



Standard Guide for Measuring Electromotive Force (emf) Stability of Base-Metal Thermoelement Materials with Time in Air¹

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1. Scope

1.1 This guide provides a method for measuring the emf stability of base-metal thermoelement materials in air referenced to platinum at specified constant elevated temperatures using dual, simultaneous, emf indicators, or using a single emf indicator, with the test and reference emf measured alternately. This test is conducted over a period of weeks.

1.2 A calibrated platinum-rhodium/platinum thermocouple is used as a reference standard to establish the test temperature.

1.3 The useful life of a thermocouple depends on the stability of the emf generated at given temperatures for a required time interval. This method provides a quantitative measure of the stability of individual thermoelements. By combining the results of the positive (P) and negative (N) thermoelements, the stability of a thermocouple comprised of both P and N thermoelements may be obtained. The emf of an individual thermoelement is measured against platinum, which may be the platinum leg of the platinum-rhodium/platinum reference thermocouple, or an additional platinum reference.

NOTE 1—Some thermoelements may show insignificant emf drift while undergoing relatively rapid oxidation. In these cases, failure of the thermoelement may be indicated only by a large rise in the electrical resistance between joined thermoelements, as measured at the reference junctions.

NOTE 2—See ASTM MNL 12 for recommended upper temperature limits in air.²

NOTE 3—This guide is only applicable for initially new thermoelements. Base-metal thermoelements exposed to temperatures above 200°C become thermoelectrically inhomogeneous, and stability testing of inhomogeneous thermoelements will give ambiguous results.

1.4 *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 limitations prior to use.*

¹ This guide 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 *Manual on the Use of Thermocouples in Temperature Measurement: Fourth Edition*, Available from ASTM Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428, www.astm.org.

2. Referenced Documents

2.1 ASTM Standards:³

E220 Test Method for Calibration of Thermocouples By Comparison Techniques

E230 Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples

E344 Terminology Relating to Thermometry and Hydrometry

E563 Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

E1159 Specification for Thermocouple Materials, Platinum-Rhodium Alloys, and Platinum

2.2 Other Referenced Documents

NIST Monograph 175

3. Terminology

3.1 *Definitions*—The definitions given in Terminology E344 shall apply to this guide.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *emf indicator, n*—an instrument that measures the emf and displays the value, for example, a digital voltmeter (DVM).

3.2.2 *emf stability, n*—change in emf (or in equivalent temperature) with time, with the thermocouple junctions held at fixed temperatures and with the thermal profile along the thermoelements held constant.

3.2.3 *half-maximum heated length, n*—the distance between the tip of the temperature sensor and the position along the length of the sensor leads or sheath where the temperature equals the average of the calibration-point and ambient temperatures.

3.2.4 *gradient zone, n*—the section of a thermocouple that is exposed during a measurement to temperatures in the range from $t_{\text{amb}} + 0.1(t_{\text{m}} - t_{\text{amb}})$ to $t_{\text{amb}} + 0.9(t_{\text{m}} - t_{\text{amb}})$, where t_{amb} is ambient temperature and t_{m} is the temperature of the measuring junction.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.