6470247 0521071 974

ADOPTION NOTICE

National Electrical Manufacturers Association (NEMA) Standard NEMA HP 3, "Electrical and Electronic PTFE (Polytetrafluoroethylene) Insulated High Temperature Hook-up Wire; Types ET (250 Volts), E (600 Volts) and EE (1000 Volts)", was adopted on 22 September 1999 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Defense Logistics Agency, Defense Supply Center, Columbus, ATTN: DSCC-VAI, P.O. Box 3990, Columbus, OH 43216-5000. DoD activities may obtain copies of this standard from the Defense Automated Printing Service, DODSSP, 700 Robbins Avenue, Building 4, Section D, Philadelphia, PA 19111-5094. The private sector and other Government agencies may purchase the document from the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

CONCLUDING MATERIAL

Custodians:
Navy - SH
Air Force - 99
DLA - CC

Review activity:
Navy - AS

Adopting Activity:
DLA - CC
(Project 6145-2202)

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

STD.NEMA HP 3-ENGL 1997 6470247 0516054 443

NEMA STANDARDS PUBLICATION

NEMA HP 3

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

NEMA Standards Publication No. HP 3-1997

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

Published by

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

© Copyright 1997 by the National Electrical Manufacturers Association. All rights including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American Copyright Conventions.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE OF CONTENTS

Foreword ii

Section 1 General 1
1.1 Scope 1
1.2 Referenced Standards and Specifications 1
1.3 Recommended Uses of Wire Types 2
1.4 Part Numbering 3

Section 2 Conductors 5
2.1 Conductor Materials 5
2.2 Conductor Coatings 5
2.3 Stranding 5
2.4 Minimum Conductor Diameter 5

Section 3 Insulation 7
3.1 General 7
3.2 PTFE Insulation 7

Section 4 Wire Identification 13
4.1 Circuit Identification 13
4.2 Identification by Printing 13

Section 5 Physical and Electrical Requirements 15
5.1 General 15
5.2 Quality Conformance Inspection of Finished Product 15
5.3 Workmanship 15
5.4 Materials Certification 15

Section 6 Procedures 17
6.1 Physical Tests 17
6.2 Electrical Tests 18

Section 7 Packaging 19
7.1 Packaging Requirements 19
7.2 Labeling 19

Section 8 Ordering Data 21
8.1 Ordering Information 21

Appendix A Measurement and Calculation Data for Table 2 23

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS

Not for Resale

FOREWORD

The Standard Publication was developed by the NEMA High Performance 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 requirements associated with high reliability commercial electrical and electronic equipment in which it is used. 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.

This Standards Publication was designed as a non-government standard for replacement of MIL-W-16878 PTFE insulated wire slash sheets (/4, /5, /6, /20 through /27, /34, and /35).

This Standards Publication was developed by the High Performance Wire and Cable Section of NEMA. Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development. At the time it was approved, the Section was composed of the following members:

Barcel Wire and Cable Corporation—Irvine, CA
BICC/Brand-Rex—Willimantic, CT
Cable USA Inc.—Naples, FL
Comm Scope Inc.—Elm City, NC
Furon Company/Dekron Division—Akron, OH
Judd Wire Inc.—Turner Falls, MA
Quirk Wire Company Inc.—West Brookfield, MA
Radix Wire Company—Cleveland, OH
Raychem Corporation—Menlo Park, CA
Rockbestos/Surprenant Cable Corp.—Clinton, MA
Times Microwave Systems—Wallingford, CT
Tensolite Company—St. Augustine, FL

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 1
GENERAL

1.1 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 silver-coated conductors and -65°C to +260°C with nickel-coated conductors. These types of hook-up wire are used when the following properties are called for:

- High temperature resistance
- Low 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

1.2 REFERENCED STANDARDS AND SPECIFICATIONS

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

American Society For Testing and Materials
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

