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NEMA STANDARDS PUBLICATION NO. HP 3

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Electrical and Electronic PTFE (Polytetrafluoro-ethylene) Insulated High Temperature Hook-Up Wire; Types E (600 Volt), EE (1000 Volt), and ET (250 Volt)

NEMA

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ELECTRICAL AND ELECTRONIC PTFE (POLYTETRAFLUOROETHYLENE) INSULATED HIGH TEMPERATURE HOOK-UP WIRE; TYPES E (600 VOLT), EE (1000 VOLT), AND ET (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 PTFE (polytetrafluoroethylene) insulated solid and stranded wire, designed for the internal wiring of high reliability electrical and electronic equipment. This Standards Publication addresses 250 volt (Type ET), 600 volt (Type E), and 1000 volt (Type EE) wire and permits continuous conductor temperature ratings of −65°C to +200°C with silverplated conductors and −65°C to +260°C with nickel-plated conductors. These types of hook-up wire are used when the following requirements are called for:

- High temperature resistance
- Low dielectric constant
- Solder iron 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

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ELECTRICAL AND ELECTRONIC PTFE (POLYTETRAFLUOROETHYLENE) INSULATED HIGH TEMPERATURE HOOK-UP WIRE; TYPES E (600 VOLT), EE (1000 VOLT), AND ET (250 VOLT)

Section 1

REFERENCED STANDARDS AND GENERAL INFORMATION

1.1 REFERENCED STANDARDS AND SPECIFICATIONS

In this publication, reference is made to the standards listed below. Copies are available from the indicated sources.

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

B3-74 (R 1980)	*Soft or Annealed Copper Wire*
B286-74 (R 1984)	*Copper Conductors for Use in Hook-Up Wire for Electronic Equipment*
B298-74 (R 1984A)	*Silver-Coated Soft or Annealed Copper Wire*
B355-74 (R 1980)	*Nickel-Coated Soft or Annealed Copper Wire*
B624-77 (R 1982)	*High-Strength, High Conductivity Copper-Alloy Wire for Electronic Application*
D1457-83	*PTFE Molding and Extrusion Materials*
D3032-85A	*Hook-Up Wire Insulation*

Electronic Industries Association
2001 Eye Street, N.W.
Washington, D.C. 20006

RS-359-A-84 (R 1985)	*EIA Standard Colors for Color Identification and Coding*

General Services Administration, Specifications Activity
Printed Materials Supply Div.-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, N.W., Suite 300
Washington, D.C. 20037

WC 52-1985	*High Temperature and Electronic Insulated Wire-Impulse Dielectric Testing*

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1.2 RECOMMENDED USES OF WIRE TYPES

1.2.1 Type ET

Type "ET" wire is intended for use in low voltage, high temperature applications. It is considered suitable for use up to a maximum of 250 volts r.m.s. (root mean square) and for high frequency circuitry.

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

Authorized Engineering Information 5-27-1987.

1.2.2 Type E

Type "E" is intended for medium voltage and high temperature applications and is considered suitable for use at a maximum of 600 volts r.m.s. and for high frequency circuitry.

Authorized Engineering Information 5-27-1987.

1.2.3 Type EE

Type "EE" is intended for high voltage and high temperature applications and is considered suitable for use at a maximum of 1000 volts r.m.s. and for high frequency circuitry.

Authorized Engineering Information 5-27-1987.

Section 2
CONDUCTORS

2.1 CONDUCTOR MATERIALS

The basic conductor shall be composed of either soft, annealed copper wire of strands conforming to ASTM B3, or a copper alloy per ASTM B624. 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 5-27-1987.

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 B298.

NEMA Standard 5-27-1987.

2.2.2 Nickel-Coated Conductors

Nickel-coated conductors shall be employed for applications up to conductor temperatures of 260°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 ASTM B355.

NEMA Standard 5-27-1987.

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 B286. Missing strands shall not be permitted.

NEMA Standard 5-27-1987.

2.4 MINIMUM WIRE DIAMETER

The minimum wire diameter shall be controlled by maximum dc resistance per Table 2-1.

NEMA Standard 5-27-1987.

