



Designation: F1863 – 16

Standard Test Method for Measuring the Night Vision Goggle-Weighted Transmissivity of Transparent Parts¹

This standard is issued under the fixed designation F1863; 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 Methods **D1003** and **F1316** apply to the transmissivity measurement of transparent materials, the former being for small flat samples, and the latter for any materials including larger, curved pieces such as aircraft transparencies. Additionally, in Test Method **D1003**, the transmissivity is measured perpendicular to the surface of test sample and both test methods measure only in the visible light spectral region. Night vision goggles (NVGs) are being used in aircraft and other applications (for example, marine navigation, driving) with increasing frequency. These devices amplify both visible and near-infrared (NIR) spectral energy. Overall visual performance can be degraded if the observer uses the NVGs while looking through a transparency that has poor transmissivity in the visible and NIR spectral regions. This test method describes both direct and analytical measurement techniques that determine the NVG-weighted transmissivity of transparent pieces including ones that are large, curved, or held at the installed position.

1. Scope

1.1 This test method covers apparatuses and procedures that are suitable for measuring the NVG-weighted transmissivity of transparent parts including those that are large, thick, curved, or already installed. This test method is sensitive to transparencies that vary in transmissivity as a function of wavelength.

1.2 Since the transmissivity (or transmission coefficient) is a ratio of two radiance values, it has no units. The units of radiance recorded in the intermediate steps of this test method are not critical; any recognized units of radiance (for example, $\text{watts/m}^2\text{-str}$) may be used, as long as it is consistent.²

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

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 *RCA Electro-Optics Handbook*, RCA/Solid State Division/Electro Optics and Devices. Technical Series EOH-11. Lancaster, PA; 1974.

2. Referenced Documents

2.1 *ASTM Standards*:³

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F1316 Test Method for Measuring the Transmissivity of Transparent Parts

3. Terminology

3.1 *Definitions*:

3.1.1 *analytical test method, n*—the test method that uses spectral transmissivity data of a transparent part collected by the use of either spectrophotometric or spectroradiometric instrumentation. The data are then examined using analytic methods to determine the NVG-weighted transmissivity of the part.

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.

3.1.2 *direct test method, n*—the test method that uses the actual luminous output, as measured by a photometer, properly coupled to the eyepiece of the test NVG. The NVG-weighted transmissivity of the part is then determined by forming the ratio of the NVG output luminance with the transparent part in place to the luminance output without the part.

3.1.3 *NVG-weighted spectral transmissivity, n*—the spectral transmissivity of a transparent part multiplied by the spectral sensitivity of a given NVG (see Fig. 1).

3.1.4 *NVG-weighted transmissivity (T_{NVG}), n*—the spectral transmissivity of a transparent part multiplied by the spectral sensitivity of a given NVG integrated with respect to wavelength (see Fig. 1, Eq 1 and Eq 2).

3.1.5 *NVG spectral sensitivity, n*—the sensitivity of an NVG as a function of input wavelength.

3.1.6 *photometer, n*—a device that measures luminous intensity or brightness by converting (weighting) the radiant intensity of an object using the relative sensitivity of the human visual system as defined by the photopic curve.^{2,4}

3.1.7 *photopic curve, n*—the photopic curve is the spectral sensitivity of the human eye for daytime conditions as defined by the *Commission Internationale d’Eclairage* (CIE) 1931 standard observer.^{2,4}

3.1.8 *transmission coefficient, n*—see *transmissivity*.

3.1.9 *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 same object measured directly.

⁴ Wyszecki, Gunter, and Stiles, WS, *Color Science: Concepts and Methods, Quantitative Data and Formulae*, 2nd ed., New York, John Wiley and Sons, 1982.

4. Summary of Test Method

4.1 *General Test Conditions*—The test method shall be performed in light-controlled area (for example, light-tight room, darkened hangar, or outside at night away from strong light sources). The ambient illumination must be very low because of the extreme sensitivity of the NVGs. A fixture holds the NVG and its objective lens is aimed at and focused on a target. The target shall be either an evenly illuminated white, diffusely reflecting surface or a transilluminated screen (light-box). The illumination is provided by a white, incandescent light source. Handle the samples carefully so as not to cause any damage. Do not clean them with any solvents. Use part-specific, prescribed cleaning materials and methods.

