

Thermocouples provide information that permits the control of temperature necessary for aerospace and medical thermal processing. The AMS2750E specification provides the requirements to assure the accuracy of this information.

How does it work?

Thermocouples work because of a property of metals called the thermo-electric effect or Seebeck effect.

A wire that is hotter at one end will have a voltage difference between the two ends. If we take two different metal wires, we can measure a difference in the voltages and convert that measurement into a temperature difference between the hot end and the cold. If we know the temperature at the cold end, we now know the temperature where the wires join.

How are they classified?

Thermocouples are classified based on the chemical composition of the two wires.

Noble metal thermocouples (commonly Types B, R or S) have wires containing platinum or platinum-rhodium. Base metal thermocouples (commonly Types E, J, K, N and T) do not contain platinum or

platinum-rhodium. Noble metal thermocouples are more resistant to exposure to temperatures and atmospheres, but are also significantly more expensive.

Thermocouples are further classified based on their insulation. The insulation protects the wires from contact with each other, as well as from the atmosphere. The two wires can only be allowed to touch at the measurement tip or a false reading will result. Expendable thermocouples are those where each wire is individually wrapped with an insulator and the pair of wires then over-wrapped. Non-expendable thermocouples are those of any other configuration.

What are they used for?

Requirements for calibration frequency and accuracy and for usage limits are found in Table 1 and Figure 1 and are determined by the application. Standard thermocouples are those used for calibration. Test thermocouples are those of which are used for System Accuracy Tests (SAT) and for Temperature Uniformity Surveys (TUS). Working (or System) thermocouples are those which control, monitor, and record temperature. Load thermocouples are those in contact with the actual parts or raw material being processed to provide actual metal temperature rather than that of the furnace atmosphere.

How does calibration work?

Calibration means comparing the thermocouples being checked against the known standard thermocouple. The result is a table of correction factor which tells the difference between the reading of the thermocouple being tested and the true temperature. That difference is called the error, and the opposite sign value is called the correction factor. Adding the correction factor to the measured reading gives the true temperature. AMS2750E requires the use of these correction factors during System Accuracy Testing and Temperature Uniformity Surveys.

AMS2750E is very specific on the content of thermocouple calibration certificates. The temperature points can be no more than 250°F (140°C) apart except when fixed point calibration is used. The calibration points must cover the entire range over which the thermocouples are to be used. No set point lower than the minimum calibration temperature or higher than the maximum calibration temperature is allowed. There must be traceability back to the National Institute of Standards and Technology (or appropriate national standards body).

Calibration frequency and usage limitations are specified in Table 1 and Figure 1. Thermal exposure causes drift, meaning changes in response



of thermocouples. Thermocouples must be recalibrated or replaced periodically to assure that they still have the required accuracy. AMS2750E sets these maximum time periods. Figure 1 includes requirements for applications where recalibration is not permitted. It specifies usage restrictions as to how long and under what circumstances a thermocouple which cannot be recalibrated can continue to be used.

Resident thermocouples

There are special requirements for resident thermocouples. If an SAT thermocouple stays in place all of the time, it is resident. Resident base metal thermocouples can only be used up to 500°F (260°C), except for Type N. Type N can be used at higher temperature, but must be non-expendable above 1000°F (538°C). Noble metal thermocouples can be used at any temperature, but must also be nonexpendable if used above 1000°F (538°C). In addition, a particular Type cannot be used to check a thermocouple of the same Type and Types R and S are considered too similar and cannot be used to check each other.

Figure 1 includes the U formula. This sets a limit of 30 uses on expendable base metal SAT and TUS thermocouples. If the temperature is below 1200°F (650°C), a thermal cycle counts as one use. If the temperature is 1200 to 1800°F (650 to 980°C), each thermal cycle counts as 2 uses. Only a single use is permitted above 1800°F (980°C).

Load thermocouples

Load thermocouples also have recalibration and usage limits. Noble metal load thermocouples must be recalibrated at least every 6 months. Expendable base metal load thermocouples cannot be recalibrated and are limited to 90 days from first use or 30 uses if used at or below a set point of 1200°F (650°C). They are allowed only a single use if used above 1200°F (650°C). Non-expendable base metal load thermocouples also cannot be recalibrated. They are restricted to a single use at 2300°F (1260°C) or above. At lower temperatures, the calendar time restriction remains at 90 days, but the number of uses depends on the maximum temperature of use. Once a thermocouple is used at a higher temperature, the number is restricted to the total number of allowed uses at that higher range even if later usage is at a lower temperature.

Reuse and recalibration

Requirements on reuse and recalibration also involve thermocouple condition. There must be a process to inspect for the condition of the measuring junction and of the insulation. If there is damage, salvage is possible but repair must involve removing the damage, remaking the junction and recalibration. Any salvage does not zero out prior usage. If, for example, 30 uses are allowed and salvage occurs after 20, therefore, only 10 uses remain. Salvage does not reset the life.

Conclusion

In summary, AMS2750E establishes requirements for control of thermocouples. There are many special cases and exceptions. Careful attention to requirements and detailed record keeping are necessary to ensure compliance. **The [eQualLearn Introduction to Pyrometry](#) course provides a detailed discussion of this subject**, as well as other major subjects of Pyrometry – Instrumentation, Equipment Classification, System Accuracy Testing and Temperature Uniformity Surveys. Learn more about the Introduction to Pyrometry course at www.eQualLearn.com

