



U.S. Department
of Transportation

Federal Aviation
Administration

Advisory Circular

Subject: EMERGENCY EXIT SIZE AND SHAPE

Date: 10/29/87

AC No: 23.807-1A

Initiated by: ACE-100

Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance regarding acceptable means of compliance with Part 3 of the Civil Air Regulations (CAR) and Part 23 of the Federal Aviation Regulations (FAR) applicable to the size and shape of the emergency exits in normal, utility, acrobatic, and commuter category airplanes. This material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. CANCELLATION. AC 23.807-1, Emergency Exits in Small Airplanes, dated September 7, 1983, is cancelled.

3. RELATED REGULATIONS. Section 3.387 of CAR 3 and Section 23.807 of FAR 23.

4. BACKGROUND. Part 3 of the CAR, section 3.387 and Part 23 of the FAR, section 23.807 have required that all emergency exits have sufficient size and shape to admit a 19- by 26-inch ellipse. Time to egress through an exit is related to the total open area and the most critical dimension of the exit. The area of a 19- by 26-inch ellipse is 388 square inches. Studies for evacuation demonstrations with the standard 19- by 26- inch ellipse have shown that the duration to egress was equal or less with exits having a total open area equal to or greater than 388 square inches and the most critical dimension, width or height, greater than 19 inches, but lacking the shape to admit a 19- by 26-inch ellipse.

5. APPLICATION. This guidance material is applicable for new, amended, and supplemental type certificates or alterations that affect emergency exits.

6. ACCEPTABLE MEANS OF COMPLIANCE.

a. General. Alternatives for compliance to the airworthiness standards are permitted by an equivalent level of safety. One method for determining compliance by an equivalent level of safety is by the test procedure in paragraph 6b below. Demonstrations have shown that the emergency exit size and shape greatly effect the time and ease of an emergency evacuation. An equivalent level of safety finding should only be considered if the exit meets the logical limits which correspond to the standard exit; that is, the total open area is equal to or greater than 388 square inches and the most critical dimension, width or height, is not less than 19 inches. These limits for area, width, and height were established after considering human engineering factors, evacuation demonstrations, and existing airworthiness standards.

b. Test Procedure. The purpose of this test procedure is to determine the acceptability of the proposed exit configuration by comparing the egress time from the proposed exit to the time required to pass through an exit configuration defined by § 3.387 of the CAR and § 23.807 of the FAR.

(1) Area of Opening. The following factors should be considered when measuring or computing the area of opening:

(i) Firm protusions that would hamper egress in the opening should be eliminated from the minimum required exit opening. Examples of these protrusions are seals or escape exit latches, which will not easily compress, move, or fold out of the opening with the motion of a person moving through the opening.

(ii) When a compressible seal protrudes into an opening, the seal may be in the compressed condition when measuring or computing the opening area.

(iii) During the comparison test, the emergency exit opening used as a standard is an opening that will allow passage of 19- by 26-inch ellipse with the major axis of the ellipse being in at least one position; that is, vertical, horizontal, or any other position.

(iv) The area leading to the opening should be clear and unobstructed. Minor obstructions in the region could be acceptable if there are compensating factors to maintain the effectiveness of the exit; that is, a total effective open area of 388 square inches and the most critical dimension, width or height, is not less than 19 inches. For example, soft seat back cushions may constitute minor obstructions. Certain unattached, or loose, soft seat back cushions may be permitted to encroach into the minimum required exit opening providing that:

(A) the cushion can be readily moved away from the exit and the exit can be easily opened; and

(B) when the cushion is in its normal position, the exit locating sign is not obscured and the exit is identifiable.

(2) Comparison Test Conditions. The comparison test will determine the difference in mean escape time between the proposed and standard exit or exits.

(i) A mockup of a section of the fuselage may be used so that arrangement of exit, passenger seats, step-up distance from cabin floor to exit sill, and stepdown distance from sill to wing or step, simulate those proposed for the airplane. Ramps or stands are permitted to assist participants in descending from the wings when overwing exits are used, provided the acceptance rate of the ramp or stand is no greater than the acceptance rate of the means available on the airplanes for descent from the wing during an actual crash landing situation. Mats may be used on the floor or ground to protect participants. No other equipment that is not part of the airplane's emergency evacuation equipment may be used to aid the participants in reaching the ground.

(ii) At start of each trial, participants may either be seated with belts fastened or may be standing in line, whichever is more convenient, provided that the procedure is maintained consistently for each trial.

(iii) Participants should not be permitted any trials prior to the test, but they may be briefed on the purpose of the test; that is, to demonstrate a rapid emergency evacuation of the airplane and the method of escape. Examples of briefing to ensure rapid egress in escaping through window exits would be the instruction to pass through one foot first, then head and body, then the other foot; that is, "foot first, then head." The participants should not be informed that this test is to compare exits. The context of the briefing should be documented for consistency.

