25 (0.010)	0.38 (0.015)	0.23 (0.009)	0.19 (0.007)	0.28 (0.011)
28	0.33 (0.013)	0.48 (0.019)	0.23 (0.009)	0.18 (0.007)	0.28 (0.011)
26	0.41 (0.016)	0.56 (0.022)	0.23 (0.009)	0.18 (0.007)	0.28 (0.011)
24	0.51 (0.020)	0.69 (0.027)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
22	0.64 (0.025)	0.81 (0.032)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)
20	0.81 (0.032)	1.01 (0.040)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
19	0.91 (0.036)	1.11 (0.044)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
18	1.02 (0.040)	1.25 (0.049)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
17	1.14 (0.045)	1.38 (0.054)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
16	1.30 (0.051)	1.55 (0.061)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
15	1.45 (0.057)	1.70 (0.067)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
14	1.63 (0.064)	1.88 (0.074)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
13	1.83 (0.072)	2.08 (0.082)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
12	2.06 (0.081)	2.31 (0.091)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
11	2.31 (0.091)	2.57 (0.101)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
10	2.59 (0.102)	2.85 (0.112)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)
9	2.90 (0.114)	3.15 (0.124)	0.38 (0.015)	0.31 (0.012)	0.46 (0.018)
8	3.28 (0.129)	3.58 (0.141)	0.38 (0.015)	0.31 (0.012)	0.46 (0.018)
7	3.66 (0.144)	4.01 (0.158)	0.38 (0.015)	0.31 (0.012)	0.46 (0.018)
6	4.12 (0.162)	4.52 (0.178)	0.38 (0.015)	0.31 (0.012)	0.46 (0.018)
5	4.62 (0.182)	5.03 (0.198)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)
4	5.18 (0.204)	5.69 (0.224)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)
3	5.82 (0.229)	6.33 (0.249)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)
2	6.55 (0.258)	7.06 (0.278)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)
1	7.34 (0.289)	7.90 (0.311)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)
0	8.26 (0.325)	8.81 (0.347)	0.38 (0.015)	0.35 (0.012)	0.46 (0.018)

to refer to specific aspects of this specification, as illustrated below.

	Specification				
Standard Number: Block	Type :	Grade :	Class	:	Special Notes
	:	:	::		
Example: Specification D 3295 – 97	I	A			

For this example, the line callout would be Specification D 3295 – 97, IA and would specify tubing having walls listed as lightweight wall that has all the properties listed for that type and grade in the appropriate specified properties, tables, or both, in the specification identified. A comma is used as the separator between the standard number and the type. Separators are not needed between the type, and grade.[7] Provision for special notes is included so that other information can be provided when required. An example would be in Specification

[7] See the *Form and Style Manual* for *ASTM Standards*, available from ASTM Headquarters.

TABLE 2 Dimensions and Tolerances for Type I PTFE Tubing, mm (in.) (Grades C and E)

