US Environmental Protection Agency
Office of Pesticide Programs

Office of Pesticide Programs
Microbiology Laboratory
Environmental Science Center, Ft. Meade, MD

Standard Operating Procedure for Calibration and Maintenance of Thermometers and Thermometer/Hygrometers

SOP Number: EQ-02-07

Date Revised: 09-26-14

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Title	Calibration and Maintenance of Thermometers and Thermometer/Hygrometers
Scope	Describes thermometers and thermometer/hygrometers in use in the laboratory, calibration requirements, and the procedure to point-check thermometer accuracy.
Application	Thermometers, including digital thermometers, are used to measure the temperature of autoclaves, water baths, incubators, refrigerators, and freezers. Thermometer/hygrometers are used to measure the temperature and humidity of laboratory rooms, incubators, and sample storage areas.

	Approval Date
SOP Developer:	_____ Print Name: _____
SOP Reviewer	_____ Print Name: _____
Quality Assurance Unit	_____ Print Name: _____
Branch Chief	_____ Print Name: _____

Date SOP issued:	
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Date SOP withdrawn:	

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1. **Definitions**	1. ISO = International Organization for Standardization 2. Vendor calibration = calibration by an ISO 17025 accredited vendor. Abbreviations/definitions are provided in the text.
2. **Health and Safety**	1. The only mercury thermometers permitted in the laboratory are those which are coated with teflon. The teflon coating reduces the likelihood that mercury will be spilled in the event that the thermometer is broken. 2. If a teflon-coated mercury in glass thermometer breaks (teflon remains intact), place the thermometer in the chemical waste bin in the fume hood in B209 for disposal. If the integrity of the teflon coating is questionable, call the SHEM manager (or contact security at extension 52800 if SHEM manager cannot be reached) immediately for assistance.
3. **Personnel Qualifications and Training**	Refer to SOP ADM-04, OPP Microbiology Laboratory Training.
4. **Instrument Calibration**	1. See section 11 for thermometers, digital thermometers, and thermometer/hygrometers requiring vendor calibration annually. 2. Calibration certificates/reports must contain the stamp of the accrediting body (e.g., A2LA, NVLAP) and the calibration vendor certificate number.
5. **Sample Handling and Storage**	Not applicable
6. **Quality Control**	For quality control purposes, the required information is documented on the appropriate form(s) (see section 14).
7. **Interferences**	Allow the thermometer to equilibrate with the solutions before taking the temperature reading.
8. **Non-conforming Data**	1. On occasion, thermometers must be discarded (e.g., broken columns, unreasonably large correction factor). Contact the facility Safety, Health, and Environmental Management Program Manager for proper disposal procedures. 2. Procedures will be consistent with SOP ADM-07, Non-Conformance Reports.
9. **Data Management**	1. Completed Point Check Calibration of Laboratory Thermometers Record forms are archived in the Point-Check Calibration of Laboratory Thermometers Record Book. 2. An inventory of thermometers requiring vendor calibration will be maintained electronically (see Sample Inventory of Thermometers Requiring

	Vendor Calibration). After each addition to or deletion from the inventory, a hard copy of the inventory will be filed in the Thermometer and Hygrometer Calibration Certificates notebook. 3. Annual Thermometer Calibration Reports for vendor-calibrated thermometers, including vendor-calibrated digital and liquid in glass thermometers, Kessler maximum registration thermometers, and thermometer/hygrometers, are stored in the Thermometer and Hygrometer Calibration Certificates notebook. 4. Data will be archived consistent with SOP ADM-03, Records and Archives.
10. **Cautions**	1. Thermometers and thermometer/hygrometers requiring vendor calibration (see section 11) are removed from service when the calibration expires (one year from the date of calibration) and are returned to service when recalibration is completed. 2. Thermometers subjected to point-check may be used for one year, at which time the point-check must be repeated. 3. Analysts are not to attempt to clean up any spills of mercury from broken teflon-coated autoclave thermometers. Call the SHEM manager (or contact security at extension 52800 if SHEM manager cannot be reached) immediately for assistance. 4. During the point-check process (section 12.2), the temperature reading on the verification thermometer must be within the range at which the thermometer to be calibrated will be used or is being used (see SOP QC-05, Monitoring Temperatures, for acceptable temperature ranges for equipment).

11. **Special Apparatus and Materials**

Thermometer Type	Use	Annual Vendor Calibration Required	Point Check Required
1. Verification thermometer/Liquid in glass (one thermometer)	Used to verify the accuracy of other liquid in glass thermometers (line #6)	Yes	No*
2. Verification thermometer/Mercury in teflon-coated glass (one Kessler thermometer)	Used to verify the accuracy of other mercury in teflon-coated glass thermometers (line #3)	Yes	No*
3. Kessler maximum registration thermometers/Mercury in teflon-coated glass	Used to verify autoclave temperatures	No	Yes; using thermometer in line #2
4. Digital thermometers	Used periodically to measure temperature of incubators, refrigerators, and freezers	Yes	No*
5. Thermometer/hygrometers	Used to measure temperature and humidity of laboratory rooms, incubators, and sample storage areas	Yes	No*
6. Liquid in glass thermometers	Used to measure the temperature of water baths, incubators, refrigerators, and freezers, including FRIO-Temp	No	Yes; using thermometer in line #1

