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Uncoated Treated Fiberglass Sleeving Standard

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FOREWORD

The Standards Publication has been prepared by the Electrical Tubing and Sleeving Section of the National Electrical Manufacturers Association and is intended primarily to establish test methods and performance characteristics for heat treated (annealed) and saturated fiberglass sleeving.

Parallel standards activities in International Electrotechnical Commission (IEC) Subcommittee 15C "Specifications for Insulating materials" were considered in the development of this Standards Publication.

In the preparation of this Standards Publication, input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed recommended revisions should be submitted to the concerned NEMA Product Subdivision by contacting the:

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National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

SCOPE

This Standards Publication covers physical requirements and methods of testing heat-treated (annealed) and saturated fiberglass sleeving used in the insulation of electrical equipment.

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Section 1
REFERENCED STANDARDS AND DEFINITIONS

1.1 REFERENCED STANDARDS

The following publication is adopted, in whole or in part, as indicated by reference in this Standards Publication.

ASTM
1916 Race Street
Philadelphia, PA 19103

D3636-1980 *Sampling and Judging of Solid Electrical Insulating Materials*

1.2 DEFINITIONS

1.2.1 Dyed

A condition of sleeving wherein a colorant dispersed in a suitable vehicle has been applied and thereafter dried or cured for the purpose of imparting an identifying color.

1.2.2 Fraying

A tendency in the sleeving to produce a flared condition when cut.

1.2.3 Heat-Treated (Annealed)

A condition wherein the sleeving has been softened by application of heat so as to substantially relieve the strains induced by the fabrication process, to aid in the rounding of the sleeving to a pre-determined size, to reduce the organic sizing content of the yarns and to minimize the tendency to fray.

1.2.4 Saturated Fiberglass Sleeving

A fray-resistant, tubular product woven from continuous-filament electrical grade glass yarns which has been saturated with or without heat-treatment (annealed).

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Section 2
GENERAL REQUIREMENTS

2.1 INTRODUCTION

There are no breakdown voltage grade requirements for uncoated treated fiberglass sleeving. Levels of voltage protection are determined by the wall thickness of the sleeving, acting as a space barrier to ground.

Some manufacturers have applied the designation, Grade C-3, to the dyed or saturated style.

2.2 TYPES

Treated sleeving shall be one of the following types.

Type 1—Sleeving of nominal 0.008 in. (0.020 mm) wall thickness and available in inside diameters from about 1/16 in. (1.6 mm) to about 1 in. (25.4 mm) in increments of about 1/16 in. (1.6 mm)

Type 2—Sleeving of nominal 0.006-in. (0.15 mm) wall thickness and available in inside diameters from about 1/16 in. (1.6 mm) to about 1/2 in. (12.7 mm) in increments of about 1/16 in. (1.6 mm)

Type 3—Sleeving conforming in diameter to American Wire Gage sizes (AWG) and having wall thicknesses proportionate to the inside diameter.

Type 4—Sleeving similar to Type 3 but having wall thicknesses of nominal 0.031 in. (0.79 mm) as required for specific end-use applications.

The above types are available as heat-treated, dyed, or saturated.

2.3 COLORS

Colors shall be mutually agreed upon by the supplier and the user.

2.4 COIL AND SPOOL LENGTHS

Sleeving in normally supplied in continuous lengths of 1000, 500, 250, 100 and 50 feet (300, 150, 75, 30 and 15 meters, respectively) depending on the inside diameter and wall thickness. Other lengths may be obtained as mutually agreed upon by the supplier and the user.

2.5 LENGTH/SPLICES

Uncoated sleeving is normally supplied in coils or spools of continuous length or in 36 in. (0.91 m) lengths, depending on size, as shown in Table 2-1, and varying according to the manufacturer.

The length of product in any coil or spool shall not be less than declared. The length of cut pieces shall conform to the tolerances shown in Table 2-2.

2.6 THERMAL CLASSIFICATION

Heat-treated sleeving may be used at temperature above 240°C as performance characteristics are essentially the same as those of fiberglass. Property degradation at elevated temperatures will be experienced.

Saturated or dyed sleeving is shown by experience to be suitable for use in equipment intended for operation up to 240°C.

