



Designation: E235/E235M – 19

# Standard Specification for Type K and Type N Mineral-Insulated, Metal-Sheathed Thermocouples for Nuclear or for Other High-Reliability Applications<sup>1</sup>

This standard is issued under the fixed designation E235/E235M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification covers the requirements for simplex, compacted mineral-insulated, metal-sheathed (MIMS), Type K and N thermocouples for nuclear or other high reliability service. Depending on size, these thermocouples are normally suitable for operating temperatures to 1652 °F [900 °C]; special conditions of environment and life expectancy may permit their use at temperatures in excess of 2012 °F [1100 °C]. This specification was prepared to detail requirements for this type of MIMS thermocouple for use in nuclear environments, but they can also be used for laboratory or general commercial applications where the environmental conditions exceed normal service requirements. The intended use of a MIMS thermocouple in a specific nuclear application will require evaluation of the compatibility of the thermocouple, including the effect of the temperature, atmosphere, and integrated neutron flux on the materials and accuracy of the thermoelements in the proposed application by the purchaser.

1.2 This specification does not attempt to include all possible specifications, standards, etc., for materials that may be used as sheathing, insulation, and thermocouple wires for sheathed-type construction. The requirements of this specification include only the austenitic stainless steels and other alloys as allowed by Specification E585/E585M for sheathing, magnesium oxide or aluminum oxide as insulation, and Type K and N thermocouple wires for thermoelements (see Note 1).

1.3 *General Design*—Nominal sizes of the finished thermocouples shall be 0.0400 in., 0.0625 in., 0.125 in., 0.1875 in., or 0.250 in. [1.000 mm, 1.500 mm, 3.000 mm, 4.500 mm, or 6.000 mm]. Sheath dimensions and tolerances for each nominal size shall be in accordance with Table 1 and Figs. 1 and 2. The measuring junction styles for thermocouples covered by this specification are as follows:

1.3.1 *Style G<sup>2</sup> (grounded)*—The measuring junction is electrically connected to its conductive sheath, and

1.3.2 *Style U<sup>2</sup> (ungrounded)*—The measuring junction is electrically isolated from its conductive sheath and from reference ground.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents or conversions; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

E3 Guide for Preparation of Metallographic Specimens

E45 Test Methods for Determining the Inclusion Content of Steel

E112 Test Methods for Determining Average Grain Size

E165/E165M Practice for Liquid Penetrant Testing for General Industry

E220 Test Method for Calibration of Thermocouples By

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.12 on Thermocouples - Specifications.

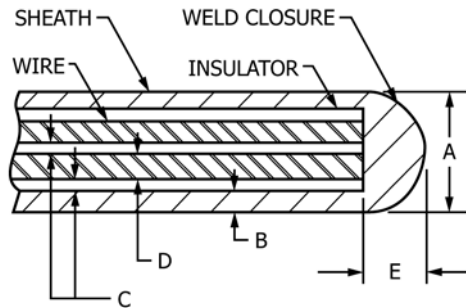
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<sup>2</sup> Style G and Style U measuring junctions were previously termed Class 1 and Class 2 measuring junctions respectively.

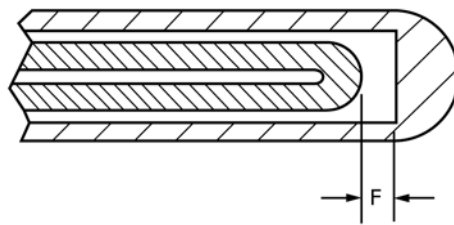
<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**TABLE 1 Dimensions for Style G and U Measuring Junctions**

Sheath Outside Diameter, <i>A</i>			Minimum Sheath Wall, <i>B</i>	Minimum Insulation Thickness, <i>C</i>	Minimum Wire Diameter, <i>D</i>	<i>E</i> , Tolerance		<i>F</i> , Tolerance	
Nominal	Tolerance					min	max	min	max
	min	max							
Inches									
0.0400	0.0390	0.0415	0.006	0.004	0.005	0.006	0.020	0.004	0.021
0.0625	0.0615	0.0640	0.009	0.005	0.010	0.009	0.032	0.005	0.032
0.1250	0.1240	0.1265	0.012	0.012	0.020	0.012	0.062	0.012	0.063
0.1875	0.1865	0.1890	0.020	0.022	0.031	0.020	0.093	0.022	0.095
0.2500	0.2480	0.2520	0.030	0.024	0.040	0.030	0.125	0.024	0.125
[Millimetres]									
[1.000]	[0.975]	[1.038]	[0.15]	[0.10]	[0.13]	[0.15]	[0.51]	[0.10]	[0.53]
[1.500]	[1.475]	[1.538]	[0.23]	[0.13]	[0.25]	[0.23]	[0.81]	[0.13]	[0.81]
[3.000]	[2.975]	[3.038]	[0.30]	[0.30]	[0.51]	[0.30]	[1.57]	[0.30]	[1.60]
[4.500]	[4.475]	[4.538]	[0.51]	[0.56]	[0.79]	[0.51]	[2.36]	[0.56]	[2.41]
[6.000]	[5.950]	[6.050]	[0.76]	[0.61]	[1.02]	[0.76]	[3.18]	[0.61]	[3.18]



**FIG. 1 Grounded Measuring Junction, Style G**



**FIG. 2 Ungrounded Measuring Junction, Style U**

**Comparison Techniques**

**E230/E230M** Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples

**E344** Terminology Relating to Thermometry and Hydrometry

**E585/E585M** Specification for Compacted Mineral-Insulated, Metal-Sheathed, Base Metal Thermocouple Cable

**E780** Test Method for Measuring the Insulation Resistance of Mineral-Insulated, Metal-Sheathed Thermocouples and Mineral-Insulated, Metal-Sheathed Cable at Room Temperature

**E839** Test Methods for Sheathed Thermocouples and Sheathed Thermocouple Cable

**E883** Guide for Reflected-Light Photomicrography

**E1652** Specification for Magnesium Oxide and Aluminum Oxide Powder and Crushable Insulators Used in the Manufacture of Base Metal Thermocouples, Metal-

Sheathed Platinum Resistance Thermometers, and Noble Metal Thermocouples

2.2 *ANSI Standard:*

**B46.1** Surface Texture<sup>4</sup>

2.3 *American Welding Society Standard:*

**A5.9** Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel-Welding Rods and Bare Electrodes<sup>5</sup>

**3. Terminology**

3.1 The definitions given in Terminology **E344** shall apply to this specification.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>5</sup> Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, <http://www.aws.org>.