



Technical Bulletin

North Carolina State Laboratory of Public Health | Laboratory Improvement Unit

LABORATORY THERMOMETERS

Types of Thermometers

The types of thermometers used in the laboratory include partial immersion, total immersion, liquid filled (mercury, spirit filled, or a nontoxic liquid), dial thermometers, and digital thermometers. Partial immersion thermometers have a mark on the stem of the thermometer indicating the length that needs to be inserted or immersed in the object being monitored, e.g. liquid, water bath, or heat block. Total immersion thermometers are considered more accurate than partial immersion because the thermometer is totally immersed in the environment that is being monitored, e.g. refrigerator or freezer, and these thermometers are not affected by external factors.

Mercury Filled Thermometers

Although mercury filled thermometers are accurate, some states outlaw the sale and shipment of mercury filled thermometers and are asking hospitals and laboratories to phase out the use of this type of thermometer. If you are still using a mercury filled thermometer, you must have a mercury spill kit in the lab in case of breakage. Mercury is considered a hazardous waste product and must be disposed of with other hazardous chemical waste.

Types of Certifications

Most all laboratory personnel have heard of the designation, NIST, which stands for National Institute of Standards and Technology, a non-regulatory federal agency under the Department of Commerce. The mission of NIST is to certify and provide standard reference materials or SRMs that can be used to support the traceability of measurements, i.e. reproducibility. A NIST Certified thermometer will come with a NIST Certificate of Calibration and usually a price tag of about \$300 and up!

A NIST Certified thermometer has been tested against reference standards and has performed within a standard accuracy and if not, it was adjusted. It is sold with a NIST certificate and includes an expiration date so the user will know when to have it retested or recalibrated.

A NIST Traceable[®] thermometer means that the thermometer would not have been tested against a NIST standard reference material, but was tested against an item that can be traced back to a NIST standard reference and has a paper trail that leads back to the NIST reference. There are several vendors that sell NIST Traceable[®] thermometers in either a partial or total type of thermometer with liquid filled glass or with digital readouts. A NIST Traceable[®] Certificate will accompany the thermometer and will include an expiration date with the paperwork. The NIST Traceable[®] thermometers have a price tag starting at about \$40 each and are very affordable for laboratories needing accurate thermometers.

Deciding What Type to Purchase

The biggest difference in a NIST Certified and a NIST Traceable[®] is the paperwork that will accompany the thermometer. The end user must decide how important the documentation is for their particular application. When you purchase a NIST Certified thermometer, you are getting a thermometer that has been tested for accuracy and can be used as a reference for testing other thermometers that are not NIST Certified.

The user must also decide whether they need a partial immersion thermometer for use in monitoring a water bath, or a total immersion thermometer for use in monitoring room temperature or a refrigerator or freezer.

Another consideration is the temperature range being monitored and whether the thermometer they will be purchasing is calibrated or certified at that range. Budget is always a concern, and the user should not sacrifice accuracy because of money. All NIST Certified and NIST Traceable[®] thermometers will have a statement about accuracy in their description. For example, a NIST Traceable[®] thermometer may state the range as -50°C to +70°C and will have an accuracy of $\pm 1^\circ\text{C}$. On the other hand a NIST Certified thermometer may state that it is certified at five temperatures with correction factors and tested at 0°C (ice point), assuring the user very accurate measurements.

Yearly Thermometer Check

It is recommended by the Clinical and Laboratory Standards Institute (CLSI) to check or verify all thermometers in use in the laboratory. The annual check requires the user to check a reference or NIST Certified thermometer at 0°C (ice point) each year by immersing the NIST thermometer into a slush bath of distilled water and documenting the reading on a log sheet. Checking the NIST thermometer at the ice point is a sufficient check for verifying other thermometers at temperature readings up to 100°C. After the ice point is verified, the user can verify other thermometers by immersing the NIST thermometer and the "in use" thermometer together in a like environment and recording the reading on a log sheet. It is recommended to test thermometers used in the lab at three different temperatures. For example, a refrigerator thermometer may be used to take daily readings that should fall between a 2-10°C range, so this thermometer would be checked at 0, 5, and 10°C and documented. When performing the yearly checks, it helps to first sort the thermometers according to their function. For example, all refrigerators could be tested together and all incubators could be tested together. Digital thermometers are the exception and only need to be tested at one point, the temperature they are used to monitor. To be CLIA compliant, all records relating to yearly thermometer checks should be kept current and easily accessible.

Problems with Thermometers

Occasionally the user may experience problems when performing the yearly thermometer check. If a thermometer has a greater than 1°C deviation relative to the reference thermometer, it needs to be replaced. Digital thermometers that have a greater than 2°C deviation relative to the reference thermometer should be replaced. Liquid filled column thermometers with breaks in the column should either be discarded or manipulated to try and re-connect the column. Please refer to manufacturer's instructions and recommendations before attempting to re-unite columns. The user should check all thermometers for bubbles, cracks, and separations in the column each time the thermometer is read.

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References:

CLSI GP31-A, Laboratory Instrument Implementation, Verification, and Maintenance; Approved Guideline, April 2009.

NCSLPH "Thermometer Calibration Procedure", revised March 2011.

"What is Traceability?"

<http://www.epa.gov/hg/traceability.htm>, accessed November 14, 2011.

EZ Facts[®] Safety Info Online NIST and ISO Document Number: 194.

<http://www.labsafety.com/refinfo/ezfacts/ezf194.htm>, accessed October 10, 2011.