Table 2-1
NUMBER OF ALLOWABLE SPLICES*

Spool or Coil Length**	Size Range, in.†	Max. No. of Splices
50 ft. (15m)	24 AWG - 1"	2
100 ft. (30m)	24 AWG - 3/8"	3
100 ft. (30m)	7/16" - 1"	4
150 ft. (45m)	24 AWG - 1 AWG	3
150 ft. (45m)	0 AWG - 3/8"	4
150 ft. (45m)	7/16" - 1"	5
250 ft. (75m)	24 AWG - 1 AWG	3
250 ft. (75m)	0 AWG - 1/2"	4
250 ft. (75m)	5/8" - 1"	6
500 ft. (150m)	24 AWG - 6 AWG	5
500 ft. (150m)	5 AWG - 1/2"	7
500 ft. (150m)	5/8" - 1"	8
1000 ft. (300m)	24 AWG - 14 AWG	6
1000 ft. (300m)	13 AWG - 1"	10
Over 1000 ft. (300m)	24 AWG - 1"	†

* Cut pieces in lengths up to 20 ft., in any size, shall contain no splices.

**Splices in spools or coils shall be at least 20 ft. apart.

† For lengths over 1,000 ft. (300m), or sizes over 1" (25mm), the number of splices shall be as agreed upon by the purchaser and the supplier.

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Table 3-2
TOLERANCE ON CUT LENGTHS

Length of Piece, in. (mm)	±Tolerance, in. (mm)
Up to 3 (76 mm)	1/16 in. (1.6 mm)
3 in. (76 mm) up to 6 in. (152 mm)	3/32 in. (2.4 mm)
6 in. (152 mm) up to 12 in. (305 mm)	1/8 in. (3.2 mm)
12 in. (305 mm) to 36 in. (914 mm)	1/4 in. (6.4 mm)
Over 36 in. (914 mm)	+1/2 in./-0 (12.7 mm)

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Section 3
DIMENSIONAL AND YIELD REQUIREMENTS

3.1 INSIDE DIAMETER AND WALL THICKNESS

Inside diameter and wall thickness for the various types of treated sleeving shall be shown in Tables 3-1 and 3-2.

3.2 YIELD REQUIREMENTS

Yield requirements for Type 1 and 2 shall be as shown in Table 3-1.

Table 3-1
DIMENSIONAL AND YIELD REQUIREMENTS (Types 1 and 2)

Type 1—Wall thickness 0.008 ± 0.001 in. (0.20 ± 0.03 mm)				
	Inside Diameter, in. (mm)		Yield, yd/lb (m/kg)	
Size, in. (mm)	Max.	Min.	Max.	Min.
1/16 (1.6)	0.079 (2.01)	0.063 (1.60)	259 (520)	212 (426)
1/8 (3.2)	0.141 (3.58)	0.125 (3.18)	123 (248)	101 (203)
3/16 (5.0)	0.204 (5.18)	0.188 (4.78)	94 (189)	77 (155)
1/4 (6.3)	0.281 (7.13)	0.250 (6.35)	73 (147)	59 (121)
5/16 (8.0)	0.344 (8.74)	0.313 (8.38)	63 (126)	51 (103)
3/8 (10.0)	0.406 (10.3)	0.375 (9.53)	51 (103)	41 (84)
1/2 (12.5)	0.563 (14.3)	0.500 (12.7)	46 (94)	38 (77)
5/8 (16.0)	0.688 (17.5)	0.625 (15.9)	39 (79)	32 (64)
3/4 (20.0)	0.812 (20.8)	0.750 (19.1)	34 (68)	28 (56)
7/8 (22.4)	0.938 (23.8)	0.875 (22.2)	32 (64)	26 (52)
1 (25.0)	1.063 (27.0)	1.000 (25.4)	23 (47)	19 (39)
Type 2— Wall Thickness 0.006. ± 0.001 in. (0.15 ± 0.03 mm)				
	Inside Diameter, in. (mm)		Yield, yd/lb (m/kg)	
Size, in. (mm)	Max.	Min.	Max.	Min.
1/16 (1.6)	0.079 (2.01)	0.063 (1.60)	416 (839)	340 (687)
1/8 (3.2)	0.141 (3.58)	0.125 (3.18)	230 (464)	188 (380)
3/16 (5.0)	0.204 (5.18)	0.188 (4.78)	168 (339)	138 (277)
1/4 (6.3)	0.281 (7.13)	0.250 (6.35)	133 (267)	109 (219)
5/16 (8.0)	0.344 (8.74)	0.313 (8.38)	100 (201)	82 (163)
3/8 (10.0)	0.406 (10.3)	0.375 (9.53)	79 (160)	65 (131)
1/2 (12.5)	0.563 (14.3)	0.500 (12.7)	63 (126)	51 (103)

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Table 3-2
DIMENSIONAL REQUIREMENTS

