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Aviation Research Division
Atlantic City International Airport
New Jersey 08405

A Research Study Into the More Pertinent Features of Small Commercial Airplanes Affecting Emergency Evacuation

July 2012

Final Report

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The Transport Canada Civil Aviation Technical Monitor was Claude Lewis. The Federal Aviation Administration Aviation Research Division Technical Monitor was Richard Hill.

16. Abstract

The majority of evacuation research has been directed toward large transport airplanes. The significant factors in evacuation from smaller transport airplanes are less generally understood. In addition to this, evacuation demonstrations are only required for airplanes certificated under CAR Chapter 525/14 CFR Part 25 with a passenger seating capacity of more than 44 passengers (CAR 525.803 (c)/14 CFR 25.803 (c)).

This study is intended to determine the features of smaller transport airplanes that are pertinent to evacuation by conducting an evaluation of cabin safety and evacuation regulations, an inspection of several smaller airplanes, and a review of smaller airplane past accident evacuation issues.

The report covers aspects that directly and indirectly influence an emergency evacuation, with emphasis on the differences and constraints that the design or operation of smaller airplanes may impose. These aspects include Doors and Emergency Exits, Evacuation Flow and Emergency Exit Access, Flight Attendants, Assist Means, Interior Emergency Lighting and Marking, Communication System, Emergency Equipment Requirement, and Survivability Factors.

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LIST OF ACRONYMS

CAR	Civil Aviation Regulations
CFR	Code of Federal Regulations
CSRTG	Cabin Safety Research Technical Group
FAA	Federal Aviation Administration
LH	Left-hand
MCTOW	Maximum certified take-off weight
RH	Right-hand

EXECUTIVE SUMMARY

The majority of evacuation research has been directed toward large transport airplanes. The significant factors in evacuation from smaller transport airplanes[1] are less generally understood. In addition to this, evacuation demonstrations are only required for airplanes certificated under CAR Chapter 525/14 CFR Part 25 with a passenger seating capacity of more than 44 passengers (CAR 525.803 (c)/14 CFR 25.803 (c)).

This study is intended to determine the features of smaller transport airplanes that are pertinent to evacuation by conducting an evaluation of cabin safety and evacuation regulations, an inspection of several smaller airplanes, and a review of smaller airplane past accident evacuation issues.

The report covers aspects that directly and indirectly influence an emergency evacuation, with emphasis on the differences and constraints that the design or operation of smaller airplanes may impose. These aspects include Doors and Emergency Exits, Evacuation Flow and Emergency Exit Access, Flight Attendants, Assist Means, Interior Emergency Lighting and Marking, Communication System, Emergency Equipment Requirement, and Survivability Factors.

[1] For the purposes of this study, ‘smaller transport airplanes’ are defined as corporate jets and all transport airplanes with a seating capacity of up to 60 passengers.

1. INTRODUCTION.

This study is intended to determine the features of smaller transport airplanes that are pertinent to evacuation, to facilitate future studies, because the significant factors in evacuation from smaller transport airplanes are less generally understood. This is primarily due to the fact that the majority of evacuation research has been directed toward large transport airplanes, and because evacuation demonstration is only required for airplanes certificated under CAR Chapter 525/14 CFR Part 25 having a passenger seating capacity of more than 44 passengers, as stated in CAR 525.803 (c)/14 CFR 25.803 (c).

> "(c) For airplanes having a seating capacity of more than 44 passengers, it must be shown that the maximum seating capacity, including the number of crewmembers required by the operating rules for which certification is requested, can be evacuated from the airplane to the ground under simulated emergency conditions within 90 seconds. Compliance with this requirement must be shown by actual demonstration using the test criteria outlined in appendix J of this part unless the Minister (Administrator2) finds that a combination of analysis and testing will provide data equivalent to that which would be obtained by actual demonstration."

A demonstration of emergency evacuation procedures for operators under 14 CFR Part 121 and 125 is also only required for airplanes with a seating capacity of more than 44 passengers (14 CFR 121.291, 125.189).

The initial part of the study is based on a survey of related requirements in CAR Subparts 525, 602, 604, 605, 701, 703/723, 704/724, and 705/725 (reference 1) and 14 CFR Parts 25, 91, 121, 125 and 135 (reference 2) to determine those differences that result from regulations pertinent to cabin safety and evacuation. The second part of the study involved inspection of several airplanes to ascertain differences not attributable to the regulations and to identify some of the more usual design features of the smaller transport airplanes. An additional study was conducted to obtain some indications of possible recurring issues encountered in the evacuation of smaller airplane accidents through the review of the CSRTG Accident Database (reference 3). However, it is important to note that the Accident Database only contains accidents to airplanes with maximum certificated passenger seating capacity of 19 or more.

The following are the primary aspects discussed in this study that are considered as having a direct and significant influence on an emergency evacuation:

1. Type, number and operation of exits.

2. Location/distribution of exits and access to exits.

[2] In 14 CFR 25.803 (c)

3. Aircraft interior configuration/characteristics that can affect the evacuees' access and flow to any emergency exit (e.g. aisle shape, passageway shape/clearance, headroom, seats, partition, galley, etc.).

4. Cabin crew location/distribution (if applicable), in relation to cabin crew workload during evacuation (monitoring of exits, operation of exits).

5. Assist means (if applicable) and exit height to the ground.

6. Interior emergency lighting and exit marking.

7. Stowing and securing of carry-on baggage/cargo and service/emergency equipment.

Other cabin safety issues that may also be specific to smaller transport airplanes and could possibly influence emergency evacuation are also discussed, such as communication system, emergency equipment requirement, and survivability of occupants.

Other aspects such as passenger behaviour and cabin damage/debris in smaller airplane accidents may also be unique in smaller airplane accidents. However, these topics are beyond the scope of this study.

