Understanding Precision Statements for Standard Reference Materials

Roger Blaine, Ph.D.
TA Instruments, 109 Lukens Drive, New Castle DE 19720, USA

Certified reference materials are accompanied by a Certificate of Measurement that identifies the value for the reference material followed by some indicated range, for example, 154.16 +/- 0.31 °C. The first number in this couplet (the 154.16 °C) represents to best estimate of the true value for the material. It is typically the mean value from an interlaboratory test.

The second number (the +/- 0.31 °C) represents the uncertainty in the best estimate value. You will need to read the certificate closely, but this value typically represents the 95 % confidence level and is twice the standard deviation. The standard deviation has a statistical meaning and estimates the likelihood that the true value for a property is close to the value quoted in the first number. Specifically, there is a 63 % likelihood (2 chances in 3) that the true value is within one standard deviation of that value and a 95 % likelihood (19 chances in 20) that the true value is within twice the standard deviation. For the value quoted above, there is a 95 % chance that the true value is within the range of 153.54 and 154.78 with 154.16 °C being the most likely value.

Users often ask, “How close should my instrument measurement be to the quoted value for the reference material to consider it to be within calibration?” It is sometimes erroneously thought that the instrument calibration should fall within the range quoted in the reference material Certification of Measurement. This is not correct. The best place to obtain information on how close to the mean one should be is from the precision and bias statement associated with the ASTM International standard for calibration of the indicated signal. Such standards provide “real world” estimates based upon interlaboratory testing.

The mean value and standard deviation are generated by means of a large number of individual tests and so the values have statistical meaning. When performing a calibration, the number of actual experiments is much smaller. Based upon statistics (which will not be covered here) the acceptability window for calibration is typically taken to be 2.8 times the within laboratory repeatability standard deviation. In the ASTM standards this concept typically reads, “Based upon an interlaboratory study, the repeatability standard deviation of results is estimated to be 0.48 °C. Two such results should be considered suspect (at the 95 % confidence level) if they differ by 2.8 times the standard deviation or 1.3 °C.

When working with reference materials, there are two other words that are commonly used. One of these is “certified”. When used with reference materials, the word ”certified” typically means that the value of interest has been tested in some formal of test program and that a signed document is provided with the reference material that attests to the validity of the tests results.

The second word is “traceability”. Traceability means that a documented chain of comparisons exists connecting a working reference material to a reference material maintained by a national metrology laboratory such as the United States National Institute for Standards and Technology (NIST) and the British Laboratory of the Government Chemists (LGC).

In summary, the standard deviation found on the reference material certificate is a measure of the uncertainty in the quoted value, not the range over which the user should consider the instrument calibrated. This latter value is provided by the repeatability value provided in the ASTM International standard for the calibration of the desired signal.

KEYWORDS

Reference materials, calibration, precision

TA Instruments

United States, 109 Lukens Drive, New Castle, DE 19720 • Phone: 1-302-427-4000 • Fax: 1-302-427-4001
E-mail: info@tainstruments.com

Spain • Phone: 34-93-600-9300 • Fax: 34-93-325-9896 • E-mail: spain@tainstruments.com

United Kingdom • Phone: 44-1-293-658900 • Fax: 44-1-293-658901 • E-mail: uk@tainstruments.com

Belgium/Luxembourg • Phone: 32-2-706-0080 • Fax: 32-2-706-0081
E-mail: belgium@tainstruments.com

Netherlands • Phone: 31-76-508-7270 • Fax: 31-76-508-7280
E-mail: netherlands@tainstruments.com

Germany • Phone: 49-6023-9647-0 • Fax: 49-6023-96477-7 • E-mail: germany@tainstruments.com

France • Phone: 33-1-304-89460 • Fax: 33-1-304-89451 • E-mail: france@tainstruments.com

Italy • Phone: 39-02-27421-283 • Fax: 39-02-2501-827 • E-mail: italia@tainstruments.com

Sweden/Norway • Phone: 46-8-594-69-200 • Fax: 46-8-594-69-209
E-mail: sweden@tainstruments.com

Japan • Phone: 813 5479 8418 • Fax: 813 5479 7488 • E-mail: nurayama@taij.po-jp.com

Australia • Phone: 613 9553 0813 • Fax: 61 3 9553 0813 • E-mail: steve_shamis@waters.com

To contact your local TA Instruments representative visit our website at www.tainst.com