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ANSI/NEMA MW 1000-2018

American National Standard for Magnet Wire

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FOREWORD

ANSI/NEMA MW 1000-2018 supersedes ANSI/NEMA MW 1000-2016. It has been approved as an American National Standard.

This Standard is periodically reviewed by the NEMA Magnet Wire Section for revisions considered to be necessary to keep it up to date with changes in technology and regulations. See <http://www.MW1000.com> for additional information.

Proposed or recommended revisions should be submitted to:

Technical Director, Operations
National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

MW 1000 was developed by the Magnet Wire Section of NEMA, working closely with representatives of various industries that use magnet wire. At the time this edition was approved, the Magnet Wire Section had the following members:

Bridgeport Insulated Wire Company
CONDUMEX
Elektrisola, Inc.
Essex Magnet Wire
Magnekón
MWS Wire Industries
New England Wire Technologies
Rea Magnet Wire Company, Inc.
Rubadue Wire Company, Inc.
Virginia Insulated Products, Inc.

Bridgeport, CT
México, D.F., México
Boscawen, NH
Fort Wayne, IN
San Nicolas, NL, México
Westlake Village, CA
Lisbon, NH
Fort Wayne, IN
Greeley, CO
Saltville, VA

How to Use This Publication

First, review Part 1 for general information. Then in Part 2, locate the specification for the type of insulation and conductor of interest. Part 2 is arranged in numerical order as shown beginning on page 14. The dimensions for each Part 2 MW type are provided in Part 1, beginning with Table 1. The specification in Part 2 will indicate the requirements to be met and will refer to the test procedures and corresponding test values to be attained in Part 3.

Part 1 of this publication deals with information common to all types of magnet wire: ordering information, general material requirements, general test conditions, definitions, and manufacturing data in support of thermal rating. This part also includes dimensions with metric equivalents for all bare, minimum insulation increase, and overall dimensions for all Part 2 MW specification requirements.

Part 2 consists of product specifications requirements (other than dimensions) for magnet wire with different types of coatings and/or coverings. Insofar as possible, the product specifications are complete on one sheet, since they are arranged to include only one insulation or covering per sheet. The title on each sheet identifies the product. Example: MW 15-C, Polyvinyl Acetal Round Copper Magnet Wire. MW 15-A covers the aluminum version of the same generic product.

Part 3 contains the test procedures to be followed and corresponding tables of specific test values to be attained in determining compliance with the requirements given in Part 2. The requirements are consolidated with the test procedures and testing parameters for a given property. An index of the main test paragraphs is provided, beginning on page 14, Part 3 Test Procedures, in the Table of Contents.

Annex A provides a cross reference between test procedures in this Standards publication and those published by the American Society for Testing and Materials (ASTM).

Annex B consists of definitions, requirements, and recommended test procedures for reusable magnet wire packaging, standardized dimensions for spools and reels, and formatting for the labeling of magnet wire products.

Annex C provides a cross reference between NEMA and IEC magnet wire specifications.

Annex D provides the formulas for determining dimensional requirements of round film-insulated magnet wire and dielectric breakdown, as well as cross-sectional area and resistance calculations.

Annex E provides the dimensional criteria for ranges of sizes of rectangular bare, film, and fabric magnet wire products, setting the general rules and guidelines for various traditional yet non-Standard rectangular magnet wire products.

Annex F provides properties of selected refrigerants determined as suitable alternatives to refrigerant R22 in the Refrigerant Extraction Test, clause 3.55.

Annex G provides recommended winding tensions for round copper and aluminum magnet wire to ensure that wire, as it is de-reeled, is not stretched beyond end user requirements.

Annex H provides the test methods and requirements for fully insulated winding wire (FIW) referenced in specification MW 85-C in Part 2.

Annex I provides a standardized repeated (bi-directional) scrape resistance procedure for film insulated magnet wire.

