STANDARDS PUBLICATION NO. HP 100.1

nema

High Temperature Instrumentation and Control Cables Insulated and Jacketed with FEP Fluorocarbons

NEMA

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

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 100.1-1991 (R2005)

High Temperature Instrumentation and Control Cables
Insulated and Jacketed with FEP Fluorocarbons

Published by:

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

© Copyright 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

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The National Electrical Manufacturers Association (NEMA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety–related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

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	i
	SCOPE	ii
Section 1	REFERENCED STANDARDS AND GENERAL INFORMATION	1
	Referenced Standards	1
	General Information	1
Section 2	REQUIREMENTS	3
	Introduction	3
	Conductors	3
	Temperature Rating	3
	Insulation	3
	Circuit Identification	7
	Assembly	7
	Jackets	7
	Test Procedures	7
Tables		
Table 2-1	PRIMARY INSULATION THICKNESS	4
Table 2-2	INSULATION AND JACKET MATERIAL	5
Table 2-3	OVERALL JACKET THICKNESS	7

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

This Standards Publication for High Temperature Instrumentation and Control Cables Insulated and Jacketed with FEP Fluorocarbons was developed by the High Performance Wire and Cable Section (formerly known as the High Temperature Insulated Wire and Cable Section) of the National Electrical Manufacturers Association.

National Electrical Manufacturers Association standards are adopted in the public interest and designed to eliminate misunderstanding between the manufacturer and the user and to assist the user in selecting and obtaining the proper product for his particular need. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude the manufacture or use of products not conforming to the standard.

Suggestions for improvements gained in the use of this standard will be welcomed. They should be sent to:

Vice President, Engineering
National Electrical Manufacturers Association
2101 L Street, N.W., Suite 300
Washington, DC 20037-1526

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

Scope

This Standards Publication covers specific requirements for multiple-conductor instrumentation and control cables insulated and jacketed with FEP fluorocarbons. It supplements the general requirements and testing procedures contained in NEMA Standards Publication HP 100.

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

HIGH TEMPERATURE INSTRUMENTATION AND CONTROL CABLES INSULATED AND JACKETED WITH FEP FLUOROCARBONS

Section 1
REFERENCED STANDARDS AND GENERAL INFORMATION

1.1 REFERENCED STANDARDS

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

ASTM D-2116-89 — *FEP-Fluorocarbon Molding and Extrusion Material*

National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269

ANSI/NFPA 70-1993 — *National Electrical Code*

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

NEMA HP 100-1985 — *High Temperature Instrumentation and Control Cables*

1.2 GENERAL INFORMATION

The requirements in this publication supplement HP 100-1985 and cover specific requirements for multiple-conductor cables, insulated and jacketed with fluorinated ethylene propylene copolymer (FEP) for use in ducts, conduit and trays.

These cables shall be designed to operate continuously at conductor temperatures to 200°C(392°F). They shall be suitable for use up to a maximum circuit potential of 1000 volts rms.

These cables are limited to use in dry locations as defined by ANSI/NFPA 70 and are not for direct burial.

FEP cables are for service as shown in 1.3 of NEMA HP 100.

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

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
REQUIREMENTS

2.1 INTRODUCTION

FEP insulated and jacketed cables shall be in accordance with this Standard and NEMA Standards Publication HP 100.

NEMA Standard 8-28-1991

2.2 CONDUCTORS

Conductors shall be in accordance with Section 2, NEMA HP 100.

NEMA Standard 8-28-1991

2.3 TEMPERATURE RATING

Maximum continuous operating temperatures shall be as follows:

1. 200°C(392°F) for silver-coated copper, nickel-coated copper conductors for all strand sizes, or uncoated copper conductors with strands of 0.015 inch or greater, and all other thermocouple conductors.
2. 150°C(302°F) for tin-plated copper conductors, lead or lead-alloy coated conductors or uncoated copper conductors with strands less than 0.015 inch.

NEMA Standard 8-28-1991

2.4 INSULATION

Insulation shall be in accordance with Section 3 of NEMA HP 100, Tables 2-1 and 2-2 of this Standard and ASTM D-2116.

NEMA Standard 8-28-1991

2.5 CIRCUIT IDENTIFICATION

Circuit identification of these cables shall be in accordance with Section 4, NEMA HP 100.

2.6 ASSEMBLY

Assembly of these cables shall be in accordance with Section 5, NEMA HP 100.

NEMA Standard 8-28-1991

2.7 JACKETS

Jackets of these cables shall be in accordance with Section 6 of NEMA HP 100, Tables 2-2 and 2-3 of this Standard and ASTM D-2116.

NEMA Standard 8-28-1991

2.8 TEST PROCEDURES

Testing shall be performed in accordance with Section 7, NEMA HP 100.

