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Electrical and Electronic FEP Insulated High Temperature Hook-Up Wire, Types K, KK, and KT

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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HP 4

ELECTRICAL AND ELECTRONIC FEP (FLUORINATED ETHYLENE PROPYLENE) INSULATED HIGH TEMPERATURE HOOK-UP WIRE, TYPES K (600 Volt), KK (1000 Volt), AND KT (250 Volt)

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Foreword

This Standards Publication was developed by the NEMA High Temperature Insulated Wire and Cable Section. This Standard was developed to assure that these types of hook-up wire can be procured and that they will meet the exacting requirements associated with high reliability commercial electrical and electronic equipment in which it is used, in much the same way that Mil-W-16878 is used for equipment procured for military purposes. Unlike military specifications, however, compliance with provisions of this Standards Publication is strictly voluntary and any certification of compliance is left to the discretion of the buyer and seller.

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Scope

This Standards Publication covers specific requirements for FEP (Fluorinated Ethylene Propylene) insulated solid and stranded wire, designed for the internal wiring of high reliability electrical and electronic equipment. This Standards Publication addresses 250 volt (Type KT), 600 volt (Type K), and 1000 volt (Type KK) wire and permits continuous conductor temperature ratings of −65 °C to +200 °C with silver-plated or nickel-plated conductors and −65 °C to +150 °C with tin-plated conductors. These types of hook-up wire are used when the following requirements are called for:

- Low dielectric constant
- Low temperature resistance
- Resistance to cleaning solutions or a variety of chemicals that may come in contact with either the wire or the equipment
- Good flexibility and flex life when stranded conductors are used
- High temperature resistance
- Long lengths are required

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ELECTRICAL AND ELECTRONIC FEP (FLUORINATED ETHYLENE PROPYLENE) INSULATED HIGH TEMPERATURE HOOK-UP WIRE, TYPES K (600 Volt), KK (1000 Volt), AND KT (250 Volt)

Section 1

REFERENCED STANDARDS AND GENERAL INFORMATION

1.1 REFERENCED STANDARDS AND SPECIFICATIONS

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

B-3-74 (R 1980)	*Soft or Annealed Copper Wire*
B-33 (R 1985)	*Tinned Soft or Annealed Copper Wire*
B-286-74 (R 1984)	*Copper Conductors for Use in Hook-Up Wire for Electronic Equipment*
B-298-74 (R 1984A)	*Silver-Coated Soft or Annealed Copper Wire*
B-355 (R 1980)	*Nickel-Coated Soft or Annealed Copper Wire*
B-624-77 (R 1982)	*High-Strength, High Conductivity Copper-Alloy Wire for Electronic Applications*
D-2116-83	*FEP Fluorocarbon Molding and Extrusion Materials*
D-3032-86A	*Methods of Testing Hook-Up Wire Insulation*

General Services Administration, Specifications Activity
Printed Materials Supply Division—Building 197
Naval Weapons Plant
Washington, D.C. 20407

Fed-STD-228 (April 14, 1978)	*Cable and Wire, Insulated, Methods of Testing*

National Electrical Manufacturers Association
2101 L Street, NW, Suite 300
Washington, D.C. 20037

WC 52-1985	*High Temperature and Electronic Insulated Wire—Impulse Dielectric Testing*
WC 56-1986	*3.0 kHz Insulation Continuity Proof Testing of Hook-Up Wire*

1.2 RECOMMENDED USES OF WIRE TYPES

1.2.1 Type KT wire is intended for use in low voltage, high temperature applications. It is suitable for use up to a maximum of 250 volts rms and for high frequency circuitry.

Wires having KT thin wall insulation are relatively fragile and can be damaged. They should not be used when mechanical stress or an abrasive environment exists and should not be used for open wiring without additional jackets or other protection.

Authorized Engineering Information 5-25-1988.

1.2.2 Type K is intended for medium voltage and high temperature applications and is suitable for use at a maximum of 600 volts rms and for high frequency circuitry.

