Thermometer Accuracy Check and Use

1. SCOPE AND APPLICATION

1.1. This method is used to ensure that thermometers used in the bioassay laboratory are accurate to ±0.2°C. It is applicable for thermometers used to measure temperatures of aqueous solutions in the range of 0.1°C to 30°C. Typical range of use should be bracketed by a calibration check (verification). Please be aware that SOP LB-035 (which uses the fluke for temperature verification) is presently used to verify accuracy of temperature measuring devices in the Tox Lab. This SOP exists for use in the event the fluke is not available. See note below as well.

2. SUMMARY OF METHOD

2.1. A two-point verification/calibration check is performed by placing a certified thermometer and a thermometer that is to be checked in aqueous solutions that bracket the range of use. The temperatures registered by the checked thermometer are compared to the temperatures registered by the certified thermometer. Thermometers meeting acceptance criteria are labeled and are suitable for use in the bioassay laboratory.

Note: Bureau SOP LB-035 *Calibration of Lab Thermometers Using a Constant Temperature Calibration Bath* can be used to verify calibrations of bioassay laboratory thermometers. All thermometers exceeding a readability range of 10°C - 30°C should have their calibrations verified per SOP LB-035 (ex. oven and autoclave thermometers).

2.2. Calibration verifications shall be performed using a recognized National Metrology Institute traceable reference, such as NIST, when available.

2.2.1. If the temperature measuring device is used over a range of 10°C or less, then a single point verification within the range of use is acceptable.

2.2.2. If the temperature measuring device is used over a range of greater than 10°C, then the verification must bracket the range of use.

3. EQUIPMENT AND SUPPLIES

3.1. Thermometers (electronic and glass) that are to be checked

3.1.1. All thermometers used in the bioassay laboratory are checked annually. The toxicity section uses non-mercury filled glass thermometers for general temperature measurement in incubators, lab spaces, and refrigerators. Digital thermometers are used for measuring bioassay test temperatures.

3.2. Certified Digital thermometer

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3.2.1. If the certified digital thermometer in the Toxicity lab is not available, the certified digital thermometer belonging to the Chemistry Section can be used. Make certain that the certification is current on the thermometer that is used for the check.

3.3. 1 L beaker

3.4. Milk dilution bottle

3.5. Ice cubes

3.6. 500 mL beaker

3.7. Labeling tape

3.8. Tap water

3.9. Black permanent pen or marker

4. ACCURACY CHECK

4.1. Fill the 500-mL beaker and the milk dilution bottle with tap water.

4.1.1. Set the 500-mL beaker aside until needed to allow the tap-water temperature inside to stabilize to near room temperature. Before use (Step 4.8), warm the water to > than the upper range of use of the thermometer being checked.

4.2. Place the milk dilution bottle in the center of the 1 L beaker and surround the milk dilution bottle with ice cubes obtained from the ice machine located in room B-227. Add tap water to the ice in the 1 L beaker to fill the air spaces. Do not allow water added to the beaker to flow into the milk-dilution bottle.

4.2.1. Alternately, water can be chilled in the walk-in freezer or walk-in refrigerator. Small volumes will freeze rapidly in the walk-in freezer.

4.3. Allow 5–10 minutes for the water in the milk dilution bottle to cool to < the lower range of use temperature of the thermometer being used. Check the temperature by placing the certified thermometer probe in the cooled water.

4.3.1. Do not touch the sides or bottom of the milk dilution bottle with the thermometer as it may give a false reading.

4.4. Label the laboratory thermometer being checked with an identification number recorded on a piece of scotch-tape or label-tape. Attach the tape to the end of the thermometer opposite the bulb.

4.4.1. The identification numbers for the laboratory and NIST-certified thermometers are recorded in the *Toxicology Thermometer Calibration Log.*

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4.5. Place the digital thermometer probe or the glass thermometer being checked in the milk dilution bottle. Immerse the thermometer to measure the temperature. Place the probe of the certified thermometer in the milk dilution bottle.

4.5.1. Adjust water level and add ice to the beaker as needed to maintain a temperature of < the lower range of use of the thermometer being used in the milk dilution bottle.

4.5.2. Do not touch the sides or bottom of the milk dilution bottle with the thermometer or the digital thermometer probe as a false reading can occur.

4.5.3. The certified thermometer probe and the thermometer being checked must be placed (probe for digital and to immersion mark for glass) in the water at the same time.

4.6. Allow indicated temperatures (of thermometers in milk dilution bottle) to stabilize.

4.6.1. The temperature reading is stable when it does not change over a period of 20-30 seconds.

4.7. Read thermometers and record results.

4.7.1. Temperatures are recorded in appropriate columns on *Toxicology Thermometer Calibration Log* sheet. The “indicated” temperature is the one read from the laboratory thermometer being checked. The “actual” temperature is the one read from the certified thermometer.

4.8. Place the digital thermometer probe or the glass thermometer being checked (glass thermometer to the immersion mark; probe approximately 5 cm into the liquid) into the 500-mL beaker of warmed tap water. Place the probe of the certified thermometer in the 500-mL beaker of tap water.

4.8.1. Do not touch the sides or bottom of the beaker with the thermometer or the digital thermometer probe.

4.8.2. The certified thermometer probe and the thermometer being checked must be placed in the water at the same time.

4.9. Repeat calibration verification steps 4.6 and 4.7.

4.10. If the “indicated” temperature differs by more than ± 0.2°C from the “actual” temperature in either the ice water or tap water, recycle, or return the thermometer to the manufacturer.

4.10.1. Mercury thermometers are classified as hazardous waste, so **DO NOT PLACE IN TRASH.** Notify the safety officer that you have a thermometer that needs collecting.

