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Designation: D 372 – 00

Standard Specification for Flexible Treated Sleeving Used for Electrical Insulation¹

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^{ε1} ~~Note—Section 12, Keywords, was added editorially in March 1995.~~

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1. Scope

1.1 This specification covers electrical insulating sleeving suitable for use on lead wires and in connections in electrical apparatus, such as motors, transformers, and switch gears.

1.2 Materials under this specification are limited to a flexible tubular product made from a woven textile fiber base, such as cotton, rayon, nylon, or glass, thereafter impregnated, or coated, or impregnated and coated, with a suitable insulating material.

NOTE 1—This standard resembles IEC 60684-3-400 to 408 in title only. The content is significantly different.

2. Referenced Documents

2.1 ASTM Standards:

D 350 Test Methods for Flexible Treated Sleeving Used for Electrical Insulation²

D 1711 Terminology Relating to Electrical Insulation²

D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials³

D 4088 Practice for Preparation for Shipment of Solid Electrical Insulating Materials³

2.2 IEC Standard:

IEC 60684-3 Specification for Flexible Insulating Sleeving⁴

3. Terminology

3.1 Definitions— For definitions of terms used in this specification, see Terminology D 1711.

4. Classification

34.1 Sleeving is categorized by the type of coating, base fabric material, dielectric breakdown voltage, temperature index, minimum wall thickness, and inside diameter, as follows:

34.1.1 *Type I*—A flexible treated sleeving made from organic-base fibers such as cotton, rayon, or nylon and impregnated or coated with an insulating material which can be shown by applicable experience or accepted test to have a temperature index of 105.

34.1.2 *Type II*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material which can be shown by applicable experience or accepted test to have a temperature index of 130.

34.1.3 *Type III*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material, such as poly(vinyl chloride), which can be shown by applicable experience or accepted test to have a temperature index of 105.

34.1.4 *Type IV*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material, such as silicone resin or polytetrafluoroethylene, which can be shown by applicable experience or accepted test to have a temperature index of 200.

34.1.5 *Type V*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material, such as silicone elastomer, which can be shown by experience or accepted test to have a temperature index of 200.

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 10.02.

⁴ Available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

34.1.6 *Type VI*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material, such as epoxies, polyesters, or acrylics, which can be shown by experience or accepted test to have a temperature index of 155.

34.1.7 *Type VII*—A flexible treated sleeving made from inorganic-base yarns such as fibrous glass and impregnated or coated with an insulating material which can be shown by experience or accepted test to have a temperature index of 180.

34.2 Grades of sleeving are identified in terms of minimum average dielectric breakdown voltage, as shown in Table 1.

34.3 Sleeving sizes are shown in Table 2, and are based on the size of round conductors that will fit snugly into the product without distortion of the sleeving.

4. Ordering Information

4.1 Orders for sleeving shall include the following information:

4.1.1 Type and color (Sections 3 and 7);

4.1.2 Grade (Section 3);

4.1.3 Size (Table 2);

4.1.4 Type of put-up (coils, spools, cut lengths, etc.);

4.1.5 Type of packing and packaging (see Practice D 4088), and

4.1.6 Marking, if other than specified in Practice D 4088.

5. Ordering Information

5.1 Orders for sleeving shall include the following information:

5.1.1 Type and color (Sections 4 and 6),

5.1.2 Grade (Section 4),

5.1.3 Size (Table 2),

5.1.4 Type of put-up (coils, spools, cut lengths, and so forth),

5.1.5 Type of packing and packaging (see Practice D 4088), and

5.1.6 Marking, if other than specified in Practice D 4088.

6. General Requirements

6.1 Colors shall be as agreed upon between the purchaser and the supplier.

7. Dimensional Requirements

7.1 Sleeving shall conform to the inside diameter and wall thickness requirements shown in Table 2.

7.2 The length of product in any coil or spool shall not be less than declared. Spools or coils shall not contain more splices than are allowed in Table 3. The splices shall be minimum in length and conspicuously marked. They shall be strong enough to withstand normal handling during fabrication operations.

7.3 The length of cut pieces of sleeving shall conform to the tolerances shown in Table 4.

68. Chemical and Physical Requirements

68.1 The sleeving shall conform to the requirements for chemical, thermal, electrical, and mechanical properties shown in Table 5.

