



Designation: E100 – 10

## Standard Specification for ASTM Hydrometers<sup>1</sup>

This standard is issued under the fixed designation E100; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope

1.1 This specification covers glass hydrometers of various scale graduation systems, as required by the ASTM Test Methods in which they are used.

1.2 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

**D287** Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)

**D1250** Guide for Use of the Petroleum Measurement Tables

**D3290** Specification for Bond and Ledger Papers for Permanent Records (Withdrawn 2010)<sup>3</sup>

**E1** Specification for ASTM Liquid-in-Glass Thermometers

**E77** Test Method for Inspection and Verification of Thermometers

**E126** Test Method for Inspection, Calibration, and Verification of ASTM Hydrometers

**E344** Terminology Relating to Thermometry and Hydrometry

**E2251** Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

### 3. Terminology

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

#### 3.2 Definitions of Terms Specific to This Standard:

<sup>1</sup> 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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<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

3.2.1 *ledger paper, n*—a paper characterized by strength, high tearing resistance, eraseability, water resistance, ink receptivity, uniformity of surface, and smoothness.

3.2.1.1 **Discussion**—Originally, ledger paper was used especially for pen and ink records. Most ledger papers are surface sized, frequently subjected to appreciable wear, and shall have a high degree of permanence and durability.

3.2.2 *length of the scale, n*—length of the nominal range in the stem, not including graduations extending above and below the nominal limits.

3.2.3 *relative density (formerly specific gravity), n*—ratio of the mass of a given volume of material at a stated temperature to the mass of an equal volume of gas-free distilled water at the same or different temperature. Both reference temperatures shall be explicitly stated.

3.2.3.1 **Discussion**—Common reference temperatures include 60°F/60°F, 20°C/20°C, 20°C/4°C. The historic term specific gravity may still be found.

3.2.4 *specific gravity, n*—an historic term, replaced by *relative density*.

3.2.4.1 **Discussion**—hydrometers manufactured to this standard may be marked sp. gr., rel. density, or with both designations. The two terms are both equally acceptable in this standard and are used interchangeably.

3.2.5 *thermohydrometer, n*—glass hydrometer having an integral thermometer.

3.2.6 *top of the hydrometer, n*—top of the finished instrument.

3.2.7 *total length, n*—overall length of the finished hydrometer.

### 4. Specifications

4.1 Individual hydrometers shall conform to the detailed specifications in Table 1 and to the general requirements specified in Sections 5–15.

4.2 Hydrometers shall be subjected to the inspection criteria found in Section 16 and the standardization criteria found in Section 17.

4.3 Hydrometers manufactured to previous revisions of this specification shall retain the same ASTM status as those meeting current specifications.

4.4 At the time of purchase, scale errors shall be within the maximum scale error found in Table 1.

## 5. Type

5.1 Hydrometers shall be of the constant-mass, variable-displacement type. Hydrometers shall be made of glass, except for the scale, ballast, and the thermometric liquid of thermohydrometers.

5.2 The outer surface of the stem and body shall be symmetrical about the vertical axis. There shall be no uneven or unnecessary thickening of the walls, and no abrupt changes or constrictions that would hinder thorough cleaning or tend to trap air bubbles when the instrument is immersed.

5.3 The hydrometer shall always float with its axis vertical in liquids for which it is intended.

5.4 The hydrometer shall be thoroughly dry on the inside when sealed. The top of the stem shall be neatly rounded without unnecessary thickening.

5.5 The glass shall be smooth, transparent, and free of bubbles, cracks, strain patterns, or other imperfections that might interfere with the use of the hydrometer. The glass shall adequately resist the reaction of chemical agents to which hydrometers may be exposed and shall have suitable thermal properties to permit its use over the range of temperatures to

which it may be subjected. In general, glasses suitable for constructing the bulbs of thermometers are satisfactory for hydrometers.

5.6 The API hydrometers are intended to be used in conjunction with Test Method D287, hydrometer readings being corrected using Guide D1250, IP 200. Therefore, these hydrometers shall be made of glass having a coefficient of volumetric or cubical expansion of approximately 0.000023/1°C or 0.0000128/1°F at 15.56°C (60°F).

