

## Standard Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples<sup>1</sup>

This standard is issued under the fixed designation E 230; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

Note—Paragraph 1.1, and Tables 7, 13, 19, 21, and 46 were editorially corrected and the year date changed on Sept. 23, 2003.

### 1. Scope

1.1 This specification contains reference tables (Tables 8–25) that give temperature-electromotive force (emf) relationships for Types B, E, J, K, N, R, S, T, and C thermocouples.<sup>2</sup> These are the thermocouple types most commonly used in industry.

1.2 Also included are lists of standard and special tolerances on initial values of emf versus temperature for thermocouples (Table 1), thermocouple extension wires (Table 2), and compensating extension wires for thermocouples (Table 3).

1.3 Tables 4–5, included herein, give data on insulation color coding for thermocouple and thermocouple extension wires as customarily used in the United States.

1.4 Recommendations regarding upper temperature limits for the thermocouple types referred to in 1.1 are given in Table 6.

1.5 Tables 26–45 give temperature-emf data for single-leg thermoelements referenced to platinum (NIST Pt 67). The tables include values for Types BP, BN, JP, JN, KP (same as EP), KN, NP, NN, TP, and TN (same as EN).

1.6 Tables for Types RP, RN, SP, and SN thermoelements are not included since, nominally, Tables 18–21 represent the thermoelectric properties of Type RP and SP thermoelements referenced to pure platinum. Tables for the individual thermoelements of Type C are not included because materials for Type C thermocouples are normally supplied as matched pairs only.

1.7 Polynomial coefficients that may be used for computation of thermocouple emf as a function of temperature are given in Table 7. Coefficients for the emf of each thermocouple pair as well as for the emf of most individual thermoelements versus platinum are included. Coefficients for type RP and SP thermoelements are not included since they are nominally the same as for the types R and S thermocouples, and coefficients

for type RN or SN relative to the nominally similar Pt-67 would be insignificant. Coefficients for the individual thermoelements of type C are not established.

1.8 Coefficients for sets of inverse polynomials are given in Table 44. These may be used for computing a close approximation of temperature ( $^{\circ}\text{C}$ ) as a function of thermocouple emf. Inverse functions are provided only for thermocouple pairs and are valid only over the emf ranges specified.

1.9 This specification is intended to define the thermoelectric properties of materials that conform to the relationships presented in the tables of this standard and bear the letter designations contained herein. Topics such as ordering information, physical and mechanical properties, workmanship, testing, and marking are not addressed in this specification. The user is referred to specific standards such as Specifications E 235, E 574, E 585, E 608, E 1159, or E 1223, as appropriate, for guidance in these areas.

1.10 The temperature-emf data in this specification are intended for industrial and laboratory use.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

E 235 Specification for Thermocouples, Sheathed, Type K, for Nuclear or for Other High-Reliability Applications<sup>3</sup>

E 574 Specification for Duplex, Base-Metal Thermocouple Wire with Glass Fiber or Silica Fiber Insulation<sup>3</sup>

E 585 Specification for Sheathed Base-Metal Thermocouple Materials<sup>3</sup>

E 608 Specification for Metal-Sheathed Base-Metal Thermocouples<sup>3</sup>

E 1159 Specification for Thermocouple Materials, Platinum-Rhodium Alloys, and Platinum<sup>3</sup>

E 1223 Specification for Type N Thermocouple Wire<sup>3</sup>

#### 2.2 NIST Monograph:

NIST Monograph 175 Temperature-Electromotive Force Reference Functions and Tables for the Letter-Designated Thermocouple Types Based on the ITS-90<sup>4</sup>

<sup>1</sup> These tables are under the jurisdiction of ASTM Committee E20 on Temperature Measurement and are the direct responsibility of Subcommittee E20.04 on Thermocouples.

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<sup>2</sup> These temperature-emf relationships have been revised as required by the international adoption in 1989 of a revised International Temperature Scale (ITS-90).

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 14.03.

<sup>4</sup> Available from National Institute of Standards and Technology, U.S. Department of Commerce, Gaithersburg, MD 20899.