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(R)

Instrument and Cockpit Illumination for General Aviation Aircraft

1. SCOPE:

This document establishes acceptable design criteria for instrument and cockpit illumination for general aviation aircraft.

2. REFERENCES:

The Human Engineering Guide to Equipment Design, DOD, US Government Printing office, 1972

Human Engineering Guide for Equipment Designers, Woodson, Conover, University of California Press, Berkeley, 1985

IES Lighting Handbook, Illumination Engineering Society, 8th Ed., 1993

ARP4256, Design Objectives for LCDs for Part 25 (Transport) Aircraft

Walsh, J. W. T., Photometry, Dover, NY 1965

3. DEFINITIONS:

3.1 Footlambert:

A measure of the luminance of a surface which emits or reflects light. A perfectly reflecting surface illuminated by 1 fc has a luminance of 1 fL (i.e., Footlamberts = footcandles x reflectance factor of surface, Footlamberts (fL) x 1.076 = millilamberts (mL), Millilamberts x 0.929 = fL).

3.2 Footcandle:

A unit of measure of illumination. 1 fc is the illumination on a surface 1 ft from a uniform point source of 1 candela (cd).

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3.3 Reflectance:

The ratio of the amount of light reflected from a surface to the amount of light incident on a surface. Usually this is given as a percentage.

3.4 $$\% \text{ Reflectance} = \frac{\text{Light reflected from a surface}}{\text{Light incident on a surface}} \times 100 \qquad \text{(Eq. 1)}$$

If the surface were a perfect white reflector, this would be 100%. For example, white paint will reflect about 80 to 95% of the light that hits it. Medium gray has a reflectance of around 50%, dark blue about 8%.

3.5 Contrast Ratio:

The ratio of the amount of light coming from an object to the amount of light from the area surrounding the object.

$$\text{Contrast ratio} = \frac{\text{Amount of light from object}}{\text{Amount of light from surrounding area}} \qquad \text{(Eq. 2)}$$

Example: If we put a white instrument (reflectance 90%) on a dark blue panel (reflectance 8%) we will get a 90:8 (11:1) reflectance ratio. The same instrument on a dark gray panel (reflectance 30%) would have a 3:1 contrast ratio.

Note that this ratio could work with an internally illuminated instrument or a flood-lighted panel.

4. METHODS OF LIGHTING:

Any lighting method which meets the recommendations should be considered satisfactory. White lighting should be considered the basic illumination. In special applications where maintenance of maximum dark adaptation is necessary, red lighting may be used.

5. RECOMMENDATIONS:

5.1 The desired system for general aviation aircraft instrument panel and cockpit lighting should furnish light of adequate intensity and distribution under all conditions of external illumination so that the crew may read instrumentation, placards, check lists, manuals, maps, instrument color coding, and distinguish controls without undue interference with their vision outside of the aircraft.

5.2 General:

5.2.1 If different colored lighting systems are incorporated, they should be separately controlled.

5.2.2 Whatever method of lighting is used, it should provide for illuminating not only instruments and indicators, but also switches, placards, and knobs. Light assemblies should not interfere with a clear view of the instrument face. The designer should take into consideration the angle of the view of the user(s) of the instrument.

Light distribution and shielding should be accomplished to eliminate or minimize direct or indirect glare and reflection from instrument faces, panels, and windshields. Shadow blanketing of the panel and its components by controls, accessories, or the pilot's body should be avoided.

5.2.3 Lighting shall not interfere with legibility of markings for daylight operation.

5.3 Arrangements:

5.3.1 It is recommended that the instrument panel and other areas be lighted in sections corresponding to the intended use of the aircraft. For single-pilot aircraft the light may be controlled by a single intensity control. For two-pilot aircraft the panel should be lighted in at least two flight sections, with separate intensity controls covering duplicated instruments. If a third section is used to include shared instruments and indicators, it should have its own intensity control. If flood lighting is used, the previously mentioned principles should be followed.

5.3.2 Specific effort should be made to provide even illumination on the face of each instrument or indicator and to balance illumination among the instruments. The light reflected from an instrument as compared to the light reflected from the instrument panel should not exceed a 7:1 ratio. For example, if the light reflected from an instrument was 7 fL, the light reflected from the panel surrounding the instrument should not be less than 1 fL. Note 5.7.1. See Section 3, Definitions.

5.3.3 Aircraft should be provided with adequate light traps and curtains to isolate the pilots from strong light coming from the passenger areas or provide for ultimate control of the light by the pilot.

5.3.4 Each pilot should be provided with a map-reading light, controlled by an intensity control. This light should provide diffused illumination for an area adequate for chart reading without interfering with other cockpit activities.

5.3.5 To provide an emergency lighting system, a source of white light for the pilot(s) should be supplied. (A flashlight or other independent means is acceptable.)