Designation: F1252 – 08

# Standard Test Method for
# Measuring Optical Reflectivity of Transparent Materials[1]

This standard is issued under the fixed designation F1252; 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.

## 1. Scope

1.1 This test method covers a procedure for measuring the reflectivity of transparent materials, hereafter known as specimens. The results are repeatable without specifying a particular brand name of instrumentation.

1.2 This test method applies to substantially flat parts. Errors in measurement can occur if the parts being measured are not substantially flat.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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.*

## 2. Terminology

2.1 *Definitions:*

2.1.1 *angle of incidence* ($\Theta_i$)—in the plane of the light source, specimen, and photometer, the angle of incidence is the angle between the incident light ray and the normal to the surface (see Fig. 1).

2.1.2 *angle of reflection* ($\Theta_r$)—in the plane of the light source, specimen, and photometer, the angle of reflection is the angle between the reflected light ray and the normal to the surface (see Fig. 1).

2.1.3 *light source*—unless otherwise specified, the National Institute of Standards and Technology (NIST) diffused nonpolarized Standard Illuminance A or C light source shall be used. The light source size will be such that there will be sufficient overlap of the front and rear images on the specimen to overfill the measurement field size of the photometer. This overlap is illustrated in Fig. 2. (As angle of incidence and specimen thickness increase, the two images will diverge.) The light source used should be specified and reported as part of the test results.

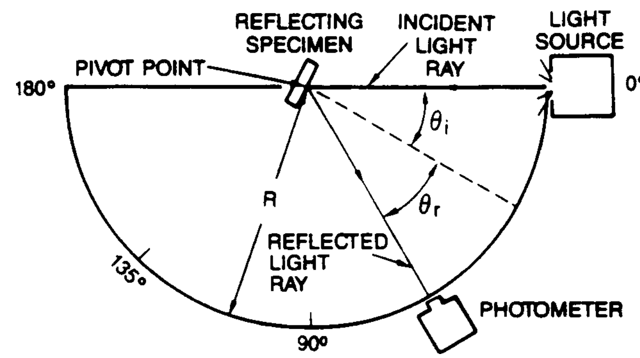


FIG. 1 Apparatus Set-Up

2.1.4 *measurement field size*—the angular extent, in degrees, of the measurement aperture of the photometer.

2.1.5 *photometer*—any commercial photometer or photopic filtered radiometer with a suitable measurement field size (1° or smaller is recommended). A model with a viewfinder is recommended.

2.1.6 *pivot point*—the point in space at which the incident light ray and reflected light ray are to intersect (see Fig. 1).

2.1.7 *reflectivity*—the reflectivity of a transparent specimen is defined as the ratio of the luminance of the reflected image of a light source to the luminance of the light source. The reflectivity will depend upon several factors: the angle at which the reflected light is measured, the thickness, surface quality, and type of material of the specimen, whether the specimen is coated, the spectral distribution of the light source, and the spectral sensitivity of the measurement device. The reflectivity, as defined here, includes the small amount of scattered light that contributes to the luminance of the reflected image.

## 3. Summary of Test Method

3.1 The luminance of the standard source is determined by measuring it directly with the photometer. The luminance of the reflection of the source is then measured off the specimen

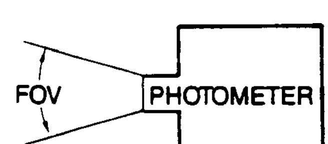


FIG. 2 Photometer Field of View

[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.

Current edition approved April 1, 2008. Published April 2008. Originally approved in 1989. Last previous edition approved in 2002 as F1252 – 89(2002). DOI: 10.1520/F1252-08.

at a specified geometry. The luminance of the reflection is divided by the luminance of the source to obtain the reflectivity of the specimen.

## 4. Significance and Use

4.1 Reflections from aircraft transparencies of instrument lights and other cockpit objects have been a concern to many pilots. Attempts to reduce these reflections have been hampered by the lack of a repeatable measurement method and variances in reflection measuring instrumentation. The problem with measuring instrumentation is that different brands will often give significant value differences using the same specimen surface.

4.2 This test method reduces the instrument variations by standardizing the light source, calculation method, and area of specimen surface being measured; a brand of instrumentation is not specified. Since the reflectivity is defined as the ratio of two luminance measurements and does not depend on an absolute measurement, dependence upon the accuracy of the measuring instrument is reduced.

