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Standard Operating Procedure for Calibrating, Certifying and Tracing Thermometers

Access to this SOP shall be available within the laboratory for reference purposes; the official copy of this SOP resides on the official Georgia EPD website at <https://epd.georgia.gov/about-us/epd-laboratory-operations>. Printed copies of this SOP will contain a watermark indicating the copy is an uncontrolled copy.

1 Scope and Application

This SOP is a guide for maintaining the integrity of thermometers and temperature recordings by proper calibration and maintaining traceability. Due to the time and effort required to maintain in-house certifications of thermometers, especially digital thermometers, laboratories are encouraged to use “disposable” liquid bearing thermometers instead wherever possible.

2 Definitions

2.1 NIST – National Institute of Standards and Technology.

2.2 Certified Thermometer – A thermometer that has been calibrated by the EPD against an NIST certified thermometer.

3 Requirements

3.1 NIST Calibrated Thermometer

3.1.1 The NIST thermometer should be returned to and recalibrated by the manufacturer every three years.¹

3.2 Liquid Bearing Thermometers

3.2.1 Liquid bearing thermometers, such as mercury or alcohol, must be traceable to NIST calibration and must be verified annually or whenever exposed to temperature extremes.

3.2.2 In lieu of performing annual calibrations of liquid bearing thermometers, certified liquid bearing thermometers may be purchased. Certifications of purchased liquid bearing thermometers expire one year from first use, or on the manufacturer’s stated expiration date, whichever first occurs.

3.3 Infrared Thermometers

3.3.1 Infrared thermometers must be verified every six months over the full range of use and must be traceable to NIST calibration.

3.3.2 In lieu of performing biannual calibrations of infrared thermometers, certified infrared thermometers may be purchased. Certifications of purchased infrared thermometers expire six months after receipt or on the manufacturer’s stated expiration date, whichever first occurs.

3.3.3 Infrared thermometers are checked daily against an ice water bath containing a calibrated

liquid bearing thermometer to ensure accuracy at 0°C (or at a temperature near the typical expected temperature if other than near 0° C). The infrared thermometer must agree with the calibrated thermometer within 0.5° C. If it does not, it must be recalibrated.

3.4 Digital Thermometers

- 3.4.1 Whenever possible, liquid bearing thermometers must be used instead of digital thermometers. If a digital thermometer is attached to a device or instrument and is not to be used, it must be marked with “Not certified for use” or similar verbiage, preferably in such a way as to mask the display to make it unreadable.
- 3.4.2 Digital thermometers, thermocouples and other similar electronic temperature measuring devices must be verified quarterly and must be traceable to NIST calibration.
- 3.4.3 In lieu of performing quarterly calibrations of digital thermometers, certified digital thermometers may be purchased. Certifications of purchased digital thermometers expire 3 months from the date of first use, or on the manufacturer’s stated expiration date, whichever occurs first.
- 3.4.4 Continuous recording devices that are used to monitor incubator or clean room temperatures should be recalibrated at least annually unless specific program requirements dictate otherwise.

4 Procedure

- 4.1 The NIST certified thermometer should never be exposed to temperature extremes. Such exposure would require recertification of the thermometer. Hot and/or cold water from the tap and ice should be sufficient for the calibration of most of the laboratory’s non-“disposable” thermometers.
- 4.2 Examine the thermometer for defects that might affect the accuracy of the device. For example, look for separations in the liquid for liquid bearing thermometers.
- 4.3 Determine the temperature range of use for the thermometer in question. The calibration temperatures should encompass that range and include one temperature near the mid-point of the range.
- 4.4 Prior to calibration of a thermometer, the fields available in the online form should be completed and the form printed². Use the official copy of the form located in S:\APPROVEDFORMS\Certification Form SOP 6-010 SOP for Thermometer Certification and Tracing.DOC. Do not make electronic copies of this form.
- 4.5 Compare and record the temperature reading of NIST thermometer in water or ice to the reading of the thermometer in question at each of the three temperatures determined above.
- 4.6 If the thermometer being calibrated differs from the NIST by more than 1° C for a thermometer with 0.5° to 1° increments, it should be discarded. For thermometers with increments of more than 1° C, the variance should not be more than one increment.
- 4.7 Determine the correction factor for the thermometer being calibrated. If the variance from the NIST thermometer is much different at the top of the temperature range than it is from the bottom of the range, the thermometer in question should be considered suspect and should be discarded.
- 4.7.1 Example: For a temperature range of 33.0° C to 37.0° C, the thermometer being calibrated has readings of 33.1° vs. 33.0° C on the NIST, 35.1° C at the mid-range temperature of 35.0° C on the NIST thermometer and 37.0° C at 37.0° C NIST. The thermometer can be judged to have a 0.1 variance from NIST for half the range or more therefore the correction factor would be –0.1° C. The correction factor is the temperature that must be added (positive correction factor) or subtracted (negative correction factor) from the calibrated thermometer to determine the correct temperature.
- 4.8 See section 5, Record Keeping for guidance concerning documentation and labeling of

