U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Emergency Evacuation Demonstrations	**Date:** 03/12/12	**AC No:** 25.803-1A
	Initiated By: ANM-115	

1. Purpose. This advisory circular (AC) provides guidance on means, but not the only means, of compliance with Title 14, Code of Federal Regulations (14 CFR) part 25 concerning: (1) conduct of full-scale emergency evacuation demonstrations, and (2) use of analysis and tests in lieu of conducting an actual demonstration. Throughout this AC, any reference to a full-scale demonstration, unless further qualified, means an evacuation demonstration in which a full complement of passengers and the requisite number of crewmembers evacuate an airplane using assist means, if installed, under the conditions specified in part 25, appendix J. References to "appendix J" means 14 CFR part 25, appendix J. Additionally, any reference to an analysis, which is to be used to satisfy the emergency evacuation requirements of part 25, means a formal analysis document supported by data from tests or demonstrations. Terms such as "shall" and "must" are used only in the sense of ensuring applicability of this particular means of compliance when the acceptable means of compliance described herein is used.

2. Applicability.

a. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration (FAA) transport airplane type certification engineers, and their designees.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other means of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. Cancellation. Advisory Circular 25.803-1, Emergency Evacuation Demonstrations, dated November 13, 1989, is canceled.

4. Related Requirements.

a. Section 25.803, Emergency evacuation, as amended through Amendment 25-117.

b. Appendix J to part 25 - Emergency Evacuation, as amended through Amendment 25-117.

c. Section 121.291, Demonstration of emergency evacuation procedures, as amended through Amendment 121-233.

5. Background.

a. The requirements for emergency evacuation demonstrations were first established in 14 CFR part 121 (§ 121.291) by Amendment 121-2, effective March 3, 1965. Operators were required to conduct full-scale evacuation demonstrations within a time limit of two minutes using 50 percent of the exits. The purpose of the demonstration was to validate the crewmembers' abilities to execute the established emergency evacuation procedures and to ensure realistic assignment of functions to the crew. A full-scale demonstration was required upon:

(1) initial introduction of a type and model of airplane into passenger-carrying operation,

(2) an increase in passenger seating capacity of five percent or greater, or

(3) a major change in the cabin interior that would affect emergency evacuation.

b. The requirement for the airplane manufacturer to conduct an evacuation demonstration for airplanes having a seating capacity of more than 44 passengers was established in § 25.803 by Amendment 25-15, effective October 24, 1967. The time limit for the manufacturer's demonstration was established at 90 seconds, and the part 121 time limit was reduced to 90 seconds. It was considered that the manufacturer's demonstration would show the basic capability of a new airplane and, as before, the part 121 demonstration was intended to account for crew training and adequate crew procedures. Therefore, the demonstration conditions were somewhat different.

With the addition of the requirement for a full-scale demonstration in part 25, § 25.803(d) allowed for analysis in lieu of demonstration under certain conditions. Section 25.803(d) stated that the demonstration need not be repeated for a change in the interior arrangement or a passenger capacity change of not more than five percent, or both, if it could be substantiated by

analysis that the passengers could be evacuated in 90 seconds. At that time, analysis was used for decreases in passenger capacity when an airplane was reduced in size. Generally, the analysis was based on a full-scale demonstration for the larger airplane. Analyses were also used for increases of less than five percent.

c. Since Amendment 25-15, numerous full-scale demonstrations have been conducted by airplane manufacturers to satisfy both type certification and operational requirements. These demonstrations provided data on evacuation rates, escape system performance, and the behavior of evacuees (passengers and crewmembers who evacuate the airplane) during the demonstration.

d. By Amendments 25-46 and 121-149, effective December 1, 1978, § 25.803 was revised to allow a means other than actual demonstration to substantiate the evacuation capability of the airplane and to replace the existing part 25 demonstration conditions with conditions that would satisfy both part 25 and part 121 so one demonstration could serve both requirements. Part 25 was changed to match the conditions in part 121.

Amendment 25-46 removed the five percent limitation on analysis from § 25.803(d). It was proposed in Notice 75-26, that analysis or a combination of analysis and tests be used to show evacuation capability. Amendment 25-46 dropped the provision which allowed analysis alone and required a combination of analysis and tests to assure approvals would be based on sufficient test data. The possibility was considered that sufficient data may not be available in the case of a completely new airplane model or a model which had major changes or a considerably larger passenger capacity than a previously approved model. Thus, the requirement that the Administrator find the data used in the analysis acceptable was intended to preclude approvals which might be based on insufficient test data to support the proposed analysis.

e. Amendment 121-176, effective January 18, 1982, allowed a part 121 certificate holder to use the results of a part 25 demonstration or the part 121 demonstration of another operator to show compliance with § 121.291. This amendment also eliminated the five percent limit from part 121 because the manufacturer would have already shown compliance with § 25.803 and the partial demonstration required by § 121.291 would show that the air carrier's procedures, training program and maintenance program are adequate.

f. The conduct of emergency evacuation demonstrations and the use of analysis in lieu of a full-scale demonstration were discussed at the Public Technical Conference held by the FAA in September 1985, in Seattle, Washington. These items were later discussed in detail at working group meetings. As a result of a paragraph by paragraph review of § 25.803(c), the FAA concluded that it was necessary to formalize its policy on how to conduct an evacuation demonstration and to clarify items of concern expressed by the group members. Most of the guidance presented in the original version of this AC, and much of the guidance in this revised version, is consolidated from existing FAA policy or the consensus of the working group. In

those areas where no consensus could be reached, for example the use of analysis in lieu of full-scale demonstration, the FAA decided how best to implement the regulations.

g. Amendment 25-72 to part 25 revised § 25.803 by moving the conditions under which an emergency evacuation demonstration was to be conducted from § 25.803(c) to a new appendix J to part 25. Additionally, other sections of part 25 were relocated to group requirements more logically.

h. Amendment 25-79 revised appendix J by revising the age/gender mix to be used when conducting an emergency evacuation demonstration, by prohibiting flightcrew assistance, and by allowing the use of stands or ramps for descending from overwing exits only when the airplane is not equipped with an off-wing descent means.