AWG Size	Inside Diameter		Grade C		
			Standard Wall		
	min	max	nom	min	max
30	0.25 (0.010)	0.38 (0.015)	0.23 (0.009)	0.18 (0.007)	0.28 (0.011)
28	0.33 (0.013)	0.48 (0.019)	0.23 (0.009)	0.18 (0.007)	0.28 (0.011)
26	0.41 (0.016)	0.56 (0.022)	0.23 (0.009)	0.18 (0.007)	0.28 (0.011)
24	0.51 (0.020)	0.67 (0.027)	0.31 (0.012)	0.23 (0.010)	0.38 (0.014)
22	0.64 (0.025)	0.81 (0.032)	0.31 (0.012)	0.25 (0.010)	0.36 (0.014)
20	0.81 (0.032)	1.02 (0.040)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
19	0.91 (0.036)	1.11 (0.044)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
18	1.02 (0.040)	1.25 (0.049)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
17	1.14 (0.045)	1.37 (0.054)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
16	1.30 (0.051)	1.55 (0.061)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
15	1.45 (0.057)	1.70 (0.067)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
14	1.63 (0.064)	1.88 (0.074)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
13	1.83 (0.072)	2.08 (0.082)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
12	2.06 (0.081)	2.31 (0.091)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
11	2.31 (0.091)	2.57 (0.101)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
10	2.59 (0.102)	2.85 (0.112)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
9	2.90 (0.114)	3.15 (0.124)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
8	3.28 (0.129)	3.58 (0.141)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
7	3.66 (0.144)	4.01 (0.158)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
6	4.12 (0.162)	4.52 (0.178)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
5	4.62 (0.182)	5.03 (0.198)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
4	5.18 (0.204)	5.69 (0.224)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
3	5.82 (0.229)	6.33 (0.249)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
2	6.55 (0.258)	7.06 (0.278)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
1	7.34 (0.289)	7.90 (0.311)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
0	8.26 (0.325)	8.81 (0.347)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
AWG Size	Inside Diameter		Grade E		
			Heavy Wall		
	min	max	nom	min	max
24	0.51 (0.020)	0.69 (0.027)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
22	0.64 (0.025)	0.81 (0.032)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
20	0.81 (0.032)	1.02 (0.040)	0.46 (0.018)	0.38 (0.015)	0.53 (0.021)
19	0.91 (0.036)	1.12 (0.044)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
18	1.02 (0.040)	1.25 (0.049)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
17	1.14 (0.045)	1.37 (0.054)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
16	1.30 (0.051)	1.55 (0.061)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
15	1.45 (0.057)	1.70 (0.067)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
14	1.63 (0.064)	1.88 (0.074)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
13	1.83 (0.072)	2.08 (0.082)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
12	2.06 (0.081)	2.31 (0.091)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
11	2.31 (0.091)	2.57 (0.101)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)
10	2.59 (0.102)	2.85 (0.112)	0.64 (0.025)	0.51 (0.020)	0.76 (0.030)
9	2.90 (0.114)	3.15 (0.124)	0.64 (0.025)	0.51 (0.020)	0.76 (0.030)
8	3.28 (0.129)	3.58 (0.141)	0.76 (0.030)	0.64 (0.025)	0.89 (0.035)
7	3.65 (0.144)	4.01 (0.158)	0.76 (0.030)	0.64 (0.025)	0.89 (0.035)
6	4.12 (0.162)	4.52 (0.178)	0.76 (0.030)	0.64 (0.025)	0.89 (0.035)
5	4.62 (0.182)	5.03 (0.198)	0.81 (0.032)	0.69 (0.027)	0.94 (0.037)

D 3295 – 96 where dimensions and tolerances are specified for each AWG size within type and grade. When special notes are used, they should be preceded by a comma.

5. Physical Properties

5.1 The tubing shall be made of PTFE meeting the requirements of Specification D 4895 and may contain a maximum of two mass percentage of additive.

5.2 The melting point for both types of tubing shall be 327 ± 10°C (621 ± 18°F) when measured in accordance with 8.1.4.

5.3 The inside diameter, wall thickness, and tolerances of the tubing shall be as shown in Tables 1-3 and when determined in accordance with 8.1.3.1 and 8.1.3.2.

5.4 The specific gravity of the tubing shall be as specified in Table 4 when determined in accordance with 8.1.5.

5.5 The weight loss of the tubing shall not exceed 0.05 % when determined in accordance with 8.1.6.

5.6 The tubing shall have tensile properties as specified in Table 4 and a minimum elongation of 200 % when determined in accordance with 8.1.7.

5.7 The tubing shall be a minimum dielectric breakdown as shown in Table 5 when determined in accordance with 8.1.8.

5.8 The inside diameter of the tubing shall be within the applicable tolerance limits after subjection to the thermal treatment of 8.1.9.

5.9 The tubing shall remain free of cracks when tested for low-temperature flexibility in accordance with 8.1.11.

5.10 The color of the tubing shall be as agreed upon between the purchaser and the seller. The tubing shall exhibit

TABLE 3 Dimensions and Tolerances for Type II PTFE Tubing, mm (in.)