	<table><tr><td></td><td>precision thermometers</td><td></td><td></td></tr></table> * Point-check of these units is not performed because they are vendor-calibrated annually.
12. **Procedure and Analysis**	
12.1 Annual Vendor Calibration	a. Refer to section 11. b. Before the calibration expires, remove the thermometer from service. c. Consult ISO 17025 accredited vendor regarding quote for service, packing/shipping instructions, and completion of any required forms prior to shipping timers. d. Pack and ship thermometer to vendor. e. Once thermometer has been certified and shipped back to the laboratory, file the certificate/record in the Thermometer and Hygrometer Calibration Certificates notebook, and return the thermometer to service. f. Thermometers that fail the calibration process are replaced.
12.2 Point-Checking Accuracy of Thermometers	a. Once a year, Kessler maximum registration thermometers and water bath thermometers (liquid in glass) are checked at operating temperatures against a similar type verification thermometer (see section 11, #1 and #2). This is the point-check of thermometer accuracy. b. The laboratory utilizes the Environmental Monitoring and Alarm System (EMAS) (see SOP QC-05, Monitoring Environmental Parameters) to collect environmental data electronically for incubators, refrigerators, freezers, laboratories, and sample storage rooms. In the event that EMAS is not working, the appropriate liquid in glass thermometers will be point-checked against a verification liquid in glass thermometer and employed to measure the temperature of incubators, refrigerators, and freezers. i. As an alternative to conducting point-check of liquid in glass thermometers in the event of an EMAS failure, digital thermometers (section 11) may be used to measure the temperature of incubators, refrigerators, and freezers. ii. Thermometer/hygrometers (section 11) may be used to monitor the temperature/humidity of laboratories and sample storage

areas in the event of an EMAS failure.

c. All other liquid in glass thermometers in section 11 (e.g., incubator, refrigerator, freezer thermometers, including FRIO-Temp Precision Thermometers) are point-checked on an as-needed basis, depending upon the functionality of the EMAS.

d. Once a point-check is performed, thermometers may be used for one year before the point-check must be repeated.

e. To point-check the accuracy of the Kessler maximum registration thermometers, place the thermometer to be checked and the verification thermometer (mercury in teflon-coated glass; section 11 #2) side-by-side in one of the laboratory's autoclaves and run a sterilization cycle (e.g., gravity 15 minute cycle).

f. To point-check the accuracy of FRIO-Temp Precision Thermometers, place a flask of de-ionized water or ethanol next to the thermometer in the incubator, refrigerator, or freezer. Place the liquid in glass verification thermometer (section 11 #1) into the flask of de-ionized water or ethanol. Once the de-ionized water or ethanol has reached the temperature of interest, conduct the accuracy check. Neither the FRIO-Temp Precision nor the verification thermometer may rest on the bottom of their respective container/flask.

g. To point-check the accuracy of liquid in glass thermometers other than FRIO-Temp (e.g., water bath thermometers), use a water bathto simultaneously immerse the liquid in glass verification thermometer (section 11 #1) and the thermometer to be calibrated into the water bath at the temperature of interest. Otherwise, point-checks are taken by simultaneous immersion of the thermometers in a flask of deionized water or ethanol and then placing the flask containing both thermometers in the instrument being monitored until the deionized water or ethanol reaches the temperature of interest. Thermometers may not touch the bottom of the flask.

h. Any difference in temperature readings between the verification thermometer and the laboratory thermometer is recorded on the Point-Check Calibration of Laboratory Thermometers Record Form (see 14.0).

i. Add a label displaying the date of calibration and correction factor (even if it is zero), around the top of the corresponding thermometer.

j. When routinely recording temperatures for the laboratory, laboratory equipment, media etc., the observed temperature reading of the thermometer read plus the correction factor for that specific

	thermometer must be recorded. k. Refer to the Point-Check Calibration of Laboratory Thermometers Record Book to determine which thermometers are currently in use in the laboratory.
13. **Data Analysis/ Calculations**	1. The correction factor for the vendor calibrated verification thermometers is determined by the accredited company that performs the calibration verification for this thermometer. Consult the certificate for this value. 2. Digital thermometers and thermometer/hygrometers are indicated to be within tolerance. No correction factor is indicated on the calibration certificates. 3. Point-Check Process: a. The Check Point for both the verification thermometer and the thermometer being calibrated = the reading on the verification thermometer during the point-check process. The Observed Temperature = the temperature reading of a thermometer during the check point process. b. The True Temperature of the verification thermometer = Observed Temperature + Correction Factor indicated on the certificate provided by vendor. See section 13.1. c. Correction Factor for thermometer being point-checked = calculate by subtracting its observed temperature from the true temperature of the verification thermometer. d. The True Temperature of the laboratory thermometer being point-checked = the Observed Temperature + Correction Factor for that thermometer.
14. **Forms and Data Sheets**	Forms are stored separately from the SOP under the following file names: Point-Check Calibration of Laboratory Thermometers Record Form — EQ-02-07_F1.docx Sample Inventory of Thermometers Requiring Vendor Calibration — EQ-02-07_F2.docx
15. **References**	Operation manuals for thermometer/hygrometers are located in file cabinet in D-wing.