TABLE 1 Dielectric Breakdown Voltage Grade Requirements in Kilovolts

Grade	Conditioning		Types						
			1	2	3	4	5	6	7
—A A	C-48/23/50	min avg	7.0	7.0	8.0	7.0	8.0	7.0	7.0
		min ind	5.0	5.0	6.0	5.0	6.0	5.0	5.0
	C-96/23/93 ^A	min ind	5.0	5.0	6.0	5.0	6.0	5.0	5.0
		min avg	25	30	50	70	80	30	50
—B B	C-48/23/50	min avg	4.0	4.0	4.0	4.0	4.0	4.0	4.0
		min ind	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	C-96/23/93 ^A	min avg	20	30	50	70	80	30	50
		min ind	2.5	2.5	2.5	2.5	2.5	2.5	2.5
—C C	C-48/23/50	min avg	2.5	2.5	2.5	2.5	2.5	2.5	2.5
		min ind	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	C-96/23/93 ^A	min avg	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		min ind	1.5	1.5	1.5	1.5	1.5	1.5	1.5
C-2	min avg	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
	min ind	0.8	0.8	0.8	0.8	0.8	0.8	0.8	

^A Percentage of average test values found after C-48/23/50.

TABLE 3 2 Number of Allowable Splices and Wall Thicknesses for Spoolings

Splice No.	Inside Diameter, in. (mm)		Minimum Wall Thickness ^A , in. (mm)		
	No. of splices	Maximum	Grade A	Grade B	Grade C
24	50	27 (0.69)	0.020 (0.51)	0.041 (0.28)	0.007 (0.18)
	0.006 (0.15)	0.027 (0.69)	0.020 (0.51)	0.011 (0.28)	0.007 (0.18)
22	100	32 (0.81)	0.025 (0.64)	0.043 (0.33)	0.007 (0.18)
	0.006 (0.15)	0.032 (0.81)	0.025 (0.64)	0.013 (0.33)	0.007 (0.18)
20	250	40.039 (0.99)	0.032 (0.81)	0.043 (0.33)	0.007 (0.18)
	0.006 (0.15)	0.039 (0.99)	0.032 (0.81)	0.013 (0.33)	0.007 (0.18)
19	500	0.044 (1.12)	0.036 (0.91)	0.043 (0.33)	0.007
	0.006 (0.15)	0.044 (1.12)	0.036 (0.91)	0.013 (0.33)	0.007 (0.18)
18	1000	1.24	0.040 (1.02)	0.045 (0.38)	0.007 (0.18)
	0.006 (0.15)	0.049 (1.24)	0.040 (1.02)	0.015 (0.38)	0.007 (0.18)
17	0.006 (0.15)	0.054 (1.37)	0.045 (1.14)	0.015 (0.38)	0.007 (0.18)
16	0.006 (0.15)	0.061 (1.55)	0.051 (1.30)	0.015 (0.38)	0.007 (0.18)
15	0.006 (0.15)	0.067 (1.70)	0.057 (1.45)	0.015 (0.38)	0.007 (0.18)
14	0.006 (0.15)	0.074 (1.88)	0.064 (1.63)	0.015 (0.38)	0.007 (0.18)
13	0.006 (0.15)	0.082 (2.08)	0.072 (1.83)	0.015 (0.38)	0.007 (0.18)
12	0.006 (0.15)	0.091 (2.31)	0.081 (2.06)	0.015 (0.38)	0.007 (0.18)
11	0.008 (0.20)	0.101 (2.6)	0.091 (2.31)	0.018 (0.46)	0.009 (0.23)
10	0.008 (0.20)	0.112 (2.8)	0.102 (2.6)	0.018 (0.46)	0.009 (0.23)
	over 1000	0.124 (3.1)	0.114 (2.9)	0.018 (0.46)	0.009 (0.23)
9	0.008 (0.20)	0.124 (3.1)	0.114 (2.9)	0.018 (0.46)	0.009 (0.23)
8	0.008 (0.20)	0.141 (3.6)	0.129 (3.3)	0.018 (0.46)	0.009 (0.23)
7	0.008 (0.20)	0.158 (4.0)	0.144 (3.7)	0.018 (0.46)	0.009 (0.23)
6	0.010 (0.25)	0.178 (4.5)	0.162 (4.1)	0.020 (0.51)	0.011 (0.28)
5	0.010 (0.25)	0.198 (5.0)	0.182 (4.6)	0.020 (0.51)	0.011 (0.28)
4	0.010 (0.25)	0.224 (5.7)	0.204 (5.2)	0.020 (0.51)	0.011 (0.28)
3	0.010 (0.25)	0.249 (6.3)	0.229 (5.8)	0.020 (0.51)	0.011 (0.28)
2	0.010 (0.25)	0.278 (7.1)	0.258 (6.6)	0.020 (0.51)	0.011 (0.28)
1	0.010 (0.25)	0.311 (7.9)	0.289 (7.3)	0.020 (0.51)	0.011 (0.28)
0	0.016 (0.41)	0.347 (8.8)	0.325 (8.3)	0.025 (0.64)	0.017 (0.43)
3/8 in.	0.016 (0.41)	0.399 (10.1)	0.375 (9.5)	0.025 (0.64)	0.017 (0.43)
7/16 in.	0.016 (0.41)	0.462 (11.7)	0.438 (11.1)	0.025 (0.64)	0.017 (0.43)
1/2 in.	0.016 (0.41)	0.524 (13.3)	0.500 (12.7)	0.025 (0.64)	0.017 (0.43)
5/8 in.	0.016 (0.41)	0.655 (16.6)	0.625 (15.9)	0.025 (0.64)	0.017 (0.43)
3/4 in.	0.016 (0.41)	0.786 (20.0)	0.750 (19.1)	0.025 (0.64)	0.017 (0.43)
7/8 in.	0.016 (0.41)	0.911 (23.1)	0.875 (22.2)	0.025 (0.64)	0.017 (0.43)
1 in.	0.016 (0.41)	1.036 (26.3)	1.000 (25.4)	0.025 (0.64)	0.017 (0.43)