Size	Inside Diameter, in. (mm) Types 3 and 4 Max.	Inside Diameter, in. (mm) Types 3 and 4 Min.	Wall Thickness, in. (mm) Type 3 Min.	Wall Thickness, in. (mm) Type 4 Min.
24 AWG	0.027 (0.96)	0.020 (0.51)	0.005 (0.13)	0.028 (0.71)
22 AWG	0.032 (0.81)	0.025 (0.64)	0.005 (0.13)	0.028 (0.71)
20 AWG	0.039 (0.99)	0.032 (0.81)	0.009 (0.23)	0.028 (0.71)
19 AWG	0.044 (1.12)	0.036 (0.91)	0.009 (0.23)	0.028 (0.71)
18 AWG	0.049 (1.25)	0.040 (1.02)	0.011 (0.28)	0.028 (0.71)
17 AWG	0.054 (1.37)	0.045 (1.14)	0.011 (0.28)	0.028 (0.71)
16 AWG	0.061 (1.55)	0.051 (1.30)	0.011 (0.28)	0.028 (0.71)
15 AWG	0.067 (1.70)	0.057 (1.45)	0.011 (0.28)	0.028 (0.71)
14 AWG	0.074 (1.88)	0.064 (1.63)	0.011 (0.28)	0.028 (0.71)
13 AWG	0.082 (2.08)	0.072 (1.83)	0.011 (0.28)	0.028 (0.71)
12 AWG	0.091 (2.31)	0.081 (2.06)	0.011 (0.28)	0.028 (0.71)
11 AWG	0.101 (2.6)	0.091 (2.31)	0.011 (0.28)	0.028 (0.71)
10 AWG	0.112 (2.8)	0.102 (2.6)	0.011 (0.28)	0.028 (0.71)
9 AWG	0.124 (3.2)	0.114 (2.9)	0.011 (0.28)	0.028 (0.71)
8 AWG	0.141 (3.6)	0.129 (3.3)	0.011 (0.28)	0.028 (0.71)
7 AWG	0.158 (4.0)	0.144 (3.7)	0.013 (0.33)	0.028 (0.71)
6 AWG	0.178 (4.5)	0.162 (4.1)	0.013 (0.33)	0.028 (0.71)
5 AWG	0.198 (5.0)	0.182 (4.6)	0.013 (0.33)	0.028 (0.71)
4 AWG	0.224 (5.7)	0.204 (5.2)	0.016 (0.41)	0.028 (0.71)
3 AWG	0.249 (6.3)	0.229 (5.8)	0.016 (0.41)	0.028 (0.71)
2 AWG	0.278 (7.1)	0.258 (6.6)	0.016 (0.41)	0.028 (0.71)
1 AWG	0.311 (7.9)	0.289 (7.3)	0.016 (0.41)	0.028 (0.71)
0 AWG	0.347 (8.8)	0.325 (8.3)	0.016 (0.41)	0.028 (0.71)
3/8"	0.399 (10.1)	0.375 (9.5)	0.016 (0.41)	0.028 (0.71)
7/16"	0.462 (11.7)	0.438 (11.1)	0.018 (0.46)	0.028 (0.71)
1/2"	0.524 (13.3)	0.500 (12.7)	0.018 (0.46)	0.028 (0.71)
5/8"	0.655 (16.7)	0.625 (15.9)	0.018 (0.46)	0.028 (0.71)
3/4"	0.786 (20.0)	0.750 (19.1)	0.018 (0.46)	0.028 (0.71)
7/8"	0.991 (23.1)	0.875 (22.2)	0.018 (0.46)	0.028 (0.71)
1"	1.036 (26.3)	1.000 (25.4)	0.018 (0.46)	0.028 (0.71)

Table 3-2 continued next page

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Table 3-2 (continued)
DIMENSIONAL REQUIREMENTS