Authorized Engineering Information 5-25-1988.

1.2.3 Type KK is intended for high voltage and high temperature applications and is suitable for use at a maximum of 1000 volts rms and for high frequency circuitry.

Authorized Engineering Information 5-25-1988.

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Section 2
CONDUCTORS

2.1 CONDUCTOR MATERIALS

The basic conductor shall be composed of either soft, annealed copper wire of strands conforming to ASTM B-3 or a copper alloy per ASTM B-624. Each individual conductor shall have a plated metallic coating. The addition of the plating material after stranding shall not be permitted. All strands of a conductor shall be of the same composition.

NEMA Standard 5-25-1988.

2.2 CONDUCTOR COATINGS

2.2.1 Silver-Coated Conductors

Silver-coated conductors shall be employed for applications up to conductor temperatures of 200 °C. The silver coating shall be commercially pure silver and not less than 40 microinches in thickness. The conductor shall be tested for continuity of coating and coating thickness prior to stranding in accordance with ASTM B-298.

NEMA Standard 5-25-1988.

2.2.2 Nickel-Coated Conductors

Nickel-coated conductors shall be employed for applications up to conductor temperatures of 200 °C. The nickel coating shall be commercially pure nickel and not less than 50 microinches in thickness. The conductor shall be tested prior to stranding for continuity of coating and coating thickness in accordance with ASTM B-355.

NEMA Standard 5-25-1988.

2.2.3 Tin-Coated Conductors

Tin-coated conductors shall be employed for applications up to conductor temperatures of 150 °C. The conductor shall be tested prior to stranding for continuity of coating in accordance with ASTM B-33.

NEMA Standard 5-25-1988.

2.3 STRANDING

Stranding shall be in accordance with Table 2-1. All requirements for stranded conductors, not specified in Table 2-1, shall be in accordance with the applicable requirements of ASTM B-286.

NEMA Standard 5-25-1988.

2.4 MINIMUM WIRE AND STRAND DIAMETER

Minimum wire and strand diameter shall be controlled by maximum dc resistance.

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Table 2-1
DETAILS OF CONDUCTORS

Sizing (AWG)	Stranding[1]	Nominal Conductor CMA	Typical Strand Dia. (Inches)	Length of Lay (Maximum) (Inches)	Conductor Diameter		Maximum DC Resistance of Finished Wire (OHMS/1000 ft at 20°C)					Breaking Strength (Lbs. Min.)
					Nominal (inches)	Maximum[2] (inches)	Annealed Copper			High Strength Copper Alloy		
							SPC	NPC	TPC	S.P. Alloy	N.P. Alloy	
32	1 × 32	64	.0080	...	.0080	.0090	169.0	175.0	178.0	200.0	205.0	3.01
	7 × 40	67	.0031	.187	.0093	.0110	173.0	185.0	189.0	204.0	232.0	3.17
	19 × 44	76	.0020	.187	.0099	.0110	160.3	178.6	169.0	188.5	210.1	3.58
30	1 × 30	100	.0100	...	.0100	.0110	108.0	112.0	116.0	127.0	132.0	4.71
	7 × 38	112	.0040	.187	.0120	.0130	100.7	110.7	114.1	117.4	129.6	5.17
	19 × 42	119	.0025	.187	.0124	.0130	100.5	109.4	106.0	118.2	128.7	5.60
28	1 × 28	159	.0126	...	.0126	.0130	68.0	70.0	71.6	80.0	82.0	7.48
	7 × 36	175	.0050	.20	.0150	.0160	63.8	67.9	68.6	74.4	79.0	8.16
	19 × 40	183	.0031	.20	.0146	.0160	64.3	70.6	67.7	75.6	77.9	8.60
26	1 × 26	253	.0159	...	.0159	.0170	42.7	43.8	45.3	50.2	51.5	11.9
	7 × 34	278	.0063	.25	.0189	.0200	40.5	43.1	43.4	47.6	50.7	13.1
	19 × 38	304	.0040	.25	.0188	.0220	38.4	42.2	41.3	44.8	49.4	14.2
24	1 × 24	404	.0201	...	.0201	.0220	26.8	27.4	27.8	31.4	31.9	19.0
	7 × 32	448	.0080	.33	.0240	.0250	25.2	26.5	27.0	29.4	30.8	21.1
	19 × 36	475	.0050	.33	.0235	.0270	24.3	25.9	26.2	28.4	30.1	22.4
22	1 × 22	640	.0253	...	.0253	.0260	17.0	18.1	17.7	19.6	19.9	30.2
	7 × 30	700	.0100	.33	.0300	.0310	15.9	16.6	17.1	18.7	19.5	33.0
	19 × 34	754	.0063	.33	.0296	.0330	15.1	16.0	16.2	17.5	18.6	35.8
20	1 × 20	1024	.0320	...	.0320	.0330	10.5	10.7	10.9	12.2	12.6	48.3
	7 × 28	1111	.0126	.50	.0378	.0390	10.0	10.4	10.7	11.8	12.2	52.4
	19 × 32	1216	.0080	.50	.0376	.0410	9.19	9.77	9.88	10.8	11.4	58.1
18	1 × 18	1624	.0403	...	.0403	.0410	6.60	6.70	6.90			
	7 × 26	1770	.0159	.62	.0477	.0500	6.28	6.50	6.70			
	19 × 30	1900	.0100	.62	.0470	.0520	5.79	6.10	6.23			
16	1 × 16	2581	.0508	...	.0508	.0520	4.20	4.35	4.36			
	19 × 29	2426	.0113	.75	.0531	.0590	4.52	4.76	4.81			
14	19 × 27	3831	.0142	.875	.0667	.0730	2.88	3.00	3.06			
12	19 × 25	6088	.0179	1.00	.0841	.0930	1.81	1.88	1.92			
	37 × 28	5874	.0126	1.25	.0858	.0910	1.90	1.98	2.02			
10	37 × 26	9334	.0159	1.50	.108	.1150	1.19	1.24	1.26			
8	133 × 29	16983	.0113	2.00	.161	.0173	.658	.694	.701			
6	133 × 27	26818	.0142	2.50	.202	.217	.418	.436	.445			
4	133 × 25	42615	.0179	4.3	.266	.274	.264	.275	.280			
2	665 × 30	66500	.010	5.4	.335	.342	.170	.177	.183			
1	817 × 30	81700	.010	6.0	.378	.382	.139	.144	.149			
1/0	1045 × 30	104500	.010	6.8	.410	.431	.108	.113	.116			
2/0	1330 × 30	133000	.010	7.6	.477	.486	.085	.089	.091			
3/0	1672 × 30	167200	.010	8.5	.535	.545	.068	.071	.071			
4/0	2109 × 30	210900	.010	9.6	.601	.635	.054	.056	.056			

NOTES: [1]See 2.2. [2]See 2.4.
CMA=Circular Mil Area
SPC=Silver Plated Copper
SPA=Silver Plated Alloy
NPC=Nickel Plated Copper
TPC=Tin Plated Copper
NPA=Nickel Plated Alloy

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Section 3
CONDUCTOR INSULATION

3.1 GENERAL

The FEP insulating material shall conform to ASTM D-2116. The minimum tensile strength and elongation of the extruded insulation shall be 2500 psi and 200 percent respectively.

NEMA Standard 5-25-1988.

3.2 FEP INSULATION

The insulation shall be extruded concentrically about the conductor with not less than 70 percent concentricity to provide for accurate centering of the conductor and retention of a circular cross section measured in accordance with ASTM D-3032.

The diameter of the insulated conductor, prior to adding any outer coverings, shall conform to Table 3-1 for Type KT wire, Table 3-2 for Type K wire, and Table 3-3 for Type KK wire.

NEMA Standard 5-25-1988.

