NEMA HP 100

HIGH TEMPERATURE INSTRUMENTATION AND CONTROL CABLES

NEMA Standards Publication HP 100-1991 (R1999, R2005, R2010)

High Temperature Instrumentation and Control Cables

Reaffirmed September 10, 2010

Published by:

National Electrical Manufacturers Association 1300 North 17th Street, Suite 1752 Rosslyn, Virginia 22209

www.nema.org

© Copyright 2010 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.

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.

i

1

:

TABLE OF CONTENTS

	FOREWORD	i
	SCOPE	ü
Section 1	REFERENCED STANDARDS AND GENERAL INFORMATION	1
	Referenced Standards	1
	Introduction	3
	Types	3
	Instrumentation Cables	3
	300V Control Cables	3
	600V Control Cables	3
	1000V Control Cables	3
Section 2	CONDUCTORS	5
	Conductor Material	5
	Conductor Construction for Other Than Thermocouple	5
	Stranding	5
	Thermocouple Conductor Construction	5
Section 3	INSULATION	7
	Materials	7
	Thickness	7
Section 4	CIRCUIT IDENTIFICATION	9
0000000	Unpaired Cables	ģ
	Paired Cables	ģ
	Thermocouple or Thermocouple Extension Lead Wires	ģ
Section 5	ASSEMBLY	13
	Electrical Testing of Individual Conductors	13
	Color Sequence of Conductors	13
	Shielding of Conductors Component Groups or Cable Core	13
Section 6	IACKETS	15
	Introduction	15
	Materials	15
	Thickness	15
Section 7	TEST PROCEDURES	17
		17
	Physical Requirements	17
	Test Temperature	17
	Type of Testing Machine	17
	Tensile Strength Tests	17
	Alternative Tensile Strength Test	17
	Florgation Test	17
	Alternative Flongation Test Method	17
	Aging Test	17
	Air Oven Test	17
	Oil Immersion Test	17
	Heat Shock Test	18
	Heat Distortion Test	18
		19
	Test Specimen For Insulation	18
	Test Specimen For Jackets 50 Mil or Greater in Thickness	19
	Test Specimen For Jackets Jonan of Societa in Thickness	19
		10
		10

TABLE OF CONTENTS (Continued)

	Cold Bend Test	18
	Thickness Determination	19
	Flame Propagation Test	19
	Electrical Tests	19
	Voltage Tests	19
	General	19
	Alternating Current Voltage Test	19
	Direct-Current Voltage Test	19
	Direct-Current Spark Test	19
	Impulse Dielectric Voltage Test	19
	Test Requirements For Cables Without Metallic Shield	19
	Test Requirements For Cables With Metallic Shield	20
	Insulation Resistance Test	20
	Test Apparatus	20
	Test Procedure	20
	Dielectric Constant (SIC) Test Procedure	23
Tables		
Table 4-1	COLOR SEQUENCE FOR INSTRUMENTATION AND	10
Table 5-1	TEST VOLTAGES, COMPLETED CABLES	14
Table 7-1	TEST VOLTAGES, INSULATED CONDUCTORS	20
Table 7-2	TEMPERATURE CORRECTION FACTORS FOR INSULATION RESISTANCE TO 15.6°C (60°F)	21
Table 7-3	STRANDING FACTOR	23

1

- -- -

Foreword

This Standards Publication for High Temperature Instrumentation and Control Cables for the Transmission and Distribution of Low Voltage Electrical Energy was developed and approved by the High Performance Wire and Cable Section (formerly known as the High Temperature Insulated Wire & 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 standards.

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

Vice President, Technical Services NEMA 1300 North 17th Street Suite 1752 Arlington, VA 22209

Scope

This Standards Publication covers general requirements and testing procedures for a series of multiple-conductor high-temperature instrumentation and control cables for use in ducts, conduit and trays. See the following individual HP 100 Standards Publications for additional requirements.