Size	Inside Diameter, in. (mm) Types 3 and 4 Max.	Inside Diameter, in. (mm) Types 3 and 4 Min.	Wall Thickness, in. (mm) Type 3 Min.	Wall Thickness, in. (mm) Type 4 Min.
1-1/8"	1.161 (29.6)	1.125 (28.7)	0.022 (0.56)	0.028 (0.71)
1-1/4"	1.286 (32.8)	1.250 (31.9)	0.022 (0.56)	0.028 (0.71)
1-3/8"	1.411 (35.9)	1.375 (35.1)	0.022 (0.56)	0.028 (0.71)
1-1/2"	1.536 (39.2)	1.500 (38.3)	0.022 (0.56)	0.028 (0.71)
1-3/4"	1.786 (45.5)	1.750 (44.6)	0.022 (0.56)	0.028 (0.71)
2"	2.036 (51.9)	2.000 (51.0)	0.024 (0.61)	0.028 (0.71)
2-1/4"	2.330 (59.4)	2.250 (57.4)	0.024 (0.61)	0.028 (0.71)
2-1/2"	2.536 (64.7)	2.500 (63.8)	0.024 (0.61)	0.028 (0.71)
2-3/4"	2.850 (72.7)	2.750 (70.1)	0.024 (0.61)	0.028 (0.71)
3"	3.036 (77.4)	3.000 (76.5)	0.028 (0.71)	0.028 (0.71)
3-1/4"	3.330 (84.9)	3.250 (82.9)	0.028 (0.71)	0.028 (0.71)
3-1/2"	3.538 (90.2)	3.500 (89.3)	0.028 (0.71)	0.028 (0.71)
3-3/4"	3.850 (98.2)	3.750 (95.6)	0.028 (0.71)	0.028 (0.71)
4"	4.038 (103.0)	4.000 (102.0)	0.028 (0.71)	0.028 (0.71)

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Section 4
PERFORMANCE REQUIREMENTS

4.1 FLAME RESISTANCE

When tested in accordance with the procedure described in 6.3, sleeving shall not burn or glow more than 60 seconds after any flame application. The cotton used in the test shall not be ignited by flame drippings from the specimen. No more than 25 percent of the indicator paper shall be burned or charred during the test.

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Section 5
SAMPLING

5.1 SAMPLING LOTS

A lot of sleeving shall be defined as all material of any one type, size and color offered for delivery at the same time.

Samples for lot acceptance shall be selected according to the following:

Lot size (ft. or pieces)	Sample size (ft. or pieces)
up to 1000	5
1000 to 10,000	10
over 10,000	15

This sampling corresponds approximately to Inspection Level S-1 of ASTM Method D3636.

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Section 6
METHODS OF TEST

6.1 INSIDE DIAMETER

6.1.1 Gage Rods

Steel gage rods having rounded ends and smooth surfaces shall be used to determine inside diameter of treated sleeving. Each rod shall have a diameter within 0.005 in. (0.13 mm) of the dimensions shown in Table 3-1.

6.1.2 Method of Measurement

Pass the minimum gage rod for the nominal sleeving size into the test specimen for a distance of about 5 in. (130 mm). If the rod fits snugly without expanding the sleeving, the specimen shall be considered as having an inside diameter equal to the diameter of the gage rod. If the rod fits loosely, the maximum gage rod for that size shall be similarly inserted in a different specimen. If the rod fits snugly or visibly expands the sleeving, then the size of the specimen shall be taken as falling within the prescribed limits of maximum and minimum inside diameter, as shown under Tables 3-1 and 3-2.

6.1.2 Method of Measurement

This procedure is recommended where error caused by inadvertent distortion of the sleeving due to handling during testing may preclude agreement on size.

Carefully cut specimens of approximately 6 in. long and mark off a length of exactly 100 mm, locating the marked-off length centrally on the specimen.

Select two mandrels of known diameter so as to be larger and smaller than the nominal stated inside diameter of the sleeving.

This selection may be facilitated by a preliminary measurement of inside diameter made on a separate specimen using the procedure in 6.1.2.

Insert the smaller mandrel into the sleeving and pull the sleeving down on the mandrel so as to provide a snug fit throughout the entire length of the specimen. Secure the test specimen on the mandrel and measure the distance between the marks to the nearest mm. Remove the mandrel and repeat on the same specimen using the larger mandrel.

Calculate the inside diameter of the sleeving from the measurements made above using the following expression.

$$D = d_2 - \frac{(100 - L_2)(d_2 - d_1)}{(L_1 - L_2)}$$

Where:

D= inside diameter of sleeving, in.

d_1 = diameter of smaller mandrel, in.

d_2 = diameter of larger mandrel, in.

L_1 = measured gage length over smaller mandrel, mm

L_2 = measured gage length over larger mandrel, mm

6.1.4 Report

The report shall include the following.

a. Identification of the sleeving
b. Size of sleeving
c. Inside diameter of sleeving in inches

6.2 WALL THICKNESS

6.2.1 Micrometer

A dial-type micrometer, capable of exerting a deadweight of 3 oz. between the presser foot and the anvil shall be used. The presser foot shall have a diameter of 0.25 in. (6.3 mm) and the anvil shall preferably be the same diameter.

6.2.2 Method of Measurement

Insert a gage rod of such diameter into the sleeving as to effect a snug fit without expanding the specimen. Measure the outside diameter of the mounted specimen, taking care to apply the load through the presser foot slowly on the mounted specimen. Calculate the wall thickness as one-half the difference between the outside diameter of the mounted sleeving and the measured diameter of the supporting gage rod.

