



Standard Guide for Thermocouple Verification¹

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NOTE- Balloted and approved Figures X2.1, X2.2, X2.3, and Tables X3.1 and X3.2 have been included in the standard and the year date was changed on October 7, 2014.

INTRODUCTION

A thermocouple should be periodically verified (tested for compliance with specifications) to ensure that it has not incurred physical, metallurgical, or chemical changes that inhibit or prevent temperature measurements with acceptable accuracy. Unlike many other sensors, the signal generated by a thermocouple depends on the physical and chemical state of the region of the thermocouple wires or thermoelements where temperature gradients exist rather than the state of the measuring junction. Physical or chemical degradation of the thermocouple along only part of its length results in thermocouple inhomogeneity. Such inhomogeneity causes the measured temperature to depend on the intermediate thermal environment between the measuring and reference junctions of the thermocouple. If a thermocouple becomes more inhomogeneous with time, the temperature measured by that thermocouple may appear to drift from its original value, even though the actual temperature it is measuring is constant. If the intermediate thermal environment during use is different from that during calibration, the temperature measurement of an inhomogeneous thermocouple will be inaccurate. Thermocouples used in a harsh environment often become progressively more inhomogeneous; for such thermocouples it is particularly important to make periodic tests of their performance. In addition, a thermocouple becomes unreliable if it undergoes certain other physical changes. It will not measure properly if its wires or the measuring junction are broken or if its thermoelements are in electrical contact in a location other than the measuring junction. Metal-sheathed thermocouples will perform unreliably if there is excessive electrical leakage between the sheath and the thermocouple wire; this can occur if holes have developed in the sheath or the seal of the end closure develops a leak. Periodic tests can check for these undesirable changes, allowing the user to know whether the performance of the thermocouple can be trusted. These tests are particularly important before the calibration of a thermocouple, because they determine whether the thermocouple's performance is worthy of the effort and expense of calibration.

1. Scope

1.1 This guide describes tests that may be applied to new or previously used thermocouples for the purpose of verification. Some of the tests perform a suitable verification by themselves, but many tests merely alert the user to serious problems if the thermocouple fails the test. Some of the tests examine inhomogeneity and others detect wire or measuring-junction breakage. For Style U mineral-insulated metal-sheathed (MIMS) thermocouples with ungrounded measuring junctions, this guide includes tests that examine the electrical isolation of the sheath as well as sheath deterioration.

1.2 The first set of tests involves measurement verifications designed to be performed while the thermocouple is in its

usage environment. The second set is composed of electrical tests and visual inspections designed to evaluate the functionality of the thermocouple; these tests may be performed either in house or in a calibration laboratory. The third set is made up of homogeneity tests designed to be performed in a calibration laboratory. Some of the tests provide simple methods to identify some, but not all, defective thermocouples, and alone do not suffice to verify a used thermocouple. They may need to be complemented by other tests for a complete verification.

1.3 The reader of this guide should decide which of the described tests need to be performed. This decision is dependent on whether the reader uses thermocouples for temperature measurement or performs thermocouple calibrations in a laboratory. For users of thermocouples, it is recommended that appropriate tests from the first and second sets be performed initially, as they provide immediate on-site verification of the thermocouples. The appropriateness of a test is dependent upon the user's temperature measurement uncertainty requirements. Some tests may have lower uncertainties in their verification

¹ This practice 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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