B3-90	*Soft or Annealed Copper Wire*
B286-89	*Copper Conductors for Use in Hook-up Wire for Electronic Equipment*
B298-94	*Silver-Coated Soft or Annealed Copper Wire*
B355-90	*Nickel-Coated Soft or Annealed Copper Wire*
B452-93	*Copper Clad Steel Wire for Electronic Applications*
B501-93	*Silver-Coated Copper-Clad Steel Wire for Electronic Applications*
B559-93	*Nickel-Coated Copper-Clad Steel Wire for Electronic Applications*
B624-90	*High-Strength, High Conductivity Copper-Alloy Wire for Electronic Application*
D3032-96	*Hook-up Wire Insulation*
D4895-94	*PTFE Resin Produced from Dispersion*

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

American Society for Quality Control
611 E. Wisconsin Ave.
Milwaukee, WI 53202

ANSI/ASQC Z1.4 *Sampling Procedures and Tables for Inspection by Attributes*

Electronic Industries Association
2500 Wilson Blvd.
Arlington, VA 22201

EIA-359 *EIA Standard Colors for Color Identification and Coding*

DODSSP-Customer Service
Bldg. 4D
700 Robbins Ave.
Philadelphia, PA 19111-5094

MIL-STD-2223 *Test Methods for Insulated Electric Wire*

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209

WC 52-1991 *High Temperature and Electronic Insulated Wire-Impulse Dielectric Testing*

WC 56-1993 *3.0 kHz Insulation Continuity Proof Testing of Hook Up Wire*

1.3 RECOMMENDED USES OF WIRE TYPES

1.3.1 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 RMS (root mean square) and/or 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.

1.3.2 Type E

Type E is intended for high temperature applications and is considered suitable for use at a maximum of 600 volts RMS and/or for high frequency circuitry.

1.3.3 Type EE

Type EE is intended for high temperature applications and is considered suitable for use at a maximum of 1000 volts RMS and/or for high frequency circuitry.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

1.4 Part Numbering

The part numbers shall be of the following form:

HP3-(TYPE))(CONSTRUCTION)(AWG)(NUMBER OF STRANDS)(CONDUCTOR MATERIAL)(COLOR)

NEMA STANDARD
for PTFE

NEMA TYPE E, EE
ET as described above

CONSTRUCTION
Wrapped (W) Extruded (X)

Example:
HP3-EXGAB9

PTFE ,Type E, Extruded, 20 AWG, Solid Silver Coated Copper, White

AWG NOMINAL CONDUCTOR SIZE

AWG	Letter	AWG	Letter	AWG	Letter	AWG	Letter
32	A	20	G	8	N	00	W
30	B	18	H	6	P	000	Y
28	C	16	J	4	R	0000	Z
26	D	14	K	2	S		
24	E	12	L	1	T		
22	F	10	M	0	U		

NUMBER OF STRANDS

Letter	Number of Strands	Letter	Number of Strands	Letter	Number of Strands	Letter	Number of Strands
A	1			L	133	S	1045
B	7	G	37			T	1330
						V	1665
				P	665	W	2109
E	19			R	817		

CONDUCTOR MATERIAL AND COATING

Letter	Conductor Material & Coating	Letter	Conductor Coating & material
B	Silver-coated Copper (SCC)	E	Nickel-coated high-strength copper alloy (NCA)
C	Nickel-Coated Copper	F	Silver-coated copper clad steel (SCCCS)
D	Silver-coated high-strength copper alloy (SCA)	G	Nickel coated copper clad steel (NCCCS)

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS

Not for Resale

COLOR

Color (see para. 4.1)	Number Designator	Color	Number Designator
Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet (Purple)	7
Orange	3	Gray (Slate)	8
Yellow	4	White	9

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 2
CONDUCTORS

2.1 CONDUCTOR MATERIALS

The base conductor material shall be composed of soft or annealed copper conforming to ASTM B3, or copper-clad steel conforming to ASTM B452, Class 40A, or a copper alloy conforming to ASTM B624. Conductor strands shall be individually coated. The addition of the coating material after stranding shall not be permitted.