6.2.3 Report

The report shall include the following.

a. Identification of the sleeving
b. Wall thickness in inches (mm)

6.3 FLAME RESISTANCE

6.3.1 Apparatus and Equipment

6.3.1.1 SHEET-METAL ENCLOSURE

A three-walled sheet-metal enclosure, 12 in. (304.8 mm) wide by 14 in. (355.6 mm) deep and 29 in. (736.6 mm) high, open at the top and front shall be used. It shall be equipped with two metal horizontal rods 16 in. (406.4 mm) apart, so that a wire stretched perpendicularly to the rods shall be at an angle of 90 degree with the horizontal. The rods shall be at least 2 in. (50.8 mm) from the rear wall.

6.3.1.2 BARE STEEL WIRE

Spring steel music-wires, 0.015 (.038 mm) to 0.020 in. (0.51 mm) and 0.029 in. (0.74 mm) in diameter shall be used.

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6.3.1.3 BURNER

A Bunsen-type burner having a 3/8-in. (9.53 mm) diameter barrel and an adjustable air and gas inlet capable of maintaining a flame height of 5 in. (127 mm) overall, with an inner cone height of 1-1/2 in. (38.1 mm) shall be used. A regulated gas supply (methane or natural gas) that provides a flame temperature of 840°C minimum, measured at the tip of the inner cone shall be used.

6.3.2 Procedure

Select five specimens of sleeving 26 in. (604.4 mm) long. Mount the specimens on a steel wire 0.029 in. (6.74 mm) in diameter and 35 in. (889 mm) long. In the case of sleeving of inside diameter less than 0.032 in. (0.81 mm), the diameter of the wire shall be between 0.0105 (.38 mm) and 0.020 in. (.50 mm).

Attach the mounted sleeving specimens at one end to an upper horizontal bar by kinking the sleeving and clamping it, so as to provide a closed end to the specimens, thus preventing any chimney effects during burning. Pass the lower end of the mounted specimens over the lower bar and secure. Attach a paper indicator to the upper end of the specimens so that the lower edge of the indicator is 10 in. (254 mm) above the point of flame application and the indicator projects 3/4 in. (19.05 mm) from the specimen surface. Place a flat piece of untreated surgical cotton centrally beneath the specimens at a distance of not more than 9-1/2 in. (241.3 mm) below the point of flame application.

Apply the flame to the specimens at an angle of 20 degree to the axis of the specimens and at a point not less than 3 in. (76.2 mm) from the lower end. The flame shall be applied so that the tip of the inner cone touches the surface of the specimens.

The flame shall be applied to the specimens for a period of 15 sec. and then removed. The period of removal shall be 15 sec. or until such time as the burning or glowing ceases, whichever is the longer. This procedure is to be repeated four times. Record the duration of burning or glowing after each flame application. Also record any cotton ignition due to dripping of burning particles from the specimens during the test. Record the percentage of indicator flag burned or charred during the test, ignoring any soot accumulation thereon.

6.3.3 Report

The report shall include the following:

a. Identification of the sleeving
b. Duration of burning and glowing after each flame application, sec
c. Burning of cotton caused by ignited drippings
d. Percentage of the area of the indicator flag burned or charred

6.4 YIELD

6.4.1 Apparatus

6.4.1.1 MANDRELS

Metal rods, about 1 meter in length, having diameters equal to the minimum inside diameters specified in Table 3-1 shall be used.

6.4.1.2 SCALE

A metal scale 1 meter long, graduated in millimeter shall be used.

6.4.1.3 BALANCE

Analytical-type, capable of weighing to nearest milligram shall be used.

6.4.2 Procedure

Prepare two lengths of sleeving approximately 1 meter long. Mount sleeving lengths on mandrels, whose diameter corresponds to the nominal inside diameter of the sleeving to be tested, making certain that the sleeving fits snugly throughout on the mandrels. Mark off a gage length of about 100 mm on the central portion of each length and cut accurately at the gage marks using a sharp instrument. Weigh the lengths to the nearest 1 mg. Calculate the yield, using the following expression.

$$Y = 0.497 \frac{1}{W}$$

Where:

Y = yield, yd/lb

1 = measured length of specimen, mm

W = specimen weight, per 100 mm sample (gms)

6.4.3 Report

The report shall include the following.

a. Identification of the sleeving
b. Average yield, yd/lb (m/kg)

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NEMA STANDARDIZATION BACKGROUND

The purpose of NEMA standards, their classification, and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp. 5)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, pp. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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