SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP503

REV. F

Issued 1956-12
Revised 2004-07

Superseding ARP503E

Emergency Evacuation Illumination

1. SCOPE:

This Aerospace Recommended Practice (ARP) provides criteria for design and location of power supplies, controls, light fixtures, and associated equipment which are used to provide emergency illumination in transport aircraft, designed to comply with FAR 25 (Ref. 1) for operation under FAR 91 (Ref. 11) and FAR 121 (Ref. 2), and also in compliance with FAA Advisory Circulars AC25.812-1A (Ref. 3) and AC25.812-2 (Ref. 10).

It is not the purpose of an ARP to specify design methods to be followed in the accomplishment of the stated objectives.

2. INTRODUCTION:

The purpose of this ARP is to provide criteria that will lead to standards of illumination for emergency evacuation in passenger or cargo transport aircraft such that the emergency illumination will facilitate egress under emergency conditions.

Consideration is given to existing requirements of the FAA and to the recommendations of aircraft operators and those involved in the manufacture or use of the Emergency Lighting System. Occupant safety is the primary objective, with appropriate provisions for crew system control taken into consideration. The criteria established herein are intended to produce an Emergency Lighting System that will comply with the Federal Regulations for Commercial Transport Airplanes. However, these recommendations are but one means of meeting the objective. Alternate practices may provide equivalent or superior results.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1 Definition:

Emergency illumination is that illumination that is provided when normal illumination is unavailable. Emergency illumination should be adequate to permit aircraft occupants when leaving certified seats to locate, proceed to, operate, and use cabin emergency exits, escape slides, life jackets, life rafts, slide rafts and special survival equipment.

3. DETAIL RECOMMENDATIONS:

3.1 General Provisions:

3.1.1 System Description: An emergency lighting system(s) independent of the main lighting system, should be provided for (1) interior emergency lighting which includes illumination of the cabin, exit areas, floors of the passageways leading to each passenger emergency exit, (2) exit locating and marking signs, (3) exterior emergency lighting, and (4) floor proximity escape path lighting/markings.

3.1.2 Dark Adaptation: Emergency illumination should be designed to minimize glare or not affect dark adaptation in such a way as to compromise the ability to escape.

3.1.3 Obstruction of Light: Emergency light fixtures should be in locations that assure that devices such as open life raft compartment doors or emergency equipment doors do not obstruct the illumination of emergency equipment and escape routes.

3.1.4 Crash Protection: The emergency illumination system should be designed and installed as specified in 3.1.10 and located in a manner that will minimize damage to or loss of any portion of the emergency illumination as a result of a survivable emergency landing on land or water.

3.1.5 Fuselage Break-up: Break-up of the fuselage should not render inoperative more than 25% of the required electrically illuminated emergency lights in addition to those directly destroyed by the break. At least one exterior emergency light on each side of the airplane shall be operative exclusive of those that are directly damaged by the separation. At each useable exit, each exit marking sign should remain operative exclusive of those that are directly damaged by the separation.

3.1.6 Operating Duration: Both interior and exterior emergency illumination should be maintained at or above minimum levels for no less than 10 min at critical ambient conditions after an emergency landing.

Critical ambient conditions should be determined for each application and utilized for testing to satisfy this recommendation. If battery packs are used, conditions to be considered are: cold soak at lowest ambient temperature anticipated, cabin heating for an appropriate period, passenger loading, taxi, and emergency evacuation. If battery packs are used and installed outside the heated and/or pressurized compartment the cabin heating period may not be appropriate; the landing phase after a long cruise may be more critical.

3.1.7 Control and Indication: The emergency lighting system should provide for manual operation of the lights from the flight crew station and from a location in the passenger compartment that is within reach of a flight attendant seated in an assigned seat. In an emergency lighting system design that allows the activation of flight deck emergency lighting from the cabin, such facilities should be available only when normal aircraft power is off. Emergency lighting in the flight deck should be arranged so as to minimize glare and problems with dark adaptation by the flight crew.

