



Designation: D 1044 – 99

Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion¹

This standard is issued under the fixed designation D 1044; 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 approval. 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 Department of Defense.

1. Scope *

1.1 This test method describes a procedure for estimating the resistance of transparent plastics to one kind of surface abrasion by measurement of its optical effects.

1.2 Abrasive damage is judged by that percentage of transmitted light which, in passing through the abraded track, deviates from the incident beam by forward scattering. For the purpose of this test method, only light flux deviating more than 0.044 rad (2.5°) on the average is considered in this assessment of abrasive damage.

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

NOTE 1—Recent attempts to employ the Taber Abraser for volume loss determinations of various plastics, like earlier ones,² have been unsuccessful because of excessively large coefficients of variation attributed to the data. Insufficient agreement among the participating laboratories has rendered the use of volume loss procedure inadvisable as an ASTM test method.

NOTE 2—For determining resistance to abrasion of plastics by measurement of volume loss, reference should be made to Test Methods D 1242.

NOTE 3—For determining the resistance to abrasion of organic coatings by weight loss, reference is made to Test Method D 4060. This test method uses more aggressive CS-10 or CS-17 abrasive wheels. It suffers from poor reproducibility between laboratories when numerical abrasion resistance values are used. Interlaboratory agreement improves significantly when ranking a series of coatings for their abrasion resistance.

NOTE 4—This test method is similar to ISO 3444 and ISO 4586/2. Their technical content is somewhat different. This test method and ISO 9352-89 are not technically equivalent.

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 and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 8.1.2.

¹ This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties. Current edition approved July 10, 1999. Published October 1999. Originally published as D 1044 – 49. Last previous edition D 1044 – 94.

² Supporting data are available from ASTM Headquarters. Request RR:D20-48 and RR:D20-1090.

2. Referenced Documents

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³
- D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics³
- D 1242 Test Methods for Resistance of Plastic Materials to Abrasion³
- D 2240 Test Method for Rubber Property—Durometer Hardness⁴
- D 4000 Classification System for Specifying Plastic Materials⁵
- D 4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser⁶
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁷

2.2 ISO Standards:

- ISO 3444 Paper and Board Determination of Abrasion Resistance⁸
- ISO 4586/2 Abrasion Resistance of Decorative Laminated Sheets⁸
- ISO 9352-89 Plastics—Determination of Resistance to Wear Abrasive Wheels⁸

3. Terminology

3.1 Definitions:

3.1.1 *abrasion*—abrasive wear caused by displacement or rearrangement of a softer material due to rubbing or scuffing against hard sharp particles.

3.1.2 *haze*—See definitions in Test Method D 1003.

3.1.3 *reface*—preparation of an abrasive wheel on a conditioning stone prior to use in testing.

3.1.4 *wheel*—an abrasive wheel consisting of hard particles (aluminum oxide) embedded in rubber.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vol 09.01.

⁵ Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 06.01.

⁷ Annual Book of ASTM Standards, Vol 14.02.

⁸ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

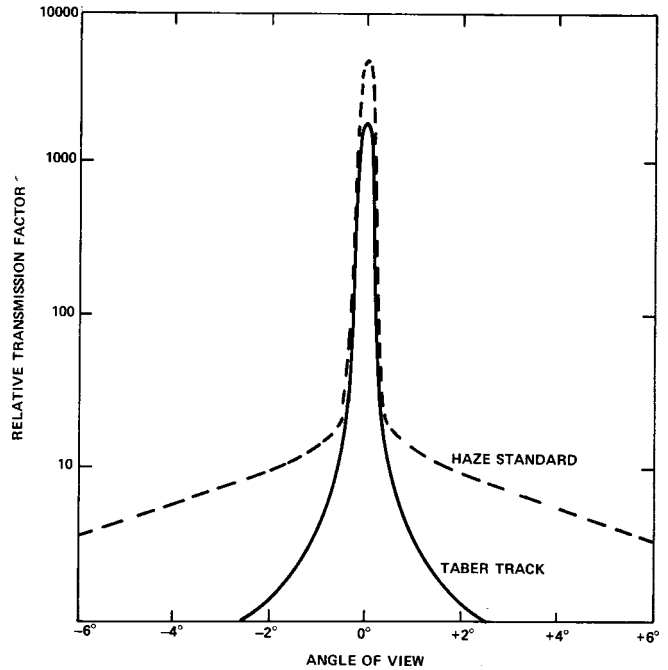
*A Summary of Changes section appears at the end of this standard.