2. OBJECTIVES.

The objective of this study is to review and identify the cabin design features unique to smaller transport category airplanes, as a basis for evacuation testing experiments, in support of the Canadian manufacturing industry.

3. DEFINITION OF TERMS.

CAR Chapter 525:
Canadian Aviation Regulations Airworthiness Manual for Transport Category Airplanes.

CAR Part VI Subpart 2 (602):
Canadian Aviation Regulations General Operating and Flight Rules – Operating and Flight Rules.

CAR Part VI Subpart 4 (604):
Canadian Aviation Regulations General Operating and Flight Rules – Private Operator Passenger.

CAR Part VI Subpart 5 (605):
Canadian Aviation Regulations General Operating and Flight Rules – Aircraft Requirements.

CAR Part VII Subpart 1 (701):
Canadian Aviation Regulations for Commercial Air Services – Foreign Air Operations.

CAR Part VII Subpart 3 (703):
Canadian Aviation Regulations for Commercial Air Services – Air Taxi Operations.

CAR Part VII Subpart 4 (704):
Canadian Aviation Regulations for Commercial Air Services – Commuter Operations.

CAR Part VII Subpart 5 (705):
Canadian Aviation Regulations for Commercial Air Services – Airline Operations.

CAR Standard 723:
Canadian Aviation Regulations Standard for Air Taxi Operations Airplanes.

CAR Standard 724:
Canadian Aviation Regulations Standards for Commuter Operations Airplanes.

CAR Standard 725:
Canadian Aviation Regulations Standard for Airline Operations Airplanes.

14 CFR Part 25:
Federal Aviation Administration Airworthiness Standard for Transport Category Airplanes.

14 CFR Part 91:
Federal Aviation Administration General Operating and Flight Rules.

14 CFR Part 121:
Federal Aviation Administration Operating Requirements for Domestic, Flag, and Supplemental Operations.

14 CFR Part 125:
Federal Aviation Administration Certification and Operations for Airplanes having a seating capacity of 20 or more passengers or a maximum payload capacity of 6,000 pounds or more.

14 CFR Part 135:
Federal Aviation Administration Operating Requirements for Commuter and On-Demand Operations and Rules Governing Persons Onboard Such Aircraft.

Transport airplanes (FAA definition):
All jets with 10 or more seats or greater than 12,500lb Maximum Takeoff Weight.
All propeller driven airplanes with greater than 19 seats or greater than 19,000 lb Maximum Takeoff Weight.

Smaller Transport Airplanes (definition used for this study):
Corporate jets and all transport airplanes with a seating capacity up to 60 passengers.

4. METHODOLOGY.

4.1 REGULATION REVIEW.

The regulations pertinent to cabin safety and evacuation that are contained in CAR Subparts 525, 602, 604, 605, 701, 703, 704, 705, 723, 724, and 725 and 14 CFR Parts 25, 91, 121, 125 and 135 were reviewed. Most of the regulations are applicable regardless of airplane passenger capacity and/or size. The regulations reviewed are as follows:

1. Evacuation demonstration
2. Minimum type and number of emergency exits
3. Exit above waterline requirements and overhead hatch
4. Flightcrew emergency exit location
5. Emergency exit location
6. Distribution of emergency exit
7. Emergency exit opening instruction
8. Means of opening and arrangement of emergency exit doors
9. Integral stairs
10. Minimum aisle width
11. Passageway width for large exit
12. Passageway width for Type III and IV exit
13. Passageway obstruction
14. Assist space
15. Carry-on baggage regulation
16. Retention of items of mass in passenger/crew compartments
17. Enclosed stowage compartment
18. Stowage of food and service equipments
19. Exit seating regulation applicability
20. Flight attendant requirement
21. Flight attendant station
22. Assist means
23. Interior emergency lighting and floor proximity lighting
24. Interior emergency exit marking
25. Emergency exit signs
26. Public Address system and Crewmember interphone system requirement
27. Megaphones
28. Emergency equipment requirement applicability
29. Crash Ax requirement
30. Required number of hand fire extinguisher
31. Passenger seat and restraint system
32. Compartment interior flammability requirements

The summary of regulations against airplane passenger capacity is attached as a table in appendix A. It is important to note that each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example,

CAR Subpart 705 only applies to airplane having an MCTOW >19,000 lb or with passenger seating capacity of more than 19).

4.2 AIRPLANE INSPECTION.

The purpose of the airplane inspection was intended to identify any smaller aircraft features that may affect emergency evacuation that are not attributable directly to the regulations. These features may also arise from any exemption or inapplicability of certain regulations, or any equivalent safety findings.

The airplanes inspected are listed in table 1. They were selected to represent all sub-classes of smaller transport airplanes (i.e. corporate jets and small transport airplanes with 10-19 seats, regional transport airplanes with 20-44 seats, and regional transport airplanes with 45-60 seats).

Table 1. Airplanes Inspected

Identifier Used for Aircraft Inspected	Aircraft Type	Passenger Capacity of Inspected Airplane
A	Twin-engine corporate jet	6-8
B	Twin-engine corporate jet	8
C	Twin-engine corporate jet	9
D	Twin turboprop regional airplane	19
E	Twin turboprop regional airplane	19
F	Twin turboprop regional airplane	28
G	Twin turboprop regional airplane	34
H	Twin turbofan regional airplane	49
I	Twin turboprop regional airplane	50

Fuselage cross section and cabin layout diagrams of inspected airplanes are attached as appendix B.

4.3 PAST ACCIDENT EVACUATION ISSUES.

A search was carried out using the CSRTG Accident Database at Issue 26 (reference 3) for evacuation-related accidents, to smaller transport airplanes, for which textual data was available. Accidents satisfying this search criteria were reviewed and 19 were found to address relevant evacuation issues. Again, it should be noted that the Accident Database only contains accidents to airplanes with maximum certificated passenger seating capacity of 19 or more. The result of this review is summarized in appendix C.

For the purposes of the review, evacuation issues were considered to be any factors that had impeded the evacuation, caused injuries during the evacuation, or could have reduced the survivability of the passengers. Some of the issues may or may not be specific to smaller transport airplanes.

5. FACTORS DIRECTLY AFFECTING EVACUATION.

5.1 DOORS AND EMERGENCY EXITS.

5.1.1 Required Type and Number of Emergency Exits.

5.1.1.1 Regulation Review.

Based on passenger seating capacity, the number and type of emergency exits required is regulated by CAR 525.807 (g)/14 CFR 25.807 (g), as follows:

1. For a passenger seating configuration of 1 to 9 seats, there must be at least one Type IV or larger overwing exit in each side of the fuselage or, if overwing exits are not provided, at least one exit in each side that meets the minimum dimensions of a Type III exit.

2. For a passenger seating configuration of more than 9 seats, each exit must be a Type III or larger exit.

3. For a passenger seating configuration of 10 to 19 seats, there must be at least one Type III or larger exit in each side of the fuselage.

4. For a passenger seating configuration of 20 to 40 seats, there must be at least two exits, one of which must be a Type II or larger exit, in each side of the fuselage.

5. For a passenger seating configuration of 41 to 110 seats, there must be at least two exits, one of which must be a Type I or larger exit, in each side of the fuselage.

6. For a passenger seating configuration of more than 110 seats, the emergency exits in each side of the fuselage must include at least two Type I or larger exits.

5.1.1.2 Airplane Inspection.

It was found that smaller airplanes usually have a good passenger seat/exit ratio, as shown in table 2.

Table 2. Number, Type, and Location of Emergency Exits on Inspected Airplanes

Airplane	Applicable Exit No. /Type Requirement	No/Type/Location	Remarks
A	525.807 (g)(1) 25.807 (g)(1)	1 Type I (LH forward) 1 Type III (RH middle)	Better passenger seat/exit ratio than requirement.
B	525.807 (g)(1) 25.807 (g)(1)	1 Type I (LH forward) 1 Type III (RH middle)	Better passenger seat/exit ratio than requirement.
C	525.807 (g)(1) 25.807 (g)(1)	1 Type I (LH forward) 1 Type III (RH middle)	Better passenger seat/exit ratio than requirement.
D	525.807 (g)(3) 25.807 (g)(3)	1 Type C (LH aft) 1 Type IV (LH middle) 1 Type III (RH middle).	Better passenger seat/exit ratio than requirement.
E	525.807 (g)(3) 25.807 (g)(3)	1 Type I (LH aft) 1 Type II (RH aft) 2 Type IV (LH & RH middle)	Better passenger seat/exit ratio than requirement.
F	525.807 (g)(4) 25.807 (g)(4)	1 Type I (LH forward) 1 Type II (RH aft) 2 Type III (RH & LH middle)	Better passenger seat/exit ratio than requirement.
G	525.807 (g)(4) 25.807 (g)(4)	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	Better passenger seat/exit ratio than requirement.
H	525.807 (g)(5) 25.807 (g)(5)	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	Exit type and number are the minimum required.
I	525.807 (g)(5) 25.807 (g)(5)	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	Exit type and number are the minimum required. There is a galley service door (RH aft) and a door leading to the cargo compartment at the rear with cargo door, but these doors are not designated exits.

5.1.1.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to required type and number of emergency exits.

5.1.2 EXITS ABOVE THE WATERLINE.

5.1.2.1 Regulation Review.

The number of exits above the waterline based on passenger seating capacity is regulated under CAR 525.807 (i)/14 CFR 25.807 (i). Smaller airplanes usually have overhead hatches, as it may be impractical for them to have exits above the waterline.

"(i) *Ditching emergency exits for passengers.* Whether or not ditching certification is requested, ditching emergency exits must be provided in accordance with the following requirements, unless the emergency exits required by paragraph (g) of this section already meet them:

(1) For airplanes that have a passenger seating configuration of nine or fewer seats, excluding pilot seats, one exit above the waterline in each side of the airplane, meeting at least the dimensions of a Type IV exit.

(2) For airplanes that have a passenger seating configuration of 10 of more seats, excluding pilot seats, one exit above the waterline in a side of the airplane, meeting at least the dimensions of a Type III exit for each unit (or part of a unit) of 35 passenger seats, but no less than two such exits in the passenger cabin, with one on each side of the airplane. The passenger seat/exit ratio may be increased through the use of larger exits, or other means, provided it is shown that the evacuation capability during ditching has been improved accordingly.

(3) If it is impractical to locate side exits above the waterline, the side exits must be replaced by an equal number of readily accessible overhead hatches of not less than the dimensions of a Type III exit, except that for airplanes with a passenger configuration of 35 or fewer seats, excluding pilot seats, the two required Type III side exits need be replaced by only one overhead hatch."

5.1.2.2 Airplane Inspection.

There were no particular issues relating to exits above the waterline found on the inspected airplanes.

5.1.2.3 Past Accident Evacuation Issues.

Overhead escape hatches, which are more common in smaller airplanes, may not usually be shown in the safety card. This concern is addressed in accident reference 19820221A, which states "the safety briefing card did not show the location of the overhead escape hatch in the cabin" (see appendix C).

5.1.3 Flightcrew Emergency Exit.

5.1.3.1 Regulation Review.

The location of flightcrew emergency exits for airplanes having a passenger seating capacity of more than 20 should be in the flightcrew area, as regulated in CAR 525.807 (j)/14 CFR 25.807 (j).

"(j) *Flightcrew emergency exits.* For airplanes in which the proximity of passenger emergency exits to the flightcrew area does not offer a convenient and readily accessible means of evacuation of the flightcrew, and for all airplanes

> having a passenger seating capacity greater than 20, flightcrew exits shall be located in the flightcrew area. Such exits shall be of sufficient size and so located as to permit rapid evacuation by the crew. One exit shall be provided on each side of the airplane; or, alternatively, a top hatch shall be provided. Each exit must encompass an unobstructed rectangular opening of at least 19 by 20 inches unless satisfactory exit utility can be demonstrated by a typical crewmember."

5.1.3.2 Airplane Inspection.

There were no particular issues relating to flightcrew emergency exits found on the inspected airplanes.

5.1.3.3 Past Accident Evacuation Issues.

Flightcrew exit issues identified in past accidents were (see appendix C):

- The cockpit door and overhead emergency exit were both jammed, and the flightcrew were unable to break the cockpit window using the ax. The flightcrew had to be rescued by fire-fighters (accident reference 19880415A).

- Movement of the right and left cockpit sliding windows was restricted by airframe damage (accident reference 19950821A)

Compared to the flightcrew exit in a large airplane, the flightcrew exit in a smaller airplane may be more likely to be used by passengers to evacuate, as found in accident reference 19831123A.

5.1.4 Location and Distribution of Emergency Exits.

5.1.4.1 Regulation Review.

Location of emergency exits based on passenger seating capacity is regulated by CAR 525.772 (a)/14 CFR 25.772 (a):

> "For an airplane that has a [lockable door installed between the pilot compartment and the passenger compartment:
>
> (a) For airplanes with a maximum passenger seating configuration of 20 seats or more (of more than 20 seats3), the emergency exit configuration must be designed so that neither crewmembers nor passengers require use of the flightdeck door in order to reach the emergency exits provided for them;]"

The requirement for uniform distribution of exits is applicable regardless of passenger seating capacity, as stated in CAR 525.807 (e)/14 CFR 25.807 (e):

[3] In 14 CFR 25.772 (a)

(e) Uniformity. Exits must be distributed as uniformly as practical, taking into account passenger seat distribution

The acceptable means of demonstrating compliance with this 14 CFR requirement are discussed in Advisory Circular 25.807-1, but this AC does not address airplanes with only one pair of required exits (i.e. airplanes with less than 20 seats).

In CAR 525.813/14 CFR 25.813, distribution of emergency exits is prescribed as:

> "Each required emergency exit must be accessible to the passengers and located where it will afford an effective means of evacuation. Emergency exit distribution must be as uniform as practical, taking passenger distribution into account; however, the size and location of exits on both sides of the cabin need not be symmetrical. If only one floor-level exit per side is prescribed, and the airplane does not have a tail cone or ventral emergency exit, the floor-level exit must be in the rearward part of the passenger compartment, unless another location affords a more effective means of passenger evacuation. Where more than one floor-level exit per side is prescribed, at least one floor-level exit per side must be located near each end of the cabin, except that this provision does not apply to combination cargo/passenger configurations."

5.1.4.2 Airplane Inspection.

In smaller airplanes, the location and distribution of the exits are often compromised due to practical considerations. Cabin layouts of the inspected airplanes are attached to this report as appendix B.

5.1.4.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to location and distribution of emergency exits.

5.1.5 Emergency Exit Opening Instructions and Operation.

5.1.5.1 Regulation Review.

The regulations for emergency exit marking and opening instructions are contained in CAR 525.811/14 CFR 25.811, and are independent of passenger seating capacity. The regulations regarding means of opening the doors and emergency exit arrangement are contained in CAR 525.809/14 CFR 25.809. In CAR 525.813 (c)(3)/14 CFR 25.813 (c)(3), it is stated that:

> "(3) For each Type III exit, regardless of the passenger capacity of the aeroplane in which it is installed, there must be placards that:
>
> (i) Are readable by all persons seated adjacent to and facing a passageway to the exit;

(ii) Accurately state or illustrate the proper method of opening the exit, including the use of handholds; and
(iii) If the exit is a removable hatch, state the weight of the hatch and indicate an appropriate location to place the hatch after removal."

5.1.5.2 Airplane Inspection.

On the corporate jets inspected, the instruction on the Type III emergency exit only reads "PULL TO REMOVE COVER" or "REMOVE COVER" and is not accompanied by any illustration (see figure 1).

Figure 1. Type III Emergency Exit Opening Instruction (Airplanes B and C)

Other (larger) airplanes that were inspected have complete and graphical descriptions of the Type III/Type IV emergency exit opening instruction, including where to place the hatch after opening (outside of the airplane). It was considered however that some of the graphical descriptions could be misleading as they usually show a person standing up with a lot of space and headroom (see figure 2 and figure 3), since inspection of the aircraft showed that space around these exits was restricted.

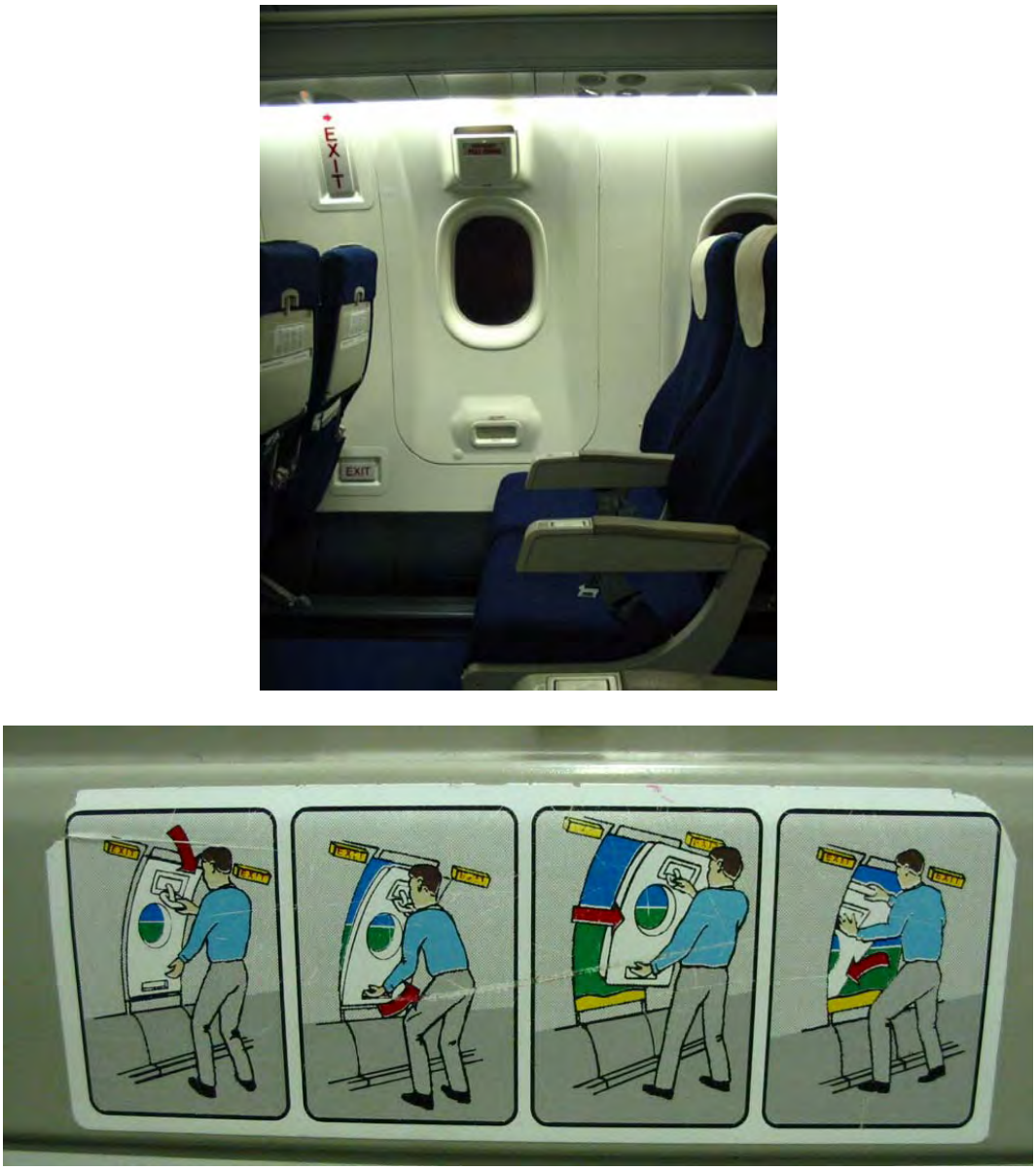


Figure 2. Type III Emergency Exit and Opening Instructions—
Passenger Standing Up (Airplane I)

Figure 3. Type III Emergency Exit and Opening Instructions—
Passenger Standing Up (Airplane D, similar to Airplane F)

In Airplanes G and H, the Type III emergency exit opening instructions show the passenger sitting down while opening the exit (figure 4 and figure 5).