Fractional Sizes	Inside Diameter			Wall Thickness								
	Grade A, B, C			Grade A			Grade B			Grade C		
	nom	min	max	nom	min	max	nom	min	max	nom	min	max
0.79 (1/32)	0.79 (0.031)	0.74 (0.031)	0.84 (0.014)	0.15 (0.006)	0.10 (0.004)	0.20 (0.008)	0.25 (0.010)	0.20 (0.008)	0.31 (0.012)	0.31 (0.012)	0.25 (0.010)	0.36 (0.014)
1.6 (1/16)	1.7 (0.063)	1.6 (0.063)	1.85 (0.063)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
2.4 (3/32)	2.4 (0.094)	2.3 (0.091)	2.5 (0.099)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)	0.41 (0.016)	0.33 (0.013)	0.48 (0.019)
3.2 (1/8)	3.2 (0.125)	3.1 (0.120)	3.3 (0.130)	0.20 (0.008)	0.15 (0.006)	0.25 (0.010)	0.38 (0.015)	0.28 (0.011)	0.48 (0.019)	0.51 (0.020)	0.40 (0.016)	0.61 (0.024)
4.8 (3/16)	4.7 (0.192)	4.6 (0.192)	5.0 (0.198)	0.25 (0.010)	0.18 (0.007)	0.33 (0.013)	0.38 (0.015)	0.28 (0.011)	0.48 (0.019)	0.51 (0.020)	0.40 (0.016)	0.61 (0.024)
6.4 (1/4)	6.5 (0.255)	6.4 (0.250)	6.6 (0.260)	0.24 (0.010)	0.18 (0.007)	0.33 (0.013)	0.38 (0.015)	0.28 (0.011)	0.48 (0.019)	0.51 (0.020)	0.40 (0.016)	0.61 (0.024)
7.9 (5/16)	8.1 (0.321)	8.0 (0.313)	8.2 (0.332)	0.31 (0.012)	0.23 (0.009)	0.38 (0.015)	0.38 (0.015)	0.28 (0.011)	0.48 (0.019)	0.51 (0.020)	0.40 (0.016)	0.61 (0.024)
9.5 (3/8)	9.7 (0.381)	9.5 (0.375)	9.8 (0.394)	0.38 (0.015)	0.31 (0.012)	0.46 (0.018)	0.38 (0.015)	0.30 (0.012)	0.46 (0.018)	0.64 (0.025)	0.48 (0.020)	0.79 (0.030)
11.1 (7/16)	11.3 (0.451)	11.1 (0.438)	11.7 (0.458)	0.46 (0.018)	0.38 (0.015)	0.53 (0.021)	0.46 (0.018)	0.36 (0.014)	0.56 (0.022)	0.64 (0.025)	0.48 (0.020)	0.79 (0.030)
12.7 (1/2)	12.9 (0.515)	12.7 (0.500)	13.3 (0.520)	0.46 (0.018)	0.38 (0.015)	0.53 (0.021)	0.46 (0.018)	0.36 (0.014)	0.56 (0.022)	0.64 (0.025)	0.48 (0.020)	0.79 (0.030)
15.9 (5/8)	15.2 (0.643)	15.9 (0.625)	16.6 (0.650)	0.07 (0.020)	0.38 (0.015)	0.64 (0.025)	0.51 (0.020)	0.41 (0.016)	0.61 (0.024)	0.76 (0.030)	0.60 (0.020)	0.91 (0.035)
19.0 (3/4)	19.3 (0.750)	19.0 (0.750)	20.0 (0.775)	0.51 (0.090)	0.38 (0.015)	0.64 (0.025)	0.64 (0.025)	0.51 (0.020)	0.76 (0.030)	0.89 (0.035)	0.68 (0.024)	1.09 (0.036)
22.2 (7/8)	22.4 (0.902)	22.2 (0.875)	23.1 (0.927)	...	...	...	...	...	...	0.89 (0.035)	0.68 (0.028)	1.09 (0.042)
25.4 (1)	25.6 (1.03)	25.4 (1.000)	26.3 (1.060)	...	...	...	...	...	...	0.89 (0.035)	0.68 (0.028)	1.09 (0.042)
31.8 (1 1/4)	32.1 (1.265)	31.8 (1.250)	32.7 (1.325)	...	...	...	...	...	...	1.02 (0.040)	0.81 (0.038)	1.22 (0.047)
38.1 (1 1/2)	38.6 (1.550)	38.1 (1.500)	39.4 (1.580)	...	...	...	...	...	...	1.02 (0.045)	0.81 (0.038)	1.22 (0.052)