## 6. Body

6.1 The preferred shapes for the bodies of hydrometers are shown in Figs. 1 and 2.

## 7. Ballast

7.1 Material used for ballast shall be secured to the lower part of the body, and no loose material of any sort may be inside a hydrometer. When cement is used to hold the ballast securely in place, this cement shall not soften below 105°C (221°F).

7.2 A solid material, such a shot, may be placed in a small bulb below the main bulb of the hydrometer and then melted or secured by cement.

7.3 If steel shot is used and sealed with wax, the wax shall not soften below 105°C (221°F).

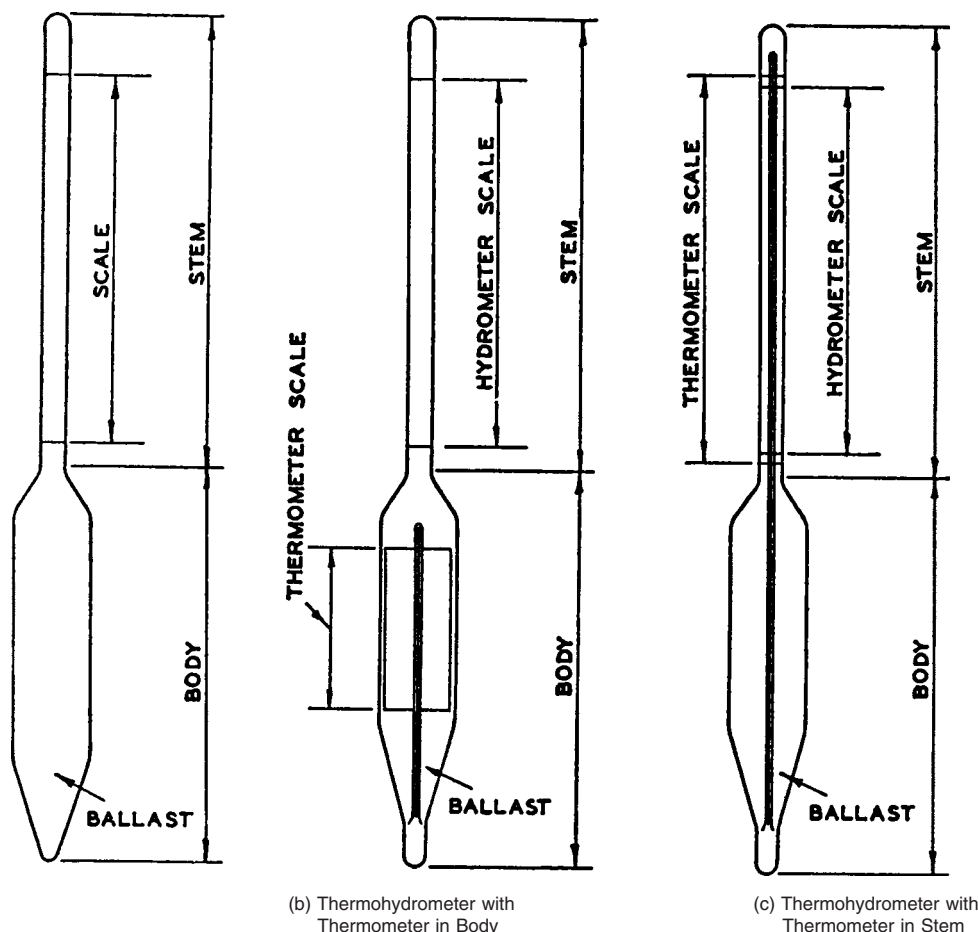


FIG. 1 Typical Hydrometers Designs

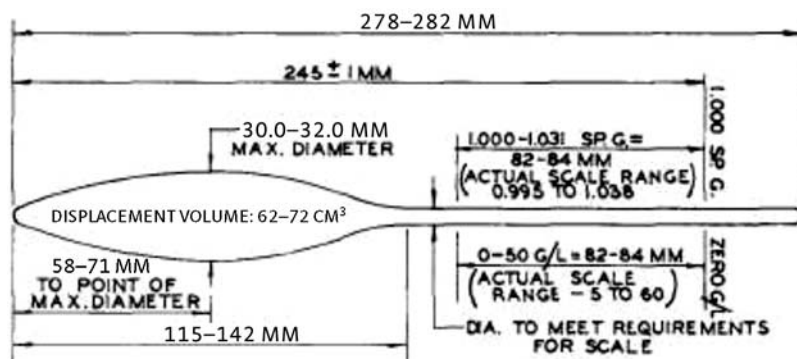


FIG. 2 Soil Hydrometers

7.4 Mercury shall not be used as ballast material in plain form hydrometers.

## 8. Stem

8.1 The stem shall be uniform in cross section, with no perceptible irregularities. It shall extend at least 15 mm above the top graduation and remain cylindrical for at least 3 mm below the lowest graduation.

## 9. Scale

9.1 The material for the scale is not specified. However, if paper is used, it shall only be ledger paper, meeting the specifications in Specification D3290. The scale may be anchored by a design which prevents it from moving; otherwise, it shall be fixed in place with cement that will not soften below 105°C (221°F) and will not deteriorate with time. The paper shall show no evidence of scorching or charring when received or after use at 105°C (221°F). The scale shall be straight and without twist.

## 10. Markings

10.1 Graduation lines and inscriptions shall be in a permanent black marking material, such as India ink.

10.2 All graduation lines shall be straight, fine lines not exceeding one fifth of the graduation interval in thickness, and in no case more than 0.2 mm. The lines shall be perpendicular to the vertical axis of the hydrometer. The lengths of main division lines, subdivision lines, and intermediate lines, if used, shall be so chosen as to facilitate readings. The shortest lines shall be at least 2 mm long.

10.3 All numbers on API hydrometers shall be complete. The numbers for the 0.050 graduation lines on relative density (specific gravity) and density hydrometers shall include the values for the first three decimal places, for example: 0.750, 0.900, 1.100; the other numbered lines may be abbreviated.