i. Amendment 121-233 revised § 121.291 to require demonstrations conducted after September 27, 1993, be in accordance with paragraph (a) of appendix D to part 121 or with the § 25.803 in effect on or after that date.

j. Amendment 25-117 revised appendix J by including provisions to reduce the potential for injuries to participants. This included a provision for pre-deployed escape slides, a low level of ambient lighting in the test facility, and briefing of test passengers on the safety precautions taken for the demonstration. None of these new provisions are mandatory.

k. The FAA established the Aviation Rulemaking Advisory Committee (ARAC) on January 22, 1991, to provide advice and recommendations to the FAA concerning the full range of the FAA's safety-related rulemaking activity. The ARAC, in turn, established a Performance Standards Working Group to study the rules involving emergency evacuation to see if they could be restated in terms of performance standards. A second task was given to the group to recommend revisions to the existing emergency evacuation demonstration requirements and compliance methods to eliminate or minimize injury for participants (persons performing the roles of either passengers or crewmembers in an evacuation demonstration). In January 1993, the working group forwarded a report, "Emergency Evacuation Requirements and Compliance Methods that Would Eliminate or Minimize the Potential for Injury to Full Scale Evacuation Demonstration Participants," to the ARAC. The ARAC accepted the report and forwarded it to the FAA. Many of the recommendations for revising the compliance methods associated with the demonstration have been incorporated into this AC.

6. Objective of the Rule.

a. A full-scale demonstration is conducted to assess the evacuation capability of the airplane and, when compliance with paragraph g of appendix J regarding compliance with § 121.291 is requested, to also demonstrate the effectiveness of crew training and emergency

procedures. Appendix J to part 25 specifies the conditions for conduct of the evacuation demonstration.

b. The objective of any analysis allowed by § 25.803(c) is to substantiate that the airplane can be evacuated within 90 seconds under the conditions specified in appendix J without actually conducting the demonstration. The use of analysis can eliminate the need to conduct a full-scale demonstrations where adequate knowledge is already available from previous full-scale demonstrations or other tests. A decrease in the number of full-scale demonstrations will reduce the number of participants subjected to possible injury.

7. Determination of Whether Analysis or a Full-scale Demonstration is Required for a New Airplane Type or a New Configuration of an Existing Airplane Type.

a. Each new airplane type and each change in airplane design of an existing airplane type that may have an effect on the emergency evacuation capability of the airplane should be evaluated by the applicant for its impact on compliance with § 25.803, either by conducting a full-scale demonstration or, if appropriate, by submitting the results of a combination of tests and analysis.

b. The following are examples of design changes that may have an effect on evacuation capability and therefore should be evaluated:

(1) A change in type, number, or location of exits.

(2) An increase in passenger capacity above that listed on the type certificate data sheet.

(3) Changes in passenger distribution within the cabin area that would increase the number of passengers expected to use an exit pair to a number greater than the exit rating of the exit pair.

(4) Classifying an exit as an "excess" exit in accordance with the requirements of § 25.807(h).

(5) Installation of escape slides or other assist means not previously approved for that model airplane.

(6) Changes to the passenger cabin configuration that reduce the passengers' access to any emergency exit below the access that was provided in the certification demonstration. Examples of such changes include partitions, galleys, etc., that restrict the flow of passengers merging from an aisle and cross aisle; the crew's ability to determine which exits are operable; or the crew's ability to balance the passenger flow among the active exits.

(7) Changes to the flight attendant seating locations.

c. If compliance with § 121.291 is sought per paragraph g of appendix J of part 25, then any change that affects the duties of the flight attendant(s) must be evaluated. Any change to flight attendant training must be clearly specified because such changes are likely to become mandatory training for all U.S. operators of the airplane type in question.

d. The determination whether a demonstration or formal analysis is required is made by the FAA. As noted above, reducing the number of full-scale demonstrations will reduce the number of demonstration participants subjected to potential injury, particularly during the phase of the demonstration when evacuees are transitioning from the airplane to the ground. For this reason the FAA will consider proposals for analysis for all new and modified airplanes. The analysis, however, must be supported by appropriate testing. Such tests may include, but are not limited to, the following:

(1) Tests to determine the evacuation rates for all new exit/assist means combinations under appendix J conditions.

(2) Tests to determine the time necessary to open exits and have assist means ready to receive evacuees.

(3) Tests to determine that flight attendant training and procedures are adequate to assist passengers in expeditiously exiting the airplane. This may include a full-scale test in which the evacuees exit onto platforms or ramps rather than onto airplane-installed assist means.

(4) Tests to determine the impact of revised passageways, including their orientation to the exit, or relocated cross aisles, which may merge passengers from one aisle into passengers in another aisle at a different point than was previously demonstrated.

(5) Tests to determine the impact of revised, brighter or dimmer, emergency lighting inside or outside of the airplane.

(6) Tests to determine that the relocation of flight attendant seated positions has not adversely impacted the flight attendants' abilities to manage the evacuation.

(7) Tests to determine that, on airplanes with more than one occupied deck, communications and, if necessary, transiting between decks is adequate.

e. If the FAA decision is to allow analysis, the applicant must indicate the source(s) of the data for the analysis and have these sources available to the FAA during any evaluation of the analysis.

8. Guidance For Demonstrating Compliance With § 25.803(c) and Appendix J Using an Actual Demonstration.

a. Section 25.803(c) and appendix J. The following is intended to provide uniform standards for conducting demonstrations in order to make demonstration results as directly comparable to each other as is practical.

(1) Upon determination that an actual demonstration will be required, the applicant should prepare a plan that outlines such details as time and place for the demonstration, demonstration vehicle configuration, and crew training program. This plan should be submitted to the FAA as soon as possible to allow the FAA time to review, request any necessary changes, and approve the plan, as well as arrange for participation of the appropriate FAA organizations.

(2) The phrase "The maximum capacity... for which certification is requested," refers to the airplane model presented for certification.