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 for copper and copper alloys and not less than 50 microinches for copper-clad steel. The conductor shall be tested prior to stranding for continuity of coating and coating thickness in accordance with ASTM B298 for silver-coated copper and copper alloy or ASTM B501 for silver-coated copper-clad steel.

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 with ASTM B355 for nickel-coated copper and copper alloy or ASTM B559 for nickel-coated copper-clad steel.

2.3 STRANDING

Stranding shall be in accordance with Table 2. The lay length of the outer layer shall be 8 to 16 times the maximum conductor diameter. All requirements for stranded conductors, not specified in Table 2, shall be in accordance with the applicable requirements of ASTM B286.

2.4 MINIMUM CONDUCTOR DIAMETER

The minimum conductor diameter shall be controlled by maximum dc resistance per Table 2.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

TABLE 2
Details of Conductors[1]

Size (AWG)	Stranding	Single End Strand Dia. Nominal (inches)	Nominal CMA	Conductor Diameter[2] Nominal (inches)	Conductor Diameter[2] Maximum (inches)	Maximum DC Resistance of Finished Wire[3] (Ohms/1000 Ft. at 20 °C) SCC	NCC	SCA	NCA	SCCCS	NCCCS	Alloy Breaking Strength Minimum (Lbs.)
32	1 X 32	0.0080	64	0.0080	0.0083	166	177	196	210	424	433	2.94
	7 X 40	0.0031	67	0.0093	0.0102	170	186	199	223	433	449	2.97
	19 X 44	0.0020	76	0.0094	0.0115	157	179	185	215	401	423	3.23
30	1 X 30	0.0100	100	0.0100	0.0103	106	110	124	131	270	273	4.62
	7 X 38	0.0040	112	0.0120	0.0129	100	110	118	132	256	265	5.02
	19 X 42	0.0025	119	0.0118	0.0140	98.6	112	116	135	251	265	5.16
28	1 X 28	0.0126	159	0.0126	0.0130	66.7	69.4	78.4	82.3	170	172	7.33
	7 X 36	0.0050	175	0.0150	0.0159	63.6	67.6	74.8	80.5	162	166	7.92
	19 X 40	0.0031	183	0.0146	0.0170	63.1	69.3	74.2	83.0	161	167	8.06
26	1 X 26	0.0159	253	0.0159	0.0164	41.9	43.6	49.2	51.7	107	108	11.7
	7 X 34	0.0063	278	0.0189	0.0198	39.7	42.2	46.7	50.3	101	103	12.7
	19 X 38	0.0040	304	0.0188	0.0215	37.3	41.0	43.9	49.1	95.2	98.7	13.6
24	1 X 24	0.0201	404	0.0201	0.0207	26.2	27.3	30.8	32.3	66.8	67.5	18.7
	7 X 32	0.0080	448	0.0240	0.0249	24.5	26.0	28.8	31.0	62.4	63.7	20.6
	19 X 36	0.0050	475	0.0235	0.0265	23.6	25.2	27.8	29.9	60.3	61.6	21.5
22	1 X 22	0.0253	640	0.0253	0.0261	16.5	17.2	19.4	20.4	42.2	42.6	29.6
	7 X 30	0.0100	700	0.0300	0.0309	15.6	16.2	18.3	19.2	39.7	40.1	32.3
	19 X 34	0.0063	754	0.0296	0.0330	14.8	15.7	17.4	18.7	37.7	38.5	34.4
20	1 X 20	0.0320	1024	0.0320	0.0330	10.3	10.8	12.2	12.8	26.4	26.6	47.3
	7 X 28	0.0126	1111	0.0378	0.0389	9.81	10.2	11.5	12.1	25.0	25.3	51.3
	19 X 32	0.0080	1216	0.0376	0.0415	9.10	9.68	10.7	11.5	23.2	23.7	55.9
18	1 X 18	0.0403	1624	0.0403	0.0415	6.52	6.79	7.67	8.04	16.6	16.8	75.0
	7 X 26	0.0159	1770	0.0477	0.0491	6.16	6.42	7.25	7.60	15.7	15.9	81.7
	19 X 30	0.0100	1900	0.0470	0.0515	5.79	6.03	6.81	7.15	14.8	14.9	87.8
16	1 X 16	0.0508	2581	0.0508	0.0523	4.10	4.27	4.82	5.06	10.5	10.6	119
	19 X 29	0.0113	2426	0.0531	0.0582	4.54	4.73	5.34	5.60	11.6	11.7	112
14	19 X 27	0.0142	3831	0.0667	0.0731	2.87	2.99					
12	19 X 25	0.0179	6088	0.0841	0.0922	1.81	1.88					
	37 X 28	0.0126	5874	0.0858	0.0908	1.89	1.97					
10	37 X 26	0.0159	9354	0.108	0.115	1.19	1.24					
8	133 X 29	0.0113	16983	0.161	0.175	0.661	0.688					
6	133 X 27	0.0142	26818	0.202	0.219	0.418	0.436					
4	133 X 25	0.0179	42615	0.266	0.277	0.263	0.274					
2	665 X 30	0.0100	66500	0.335	0.342	0.170	0.177					
1	817 X 30	0.0100	81700	0.378	0.382	0.139	0.144					
1/0	1045 X 30	0.0100	104500	0.410	0.431	0.108	0.113					
2/0	1330 X 30	0.0100	133000	0.477	0.486	0.085	0.0887					
3/0	1665 X 30	0.0100	166500	0.535	0.545	0.067	0.0705					
4/0	2109 X 30	0.0100	210900	0.601	0.635	0.053	0.0559					