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Table 2-1
DETAILS OF CONDUCTORS

Size (AWG)	(1) Stranding	Nominal Conductor CMA	Strand Dia. Nominal (Inches)	Length of Lay Max. (Inches)	Wire Diameter		Maximum DC Resistance of Finished Wire (OHMS/1000 Ft. at 20°C)				Breaking Strength Alloy (Lbs. Min.)
							Annealed	Copper	High Strength Copper Alloy		
					Nominal (Inches)	Max. (2) (Inches)	SPC	NPC	S.P. Alloy	N.P. Alloy	
32	1×32	64	.0080	—	.0080	.0090	169.0	175.0	200.0	205.0	3.01
	7×40	67	.0031	.187	.0093	.0110	173.0	185.0	204.0	232.0	3.17
	19×44	76	.0020	.187	.0099	.0110	160.3	178.6	188.5	210.1	3.58
30	1×30	100	.0100	—	.0100	.0110	108.0	112.0	127.0	132.0	4.71
	7×38	112	.0040	.187	.0120	.0130	100.7	110.7	117.4	129.6	5.17
	19×42	119	.0025	.187	.0124	.0130	100.5	109.4	118.2	128.7	5.60
28	1×28	159	.0126	—	.0126	.0130	68.0	70.0	80.0	82.0	7.48
	7×36	175	.0050	.20	.0150	.0160	63.8	67.9	74.4	79.0	8.16
	19×40	183	.0031	.20	.0146	.0160	64.3	70.6	75.6	77.9	8.60
26	1×26	253	.0159	—	.0159	.0170	42.7	43.8	50.2	51.5	11.9
	7×34	278	.0063	.25	.0189	.0200	40.5	43.1	47.6	50.7	13.1
	19×38	304	.0040	.25	.0188	.0220	38.4	42.2	44.8	49.4	14.2
24	1×24	404	.0201	—	.0201	.0220	26.8	27.4	31.4	31.9	19.0
	7×32	448	.0080	.33	.0240	.0250	25.2	26.5	29.4	30.8	21.1
	19×36	475	.0050	.33	.0235	.0270	24.3	25.9	28.4	30.1	22.4
22	1×22	640	.0253	—	.0253	.0260	17.0	18.1	19.6	19.9	30.2
	7×30	700	.0100	.33	.0300	.0310	15.9	16.6	18.7	19.5	33.0
	19×34	754	.0063	.33	.0296	.0330	15.1	16.0	17.5	18.6	35.8
20	1×20	1024	.0320	—	.0320	.0330	10.5	10.7	12.2	12.6	48.3
	7×28	1111	.0126	.50	.0378	.0390	10.0	10.4	11.8	12.2	52.4
	19×32	1216	.0080	.50	.0376	.0410	9.19	9.77	10.8	11.4	58.1
18	1×18	1624	.0403	—	.0403	.0410	6.60	6.70	—	—	—
	7×26	1770	.0159	.62	.0477	.0500	6.28	6.50	—	—	—
	19×30	1900	.0100	.62	.0470	.0520	5.79	6.10	—	—	—
16	1×16	2581	.0508	—	.0508	.0520	4.20	4.35	—	—	—
	19×29	2426	.0113	.75	.0531	.0590	4.52	4.76	—	—	—
14	19×27	3831	.0142	.875	.0667	.0730	2.88	3.00	—	—	—
12	19×25	6088	.0179	1.00	.0841	.0930	1.81	1.88	—	—	—
	37×28	5874	.0126	1.25	.0858	.0910	1.90	1.98	—	—	—
10	37×26	9334	.0159	1.50	.108	.1150	1.19	1.24	—	—	—
8	133×29	16983	.0113	2.00	.161	.1730	.658	.694	—	—	—
6	133×27	26818	.0142	2.50	.202	.2170	.418	.436	—	—	—

(1) See 2.2
(2) See 2.4

CMA—Circular Mil Area
SPC—Silver-plated copper
NPC—Nickel-plated copper
SP—Silver-plated
NP—Nickel-plated

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Section 3
CONDUCTORS

3.1 GENERAL

The PTFE insulating material shall conform to ASTM D 1457. The minimum tensile strength and elongation of the extruded or tape-wrapped insulation shall be 4000 PSI and 200 percent respectively.

NEMA Standard 5-27-1987.

3.2 PTFE INSULATION

The insulation shall be extruded or tape-wrapped 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 the addition of outer coverings shall be in accordance with Table 3-1 for Type ET wire, Table 3-2 for Type E wire, and Table 3-3 for Type EE wire.

NEMA Standard 5-27-1987.