thermometers.

5 Record Keeping

- 5.1 Record calibrations on Form SOP 6-010 (see Appendix A for an example of this form and section 5.2 for the online location of this form).
- 5.2 Prior to calibration of a thermometer, the fields available in the online form should be completed and the form printed³. Use the official copy of the form located in S:\APPROVEDFORMS\Certification Form SOP 6-010 SOP for Thermometer Certification and Tracing.DOC. Do not make electronic copies of this form.
- 5.3 Manually enter the appropriate temperatures for the calibrated thermometer, the temperature differences, calibration factor, and expiration date where appropriate. Initial and date the form where indicated. A Supervisor or Manager must also review, initial and date the form before the calibrated thermometer may be put into service.
- 5.4 The forms are to be paginated and stored by laboratory in a 3-ring binder per EPD Laboratory protocols.
- 5.5 Thermometers are labeled and tracked with a unique identifier if there are no manufacturers serial numbers imprinted.
 - 5.5.1 For convenience, an in-house identifier may be assigned that even if there is a serial number associated with the thermometer as long as the in-house identifier can be traced back to the serial number.
 - 5.5.2 The label must include the identifier/serial number, calibration date, expiration date, calibration factor, and must be initialed and dated by the analyst performing the calibration.
 - 5.5.3 "Disposable" thermometers must be similarly labeled if the manufacturer's expiration date exceeds the in-house expiration date (i.e. one year after date of first use).

6 Forms

- 6.1 Appendix A: Certification Form SOP 6-010 SOP for Thermometer Certification and Tracing.DOC.
- 6.2 The file path to the official form is S:\APPROVEDFORMS\Certification Form SOP 6-010 SOP for Thermometer Certification and Tracing.DOC. Available fields are to be filled out prior to printing the form.
- 6.3 Do not make electronic copies of this file. Always use the file located as described above.

7 References

- 7.1 "Laboratory Quality Assurance Plan" Revision 11, September 2018 or later, Georgia Department of Natural Resources, Environmental Protection Division.
- 7.2 "Manual for the Certification of Laboratories Analyzing Drinking Water, 5th edition", EPA 815-R-05-004, January 2005.

Appendix A

Thermometer Certification Form

Analyst Initials: _____

Date: 08/18/2021Laboratory: 1-Organic

NIST Thermometer ID/Serial Number: _____

Expiration Date: _____

Thermometer to Calibrate ID or Serial Number: _____

Type: Liquid Bearing (Hg)

| NIST Temperature | #1 | #2 | #3 | #4 | #5 |
|------------------------------------|-----------|-----------|-----------|-----------|-----------|
| | (____) °C | (____) °C | (____) °C | (____) °C | (____) °C |
| Calibrated Thermometer Temperature | °C | °C | °C | °C | °C |
| Difference (NIST - Calibrated) * | °C | °C | °C | °C | °C |

*Retain minus sign if [NIST – Calibrated] < 0.

Cal Factor: _____ °C

Expiration Date: _____

Analyst Initials/Date: _____ **Supervisor Initials/Date:** _____

¹Georgia Department of Natural Resources, Environmental Protection Division, Laboratory Quality Assurance Plan Section 6.3.2.² Note that some of the fields are drop-down boxes with pick lists of items from which to choose.³ Note that some of the fields are drop-down boxes with pick lists of items from which to choose.