(3) All passengers and crewmembers used in the demonstration must be evacuated to the ground or to an off-wing ramp (if applicable) within 90 seconds to constitute a successful demonstration. Seats, including restraint systems, adequate for purposes of the demonstration, must be provided for all passengers. (For example, a 5-place seat assembly may be used to seat 6 passengers, if the 6 passengers can be accommodated and 6 restraint systems are installed and used.) The limits of § 25.807(g) or (i) may not be exceeded. Partial credit, equal to or less than the number of evacuees on the ground at 90 seconds, may be granted by the FAA if all passengers and crewmembers used in the demonstration have not been evacuated by that time. For example, if an airplane is equipped with four pairs of Type A exits, the maximum seating configuration allowed by § 25.807(g) provides for 440 passengers. If certification is requested for 440 passengers plus crewmembers, that number of passengers and crewmembers must be provided seating in the airplane and they must evacuate the airplane in 90 seconds for a successful demonstration. If, in the demonstration, only 420 passengers evacuate the airplane within the 90 second time limit, the FAA may allow some credit (up to a maximum seating capacity of 420 passengers). The actual credit will depend on many factors, including the number of crewmembers that evacuate within 90 seconds, with the primary focus on the reasons that the demonstration failed. This determination is made only after submittal of test documentation by the applicant, including video or film from inside and outside the airplane, that shows that approval of the reduced capacity is warranted. Such decisions must be coordinated with the Transport Standards Staff.

(4) Federal Aviation Administration observers should be stationed inside the airplane at expected critical locations, and outside the airplane at each exit to be used. Airplanes which do not have space for adequate onboard observation should provide interior video coverage to compensate for the absence of official witnesses.

(5) The airplane should be configured with the minimum aisle, crossaisle, and passageway clearances expected to be type certificated. (Configuration changes reducing clearances below those demonstrated may require substantiation.) This may require combining features of more than one interior configuration. The airplane interior need not be representative of a specific operational configuration for the purposes of the demonstration. For example, galleys and other furnishings may be simulated by mockups; seats need not have a Technical Standard Order (TSO) authorization, etc. The interior configuration should be FAA-approved, as a demonstration configuration, prior to the demonstration, and should be described in sufficient detail to allow an FAA conformity inspection.

(6) The phrase "including the number of crewmembers required by the operating rule" refers to the minimum number of flight crewmembers listed in the Airplane Flight Manual (AFM) and the minimum number of flight attendants required by § 121.391 for the passenger seating capacity to be demonstrated. The observer seats need not be occupied for the demonstration. If the minimum number of flight attendants required for the specific passenger capacity requested results in a more favorable flight attendant to passenger ratio than would a lower passenger capacity, both arrangements should be substantiated for compliance with the 90 second requirement. If it is obvious which arrangement is more critical, then other arrangements could be addressed through analysis following a successful demonstration. If it is not obvious which arrangement is more critical, the applicant may wish to propose conducting the demonstration with one fewer flight attendant than would be required. For example, a passenger capacity of 201 requires 5 flight attendants, whereas a capacity of 199 requires only 4. In this case, the change in passengers is only about 1 percent, but the number of flight attendants is reduced by 20 percent. So, while a lower capacity, the latter arrangement is arguably more critical.

(7) If the evacuation demonstration fails, the demonstration should not be repeated until the applicant has identified the cause(s) and instituted corrective measures. The FAA should be informed of the cause(s) of the failed demonstration and the corrective action(s) taken by the applicant, before the demonstration is repeated. In accordance with the regulations, different groups of passengers and crewmembers must be used in any repeat demonstrations.

(8) Participants in the demonstration should be encouraged to wear long sleeve shirts, full length pants and low heel shoes in order to reduce the occurrence and severity of injury. If emergency escape slides are used in the demonstration, gloves should be distributed to the participants in order to reduce abrasions to the hands caused by contact with the slide surfaces.

(9) Flight attendants are a critical element in the conduct of a safe, efficient, evacuation. These crewmembers initiate the evacuation, direct the evacuation process at usable exits, direct passengers away from unusable exits, and provide passenger management within the cabin, all with the safety of the participants as a foremost consideration. Flight attendants should be cautioned about the "demonstration" nature of the evacuation and the importance of

minimizing the potential for injury by using passenger management techniques that are consistent with airline training programs.

(10) Thorough internal and external video documentation may be beneficial for acquiring data, explaining anomalies, or identifying causes of failed demonstrations, and is highly recommended.

(11) The test director should have a means to abort the demonstration in the event a safety hazard develops. A test abort signal system is recommended.

b. Paragraph c of appendix J.

(1) If the airplane is equipped with an off-wing assist means, e.g., an emergency escape slide, it must be used during the demonstration in lieu of stands or ramps.

(2) Safety personnel stationed outside the airplane to help in preventing injury should not position any assist means (e.g., slide or ramp) following its deployment or otherwise interfere or assist in the evacuation process except as necessary to prevent injury to a participant.

NOTE: If it is determined that intervention by safety personnel significantly accelerated completion of the demonstration, this may invalidate the demonstration. However, in the event that the demonstration is deemed valid, the FAA may still assess time penalties (i.e., add to the total evacuation time at any specific exit) to compensate for the assistance of ground personnel.

(3) Safety personnel stationed on the wing of an airplane equipped with removable exit hatches may accept the hatches if they are passed out of the exit opening. The hatches must be at least halfway out of the airplane before the safety personnel may assist. The safety personnel may not encourage, by word or gesture, the person in the cabin to hand the exit hatch to them.

c. Paragraph e of appendix J. The emergency assist means used in the demonstration should be of the type intended to be part of the airplane type design. If the assist means is a slide, the slide certification program should have progressed to the point where the system is reliable and can be expected to perform safely during the demonstration. Any changes to the assist means after the demonstration should be assessed for their possible effect on the outcome of the demonstration.

d. Paragraph g of appendix J.

(1) Evacuation demonstrations conducted to meet the requirements of § 25.803(c) only, for example, to demonstrate the evacuation capability of the airplane, need not use regularly

scheduled crewmembers (see sub-paragraph 7.e for a definition of regularly scheduled crewmembers). Therefore, there would be no crew training requirements specific to the operating rules, i.e., part 121, for the demonstration.

NOTE: Airplanes which have been shown to meet § 25.803(c) only, may need to have a full-scale emergency evacuation demonstration conducted which satisfies § 121.291 before being allowed into part 121 operations.