Table 3-1
DIMENSIONS—TYPE KT WIRES
(All Dimensions in Inches)

Size (AWG)	Stranding	Conductor Diameter (Nominal)	Insulated Conductor Diameter (Minimum)	Insulated Conductor Diameter (Maximum)	Cold Bend Test Mandrel Diameter
32	1 × 32	.0080	.018	.022	1
	7 × 40	.0093	.020	.024	1
	19 × 44	.0099	.020	.024	1
30	1 × 30	.0100	.020	.024	1
	7 × 38	.0120	.022	.026	1
	19 × 42	.0124	.022	.026	1
28	1 × 28	.0126	.023	.027	1
	7 × 36	.0150	.025	.029	1
	19 × 40	.0146	.025	.029	1
26	1 × 26	.0159	.026	.030	1
	7 × 34	.0189	.029	.033	1
	19 × 38	.0188	.029	.033	1
24	1 × 24	.0201	.030	.034	1
	7 × 32	.0240	.034	.038	1
	19 × 36	.0235	.034	.038	1
22	1 × 22	.0253	.035	.040	1
	7 × 30	.0300	.040	.044	1
	19 × 34	.0296	.040	.044	1
20	1 × 20	.0320	.042	.046	1
	7 × 28	.0378	.048	.052	1
	19 × 32	.0376	.048	.052	1

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Table 3-2
DIMENSIONS—TYPE K WIRES
(All Dimensions in Inches)

Size (AWG)	Stranding	Conductor Diameter (Nominal)	Insulated Conductor Diameter (Minimum)	Insulated Conductor Diameter (Maximum)	Cold Bend Test Mandrel Diameter
32	1 × 32	.0080	.024	.032	1
	7 × 40	.0093	.026	.034	1
	19 × 44	.0099	.026	.034	1
30	1 × 30	.0100	.026	.034	1
	7 × 38	.0120	.028	.036	1
	19 × 42	.0124	.028	.036	1
28	1 × 28	.0126	.029	.037	1
	7 × 36	.0150	.031	.039	1
	19 × 40	.0146	.031	.039	1
26	1 × 26	.0159	.032	.040	1
	7 × 34	.0189	.035	.043	1
	19 × 38	.0188	.035	.043	1
24	1 × 24	.0201	.036	.044	1
	7 × 32	.0240	.040	.048	1
	19 × 36	.0235	.040	.048	1
22	1 × 22	.0253	.041	.050	1
	7 × 30	.0300	.046	.054	1
	19 × 34	.0296	.046	.054	1
20	1 × 20	.0320	.048	.056	1
	7 × 28	.0378	.054	.062	1
	19 × 32	.0376	.054	.062	1
18	1 × 18	.0403	.056	.066	1
	7 × 26	.0477	.064	.074	1
	19 × 30	.0470	.064	.074	1
16	1 × 16	.0508	.067	.081	1
	19 × 29	.0531	.073	.087	1
14	19 × 27	.0667	.088	.102	2
12	19 × 25	.0841	.107	.121	2
	37 × 28	.0858	.105	.119	2
10	37 × 26	.108	.127	.141	2
8	133 × 29	.161	.185	.199	3

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Table 3-3
DIMENSIONS-TYPE "KK" WIRES
(All Dimensions In Inches)

