AEROSPACE INFORMATION REPORT

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc. 485 Lexington Ave., New York, N.Y. 10017

AIR 512

Issued 4-15-66
Revised

AIRCRAFT CABIN LIGHTING

1. PURPOSE - To bring to the attention of the aircraft designer, architect, industrial designer, and electrical engineer the many factors in addition to the footcandles, involved in proper lighting of aircraft cabins.

2. GOALS

a. Seeing efficiency
b. Comfort
c. Contentment
d. Reduction in apprehension about flying
e. Minimization of claustrophobia
f. Reduction of fatiguing contrasts
g. Interrelation of color scheme, seeing efficiency, and emotional status
h. Readability and ease of visability of signs
i. Adequate wiring and simplicity of voltages
j. Minimization of fixture weight
k. Ease of maintenance of fixtures
l. Safety

3. BASIC CONCEPTS

3.1 Radiant Energy - The radiant energy from a source or sources is only one factor in achieving proper illumination. Assuming the source to be hidden from view, we see only the result of the modification of this energy by the surround, whether by reflection or transmission.

3.2 Luminous Energy - The luminous energy from a light source that arrives at an object is referred to in terms of "footcandles." The energy from the source decreases very rapidly (inversely as the square of the distance) as the distance from the source increases.

If several sources impinge on an area, the total illumination is influenced by:

a. Number of sources
b. Size of each source
c. Distance each source is from area
d. Angle of incidence of light rays on area
e. Reflectance of the surround
f. Reflection of area

3.3 Brightness - Assuming a source hidden from the eye, the eye sees only what is reflected by or transmitted through the object, for example, the light or energy reflected off a rug or transmitted through a sign. The term used to describe this visual attribute is "brightness" and is measured in foot-lamberts.

Printed in U.S.A.

If we understand that what we see is defined by "brightness," the importance of color and texture of the materials used in aircraft cabins, the diffusing materials used around light sources, the specular reflectance of the paint and materials, and the specular distribution of light from the source becomes apparent. Obviously with the same amount of footcandles falling on a dull black velvet and a glossy piece of white paper, the paper will look very much brighter because it reflects a great deal more of the incident energy.

3.4 Color - The visible spectrum runs from 4000 to 7000 angstroms in wave lengths, the blues being in the shorter (4000) wave length end, and the reds in the longer (7000) wave length end. The greens and the yellows are in between. White light is a combination of the red, blue, and green wave lengths.

A red surface is one that reflects red wave lengths and absorbs others, while a blue surface reflects blue and absorbs others, etc. Black absorbs all wave lengths and white reflects all wave lengths. A blue light source on a red wall would look black but on a white wall would look blue. In other words, in selecting a cabin color scheme, the light source should be rich in the colors the decor will reflect, in order to get the maximum brightness from the source; otherwise, light energy is being needlessly dissipated.

The incandescent light sources have more energy output at the red-yellow end than the blue. The fluorescent, more in the blue-green than red-yellow.

3.5 Psychophysical Aspects - The eye is a remarkable instrument. It can change focus for different distances, differentiate between colors etc., but most important, by means of an iris, it can increase or decrease the amount of light energy reaching its sensitive areas, to adjust to the most comfortable level adequate for the task being accomplished.

If the light reflected from the object is too bright, and the iris has reached the limit of closure, irritation results, or the eyes are closed or turned away. Conversely, if the light reflected from the source is too dim, and the iris is open to its widest limit and still cannot get enough light energy, the result is strain, fatigue, and irritation.

Any glare in the field of view, if brighter than the object, masks the ability of the eye to see, since the iris closes to compensate for the brightness of the glare and, as a result, is too far closed to adequately see the object.

In order to distinguish one object from another, there must be contrast between the two. Contrast ratio may be low as a result of near-equal reflectance or colors, or of the light level being too low.

On the other hand, for a relaxed or sleeping condition, contrast should be at a minimum. This is more important on long flights.

3.6 Specific Areas or Conditions

3.6.1 Boarding and Departing - This is a temporary condition during which a subject changes from one environment to another. Comfort is secondary to safety. The entrance way, tops of seats, baggage compartments, steps, ramps, and partitions should be brightly and directly illuminated with white light.

3.6.2 Seated Awake - The normal direction of vision is either toward the lap if reading or eating, horizontal or upward if relaxing. Glare and contrast in the field of view should be minimum. Lights should be masked from direct view and should flood in the same direction that the people are facing. The back of the seat backs should have low reflectivity compared to the rest of the seat. The floor should be illuminated from below the knee level. The rug should not be entirely dark or non-reflecting. A small light-colored highway reflective design should be worked into the rug to outline its location.

3.6.3 Seated Asleep - Although people are normally accustomed to total darkness when sleeping, there must be some illumination in an occupied airplane. Since people will be adapted to much lower light levels, less light will be required to adequately move around.

3.6.4 Work Areas - Hostess - The galley should be illuminated by overhead fixtures located in such a way that illumination is confined to the work area. These lights should not be in a position where the hostess would normally obstruct the illumination. They should be turned off when not in use, and provisions should be made to screen the area.

The lavatory should have brilliant illumination and highly reflective ceiling, walls, and facilities, and the light should automatically be extinguished when the facility is not in use.

3.6.5 Signs - Signs, such as "No Smoking," "Fasten Seat Belts," "Return to Cabin," etc. should provide good visibility, even under bright ambient light conditions. Noncritical signs, such as "Lavatory Occupied," should be visible, but not be objectionably bright, especially in night-time cabin-lighted compartments.

3.6.6 Reading Lights - These are covered in a separate recommended practice by Subcommittee A-20C.

3.6.7 Emergency Lighting - These are covered in a separate recommended practice by Subcommittee A-20C.

3.6.8 Other Considerations - Reliability and simplicity of maintenance are important. When reliability goes down, maintenance costs go up. Light installations should be readily accessible for inspection, removal, and lamp replacement, without special skills or tools.

Light-weight miniaturized components are an important factor with jet aircraft and will be critical in supersonic jet aircraft. Not only should the size and weight of components be reduced, but also, the amount of wiring. The 115 v a-c systems in the new aircraft have provided much higher illumination levels with reduced weight of wiring, and power for small incandescent lamp fixtures can be stepped down near the luminare location, resulting in less wire of lighter weight.

The type of lamp used in a fixture should be marked inside the fixture to preclude installation of the wrong lamp. Reflectors in fixtures can direct more of the total energy in the needed direction, thus making smaller sources adequate.

3.6.9 Safety - Special attention must be paid to cooling and ventilating of luminairs. Experience has shown that a significant number of in-flight fires have resulted from heat build-up from lamps. Luminaires should be designed and located so that nothing can be put over them which will trap heat.

High voltage fixtures and connections should be grounded as a protection to passengers and mechanics.

3.7 Recommended Minimum Light Levels - See Appendix 1.

3.8 References - See Appendix 2.

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

APPENDIX 1

Recommended Minimum Light Energy and Brightness Levels

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