SAE Aerospace
An SAE International Group

AEROSPACE INFORMATION REPORT

SAE AIR5689A

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Superseding AIR5689

Light Transmitting Glass Covers for Exterior Aircraft Lighting

RATIONALE

The AIR has been revised to further clarify glass quality definitions and add dimesions to glass defects that are commonly present in glass lenses.

1. SCOPE

This SAE Aerospace Information Report (AIR) provides definitions of and inspection criteria for defects commonly encountered in molded and finished glass covers for exterior aircraft lighting.

1.1 Purpose

This document covers, but is not limited to, visual inspection and evaluation recommendations for molded glass covers used in exterior aircraft lighting applications. The included definitions are for those defects most commonly encountered. The goal is to provide specific evaluation criteria in the following areas.

a. Color

b. Internal Quality

c. External (Surface) Quality

d. Dimension

e. Coatings

Inspection of glass covers shall be made at a typical reading distance with normal or corrected 20-20 vision under adequate lighting. Covers shall be free from defects which will prevent meeting intensity and beam distribution, strength, thermal shock, and other physical requirements. All covers shall be manufactured and finished using quality workmanship.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS25050 Colors, Aeronautical Lights and Lighting Equipment, General Requirements For

2.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-DTL-7989B Covers, Light-Transmitting For Aeronautical Lights, General Specification For (INACTIVE FOR NEW DESIGN)

MIL-G-174B Glass, Optical

3. RECOMMENDATIONS

3.1 Color

3.1.1 The color shall meet the specifications defined in the detailed item drawing. The drawing shall indicate the desired chromaticity in CIE 1931 coordinates, the applicable source, and the operating temperature of the lens. In the event that no color specifications are indicated, the item shall be produced to meet the requirement of specification AS25050 using a standard CIE Illuminant A (2856 K) source with a room temperature lens.

3.1.2 The color shall be homogeneous throughout the glassware.

3.1.3 Glass has the characteristic where the color will change with increased operating temperature. This effect is most apparent with sharp-cut yellow and red filter glass, but is also present to some degree in all colored glassware. The operating temperature of the lens shall be specified on the detailed drawing for all applications where chromaticity and photometric output are critical.

3.1.4 Clear uncoated glassware shall have no visible color when viewed through the optically effective surface

3.2 Internal Quality

3.2.1 A "check" is a crack or fracture usually starting from an edge. A "crizzle" is a series of fine checks occurring in one area near the surface. Cracks, checks, and crizzles are actual fractures in the glass and shall not be accepted.

3.2.2 An "inclusion", or "stone", is an opaque, non-glassy material within the bulk of the glass. A fractured inclusion has small cracks surrounding the area of the stone and leading into the glass. Fractured stones shall not be accepted. The maximum acceptable inclusion size is related to the overall dimension of the item and the magnitude of thermally induced stress in the lens during operation.

3.2.3 "Knots" are transparent areas of incompletely melted glass. The inspection criteria for knots are the same as those for inclusions in 3.2.2.

3.2.4 "Striae", or "cords", are apparent as lines or threads within the lens, and are caused by slight variations of the refractive index in the bulk of the glass. Cords not visible to the unaided eye and not detrimental to the output of a lens shall not be cause for rejection. Striae which are light and scattered when viewed perpendicular to the optically effective surface are acceptable so long as the output of the lens is not affected. Heavy cords which appear on the surface of the lens or degrade the physical integrity or photometric output of the lens are unacceptable.

3.2.5 "Bubbles" are pockets of gas trapped within the bulk of the glass. The specifications for bubble criteria are adapted from MIL-C-7989B (INACTIVE FOR NEW DESIGN).

3.2.5.1 Bubbles should not be so large in size or number that they affect the transmittance of the part. The percentage of useful surface area of the lens obstructed by bubbles should not exceed one. The total number of bubbles shall not exceed the number shown in Table 1.

TABLE 1

Effective Diameter of Bubbles in Inches	Number of Bubbles per Effective Square Inch of Projected Area of Cover
0.050-0.060	3
0.040-0.050	4
0.030-0.040	6
0.020-0.030	11
0.015-0.020	25
0.010-0.015	44
0.005-0.010	100

3.2.5.2 Diffusing covers shall not be required to meet any bubble requirements.

3.2.5.3 "Blisters" are bubbles which exceed 0.060 in. in diameter. The size and thickness of an item shall be considered when determining the maximum allowable size of a blister.