Size (AWG)	Stranding	Conductor Diameter (Nominal)	Insulated Conductor Diameter (Minimum)	Insulated Conductor Diameter (Maximum)	Cold Bend Test Mandrel Diameter
32	1 × 32	.0080	.033	.041	1
	7 × 40	.0093	.035	.043	1
	19 × 44	.0099	.035	.043	1
30	1 × 30	.0100	.036	.044	1
	7 × 38	.0120	.038	.046	1
	19 × 42	.0124	.038	.046	1
28	1 × 28	.0126	.039	.047	1
	7 × 36	.0150	.041	.049	1
	19 × 40	.0146	.041	.049	1
26	1 × 26	.0159	.042	.050	1
	7 × 34	.0189	.045	.053	1
	19 × 38	.0188	.045	.053	1
24	1 × 24	.0201	.046	.054	1
	7 × 32	.0240	.050	.058	1
	19 × 36	.0235	.050	.058	1
22	1 × 22	.0253	.051	.060	1
	7 × 30	.0300	.056	.064	1
	19 × 34	.0296	.056	.064	1
20	1 × 20	.0320	.058	.066	1
	7 × 28	.0378	.064	.072	1
	19 × 32	.0376	.064	.072	1
18	1 × 18	.0403	.066	.076	1
	7 × 26	.0477	.074	.084	1
	19 × 30	.0470	.074	.084	1
16	1 × 16	.0508	.077	.089	1
	19 × 29	.0531	.083	.095	1
14	19 × 27	.0667	.098	.114	2
12	19 × 25	.0841	.117	.133	2
	37 × 28	.0858	.115	.131	2
10	37 × 26	.108	.137	.153	3
8	133 × 29	.161	.199	.219	3
6	133 × 27	.202	.286	.301	3
4	133 × 25	.266	.349	.369	4.5
2	665 × 30	.335	.395	.415	4.5
1	817 × 30	.378	.475	.495	6
1/0	1045 × 30	.410	.504	.524	6
2/0	1330 × 30	.477	.553	.577	10
3/0	1672 × 30	.535	.633	.657	10
4/0	2109 × 30	.601	.703	.727	10

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Section 4
WIRE IDENTIFICATION

4.1 CIRCUIT IDENTIFICATION

Circuit identification if required shall be accomplished by use of colored insulation. Colored stripe or band tracers on the insulation, and/or printed numbers or letters shall be permitted, in addition to the colored insulation.

NEMA Standard 5-25-1988.

4.2 IDENTIFICATION BY PRINTING

Identification by printing on the wire is available for Types K and KK wire for conductor sizes 22 AWG and larger. Print should be clear and legible. Printing on Type KT wire is not recommended due to the thin wall construction.

Authorized Engineering Information 5-25-1988.

Section 5
PHYSICAL AND ELECTRICAL REQUIREMENTS

5.1 GENERAL

The following paragraphs and Tables cover physical and electrical requirements for Types KT, K, and KK wire. 100 percent of the wire shall be spark-tested or impulse tested. Other tests shall be conducted on a periodic conformance basis.

NEMA Standard 5-25-1988.

5.1.1 TYPE KT

Type KT wire shall conform to the physical and electrical requirements shown in Tables 3-1 and 5-1.

NEMA Standard 5-25-1988.

5.1.2 TYPE K

Type K wire shall conform to the physical and electrical requirements shown in Tables 3-2 and 5-2.

NEMA Standard 5-25-1988.

5.1.3 Type KK

Type KK wire shall conform to the physical and electrical requirements shown in Tables 3-3 and 5-3.

NEMA Standard 5-25-1988.

5.2 WORKMANSHIP

The wire should be free of kinks, abrasions, and cracked or peeled surfaces. The wire should be a uniform and consistent product and should be free from defects which will adversely effect the serviceability of the product for the intended use, as described in 1.2.

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Table 5-1
PHYSICAL AND ELECTRICAL REQUIREMENTS FOR TYPE KT WIRE

Test	Requirements	Test Conditioning (See 6.1.1 and 6.1.2)
Conductor Resistance (See Para. 6.2.2)	See Table 2-1	A
Spark Test (or Impulse Test) (See Para. 6.2.3)	2.5 kV (4.0 kV)	A (A)
Insulation Resistance (See Para. 6.2.4)	1000 megohms – 1000 feet (Minimum)	D–4/23 ± 5°C
Heat Resistance & Dielectric Strength (See Para. 6.1.3 and 6.2.5)	1.5 kV (Minimum) dielectric strength; 1/8 inch (Maximum) shrinkage	E–96/230
Cold Bend (See Para. 6.1.4 and 6.2.5)	1.5 kV (Minimum) dielectric strength (see Table 3-1)	E–4/–65
Surface Resistance (See Para. 6.2.1)	5 megohm – inches (Minimum)	C–96/23/95
Insulation Tensile Strength (See Para. 6.1.5)	2500 psi (Minimum)	A
Insulation Elongation (See Para. 6.1.6)	200 percent (Minimum)	A