Fractional Sizes	Inside Diameter		Wall Dimensions	
	Grade D		Grade D	
	max	min	Thickness	Tolerance
3.2 (1/8)	3.3 (0.130)	3.05 (0.120)	0.635 (0.025)	±0.127 (±0.005)
3.2 (1/8)	3.3 (0.130)	3.05 (0.120)	0.762 (0.030)	±0.127 (±0.005)
4.8 (3/16)	4.9 (0.193)	4.65 (0.183)	0.762 (0.030)	±0.127 (±0.005)
6.4 (1/4)	6.5 (0.257)	6.17 (0.243)	0.762 (0.030)	±0.127 (±0.005)
9.5 (5/16)	8.13 (0.320)	7.72 (0.304)	0.762 (0.030)	±0.127 (±0.005)
11.1 (3/8)	9.73 (0.383)	9.32 (0.367)	0.762 (0.030)	±0.127 (±0.005)
(7/16)	11.4 (0.448)	10.9 (0.428)	0.762 (0.030)	±0.127 (±0.005)
(1/2)	(0.510)	(0.490)	(0.030)	(±0.006)
(9/16)	(0.572)	(0.552)	(0.030)	(±0.006)
(5/8)	(0.637)	(0.613)	(0.030)	(±0.006)
(11/16)	(0.700)	(0.676)	(0.032)	(±0.006)
(3/4)	(0.764)	(0.736)	(0.040)	(±0.007)
(7/8)	(0.891)	(0.859)	(0.045)	(±0.007)
(1)	(1.020)	(0.980)	(0.050)	(±0.008)
(1 1/4)	(1.270)	(1.230)	(0.040)	(±0.008)
(1 1/2)	(1.525)	(1.475)	(0.040)	(±0.008)

Fractional Sizes	Inside Diameter		Wall Dimensions	
	Grade E		Grade E	
	max	min	Thickness	Tolerance
3.2 (1/8)	3.2 (0.125)	2.79 (0.110)	1.57 (0.62)	±0.250 (±0.005)
7.9 (1/4)	6.35 (0.250)	5.84 (0.230)	1.5 (0.62)	±0.250 (±0.005)
(3/8)	9.53 (0.375)	8.85 (0.350)	1.5 (0.62)	±0.250 (±0.005)

TABLE 4 Physical Requirements for PTFE Tubing

Classification	Melting Point	Specific Gravity	Tensile Strength, min		Elongation, min, %
			MPa	psi	
Type I	327 ± 10°C (621 ± 18°F)	2.13 to 2.20	20.7	3000	200
Type II	327 ± 10°C (621 ± 18°F)	over 2.13	13.8	2000	200

no significant change in color after heat-aging in accordance with 8.1.10.

6. Sampling

6.1 Unless otherwise agreed upon between the purchaser and the seller, the materials shall be sampled in accordance with the sampling procedure prescribed in Practice D 1898. Adequate statistical sampling shall be considered an acceptable alternative.

7. Number of Tests

7.1 One set of test specimens shall be considered sufficient for testing each batch. The average result of the specimens tested shall conform to the requirements of this specification.

8. Test Methods

8.1 Determine the properties enumerated in this specification in accordance with the following test methods.

8.1.1 *Conditioning*—Conditioning is not required except in

TABLE 5 Minimum Dielectric Breakdown Voltage for PTFE Tubing

Nominal Wall Thickness		Dielectric Breakdown Volts, min, V
mm	in.	
0.15 to 0.17	0.006 to 0.0069	9 000
0.18 to 0.23	0.007 to 0.0089	10 000
0.23 to 0.25	0.009 to 0.0099	11 500
0.25 to 0.30	0.010 to 0.0119	12 500
0.30 to 0.38	0.012 to 0.0149	14 600
0.38 to 0.40	0.015 to 0.0159	15 000
0.41 to 0.51	0.016 to 0.0199	16 300
over 0.51	over 0.020	17 000

referee cases. When conditioning is required, condition the test specimens at 23°C for a period of at least 4 h prior to test. If the test material has been exposed to temperatures below 20°C within 24 h prior to test, the conditioning shall be for at least 24 h.

8.1.2 *Test Conditions*—Conduct tests at the standard laboratory temperature of 23 ± 2°C (73.4 ± 3.6°F). The maintenance of constant humidity is not necessary; in referee cases the standard laboratory atmosphere including 50 ± 5 % relative humidity shall apply.

8.1.3 *Dimensions and Tolerances*:

8.1.3.1 *Inside Diameter*—Determine the inside diameter in accordance with Test Method D 1675.

8.1.3.2 *Wall Thickness*—Determine the wall thickness in accordance with the procedures described in Test Method D 1675, except that no individual measurements shall be allowed to exceed the tolerances specified in Tables 1-3.

8.1.4 *Melting Point*—The melting point shall be determined in accordance with Specification D 4895, using a shaving from the tubing rather than a molded disk.

