

## Standard Operating Procedure (SOP) 3.1.2.1

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### Measurements of Temperature with Bulb and Min-Max Thermometers

This SOP provides instructions for the use of devices that record temperature-dependent change in volume, such as bulb thermometers made with mercury or dyed alcohol solution in a bulb and thin capillary, or U-shaped tube thermometers filled with mercury and equipped with minimum-maximum stopper locks. To facilitate data management, please use thermometers that report the temperature in °C if you can.

**Note: Use of mercury thermometers is being phased out.**

#### Bulb Thermometers

Bulb thermometers come in all kinds, lengths, and shapes, and are usually made of glass (although some thermometers are made of plastic). Many glass thermometers are sold with an “armor” made of a perforated metal or plastic sheath, to protect the delicate glass.

**Step 1:** To measure temperature of a solution with a bulb thermometer, immerse the thermometer in the tested solution.

**Step 2:** Allow a minute or so for equilibration, then read while still immersed in the solution.

**Step 3:** Reporting the data:

- Add or confirm the Instrument ID on the field data sheet
- Make sure that both the temperature value and the unit are recorded

#### Minimum-Maximum Thermometers

U-shaped tube thermometers are usually filled with mercury and have an air reservoir on one end (on the left side for this SOP). Movement of the mercury in the U pushes the minimum or the maximum stoppers up where they remain even after the temperature changes. This happens because the stoppers are made of metal rods, and there is a flat magnet closely behind the tube, so they get stuck. Min-Max thermometers can be used in water or air. They can be deployed over a desired period of time to obtain records of the minimum and the maximum that

had occurred during that deployment period, without having to be present. Unfortunately, they can record only one minimum and one maximum value per one deployment period, and need to be reset manually prior to a subsequent deployment.

**Step 1:** Inspect the device before use, to ensure that there are no air bubbles in the continuum of mercury in the U-shaped tube.

**Step 2:** To reset the thermometer, hold it upright and press the central ridge toward the back – this will push the magnet (that holds the stoppers in place) backwards and release the stoppers. Wait until both stoppers slide down and reach the tops of the mercury columns.

**Step 3:** Deploy the device for the desired period of time at the desired location. Make efforts to deploy in an upright position. Note that the entire device has to be in the ambience of the environment you are recording: it does not have a sensitive point like bulb thermometers or thermistor probes.

**Step 4:** Retrieve the thermometer and read the temperature scales at the following places:

- Current temperature – where the mercury levels are at the time of retrieval (they should be identical on both arms; note that the scale on the left arm is upside-down)
- Minimum temperature – where the bottom of the left-arm stopper is upon retrieval (note that the scale is upside-down)
- Maximum temperature - where the bottom of the right-arm stopper is upon retrieval.

**Step 5:** Record the three values on your data sheet, reporting the data:

- Add placeholders for Minimum and Maximum temperatures on your data sheet, if absent.
- Add or confirm the Instrument ID on the data sheet
- Make sure that both the temperature values and the units are recorded

**Step 6:** Reset the device as in Step 2 to prepare it for the next deployment.

## Monitoring Tips

Bulb thermometers used for environmental monitoring **are different from thermometers used to measure body temperature** in that they do NOT have that tiny twist in the capillary tube (which prevents the mercury from rolling back after removal from the body and requires vigorous shaking of the thermometer before the next measurement). Consequently, the operator of an environmental bulb thermometer, when measuring water temperature, **MUST** read the

temperature **while the bulb is still in water!** The same requirement applies to thermistor probes. This can be made easier by taking some of the creek water into a cup, keeping the thermometer in it and bringing it to eye level for rapid reading. The Kemmerer sampling apparatus provided by LaMotte has a special hole for the thermometer, so that the thermometer remains in the sampling apparatus while filling and retrieving, and can be read directly through the transparent wall of the apparatus immediately after retrieval.

When you measure air temperature, remember that a wet thermometer is "contaminated" in the sense that the water will alter your values. To avoid this, either dry the thermometer thoroughly before measuring air temperature, or dedicate one thermometer for water and a second thermometer for air only - and keep the second one dry at all times (buying two and dedicating may be the only solution if you are using the LaMotte armored thermometers with the blue plastic perforated sheath (i.e., the coating with holes), because there is no way of drying everything inside the armor within the time it takes to hop from one station to the next).

Whether you are using a bulb thermometer or a Minimum-Maximum thermometer, remember:

- never shake the thermometer upside down
- always keep flat or upright, never upside down
- avoid exposure to extreme heat

If you are using one of the older models of Minimum-Maximum thermometers and you **MUST** open the device, do it inside a white bag to catch the tiny spring that **WILL** fly out and which cannot be replaced.

## **Sources and Resources**

This SOP is a part of the guidance compendium created by the Clean Water Team, the Citizen Monitoring Program of the State Water Resources Control Board.