



Designation: E 710 – 86 (Reapproved 1997)

Standard Test Method for Comparing EMF Stabilities of Base-Metal Thermoelements in Air Using Dual, Simultaneous, Thermal-EMF Indicators¹

This standard is issued under the fixed designation E 710; 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 test method provides tests to compare the emf stabilities of base-metal thermoelements using dual, simultaneous, thermal-emf indicators. The tests are conducted in air at a specified constant temperature, and the emfs of the base-metal thermoelements are measured against a platinum thermoelement. Thus, the method also yields the time-dependent change of the emf of a base-metal thermoelement relative to a platinum thermoelement. The total life (time to open circuit) of the thermoelement can be determined by the method, if desired.

1.2 *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.*

2. Referenced Documents

2.1 ASTM Standards:

- E 220 Test Method for Calibration of Thermocouples by Comparison Techniques²
- E 230 Specification and Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples²
- E 344 Terminology Relating to Thermometry and Hydrometry²
- E 563 Practice for Preparation and Use of Freezing Point Reference Baths³

3. Terminology

3.1 *Definitions*—The definitions given in Terminology E 344 shall apply.

3.2 *Definition of Term Specific to This Standard:*

¹ This test method 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 14.03.

³ Discontinued; see 1994 Annual Book of ASTM Standards, Vol 14.03.

3.2.1 *emf stability*—The change in output expressed in millivolts (or in equivalent degrees if the thermoelectric power is known) occurring over a specified time at a specified temperature.

4. Summary of Test Method

4.1 In this test method, dual, thermal-emf indicators are used to measure simultaneously the emf E_1 of a thermocouple used to measure the test temperature and the emf E_2 of a base-metal thermoelement relative to a platinum thermoelement. The test method consists of the measurement of E_2 at specified time intervals and at a specified constant value of E_1 , which corresponds to a specified, constant indicated temperature, until the required time of the test is exceeded or until an open circuit in the base-metal thermoelement results. Because all the measurements are made at the same indicated test temperature (E_2 is measured at a specified constant value of E_1), temperature corrections to E_2 are not needed.

4.2 This test method is based on Method A of Test Method E 220, where the standard thermocouple of Test Method E 220 becomes the thermocouple used to measure the test temperature of this method, and a specified constant temperature replaces the series of measured temperatures of Test Method E 220.

4.3 The accuracy of this test method depends on the emf stability of the platinum thermoelement. If there is concern that the platinum thermoelement has become unstable, the procedure described in Appendix X1 shall be performed.

5. Significance and Use

5.1 This test method is important because the accuracy of the temperature measurement is related to the emf stability of the thermoelements.

5.2 This test method is used primarily by users of thermocouples to verify that they meet the intended requirements.

5.3 This test method is useful in comparing the emf stability of two base metal thermoelements using dual thermal emf indicators.

5.4 The relative stabilities of base metal thermoelements determined by this test method are valid only under the specified test conditions and would be affected by changes in

the following conditions: (1) temperature profile or gradient along the length of the thermoelements; (2) abundance, velocity and composition of the air surrounding the test pieces; (3) relative inhomogeneity of the test thermoelements; (4) purity level of the platinum thermoelement.

5.5 The test method does not include the determination of the stabilities of base metal thermoelements following changes from one constant temperature to another.

6. Apparatus

6.1 *Test Temperature Medium*—The test shall be conducted in an electrically heated tube furnace such as described in Sections A1.1 and A1.2 of Test Method E 220. The furnace employed shall have the following capabilities:

6.1.1 The furnace tube shall be long enough to permit a depth of immersion of the thermocouple measuring junctions that is sufficient to assure that the temperature of the measuring junctions is not affected by temperature gradients along the thermoelements.

6.1.2 Means shall be provided to control the temperature of the furnace to within $\pm 10^{\circ}\text{C}$ ($\pm 18^{\circ}\text{F}$) of the test temperature during the performance of the test.

6.2 *Thermocouple Used to Measure the Test Temperature*—A calibrated platinum 10 % rhodium/platinum (Type S), or a platinum—13% rhodium/platinum (Type R) thermocouple of 24-gage (0.511-mm) wire shall be used to measure the test temperature. The limit of error of this thermocouple shall be the same as given in Table 1 of Specification E 230 for a Type S or R thermocouple. The length of this thermocouple shall exceed that of the test specimen to prevent the transfer of heat from the measuring junction to the reference junction during testing.