Table 3-1
DIMENSIONS-TYPE "ET" 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	.016	.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 "E" 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	.025	.033	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	.049	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

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Table 3-3
DIMENSIONS-TYPE "EE" 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	.034	.042	1
	7 × 40	.0093	.036	.044	1
	19 × 44	.0099	.036	.044	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	.253	.273	3

Section 4

WIRE IDENTIFICATION

4.1 CIRCUIT IDENTIFICATION

Circuit identification shall be accomplished by use of insulation colored in accordance with EIA RS-359-A. 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 5-27-1987.

4.2 IDENTIFICATION BY PRINTING

Identification by printing on the wire is considered acceptable for Types E and EE wire for conductor sizes 24 AWG and larger. Printing should be clear and legible. Printing on Type ET wire is not recommended due to the thin wall construction.

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Section 5

PHYSICAL AND ELECTRICAL REQUIREMENTS

5.1 GENERAL

The physical and electrical requirements for Types ET, E, and EE wire shall be in accordance with this Section. Testing shall be conducted in accordance with Section 6. 100 percent of the wire shall be spark tested or dielectric tested. Other tests shall be conducted on a periodic conformance basis.

NEMA Standard 5-27-1987.

5.1.1 Type ET

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

NEMA Standard 5-27-1987.

5.1.2 Type E

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

NEMA Standard 5-27-1987.

5.1.3 Type EE

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

NEMA Standard 5-27-1987.

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 affect the serviceability of the product for the intended use, as described in 1.2.

Authorized Engineering Information 5-27-1987.

Table 5-1
PHYSICAL AND ELECTRICAL REQUIREMENTS FOR TYPE ET 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/Impulse Test (See 6.2.3)	2.5 kV/4.0 kV	A/A
Insulation Resistance (See 6.2.4)	500 megohm-1000 feet (Minimum)	D-4/23 ± 5°C
Heat Resistance & Dielectric Strength (See 6.1.3 and 6.2.5)	1.5 kV (Minimum) dielectric strength-1/8 inch (Maximum) shrinkage	E-96/290
Cold Bend (See 6.1.4 and 6.2.5)	1.5 kV (Minimum) dielectric strength (see Table 3-1)	E-4/-65
Surface Resistance (See 6.2.1)	5 megohm-inches (Minimum)	C-96/23/95
Insulation Tensile Strength (See 6.1.6)	4000 PSI (Minimum)	A
Insulation Elongation (See 6.1.7)	200 percent (Minimum)	A
Wrapback Test (See 6.1.5 and 6.2.5)	1.5 kV (Minimum) dielectric strength	E-2/307 ± 5°C

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Table 5-2
PHYSICAL AND ELECTRICAL REQUIREMENTS
FOR TYPE E 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/Impulse Test (See 6.2.3)	3.4 kV/6.5 kV	A/A
Insulation Resistance (See 6.2.4)	5000 megohm-1000 feet (Minimum)	D-4/23 ± 5°C
Heat Resistance & Dielectric Strength (See 6.1.3 and 6.2.5)	2.0 kV (Minimum) dielectric strength-1/8 inch (Maximum) shrinkage	E-96/290
Cold Bend (See 6.1.4 and 6.2.5)	2.0 kV (Minimum) dielectric strength (see Table 3-2)	E-4/ − 65
Surface Resistance (See 6.2.1)	5 megohm-inches (Minimum)	C-96/23/95
Insulation Tensile Strength (See 6.1.6)	4000 PSI (Minimum)	A
Insulation Elongation (See 6.1.7)	200 percent (Minimum)	A
Wrapback Test (See 6.1.5 and 6.2.5)	2.0 kV (Minimum) dielectric strength	E-2/307 ± 5°C

Table 5-3
PHYSICAL AND ELECTRICAL REQUIREMENTS
FOR TYPE EE 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/Impulse Test (See 6.2.3)	5.0 kV/8.0 kV	A/A
Insulation Resistance (See 6.2.4)	5000 megohm-1000 feet (Minimum)	D-4/23 ± 5°C
Heat Resistance & Dielectric Strength (See 6.1.3 and 6.2.5)	3.0 kV (Minimum) dielectric strength-1/8 inch (Maximum) shrinkage	E-96/290
Cold Bend (See 6.1.4 and 6.2.5)	3.0 kV (Minimum) dielectric strength (see Table 3-3)	E-4/ − 65
Surface Resistance (See 6.2.1)	5 megohm-inches (Minimum)	C-96/23/95
Insulation Tensile Strength (See 6.1.6)	4000 PSI (Minimum)	A
Insulation Elongation (See 6.1.7)	200 percent (Minimum)	A
Wrapback Test (See 6.1.5 and 6.2.5)	3 kV (Minimum) dielectric strength	E-2/307 ± 5°C

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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 5-27-1987.

