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Standard Test Method for Measuring the Transmissivity of Transparent Parts[1]

This standard is issued under the fixed designation F1316; 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.

INTRODUCTION

Test Method D1003 has received wide acceptance as a test method to measure luminous transmissivity in transparent materials. However, because Test Method D1003 requires critical alignment of equipment on both sides of the transparency, it is not suited to measuring the transmissivity of large, curved parts or parts that are installed. In addition, Test Method D1003 measures the luminous transmissivity of the material in a direction perpendicular to the surface of the material. For the majority of aircraft windscreens, the pilot is not viewing through the transparency perpendicular to the surface. Since the transmissivity varies as a function of viewing angle the values of transmissivity measured perpendicular to the surface do not indicate what the pilot will see when viewing through the windscreen.

For the above reasons this test method has been developed to allow the measurement of transmissivity of a transparent part at any angle. Since the relative alignment of the equipment items on either side of the transparency is not critical, this test method can also be used on large, thick, or curved parts and parts that are already installed.

1. Scope

1.1 This test method describes an apparatus and procedure that is suitable for measuring the transmissivity of large, thick, or curved transparent parts including parts already installed. This test method is limited to transparencies that are relatively neutral with respect to wavelength (not highly colored).

1.2 Since the transmissivity (transmission coefficient) is a ratio of two luminance values, it has no units. The units of luminance recorded in the intermediate steps of this test method are not critical; any recognized units of luminance (for example, foot-lamberts or candelas per square metre) are acceptable for use, as long as use is consistent.

1.3 *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.*

1.4 *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]

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

3. Terminology

3.1 *Definitions:*

3.1.1 *black reference, n*—a light-absorbing, black material, such as black velvet flocking.

3.1.2 *photometer, n*—a device that measures luminance as defined by the spectral sensitivity of the photopic curve.

3.1.3 *Photopic curve, n*—the photopic curve is the spectral sensitivity of the eye for daytime conditions as ***Committee Internationale d'Elairage (CIE) 1931 standard observer***.

3.1.4 *regulated light source, n*—a light source with electronic feedback to ensure that its illuminance remains constant over time.

3.1.5 *transmission coefficient, n*—same as *transmissivity*.

[1] This test method is under the jurisdiction of ASTM Committee F07 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

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[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.

3.1.6 *transmissivity, n*—the transmissivity of a transparent medium is the ratio of the luminance of an object measured through the medium to the luminance of the object measured directly.

4. Summary of Test Method

4.1 A regulated light source with a relatively large, diffusely radiating surface area is placed on one side of a transparent part to be measured. A black, light-absorbing reference surface is placed next to the light source. A photometer is used to measure the luminance of the light source and black reference directly and through the transparency. The light source reading measured through the transparency minus the black reference reading through the transparency is divided by the light source measured directly minus the black reference measured directly (see Eq 1). This ratio is the transmission coefficient of the transparency. The black reference surface is used to correct the measurement from the effects of light scatter due to haze and from reflections.[3]

5. Significance and Use

5.1 *Significance*—This test method provides a means to measure the transmissivity of parts in the field (already installed on aircraft) and of large, thick or curved parts physically difficult to measure using Test Method D1003.

5.2 *Use*—This test method is acceptable for use on any transparent part. It is primarily intended for use on large, curved, or thick parts either pre- or post-installation (for example, windscreens on aircraft).

6. Apparatus

6.1 *Test Environment*—It is preferable to carry out this test method in a light-controlled environment although this is not absolutely necessary. To do so, shade the transparency from direct sunlight falling on the surface and place a light-absorbing black cloth in the appropriate reflection geometry with respect to the transparency to reduce reflections.

6.2 *Photometer*—Use any properly calibrated photometer for this measurement. The photometer is to have a measurement field that is smaller than the regulated light source to ensure accurate readings. It is recommended that a small, portable photometer with a 1° measurement field (or less) be used.

6.3 *Light Source*—Regulate the light source to ensure that it does not change luminance during the reading period. The light source is to have a relatively large, diffusely emitting surface area to permit easy measurement when using the photometer. The spectral distribution of the light source is not critical unless the transparency under test has significant spectral peaks or voids. For daylight measurements it is possible to use a white reflecting surface illuminated by sunlight instead of a powered light source. Care must be taken that the luminance of the reflective surface does not change during the reading.

6.4 *Black Reference*—Use a shaded, light-absorbing black material such as velvet to increase the accuracy of the measurement. This reference must have about the same area as the light source or reflective material used for the light reading since the photometer must also measure the apparent luminance of the black reference.

7. Test Specimen

7.1 Clean the part to be measured, using any acceptable procedure, to remove any surface contaminants with the potential to contribute to the loss of transmissivity. No special conditioning other than cleaning is required.

8. Calibration and Standardization

8.1 The photometer is to have the same spectral sensitivity as the eye but since the measurement involves the division of two quantities measured by the photometer it is not necessary that the photometer be calibrated in absolute luminance units.

9. Procedure

9.1 Place the light source (or white-reflective surface) on one side of the transparency such that is can be viewed from the other side of the transparency. Place the transparency at the desired angle for measurement. The distance from the light source to the transparency is not critical but must be greater than 30 cm (11.8 in.) to prevent erroneous readings due to light scatter and reflections. The distance from the light source to the photometer is also not critical, but is to be short enough so that the photometer measurement field easily falls within the emitting area of the light source. The distance from the transparency to the photometer is not critical, as the smallest permitted distance is 0 cm. Place the black reference adjacent to the light source so that it is also visible through the transparency. Place the light-absorbing cloth next to the transparency on the opposite side from the light source (see Fig. 1).

9.2 If the transparency is subject to direct sunlight, use a solar shield to shade the area of the transparency (see Fig. 1).

9.3 The photometer is then used to measure the luminance of the light source and the black reference. These readings are designated L_s and L_b respectively. The light source and black reference are then measured again but this time viewing through the transparency. These readings are L_{s_t} and L_{b_t} respectively. Make both the direct measurements and the measurements through the transparency from about the same distance and angle from the light source.

10. Calculation

10.1 The transmissivity of the transparency is calculated using the following equation:

$$t = \frac{L_{s_t} - L_{b_t}}{L_s - L_b} \tag{1}$$

[3] Task, H. L. and Merkel, H. S., *A New Method for Measuring the Transmissivity of Aircraft Transparencies*. Technical Report AAMRL-TR-89-044, Armstrong Aerospace Medical Research Laboratory, 1989.