CMA – Circular Mil Area
SCC – Silver- coated copper
NCC – Nickel- coated copper
SCA – Silver-coated high-strength copper alloy
NCA – Nickel-coated high-strength copper alloy
SCCCS – Silver-coated copper-clad steel
NCCCS - Nickel-coated copper-clad steel

[1] See Appendix A for measurements and calculations
[2] See 2.2
[3] See 2.4

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 3
INSULATION

3.1 GENERAL

The insulating material shall be a PTFE resin conforming to ASTM D 4895.

3.2 PTFE INSULATION

A continuous coating of extruded or tape-wrapped PTFE insulation shall be added over the conductor and shall be processed to meet the requirements listed herein. Sizes AWG 2 and larger shall be tape-wrapped only.

The diameter of the insulated conductors shall be in accordance with Table 3 (see paragraph 6.1.5).

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Table 3
DIAMETERS OF INSULATED CONDUCTORS
(TYPES ET, E, EE)
(All Dimensions in Inches)

			Insulated Conductor Size Diameter	
AWG	**Type**	**Stranding**	**(Minimum)**	**(Maximum)**
32	ET	1x32	0.016	0.022
	ET	7x40	0.020	0.024
	ET	19x44	0.020	0.024
	E	1x32	0.025	0.033
	E	7x40	0.026	0.034
	E	19x44	0.026	0.034
	EE	1x32	0.034	0.042
	EE	7x40	0.036	0.044
	EE	19x44	0.036	0.044
30	ET	1x30	0.020	0.024
	ET	7x38	0.022	0.026
	ET	19x42	0.022	0.026
	E	1x30	0.026	0.034
	E	7x38	0.028	0.036
	E	19x42	0.028	0.036
	EE	1x30	0.036	0.044
	EE	7x38	0.038	0.046
	EE	19x42	0.038	0.046
28	ET	1x28	0.023	0.027
	ET	7x36	0.025	0.029
	ET	19x40	0.025	0.029
	E	1x28	0.029	0.037
	E	7x36	0.031	0.039
	E	19x40	0.031	0.039
	EE	1x28	0.039	0.047
	EE	7x36	0.041	0.049
	EE	19x40	0.041	0.049