^A The number of allowable splices per spool for spools which contain over 1000 ft shall be as agreed upon between the purchaser and supplier.

TABLE 4 3 Number of Allowable Splices per Spool

Length/Spool Cut, in. (mm)	No. of splices, in. (mm)
up to 3 (76.2)	±1/8 (±1.59)
50	2
3 to less than 6 (152.4)	±3/32 (±2.38)
100	3
6 to less than 12 (304.8)	±1/8 (±3.17)
250	4
12 to less than 36 (914.4)	±1/4 (±6.35)
500	7
over 36	±1/2, 0 (+)
1000	10
over 1000	A

^A The number of allowable splices per spool for spools which contain over 1000 ft shall be as agreed upon between the purchaser and supplier.

7. General Requirements

7.1 Colors shall be as agreed upon between the purchaser and the supplier.

8. Number of Tests

8.1 Certain of the requirements specified, such as thermal endurance, hydrolytic stability, and effects of solvents, are considered to be related primarily to the composition of the coating rather than to the processing. The length of time required to evaluate these properties may make it impractical to use them for the purpose of lot acceptance. Therefore, the following tests are to be used for lot acceptance testing on all specimens taken (except as shown), unless otherwise agreed to by the purchaser and supplier:

TABLE 5.4 Physical Requirements for All Grades

Property	Type 1	Types					Tolerance, in. (mm)
		2	3	4	5	6		7
1h of Cut, in. (mm)	2	3	4	5	6	7	
Brittleness temp., °C, min	...	...	-20	-16	10	-60	-10
Up to 3 (76.2)	...	...	-20	-16	(± 10)	-60	-10
Flammability:							
3 to less than 6 (152.4)							
Method A: 3/2							
Method A: 3/2 (± 2.38)							
Burn/glow time, s, max	...	...	30	...	...	...	...
6 to less than 12 (304.8)	...	...	30	...	...	...	...
Cotton ignited 1/8 in.	...	...	none	...	...	...	...
Cotton ignited 1/8 in. (± 3.0)	...	...	none	...	...	...	...
Percentage indicator burnt, max area	...	...	25	...	...	...	...
12 to less than 36 (914.4)	...	...	25	...	...	...	...
Flammability:							
Method B: 1/4							
Method B: 1/4 (± 6.35)							
Burn rate, s/in., min:	...	45	...	45	45	45	45
Over 36	...	45	...	45	45	45	45
Oil resistance:							
Blistering	none	none	...	...	...	...	...
Percentage swelling of wall, max	2-020	...	20	...	...	...	...
Percentage swelling of wall + 1/2 in. max	2-020	...	20	...	...	...	...
Solvent resistance:							
Visible effects	none	none	none	...	...	...	...
Percentage swelling of wall, max	20	20	20	...	...	20	...
Thermal endurance:							
Temp. index at 20 000 h, min (Grade A only)	105	130	105	200	200	155	180
Thermal endurance:							
Temp. index at 20 000 h, min (Grade A only)	105	130	105	200	200	155	180
Dielectric Breakdown Voltage:							
After push back test, straight specimens	...	...	...	...	5.0	...	...
After aging 96 hr at 50°C overrated temp.	4.0	4.5	4.0	4.5	5.5	4.5	5.0
After aging 96 hr at 50°C overrated temp.	4.0	4.5	4.0	4.5	5.5	4.5	5.07