3.1.7.1 The cockpit control device should have ON, OFF, and ARMED positions and have means to safeguard against inadvertent operation of the control device from the ARMED and from the ON positions. When either the cockpit control or the control at the cabin attendant's seat is ON the lights should remain lighted upon interruption of the airplane's normal electrical power source, except as noted in 3.1.5. When the cockpit control is in the armed position, the lights should illuminate upon interruption of the airplane's normal electrical power sources and remain illuminated except for an interruption caused by a transverse separation of the fuselage during a crash landing. Operation of the emergency lighting system should not be dependent upon normal aircraft power.

3.1.7.2 The cabin control device should have a means to safeguard against inadvertent operation and be capable of turning on the emergency light system, even with the cockpit control device in the OFF or ARMED position.

3.1.7.3 There should be a flight crew warning light that illuminates when normal aircraft power is on in the airplane and the emergency lighting system is not ARMED.

3.1.8 Other Use of Emergency Lighting System Components: Illuminated signs and other portions of the emergency lighting system may be used under normal conditions, provided that depletion of the emergency illumination power supply is not possible, beyond the requirement of 3.1.6.

3.1.9 Independent Power Source: If rechargeable batteries are used as the energy supply for the emergency lighting system, they may be recharged from the airplane's main electric power system: provided that the charging circuit is designed to preclude inadvertent battery discharge into charging circuit faults. It is desirable that the charging system be capable of recharging within 1 hour to facilitate aircraft dispatch. However, achievement of this charging rate should not reduce the system integrity.

3.1.10 Inertia Forces: Components of the emergency lighting system, including batteries, wiring, relays, lamps, and switches should be capable of normal operation after having been subjected to the inertia forces acting separately relative to the surrounding structure: (a) upward 3.0 g; (b) forward 9.0 g; (c) sideward 3.0 g on the airframe and 4.0 g on the seats and their attachments; (d) downward 6.0 g; (e) rearward 1.5 g.

Design consideration should be given to the fact that passenger survival may occur in crashes experiencing 20 g upward, forward and downward directions and 10 g sidewards.

3.1.11 Functional Testing: As a design objective, the emergency lighting system and associated equipment should be designed and installed so that functional tests of the system can be readily performed.

3.1.12 Maintainability: The emergency lighting system and equipment should be designed and qualified for ease of maintainability and highly reliable operation under the applicable aircraft environments.

3.2 Interior Illumination:

3.2.1 General Emergency Illumination:

3.2.1.1 Sufficient general emergency illumination should be provided in all compartments normally occupiable during taxi, takeoff and landing to permit occupants to don life jackets, to operate escape means, and to avoid obstacles while moving toward exits.

3.2.1.2 White flood light should be provided on passenger and cargo aircraft, as applicable:

a. Illumination at 64 cm (25 in) above the floor at the exit door in flight crew station of not less than 0.54 lux (0.05 ft-c).

b. Average illumination of not less than 0.54 lux (0.05 ft-c) along the center of the main passenger aisle(s) and cross aisle(s) between main aisles. This average should be determined from measurements made every 102 cm (40 in) along the center of the main passenger aisle(s) at seat arm rest height. The illumination of each 102-cm (40-in) interval should not be less than 0.11 lux (0.01 ft-c) at seat arm rest height measured parallel to the floor.

3.2.1.2 (Continued):

c. The floor of the passageway leading to each floor level passenger emergency exit, between the main aisles and the exit openings, should be provided with illumination that is not less than 0.22 lux (0.02 ft-c) measured along a line that is within 15 cm (6 in) of and parallel to the floor and centered on the passenger evacuation path.

3.2.1.3 For aircraft with passenger compartments on more than one deck level intended for occupancy during taxi, takeoff or landing, the recommendation of 3.1 and 3.2 should apply to each deck level and interconnecting stairways.

