

Why use a triple point of water?

Application Note

Have you heard that primary standards are expensive and complex to use? Have you heard there's an exception to that and it's the triple point of water cell?

There's never been a less expensive, easier-to-use primary standard than the TPW cell. Fluke Calibration cells achieve an expanded uncertainty of 0.0001 °C or better and cost less than \$1,100. There's not a better bargain in the temperature calibration business.

Fixed-points, sometimes called intrinsic standards, are used to define the International Temperature Scale of 1990 (ITS-90). The most commonly used fixed-point is the triple point of water. A triple point of water cell is used to create a thermal equilibrium between the three phases of pure water: liquid, solid and gas. This thermal equilibrium occurs at 273.16 Kelvin, or 0.01 °C.

If you use SPRTs, the triple point of water cell is your most important fixed-point because ITS-90 specifies the interpolation equations of an SPRT based on its resistance ratio stated as $W(t) = R(t)/R(0.01\text{ °C})$, thus requiring you to measure the resistance of your SPRT at the triple point of water frequently. Directly measuring $R(0.01\text{ °C})$ in a triple point of water cell reduces most of the error caused from the instability of an SPRT.

Fluke Calibration's TPW cell is a cylindrical borosilicate glass container filled with water and having a re-entrant tube serving as a thermometer well. The water in the cell is high purity and gas free and has the isotopic composition of seawater. The equilibrium temperature is measured at the liquid-solid interface surrounding the thermometer.

Triple point of water cells are not the only means of achieving a near 0 °C reference temperature. Ice baths are an alternative, and if done properly, produce a temperature of 0.0 °C.

Ice baths are made with chopped-up ice in a dewar flask. The flask should be 36 cm deep and 8 cm in diameter. The outside of the flask should be covered with some type of waterproof tape and then inserted in an appropriate metal sleeve. Shaved ice and distilled water are then added to the flask and allowed to reach a constant temperature.

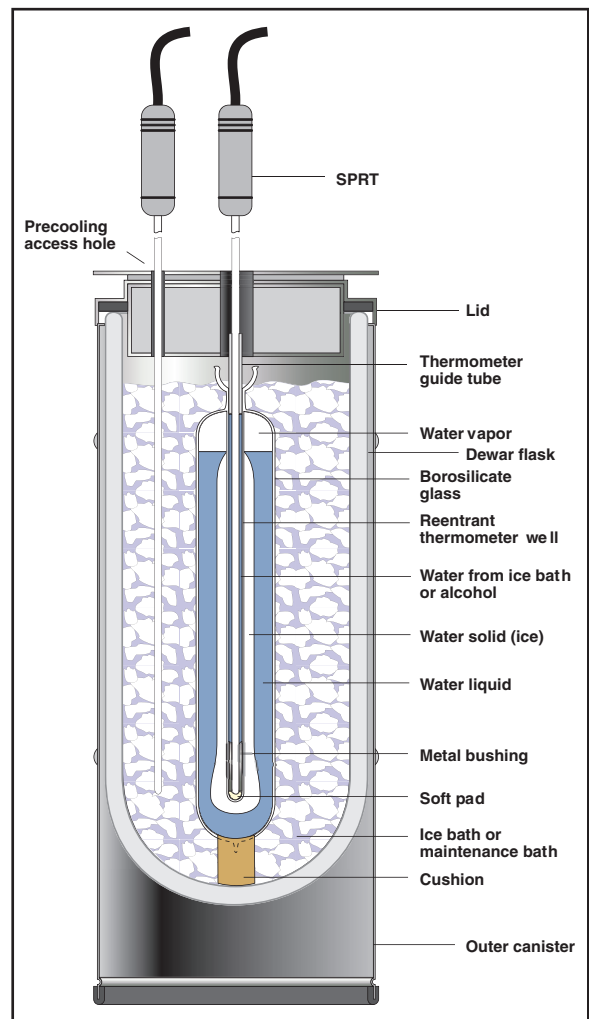
To reduce vertical or radial temperature gradients, distilled water must fill all of the crevices between the ice chips. Ice chips should be 2 to 5 mm in diameter and must be free of contaminants.

As shown from these steps, ice baths are relatively easy to make and inexpensive. Ice baths, however, have several limitations, including gradients throughout the bath, potential purity problems, repeatability issues and variances in individual construction and measurement techniques.

The difficulty of using ice baths led to the inclusion of the triple point of water cell in ITS-90. TPW cells address many of the problems of ice baths. With the high-purity water in a sealed cell, contamination worries are eliminated. The cell operates free of atmospheric pressure and forces proper operator technique for thermal equilibrium to occur.

Cells are delicate and must be handled with care. However, cells are inexpensive and give confidence in measurement accuracy and repeatability. A new cell design with wider openings at the top of the re-entrant tube and a rubber shock absorber on the base make Fluke Calibration water triple point cells more convenient than ever.

Triple point of water cells are fundamental calibration instruments for many labs. Platinum resistance thermometers require the determination of the resistance at 0.01 °C for input into linearization equations. Periodically, the water triple point is used



as a certification check on the thermometers. In general, if the resistance has not changed at the water triple point, the thermometer does not need recalibration.

Fluke Calibration makes several shapes and sizes of TPW cells to suit any preference you might have for design, shape or use. We're the only company that makes this wide variety of cells. We guarantee cell accuracy and quality, and we have a unique insurance program that protects you against breakage.

Fluke Calibration. *Precision, performance, confidence.™*

Electrical	RF	Temperature	Pressure	Flow	Software
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