- 8.1.1 Dimensions (inside diameter, wall thickness, length);
- 8.1.2 Color;
- 8.1.3 Visual examination for defects;
- 8.1.4 Dielectric breakdown voltage (C-48/23/50 and C-96/23/93);
- 8.1.5 Flammability (one specimen only);
- 8.1.6 Push-back resistance after heat aging (one specimen only), and
- 8.1.7 Flexibility after heat aging (one specimen only);

8.2 The number of specimens which are to be tested for each of these properties is specified in Test Methods D 350, unless otherwise noted.

9. Number of Tests

9.1 Certain of the requirements specified, such as thermal endurance, hydrolytic stability, and effects of solvents, are considered to be related primarily to the composition of the coating rather than to the processing. The length of time required to evaluate these properties may make it impractical to use them for the purpose of lot acceptance. Therefore, the following tests are to be used for lot acceptance testing on all specimens taken (except as shown), unless otherwise agreed upon between the purchaser and the supplier:

- 9.1.1 Dimensions (inside diameter, wall thickness, length);
- 9.1.2 Color;
- 9.1.3 Visual examination for defects;
- 9.1.4 Dielectric breakdown voltage (C-48/23/50 and C-96/23/93);
- 9.1.5 Flammability (one specimen only);
- 9.1.6 Push-back resistance after heat aging (one specimen only), and
- 9.1.7 Flexibility after heat aging (one specimen only).

9.2 The number of specimens which are to be tested for each of these properties is specified in Test Methods D 350, unless otherwise noted.

10. Test Methods

- 10.1 Conditioning and testing shall be in accordance with Test Methods D 350.

TABLE 6 5 Compatibility of Sleeving with Magnet Wire Requirements for All Grades

Property	Method A ^A			Method B ^B		Method C ^B	
	1	2	3	4	5	6	7
Brittleness temp., °C, min	...	...	°C	Retention, %	°C	Retention, %	°C
Brittleness temp., °C, min	...	...	°C	-10	°C	-10	-10
Flammability:							
4	All	130	50	130	50		
Method A:							
2	All	155	50	155	50	...	...
Burn/glow-time, s, max	...	...	30	...	...	...	...
3	All	155	50	155	50	...	...
Cotton ignited	...	...	none	...	...	...	...
4	All	225	50	225	50	...	...
Percentage indicator burnt, max area	...	...	25	...	...	...	...
Flammability:							
5	All	225	50	225	50		
Method B:							
6	All	180	50	180	50	45	45
Burn rate, s/in., min	...	45	...	45	45	45	45
Oil resistance:							
7	All	...	...	...	...	...	...
Blistering	none	none	...	none	...	...	...
Percentage swelling of wall, max	20	20	...	20	...	...	...
Solvent resistance:							
Visible effects	none	none	none	...	...	none	...
Percentage swelling of wall, max	20	20	20	...	...	20	...
Thermal endurance:							
Temp. index at 20 000 h, min (Grade A only)	105	130	105	200	200	155	180
Dielectric Breakdown Voltage:							
After push back test, straight specimens	...	...	...	...	5.0	...	...
After aging 96 h at 50°C overrated temperature	4.0	4.5	4.0	4.5	5.5	4.5	5.0

^A Percentage retention (minimum) of breakdown voltage of twisted pairs after 672 h at temperatures shown (based on controls).

^B Percentage retention (minimum) of breakdown voltage of twisted pairs after 72 h at temperatures shown (based on controls).

NOTE 1—Table 6 contains typical values of breakdown voltage retention for compatibility of the sleeving of this specification with magnet wire.