3.2.1.4 Considerations for Cabin Smoke Conditions: It has been reported by survivors of airplane crashes involving cabin smoke that cabin emergency light sources and signs located at ceiling height were totally obscured by dense black smoke. Tests conducted under authentic postcrash cabin fire environment have conclusively confirmed this (Ref. 4). In these tests the dense black smoke from fuel fires quickly rose to the ceiling and spread longitudinally through the cabin, then progressed toward the floor. In addition to the high opacity of the smoke, high temperatures, high carbon dioxide concentrations, other harmful products of combustion were carried with the smoke.

Evacuation tests under simulated white smoke conditions confirmed that lights and signs located at ceiling height were of little or no value to passenger egress once the cabin filled with smoke (Ref. 5). Both tests substantiated that while hostile smoke conditions exist in the upper portion of the cabin, survival conditions persist in the lower portion of the cabin for a significant time. Further, light sources and signs located in the lower portion of the cabin provided ample passenger awareness and enhanced evacuation.

3.2.1.4.1 When light sources which satisfy recommendations of 3.2.1 are located above the median between the floor and ceiling, additional light sources should be installed at locations within the lower half of the cabin to provide emergency path awareness. With the upper emergency lights extinguished, the lower emergency escape path markings should enable passengers to:

a. After leaving the passenger seats, visually identify the emergency escape path along the cabin aisle floor to the first exits or pair of exits forward and aft of the seat

b. Readily identify each exit from the emergency escape path by reference only to markings and visual features not more than 4 ft above the cabin floor

A greater quantity of smaller light sources closely spaced along aisle will very significantly improve visibility of lights when attenuation due to smoke exists (Ref. 6). See Appendix A for "Additional Smoke Considerations".

3.2.1.4.2 When the signs recommended by 3.2.2 are located above the median between the floor and ceiling, additional signs should be located at or below the median height (Ref. 7). See Appendix A for "Additional Smoke Considerations".

3.2.2 Exit Sign Illumination:

3.2.2.1 Location of each passenger exit should be indicated by a sign(s) visible to occupants approaching along the main passenger aisle(s).

a. Exit locator signs should be located above the aisle(s) near each exit and be internally electrically illuminated.

b. An exit marking sign should be located next to each exit and should be internally electrically illuminated (where possible).

c. Exit signs should be located on each bulkhead or divider that prevents fore and aft vision along the passenger cabin to indicate emergency exits beyond and obscured by the bulkhead or divider or if this is not possible, the sign may be placed at another appropriate location.

d. Stairway location should be indicated by an exit sign visible to passengers approaching the main aisle(s) and be internally electrically illuminated.

3.2.2.2 For signs specified in 3.2.2.1 a through d, the lighted background-to-letter contrast should be at least 10:1. This value is also applicable to symbols, arrows and instructional placards.

3.2.2.3 Lettering of the word "EXIT" on exit signs should be red and be a minimum of 38.1 mm (1-1/2 in) high on illuminated white background. The letter height to stroke width ratio should not be more than 7:1 nor less than 6:1. The background should have an area of at least 135.4 cm^2 (21 in^2) excluding the letters, arrows and symbols.

3.2.2.4 The background luminance of lighted areas of exit signs per 3.2.2.1 a and b should be no less than 86 cd/m^2 (25 ft lamberts) and the ratio of maximum to minimum luminance should be no greater than 3:1.

3.2.2.5 The initial luminance of the exit locator signs per 3.2.2.1 c and d should be no less than 1.3 cd/m^2 (0.38 ft lambert). The colors may be reversed in case of a sign that is self-illuminated by other than electrical means.

3.2.2.6 For self-illuminated signs, the nonlighted contrast ratio under ambient light between the intelligence and background should be no less than 3.0. For self illuminated exit signs, the initial brightness should be at least 400 microlamberts.