NEMA Standard 8-28-1991

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 2-1
Primary Insulation Thickness

Conductor Size, AWG	Cable Type: Instrumentation Mils	Instrumentation mm	300 Volt Control Mils	300 Volt Control mm	600 Volt Control Mils	600 Volt Control mm	1000 Volt Control Mils	1000 Volt Control mm
24	10	0.25	12	0.31	. . .	. . .	. . .	. . .
22	10	0.25	12	0.31	. . .	. . .	. . .	. . .
20	10	0.25	12	0.31	15	0.38	. . .	. . .
18	10	0.25	12	0.31	15	0.38	. . .	. . .
16	10	0.25	12	0.31	15	0.38	18	0.46
14	. . .	. . .	12	0.31	15	0.38	18	0.46
12	. . .	. . .	. . .	. . .	15	0.38	18	0.46
10	. . .	. . .	. . .	. . .	17	0.43	20	0.51
9	. . .	. . .	. . .	. . .	17	0.43	20	0.51

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 2-2
Insulation and Jacket Material

Requirements for FEP Fluorocarbon Insulation and Jacket Materials	Test Paragraph[1]	Value
Maximum Operating Temperature		200[3]
• Rating, dry locations only, °C[2]		230
• Maximum emergency overload temperature, °C4		
Physical Requirements		2000
Tensile strength, minimum psi	7.2.3	13.8
Mpa[5]		200
Elongation at rupture, minimum percent	7.2.4	
Aging Requirements		
• After air oven test for 168 hours,, °C	7.2.6	230
Tensile strength, minimum percentage of unaged value		80
Elongation at rupture, minimum percentage of unaged value		80
• After oil immersion at 121°C± 1°C (250° 34°F) for 18 hours	7.2.7	
Tensile strength, minimum percentage of unaged value		85
Elongation at rupture, minimum percentage of unaged value		85
Heat Shock		
Temperature of Test, °C	7.2.8	230
Cracking on mandrel		no cracking
Heat distortion at 200°C (392°F) minimum, percentage	7.2.9	80
Cold Bend at -65°C (-149°F)	7.2.10	no cracks
Flame Propagation Limit	7.3	pass
Electrical Requirements		
Voltage Tests	7.4.1	Table 7-1 or 5-1 of HP 100
Insulation Resistance		
K Factor	7.4.2	5000
Temperature correction coefficient		1.00
Dielectric constant (SIC)		2.1
max at 75°C (167°F)	7.4.3	

1Unless otherwise listed, the test paragraphs refer to NEMA Standard HP 100.

2This insulation and jacket material is suitable for use at conductor and/or installed use temperature not exceeding that shown.

3Maximum of 200°C(392°F) over silver-coated, or nickel coated copper conductors (for all strand sizes) or unplated copper conductors (with strands of 0.015 inch or greater); or a maximum of 150°C over tin-plated copper conductors, lead or lead-alloy coated conductors or unplated copper conductors (with strands less than 0.015).

4Operation at these emergency overload temperatures shall not exceed 100 hr. in any 12 consecutive months nor more than 500 hr. during the lifetime of the cable.

51 Pa = 1 KG/m^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

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 2-3
Overall Jacket Thickness

Calculated Diameter of Cable Under Jacket		Jacket Thickness			
		Normal Duty		Heavy Duty	
Inches	mm	Mils	mm	Mils	mm
0.150 or less	3.82 or less	10	0.25	15	0.38
0.151-0.250	3.83-6.36	12	0.31	20	0.51
0.251-0.425	6.37-10.80	15	0.38	25	0.63
0.426-0.700	10.81-17.77	20	0.51	30	0.76
0.701-1.000	17.78-25.40	25	0.64	45	1.14

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 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.

(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, 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. 8)

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. 7 & 16)

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. 7 & 16)

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 authorized engineering information and not to procedures required for compliance with the standard.

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

HIGH PERFORMANCE WIRE AND CABLE SECTION OF THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

American Electric Cable Company
Holyoke, MA 01040

Astro Industries, Inc.
Dayton, OH 45432

AT&T
Norcross, GA 30071

Barcel Wire and Cable Corporation
Irvine, CA 92714-5885

Belden Division/
Cooper Industries Inc.
Richmond, IN 47375

Berk-Tek, Inc.
New Holland, PA 17557

Brand-Rex Company
Willimantic, CT 06226

Cable USA, Inc.
Naples, FL 33942

Cablec Continental Cables Company
York, PA 17402-9950

Carol Cable Company, Inc.
Pawtucket, RI 02862

Champlain Cable Corporation
Winooski, VT 05404

Delta Suprenant Wire and Cable
Clinton, MA 01510

Furon Company
Aurora, OH 44202

Harbour Industries, Inc.
Shelburne, VT 05482

Independent Cable, Inc.
Hudson, MA 01749

Kris-Tech Wire Company, Inc.
Rome, NY 13440

Micro-Tek Corporation
Cinnaminson, NJ 08077-2134

Mohawk Wire & Cable Corporation
Leominster, MA 01453

Montrose Products Company
Auburn, MA 01501

NEK Cable, Inc.
Bohemia, NY 11716

The Okonite Company
Ramsey, NJ 07446

Pacific Electricord Company
Gardena, CA 90247

Philadelphia Insulated Wire
Company
Moorestown, NJ 08057

Prestolite Wire Corporation
Farmington Hills, MI 48018

Quirk Wire Company, Inc.
West Brookfield, MA 01585

Radix Wire Company
Euclid, OH 44132

The Rockbestos Company
New Haven, CT 06504

Siecor Corporation
Hickory, NC 28603-0489

Specialty Cable Corp.
Wallingford, CT 06492

Teledyne Thermatics
Elm City, NC 27822

Tensolite Company
St. Augustine, FL 32092

Times Microwave Systems, Inc.
Wallingford, CT 06492

Triangle Wire and Cable, Inc.
New Brunswick, NJ 08903

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