Summary of Revisions

FOREWORD

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| Updated "How to Use this Publication" | ii |
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Part 1

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| 1.3 revised with new definitions of the terms "rounded corner", "rounded edge" and "varnish" | 3 |
| 1.4.1.2 revised with notes on current-carrying capacity of magnet wire | 6 |
| 1.5.1.1 revised for improved clarity | 7 |
| 1.8.2 added to define the thermal classification of electrical insulating varnishes | 12 |
| Tables 4-7 revised to adopt IEC mathematical progression for calculating maximum overall diameter | 15 |

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| MW 18-A, 18-C, 20-C, 36-A, 36-C, 38-C and 84-C revised with modified requirements for Dielectric Breakdown at Rated Temperature | 6, 7, 9, 21, 22, 24, 63 |
| MW 18-C, 20-C, 36-C and 84-C revised with modified requirements for Thermoplastic Flow . | 7, 9, 21, 24, 63 |
| MW 45-C revised with a modified title | 29 |
| MW 46-C revised with a modified title and insulating material requirements | 30 |
| MW 54-C and MW 55-C added as new specifications | 37, 38 |
| MW 86-A, 86-C, 87-A and 87-C revised for consistency with MW 15 and MW 18 | 65, 66, 67, 68 |

Part 3

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| 3.3.4 revised with a new note on the use of a clamping fixture | 5 |
| 3.3.5 revised to clarify the purpose of the bend and shot method dielectric method | 5 |
| 3.9.1.2 and 3.9.1.3 revised to recognize conductive fiber bush electrodes other than graphite | 23, 25 |
| 3.50.3 added with a new procedure for determining thermoplastic flow properties of rectangular wire | 34 |
| 3.52.1 revised for improved clarity | 36 |
| 3.54.3 revised to clarify the specimen preparation procedures | 38 |
| 3.57.2.3 added, restoring previously published text | 51 |
| Tables 34 and 35 (formerly Tables 38 and 39) expanded to include sizes 14-37 AWG. | 20, 21 |
| Table 43 revised to add distilled water as one of the pressure vessel components | 40 |
| Figure 3-8-6 revised to correct the illustration of the test circuitry | 19 |

Annex C

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Annex I

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| Added this edition | I-1 |
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Part 2**Specifications Listing by MW Specification Number, Thermal Class Film Insulation, Coating Covering and Form**

| Specification Number | | Thermal Class | Round | Rectangular and Square | Page No. |
|----------------------|---|---------------|-------|------------------------|----------|
| MW 5-C | Polyester (Single and Heavy) | 155 | X | — | 2 |
| MW 15-A | Polyvinyl Acetal (Single and Heavy) | 105 | X | — | 3 |
| MW 15-C | Polyvinyl Acetal (Single, Heavy, Triple, Quad) | 105 | X | — | 4 |
| MW 16-C | Polyimide (Single, Heavy, Triple, Quad) | 240 | X | — | 5 |
| MW 18-A | Polyvinyl Acetal (Heavy and Quad) | 105 | — | X | 6 |
| MW 18-C | Polyvinyl Acetal (Heavy and Quad) | 105 | — | X | 7 |
| MW 19-C | Polyvinyl Acetal with Self-bonding Overcoat (Types 1, 2, and 3) | 105 | X | — | 8 |
| MW 20-C | Polyimide (Heavy and Quad) | 240 | — | X | 9 |
| MW 24-A | Polyester (amide)(imide) Overcoated with Polyamide (Single and Heavy) | 155 | X | — | 10 |
| MW 24-C | Polyester (amide)(imide) Overcoated with Polyamide (Single, Heavy, Triple) | 155 | X | — | 11 |
| MW 28-A | Polyurethane Overcoated with Polyamide for Solderable Applications (Single and Heavy) | 130 | X | — | 12 |
| MW 28-C | Polyurethane Overcoated with Polyamide for Solderable Applications (Single and Heavy) | 130 | X | — | 13 |
| MW 30-C | Polyester (amide)(imide) (Single, Heavy, Triple) | 180 | X | — | 14 |
| MW 31-A | Paper Covered | 90 or 105 | X | | 15 |
| MW 31-C | Paper Covered | 90 or 105 | X | — | 16 |
| MW 33-A | Paper Covered Bare Rectangular and Square | 90 or 105 | — | X | 17 |
| MW 33-C | Paper Covered Bare Rectangular and Square | 90 or 105 | — | X | 18 |
| MW 35-A | Polyester (amide)(imide) Overcoated with Polyamideimide (Single and Heavy) | 220 | X | — | 19 |
| MW 35-C | Polyester (amide)(imide) Overcoated with Polyamideimide (Single, Heavy, Triple, Quad) | 200 | X | — | 20 |
| MW 36-A | Polyester (amide)(imide) Overcoated with Polyamideimide (Heavy and Quad) | 220 | — | X | 21 |
| MW 36-C | Polyester (amide)(imide) Overcoated with Polyamideimide (Heavy and Quad) | 200 | — | X | 22 |
| MW 37-C | Polyester (amide)(imide) Overcoated with Polyamideimide (Single, Heavy and Triple) | 220 | X | — | 23 |
| MW 38-C | Polyester (amide)(imide) overcoated with polyamideimide (Heavy and Quadruple) | 220 | — | X | 24 |
| MW 41-C | Glass Fiber Covered (Single and Double) | 155 | X | — | 25 |
| MW 42-C | Glass Fiber Covered (Single and Double) | 155 | — | X | 26 |
| MW 43-C | Glass Fiber Covered Silicone Treated (Single and Double) | 200 | — | X | 27 |
| MW 44-C | Glass Fiber Covered Silicone Treated (Single and Double) | 200 | X | — | 28 |
| MW 45-C | Polyester Glass Fiber Covered (Single and Double) | 155 | X | — | 29 |

