JMS SOUTHEAST, INCORPORATED
Temperature Measurement
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## Calibrating Thermocouples

JMS Southeast Inc. recommends the following method to assure a correct measurement of temperature, with a thermocouple, in an industrial process:
Use a pristine calibrated thermocouple of the same diameter, length and connection as the thermocouple under question. Take the measurement with a portable calibrated measuring device. If the difference between the two readings is unacceptable, leave the pristine thermocouple in the process and order a new one (or twenty) from JMS for the next time you need to check. If unused and kept in a dry environment, these sensors may be stored indefinitely.
This is a very simple method and complies with the recommendations of the ASTM manual "The Use of Thermocouples in Temperature Measurement" *(Section 8.3.3 Fixed Installations)*. See attached excerpt.

ASTM Manual On The Use of Thermocouples In Temperature Measurement does not recommend using the method of removing thermocouples sensors from processes and sending them to laboratories for calibrations as a means to verify sensor accuracy. Instead, they recommend inserting calibrated reference probes into the process as a means to validate the in process sensor readings. This method yields real time data that is typically more accurate than sending used probes off to a "foreign" environment (cal-lab) as a means for comparison. This way, essentially all sources of temperature bias are eliminated. (e.g.: stem losses, inhomogeneity in lead wires, insertion depth, etc.)

If thermocouple recalibrations are required, JMS recommends that probes used as comparison probes for in process calibrations, be calibrated once per year to NIST standards.

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Note: For RTDs and new thermocouples, JMS has a complete certified metrology lab and procedures for calibration.

*"8.3.3 Fixed Installations*

After thermocouples have been used for some time at high temperatures, it is difficult, if not impossible, to determine how much the calibrations are in error by removing them from an installation and testing in a laboratory furnace. The thermocouples are usually heterogeneous after such use [*24*] and in such a condition that the emf developed by the thermocouples depends upon the temperature distribution along the wires. If possible, such a thermocouple should be tested under the same conditions and in the same installation in which it is used. Although it is not usually possible to obtain as high a precision by testing the thermocouple in place as is obtained in laboratory tests, the result is far more useful in the sense of being representative of the behavior of the thermocouple [*23*]. The calibration is accomplished by comparing the thermocouple with a reference thermocouple.

In this case, as in the calibration of any thermocouple by comparison methods, the main objective is to bring the measuring junction to the same temperature as that of the thermocouple being tested. One method is to drill a hole in the furnace, flue, etc., at the side of each thermocouple permanently installed, large enough to permit insertion of the reference thermocouples. The hole is kept plugged, except when tests are being made. The reference thermocouple is inserted through this hole to the same depth as the thermocouple being tested with the measuring junction ends of the protecting tubes as close together as possible. Preferably a potentiometer or digital voltmeter should be used to measure the emf of the reference thermocouple.

In many installations the base-metal thermocouple and its protecting tube are mounted inside another protecting tube of iron, fire clay, carborundum, or some other refractory which is permanently cemented or fastened into the furnace wall. Frequently there is room to insert a reference thermocouple in the outer tube alongside of the fixed thermocouple. A third method, much less satisfactory, is to wait until the furnace, flue, etc., have reached a constant temperature and make observations with the thermocouple being tested, then remove this thermocouple and insert the reference thermocouple to the same depth.

If desired, comparisons can be made, preferably by either of the first or second methods at several temperatures, and a curve obtained for each permanently installed thermocouple showing the necessary corrections to be applied to its readings. Although testing a thermocouple at one temperature yields some information, it is not safe to assume that the changes in the emf of the thermocouples are proportional to the temperature or to the emf. For example, it has been observed that a thermocouple which had changed in use by the equivalent of 9°C at 315°C (16°F at 599°F) had changed only the equivalent of 6°C at 1100°C (11°F at 2012°F).

It may be thought that the method of calibrating thermocouples under working conditions is unsatisfactory because, in most furnaces used in industrial processes, large


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temperature gradients exist, and there is no certainty that the reference thermocouple is at the same temperature as the thermocouple being tested. This objection, however, is not serious, because if temperature gradients do exist of such a magnitude as to cause much difference in temperature between two similarly mounted thermocouples located close together, the reading of the reference thermocouple represents the temperature of the fixed thermocouple as closely as the temperature of the latter represents that of the furnace.

Another advantage of calibrating thermocouples in the same installation in which they are used is that the thermocouple, extension wires, and indicator are tested as a unit and under the conditions of use."

*Excerpt from ASTM Manual On The Use of Thermocouples In Temperature Measurement. Fourth Edition. Section 8.3.3 (pages 156-158).*


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