3.2.3 Instructional Placards and Signs:

3.2.3.1 The location of the exit opening handle and instruction for opening the exit should be illuminated. If self illuminated, the initial brightness should be at least 160 microlamberts.

3.2.3.2 Life raft and escape assist means stowage locations should be marked by illuminated placards or signs, with instructions as to how to operate the compartment doors. Refer to ARP577 (Ref. 8) for additional placard recommendations.

a. All letters should be no less than 7.9 mm (5/16 in) high and the luminance of lighted areas, whether floodlighted by either emergency area lighting or electrically illuminated or self-illuminated, should be no less than 0.5 cd/m^2 (0.15 ft lambert).

b. If deployment and erection of the assist means is fully automatic with opening of the associated exit, illumination of the stowage locations is not necessary.

3.2.3.3 On aircraft with an overhead escape hatch emergency lighting should be provided to illuminate the hatch outline, release handle, signs and placards per 3.2.3.2. The hatch outline should be measured at not less than four points around the outline. Obstructions, such as bunks or seat backs, along the escape route should be similarly illuminated.

3.3 Exterior Illumination:

3.3.1 General Emergency Illumination: Evacuation demonstrations have revealed that evacuees whose vision is adapted to the relatively high intensity of normal cabin lighting may not have adequate time to adapt to the dark conditions beyond the deboarding end of the escape assist means. Design consideration should be given to providing sufficient illumination of the area beyond the assist means to permit evacuees to expeditiously move away from the exit area while avoiding inhospitable terrain, aircraft components or other objects. Levels of illumination and areas of coverage should be determined for each application.

3.3.2 Inflatable Readiness Indicators: At all external exits that are equipped with escape assist means that incorporate readiness indicators, such indicators should be adequately illuminated by the exterior emergency lighting systems so as to be visible from within the cabin prior to the initiation of an evacuation.

3.3.3 Overwing Exits:

3.3.3.1 Provide a minimum of 0.32 lux (0.03 ft-c) of illumination (measured normal to the direction of the incident light) in a 0.2 m^2 (2 ft^2) area where the egressing person will make his first step outside the overwing exit(s). This light source may be inside the airplane. The 0.2 m^2 (2 ft^2) area may include any steps that are installed to decrease the height of the first step from the exit to the wing, and the lighted area on the wing surface shall be considered to begin at the inboard edge of the shadow of the step, if the lighting is installed above the door and inside the airplane.

3.3.3.2 Provide a minimum of 0.54 lux (0.05 ft-c) of illumination (measured normal to the direction of the incident light) for a minimum width of 107 cm (42 in) for a Type A overwing emergency exit and of 61 cm (2 ft) for all other overwing emergency exits along the 30% of the slip-resistant portion of the escape route that is farthest from the exit.

3.3.3.3 Provide a minimum of 0.32 lux (0.03 ft-c) of illumination (measured normal to the direction of the incident light) on the ground surface with the airplane in each of the attitudes corresponding to the normal ground attitude and the collapse of one or more legs of the landing gear where an evacuee using the established escape route would normally first contact with the ground. If the escape route is over the wing trailing edge flaps it is recommended that the ground contact area be measured from a point projected from the upper surface of the fully lowered flap to a point on the ground at least 152 cm (5 ft) aft and laterally 61 cm (2 ft) minimum width.

3.3.3.4 At over-wing exits not incorporating escape slides, lighting should provide illumination of the escape to the ground, and if provided, the overwing escape line attach points.

3.3.4 Cabin Side Exits Incorporating Escape Assist Means: The means provided to assist the occupants in descending to the ground should be externally illuminated and/or self-illuminated, so that the means is visible from the airplane in dark conditions.

3.3.4.1 External illumination should be minimum of 0.32 lux (0.03 ft-c) of illumination (measured normal to the direction of incident light) at the ground end of the escape device after full deployment when the airplane is in its normal ground attitude and when any one or more legs of the landing gear are collapsed. This illumination level should be provided where an evacuee would normally make first contact with the ground. Illumination of the ground area beyond the first contact area should be considered as indicated in 3.3.1.

