June 2018 | Vol. 14, Issue 2

Technical Bulletin

North Carolina State Laboratory of Public Health | Laboratory Improvement Unit

Laboratory Thermometers

Thermometers are one of the most common types of equipment in a laboratory, but it is important they are used correctly and periodically checked for accuracy. When purchasing thermometers for your lab, consideration must be given to selecting the correct type of thermometer based on how it will be used. The following provides basic information on appropriately purchasing and using thermometers in the laboratory setting.

Types of Thermometers

There are several different types of thermometers used in the laboratory. These include partial immersion, total immersion, liquid filled, digital and dial thermometers. A partial immersion thermometer has a mark on the stem indicating the length of the thermometer that needs to be inserted or immersed into the object being monitored, such as liquid, a water bath or heat block. Total immersion thermometers are more accurate than partial thermometers since the thermometer is totally immersed in the environment that is being monitored, such as a refrigerator or freezer. Total immersion thermometers are also not affected by external factors.

Mercury Filled Thermometers

Although mercury filled thermometers are accurate, many facilities have opted out of using them since mercury is considered a hazardous waste product. If your facility is still using a mercury filled thermometer, you must have a mercury spill kit available. Mercury must be disposed of the same as other hazardous chemical waste. Most facilities have chosen to use thermometers that are spirit filled or contain other nontoxic liquids rather than a mercury filled thermometer.

Types of Certifications

The National Institute of Standards and Technology (NIST) is a non-regulatory federal agency within 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, for example reproducibility. A NIST Certified thermometer will come with a NIST Certificate of Calibration and a cost starting around $300.

A NIST Certified thermometer has been tested against reference standards and has performed within a standard accuracy. If performance does not meet specifications, it is adjusted to meet the standard. It comes with a NIST certificate and includes an expiration date, so the user will know when it must be retested or recalibrated.

A NIST Traceable® thermometer means that the thermometer has **not** been tested against a NIST standard reference material but has been tested against an item that is traceable back to a NIST standards reference and has paperwork that

references the NIST reference to which it is compared. Several vendors sell NIST Traceable® thermometers in either a partial or total type of thermometer with liquid filled glass or digital readouts. A NIST Traceable® Certificate will come with the thermometer and will have an expiration date on the paperwork. NIST Traceable® thermometers start at about $40.

Deciding What Type to Purchase

The main difference between a NIST Certified thermometer and a NIST Traceable® thermometer is the paperwork that accompanies the thermometer. The user must decide how important the documentation is for their application. When a NIST Certified thermometer is purchased, it 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 consider the environment in which the thermometer will be used. For example, if monitoring a water bath, a partial immersion thermometer is needed. If monitoring a room temperature, refrigerator or freezer, a total immersion thermometer is the appropriate choice. Consideration should also be given to the temperature range that is being monitored, and if the thermometer that is being purchased is calibrated or certified at that range. 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 -50ºC to +70 ºC and will have an accuracy of ± 1 ºC. A NIST Certified thermometer may state that it is certified at five temperatures with correction factors and tested at 0 ºC (ice point), assuring very accurate measurements.

Yearly Thermometer Check

It is recommended by the Clinical and Laboratory Standards Institute (CLSI) that all thermometers used in the lab must be checked or verified annually. The annual check requires the user to check a reference or NIST thermometer at 0 ºC (Ice point) each year by immersing the NIST thermometer into a slush bath of distilled water. The readings must be documented on a log sheet along with any correction factors. Checking the NIST thermometer at the ice point is sufficient for verifying other thermometers at temperature readings up to 100ºC. After the ice point is verified, the user can then verify other thermometers by immersing the NIST thermometer and the "in use" thermometer together in a like environment and recording the temperatures on a log sheet. It is recommended to test the thermometers used at three different temperatures. For example, a refrigerator thermometer may be used to take daily temperatures that are between a 2-10 ºC range, so the thermometer should be checked at 0, 5, and 10 ºC. When performing the yearly checks, it is helpful to sort the thermometers to be checked into categories such as all refrigerator thermometers, and these can all be checked together at the same time. Digital thermometers are the exception and only need to be tested at one point, the temperature for which they are being monitored.

As an alternative to ice point checks, facilities may choose to send thermometers to an authorized calibration service for recalibration or choose to purchase new thermometers when calibration expires. No matter the method chosen, to be CLIA compliant, all records relating to yearly thermometer checks should be kept current and easily accessible.

Problems with Thermometers

Sometimes the user may encounter a problem when performing a yearly thermometer check. If a thermometer has a greater than 1◦C deviation compared to the reference thermometer, it should be replaced. Digital thermometers having greater than a 2 ºC difference compared to the reference thermometer should also be replaced. Liquid filled thermometers with breaks in the column should either be discarded or manipulated to try to re-connect the liquid column. Refer to the manufacturer instructions and recommendations before trying to reunite the column. All thermometers should also be checked for bubbles, cracks, and separations in the column each time the thermometer is read.

Other Suggestions

A few other helpful tips for thermometer use are as follows:

- Facilities need to make sure they record temperatures daily or in some cases, twice a day, according to your SOP.
- Make sure the temperature is in range and if not, adjust the unit. After adjusting, make sure to go back and check the temperature after two to three hours, and record the results.
- Temperature logs need to reflect the correct range for the equipment you are monitoring along with the correct information about the equipment, for example name, serial number, etc.
- Make sure the thermometer being used is the correct temperature range for the equipment.
- Ensure the thermometer is NIST Traceable® or NIST Certified and remember, if your thermometer has bubbles or cracks that can not be fixed, it must be replaced.

References:

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

NCSLPH *"Thermometer Calibration Procedure"*, revised March 2011

Laboratory Thermometers – Technical Bulletin December 2011

Mercury in Your Environment, http://www.epa.gov/hg/traceability.htm, January 2017

Revised by Angie Bradley, MLT (ASCP)
(Original release December 2011 by D. Scarborough)

State of North Carolina • Roy Cooper, Governor
Department of Health and Human Services
Mandy Cohen, MD, MPH, Secretary, Division of Public Health
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