(2) Evacuation demonstrations intended to meet the requirements of § 25.803(c) and § 121.291(a)(1) should use regularly scheduled line flight attendants. These demonstrations are conducted to demonstrate both the evacuation capability of the airplane and the effectiveness of the flight attendants' emergency training program and evacuation procedures.

NOTE: These procedures, once successfully demonstrated, should not be revised in service without due consideration of the possible impact on the emergency evacuation capability of the airplane.

(3) Flight attendants should be seated with their restraints fastened at cabin locations consistent with § 121.391 at the start of the demonstration. Each flight attendant should be sitting in a normal position without either hand resting on the seat restraint release mechanism.

(4) The normal demonstration start signal is the interruption of ground power to the airplane, as evidenced by the extinguishing of normal cabin lighting. This is the signal for flight attendants to begin the demonstration.

(5) Following the demonstration start signal, the flightcrew should delay evacuating the flightdeck by a time equivalent to that required to accomplish appropriate emergency procedures.

(6) Crewmembers in excess of the number required for the demonstration should be available so that the FAA can select the crew that will participate in the demonstration. Crewmembers that are not selected may be considered by the FAA for participation in any subsequent demonstrations that may be conducted.

e. Paragraph g of appendix J. In order to be considered a "regularly scheduled line crew," the flight attendants should meet the following requirements:

(1) The flight attendants should be trained in specific duties related to an emergency evacuation in accordance with an FAA-approved training program (for evacuation demonstration purposes). This training program need not be a complete flight attendant training program but should be an emergency evacuation training program similar in content and duration to the emergency evacuation portion of training programs approved under part 121. Reference paragraph r of appendix J.

(2) If the flight attendants to be used for the demonstration have been previously trained under an operator's FAA-approved program, additional training may be given when the airplane model or layout to be demonstrated differs from the one used by that operator. Training in exit operation and passenger management is especially important for a demonstration of a new model airplane. This training should be similar in content and duration to the training received by a flight attendant when an operator adds a new model airplane to their operating certificate. The flight attendants should not be trained for specific demonstration conditions, except that specific training should be given which relates to the safety of the participants prior to and during the demonstration. This specific safety training should relate to initiating and recognizing the signal for emergency termination of the demonstration and emergencies related to the demonstration site. The FAA should be provided with documentation describing all special training that was given in preparation for the demonstration.

(3) If the demonstration is not successful and flight attendant procedures are changed in order to successfully conduct a repeat demonstration, the changes in procedures should be fully documented and added to the training program.

(4) The flight attendant training required for a successful demonstration should be the basis for the training program of all operators utilizing the demonstration for compliance with § 121.291(a)(1).

(5) The flight attendants to be used in the demonstration should not be instructors, supervisory personnel, safety representatives from worker organizations, or anyone else who may be expected to have knowledge of evacuation demonstrations beyond that of an average flight attendant.

(6) Flight attendants from more than one operator may be used in the demonstration.

f. Paragraph h of appendix J. The term "normal health" means that participants should be free of medical conditions or physical limitations that could affect the demonstration results or increase the chance of injury to themselves or others.

g. Paragraph h of appendix J. An alternative age/gender distribution may be utilized, provided the applicant can present justification that the overall evacuation capability of the proposed distribution is no faster than the overall evacuation capability of the group specified in the regulation. Age/gender distributions defined in previous versions of appendix J (or in § 25.803 itself) are acceptable for airplanes with the respective earlier certification basis.

h. Paragraph h(4) of appendix J. The life size dolls should be of appropriate size and weight to simulate children approximately two years old.

i. Paragraph h(5) of appendix J. In addition to those persons prohibited by the regulation, persons involved in the design or type certification of escape systems, development of emergency evacuation crew training, or those who have previously conducted evacuation demonstrations should not be used as passengers for the demonstration.

j. Paragraph i of appendix J. Passenger seating for the demonstration should be random. One method for ensuring this is to allow passengers to select their own seats. Employees of the applicant are not allowed to sit next to exits. Federal Aviation Administration observers may, at their discretion, relocate passengers.

k. Paragraph k of appendix J. Simulated carry-on luggage in the form of small suitcases, gym bags, airplane flight bags, briefcases, etc., filled with clothes or newspaper, that will fit under a passenger seat, should be placed in the main aisle(s) with approximately one bag per seat row for each aisle. Also, some bags should be placed in the cross aisles and passageways, at approximately the same spacing as in the main aisle(s). Additionally, pillows and blankets should be scattered in the main aisle(s), approximately one pillow or blanket for every two rows. In order to maintain a more typical preflight scenario, the bags, etc., should be distributed after the safety briefing takes place.

l. Paragraph l of appendix J.

(1) Neither the crew nor passengers should hear or otherwise receive any indication that the demonstration is about to begin. The first indication to participants should be the extinguishing of the normal cabin lighting.

(2) If safety devices or any other equipment external to the airplane could indicate to the test participants which exits are to be used in the demonstration, passengers and crew should enter the airplane through a tunnel or other means that will prevent them from seeing that indication. Similarly, exterior windows should be obscured from the outside to prevent both viewing of the outside conditions and any ground lighting from shining into the airplane.

(3) Placement of video cameras inside the airplane should not indicate which exits are to be used in the demonstration. This may require installation of cameras at all exits.

(4) Mechanical methods of exit deactivation which are not perceptible to crew or passengers prior to attempting to operate the exit should be used. The applicant should ensure that the deactivation means can withstand the high forces which may be applied by crewmembers or passengers, since inadvertent opening of a deactivated exit will likely invalidate the demonstration.

(5) If one or more of the exits must be mechanically deactivated after the airplane has been boarded, care should be taken to prevent the crew from becoming aware of the deactivation

by sounds or other indications. One means to accomplish this is to have an FAA observer inside the airplane temporarily move flight attendants to a location inside the airplane away from the vicinity of any exit which will be worked on.

(6) For those airplanes equipped with emergency assist means, the means should be installed at inactive exits as well as active exits, to avoid revealing which exits are active through the absence of the assist means.

m. Paragraph m of appendix J. The following are guidelines for the applicant to use to obtain informed consent from participants in the demonstration and still comply with the intent of paragraph m of appendix J. These guidelines are not intended to be a complete list or meet specific legal requirements. The applicant is responsible for obtaining informed consent and for complying with all applicable local, state, and federal laws and regulations regarding the protection of human beings employed in demonstrations of this nature.

(1) The applicant should seek consent under circumstances that provide the prospective participants sufficient opportunity to freely consider whether or not to participate in the demonstration. Coercion or undue influence to participate in the demonstration is not permitted.

(2) The prospective participants should be informed of the purpose of the demonstration and the expected duration of their participation. They should also be given a description of any logistical procedures to be followed before and after the demonstration. Details of the demonstration parameters, e.g., time limits, active exit percentages, etc., should not be disclosed, but the approximate number of participants in the demonstration may be revealed.

(3) The prospective participants should be given a description of any reasonably foreseeable risks or discomforts which may be encountered in the demonstration, such as the type or probability of injury when using an escape slide. Participants may also be informed of any techniques and/or equipment that will be used to limit the discomfort or injury such as protective clothing, emergency abort procedures for the demonstration, pads around the slides, availability of restrooms, etc.

(4) Prospective participants should be informed of any direct benefits to them (e.g., pay, meals, etc.) and of benefits to society (e.g., improved safety by demonstrating the emergency evacuation capability of the airplane) that would result from their participation.

(5) Prospective participants should also be informed of any compensation and/or medical treatments that will be available if injury should occur. They should also be informed of the procedure for acquiring these services, and where further information may be obtained.

(6) Prospective participants should be informed that participation in the demonstration is voluntary, that refusal to participate will involve no penalty, and that a participant may

discontinue participation at any time prior to the beginning of the demonstration without penalty or loss of benefits to which the participant is otherwise entitled.

(7) Prospective participants should be informed of the potential consequences of a decision to withdraw from the demonstration at any given time and the procedures to follow for orderly termination of participation. This explanation should include the consequences of attempting to withdraw after the demonstration has started, for example, the possibility of being pushed out of the airplane if the participant stops at the exit.

(8) The prospective participants should be given the opportunity to ask questions, and be provided information on whom to contact for answers to future questions and how to withdraw from the demonstration.

(9) After participants have been fully informed, they should provide written informed consent to express their understanding and willingness to participate.

n. Paragraph n of appendix J. The passengers may be told that they are evacuating an airplane via the escape slides, if applicable, and to follow the instructions of the crew. A description of the location or operation of the exits, the conduct of the demonstration, or additional information not in the passenger briefings required by §§ 91.519, 121.333(f), 121.571(a), 121.573 (a), (c) and (d), 121.585(h) and (i), 125.327, or 135.117 should not be given.

o. Paragraph p of appendix J. In order for the active exits to be representative of all of the required emergency exits on the airplane, one exit from each pair should be used. Flightcrew exits, and exits that are not part of a pair (such as ventral exits, tail-cone exits, and exits on only one side of the fuselage) should not be used for the demonstration (even if additional passenger capacity has been granted). (Note that the MD-81 and MD-82 have a tail-cone exit and a Type I exit which is located on the left-hand side of the fuselage, aft of the wing. The FAA has certificated these two exits as an exit pair.)

p. Paragraph s of appendix J.

(1) The restriction on the acceptance rate of the stand or ramp is considered to be met, if the width of the stand or ramp is not greater than the width of the escape route required by § 25.810(c).

(2) The demonstration is complete when the last evacuee (passenger or crew) has cleared the assist means and has both feet on the ground or ramp (if provided at the off-wing exit). Typically, the entry to the ramp is coincident with the area on the wing where evacuees, led by required markings on the wing, would slide or jump to the ground.

9. Guidance for Demonstrating Compliance with § 25.803(c) Using a Combination of Analysis and Testing.

a. Regulatory Background.

(1) The preamble to Amendment 25-46 makes it clear that adequate test data are a prerequisite for using analysis instead of conducting a full-scale emergency evacuation demonstration to substantiate airplane evacuation capability. It is intended that the analysis be a conservative prediction of the results that would be achieved if a full-scale demonstration were to be conducted. As such, the assumptions used should be conservative.

(2) Full-scale demonstrations should be required when the effects on evacuation performance of configuration changes identified in paragraph 7.b cannot be substantiated by component and/or system test and analysis.

b. Technical Basis for the Analytical Approach.

(1) The analytical approach for substantiation of evacuation system capability should be based on all available, valid performance data from formal tests. The primary source of data should be from successful full-scale demonstrations. Documentation of the analysis should establish credibility by identifying elements of the evacuation system, (e.g., features of the interior arrangement, door sizes, egress assist means, and relative door locations), citing applicable tests of record involving similar or identical elements, and then applying the recorded, verifiable performance data to the new configuration in a valid manner. Data from unsuccessful full-scale demonstrations should be carefully scrutinized before being used, to ensure that the failure has not biased the data. Additionally, however, it should be verified that identified causes (equipment, configuration, or procedures) for the failed demonstrations are not included in the new configuration.

(2) Graphical representations and a detailed description of the airplane interior configuration emphasizing the emergency evacuation provisions are essential and are required for database development. A detailed configuration description should lead into and justify the use of the certification demonstrations and any other tests that are included in the database.

(3) The certification bases that apply to the specific model in question and those of other models that will be used, should be clearly stated in the analysis. The resulting implications should be thoroughly reviewed and discussed.

(4) If evacuation system certification data (from a test conducted by the applicant and witnessed by appropriate airworthiness authority personnel or representatives) with apparent relevance to the subject configuration has been purposely excluded from the analysis, the reason(s) for excluding these data should be documented and agreed to by the FAA.

(5) Any special condition, exemption, or equivalent safety finding that applies to the evacuation systems of the subject configuration, or any configuration for which data will be presented, should be discussed and referenced or included as an appendix to the analysis document.

c. The Airplane Configuration.

(1) The configuration should be described in detail. If the configuration is a derivative of an existing, previously certified configuration, the primary differences should be clearly stated in the analysis in terms of passenger capacity and evacuation capability.

(2) Features of the passenger cabin interior arrangement and evacuation system (such as aisles and cross-aisles, exit passageways, attendant assist spaces, doors and emergency hatches, etc.) significant to the analysis should be presented in the form of diagrams or formally controlled drawings in an appropriate scale. Supplemental drawing or diagrams should be provided for those features that require special attention in the analysis.

(3) The cabin arrangement and evacuation system components should be depicted and described in enough detail to establish a useful historical record. These descriptions should include, as applicable, the location, operation, and dimensions of the cabin and its features that are significant to evacuation, such as:

(a) passenger and flight attendant seats and the associated restraint systems,

(b) aisles, cross aisles, and passageways,

(c) exits, including type classification,

(d) emergency egress assist means,

(e) flight attendant assist spaces,

(f) monuments (e.g., galleys and closets), including the aspect of visual obstruction,

(g) safety equipment,

(h) lighted signs and emergency lighting, and

(i) any other cabin characteristics affecting evacuation.

(4) Features of the airplane exterior which affect evacuation (such as engines and wing flaps) should be described in detail. Exterior features and the evacuation system they affect should be presented in the form of dimensioned diagrams or formally controlled dimensioned drawings in an appropriate scale.

d. Similar Features in Previously Demonstrated Airplanes. When the configuration under consideration is a derivative model of a configuration certified by a full-scale demonstration, common features of the two configurations need to be clearly identified and discussed. Typically, some door and assist-to-ground systems are likely to remain unchanged or be very similar in derivative models evolved from a baseline configuration. Interior features may be unchanged within complete or major parts of cabin zones.

e. Unique Features of the Configuration.

(1) Comparative drawings should be used to focus attention on configuration differences as well as similarities. The features that are unique to the configuration should receive a great deal of attention. If, for instance, a new door system is to be installed in a production model derivative, the effects of this change should be documented. Data from "similar" door systems demonstrated in other airplane models are obvious sources. To use these data, a strong case for "similarity" must exist and be developed in the analysis. For example, dimensional parameters of the unique features should match those of the demonstrated, certificated systems. Performance data from those systems could then be included in the analysis to ensure the new configuration meets the regulations.

(2) When a new installation changes some specific features of an earlier installation and, therefore, changes system performance, the change should be substantiated. Performance data from both the earlier installation and the new installation should be provided in the analysis.

f. Flight Attendant Requirements. The required minimum number of flight attendants is established by § 121.391(a). As stated in § 121.391(b), when the number of flight attendants used during a full-scale airplane evacuation demonstration for certification exceeds the minimum number stipulated by regulation, the number of flight attendants in excess of the minimum number required in § 121.391(a) must be added to the number of flight attendants required by § 121.391(a) for any seating capacity. The required number of flight attendants and their seating provisions should be indicated on an appropriate configuration diagram.

g. Interior Configuration Overview. Compliance with the requirements of §§ 25.807 through 25.815 is a prerequisite for showing compliance with § 25.803. In particular, a discussion of how the subject configuration satisfies the intent of §§ 25.807 and 25.813 is an important part of the evacuation capability analysis and should receive appropriate emphasis. These sections define the various passenger emergency exit types, stipulate the required number and types of exits necessary to accommodate passenger seating capacities, and set forth

requirements for accessibility and location of exits. The analysis should directly address the issue of passenger distribution and exit capability distribution within the cabin. When physical constraints, for example, body structure, wing and engine location, prevent appropriate geometrical uniformity of exit placement, compensating factors that enhance evacuation capability should be discussed.

h. Exit Distribution Uniformity. The geometric distribution of the exits, rated capacities of the exit types provided, and passenger seating densities of the various cabin zones should be documented. The geometric distribution of exit openings is obvious when depicted to scale on a drawing. Uniform distribution of the exits relative to passenger distribution may not be immediately obvious. One means for addressing adequate exit distribution uniformity, taking passenger distribution into account, is provided in AC 25.807-1, Uniform Distribution of Exits.

i. Historical Data Foundation for the Analysis. Any analysis to determine evacuation capability of an airplane depends on the existence of applicable demonstration or test data that are formally recorded and verifiable. Applicability and validity of data are governed by evacuation system component similarity and conditions of test conduct. Conditions called out in appendix J to part 25 and § 121.291 are the best qualifiers for screening existing evacuation performance data to be applied to the subject configuration. All such data should be addressed in the analysis. Results from partial evacuation demonstrations and developmental or qualification tests should be used to fill data gaps where no full-scale evacuation demonstration precedents can be cited for elements of the subject configuration; these partial demonstrations or tests should be shown to have been conducted under appropriate conditions. In many situations the appropriate conditions are those specified in appendix J of part 25.

j. Applicable Previous Full Scale Demonstrations. Test data from full-scale certification demonstrations that are offered in support of the analysis need to be identified and described. The date and location of the demonstration, the airplane model involved, the passenger and crew complements, and the regulation upon which the demonstration was based (part 25 and/or part 121) should be provided. The description should address the elements of paragraphs 9.c and 9.f. If the applicability of the data is not obviously indicated by the airplane model, the reason(s) for including the demonstration should be clearly stated.

k. Applicable Subsystem Developmental, Qualification and Certification Tests.

(1) Data from tests other than full-scale emergency evacuation demonstrations that are included as data sources for the analysis, should be specifically identified and discussed. Reasons for their inclusion should be clearly stated. As an example, deployment/inflation time data for a new slide or slide/raft could be introduced and substituted into an evacuation event sequence (time line) for a system that is otherwise identical. This would be acceptable because slide or slide/raft deployment and inflation, once initiated, is independent of further human intervention and insensitive to the test conditions of appendix J.

(2) Similarly, Latin Square testing (see appendix 4 of AC 25-17A, Transport Airplane Cabin Interiors Crashworthiness Handbook) may be used to compare the performance capability of a new escape system or systems component against the known capability of an existing system or component. Unless it is verified in other testing, however, such a comparison may need to be conducted under the test conditions of appendix J to ensure that the interface between passengers and the new system is appropriate under those conditions, for example, is the lighting of the slide sufficient to encourage evacuees to jump with minimum hesitation?