3.3.4.2 The light(s) specified in 3.3.4.1 should be located high enough so that they will not be submerged after an emergency landing on water in the anticipated floating attitude.

3.3.4.3 The location of the light(s) should be such as to minimize shadows or light obstruction by deplaning evacuees, escape means, door, or hatches.

3.3.4.4 The operating duration of these lights should be equivalent to the interior emergency lighting as indicated in 3.1.6.

3.3.5 Escape Assist Means With Integral Lighting:

3.3.5.1 If an emergency lighting subsystem illuminating an escape assist means serves no other assist means, it may be independent of the airplane's main emergency lighting system, and should be automatically activated when the assist means is erected. The lighting system should not be adversely affected by stowage.

3.3.5.2 The assist means should be illuminated by integral emergency lighting, as recommended in 3.3.4.1.

3.3.5.3 The shelf life or replacement date of any dated components of the system should be marked in a conspicuous place on the system.

3.3.5.4 The operating duration of these lights should be equivalent to the interior emergency lighting as stated in 3.1.6.

3.4 Tail Cone Exits:

3.4.1 General: If a tail cone escape arrangement is provided, then emergency lighting should be provided that will:

a. Illuminate the escape route leading to the tail cone

b. Show any obstructions

c. Illuminate the escape route to the ground and the escape assist means and the readiness indicator, if provided

3.4.2 Passageway Illumination: The passageway leading to tail cone exits should be provided with illumination. The illumination measured at each 102 cm (40 in) interval should not be less than 0.11 lux (0.01 ft-c) at 64 cm (25 in) above the floor and should average not less than 0.54 lux (0.050 ft-c).

3.4.3 Operating Duration: The operating duration of these should be equivalent to the interior emergency lighting as stated in 3.1.6.

3.5 Means of Compliance:

Compliance with the exterior emergency lighting recommendation may be shown by the application of candlepower distribution curves of the lighting fixture to the airplane geometry under all foreseeable conditions. Refer to AC 20-38 (Ref. 9) for determining compliance with FAA emergency lighting requirements.

4. REFERENCES:

1. Federal Aviation Regulation, Part 25 Airworthiness Standards: Transport Category Airplane, Amendments 25-1 thru 25-110. Emergency Lighting FAR 25.811 & FAR 25.812 last revision 25-88.

2. Federal Aviation Regulations, Part 121 Certification and Operations: Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft, Amendments 121-1 thru 121-156.

3. FAA Advisory Circular AC 25.812-1A.

4. DOT/FAA/CT-82/55, Examination of Aircraft Interior Emergency Lighting in a Postcrash Fire Environment; James Demaree, June 1982.

5. FAA/AM-80-13, Readability of Self-Illuminated Signs Obscured by Black Fuel-Fire Smoke; P. G. Rassmussen, et al, July 1980.

6. Allard's Law and Smoke-Filled Cabins, A Preliminary Report, presented at the meeting of Subcommittee A-20C, of the SAE Aircraft Lighting Committee A-20, Orlando, Florida, May 16, 1977; Ted projector.

7. FAA-AM-81-7, Emergency Cabin Lighting Installation: An Analysis of Ceiling vs Lower-Mounted Lighting During Evacuation Trials; P. G. Rassmussen, et al, February 1981.

8. SAE ARP577, Emergency Placarding - Internal and External.

9. FAA Advisory Circular AC 20-38A.

10. FAA Advisory Circular AC 25.812-2.

11. Federal Aviation Regulation, Part 91 General Operating and Flight Rules.

5. NOTES:

5.1 The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not technical changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

PREPARED UNDER THE JURISDICTION OF
SAE SUBCOMMITTEE A-20C, AIRCRAFT LIGHTING INTERIOR OF
COMMITTEE A-20, AIRCRAFT LIGHTING