4.3 The test method may be used to objectively compare the reflection characteristics of various transparent materials. Furthermore, the test method may be used to evaluate reflections of a specified spectral source by using that source in place of the standard light source.

4.4 Provisions are made to check for polarization effects of the sample and to record the reflectivity of a standard specimen. These provisions are offered as an option to the tester; it is up to the user or the requiring agency to determine the significance and use of these data.

4.5 Since the reflections are measured photopically, the results are representative of what the pilot would visually perceive.



## 5. Apparatus and Setup

5.1 The apparatus shall be set up as shown in Fig. 1.

5.2 The angle of incidence $\Theta_i$ shall be determined by the user or requiring agency. Since $\Theta_i = \Theta_r$, the total angle of reflection $\Theta = 2\Theta_i = 2\Theta_r$. $\Theta_i$and $\Theta_r$ shall be accurate to within $\pm 0.5°$, hence $\Theta$ shall be accurate to within $\pm 1°$.

5.3 The distance from the light source to the specimen and from the specimen to the photometer is not critical. However, it is desirable to position the light source relatively far from the sample (for example, 50 cm or more) to minimize the effects of scattered light from the specimen contaminating the reflectivity measurement. The light source to specimen distance must be such that the reflected image viewed through the photometer is sufficiently large to overfill the photometer measurement field (see 2.1.3). The distance from the specimen to the photometer must be short enough to ensure the reflected images overfill the measurement aperture but long enough to ensure the photometer can focus on the image.

5.4 The testing shall be done in a room with controlled lighting such that the photometer reading with the reference light off is less than 0.1 % of the reflection reading measured with the reference light on. This will ensure ambient room light contamination of the results is less than 0.1 %.

5.5 A flat black surface (such as black velvet) may be positioned behind (but not touching) the specimen during measurement to reduce possible ambient light contamination effects.

5.6 The photometer measurement aperture size (for example, 1°), the reference light source emitting surface size (for example 5 cm circular), the distance from the reference light source to the specimen, the distance from the photometer to the specimen and the angle of incidence should all be included in the report.

## 6. Procedure

6.1 Allow the light source and photometer to warm up per manufacturer's specification.

6.2 The pivot point is the point in space at which the surface of the specimen will be placed (6.5) such that the reflection occurs at the desired geometry. Establish the pivot point by marking the point with a small object, such as a piece of cardboard. Position the light source at a proper distance from the pivot point (5.3).

6.3 Locate the photometer such that the light source, pivot point, and photometer are in line (see Fig. 3). Direct the photometer such that its measurement field is centered on the light source. Focus the photometer on the light source and record the luminance *L*.

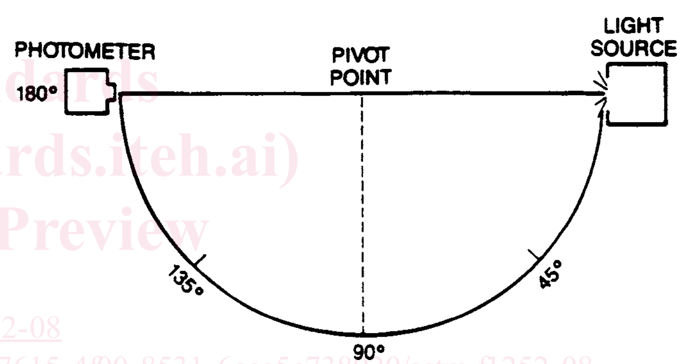


**FIG. 3 Apparatus Set-Up for Source Measurement**

6.4 Locate the photometer at a position equidistant from the pivot point such that the angle between the source, pivot point, and photometer is twice the desired angle of incidence[2] (see Fig. 1). Direct the photometer such that the pivot point is centered in the FOV.

6.5 Position the specimen such that the center of the front surface is at the pivot point. Remove any object that may have been used to mark the pivot point. Keeping the photometer and source fixed, adjust the attitude of the specimen until the image of the source completely covers the photometer's measurement field. Depending on the specimen, the image of the source may

[2] There exists a maximum angle of incidence for which measurements can be made. For the apparatus specified, this angle, $\Theta_{max}$, depends only upon the size, thickness, and index of refraction of the specimen. A thin specimen four inches wide will permit measurements for $\Theta$ up to 132°. $\Theta_{max}$ will decrease as the specimen thickness increases. For most measurements a four inch wide specimen will be adequate; a larger width may be required for very thick specimens and/or large values of $\Theta$.