(3) Technical Standard Order C-69c requires testing under conditions that are very similar to the conditions required in appendix J. Use of these data in support of compliance with § 25.803 is acceptable when it is clear that the data generated under the TSO approval matches the data that would be generated under the type certificate. In those instances where they do not match, or it is not clear if they match, additional testing may need to be performed. The applicant should contact the FAA to determine if additional testing can be completed by the TSO approval holder (or applicant) or should involve the TC holder (or applicant). Any such proposal should be fully coordinated in advance with the FAA.

(4) A test method referred to as a "platform" or "ramp" test has also been used to assess the crew's ability to manage flow of passengers for a given interior configuration. Appropriate test conditions and pass/fail criterion need to be discussed with and agreed to by the FAA for each new situation.

(5) The formal test reports and supplemental record (movie film or video tape) of subsystem testing should be referenced in the analysis and available for FAA review.

l. Elements of Time Required for Evacuation.

(1) A formula suited to the evacuation capability analysis task and accepted as credible and correct by the FAA has been established. It is based on an escape system time line or sequence of events that can be readily observed in film or video tape coverage of full-scale evacuation demonstrations.

(2) The total evacuation time (in seconds) through a given exit can be defined by the following expression:

$$T_{Total} = T_{Exit\ Prep} + T_{Exit\ Flow}$$

where:

T_{Total} = Total evacuation time for the exit, equal to the time interval from demonstration initiation until the last evacuee arrives on the ground or onto a stand at an overwing exit as allowed by paragraph c of appendix J.

$T_{Exit\ Prep}$ = Time for exit preparation, equal to the time interval from demonstration initiation until the first evacuee arrives on the ground or onto a stand at an overwing exit, including:
-- flight attendant or passenger reaction time, as appropriate,
-- exit opening,
-- assist means deployment, and inflation to the point of being usable (if applicable),
-- first evacuee hesitation time (defined as the elapsed time between when the device becomes ready for use and when definite contact with the device, with motion toward the ground, has been achieved by the first evacuee), and
-- time for initial evacuee to traverse to the ground (using the assist means, if applicable), or onto a stand at an overwing exit.

$T_{Exit\ Flow}$ = Time of exit flow, equal to the time interval from first evacuee on the ground or onto a stand at an overwing exit to last evacuee on the ground or onto a stand at an overwing exit.

m. Database to Support the Analysis.

(1) Pertinent data values from the tests and demonstrations discussed in paragraphs 8.k and 8.l should be organized into a "database" for the analysis. The database should identify the source of each data point to the degree necessary for independent verification. For evacuation system certification demonstrations, the identifying parameters should include (as a minimum):

(a) airplane model (and operator, if applicable),

(b) date of demonstration,

(c) governing regulations, i.e., part 25 or part 121, and

(d) exit identification.

(2) When the data value used in the analysis is an interval of time between two observed events, the event times, in addition to the time intervals, should be included in the "database." The events are observable and can be verified directly, whereas the intervals are derived from the event times. A single tabulation of all events necessary to support the analysis provides a centralized database and is more easily understood and verified.

(3) Whenever a dataset contains an unusual event affecting interval time, such as an evacuee jumping out prior to full inflation of the assist means, or assist means deflating during the demonstration, those data should be adjusted as appropriate. Such adjustments should be documented in the analysis.

(4) When data values from multiple tests or demonstrations are available, it is permissible to use average performance values in the analysis. Exit flow rate data (expressed in evacuees per unit time) can be transformed to time intervals per evacuee by taking the reciprocal, then the intervals are averaged to yield the average interval per evacuee.

n. Data Presentation (Organization). Several event times in the database may need to be processed to yield the numerical values for evaluating the evacuation time of the subject configuration. Organizing the respective database values according to the time elements of the evacuation process provides a convenient means to show the data and the process. The data presentation section of an analysis should contain a subsection for each time element of the evacuation time line that requires reduction or processing of database event data, e.g., Table 1.

Table 1

DATABASE PRESENTATION EXAMPLE

757-200 CERTIFICATION DEMONSTRATION DATA

	Door 1L	Door 2L	Door 4L
Exit Prep. Time (sec.)	8.1	11.8	10.0
Flow rate (epm)	70.8	68.7	52.0
Time per evacuee (sec.)	.847	.873	1.154

o. Time for Exit Preparation.

(1) The time for exit preparation needs to be determined. If part of an exit system has been upgraded or otherwise changed since the full-scale evacuation demonstration(s), it may be necessary to revise the exit preparation time from that observed in previous demonstrations before using it in the analysis. $T_{Exit\ Prep}$ can be determined by timed tests of the new system or by summing the separate elements of $T_{Exit\ Prep.}$ Any adjustments should be fully documented.

(2) Exit preparation includes opening the exit and deploying any installed assist means. If the external assist means is an inflatable slide or slide/raft, the device is considered deployed when it exhibits the rigidity necessary to safely sustain a load (stable and fully extended)

although it may not necessarily be touching the ground. When the subject configuration includes the same basic exit system as formerly demonstrated, a straightforward tabulation of values applicable to that exit system should be presented. The average(s) should be shown and identified accordingly.

(3) "Hesitation time" may be defined as the interval of time between when the assist means (if required, usually a slide) is ready for use and the egress of the first evacuee. It may simply be the time necessary for the first evacuee to respond to the flight attendant's command, or it may include a reluctance to jump. The analysis should account for hesitation by measuring the time that elapses when the slide is perceived as inflated and fully extended (though not necessarily on the ground) until the first evacuee starts to descend on the slide. A suitable hesitation time may be derived by averaging all hesitation data values.

(4) Some off-wing escape systems may prompt a modification to the analysis technique to properly account for first evacuee hesitation. Overwing door opening or hatch removal may trigger a slightly delayed deployment and inflation of the off-wing inflatable. The first evacuee could emerge through the exit to the wing or wing ramp surface in advance of the off-wing slide being ready for use. Depending on available data, the evacuation capability analysis for some such systems should be based on first evacuee on the ground.