10.4 Relative density (specific gravity) hydrometers may be marked sp. gr., rel. density, or with both designations. The two terms are both acceptable in this standard and are used interchangeably.

10.5 For cemented scales, there shall be a permanent reference mark on the stem or on the scale of the hydrometer corresponding to a designated reference mark on the scale.

NOTE 1—An etched mark, visible to the naked eye, on the stem corresponding to the first nominal line on the scale or a red length of glass inside the stem ending at the top nominal line are examples of acceptable means of scale slip indicators.

## 11. Graduation

11.1 All hydrometers shall be graduated to read correctly where the plane of the level liquid surface intersects the stem.

11.2 Hydrometers indicating density shall be graduated to indicate, at the temperature marked on the scale, the density of liquids in kilograms per cubic metre.

11.3 Relative Density (specific gravity) hydrometers shall be graduated to indicate the ratio of the mass of a unit volume of the liquid at the stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature.

11.4 API hydrometers shall be graduated to give degrees of API gravity obtained as follows:

$$\text{API Gravity, deg} = [141.5 / (\text{relative density @ } 60/60^\circ\text{F})] - 131.5(1)$$

11.5 A list of liquids suitable for comparisons of hydrometers is found in Table 2 of Practice E126.

## 12. Thermohydrometers

12.1 The thermometer shall be of the mercury-in-glass type. **Warning**—Mercury has been designated by EPA and many state agencies as a hazardous material that can cause central nervous system, kidney, and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website, <http://www.epa.gov/mercury/faq.htm>, for additional information. Users should be aware that selling mercury or mercury containing products, or both, into your state may be prohibited by state law.

12.2 The capillary stem shall be essentially parallel to the hydrometer axis.

12.3 When the thermometer scale is located in the stem of the hydrometer, the scale shall be in red to distinguish it from the hydrometer scale.

12.4 When the thermometer scale is in the stem, calibration and testing of the thermometer shall be done in the same