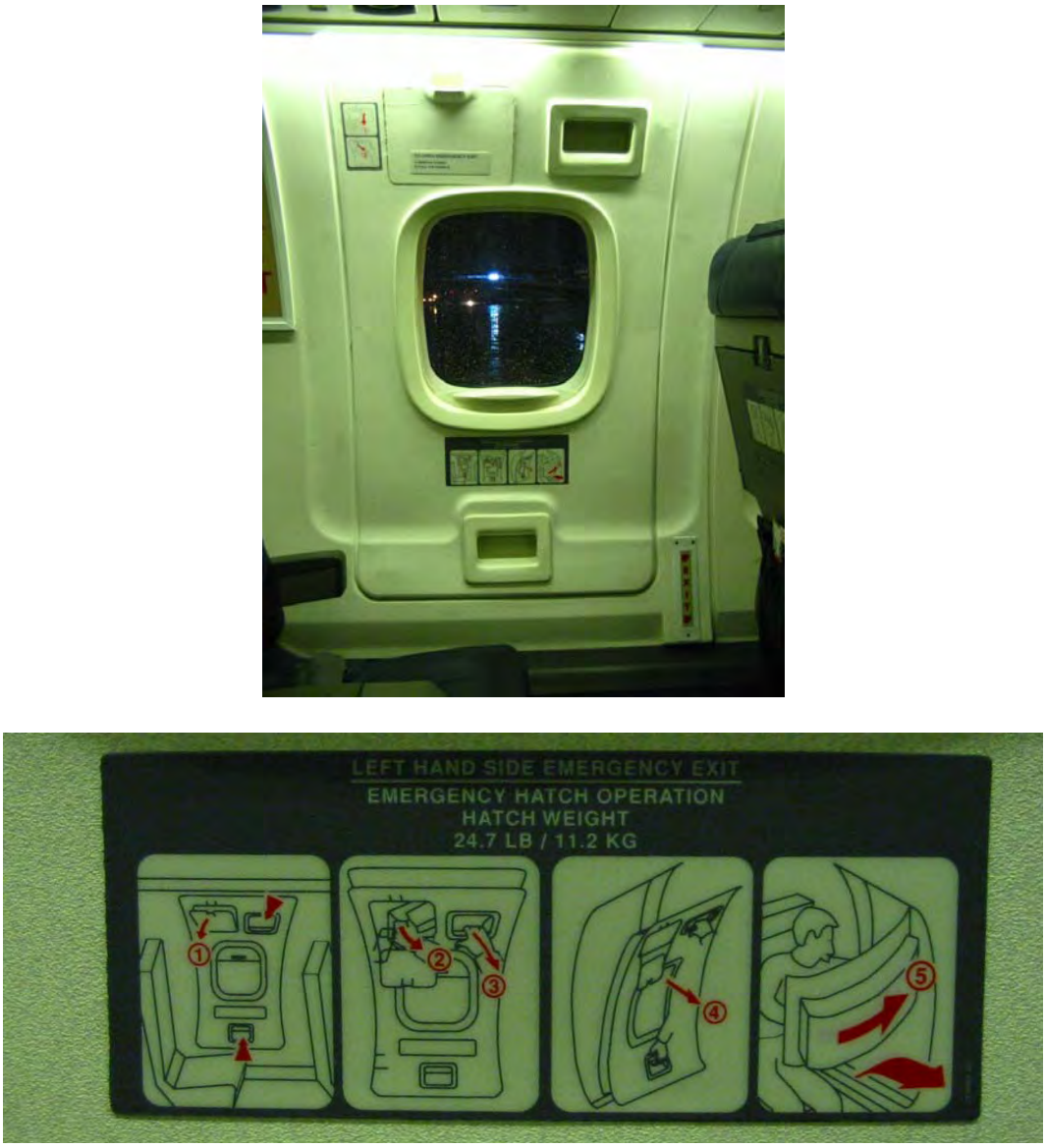


Figure 4. Type III Emergency Exit and Opening Instructions—
Passenger Sitting Down (Airplane H)

Figure 5. Type III Emergency Exit and Opening Instructions—
Passenger Sitting Down (Airplane G)

It is not known whether opening a Type III/Type IV emergency exit is easier while standing up or sitting down. While sitting down, the passenger opening the exit might be able to use his/her lap to support the hatch to throw it outside the airplane.

When the emergency exit is of a larger (and hence heavier) type (Type II and larger), it may be preferable that the opening of these exits does not necessitate the passenger/flight attendant to lift the hatch and throw it outside, as found in Airplane G (figure 6).

Figure 6. Type I Emergency Exit and Opening Instructions (Airplane G)

When space is very limited, or the hatch is relatively heavy and large, it might be helpful to have emergency exits that are easy to open and do not require much space during opening, such as hatches that fall out after the handle is pulled. This type of exit is featured on Airplane E (see figure 7) and Airplane I (see figure 8).

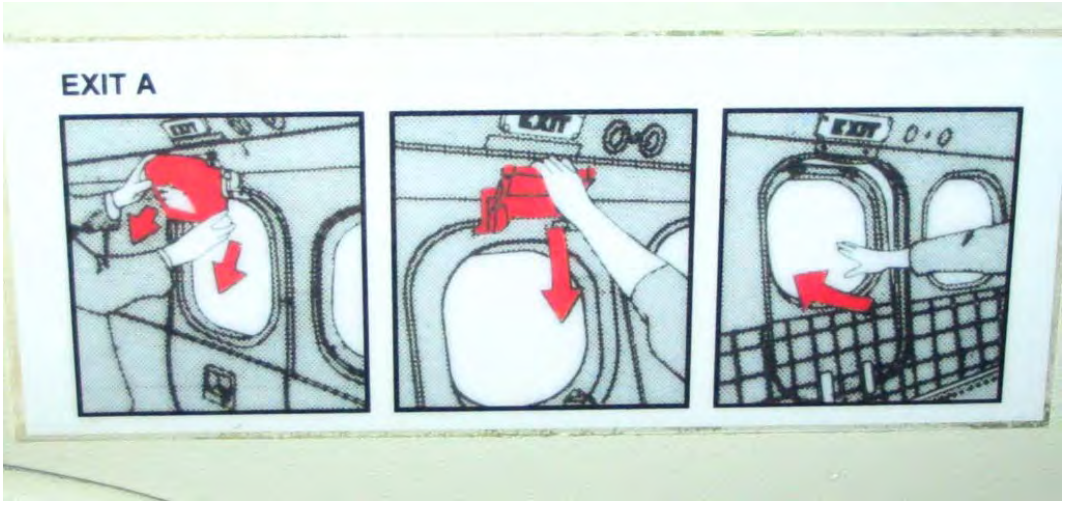


Figure 7. Type IV Emergency Exit and Opening Instructions (Airplane E)—Hatch can be Pushed Out

Figure 8. Type I Emergency Exit and Opening Instructions (Airplane I) – Hatch can be Pushed Out

The corporate jets have very limited space, and certain compromises may have to be made in regard to the emergency exit configuration. Figure 9 shows a table fitted onto the Type III overwing emergency exit hatch, which adds more weight to the hatch. There was no placard stating the weight of the hatch.

Figure 9. Table Fitted on the Type III Emergency Exit (Airplane B)

5.1.5.3 Past Accident Evacuation Issues.

Appendix C summarizes the problems encountered in opening the emergency exits during evacuation in past accidents to smaller airplanes. See accident references 19831123A, 19840113A, 19870304A, 19880202A, 19940201A, 19971207A and 20010625A.

5.1.6 Airstair.

5.1.6.1 Regulation Review.

Integral stairs regulation is contained in CAR 525.783 (i).

> "(i) If an integral stair is installed in a passenger entry door that is qualified as a passenger emergency exit, the stair must be designed so that under the following conditions the effectiveness of passenger emergency egress will not be impaired:
>
> (1) The door, integral stair, and operating mechanism have been subjected to the inertia forces specified in 525.561(b)(3), acting separately relative to the surrounding structure.
>
> (2) The airplane is in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear."

The same regulation is found in 14 CFR 25.810 (e).

5.1.6.2 Airplane Inspection.

The majority of smaller airplanes have an integral airstair on the main passenger door (figure 10), which requires the door to open downward. Compared to the doors that slide open to the side, which are more common in large airplanes, this type of exit can easily become unusable with very little external obstruction. On accidents where the airplane rests inverted, opening of this type of door can also be more difficult as it has to be pushed upwards, especially if the passenger/flight attendant has become disoriented (see appendix C, accident reference 19870304A).

