



Designation: D648 – 18

Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position¹

This standard is issued under the fixed designation D648; 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.

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

1. Scope*

1.1 This test method covers the determination of the temperature at which an arbitrary deformation occurs when specimens are subjected to an arbitrary set of testing conditions.

1.2 This test method applies to molded and sheet materials available in thicknesses of 3 mm ($\frac{1}{8}$ in.) or greater and which are rigid or semirigid at normal temperature.

NOTE 1—Sheet stock less than 3 mm (0.125 in.) but more than 1 mm (0.040 in.) in thickness may be tested by use of a composite sample having a minimum thickness of 3 mm. The laminae must be of uniform stress distribution. One type of composite specimen has been prepared by cementing the ends of the laminae together and then smoothing the edges with sandpaper. The direction of loading shall be perpendicular to the edges of the individual laminae.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.4 Some older machines still use mercury-in-glass thermometers. (**Warning**—Mercury has been designated by many regulatory agencies as a hazardous material that can cause serious medical issues. Mercury, or its vapor, has been demonstrated to be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury containing products. See the applicable product Safety Data Sheet (SDS) for additional information. Users should be aware that selling mercury and/or mercury containing products into your state or country may be prohibited by law.

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.*

NOTE 2—The text of this standard references notes and footnotes that

¹ This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties.

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provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

NOTE 3—This standard and ISO 75-1 and ISO 75-2 address the same subject matter, but differ in technical content, and results shall not be compared between the two test methods.

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.*

2. Referenced Documents

2.1 ASTM Standards:²

- D618 Practice for Conditioning Plastics for Testing
- D883 Terminology Relating to Plastics
- D4000 Classification System for Specifying Plastic Materials
- D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
- E1 Specification for ASTM Liquid-in-Glass Thermometers
- E77 Test Method for Inspection and Verification of Thermometers
- E608/E608M Specification for Mineral-Insulated, Metal-Sheathed Base Metal Thermocouples
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
- E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

2.2 ISO Standards:³

- ISO 75-1 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Method

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

*A Summary of Changes section appears at the end of this standard

ISO 75-2 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastics and Ebonite

2.3 NIST Document:⁴

NBS Special Publication 250-22

3. Terminology

3.1 *General*—The definitions of plastics used in this test method are in accordance with Terminology D883 unless otherwise indicated.

4. Summary of Test Method

4.1 A bar of rectangular cross section is tested in the edgewise position as a simple beam with the load applied at its center to give maximum fiber stresses of 0.455 MPa (66 psi) or 1.82 MPa (264 psi) (Note 4). The specimen is immersed under load in a heat-transfer medium provided with a means of raising the temperature at $2 \pm 0.2^\circ\text{C}/\text{min}$. The temperature of the medium is measured when the test bar has deflected 0.25 mm (0.010 in.). This temperature is recorded as the deflection temperature under flexural load of the test specimen.

NOTE 4—A round robin has been conducted that showed that there is no advantage to using higher loads when measuring deflection temperature of present-day plastics with present-day instruments.

5. Significance and Use

5.1 This test is particularly suited to control and development work. Data obtained by this test method shall not be used to predict the behavior of plastic materials at elevated temperatures except in applications in which the factors of time, temperature, method of loading, and fiber stress are similar to those specified in this test method. The data are not intended for use in design or predicting endurance at elevated temperatures.

5.2 For many materials, there may be a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Refer to Table 1 in Classification D4000, which lists the ASTM material standards that currently exist.

6. Interferences

6.1 The results of the test are dependent on the rate of heat transfer between the fluid and the specimen and the thermal conductivity of the fluid.

6.2 The results of this test are dependent on the measured width and depth of the specimen and the final deflection at which the deflection temperature is determined.

6.3 The type of mold and the molding process used to produce test specimens affects the results obtained in this test. Molding conditions shall be in accordance with the standard for that material or shall be agreed upon by the cooperating laboratories.

6.4 Results of testing are affected by the design of the test equipment. The test span (either 100 mm or 101.6 mm) will influence the resultant measurement. Instrumentation equipped with metal clips or other types of auxiliary supports designed to maintain specimens perpendicular to the applied load will affect the test results if the pressure is sufficient to restrict the downward motion of the specimen at its center.

7. Apparatus

7.1 The apparatus shall be constructed essentially as shown in Fig. 1 and shall consist of the following:

7.1.1 *Specimen Supports*, metal supports, allowing the load to be applied on top of the specimen vertically and midway between the supports, which shall be separated by a distance, defined in 7.1.1.1 or 7.1.1.2. The contact edges of the supports and of the piece by which load is applied shall be rounded to a radius of 3 ± 0.2 mm (0.118 ± 0.008 in.).

7.1.1.1 Method A— 101.6 ± 0.5 mm (4.0 ± 0.02 in.).

7.1.1.2 Method B— 100.0 ± 0.5 mm (3.937 ± 0.020 in.).

7.1.2 *Immersion Bath*—Choose a suitable liquid heat-transfer medium (Note 5) in which the specimen shall be immersed, which will not affect the specimen. It shall be well-stirred during the test and shall be provided with a means of raising the temperature at a uniform rate of $2 \pm 0.2^\circ\text{C}/\text{min}$. This heating rate shall be considered to be met if, over every 5-min interval during the test, the temperature of the bath shall rise $10 \pm 1^\circ\text{C}$ at each specimen location.

NOTE 5—Mineral oil is considered safe from ignition to 115°C . Silicone oils may be heated to about 260°C for short periods of time. For still higher temperatures, special heat-transfer media should be used. Improved performance with longer oil life may be obtained by the use of CO_2 or other inert gas to isolate the oil surface from the atmosphere.

7.1.3 *Deflection Measurement Device*, suitable for measuring specimen deflection of at least 0.25 mm (0.010 in.). It shall be readable to 0.01 mm (0.0005 in.) or better. Dial gauges or any other indicating or recording device, including electric displacement sensing apparatus, are acceptable.

7.1.4 *Weights*—A set of weights of suitable sizes so that the specimen are loaded to a fiber stress of 0.455 MPa (66 psi) $\pm 2.5\%$ or 1.82 MPa (264 psi) $\pm 2.5\%$. The mass of the rod that applies the testing force shall be determined and included as part of the total load. If a dial gauge is used, the force exerted by its spring shall be determined and shall be included as part of the load (Note 9). Calculate the testing force and the mass that must be added to achieve the desired stress as follows:

$$F = 2Sbd^2/3L \quad (1)$$

$$F^1 = F/9.80665$$

⁴ Mangum, B. W., "Platinum Resistance Thermometer Calibration," NBS Special Publication 250-22, 1987. Available from National Institute of Standards and Technology, Gaithersburg, MD.