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Table 5-2
PHYSICAL AND ELECTRICAL REQUIREMENTS FOR TYPE K WIRE

Test	Requirements	Test Conditioning (See 6.1.1 and 6.1.2)
Conductor Resistance (See Para. 6.2.2)	See Table 2-1	A
Spark Test (or Impulse Test) (See Para. 6.2.3)	3.4 kV (6.5 kV)	A (A)
Insulation Resistance (See Para. 6.2.4)	1000 megohms−1000 feet (Minimum)	D−4/23 ± 5°C
Heat Resistance & Dielectric Strength (See Para. 6.1.3 and 6.2.5)	2.0 kV (Minimum) dielectric strength; $^1/_8$ inch (Maximum) shrinkage	E−96/230
Cold Bend (See Para. 6.1.4 and 6.2.5)	2.0 kV (Minimum) dielectric strength (see Table 3-2)	E−4/−65
Surface Resistance (See Para. 6.2.1)	5 megohm − inches (Minimum)	C−96/23/95
Insulation Tensile Strength (See Para. 6.1.5)	2500 psi (Minimum)	A
Insulation Elongation (See Para. 6.1.6)	200 percent (Minimum)	A

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Table 5-3
Physical and Electrical Requirements
For Type KK Wire

Test	Requirements	Test Conditioning (See 6.1.1 and 6.1.2)
Conductor Resistance (See 6.2.2)	See Table 2-1	A
Spark Test (or Impulse Test) (See Para. 6.2.3)	5.0 kV (8.0 kV)	A (A)
Insulation Resistance (See Para. 6.2.4)	1000 megohms – 1000 feet (Minimum)	D–4/23 ± 5°C
Heat Resistance & Dielectric Strength (See Para. 6.1.3 and 6.2.5)	3.0 kV (Minimum) dielectric strength; 1/8 inch (Maximum) shrinkage	E–96/230
Cold Bend (See Para. 6.1.4 and 6.2.5)	3.0 kV (Minimum) dielectric strength (see Table 3-3)	E–4/–65
Surface Resistance (See Para. 6.2.1)	5 megohm – inches (Minimum)	C–96/23/95
Insulation Tensile Strength (See Para. 6.1.5)	2500 PSI (Minimum)	A
Insulation Elongation (See Para. 6.1.6)	200 percent (Minimum)	A

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Section 6
TEST PROCEDURES

6.1 PHYSICAL TESTS

Physical tests on the conductor and insulated wire shall be made in accordance with the following procedures.

NEMA Standard 5-25-1988.

6.1.1 Test Temperature

Unless otherwise specified, physical tests shall be performed at a room temperature of 23 °C ± 5 °C. The test specimens shall be kept at room temperature for not less than 30 minutes prior to the tests.

NEMA Standard 5-25-1988.

6.1.2 Nomenclature

The following letters shall be used to indicate the respective general conditioning procedures:

Condition A—As received, no special conditioning
Condition C—Humidity Conditioning
Condition D—Immersion in water
Condition E—Temperature conditioning

Conditioning procedures shall be designated as follows:

First, a capital letter indicating conditioning before test;
Second, a number indicating (in hours) duration of the conditioning;
Third, a number indicating (in °C) the conditioning temperature;
Fourth, a number indicating relative humidity (in percent), whenever relative humidity is controlled.

NEMA Standard 5-25-1988.

As an example of how conditioning procedures should be designated, the following is given:

C-96/23/95 means 96 hours at 23 °C and 95 percent relative humidity.