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Table 3 (Continued
DIAMETERS OF INSULATED CONDUCTORS
(TYPES ET, E, EE)
(All Dimensions in Inches)

			Insulated Conductor Size Diameter	
AWG	Type	Stranding	(Minimum)	(Maximum)
26	ET	1x26	0.026	0.030
	ET	7x34	0.029	0.033
	ET	19x38	0.029	0.034
	E	1x26	0.032	0.040
	E	7x34	0.035	0.043
	E	19x38	0.035	0.044
	EE	1x26	0.042	0.050
	EE	7x34	0.045	0.053
	EE	19x38	0.045	0.054
24	ET	1x24	0.030	0.034
	ET	7x32	0.034	0.038
	ET	19x36	0.034	0.039
	E	1x24	0.036	0.044
	E	7x32	0.040	0.048
	E	19x36	0.040	0.049
	EE	1x24	0.046	0.054
	EE	7x32	0.050	0.058
	EE	19x36	0.050	0.059
22	ET	1x22	0.035	0.040
	ET	7x30	0.040	0.044
	ET	19x34	0.040	0.046
	E	1x22	0.041	0.049
	E	7x30	0.046	0.054
	E	19x34	0.046	0.056
	EE	1x22	0.051	0.060
	EE	7x30	0.056	0.064
	EE	19x34	0.056	0.066

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS

Not for Resale

Table 3
DIAMETERS OF INSULATED CONDUCTORS
(TYPES ET, E, EE)
(All Dimensions in Inches)

			Insulated Conductor Size Diameter	
AWG	**Type**	**Stranding**	**(Minimum)**	**(Maximum)**
20	ET	1x20	0.042	0.046
	ET	7x28	0.048	0.052
	ET	19x32	0.048	0.052
	E	1x20	0.048	0.056
	E	7x28	0.054	0.062
	E	19x32	0.054	0.062
	EE	1x20	0.058	0.066
	EE	7x28	0.064	0.072
	EE	19x32	0.064	0.072
18	E	1x18	0.056	0.066
	E	7x26	0.064	0.074
	E	19x30	0.064	0.074
	EE	1x18	0.066	0.076
	EE	7x26	0.074	0.084
	EE	19x30	0.074	0.084
16	E	1x16	0.067	0.081
	E	19x29	0.073	0.087
	EE	1x16	0.077	0.089
	EE	19x29	0.083	0.095
14	E	19x27	0.088	0.102
	EE	19x27	0.098	0.114
12	E	19x25	0.107	0.121
	E	37x28	0.105	0.119
	EE	19x25	0.117	0.133
	EE	37x28	0.115	0.131

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Table 3
DIAMETERS OF INSULATED CONDUCTORS
(TYPES ET, E, EE)
(All Dimensions in Inches)

			Insulated Conductor Size Diameter	
AWG	**Type**	**Stranding**	**(Minimum)**	**(Maximum)**
10	E	37x26	0.127	0.141
	EE	37x26	0.137	0.153
8	EE	133x29	0.199	0.219
6	EE	133x27	0.286	0.301
4	EE	133x25	0.349	0.369
2	EE	665x30	0.395	0.415
1	EE	817x30	0.475	0.495
1/0	EE	1045x30	0.504	0.524
2/0	EE	1330x30	0.553	0.577
3/0	EE	1665x30	0.633	0.657
4/0	EE	2109x30	0.703	0.727

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS

Not for Resale

Section 4
WIRE IDENTIFICATION

4.1 CIRCUIT IDENTIFICATION

Circuit identification if required shall be accomplished by use of an insulation color in accordance with EIA-359-A-85 (R 1985). Colored stripe or band tracers on the insulation, and/or printed numbers or letters shall be permitted, in addition to the colored insulation.

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. PIN printed on wire shall not include color designation. Identification marks shall not be applied by hot stamp marking or other methods which significantly penetrate the insulation.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

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 and Tables 2, 3, and 5. Testing shall be conducted in accordance with Section 6.