4. Significance and Use

4.1 Transparent plastic materials, when used as windows or enclosures, are subject to wiping and cleaning; hence the maintenance of optical quality of a material after abrasion is important. It is the purpose of this test method to provide a means of estimating the resistance of such materials to this type and degree of abrasion.

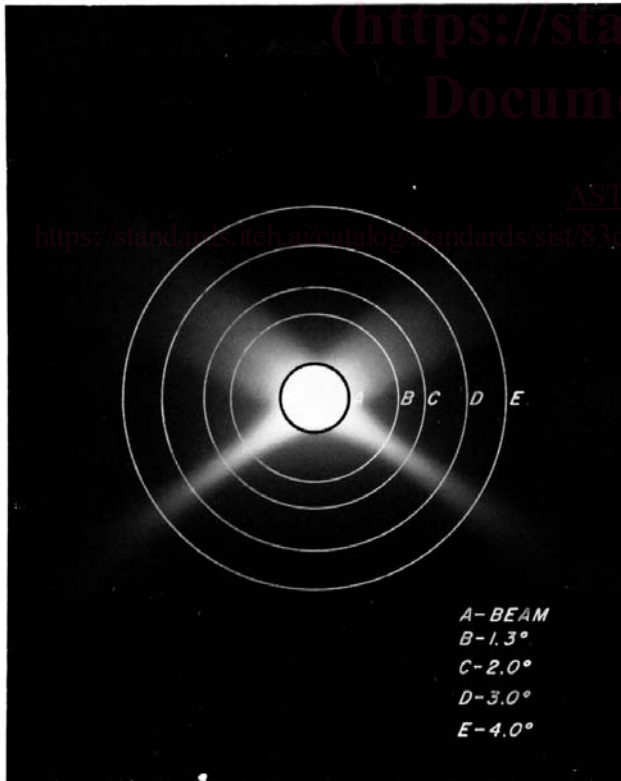
4.2 Although this test method does not provide fundamental data, it is suitable for grading materials relative to this type of abrasion in a manner which correlates with service.

4.3 Comparison of interlaboratory data or the specification of a "haze" value has no significance if the hazemeter requirements given in Section 4 are not used. This is because light diffused from the surface of a Taber track is scattered at a narrow angle (Fig. 1 and Fig. 2) while light diffused internally by a specimen is scattered at a wide angle. In many hazemeters, when a diaphragm is inserted to limit the light beam to the width of the abraded track, the specular beam at the exit port becomes smaller. The dark annulus will then be greater than the 0.023 ± 0.002 rad ($1.3 \pm 0.1^\circ$) requirements of Test Method D 1003. Since a large percentage of the narrow-angle forward-scattered light will not impinge on the sphere wall, "haze" readings become smaller. For hazemeters that have not been properly adjusted, the magnitude of this



NOTE 1—This graph shows goniophotometric curves for Taber abraded tracks. The specular angle of transmission is at 180° .

FIG. 2 Light Scattering from Surface of Abraded Tracks (Graph)



A—BEAM
 B— 1.3°
 C— 2.0°
 D— 3.0°
 E— 4.0°

NOTE 1—This photograph shows light pattern of the scattering from the surface of a Taber abraded specimen. The circles show how increasing the 1.3° dark annulus dramatically changes the amount of light impacting the sphere wall.

FIG. 1 Light Scattering from Surface of Abraded Tracks (Photograph)

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reduction is dependent both on the integrating sphere diameter and the reduction of the entrance beam.

4.4 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. Table 1 of Classification System D 4000 lists the ASTM materials standards that currently exist.

5. Apparatus

5.1 *Abrader*—The Taber abraser or its equivalent, so constructed that wheels of several degrees of abrasiveness may be readily used. Loads of 250, 500, or 1000 g on the wheels may be obtained by use of changeable weights or counterweights.

5.2 *Refacing Stone*—An ST-11 refacing stone shall be used for truing the abrasive wheels.

5.3 *Abrasive Wheels*—The grade of "Calibrase" wheel designated CS-10F shall be used. The "Calibrase" wheel shall meet the following requirements at the time of the test (Note 3):

5.3.1 The wheel shall not be used after the date stamped on it, and

5.3.2 The durometer hardness of the wheel shall be measured in accordance with Test Method D 2240, on at least four points equally spaced on the center of the abrading surface and one point on each side surface of the wheel. The test on the abrading surface shall be made with the pressure applied vertically along a diameter of the wheel, and the reading taken 10 s after full application of the pressure. Each wheel shall have a durometer hardness of $D 72 \pm 5$ at all measured points.

NOTE 5—The abrasive quality of the "Calibrase" wheels varies with