

Standard Test Method for Measuring Angular Displacement of Multiple Images in Transparent Parts¹

This standard is issued under the fixed designation F 1165; 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 measuring the angular separation of secondary images from their respective primary images as viewed from the design eye position of an aircraft transparency. Angular separation is measured at 49 points within a 20 by 20° field of view. This procedure may be performed on any aircraft transparency in a laboratory or in the field. However, the procedure is limited to a dark environment. Laboratory measurements are done in a darkened room and field measurements are done at night.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, 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.*

1.3 The values stated in acceptable metric units are to be regarded as the standard. The values in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods²

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

3. Terminology (see Fig. 1)

3.1 *primary image*—the image formed by the rays transmitted through the transparency without being reflected (solid lines).

3.2 *secondary image*—the image resulting from internal reflections of light rays at the surfaces of the transparency (dashed lines).

3.3 *angular displacement*—the apparent angular separation of the secondary image from the primary image as measured from the design eye position (θ).

3.4 *installed angle*—the part attitude as installed in the

FIG. 1

aircraft; the angle between the surface of the windscreen and the pilot's 0° azimuth, 0° elevation line of sight.

4. Summary of Test Method

4.1 The procedure for determining the angular displacement of secondary images entails photographing a light array of known size and distance from the transparency. The photograph is then used to make linear measurements of the image separation, which can be converted to angular separation using a scale factor based on the known geometry.

5. Significance and Use

5.1 With the advent of thick, highly angled aircraft transparencies, multiple imaging has been more frequently cited as an optical problem by pilots. Secondary images (of outside lights), often varying in intensity and displacement across the windscreen, can give the pilot deceptive optical cues of his altitude, velocity, and approach angle, increasing his visual workload. Current specifications for multiple imaging in transparencies are vague and not quantitative. Typical specifications state "multiple imaging shall not be objectionable."

5.2 The angular separation of the secondary and primary images has been shown to relate to the pilot's acceptability of the windscreen. This procedure provides a way to quantify angular separation so a more objective evaluation of the transparency can be made. It may be used for research of multiple imaging, quantifying aircrew complaints, or as the basis for windscreen specifications.

5.3 It should be noted that the basic multiple imaging characteristics of a windscreen are determined early in the design phase and are virtually impossible to change after the windscreen has been manufactured. In fact, a perfectly manufactured windscreen has some multiple imaging. For a particular windscreen, caution should be taken in the selection of specification criteria for multiple imaging, as the inherent

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

Current edition approved April 10, 1998. Published July 1998. Originally published as F 1165 – 88. Last previous edition F 1165 – 88.

² *Annual Book of ASTM Standards*, Vol 14.02.