



Designation: E2251 – 14 (Reapproved 2021)

Standard Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids¹

This standard is issued under the fixed designation E2251; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The purpose of this standard is to specify liquid-in-glass ASTM thermometers using low hazard thermometric liquids defined in this standard.

1.2 This standard specifies liquid-in-glass thermometers graduated in degrees Celsius or degrees Fahrenheit that are frequently identified and used in methods under the jurisdiction of the various technical committees within ASTM. The current approved thermometers are listed in [Table 1](#).

1.3 The technical requirements for the thermometric liquids used in the thermometers in [Table 1](#) are specified in [Annex A1](#). Tests for conformity to the technical requirements are also found in [Annex A1](#).

NOTE 1—It has been found by experience that ASTM Thermometers, although developed in general for specific tests, may also be found suitable for other applications, thus precluding the need for new thermometer specifications differing in only minor features. However, it is suggested that technical committees contact E20.05 before choosing a currently designated thermometer for a new method to be sure the thermometer will be suitable for the intended application.

1.4 For full rationale, see [Appendix X1](#).

1.5 *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.*

1.6 *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.*

¹ This specification is under the jurisdiction of ASTM Committee E20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.05 on Liquid-in-Glass Thermometers and Hydrometers.

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2. Referenced Documents

2.1 *ASTM Standards*:²

E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers

E344 Terminology Relating to Thermometry and Hydrometry

E563 Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

3. Terminology

3.1 *Definitions*—The definitions given in Terminology E344 apply.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *bulb length, n*—the distance from the bottom of the bulb to the junction of the bulb and the stem tubing.

3.2.2 *contraction chamber, n*—an enlargement of the capillary, located below the main scale or between the main scale and the auxiliary scale, that serves to reduce the scale length or to prevent contraction of all the liquid column into the bulb.

3.2.3 *diameter, n*—the largest outside dimension of the glass tubing as measured with a ring gage.

3.2.4 *expansion chamber, n*—an enlargement at the top of the capillary to provide protection against breakage caused by excessive gas pressure.

3.2.5 *faden thermometer, n*—a thermometer with a long, thin bulb used to determine emergent stem temperatures.

3.2.6 *interval error, n*—the deviation of the nominal value of a temperature interval from its true value; either for the total range (total interval) or for a part of the range (partial interval).

3.2.7 *low-hazard liquid, n*—a liquid that is biodegradable, non-hazardous and considered non-toxic in thermometer quantities.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

NOTE 2—It is the responsibility of the manufacturer to determine the suitability of a liquid for this standard. In marking the thermometer with the ASTM designation the manufacturer is confirming that the liquid in the thermometer is non-hazardous as defined by current OSHA (Occupational Safety and Health Administration) standards and non-toxic in thermometer quantities per current definitions of the United States Environmental Protection Agency.

3.2.8 *thermometric liquid, n*—the liquid in a liquid-in-glass thermometer that indicates the value of temperature.

3.2.9 *top of the thermometer, n*—the top of the finished instrument.

3.2.10 *total length, n*—overall length of the finished instrument.

3.3 Other terms may be found in the Terminology sections of Specification E1 and Test Method E77.

4. Specifications

4.1 The individual thermometers shall conform to the detailed specifications given in Table 1, the general requirements specified in Sections 5 – 15, and Annex A1 and Annex A2.

NOTE 3—Thermometers manufactured to previous revisions of this standard shall retain the same ASTM status as those meeting current specifications.

NOTE 4—The encapsulation (jacketing) of the glass of liquid-in-glass thermometers with polyfluorinated hydrocarbons will change their performance and physical characteristics, including, but not limited to, response time, accuracy, and physical dimensions. Therefore, under no circumstances should an encapsulated or otherwise modified ASTM thermometer be used in performing tests that specify the use of an ASTM thermometer.

5. Type

5.1 Each thermometer in Table 1 shall be of the liquid-in-glass type filled with a low hazard thermometric liquid that meets the specifications in Annex A1. The gas filling above the liquid shall be nitrogen or other suitable inert gas. The filling gas shall be chosen to have very low solubility in the thermometric fluid.

6. Stem

6.1 *Stem*—The stem shall be made of suitable thermometer tubing and shall have a plain front and enamel back.

6.2 *Top Finish*—The top of all thermometers specified in Table 1 shall have a plain rounded finish, except the following, which shall have the top finish indicated below. Any special top finish shall be included in the total length of the thermometer.

6.2.1 *Special Finish:*

6.2.1.1 Any finish suitable for assembly in a standard 304.8-mm (12-in.) non-sparking metal armor with open face; in a cup case assembly; or in a flushing case assembly as defined in standards the thermometers are used in:

Thermometers S58C, S58F, S59C, S59F, S130C, S130F

7. Bulb

7.1 The bulb shall be made of glass having a viscosity of at least $10^{14.6}$ poises at 490°C (914°F) and at least $10^{13.4}$ poises at 520°C (968°F).

NOTE 5—Thermometers made with bulb glasses having properties close to these minimum requirements should not be subjected to temperatures above 405°C (760°F) or be continuously exposed to temperatures above 370°C (700°F).

8. Capillary Clearances

8.1 The following distances between graduations and the bulb, and between graduations and enlargements in the capillary, are minimum limits acceptable for thermometers in this standard.

NOTE 6—In order for a thermometer to be usable over its entire graduated range, graduation marks must not be placed too close to any enlargement in the capillary. Insufficient immersion of the thermometric liquid in the main bulb or capillary enlargement, graduation marks placed over parts of the capillary that have been changed by manufacturing operations, or graduations so close to the top of the thermometer that excessive gas pressure results when the thermometric liquid is raised to this level, may lead to appreciable errors.

8.1.1 A 13-mm length of unchanged capillary between the bulb and the immersion line or lowest graduation, if the graduation is not above 100°C (212°F); a 30-mm length if the graduation is above 100°C (212°F).

8.1.2 A 5-mm length of unchanged capillary between an enlargement and the graduation next below, except at the top of the thermometer.

8.1.3 A 10-mm length of unchanged capillary between an enlargement, other than the bulb, and the immersion line or the graduation next above, if the graduation is not above 100°C (212°F); a 30-mm length if the graduation is above 100°C (212°F).

8.1.4 A 10-mm length of unchanged capillary above the highest graduation, if there is an expansion chamber at the top of the thermometer; a 30-mm length if there is no expansion chamber. For the purposes of this requirement, “an expansion chamber” is interpreted as an enlargement at the top end of the capillary bore that shall have a capacity equivalent to not less than 20 mm of unchanged capillary.

8.2 Due to a change in the methods used for scale placement, it is possible to manufacture thermometers that comply with the specifications given in Table 1, but not meet the requirements for capillary clearances given above. In any case, the distances given in this section are the governing factor. Under no circumstances shall the scales on thermometers be placed closer than these minimum distances.

9. Graduations and Inscriptions

9.1 All graduation lines, figures, and letters shall be clearly defined, suitably colored, and permanent. The width and the sharpness of the graduation lines shall be designed in accordance with necessary space between the graduations and the desired accuracy of interpolation. The middle of the graduation line shall be accurately determinable.

9.1.1 A suitably etched thermometer with the etched lines and figures filled with a suitable colorant shall be considered permanently marked provided it passes the test for permanency of pigment in Specification E1.

9.2 *Graduation Lines*—All graduation lines shall be straight, of uniform width, and perpendicular to the axis of the thermometer. The width of the graduation lines shall be as follows:

9.2.1 *Group 1*—Maximum line width 0.10 mm; for thermometers that may read to fractions of a division, often with magnifying aids: