Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE INFORMATION REPORT

AIR 512 A

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AIRCRAFT CABIN ILLUMINATION

1. INTRODUCTION

This document provides the aircraft designer, architect, industrial designer and electrical engineer with design criteria to properly illuminate aircraft cabin interiors.

2. PURPOSE

2.1 Scope: This document covers the general requirements for cabin lighting in order to provide satisfactory illumination for, but not limited to:

(a) Boarding and deplanning
(b) Movement about the cabin
(c) Reading
(d) Use of lavatories
(e) Use of work areas
(f) Exiting under emergency conditions
(g) Using stowage compartments, coat rooms and closets
(h) Using interior stairways and elevators

2.2 Design Goals - Visual: The designer should strive to provide a comfortable visual environment by proper consideration of:

(a) Quantity of light - the amount of illumination required at each area or location to perform the pertinent visual task.

(b) Quality of lighting - the brightness distribution, including contrasts in the field of view. This includes the surrounding area, that is, seat backs, carpeting, bulkheads, overhead, etc., as well as brightnesses of light sources and fixtures. The values will be influenced by the color, texture and finish of the materials. Visual comfort is very much dependent upon the quality of the lighting.

1. Brightness distribution is affected by glare (excessive brightness in the field of view), both direct and reflected, the source of which can be the light sources in the cabin, or light sources exterior to the cabin, such as the sun. The reflected glare may come from shiny, specular surfaces inside the cabin, or airplane parts, such as the wing on the exterior.

2. By choice of colors and brightnesses, claustrophobic effects may be reduced.

2.3 Design Goals - Electrical and Mechanical: The designer should strive to accomplish the above with:

(a) Adequate hardware design with consideration given to:

1. Minimal weight
2. Reliability of equipment and lamps
3. Ease of maintenance

(b) Safety

1. Electrical
2. Heat

2.3.1 Illumination Design Errors:

(a) Improper quantity of light - Too much as well as too little

(b) Inadequate quality of lighting

1. Improper distribution
2. Exposed light sources-direct glare
3. Improper consideration of secondary surfaces that absorb or reflect light - brightness distribution, colors, reflected glare, etc.

(c) Difficulty of maintaining lighting systems

2.3.2 Ingredients for Good Lighting:

(a) Sufficient illumination for task

(b) Adequate quality

1. Adequate brightness control with respect to:

a) Direct glare
b) Reflected glare
c) Contrast between task and surround
d) Color of furnishings and light

3. SPECIFIC RECOMMENDATIONS

3.1 Cabin Lighting:

3.1.1 Cabin Lights: Cabin lighting shall be provided in the passenger compartments by an indirect, direct, or combination lighting system to provide sufficient illumination of adequate intensity and distribution. Warm white lighting tones shall be used throughout passenger areas for comfort and aesthetic quality unless special applications make cool white or daylight tones necessary.

3.1.2 Cabin Lighting Control: Cabin illumination shall be controllable at the attendent's panel for suitable lighting levels.

3.1.3 Colors: Careful blending of colors of light with the color of the interior decorations will help to minimize the effect of claustrophobia for passengers with sensitivity to space limits.

3.1.4 Boarding Lights: When the passenger is boarding or departing, a temporary condition exists in changing from one environment to another. The entrance way, tops of seats, baggage compartments, steps, ramps, and other potential obstructions (such as partitions) should be brightly illuminated. The entrance area, when not in use, shall be illuminated the same as the remainder of the cabin.

3.1.5 Reading Lights: Passenger reading lights shall be provided for each passenger seat location. The "ON-OFF" light switch shall be located adjacent to the light or adjacent to the seat, when the former is not practical. These switches shall be separated from cabin attendant call button with as much distance that is practicable. The lighting fixtures must be mechanic-adjustable to allow for both longitudinal and transverse changes in cabin seating. The reading light design shall be in accordance with the requirements of ARP 378.

3.1.6 Galley: Galley area shall be lighted as recommended in ARP 712.

3.1.7 Flood Lights: When sidewall flood lights are used for aesthetic effects, the illumination sources shall not be visible. Provisions for dimming or cut-off shall be provided on the attendant's panel.

3.1.8 Signs: "NO SMOKING" and "FASTEN SEAT BELT" signs shall be provided in passenger compartments. "RETURN TO CABIN" or "RETURN TO SEAT" signs shall be provided in each lavatory. Signs reading "LAVATORIES-VACANT-OCCUPIED" shall be installed and visible to all passengers in respective areas. When illuminated, the signs shall be clearly visible to all persons from whatever distance or angle the viewing may occur, even under daylight ambient lighting conditions.

3.1.9 Sign Controls: An "ON-OFF" switch shall be installed in the pilot's overhead panel to control the "FASTEN SEAT BELT", "RETURN TO CABIN", and "NO SMOKING" signs. "LAVATORIES-VACANT-OCCUPIED" signs shall be controlled by the respective lavatory lock latches. The circuitry for "NO SMOKING", "FASTEN SEAT BELT" and "RETURN TO CABIN" shall be connected to the call chime circuitry to audibly alert passengers.

3.1.10 Aisle Lights: Light sources shall be provided to illuminate aisles and entry ways in the passenger compartments when general illumination is reduced or off. The light shall be controlled to provide adequate aisle lighting without annoying the passengers.

3.1.11 Lavatory Lighting: Each lavatory shall be provided with light fixtures which will illuminate the area. Lighting equipment at the mirror should direct light toward the user and not onto the mirror. Incandescent lamps shall be used for low level illumination that will not interfere with passenger comfort during night operations when the door is opened. High intensity illumination for each lavatory shall be controlled by a "BRIGHT-DIM" switch integral with the respective lavatory door lock. Opening the lavatory door shall extinguish the bright light. Provisions shall be made to maintain the lights in the "BRIGHT" position for servicing and maintenance purposes with the lavatory door open.

3.1.12 Coat Compartment Lighting: Illumination shall be provided in the fixed coat (garment bag) storage areas. The lighting fixtures shall be designed such that they do not come in contact with the garments. Control switches shall be conveniently located in the coat rack area.

3.2 Emergency Lighting: Shall be in accordance with ARP 503.

4. OTHER CONSIDERATIONS

4.1 Incandescent Fixtures: Fixtures must be designed and the lamps selected to avoid overheating, potential deterioration of the fixture, possible fire hazard and shortened lamp life.

4.1.1 Fluorescent Ballasts: Ballast must not be underdesigned for the known conditions of voltage, frequency, heat and vibration. The selection of the wire and wire size and insulation in the ballast windings must be capable of continuous duty for many thousands of hours under the known conditions. Ballasts shall be readily accessible and easily detached with terminal strip, electrical connector, or other electrical junction device for ease of maintenance.

4.2 Reliability and Maintenance: Reliability and simplicity of maintenance are important design goals. Fixture installations should be readily accessible for inspection, removal, and lamp replacement without special tools or skills.

Selection of components for design reliability is a criteria for reduction in maintenance cost. Adequate instructions should be provided in the maintenance and overhaul manual.

4.3 Safety: Lighting fixture designs shall have adequate heat dissipation and ventilation. Luminaires should be designed and located such that nothing can be put over them which will trap heat. Where this cannot be avoided (as an example, overhead stowage compartment) then means must be taken to prevent fire hazard and heat damage to the articles in these compartments. This protection shall insure physical separation and methods of conducting, convecting or radiating the heat elsewhere. All high voltage fixtures shall be grounded to protect passengers and maintenance personnel. All connecting wire terminals shall be protected from falling objects and accumulated dirt by terminal guards placed above connecting points.

4.4 Recommended Minimum Light Levels: See Appendix I.

5. LIGHT SOURCES

The types of lamps primarily used for lighting aircraft cabins are incandescent filament lamps and fluorescent lamps.

5.1 Incandescent Filament Lamps: In general, incandescent filament lamps used in aircraft cabin lighting comprise a range from 0.3 watt, 0.03 candela to 36 watt, 50 candelas. They are used in every facet of cabin lighting, including indications, signs, area, reading and decorative. Their efficacy of light production ranges from approximately 1.2 lumens per watt to 15 lumens per watt, depending on size, wattage and design life.

5.2 Fluorescent Lamps: In general, fluorescent lamps are used for area lighting, including cabin, gallery and lavatory and decorative lighting. The fluorescent lamp is an electric discharge light source, in which light is predominantly produced by fluorescent powders activated by ultraviolet energy generated by a mercury arc. There are two basic types of fluorescent lamps, hot cathode and cold cathode.

5.2.1 Hot Cathode Fluorescent Lamps: Hot cathode fluorescent lamps employ coiled tungsten filaments as electrodes. These are coated with one or more of the alkaline earth oxides. This electron-emissive coating provides an abundance of free electrons when hot. By suitable circuit arrangements, these cathodes can be heated to a satisfactory electron emitting temperature before the arc is struck (preheat, trigger or rapid start) or they may be required to act momentarily as cold cathodes until heated by the electron stream after starting (instant start or slimline). The efficacy of light production of the hot cathode lamps used on aircraft varies from about 15 lumens per watt for the 4 watt rapid start lamps to about 80 lumens per watt for the 40 watt warm white lamp. These figures are for the lamp only and do not include ballast losses.

PREPARED BY
A-20C INTERIOR SUBCOMMITTEE OF
SAE COMMITTEE A-20, AIRCRAFT LIGHTING

APPENDIX I

RECOMMENDED MINIMUM LIGHT LEVELS

Boarding and Departing	Minimum FC
Entry Door and Obstructions	10
Entry Floor	5
Aisle	2
Seats	5
Baggage Racks	5
Flight Conditions - Night - Illuminated	
Aisle	2
Seats	2
Partitions	-
Reading Lights at Arm Rest Level	25
Flight Conditions - Night - Sleeping	
Aisle	1
Partitions and Doors	1
Lavatories	
Task Area	20-30
Floor	2
Galley	
At Counter Top	20-30
At Lowest Drawer	5
Storage and Baggage (not in cabin)	5

APPENDIX 2

EXPLANATION OF TERMS

CANDELA

The candela (formerly candle) is the unit of luminous intensity of one-sixtieth of one square centimeter of projected area of a black body radiator operating at the temperature of solidification of platinum.

CANDLEPOWER

Candlepower is luminous intensity expressed in candelas.

FOOTCANDLE

The footcandle is the unit of illumination when the foot is taken as the unit of length. It is the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced on a surface all points of which are at a distance of one foot from a directionally uniform point source of one candela.

FOOTLAMBERT

The footlambert is a unit of luminance (photometric brightness) equal to $1/\pi$ candela per square foot, or to the uniform luminance of a perfectly diffusing surface emitting on reflecting light at the rate of one lumen per square foot, or to the average luminance of any surface emitting or reflecting light at that rate.

ILLUMINATION

Illumination is the density of luminous flux incident on a surface; it is the quotient of the luminous flux by the area of the surface when the latter is uniformly illuminated.

LIGHT

For the purposes of illuminating engineering, light is visually evaluated radiant energy.

LUMEN

The lumen is the unit of luminous flux. It is equal to the flux through a unit solid angle (steradian), from a uniform point source of one candela (candle), or to the flux on a unit surface, all points of which are at a unit distance from a uniform point source of one candela.

LUMINANCE (PHOTOMETRIC BRIGHTNESS)

Luminance in a direction, at a point of the surface of the source, of a receiver, or of any other real or virtual surface is the quotient of the luminous flux leaving, passing through, or arriving at an element of the surface surrounding the point, and propagated in directions defined by the elementary cone containing the given direction, by the product of the solid angle of the cone and the area of the orthogonal projection of the element of the surface on a plane perpendicular to the given direction; or it is the luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction.

LUMINOUS FLUX

Luminous flux is the time rate of flow of light.

LUMINOUS INTENSITY

Luminous intensity of a source of light in a given direction is the luminous flux per unit solid angle in the direction in question. Hence, it is the luminous flux on a small surface normal to that direction divided by the solid angle (in steradian) which the surface subtends at the source.