| Specification Number | | Thermal Class | Round | Rectangular and Square | Page No. |
|----------------------|---|---------------|-------|------------------------|----------|
| MW 46-C | Polyester Glass Fiber Covered (Single and Double) | 155 | — | X | 30 |
| MW 47-C | Polyester Glass Fiber Covered Silicone Treated (Single and Double) | 200 | X | — | 31 |
| MW 48-C | Polyester Glass Fiber Covered Silicone Treated (Single and Double) | 200 | — | X | 32 |
| MW 50-C | Glass Fiber Covered, High-Temperature Organic Varnish Treated (Single and Double) | 180 | X | — | 33 |
| MW 51-C | Polyester Glass Fiber Covered, High-Temperature Organic Varnish Treated (Single and Double) | 180 | X | — | 34 |
| MW 52-C | Glass Fiber Covered, High-Temperature Organic Varnish Treated (Single or Double) | 180 | — | X | 35 |
| MW 53-C | Polyester Glass Fiber Covered, High-Temperature Organic Varnish Treated (Single and Double) | 180 | — | X | 36 |
| MW 54-C | Polyester Glass Fiber Covered and Varnish Treated Bare or Heavy Film-Insulated | 155 | X | — | 37 |
| MW 55-C | Polyester Glass Fiber Covered and Varnish Treated Bare or Heavy Film-Insulated | 155 | — | X | 38 |
| MW 60-A | Aromatic Polyamide Paper Covered (Paper) | 220 | — | X | 39 |
| MW 60-C | Aromatic Polyamide Paper Covered (Paper) | 220 | — | X | 40 |
| MW 61-A | Aromatic Polyamide Paper Covered (Paper) | 220 | X | — | 41 |
| MW 61-C | Aromatic Polyamide Paper Covered (Paper) | 220 | X | — | 42 |
| MW 64-A | Aromatic Polyimide Tape Covered | 240 | — | X | 43 |
| MW 64-C | Aromatic Polyimide Tape Covered | 240 | — | X | 44 |
| MW 65-A | Aromatic Polyimide Tape Covered | 240 | X | — | 45 |
| MW 65-C | Aromatic Polyimide Tape Covered | 240 | X | — | 46 |
| MW 72-C | Polyester (amide)(imide) for Hermetic Applications (Heavy) | 180 | X | — | 47 |
| MW 73-A | Polyester (amide)(imide) Overcoated with Polyamideimide for Hermetic Applications (Heavy) | 220 | X | — | 48 |
| MW 73-C | Polyester (amide)(imide) Overcoated with Polyamideimide for Hermetic Applications (Heavy, Triple, Quad) | 200 | X | — | 49 |
| MW 74-A | Polyester (amide)(imide) (Single and Heavy) | 220 | X | — | 50 |
| MW 74-C | Polyester (amide)(imide) (Single and Heavy) | 200 | X | — | 51 |
| MW 75-C | Polyurethane for Solderable Applications (Single and Heavy) | 130 | X | — | 52 |
| MW 76-A | Polyester (amide)(imide) Overcoated with Polyamide (Single and Heavy) | 180 | X | — | 53 |
| MW 76-C | Polyester (amide)(imide) Overcoated with Polyamide (Single, Heavy, Triple) | 180 | X | — | 54 |
| MW 77-C | Polyester (imide) for Solderable | 180 | X | — | 55 |

| Specification Number | | Thermal Class | Round | Rectangular and Square | Page No. |
|----------------------|--|---------------|-------|------------------------|----------|
| MW 78-C | Polyester (imide) | 180 | X | — | 56 |
| MW 79-C | Polyurethane for Solderable Applications (Single, Heavy and Triple) | 155 | X | — | 57 |
| MW 80-A | Polyurethane Overcoated with Polyamide for Solderable Applications (Single and Heavy) | 155 | X | — | 58 |
| MW 80-C | Polyurethane overcoated with polyamide for solderable applications (Single, Heavy, Triple) | 155 | X | — | 59 |
| MW 81-C | Polyamideimide (Single and Heavy) | 220 | X | — | 60 |
| MW 82-C | Polyurethane for solderable applications (Single, Heavy and Triple) | 180 | X | — | 61 |
| MW 83-C | Polyurethane overcoated with polyamide for solderable applications (Single, Heavy, Triple) | 180 | X | — | 62 |
| MW 84-C | Polyamideimide Film-Insulated | 220 | | X | 63 |
| MW 85-C | Polyurethane Fully Insulated | 180 | X | — | 64 |
| MW 86-A | Polyvinyl Acetal (Single and Heavy) | 120 | X | — | 65 |
| MW 86-C | Polyvinyl Acetal (Single, Heavy, Triple) | 120 | X | — | 66 |
| MW 87-A | Polyvinyl Acetal (Heavy and Quad) | 120 | — | X | 67 |
| MW 87-C | Polyvinyl Acetal (Heavy and Quad) | 120 | — | X | 68 |
| MW 102-A | Polyester (amide)(imide) | 180 | X | — | 69 |
| MW 102-C | Polyester (amide)(imide) | 180 | X | — | 70 |
| MW 130-C | Polyurethane with self-bonding overcoat (Type 1 and Type 2) | 130 | X | — | 71 |
| MW 131-C | Polyurethane with self-bonding overcoat (Type 1 and Type 2) | 155 | X | — | 72 |
| MW 132-C | Polyurethane with Self-Bonding Overcoat (Type 1 and Type 2) | 180 | X | — | 73 |
| MW 135-C | Polyurethane overcoated with polyamide and self-bonding overcoat (Type 1 and Type 2) | 130 | X | — | 74 |
| MW 136-C | Polyurethane overcoated with polyamide and self-bonding overcoat (Type 1 and Type 2) for Solderable Applications | 180 | X | — | 75 |
| MW 137-C | Polyurethane Overcoated with Polyamide and Self-Bonding Overcoat (Type 1 and Type 2) for Solderable Applications | 180 | X | — | 76 |

Part 2

Specifications Listing by Thermal Class, Film Insulation, Coating, Covering and Form

| Thermal Class | Film Insulation, Coating, Covering, and Form | See Part 2, Specification No. | | |
|----------------------------------|--|-------------------------------|---------|----------|
| | | Aluminum | Copper | Page No. |
| FILM-INSULATED ROUND MAGNET WIRE | | | | |
| 105 | Polyvinyl Acetal | MW 15-A | MW 15-C | 3, 4 |
| 105 | Polyvinyl Acetal and Self-bonding Overcoat | - | MW 19-C | 8 |
| 120 | Polyvinyl Acetal | MW 86-A | | 65 |

| Thermal Class | Film Insulation, Coating, Covering, and Form | See Part 2, Specification No. | | |
|----------------|--|-------------------------------|----------|----------|
| | | Aluminum | Copper | Page No. |
| 120 | Polyvinyl Acetal | | MW 86-C | 66 |
| 120 | Polyvinyl Acetal | MW 87-A | | 67 |
| 120 | Polyvinyl Acetal | | MW 87-C | 67 |
| 130 Solderable | Polyurethane Overcoated with Polyamide | MW 28-A | MW 28-C | 12, 13 |
| 130 Solderable | Polyurethane | - | MW 75-C | 52 |
| 130 Solderable | Polyurethane with Self-bonding Overcoat | - | MW 130-C | 71 |
| 130 Solderable | Polyurethane Overcoated with Polyamide and Self-bonding Overcoat | - | MW 135-C | 74 |
| 155 | Polyester | - | MW 5-C | 2 |
| 155 | Polyester (amide)(imide) Overcoated with Polyamide | MW 24-A | MW 24-C | 10, 11 |
| 155 Solderable | Polyurethane | - | MW 79-C | 57 |
| 155 Solderable | Polyurethane Overcoated with Polyamide | MW 80-A | MW 80-C | 58, 59 |
| 155 Solderable | Polyurethane with Self-bonding Overcoat | - | MW 131-C | 72 |
| 155 Solderable | Polyurethane Overcoated with Polyamide and Self-bonding Overcoat | - | MW 136-C | 75 |
| 180 | Polyester (amide)(imide) | - | MW 30-C | 14 |
| 180 | Polyester (amide)(imide) Overcoated with Polyamide | MW 76-A | MW 76-C | 53, 54 |
| 180 | Polyester (amide)(imide) Overcoated with Polyamideimide and Self-bonding Overcoat | MW 102-A | MW 102-C | 69, 70 |
| 180 Solderable | Polyester (imide) | - | MW 77-C | 55 |
| 180 Solderable | Polyester (imide) Overcoated with Polyamide | - | MW 78-C | 56 |
| 180 Hermetic | Polyester (amide) (imide) | - | MW 72-C | 47 |
| 180 Solderable | Polyurethane | - | MW 82-C | 61 |
| 180 Solderable | Polyurethane Overcoated with Polyamide | - | MW 83-C | 62 |
| 180 Solderable | Polyurethane Fully Insulated FIW Zero-Defect Insulated Round Copper Wire for Solderable Applications | - | MW 85-C | 64 |
| 180 Solderable | Solderable Polyurethane with Self-bonding Overcoat | - | MW 132-C | 73 |
| 180 Solderable | Solderable Polyurethane Overcoated with Polyamide and Self-bonding Overcoat | - | MW 137-C | 76 |
| 200 | Polyester (amide) (imide) Overcoated with Polyamideimide | - | MW 35-C | 20 |
| 200 | Polyester (amide)(imide) | - | MW 74-C | 51 |
| 220 Hermetic | Polyester (amide)(imide) Overcoated with Polyamideimide | MW 73-A | - | 48 |
| 220 | Polyester (amide)(imide) Overcoated with Polyamideimide | - | MW 37-C | 23 |
| 220 | Polyester (amide)(imide) | MW 74-A | - | 50 |
| 220 | Polyamideimide | | MW 81-C | 60 |
| 240 Hermetic | Polyimide | - | MW 16-C | 4 |

| Thermal Class | Film Insulation, Coating, Covering, and Form | See Part 2, Specification No. | | |
|--|---|-------------------------------|---------|----------|
| | | Aluminum | Copper | Page No. |
| FILM-INSULATED RECTANGULAR AND SQUARE WIRE | | | | |
| 105 | Polyvinyl Acetal | MW 18-A | MW 18-C | 6, 7 |
| 200 | Polyester (amide)(imide) Overcoated with Polyamideimide | - | MW 36-C | 22 |
| 220 | Polyester (amide)(imide) Overcoated with Polyamideimide | MW 36-A | - | 21 |
| 220 | Polyester (amide)(imide) Overcoated with Polyamideimide | - | MW 38-C | 24 |
| 220 | Polyamideimide | | MW 84-C | 63 |
| 240 | Polyimide | - | MW 20-C | 9 |
| FIBROUS COVERED ROUND MAGNET WIRE | | | | |
| 90 or 105 | Paper Covered | MW 31-A | MW 31-C | 15, 16 |
| 155 | Glass Fiber Covered | - | MW 41-C | 25 |
| 155 | Polyester Glass Fiber Covered | - | MW 45-C | 29 |
| 180 | Glass Fiber Covered, High-Temperature Organic Varnish Treated | - | MW 50-C | 33 |
| 180 | Polyester Glass Fiber Covered, High-Temperature Organic Varnish Treated | - | MW 51-C | 34 |
| 200 | Glass Fiber Covered, Silicone Treated | - | MW 44-C | 28 |
| 200 | Polyester Glass Fiber Covered, Silicone Treated | - | MW 47-C | 31 |
| 220 | Aromatic Polyamide Paper Covered | MW 61-A | MW 61-C | 41, 42 |
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Part 1

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Part 1 General

1.1. Scope

This publication is designed to present in concise and convenient form all existing NEMA Standards for magnet wire. It contains Standards for round, rectangular, and square film-insulated and/or fibrous-covered copper and aluminum magnet wire for use in electrical apparatus. Included are the definitions, type designations, dimensions, constructions, performance, and test methods for magnet wire generally used in the winding of coils for electrical apparatus. Unless otherwise stated, a revision to a product specification in this Standards publication does not affect compliance of product manufactured during the time a previous version of that specification was in effect.