5.2 QUALITY CONFORMANCE INSPECTION OF FINISHED PRODUCT

5.2.1 Definitions

5.2.1.1. Inspection Lot

An inspection lot shall consist of all wire of the same part number, produced under essentially the same conditions, and presented for inspection at one time.

5.2.1.2 Unit of Product

The unit of product for determining lot size for sampling shall be the quantity of wire offered for inspection on one coil, one reel, or one spool, as applicable.

5.2.2 Sampling Inspection

All other tests shall use a sampling plan in accordance with special inspection level S-2 in ANSI/ASQC Z1.4.

5.3 WORKMANSHIP

The insulated wire shall 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 Section 1.2.

5.4 MATERIALS CERTIFICATION

Suppliers shall maintain certifications that all materials used conform to the requirements in Section 2 and Section 3.

Previous page is blank

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Table 5
PHYSICAL AND ELECTRICAL REQUIREMENTS FOR TYPE ET, E, AND EE WIRES

Test	Requirements		
	ET	E	EE
Conductor Resistance (See 6.2.1)	See Table 2	See Table 2	See Table 2
Spark Test or Impulse Test (See 6.2.2)	2.9 kV 4.0 kV	4.6 kV 6.5 kV	5.7 kV 8.0 kV
Heat Resistance & Dielectric Strength (See 6.1.2 and 6.2.3)	1.5 kV (min)	2.0 kV	3.0 kV
Insulation Tensile Strength (See 6.1.4)	4000 psi (Minimum)	4000 psi (Minimum)	4000 psi (Minimum)
Insulation Elongation (See 6.1.4)	200 percent (Minimum)	200 percent (Minimum)	200 percent (Minimum)
Wrapback Test (See 6.1.3 and 6.2.3) Dimensional Inspection (See 6.1.5)	1.5 kV (Minimum) dielectric strength See Tables 2 and 3	2.0 kV (Minimum) dielectric strength See Tables 2 and 3	3.0 kV (Minimum) dielectric strength See Tables 2 and 3

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 6
TEST PROCEDURES

6.1 PHYSICAL TESTS

Physical test on the conductor and insulated wire shall be made in accordance with the following procedures:

6.1.1 Test Temperature

Unless otherwise specified, physical tests shall be performed at a room temperature of 23°C ± 2°C. The test specimens shall be kept at room temperature for not less than 30 minutes prior to the tests.

6.1.2 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 at 290 ± 2°C for 96 hours. The specimens shall then be removed from the conditioning chamber and allowed to return to room temperature. The specimen shall be examined for cracks. 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 a maximum value of 1/8 inch.

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 than be subjected to the dielectric strength test, as specified in 6.2.3.

6.1.3 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 examined for cracks with the unaided eye and subjected to the dielectric strength test in 6.2.3 without unwinding.

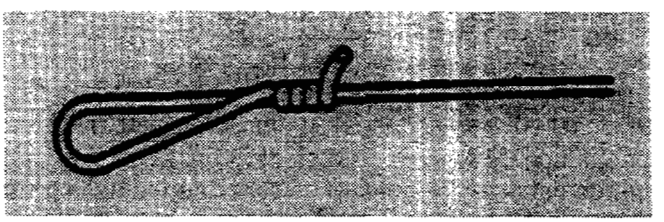


Figure 6-1
WRAP BACK TEST

6.1.4 Insulation Tensile Strength and Elongation

The insulation tensile strength and elongation test shall be conducted in accordance with, ASTM D3032, Section 17, except that the rate of travel of the power-actuated grip shall be 2 inches minimum and 20 inches maximum per minute. Determination of insulation tensile strength for tape-wrapped constructions shall use the optical method for insulated wire in ASTM D 3032 Section 15 to measure wall thickness.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

6.1.5 Dimensional Inspection

Using a micrometer or equivalent device capable of measuring to the nearest 0.0001 inch, determine the diameters of the conductor and insulation as described below.

