



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 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 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 measuring the change in optical properties.

1.2 Abrasive damage is visually judged and numerically quantified by the difference in haze percentage in accordance with Test Method **D 1003** between an abraded and unabraded specimen.

1.3 CS-10F wheels manufactured between October 2002 and September 2004 have been found to give different results than historical values. Comparisons of data using these wheels should be made with caution. Results using wheels made after September 2004 have agreed with those obtained before October 2002.

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

NOTE 1—This test method is equivalent to **ISO 3537** in the measurement of resistance to abrasion in Section 7, but is not equivalent to **ISO 3537** in any other measurement or section. This test method is not equivalent to **ISO 9352**, and results cannot be directly compared between the two methods.

NOTE 2—This test method is similar to **ANSI/SAE Z26.1**, Test 17.

NOTE 3—Prior attempts to employ the Taber Abraser for volume loss determinations of various plastics² 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 4—For determining the resistance to abrasion of organic coatings by weight loss, reference is made to Test Method **D 4060**, which 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.

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

2. Referenced Documents

2.1 ASTM Standards:³

D 618 Practice for Conditioning Plastics for Testing
D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

D 4000 Classification System for Specifying Plastic Materials

D 4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 ISO Standards:⁴

ISO 3537 Road Vehicles—Safety Glazing Materials—Mechanical Tests

ISO 9352 Plastics—Determination of Resistance to Wear by Abrasive Wheels

2.3 ANSI Standards:⁴

ANSI/SAE Z26.1 Safety Glazing Materials for Glazing Motor Vehicle and Motor Vehicle Equipment Operating on Land Highways—Abrasion Resistance, Test 17 (Plastics)

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*—In accordance with Test Method **D 1003**, that percentage of transmitted light which in passing through the specimen 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 to be haze.

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 resilient binder.

¹ This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

Current edition approved Nov. 1, 2005. Published December 2005. Originally approved in 1949. Last previous edition approved in 1999 as D 1044 - 99.

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

³ 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.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

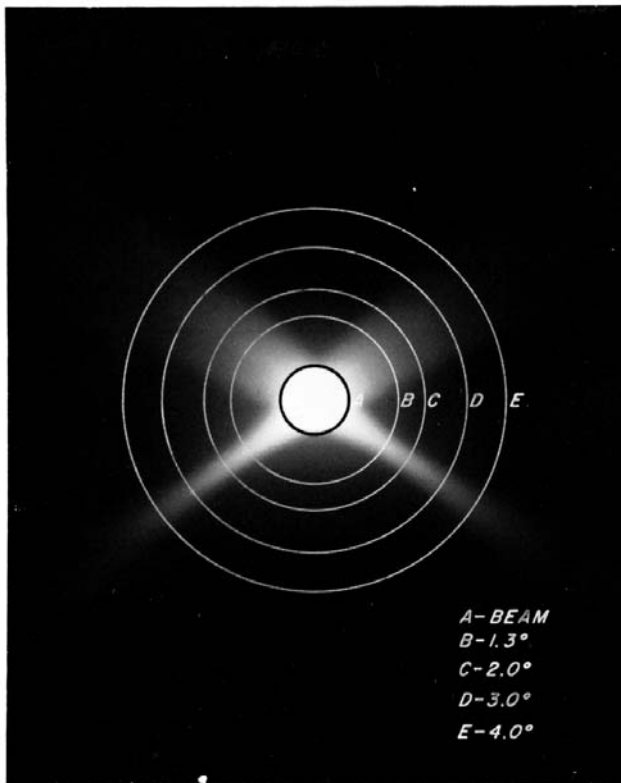
*A Summary of Changes section appears at the end of this standard.

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.

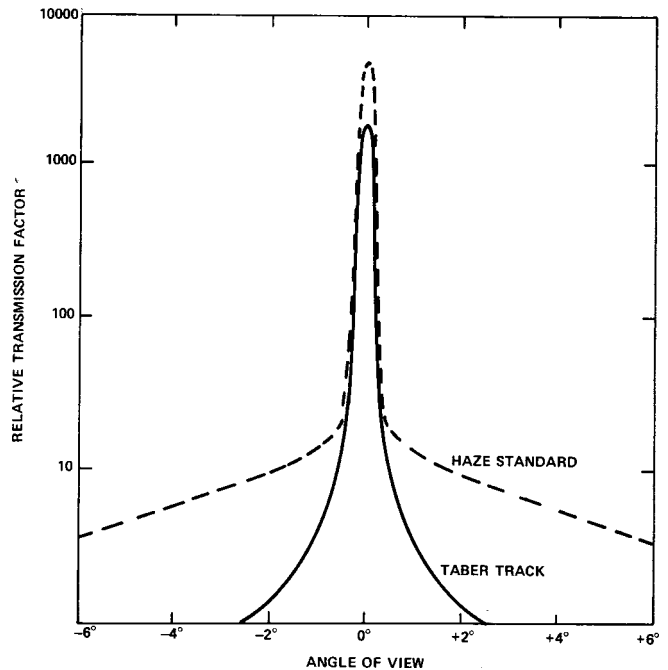
4.2 Although this test method does not provide fundamental data, it is suitable for grading materials relative to this type of abrasion in a manner which correlates with service.

4.3 Comparison of interlaboratory data or the specification of a “haze” value has no significance if the hazemeter requirements given in 5.4 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



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)



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)

properly adjusted, the magnitude of this 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.

4.5 For some materials, abrasion tests utilizing the Taber abramer may be subject to variation due to changes in the abrasive characteristics of the wheel during testing.

4.5.1 Depending on abradant type and test specimen, the wheel surface may change (that is, become clogged) due to the pick up of coating or other materials from test specimens and must be cleaned at frequent intervals.

4.5.2 The type of material being tested and the number of test cycles being run is known to sometimes influence the temperature of the running surface of the wheel with an affect on the final haze measurement. To reduce any variability due to this temperature effect, stabilize the wheels surface temperature prior to performing actual measurements. This shall be accomplished by conducting multiple refacings on an ST-11 refacing stone, followed by a test on the sample material to be tested (with results to be discarded).

5. Apparatus

5.1 Abrader—The Taber abramer or its equivalent, consisting of the following elements:

5.1.1 A horizontal turntable platform; comprised of a rubber pad, clamp plate, and nut to secure the specimen to the turntable.