4.1.1 *Direct Test Method*—Attached directly to the eyepiece of the NVG is a photodetector. The measured field of view (FOV) shall be smaller than the uniformly illuminated portion of the target. The target illumination is adjusted so that the output of the NVGs is about 1.7 cd/m² (0.5 fL). This ensures that the NVG input level is sufficiently low that it does not activate the NVG automatic gain control (AGC) circuitry. The luminance output of the NVG is measured with no transparency in place and then repeated with the transparent material in place between the light source and the NVG. The transmissivity is equal to the NVG output luminance with the transparent material in place divided by the NVG output luminance without the material (see Eq 1). The result is the NVG-weighted transmissivity (T_{NVG}) of the transparent material.

4.1.2 *Analytical Test Method*—Without the sample in place, measure the light source’s spectral energy distribution from 450 through 950 nm in 5-nm incremental steps. Place the sample into the spectrophotometer or spectroradiometer fixture. Perform spectral measurements, also from 450 through

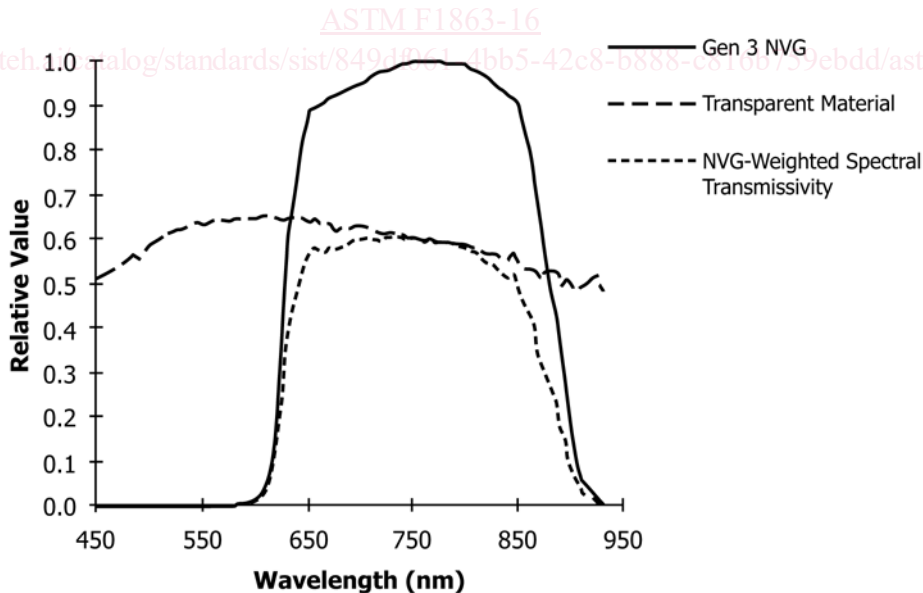


FIG. 1 An Example of How the Spectral Sensitivity of a Generation 3 NVG Multiplied by the Spectral Transmissivity of a Transparent Part Equals the NVG-Weighted Spectral Transmissivity of that Part. Integrating the Curve with Respect to Wavelength Yields the Part’s NVG-Weighted Transmissivity (T_{NVG}) Value

950 nm in 5-nm incremental steps. Obtain from the NVG manufacturer the spectral sensitivity of the goggle that will be used in conjunction with the part. Perform the analytic method as defined in Eq 2 to derive the T_{NVG} .

5. Significance and Use

5.1 *Significance*—This test method provides a means to measure the compatibility of a given transparency through which NVGs are used at night to view outside, nighttime ambient illuminated natural scenes.

5.2 *Use*—This test method may be used on any transparent part, including sample coupons. It is primarily intended for use on large, curved, or thick parts that may already be installed (for example, windscreens on aircraft).

6. Apparatus

6.1 *Test Environment*—This test method shall be performed in light-controlled area (for example, light-tight room, darkened hangar, or outside at night away from strong light sources) since the NVGs are extremely sensitive to both visible and near infrared light. Extraneous light sources (for example, exit signs, telephone pole lights, status indicator lights on equipment, and so forth) can also interfere with the measurement.

6.2 *White Diffuse Target*—The white target shall be any uniformly diffusely reflecting or translucent material (for example, cloth, flat white painted surface, plastic). The target area shall be either smaller (see Fig. 2) or larger (see Fig. 3) than the NVG FOV (35 to 60° typical) to minimize potential alignment errors.

6.3 *Light Source*—The light source shall be regulated to ensure that it does not change luminance during the reading period. It shall be a low output, 2856K incandescent light since this type emits sufficient energy in both visible and infrared without any sharp emission peaks or voids.² Its output must be uniformly distributed over the measurement area of the white diffuse target. Use of neutral density filters or varying the lamp

distance shall be used as needed to achieve sufficiently low luminance levels for test, since varying the radiator’s output will shift its color temperature.

6.4 *Night Vision Goggles*—A family of passive image intensifying devices that use visible and near-infrared light and enable the user to see objects that are illuminated by full moonlight through starlight-only conditions. The goggle that is used for test shall be the same as that intended to be used with the given transparent material.

6.5 *Photometer*—A calibrated photometer shall be used for this measurement. The detector must be properly coupled to the NVG eyepiece, and the FOV over which the light is integrated must be known.

7. Test Specimen

7.1 If necessary, clean the part to be measured using the procedure prescribed for the specific material. Use of nonstandard cleaning methods can irrevocably damage the part. No special conditions other than cleaning are required.

8. Calibration and Standardization

8.1 It is not necessary that the photometer be calibrated in absolute luminance units since the measurement involves the division of two measured quantities yielding a dimensionless value. A generic photodetector can be substituted for the photometer if its FOV is known.

9. Procedure

9.1 *General Procedures*—Perform all measurements in a darkened, light-controlled area. To control the effects of reflection, verify that there are no extraneous light sources that can produce reflections within the measurement area of the transparent material. To control the effects of haze, verify that no light other than the measurement light falls on the area being tested.

9.2 *Direct Test Method*—This test method allows analysis of large or small transparent parts placed at either normal (perpendicular to the optical axis) or installed orientations, such as

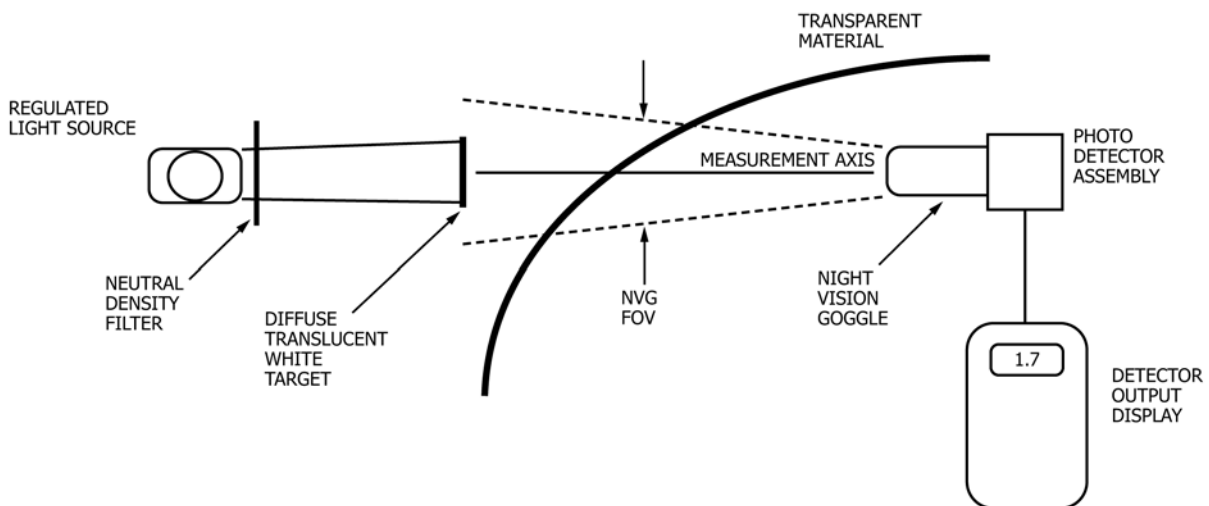


FIG. 2 Direct Test Method Equipment Set Up to Measure the Night Vision Goggle-Weighted Transmissivity of a Transparent Part Using a Transilluminated Lightbox that Underfills the NVG FOV