Figure 10. Integral Airstair (Airplane B, Airplane D, Airplane E, Airplane F, Airplane H, Airplane I)

In Airplane G, the airstair of the forward passenger door is not integral with the door, but is deployed separately (figure 11). This airstair is not supposed to be deployed during an emergency evacuation, as shown on the door instruction. To deploy the airstair, the flight attendant jumpseat has to be removed to the right side to allow unstowing of the airstair. The airstair is secured by a spring lock on the floor rail (figure 12) and any rearward shifting during a crash sequence would be blocked by the flight attendant jumpseat.

Figure 11. Forward Left Exit and Airstair Stowage (Airplane G)

Figure 12. Forward Left Exit Airstair Securing Mechanism (Airplane G)

5.1.6.3 Past Accident Evacuation Issues.

Problems with the airstairs during emergency evacuation in past smaller airplane accidents include injuries sustained by an evacuee due to falling off the steps (see appendix C, accident reference 19981025A) and a partially blocked exit due to a dislodged airstair on impact (see appendix C, accident reference 19981203A).

5.2 EVACUATION FLOW AND EMERGENCY EXIT ACCESS.

5.2.1 Aisle Width.

5.2.1.1 Regulation Review.

Aisle width is regulated by CAR 525.815/14 CFR 25.815 based on passenger seating capacity, as follows:

> "The passenger aisle width at any point between seats must equal or exceed the values in the following table:

Passenger seating capacity	Minimum passenger aisle width (inches)	
	Less than 25 in. from floor	25 in. and more from floor
10 or less	[1]12	15
11 through 19	12	20
20 or more	15	20

> Footnote:
> [1] A narrower width not less than 9 inches may be approved when substantiated by tests found necessary by the Minister (Administrator4)."

5.2.1.2 Airplane Inspection.

Most of the airplanes with a passenger seat capacity of less than 20 are configured with the minimum aisle width.

Swivel chairs, a feature common to corporate jets, may present a minor obstruction during evacuation (figure 13).

Figure 13. Swivel Chairs in Corporate Jets (Airplane C)

[4] In 14 CFR 25.815

5.2.1.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to aisle width.

5.2.2 Aisle Shape and Headroom.

5.2.2.1 Regulation Review.

Aisle shape and headroom are currently not regulated.

5.2.2.2 Airplane Inspection.

Most of the smaller airplanes have a sunken aisle, a feature not common in a large transport airplane. Fuselage cross-section diagrams of inspected airplanes are attached as appendix B.

Table 3. Sunken Aisle and Cabin Headroom

Airplane	Cabin Height*	Sunken Aisle**
A	4.75 ft	Yes (7″ deep)
B	5.58 ft	Yes (7″ deep)
C	5.58 ft	Yes (7″ deep)
D	5.9 ft	Yes (7″ deep)
E	4.92 ft	No
F	5.9 ft	Yes (6″ deep)
G	5.74 ft	Yes (3″ deep)
H	5.97 ft	No
I	6.16 ft	Yes (2″ deep)

* from aisle floor to ceiling
** from aisle floor to seat floor level

Airplane D has the main spar laid across the aisle just in front of row 4 (figure 14). The main spar measures approximately 7 inches – 9 inches high and 6 inches wide. A “Caution” light was installed on the ceiling above the main spar.

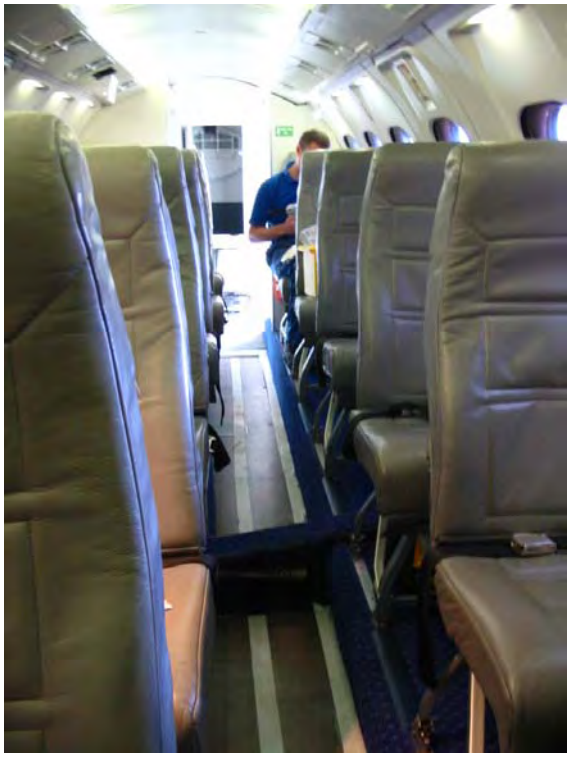


Figure 14. Main Spar Across Aisle (Airplane D)

5.2.2.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to aisle shape and headroom.

5.2.3 Emergency Exit Access for Type A/B/C/I/II Exits.

5.2.3.1 Regulation Review.

Emergency exit access is regulated by CAR 525.813/14 CFR 25.813. Requirements for large exit passageways are set out in CAR 525.813 (a)/14 CFR 25.813 (a):

> "(a) There must be a passageway leading from the nearest main aisle to each Type A, Type B, Type C, Type I, or Type II emergency exit and between individual passenger areas. Each passageway leading to a Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide. Unless there are two or more main aisles, each Type A or B exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions. If two or more main aisles are provided, there must be unobstructed cross-aisles at least 20 inches wide between main aisles. There must be –"
>
> "(1) A cross-aisle which leads directly to each passageway between the nearest main aisle and a Type A or B exit; and
>
> (2) A cross aisle which leads to the immediate vicinity of each passageway between the nearest main aisle and a Type I, Type II, or Type III exit; except that when two Type III exits are located within three passenger rows of each other, a single cross aisle may be used if it leads to the vicinity between the passageways from the nearest main aisle to each exit."