3.3 External Quality

3.3.1 Elongated blisters which catch a fingernail on the lens shall not be accepted. Open surface blisters or blisters which can be punched open with a fingernail or pencil point shall be rejected.

3.3.1.1 Elongated seeds which catch a fingernail on the lens are acceptable providing they are less than 0.015 in. deep.

3.3.2 "Wrinkles", or "chill marks", are slight wavy areas on the surface of the lens caused by variations in mold temperature and glass cooling. Unless the surface deformation is great enough to affect the output of the lens, wrinkles are cosmetic defects and shall be acceptable.

3.3.3 "Shear" marks are caused by the slicing and cooling action of the shears used in cutting an individual gob of glass for manufacturing the part. Typically the glass gob is hot enough to smooth any roughness which may have been caused by the shearing action. After molding the shear mark should appear as a smooth, possibly irregularly shaped line on the surface. The glass within the shear mark should be well fused and not act as a concentration point for residual stress. Rough shear marks, characterized by a raised mark or abraded edges, shall be rejected. Although generally cosmetic defects, shear marks should be in locations which have minimal impact on the light output of the lens.

3.3.4 Chips and Flakes

3.3.4.1 "Flakes" are small voids along an abraded or sliced edge. There shall be no cracked or residual glass remaining in the region of the flake. Flakes shall be acceptable so long as no cracks emanate from the flake into the bulk of the part.

3.3.4.2 "Chips" are larger voids along a sharp edge which are caused by contact of the glass with a hard surface under sufficient force to break off a piece of the glass. There shall be no cracked or residual glass remaining in the region of the chip. Chips are acceptable if no crack protrudes from the site of the chip into the bulk of the glass.

3.3.4.3 The acceptable size of chips and flakes depends on the dimension of the part. Chips or flakes shall not be larger than 1/4 of the width of the bottom mounting flange of the part. Chips and flakes should not extend into the main body of the lens on either the inside or the outside. Chips and flakes should not extend for more than 0.060 in for lenses less than or equal to 4 in maximum dimension, or more than 0.125 in for lenses of greater than 4 in maximum dimension.

3.3.5 "Scratches" are rough grooves on the glass surface caused by abrasive materials or contact with sharp metal or ceramic objects. Scratches can usually be seen in reflected or off-axis lighting or can be felt by rubbing a fingernail over the surface of the glass. Coarse or deep scratches will affect the physical integrity of the lens and are unacceptable. The combined length of a light scratch should not exceed 25% of the largest dimension of the lens.

3.3.6 "Laps", or "folds", are smooth ridges on the glass surface. Laps are caused by two regions of glass meeting at an interface but not being sufficiently hot enough to blend together. Laps are acceptable so long as they are cosmetically acceptable and do not affect the output of the lens.

3.3.7 "Scale" is iron oxide appearing as a reddish brown discoloration on the surface of the glass. It can usually be removed by buffing without causing permanent damage to the glass surface.

3.3.8 A "scuff" is an abrasion of the glass surface creating a cloudy or hazy appearance. Scuffs are acceptable so long as they do not affect the output of the lens.

3.3.9 "Pits" are small surface holes caused by bits of glass or dirt on the mold surface during forming. Pits are acceptable unless they are numerous, are unsightly, affect the light output, or are in regions of known high thermal stress.

3.3.10 Sharp edges remaining from molding or finishing operations can be sources of mechanical strength problems due to thermal shock or thermal stress. All sharp edges should be removed.

3.4 Dimensions

3.4.1 All lenses should meet the dimensions and contour specified in the detailed drawing.

3.5 Coating

3.5.1 Conductive Coatings

3.5.1.1 The intent of conductive coatings is to limit the amount of electromagnetic energy into or out of a light source. An undesired effect of the coating is to reduce the amount of light transmitted through the lens. The coating should not decrease the output of the uncoated lens below desired photometric levels.

3.5.1.2 "Back coating" occurs when a coating is deposited on the side opposite to that which is being coated. This effect generally results in a cloudy or hazy film on the opposite surface. Back coating is not acceptable in cases where the output of the lens is decreased below acceptable intensity levels.

3.5.1.3 "Spatter" is a surface mark caused by the deposit of large particles of coating material on the surface of the lens. Spatter marks are unacceptable if they significantly reduce the light output of a lens or degrade the required conductive performance of the coating.

3.5.1.4 A "stain" is the discoloration of the glass surface due to a reaction between the glass and the chemicals involved in the coating process. Stains are acceptable when no degradation in lens performance is determined.

3.5.1.5 "Voids" are areas where no coating has been applied and are unacceptable.