



Standard Test Method for Measuring Optical Distortion in Transparent Parts Using Grid Line Slope¹

This standard is issued under the fixed designation F2156; 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 When an observer looks through an aerospace transparency, relative optical distortion results, specifically in thick, highly angled, multilayered plastic parts. Distortion occurs in all transparencies but is especially critical to aerospace applications such as combat and commercial aircraft windscreens, canopies, or cabin windows. This is especially true during operations such as takeoff, landing, and aerial refueling. It is critical to be able to quantify optical distortion for procurement activities.

1.2 This test method covers the apparatus and procedures that are suitable for measuring the grid line slope (GLS) of transparent parts, including those that are small or large, thin or thick, flat or curved, or already installed. This test method is not recommended for raw material.

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

1.3.1 *Exception*—The values given in parentheses are for information only.

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. Referenced Documents

2.1 ASTM Standards:²

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

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.

F733 Practice for Optical Distortion and Deviation of Transparent Parts Using the Double-Exposure Method

F801 Test Method for Measuring Optical Angular Deviation of Transparent Parts

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *design eye, n*—the reference point in aircraft design from which all anthropometrical design considerations are taken.

3.1.2 *distortion, n*—the rate of change of deviation resulting from an irregularity in a transparent part.

3.1.2.1 *Discussion*—Distortion shall be expressed as the slope of the angle of localized grid line bending, for example, 1 in 5 (see Fig. 1).

3.1.3 *grid board, n*—an optical evaluation tool used to detect the presence of distortion in transparent parts.

3.1.3.1 *Discussion*—The grid board is usually, but not always, a vertical rectangular backboard with horizontal and vertical intersecting lines with maximum contrast between the white lines and the black background.

3.1.4 *grid line slope, n*—an optical distortion evaluation parameter that compares the slope of a deviated grid line to that of a nondeviated grid line.

3.1.4.1 *Discussion*—The degree of deviation shall be indicated by a ratio, for example, 1 in 2, 1 in 8, or 1 in 20 (the visual optical quality improves as the second number gets larger.)

3.1.5 *installed angle, n*—the transparency orientation as installed in the aircraft, defined by the angle between a horizontal line (line of sight) and a plane tangent to the surface of the transparency (see Fig. 2).

3.1.6 *repeatability limit (rL), n*—from Practice E177, 27.3.2, “approximately 95 % of individual test results from laboratories similar to those in an Inter-laboratory Study (ILS) can be expected to differ in absolute value from their average value by less than 1.96s (about 2s).”

3.1.6.1 *Discussion*—in terms of this test method, approximately 95 % of all pairs of replications from the same evaluator and the same photo differ in absolute value by less than the rL.

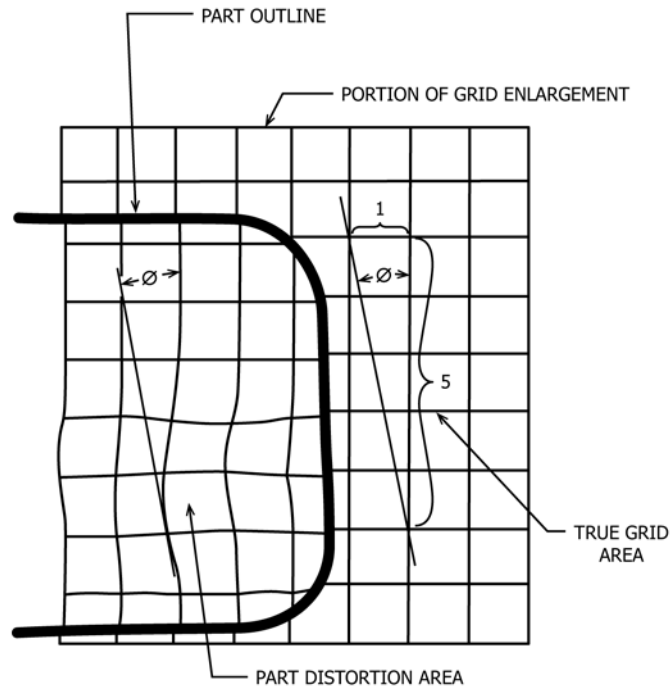


FIG. 1 Optical Distortion Represented By Tangent

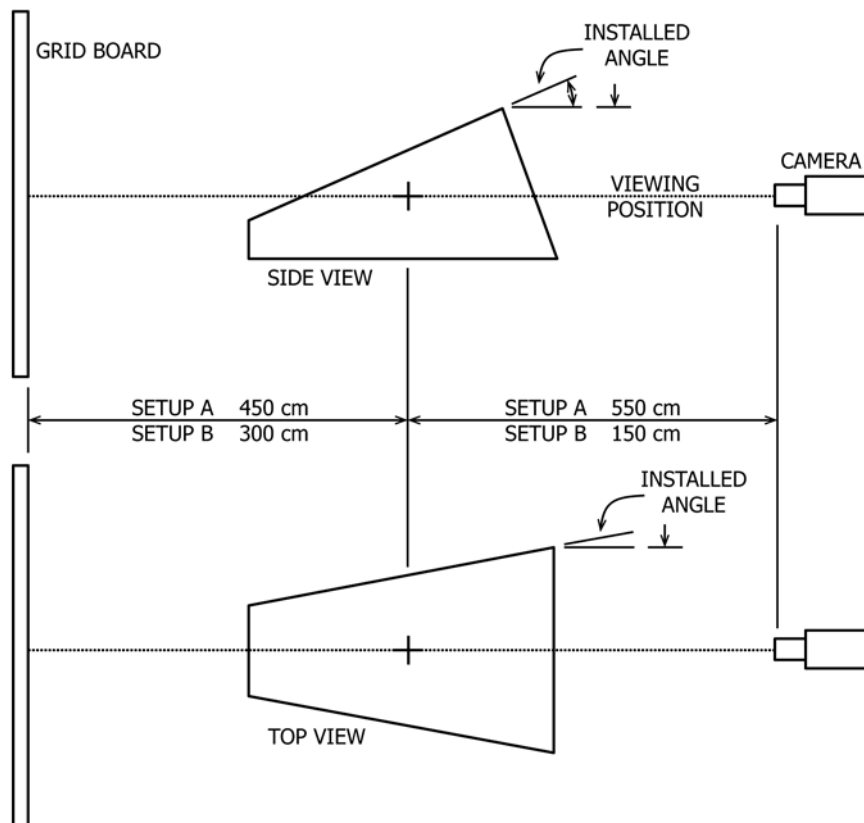


FIG. 2 Schematic Diagrams of GLS Photographic Recording Distances

3.1.7 *reproducibility limit (RL)*, n —from Practice E177, 27.3.3, “approximately 95 % of all pairs of test results from laboratories similar to those in the study can be expected to

differ in absolute value by less than $1.960\sqrt{2s}$ (about $2.0\sqrt{2s}$) = $2.77s$ (or about $2.8s$). This index is also known as the 95 % limit on the difference between two test results.”