(5) After accounting for hesitation and doorway egress, the time for the first evacuee to travel from the point of contact with the slide or overwing ramp to the ground must be added to the time line. Average values, if used, should be noted. The assist means traverse time should include the on slide and on ground event times from which the traverse time interval is derived.

p. Time for Exit Flow.

(1) The period of evacuee flow through an exit system, $T_{Exit\ Flow}$, depends on flow rate and number of evacuees. Flow rates used in the analysis are those established by earlier demonstrations and tests and converted to intervals as described in paragraph 8.m.(4). $T_{Exit\ Flow}$ is then derived by multiplying the number of evacuees allocated to the exit minus one (n-1) by the average interval established for each evacuee.

(2) A dependable and accurate technique to determine flow rate from film or video tape is to:

(a) select a stable point or plane of reference in the flow path field of view,

(b) record the event times for passage of first and last evacuees, thus determining the time of flow, and

(c) calculate the flow rate (in evacuees per unit of time) by dividing the count of evacuees minus one by the flow time.

(3) The flow time starts with the first evacuee at the reference point. The remaining evacuees pass the reference point during the flow period. One evacuee, therefore, is subtracted from the total evacuee count to determine flow rate when a fixed-point or plane of reference technique is used.

q. Evacuee Allocation to Exits. The allocation of evacuees to exits should be established and illustrated on a configuration drawing. The allocation should be consistent with the demonstrated capability of the same or similar exit systems and with the distribution of exits and passenger seating relative to the exits. The illustration should convey the substance of an emergency evacuation plan that flight attendants, and flight deck personnel (for certain part 25 applications only) work to achieve with the subject configuration. The goal of the plan is to get everyone out as soon as possible. Passenger management techniques employed in the analysis need to be substantiated by records of earlier demonstrations and/or tests.

r. Flightcrew and Flight Attendant Duties. The crew members' positions during takeoff and landing and their primary and secondary duty stations during an emergency should be indicated on a suitable configuration diagram. Their duties should be described in the analysis. Demonstration or test data should be cited that substantiates the ability of crew members to travel to their duty stations. Procedures which would require a flight attendant to bypass an exit (other than one in the immediate vicinity of the flight attendant's seat) to get to his/her primary or secondary duty station should not be proposed.

NOTE: For applicants also seeking compliance with § 121.291, the flightcrew should have no assigned evacuation duties. Flightcrew participation is limited to part 25-only applications, where the type certification bases precede Amendment 25-79.

s. Passenger Management.

(1) The definition of "passenger management" for purposes of this advisory circular is the directing of passengers to active exits by flight attendants after initiation of the evacuation. The goal of passenger management is to minimize the total time for evacuation while ensuring passenger safety.

(2) To address passenger management, the applicant must show that similar flight attendant duties (see paragraph 9.r), allocation of evacuees to exits (see paragraph 9.q), and cabin configuration (see paragraph 9.c) have resulted in a successful full-scale evacuation demonstration(s) or equivalent test(s).

NOTE 1: Bypass of an active exit, when included in the analysis, must be based on bypass accomplished at an identical exit type during a full-scale demonstration on an airplane with the same number of aisles. "Bypass," for purposes of this advisory circular, is defined as the movement of a passenger past an active exit to get to another active exit. On a twin aisle airplane, movement past an exit along the aisle that is not adjacent to the active exit is still regarded as bypass. The passenger management and associated crew training should also be consistent between the airplane being analyzed and the airplane that was actually demonstrated.

NOTE 2: When exit systems are not symmetrically located or different performance characteristics have been identified for cross cabin exits, the analysis should address the more critical exit of each exit pair.

t. Total Evacuation Time Calculations.

(1) Utilizing the data, formula, and analytical techniques described above, the total evacuation time per exit as described in paragraph 9.l can be determined for the configuration.

(2) A configuration diagram, annotated with the calculated evacuation times and evacuee counts near the exits used can be used to provide a graphic summary of results. A single configuration diagram could satisfy the multiple purposes of depicting exits used, passenger and crew allocation to exits (cabin division lines) and the resulting evacuation times per exit.

u. Success Criteria.

(1) If the results of the total evacuation time calculations are less than 90 seconds, the analysis indicates that the airplane can be evacuated under the demonstration conditions established by appendix J of part 25 or section (a) of appendix D of part 121, within the time criterion contained in §§ 25.803(c) and 121.291(a), respectively. The conservatism of the analysis should be demonstrated as noted below.

(2) The applicant should then prepare an evaluation of the additional evacuation capability (time margin) of each exit that was used in the analysis.

(a) The following formula may be used to determine the available time margin for the airplane configuration being reviewed:

$$\text{Time margin} = \sum_{i=1}^{n} (90 - T_{\text{Total Exit } i})$$

where:

$T_{Total\ Exit\ i}$ = Total evacuation time for the exit (in seconds)

n = Total number of exits used

The available time margin calculated using the above formula should be 9 or more seconds. The time interval of 9 seconds (10 percent of the current standard of 90 seconds) is based on the demonstrated capability of today's transport category airplanes. Note that this method of establishing conservatism depends on the passenger management techniques being appropriate to balance the evacuees among the exits.

(b) An alternative to the margin calculations shown above, as a means of showing conservatism in the analysis, would be to use exit flow rates less than the calculated average and exit preparation times greater than the calculated average. The amount of performance degradation can be a calculated number such as the value of a standard deviation. The average evacuee flow rate would be reduced (thereby increasing the time of exit flow) and the average exit preparation time would be increased by the respective calculated values. If, however, the data used to derive the standard deviations is widely scattered resulting in a large value for the standard deviation, the applicant may choose to use the slowest rate or longest exit preparation time instead.

v. Initial Coordination of Analysis. As a general guideline, evacuation analyses should be informally coordinated as early as possible with the FAA certification office prior to formal submittal to ensure that all significant factors have been addressed.

10. Computer Modeling. Work is being done in the field of computer modeling to develop programs which could be used to demonstrate compliance with the evacuation demonstration requirements. Although progress has been made, to date, no program has been presented to the FAA and found acceptable as a substitute for an actual demonstration. Any applications for the use of computer modeling to demonstrate compliance with § 25.803(c) should be coordinated with the Standards Staff of the Transport Airplane Directorate.

for Ali Bahrami
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