6.1.5.1 Conductor Diameter

Remove the insulation for the specimen without damaging or distorting the conductor. Measure the outer diameter in at least three locations along the length of the stripped conductor. Each measurement shall consist of two micrometer readings taken 90 degrees from each other. For sizes 8 and larger, a circumferential measuring tape may be used. Report the average of the readings.

6.1.5.2 Insulation Diameter

Measure the outer diameter of the insulated wire in at least three locations along a 12 inch length of the specimen. Each measurement shall consist of two readings taken 90 degrees from each other. For sizes 8 and larger, a circumferential measuring tape may be used. Report the average of the readings.

6.2 ELECTRICAL TESTS

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

6.2.1 Conductor Resistance

The dc resistance of the finished insulated wire shall be measured in accordance with MIL-STD-2223 Method 5003.

6.2.2 Spark or Impulse Test

Spark testing shall be conducted on 100 percent of all lengths of insulated wire per NEMA WC 52 or NEMA WC 56 at the voltages specified in the requirements of Table 5.

6.2.3 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) 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.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 7
PACKAGING

7.1 PACKAGING REQUIREMENTS

Spools, reels, and packaging material(s) shall be sufficient to afford adequate protection against physical damage during shipment from the supply source to the customer. Any special packaging requirements must be specified in the ordering data.

7.2 LABELING

HP3 PIN
Date (month, day, and year) of manufacture and inspection
Manufacturer's name or trademark

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS

Not for Resale

Section 8
ORDERING DATA

8.1 ORDERING INFORMATION

Purchasing documents should specify the following information:

1. Part identification number (PIN) See para. 1.3
2. Packaging Requirements
3. Length Requirements
4. Quantity
5. Optional Identification (stripes, bands, tracers, printing, lot coding)

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Appendix A
MEASUREMENT AND CALCULATION DATA FOR TABLE 2

Minimum alloy breaking strength calculated based on the minimum diameter and tensile strength per ASTM B624

Nominal CMA based on the square of the nominal single end diameter in mils times the number of ends.

Nominal conductor diameter based on nominal single end diameter per ASTM B3, B298, B355, B501, and B559 which are all the same.
3 times the nominal single end diameter for 7 strand and 4.7 times for 19 strand was used. The OD for 19 strand was based on the unilay construction which is the most commonly used.

Maximum conductor diameter based on maximum single end diameters for nickel coated copper per ASTM B355. Three times the maximum single end diameter for 7 strand, 5 times for 19 strand, and 7 times for 37 strand was used. A true concentric construction which represents the largest possible 19 and 37 strand diameter was used. A 19 X 7 true concentric rope which represents the largest diameter was used. Rope Stranding using bunched members maximum diameter is per ASTM B286.

Maximum DC

SCC and NCC
— DC resistance based on formula in ASTM B286 Note 2.

SCA
— DC resistance based on formula in ASTM B286 Note 2 using a conductivity of 85% IACS minimum per ASTM B624

NCA
— DC resistance based on formula in ASTM B286 Note 2 using a base conductivity of 85% IACS minimum per ASTM B624 minus the effect of nickel per ASTM B286.

Class 2: .0100" diameter and larger	81% IACS
Class 4: .0099" to .0050"	79% IACS
Class 7: .0049" to .0031"	76% IACS
Class 10: .0030" to .0020"	73% IACS

SCCCA
— DC resistance based on formula in ASTM B286 Note 2 using a minimum conductivity of 39.2% IACS for type 40A per ASTM B501

NCCCS
— DC resistance based on formula in ASTM B286 Note 2 using the minimum conductivity for type 40A per ASTM B559

Class 2: .0100" diameter and larger	38.2% IACS
Class 4: .0099" to .0050"	38.4% IACS
Class 7: .0049" to .0031"	37.8% IACS
Class 10: .0030" to .0020"	37.2% IACS

Previous page is blank

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale



NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION • 1300 NORTH 17TH STREET • SUITE 1847 • ROSSLYN, VA 22209

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale