Designation: E 235 – 88 (Reapproved 1996)ε1

Standard Specification for Thermocouples, Sheathed, Type K, for Nuclear or for Other High-Reliability Applications[1]

This standard is issued under the fixed designation E 235; 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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—Keywords were added editorially in November 1996.

1. Scope

1.1 This specification covers the requirements for sheathed, Type K thermocouples for nuclear 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 specifically to detail requirements for using this type of sheathed thermocouple in nuclear environments. This specification can be used for sheathed thermocouples which are required for laboratory or general commercial applications where the environmental conditions exceed normal service requirements. The intended use of a sheathed thermocouple in a specific nuclear application will require evaluation, by the purchaser, 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. 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 for sheathing, magnesium oxide or aluminum oxide as insulation, and Type K thermocouple wires for thermoelements (see Note 2).

1.2 *General Design*—Nominal sizes of the finished thermocouples shall be 0.0400 in. (1.016 mm), 0.0625 in. (1.588 mm), 0.1875 in. (4.763 mm), 0.125 in. (3.175 mm), or 0.250 in. (6.350 mm). Sheath dimensions and tolerances for each nominal size shall be in accordance with Table 1. The classes of thermocouples covered by this specification are as follows:

1.2.1 *Class 1*—Measuring junction grounded to sheath, and

1.2.2 *Class 2*—Measuring junction not grounded to sheath (insulated junction).

1.2.3 See Figs. 1 and 2 and Tables 1-3 for details.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels[2]

A 632 Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service[3]

E 2 Methods of Preparation of Micrographs of Metals and Alloys (Including Recommended Practice for Photography as Applied to Metallography)[4]

E 3 Methods of Preparation of Metallographic Specimens[5]

E 45 Test Methods for Determining the Inclusion Content of Steel[5]

E 94 Guide for Radiographic Testing[6]

E 112 Test Methods for Determining the Average Grain Size[5]

E 142 Method for Controlling Quality of Radiographic Testing[6]

E 165 Test Method for Liquid Penetrant Examination[6]

E 220 Test Method for Calibration of Thermocouples by Comparison Techniques[7]

E 230 Specification for Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples[7]

E 344 Terminology Relating to Thermometry and Hydrometry[7]

E 839 Test Methods for Sheathed Thermocouples and Sheathed Thermocouple Material[7]

2.2 *ANSI Standard:*

B46.1 Surface Texture[8]

[1] This specification is under the jurisdiction of ASTM Committee E-20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.04 on Thermocouples.

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

[4] Discontinued, see 1982 *Annual Book of ASTM Standards*, Part 11.

[5] *Annual Book of ASTM Standards*, Vol 03.01.

[6] *Annual Book of ASTM Standards*, Vol 03.03.

[7] *Annual Book of ASTM Standards*, Vol 14.03.

[8] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

TABLE 1 Dimensions for Class 1 and 2 Measuring Junctions

Sheath Outside Diameter, *A*			Minimum Sheath Wall, *B*	Minimum Insulation Thickness, *C*	Minimum Wire Diameter, *D*	*E*, Tolerance		*F*, 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									
1.016	0.991	1.054	0.15	0.10	0.13	0.15	0.51	0.10	0.53
1.588	1.562	1.626	0.23	0.13	0.25	0.23	0.81	0.13	0.81
3.175	3.150	3.213	0.30	0.30	0.51	0.30	1.57	0.30	1.60
4.763	4.737	4.801	0.51	0.56	0.79	0.51	2.36	0.56	2.41
6.350	6.299	6.401	0.76	0.61	1.02	0.76	3.18	0.61	3.18

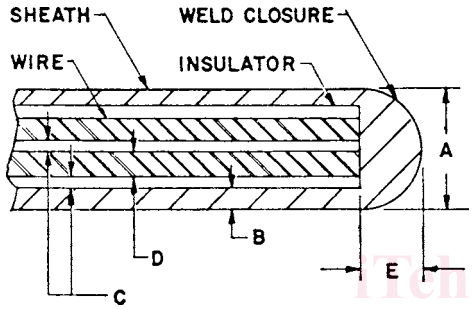

FIG. 1 Grounded Measuring Junction, Class 1

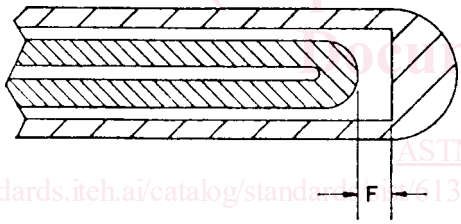

FIG. 2 Insulated (Ungrounded) Measuring Junction, Class 2

2.3 *American Welding Society Standard:*

A59 Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel-Welding Rods and Bare Electrodes[9]

3. Terminology

3.1 The definitions given in Terminology E 344E 344 shall apply to this specification.

4. Ordering Information and Basis of Purchase

4.1 The purchase order documents shall specify the following information:

4.1.1 The quantity, length, and nominal size of the sheathed thermocouple,

4.1.2 The initial calibration tolerance to be used to replace limits of error if other than standard limits (see Specification E 230E 230),

4.1.3 The type of ceramic insulation required, either alumina ($Al_2 O_3$) or magnesia (MgO),

4.1.4 The type of tubing material and other information required (see 5.1.1),

4.1.5 The class of thermocouple measuring junction,

4.1.6 The type of dye-penetrant inspection procedure to be used, and

4.1.7 Any deviations from this specification or the referenced specifications.

5. Materials and Manufacture

5.1 All materials used shall be in accordance with the following requirements:

5.1.1 *Sheath Materials, Austenitic Stainless Steels*—Austenitic stainless-steel tubing used for thermocouple sheath material shall conform to the requirements given in Specification A 632A 632. The purchaser of the thermocouples shall specify only the name of the material (seamless or welded), grade, optional requirements, test report required, and ASTM designation. The manufacturer of the thermocouples shall specify all other options including the supplementary requirements listed in Specification A 632A 632, except that alcohol shall be used as the cleaning solvent. (See Section 2 of Specification A 632A 632 for ordering requirements.) In addition to the requirements of Specification A 632A 632, the following requirements must be met:

5.1.1.1 The inclusion level of the tubing shall be determined by mounting a 1-in. minimum length of a longitudinal section of the tubing using Test Methods E 45E 45, Microscopical Method A, for examination. The inclusion level shall be less than 3 A through D, thin or heavy.

5.1.1.2 The grain size of the tubing shall be determined by a specimen taken in accordance with Test Methods E 112E 112. Grain size shall not exceed the maximum specified in Table 3 of this standard specification, as determined by the Comparison Procedure of Test Methods E 112E 112.

5.1.1.3 Each lot of tubing used shall be sampled using Practices A 262A 262 as follows. Samples shall be tested by Practice A, and further tested as outlined by Table 1, where screening tests so indicate. Acceptance levels for these tests shall be agreed upon between the purchaser and the producer.

[9] Available from the American Welding Society, 2501 North West 7th St., Miami, Fla. 33125.