6.3 *Platinum Thermoelement*—The emf of the test thermoelements shall be measured relative to a 24-gage (0.511-mm) platinum wire. This wire may be the platinum wire of the Type S or R temperature-measurement thermocouple or a second 24-gage (0.511-mm) platinum wire. The length of this wire shall exceed that of the test specimen to prevent the transfer of heat from the measuring junction to the reference junction during testing.

6.4 *Reference Junction*—The reference junction ends of the test specimens, the thermocouple used to measure the test temperature, and the platinum reference wire, if used, shall be maintained at a known constant temperature whenever emf measurements are being made. The limit of error attributable to the reference junction temperature shall be less than $\pm 0.1^{\circ}\text{C}$. Ice point reference junction baths provide a relatively simple and reliable means of maintaining the reference junctions at 0°C (32°F) when proper precautions are exercised in their use. Ice point reference junction baths are described in Practice E 563, and an acceptable method for utilizing the ice point as a reference junction bath is given in A1.3 of Test Method E 220.

6.5 *Thermal EMF Indicators*—The emf measurements required by this test method shall be made using two identical emf indicators. These instruments shall have a limit of error of less than $1\text{ }\mu\text{V}$ at $1000\text{ }\mu\text{V}$ and $12\text{ }\mu\text{V}$ at $50\text{ }000\text{ }\mu\text{V}$ and a resolution of at least $1\text{ }\mu\text{V}$. The emf indicators may be potentiometers, digital voltmeters, or analog-to-digital converters. Paragraph 4.4 of Test Method E 220 may be consulted for further discussions of thermal emf indicators.

6.5.1 Each potentiometer is provided with a reflecting, light-beam galvanometer. The spots of light are reflected from the galvanometers onto a common scale (Fig. 1), and the

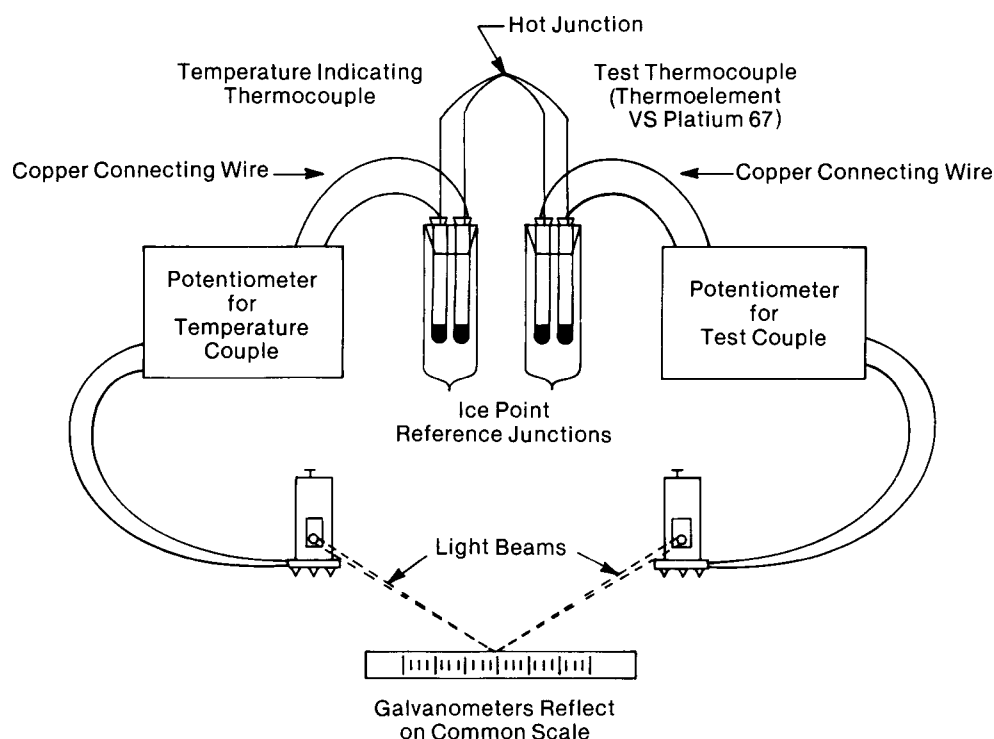


FIG. 1 Schematic Arrangement for Two-Potentiometer Methods with a Single Test Thermoelement