Authorized Engineering Information 5-25-1988.

6.1.3 Heat Resistance

Specimens of insulated wire, each having a length of 12 inches plus the length required for winding on the mandrel, shall be placed in an air-circulating oven capable of maintaining the specimen at the required temperature within ±2 °C, and subjected to the conditioning specified in Table 5-1, 5-2, or 5-3. The specimens shall then be removed from the conditioning chamber and allowed to return to room temperature. The length of exposed conductor, if any, at each end of the specimen shall be considered as shrinkage of the insulation. In no case shall the shrinkage at either end exceed the maximum value specified for the applicable type, as shown in Table 5-1, 5-2, or 5-3.

Following the oven aging, specimens shall be wound tightly around a mandrel approximately but not less than, three times the overall diameter of the wire for five close turns and removed as a helical coil. Slight discoloration shall be considered normal and acceptable. The coiled sections shall then be subjected to the dielectric strength test, as specified in 6.2.5.

NEMA Standard 5-25-1988.

6.1.4 Cold Bend

Specimens of the completed wire, each having a length of 12 inches, plus the length required for wrapping on the mandrel, shall be subjected to a conditioning temperature of −65 °C, as specified in Table 5-1, 5-2, or 5-3 with one end attached to a mandrel. After conditioning, and while still in the chamber at the specified temperature, the specimens shall be tested by bending over a mandrel of the size specified in Table 3-1, 3-2, or 3-3 for the applicable type, without opening the chamber. Specimens for which a 3-inch or larger mandrel is specified shall be subjected to a 180 degree bend over the mandrel, then unwound and bent 180 degrees in the opposite direction over the mandrel.

For specimens for which a mandrel smaller than 3 inches in diameter is specified, the mandrel shall be rotated at the approximate rate of one turn in 4 seconds, so as to wind at least three turns of wire on the mandrel and rewrapped in the opposite direction in a similar manner. Weights shall be attached to the free end of the specimen to keep the wire taut during the bending operations so that close turns of the specimens upon the mandrel will be obtained. The coiled specimens shall be removed from the mandrels and brought to room temperature. The coiled or bent specimens shall then be subjected to the dielectric strength test, as specified in 6.2.5.

NEMA Standard 5-25-1988.

6.1.5 Insulation Tensile Strength

The insulation tensile strength test shall be conducted in accordance with Fed-STD-228, Method 3021, except that the rate of travel of the power actuated grip shall be 2 inches minimum and 20 inches maximum per minute.

NEMA Standard 5-25-1988.

6.1.6 Insulation Elongation

The elongation test shall be conducted in accordance with Fed-STD-228, Method 3031, except that the rate of travel of the power actuated grip shall be 2 inches minimum and 20 inches maximum per minute.

NEMA Standard 5-25-1988.

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6.2 ELECTRICAL TESTS

Electrical tests on the insulated conductors shall be made in accordance with the following procedures.

NEMA Standard 5-25-1988.

6.2.1 Surface Resistance

Surface resistance shall be measured in accordance with Fed-Std-228, Method 6041, except that the specimen shall be conditioned as specified in Table 5-1, 5-2, or 5-3. An alternative sample consisting of two 0.250-inch ring-type metal foil electrodes shall be permitted. The test shall be considered to be complete if the initial surface resistance is greater than 1000 megohm-inches. A surface resistance of less than 1000 megohm-inches, shall not change by more than 50 percent from the initially measured value after the application of the high potential and remeasurement of surface resistance.

NEMA Standard 5-25-1988.

6.2.2 Conductor Resistance

The dc resistance of the finished insulated wire shall be measured in accordance with Fed-STD-228, Method 6021.

NEMA Standard 5-25-1988.