8.1.5 *Specific Gravity*—Determine the specific gravity in accordance with Method A of Test Methods D 792. Add two drops of wetting agent (liquid detergent) to the water in order to reduce the surface tension and ensure complete wetting of the specimen. The gradient tube method, Test Method D 1505, may be used as an alternative.

8.1.6 *Weight Loss*—Determine the loss in weight in accordance with Test Method D 1675, except that the minimum weight of the test specimens shall be 50 g and they shall be heated in a forced-draft oven for 3 h at 300 ± 5°C (572± 9°F).

8.1.7 *Tensile Strength and Elongation*—Determine the tensile strength and elongation as specified in 8.1.7.1–8.1.7.4 on five transverse specimens, using a testing speed of 50.8 mm (2 in.)/min. Average the test results for the longitudinal and the transverse specimens separately. Discard specimens that break in the jaws of the tension tester, and make new tests.

8.1.7.1 *Tubing Having an Inside Diameter of 15.9 mm (0.625 in.) and Over*—Determine the tensile strength and elongation in both the longitudinal and transverse directions in accordance with Specification D 4895. To prepare specimens, slit the tubing parallel to the axis and flatten out, prior to punching out specimens.

8.1.7.2 *Tubing Having an Inside Diameter Less Than 15.9 mm (0.625 in.) to 4.8 mm (0.190 in.) Inclusive*—Determine the tensile strength and elongation in the longitudinal direction in accordance with Specification D 4895. For longitudinal specimens, slit the tubing parallel to the axis and flatten out, prior to punching out specimens.

8.1.7.3 *Tubing Having an Inside Diameter Less Than 4.8 mm (0.190 in.)*—Test specimens as filaments. Make nonslip-type loop knots in each end of the specimen so that there are 34.9 mm (1⅜ in.) between the knots of the loops (see Fig. 1). Place loops over the drum of a standard wire specimen holder in the tension testing machine and pull in this position.

8.1.8 *Dielectric Breakdown Voltage*—Determine the dielectric breakdown voltage of the tubing in accordance with Test Method D 1675. Testing may be in air or oil, the latter being the referee method.

8.1.9 *Dimensional Stability*—Cut three specimens each 305 mm (12 in.) long, measured to the nearest 1.6 mm (1⁄16 in.). Place the specimen on steel mandrels having a diameter 5 to 10 % less than the inside diameter of the specimen, then in a circulating-air oven at 260 ± 5°C (500± 9°F) for 3 h. Determine the inner diameter and maximum and minimum wall thickness in accordance with 7.1.3.1 and 7.1.3.2. Then remove the specimens from the oven and allow to cool to 23 ± 2°C (73.4 ± 3.6°F). Again measure the length to the nearest 1.6 mm (1⁄16 in.) and the diameter and the wall thickness. Calculate the change in length as a percentage of the original length and the change in diameter and wall thickness as a percentage of the original length and the change in diameter and wall thickness as a percentage of the original.

8.1.10 *Heat Resistance*—Place three specimens, each 305 mm (12 in.) long, in a circulating-air oven at 260 ± 5°C (500 ± 9°F) for 5 h. At the completion of this heat-aging, the specimens shall be subjected to the low-temperature flexibility test of 8.1.11.

8.1.11 *Low-Temperature Flexibility*—Place three specimens, each 305 mm (12 in.) long, in a circulating-air oven at 260± 5°C (500 ± 9°F) for 5 h, cool to room temperature, and then condition at −55 ± 2°C (−67 ± 4°F) for 4 h. Condition a fixed mandrel, selected in accordance with Table 6, at the same temperature. After completion of the conditioning period and while still maintained at the conditioning temperature, wrap the specimens rapidly about the mandrel for not less than two complete wraps. The speed of wrapping shall be approximately 2 s 360° wrap.

9. Inspection

9.1 *Lot-Acceptance Inspection*—The material shall be visually and dimensionally inspected to verify compliance with the requirements of this specification. Additional items if inspection shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

9.2 *Periodic-Check Inspection*—The periodic-check inspection shall consist of the tests specified for all requirements of

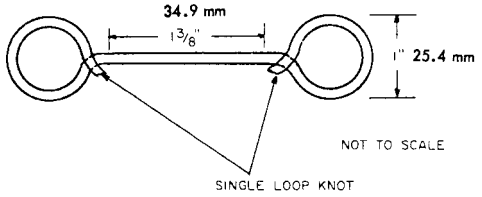

FIG. 1 Tension Specimen for Tubing Less Than 2.29 mm (0.090 in.)