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 5-27-1987.

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:

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

NEMA Standard 5-27-1987.

The following is given as an example of how conditioning procedures should be designated:

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

Authorized Engineering Information 5-27-1987.

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 5-27-1987.

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 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 5-27-1987.

6.1.5 Wrapback Test

The center portion of a 12-inch minimum length specimen of finished PTFE insulated wire shall be tightly wound back on itself for a total of four close turns as shown in Figure 6-1. The specimen shall then be placed in an oven and heated for two hours at 307°C ± 5°C. At the end of this period, the specimen shall be visually exam-

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ined for cracks and subjected to the dielectric strength test in 6.2.5.

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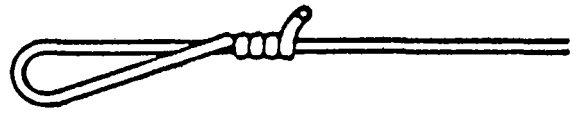


Figure 6-1
WRAP BACK TEST

6.1.6 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 5-27-1987.

6.1.6.1 Insulation Tensile Strength of Tape-Wrapped Wire

The insulation tensile strength of tape-wrapped insulation shall be conducted in accordance with Fed-STD-228, Method 1051.

NEMA Standard 5-27-1987.

For tape-wrapped wire, Method 1051 is recommended instead of Method 3021 in order to eliminate errors in measuring wall thickness.

Authorized Engineering Information 5-27-1987.

6.1.7 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 5-27-1987.

6.2 ELECTRICAL TESTS

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

NEMA Standard 5-27-1987.

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 at 23° ± 5°C. 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 5-27-1987.

6.2.2 Conductor Resistance

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

NEMA Standard 5-27-1987.

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. As an alternative method, impulse testing shall be conducted on 100 percent of all lengths of the insulated wire in accordance with NEMA WC 52.

NEMA Standard 5-27-1987.

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 ± 50 volts direct current (Vdc) shall be applied for 60 seconds, + 5 seconds, − 0 seconds 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 5-27-1987.

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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 ± 5°C, except for the uninsulated ends. After immersion for 1 hour, the voltage specified (see 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 5-27-1987.

Section 7

ORDERING DATA

7.1 ORDERING INFORMATION

Purchasing documents should specify the following information:

1. Wrapped or extruded insulation
2. Wire type (ET, E, and EE)
3. Conductor Size (AWG)
4. Conductor Material
5. Conductor Coating
6. Conductor Stranding
7. Insulation Color
8. Packaging Requirements
9. Length Requirements
10. Quantity
11. 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 Bylaws, which are quoted 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.

(Bylaw—Art. V, Sec. 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.

(Bylaw—Art. V, Sec. 2, Subsection A)

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.

(NEMA Policy Memorandum 84-2, dated June 7, 1984)

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.

(Bylaw—Art. V, Sec. 6, 1st Sentence)

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.

(Bylaw—Art. V, Sec. 6, 1st Sentence)

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.

(Bylaw—Art. V, Sec. 4, Subsection A)

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

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Dayton, OH 45432

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

Belden Electrical Wire Products
Division of Cooper Industries
Geneva, IL 60134

Berk-Tek, Inc.
New Holland, PA 17557

Cable USA, Inc.
Naples, FL 33942

Champlain Cable Corporation
Winooski, VT 05404

Continental Wire and Cable
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Fluorocarbons, Samuel Moore Group
Aurora, OH 44202

Harbour Industries, Inc.
Shelburne, VT 05482

Independent Cable, Inc.
Hudson, MA 01749

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

Micro-Tek Corporation
Cinnaminson, NJ 08077

Mohawk Wire and Cable Corporation
Leomiinster, MA 01453

Montrose Products Company
Auburn, MA 01501

NEK Cable, Inc.
Ronkonkoma, NY 11779

The Okonite Company
Ramsey, NJ 07446

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Quirk Wire Company, Inc.
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The Rockbestos Company
New Haven, CT 06504

Siecor Corporation
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Specialty Cable Corporation
Union, NJ 07083

Surprenant Wire and Cable
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Clinton, MA 01510

Teledyne Thermatics
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