



Designation: E1750 – 23

## Standard Guide for Use of Water Triple Point Cells<sup>1</sup>

This standard is issued under the fixed designation E1750; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### INTRODUCTION

The triple point of water is an important thermometric fixed point as defined in the International Temperature Scale of 1990 (ITS-90). The ITS-90 assigns a value of 273.16 K to the triple point of water which was exactly equivalent to the thermodynamic temperature in the international System (SI) of units at the time of the adoption of the ITS-90 **(1, 2)**.<sup>2</sup> The triple point of water is the temperature to which the resistance ratios  $W(T) = R(T)/R(273.16 \text{ K})$  of the standard platinum resistance thermometer (SPRT) calibrations are referred to in the ITS-90.

The triple points of various materials (where three distinct phases, for example, their solid, liquid, and vapor phases, coexist in a state of thermal equilibrium) have fixed pressures and temperatures and are highly reproducible. Of the ITS-90 fixed points, six are triple points. The water triple point is one of the most accurately realizable of the defining fixed points of the ITS-90; under the best of conditions, it can be realized with an expanded uncertainty ( $k=2$ ) of less than  $\pm 0.00005 \text{ K}$ . In comparison, it is difficult to prepare and use an ice bath with an expanded uncertainty ( $k=2$ ) of less than  $\pm 0.002 \text{ K}$  **(3)**.

### 1. Scope

1.1 This guide covers the nature of two commercial water triple-point cells (types A and B, see **Fig. 1**) and provides a method for preparing the cell to realize the water triple-point and calibrate thermometers. The qualifications concerning preparation and the types of glass used for a cell are discussed. Tests for assuring the integrity of a qualified cell and of cells yet to be qualified are given. Precautions for handling the cell to avoid breakage are also described.

1.2 The effect of hydrostatic pressure on the temperature of a water triple-point cell is discussed.

1.3 Procedures for adjusting the observed SPRT resistance readings for the effects of self-heating and hydrostatic pressure are described in **Appendix X1** and **Appendix X2**.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.07 on Fundamentals in Thermometry.

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<sup>2</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 ASTM Standards:<sup>3</sup>

E344 Terminology Relating to Thermometry and Hydrometry

E1594 Guide for Expression of Temperature

### 3. Terminology

3.1 *Definitions*—The definitions given in Terminology E344 apply to terms used in this guide.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inner melt, n*—a thin continuous layer of water between the thermometer well and the ice mantle of a water triple-point cell.

3.2.2 *reference temperature, n*—the temperature of a phase equilibrium state of a pure substance at a specified pressure, for example, the assigned temperature of a fixed point.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

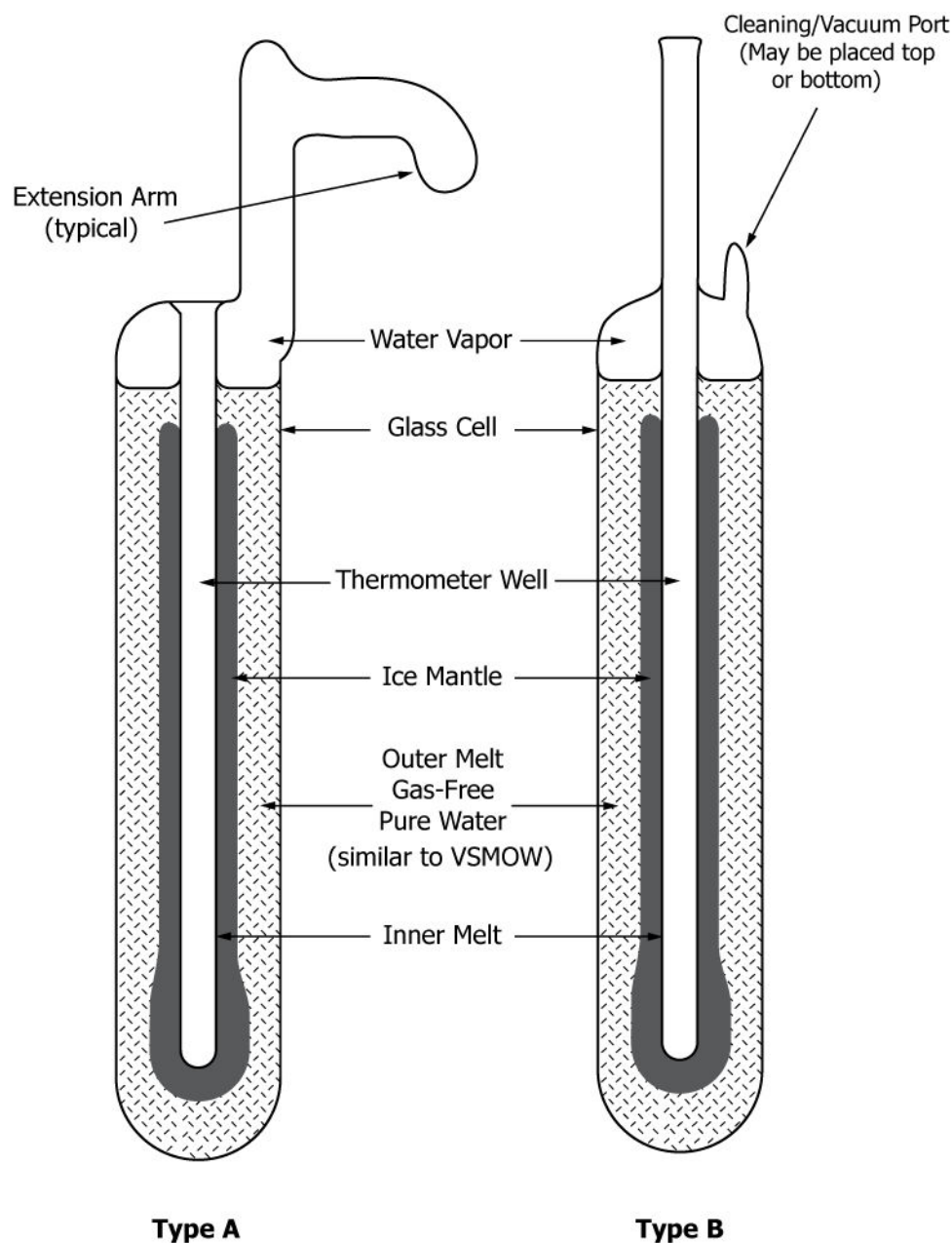


FIG. 1 Configurations of two commonly used triple point of water cells, Type A and Type B, with ice mantle prepared for measurement at the ice/water equilibrium temperature. The cells are used immersed in an ice bath or water bath controlled close to 0.01 °C (see 5.5)

3.2.2.1 *Discussion*—At an equilibrium state of three phases of a substance, that is, at the triple point, both the temperature and pressure are fixed.

#### 4. Significance and Use

4.1 This guide describes a procedure for placing a water triple-point cell in service and for using it as a reference temperature in thermometer calibration.

4.2 The reference temperature attained is that of a fundamental state of pure water, the equilibrium between coexisting solid, liquid, and vapor phases.

4.3 The cell is subject to qualification but not to calibration. The cell may be qualified as capable of representing the fundamental state (see 4.2) by comparison with a bank of similar qualified cells of known history, and it may be so qualified and the qualification documented by its manufacturer.