TABLE 6 Mandrel Dimensions for Low-Temperature Flexibility

Inside Diameter of Tubing		Diameter of Mandrel	
mm	in.	mm	in.
0.58 to 3.18	0.023 to 0.125	7.94	5/16
0.61 to 6.35	0.13 to 0.25	9.53	3/8
6.4 to 25.4	0.25 to 1.00	11.11	7/16

the material under this specification.

10. Packaging and Package Marking

10.1 *Packaging*—The material shall be packaged in standard commercial containers so constructed as to ensure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

10.2 *Marking*—Shipping containers shall be marked with the name of the material, type, class, size, and quantity contained therein.

10.3 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

11. Precision and Bias

11.1 Table 7 is based on a round robin conducted in 1985–1986 according to Practice E 691, involving seven materials tested by six laboratories. For each material, the sheeting from which the test specimens were to be cut was obtained from one source. Using a steel rule die, one set of test specimens for each laboratory was cut by one of the laboratories. Sheeting and a duplicate die were furnished each participating laboratory and used to cut a second set of test specimens. Each test result was the average of five individual determinations. Each lab obtained four test results on each material, two test results each on the specimens furnished and two on the specimens cut by the laboratory doing the testing.

TABLE 7 Precision Summary, Tensile Strength and Elongation at Break

NOTE 1—$I_r = 2.8 \times CV_r$; $I_R = 2.8 \times CV_R$.

Material	Tensile Strength				
	Mean psi	CV_r%	CV_R%	I_r%	I_R%
Granular PTFE	4801	2.79	8.85	7.81	24.78
Coagulated Dispersion PTFE	4807	2.71	3.37	7.59	9.46
PFA	4164	3.11	9.03	8.71	25.28
FEP	4144	2.98	7.98	8.34	22.34
Material	Percentage Elongation at Break				
	Mean % E	CV_r%	CV_R%	I_r%	I_R%
Granular PTFE	337	2.83	16.43	7.92	46.00
Coagulated Dispersion PTFE	300	2.17	13.74	6.08	38.47
PFA	336	3.27	9.66	9.16	27.05
FEP	319	2.21	7.60	6.19	21.28

11.1.1 The properties used in the analysis are tensile strength and elongation at break. The stress-strain curves of the fluorocarbon polymers (but not the fluoropolymers: modified ETFE and poly(vinylidene fluoride), PVDF) are similar in shape. Data on ETFE and PVDF, therefore, were excluded from the analysis used for this precision and bias statement but are available for use in precision and bias statements and are to be included in the research report at ASTM. Based on advice from experts in statistical analysis of round robin data, and since use of fillers is excluded in the applicable standards, information from the testing on glass-fiber filled PTFE also is not included in Table 7. In addition, the experts advised that information from the samples cut in one laboratory and tested by all the laboratories should not be included in Table 7. The data are available in the report.

NOTE 2—**Caution:** The following explanations of I_r and I_e (see 11.3-11.3.3) are intended only to present a meaningful way of considering the approximate precision of the test methods given in this specification. The data in Table 7 should not be applied rigorously to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials, or laboratories.

11.2 Users of this test method should apply the principles outlined in Practice E 691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles of 11.3-11.3.3 would then be valid for such data.

11.3 Concept of I_r and I_R -IF CV_r and CV_a have been calculated from a large enough body of data, and for test results:

11.3.1 I_r *: Repeatability*—In comparing two test results for the same material, obtained by the same operator using the same equipment on the same day, the two test results should be judged not equivalent if they differ by more than the I_r value for that material.

11.3.2 I_R *: Reproducibility*—In comparing two test results for the same material, obtained by different operators using different equipment on different days, the two test results should be judged not equivalent if they differ by more than the I_R value for that material.

11.3.3 Any judgment in accordance with 11.3.1 and 11.3.2 would have an approximate 95 % (0.95) probability of being correct.

11.4 Bias is systematic error that contributes to the difference between a test result and a true (or reference) value. There are no recognized standards on which to base an estimate of bias for this test procedure.

12. Keywords

12.1 coagulated dispersion PTFE; fluorocarbon polymer; fluoropolymers; polytetrafluoroethylene; PTFE; PTFE extruded tubing; thin-walled tubing

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 3295 – 97:

(1) Elongation percentage changed in 5.6 to coincide with values in Table 4.

(2) Removed statement for re-tests.