6.2.3 Spark or Impulse Test

Spark testing shall be conducted on 100 percent of all lengths of insulated wire per Fed-STD-228, Method 6211 at a rate that subjects each point on the wire to 9 cycles minimum frequency at 60 Hz or 12 cycles minimum frequency at 3 kHz, in accordance with NEMA WC 56. As an alternative method, impulse testing shall be conducted on 100% of all lengths of the insulated wire in accordance with NEMA Standard WC 52.

NEMA Standard 5-25-1988.

6.2.4 Insulation Resistance

The insulation resistance test shall be conducted in accordance with Fed-STD-228, Method 6031, with the following exceptions:

(a) The test voltage of 500 $\pm$ 50 volts direct current (Vdc) shall be applied for 60 seconds, $^{+5}_{-0}$ from the time it is reached.
(b) The specimens shall be at least 26 feet long.
(c) Use of the stirrer shall not be required.

NEMA Standard 5-25-1988.

6.2.5 Dielectric Strength

One inch of insulation shall be removed from each end of the specimen and the conductor shall be attached to an electric lead. The specimen shall be immersed in tap water at 23 °C $\pm$ 5 °C, except for the uninsulated ends. After immersion for 1 hour, the voltage specified in Table 5-1, 5-2, or 5-3 at 60 Hz shall be applied between the conductor and an electrode in contact with liquid. The applied voltage shall be uniformly increased from zero to the specified peak voltage in 30 seconds, maintained at the voltage for a period of 1 minute, and uniformly reduced to zero in 30 seconds.

NEMA Standard 5-25-1988.

Section 7
ORDERING DATA

7.1 ORDERING INFORMATION

Purchasing documents should specify the following information:

1. Wire Type (KT, K, or KK);
2. Conductor Size (AWG);
3. Conductor Material;
4. Conductor Coating;
5. Conductor Stranding;
6. Insulation Color;
7. Packaging Requirements;
8. Length Requirements;
9. Quantity; and
10. Optional Identification (stripes, bands, tracers, printing).

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NEMA STANDARDIZATION

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 its particular need. 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. *(Standardization Policies and Procedures, p. 1)*

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, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 2)

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. 9)

Classes of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
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, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 8 & 17)

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 been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 8 & 17)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 8 & 17)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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HIGH TEMPERATURE INSULATED WIRE AND CABLE SECTION OF THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

Astro Industries, Inc.
Dayton, OH 45432

Barcel Wire and Cable Corp.
Irvine, CA 92714-5885

Belden Wire and Cable
Division of Cooper Industries
Geneva, IL 60134

Cable USA, Inc.
Naples, FL 33942

Champlain Cable Corporation
Winooski, VT 05404

Continental Wire and Cable
Ericsson, Inc.
York, PA 17405

Fluorocarbon, Samuel Moore Group
Aurora, OH 44202

Harbour Industries, Inc.
Shelburne, VT 05482

The Kerite Company
Subsidiary of Hubbell, Inc.
Seymour, CT 06483

Micro-Tek Corporation
Cinnaminson, NJ 08077

Mohawk Wire and Cable Company
Leominster, MA 01453

NEK Cable, Inc.
Ronkonkoma, NY 11779

The Okonite Company
Ramsey, NJ 07446

Philadelphia Insulated Wire Company
Moorestown, NJ 08057

Prestolite Wire Corporation
Farmington Hills, 48018

Quirk Wire Company, Inc.
DBA Wirecraft Products
West Brookfield, MA 01585

Radix Wire Company
Cleveland, OH 44132

The Rockbestos Company
New Haven, CT 06504

Siecor Corporation
Charlotte, NC 28217

Specialty Cable Corporation
Wallingford, CT 06492

Surprenant Wire and Cable
Division of F.L. Industries, Inc.
Clinton, MA 01510

Teledyne Thermatics
Elm City, NC 27822

Thermo Electric Company, Inc.
Saddle Brook, NJ 07662

Thermax Wire Corporation
Flushing, NY 11354-2897

Times Microwave Systems, Inc.
Wallingford, CT 06492

WireKraft
Division of Bristol Corporation
Rolling Prairie, IN 46371

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