10. Rejection and Rehearing

10.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

11. Packaging Rejection and Package Marking

11.1 Packaging, packing, and marking shall Rehearing

11.1 Material that fails to conform to the requirements of this specification may be in accordance with Practice D 4088 unless otherwise agreed rejected. Rejection should be reported to between the purchaser producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

12. Packaging and Package Marking

12.1 Packaging, packing, and marking shall be in accordance with Practice D 4088 unless otherwise agreed upon between the purchaser and supplier.

13. Keywords

123.1 coated woven textile sleeving; electrical insulation; flexible treated sleeving

TABLE 2.6 Standard Sizes and Wall Thicknesses for Sleeving with Magnet Wire Insulation

Insid Di	Type	Gram deter, in. (mm)	Minimum Wall Thickness ^A , in. (mm)					
			Max	Min	Method B ^B			
					Grade-A	Grade-B	Grade-C	
°C	Retention, %	°C	Re-A	Grade-B	Grade-C	Retention, %		
No.	24		0.027 (0.69)	0.020 (0.51)		0.011 (0.28)	0.007 (0.18)	0.006 (0.15)
1	All		130	50		130	0.007 (0.18)	0.006 (0.15)
	22		0.032 (0.81)	0.025 (0.64)		0.013 (0.33)	0.007 (0.18)	0.006 (0.15)
2	All		155	50		155	0.007 (0.18)	0.006 (0.15)
	20		0.039 (0.99)	0.032 (0.81)		0.013 (0.33)	0.007 (0.18)	0.006 (0.15)
3	All		155	50		155	0.007 (0.18)	0.006 (0.15)
	19		0.044 (1.12)	0.036 (0.91)		0.013 (0.33)	0.007 (0.18)	0.006 (0.15)
4	All		225	50		225	0.007 (0.18)	0.006 (0.15)
	18		0.049 (1.24)	0.040 (1.02)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
5	All		225	50		225	0.007 (0.18)	0.006 (0.15)
	17		0.054 (1.37)	0.045 (1.14)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
6	All		180	50		180	0.007 (0.18)	0.006 (0.15)
	16		0.061 (1.55)	0.051 (1.30)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
7	All		...	...		...	...	0.006 (0.15)
	15		0.067 (1.70)	0.057 (1.45)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
	14		0.074 (1.88)	0.064 (1.63)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
	13		0.082 (2.08)	0.072 (1.83)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
	12		0.091 (2.31)	0.081 (2.06)		0.015 (0.38)	0.007 (0.18)	0.006 (0.15)
	11		0.101 (2.6)	0.091 (2.31)		0.018 (0.46)	0.009 (0.23)	0.008 (0.20)
	10		0.112 (2.8)	0.102 (2.6)		0.018 (0.46)	0.009 (0.23)	0.008 (0.20)
	9		0.124 (3.1)	0.114 (2.9)		0.018 (0.46)	0.009 (0.23)	0.008 (0.20)
	8		0.141 (3.6)	0.129 (3.3)		0.018 (0.46)	0.009 (0.23)	0.008 (0.20)
	7		0.158 (4.0)	0.144 (3.7)		0.018 (0.46)	0.009 (0.23)	0.008 (0.20)
	6		0.178 (4.5)	0.162 (4.1)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	5		0.198 (5.0)	0.182 (4.6)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	4		0.224 (5.7)	0.204 (5.2)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	3		0.249 (6.3)	0.229 (5.8)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	2		0.278 (7.1)	0.258 (6.6)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	1		0.311 (7.9)	0.289 (7.3)		0.020 (0.51)	0.011 (0.28)	0.010 (0.25)
	0		0.347 (8.8)	0.325 (8.3)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	3/8 in.		0.399 (10.1)	0.375 (9.5)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	7/16 in.		0.462 (11.7)	0.438 (11.1)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	1/2 in.		0.524 (13.3)	0.500 (12.7)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	5/8 in.		0.655 (16.6)	0.625 (15.9)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	3/4 in.		0.786 (20.0)	0.750 (19.1)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	7/8 in.		0.911 (23.1)	0.875 (22.2)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)
	1 in.		1.036 (26.3)	1.000 (25.4)		0.025 (0.64)	0.017 (0.43)	0.016 (0.41)

^AAs Percentage retention (minimum) of breakdown voltage of twisted pairs after 672 h at temperatures shown (based on controls).

^BPercentage retentions (min-wall thickness values may) of braided woven dielectric sleeve of twisted and stranded parallel pairs after 72 h at temperatures shown (based on controls).

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