If both “indicated” temperatures differ no more than ± 0.2°C from the respective “actual” temperatures, then record both pairs of calibration verification temperatures on the *Toxicology Thermometer Calibration Log* Sheet.

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Example:

0.1˚C @ 0.1˚C	24.8˚C @ 24.9˚C
(indicated vs. actual; ice bath)	(indicated vs. actual; warm room temp)

"Indicated" = thermometer being checked (the non-NIST certified thermometer)
"Actual" = NIST-certified thermometer.

4.11. Attach label tape around the top of the thermometer being checked. Date and initial the tape when thermometer has had its calibration verified. Date and initial the log sheet.

5. MEASUREMENT

5.1. Place checked digital thermometer probe approximately 2-5 cm into the sample or immerse the checked thermometer in the sample. Do not touch sides or bottom of the sample container with the probe or thermometer.

5.1.1. Glass (non-mercuric) or electronic thermometers can be used for temperature measurements. The immersion mark is the line marked around the thermometer indicating the depth at which the thermometer is to be submerged. The farther the ambient air temperature is from the temperature of the sample being measured, the more error is induced by more or less immersion than at calibration verification.

5.2. Allow temperature to stabilize.

5.3. Record temperature indicated by the checked laboratory thermometer on appropriate bioassay bench or calibration log sheet.

5.3.1. Do not correct the temperature based on the calibration verification value. Recorded temperatures are assumed to be correct within ±0.2 °C which is the maximum deviation allowed during calibration for accepting a thermometer for use.

6. DATA ARCHIVAL

6.1. Use a black, waterproof pen for all bench sheets and logbooks.

6.2. Record information in the *Toxicology Thermometer Calibration Log*.

6.3. To correct raw data entries, place a single line through the incorrect or illegible entry, write the corrected entry near the error, date and initial the correction. Do not overwrite entries.

6.3.1. The corrected entry is written as near as possible to the error or in the comment box on the appropriate bench sheet.

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6.3.2. If the correction requires an explanation, write a comment and reference the error with a letter. Initial and date the explanation. Do not attempt to put all information (correction and comments) into a small space.

6.4. Use sequential alphabetical annotation to identify errors and corresponding comments (i.e. use "A" for first error and use "A" for corresponding explanatory comment; use "B" for second error and "B" for corresponding explanatory comment, etc.).

7. QUALITY CONTROL

7.1. Refer to the Laboratory Quality Manual for corrective action and handling out-of-control data.

8. SAFETY/HAZARDOUS WASTE MANAGEMENT

8.1. Proper laboratory protection, including lab hood or ventilation system, lab coat, gloves, and safety glasses, is required when working with chemicals and unprocessed samples.

8.2. Refer to Laboratory Quality Manual for sample disposal https://floridadep.gov/dear/florida-dep-laboratory/content/dep-laboratory-quality-assurance-manual-and-sops

8.3. Refer to the Laboratory Health and Safety Manual and Hazardous Waste Management https://www.floridadep.net/resources/health-safety-manual

9. REFERENCES

9.1. Standard Methods for the Examination of Water and Wastewater 20th Ed. Section 2550 B.

9.2. SOP LB-035 *Calibration of Lab Thermometers Using a Constant Temperature Calibration Bath*

APPENDIX OF CHANGES

01/02/2008 Added *Scope and Application*; *Summary of Method*; and *Appendix of Changes*. Calibration Step 8 comment replaced "milk dilution bottle" with "beaker."

12/03/2008 Added "the certification certificate has not expired or" to Materials # 2 comment. Replaced *error* with *deviation* and *0.1* with *0.2* in *Measurement* Step 3 comment. Added *Reference* Section.

12/02/2009 Replaced "Vinyl gloves can be substituted for individuals allergic to latex" with "CAUTION Individuals allergic to latex should not use latex gloves. A suitable substitute should be found and used" in the Safety section.

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12/02/2009 Added “Do not allow water added to the beaker to flow into the milk-dilution bottle” to Step 2 of Calibration Section. Changed 4 to 6 in Step 3 of Calibration Section. Added “Glass (non-mercuric) or electronic thermometers can be used for temperature measurements” to Comment for Step 1 of Measurement section.

10/21/2010 Added (glass or electronic) to Materials #1. Deleted ‘was submerged when checked. The farther the ambient air temperature is from the temperature of the sample being measured, the greater the error is induced by more or less immersion than at calibration’ from the Comment for Step 1 of Measurement section and added ‘is to be submerged’ to the comment. Deleted ‘mercury’ from Calibration Step 4.

02/08/2011 Reflected change to digital thermometers for toxicity tests and changed ‘calibrated’ to ‘checked’.

02/01/2012 Added ‘single line’ to Documentation Step #2. Corrected name of calibration logbook.

12/16/2013 Reformatted SOP.

01/30/2015 Formatted for 508 compliance.

11/05/2015 Updated links. Modified SOP to bracket range of use. Added comments to use SOP LB-035.

11/30/2016 Updated links.

10/09/2018 Updated links.

10/02/2019 Updated 4.11, took out part that says to write temperatures on label tape.

10/15/2020 Updated links. Updated data archival section with universal language.

10/12/2021 Update for universal language and check for proper grammar.

10/7/2022 Updated links. Changes references to ‘calibration’ to ‘verification’ or ‘verification calibration’, as necessary.

10/12/2023 Replaced references to “NBS” to “NIST”. Added detail to the examples for the ‘indicated vs. actual’. Struck detailed language on immersion marks. Added more clarification that SOP LB-035 is the SOP presently used for thermometer verifications.

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