



Standard Test Method for Calibration of Thermocouples By Comparison Techniques¹

This standard is issued under the fixed designation E 220; 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.

1. Scope

1.1 This method describes the principles, apparatus, and procedure for calibrating thermocouples by comparison with a reference thermometer. Calibrations are covered over temperature ranges appropriate to the individual types of thermocouples within an overall range from approximately -195 to 1700 °C (-320 to 3100 °F).

1.2 In general, this method is applicable to unused thermocouples. This method does not apply to used thermocouples due to their potential material inhomogeneity—the effects of which cannot be identified or quantified by standard calibration techniques. Thermocouples with large-diameter thermoelements and sheathed thermocouples may require special care to control thermal conduction losses.

1.3 In this method, all values of temperature are based on the International Temperature Scale of 1990. See Guide E 1594.

1.4 *This standard may involve hazardous materials, operations and equipment. 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 and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- E 1 Specification for ASTM Thermometers²
- E 77 Test Method for Inspection and Verification of Thermometers²
- E 230 Specification for Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples²
- E 344 Terminology Relating to Thermometry and Hydrometry²
- E 452 Test Method for Calibration of Refractory Metal Thermocouples Using a Radiation Thermometer²

E 563 Practice for Preparation and Use of Freezing Point Reference Baths²

E 644 Test Methods for Testing Industrial Resistance Thermometers²

E 988 Standard Temperature-Electromotive Force (EMF) Tables for Tungsten-Rhenium Thermocouples²

E 1129 Specification for Thermocouple Connectors²

E 1594 Guide for Expression of Temperature²

E 1684 Specification for Miniature Thermocouple Connectors²

E 1751 Guide for Temperature Electromotive Force (EMF) Tables for Non-Letter Designated Thermocouple Combinations²

3. Terminology

3.1 *Definitions*—The definitions given in Terminology E 344 shall apply to this test method.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *check standard, n*—a measurement instrument or standard whose repeated results of measurement are used to determine the repeatability of a calibration process and to verify that the results of a calibration processes are statistically consistent with past results.

3.2.2 *isothermal block, n*—a piece of solid material of high thermal conductivity used to promote thermal equilibrium between two or more thermometers.

3.2.3 *reference junction compensation, n*—the adjustment of the indication of a thermocouple such that the adjusted indication is equivalent to the emf or temperature that the thermocouple would indicate if the reference junctions were maintained at 0 °C.

3.2.3.1 *Discussion*—In most cases, the thermocouple indication is adjusted by measuring the temperature of a terminal block where the thermocouple is connected, and then adding to the thermocouple emf an additional emf equal to the emf of the thermocouple reference function evaluated at the temperature of the terminal block. Because the emf-temperature relationship of any actual thermocouple differs slightly from that of the reference function, reference junction compensation typically introduces higher uncertainties compared to the use of a well-prepared ice bath.

3.2.4 *reference junction compensator, n*—a device that implements reference junction compensation.

¹ This method is under the jurisdiction of ASTM Committee E20 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 14.03.