(iv) The test should be conducted under dark conditions or simulated dark conditions for both the standard exit configuration and each proposed exit configuration. Dark lighting should simulate night lighting conditions; that is, no moonlight or starlight. If the airplane is equipped with a required emergency lighting system, the emergency lights may be used during the tests. Also, lighting may be allowed at ground level for aid in leaving the area near the airplane providing the lighting is kept low and shielded so it does not aid in evacuating the airplane. *

(v) Participation composition should simulate an average passenger distribution. To avoid the use of participants under 18 and over 60 years of age, the following age/sex distribution of participants has been found acceptable for emergency evacuation demonstrations addressed in this advisory circular: *

(A) At least 25 percent of the participants should be over 50 years of age with at least 40 percent of this group being female.

(B) The remaining participants may be 50 years of age or younger with at least 30 percent of this group being female.

(C) At least 5 percent of the participants should weigh 205 pounds or more.

(3) Statistical Design.

(i) There should be 15 or more subjects for each exit configuration to be tested, including the standard. Therefore, if two exit configurations are to be compared, there should be a total of at least 30 people; if three exit configurations, at least 45 people; etc.

(ii) The subjects should be assigned to a number of subgroups equal to, or a multiple of, the number of configurations to be tested, including the standard. As noted above, the number of subjects in each subgroup should be at least 15. If the number of passenger seats is less than 15, one of the following methods is satisfactory:

(A) The subgroup should be divided into sub-subgroups of approximately equivalent size wherein the sub-subgroup size is equal to, or less than, the passenger-carrying capability of the airplane. The egress time of the sub-subgroups is totaled to constitute the subgroup time.

(B) The subjects without passenger seats should enter the cabin through the entry door or any other suitable entry as necessary to supplement the passenger-carrying capability of the airplane.

(C) When a mockup for an airplane is used, even if the number of passenger seats is less than 15, the total subgroup of 15 subjects may participate at the same time, providing the increase in space from the standard mockup for the additional subjects does not degrade the comparison tests. Under these conditions, the subjects of the least physical agility should be in the most critical position.

(iii) The subgroups should be as nearly alike as possible with respect to physical agility, age, sex, weight, and the like. This can be achieved by first stratifying the total set of subjects by age and sex and then subdividing each age-sex group at random into the required number of subgroups.

(iv) Each subgroup should test each configuration, but the order of trials should be different for each subgroup and should be chosen in accordance with the principle of the Latin Square. The principle of the Latin Square is that each configuration be tried once by each group and appear once in each possible order. Thus, if there are two configurations to be tested and, therefore, two subgroups labeled A and B, then Group A should try first the standard then alternative configuration; Group B should make trials in the reverse order. For the case of three configurations, Group A might try first the standard, then the first alternative and last the second alternative; Group B would try the first alternative, second alternative, and standard, in that order; and Group C would first try the second alternative, then the standard and lastly, the first alternative. The arrangement eliminates the effects of individual participant's learning, fatigue, and agility.

(4) Recording of Trials.

(i) For analyzing the trials for difficulties with an exit, individual escape time, and other performance factors, motion pictures or video recordings should be made. Silent film is acceptable.

(ii) A large clock with a second hand should be placed in the camera field so that time will be recorded. Alternatively, synchronized electric cameras may be used with the time superimposed in the film processing. A signal light to indicate the beginning and end of each trial should be arranged in the camera field.

(iii) Evacuation time should be measured to the nearest second. The timed demonstration begins immediately following the announcement "Evacuate Airplane" and the evacuation is completed when the last occupant reaches the ground (stand or ramp if authorized for the test).

(5) Evaluation of Results.

(i) The effectiveness of the proposed exit, or exits, being tested is compared with the standard exit or exits by comparing the average time of the subgroups to pass through each exit tested. The effects of learning in the subgroups are cancelled by use of the Latin Square principle.

(ii) It is possible that, in spite of efforts to keep the composition of the subgroups equal, one group may contain one or two persons who find it particularly difficult to go through exits. The Latin Square principle will also cancel such unbalance between subgroups.

(iii) It may happen that an individual may, through chance, have considerable difficulty with an exit, but their other performance may compare with the average performance of other individuals. A study of the individual escape times will enable such occurrences to be evaluated and assist in the final determination of the acceptability of the proposed exit or exits.

(iv) The proposed exit configuration is acceptable when the egress time from the proposed exit configuration is equal to or less than the time required to pass through an exit configuration defined by § 3.387 of the CAR or § 23.807 of the FAR.

7. TYPE CERTIFICATE DATA SHEET. An equivalent level of safety should be part of the type certification basis and noted on the type certificate data sheet. Suggested wording is "Equivalent Safety Findings: § 3.387 of the CAR, § 23.807 of the FAR emergency (particular) exit in accordance with Advisory Circular 23.807-1A."



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