- HP 100.1-1991 High Temperature Instrumentation and Control Cables Insulated and Jacketed with FEP Fluorocarbons
- HP 100.2-1991 High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers
- HP 100.3-1991 High Temperature Instrumentation and Control Cables Insulated and Jacketed with Cross-Linked (Thermoset) Polyolefin (XLPO)
- HP 100.4-1991 High Temperature Instrumentation and Control Cables Insulated and Jacketed with ECTFE Fluoropolymers

ii

NEMA HP 100.1

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

NEMA Standards Publication HP 100.1-1991 (R2005, R2010)

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

Reaffirmed September 10, 2010

Published by:

National Electrical Manufacturers Association 1300 North 17th Street, Suite 1752 Rosslyn, Virginia 22209

www.nema.org

© Copyright 2010 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.

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.

TABLE OF CONTENTS

•

-

1 1 1

1 1

ł

• •

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

----- -

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, Technical Services NEMA 1300 North 17th Street Suite 1752 Arlington, VA 22209

ł

Scope

1

- ---

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.

- -

NEMA HP 100.2

HIGH TEMPERATURE INSTRUMENTATION AND CONTROL CABLES INSULATED AND JACKETED WITH ETFE FLUOROPOLYMERS

NEMA Standards Publication HP 100.2-1991 (R2005, R2010)

High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers

Reaffirmed September 10, 2010

Published by:

National Electrical Manufacturers Association 1300 North 17th Street, Suite 1752 Rosslyn, Virginia 22209

www.nema.org

© Copyright 2010 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.

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.

- ----

TABLE OF CONTENTS

∡ ₹

4

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

Foreword

This Standards Publication for High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers 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, Technical Services NEMA 1300 North 17th Street Suite 1752 Arlington, VA 22209

Scope

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

_

ł

NEMA HP 100.3

HIGH TEMPERATURE INSTRUMENTATION AND CONTROL CABLES INSULATED AND JACKETED WITH CROSS-LINKED (THERMOSET) POLYOLEFIN (XLPO)

NEMA Standards Publication HP 100.3-1991 (R2005, R2010)

High Temperature Instrumentation and Control Cables Insulated and Jacketed with Cross-Linked (Thermoset) Polyolefin (XLPO)

Reaffirmed September 10, 2010

Published by:

National Electrical Manufacturers Association 1300 North 17th Street, Suite 1752 Rosslyn, Virginia 22209

www.nema.org

© Copyright 2010 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.

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.

TABLE OF CONTENTS

Section 1	REFERENCED STANDARDS AND GENERAL INFORMATION 1
	Referenced Standards
	General Information
Section 2	REQUIREMENTS
	Introduction
	Conductors
	Insulation
	Circuit Identification
	Assembly
	Jackets
	Test Procedures
TABLES	
TABLE 2-1	INSULATION AND JACKET MATERIAL
TABLE 2-2	PRIMARY INSULATION THICKNESS (MINIMUM)
TABLE 2-3	OVERALL JACKET THICKNESS

•

. ,

-

Foreword

This Standards Publication for High Temperature Instrumentation and Control Cables Insulated and Jacketed with Cross-Linked (Thermoset) Polyolefin (XLPO) was developed by the High Performance Insulated 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, Technical Services NEMA 1300 North 17th Street Suite 1752 Arlington, VA 22209

Scope

This Standards Publication covers specific requirements for multiple-conductor instrumentation and control cables insulated and jacketed with cross-linked (thermoset) polyolefin (XLPO). It supplements the general requirements and testing procedures contained in NEMA Standards Publication HP 100.

NEMA HP 100.4

HIGH TEMPERATURE INSTRUMENTATION AND CONTROL CABLES INSULATED AND JACKETED WITH ECTFE FLUOROPOLYMERS

NEMA Standards Publication HP 100.4-1991 (R2005, R2010)

High Temperature Instrumentation and Control Cables Insulated and Jacketed with ECTFE Fluoropolymers

Reaffirmed September 10, 2010

Published by:

National Electrical Manufacturers Association 1300 North 17th Street, Suite 1752 Rosslyn, Virginia 22209

www.nema.org

© Copyright 2010 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.

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.

TABLE OF CONTENTS

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

,

-

Foreword

This Standards Publication for High Temperature Instrumentation and Control Cables Insulated and Jacketed with ECTFE Fluoropolymers 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, Technical Services NEMA 1300 North 17th Street Suite 1752 Arlington, VA 22209 NEMA HP*100.4 91 🎟 6470247 0504025 96T 🖿

Scope

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

_