5.2.3.2 Airplane Inspection.

On the smaller transport airplanes, the floor level exits (usually Type I or II) are commonly located around the galley area and hand-carried luggage compartment (figure 15 to figure 19). This means that post-crash obstruction of exit access from dislodged carts, other service equipment and hand luggage is possible, depending on impact intensity and equipment/compartment securing method.

Figure 15. Galley (left) and Luggage Compartment (right) on Aisle Leading to Main Passenger Door (Airplane B)

Figure 16. Galley & Luggage Compartment on Aisle Leading to Main Passenger Door (left: viewed from cockpit; right: viewed from cabin) (Airplane C)

Figure 17. Right-Hand Side of the Galley Area at the Aisle Leading to the Rear Main Passenger Door (left: lower part; right: upper part) (Airplane D)

Figure 18. Galley at Right-Hand Aft Emergency Exit Area (left: cart stowed; right: cart loose and blocking the exit) (Airplane F)

Figure 19. Passageway to Forward Left Emergency Exit (left) and Forward Right Emergency Exit (right)—Cart is Shown Dislodged (Airplane H)

In Airplane E, the aft right-hand floor level emergency exit is obstructed by a seatback and an unfolded jumpseat (figure 20).

Figure 20. Aft Right-Hand Emergency Exit Obstructions (Airplane E)

5.2.3.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to emergency exit access for Type A/B/C/I/II exits.

5.2.4 Emergency Exit Access for Type III/IV Exit.

5.2.4.1 Regulation Review.

The requirements for Type III/IV emergency exit access are set out in CAR 525.813 (c)/14 CFR 25.813 (c):

> "(c) The following must be provided for each Type III or Type IV exit -
>
> (1) There must be access from the nearest aisle to each exit. In addition, for each Type III exit in an airplane that has a passenger seating configuration of 60 or more -
>
> (i) Except as provided in paragraph (c)(1)(ii), the access must be provided by an unobstructed passageway that is at least 10 inches in width for interior arrangements in which the adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width for interior arrangements in which those rows contain three seats. The width of the passageway must be measured with adjacent seats adjusted to their most adverse position. The centerline of the required passageway width must not be displaced more than 5 inches horizontally from that of the exit.
>
> (ii) In lieu of one 10 or 20 inch passageway, there may be two passageways, between seat rows only, that must be at least 6 inches in width and lead to an unobstructed space adjacent to each exit. (Adjacent exits must not share a common passageway.) The width of the passageways must be measured with adjacent seats adjusted to their most adverse position. The unobstructed space adjacent to the exit must extend vertically from the floor to the ceiling (or bottom of sidewall stowage bins), inboard from the exit for a distance not less than the width of the narrowest passenger seat installed on the airplane, and from the forward edge of the forward passageway to the aft edge of the aft passageway. The exit opening must be totally within the fore and aft bounds of the unobstructed space.
>
> (2) In addition to the access -
>
> (i) For airplanes that have a passenger seating configuration of 20 or more, the projected opening of the exit provided must not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including any seatback in the most adverse position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the airplane.

(ii) For airplanes that have a passenger seating configuration of 19 or fewer, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit."

5.2.4.2 Airplane Inspection.

Most of the smaller airplanes have better access to the Type III/IV emergency exit in terms of the number of seats in the exit seat row, which is usually just one (at least on one side).

There are no requirements regarding the headroom at the passageway. Table 4 shows the headroom and seat pitch at the Type III/Type IV exit area on Airplanes D to I.

Table 4. Type III/IV Emergency Exit Space

Airplane	Headroom	Seat Pitch
D	54″ *	33″ (LH) 39″ (RH) [d]
E	58.93″ ****	32″ [m]
F	55″ **	37″ [d]
G	56″ **	32″ [d]
H	54″ **	34″ [m]
I	60″ ***	33″ [d]

*measured from floor to top of hatch
** measured from floor to PSU panel
*** from diagram (floor to PSU panel)
**** from diagram (same as cabin height)

[m] measured
[d] from diagram

Minor obstructions such as seatbacks are quite prevalent on the much smaller airplanes. On Airplane C, a divan-type seat is fitted under the Type III emergency exit hatch, requiring removal of the back cushion to open the hatch (figure 21).

Figure 21. Type III Emergency Exit With Divan-Type Seat Fitted Underneath (Airplane C)

On Airplane E, the emergency exit window is slightly obstructed by the seatback (figure 22).

Figure 22. Minor Obstruction of Emergency Exit Window (Airplane E)

5.2.4.3 Past Accident Evacuation Issues.

The review carried out of past accidents to smaller transport aircraft revealed that the seatback and armrest of the seats in the vicinity of the Type III/IV emergency exit had restricted the opening of the emergency exit hatch (see appendix C, accident reference 19840113A).

5.2.5 Assist Space.

5.2.5.1 Regulation Review.

Assist space requirements are set out in CAR 525.813 (b)/14 CFR 25.813 (b):

> "(b) Adequate space to allow crewmember(s) to assist in the evacuation of passengers must be provided as follows:
>
> (1) The assist space must not reduce the unobstructed width of the passageway below that required for the exit.
>
> (2) For each Type A or Type B exit, assist space must be provided at each side of the exit regardless of whether a means is required by 525.810 (a) (§ 25.810 (a)5) to assist passengers in descending to the ground from that exit.
>
> (3) Assist space must be provided at one side of any other type exit required by 525.810 (a) (§ 25.810 (a)6) to have a means to assist passengers in descending to the ground from that exit."

Similar requirements are mentioned in 14 CFR 121.310 (f) and 135.178 (f).

5.2.5.2 Airplane Inspection.

On the inspected airplanes to which this regulation is applicable, assist space is very limited for almost every exit, even at the main passenger door, which is usually a Type I (figures 23, 24, and 25).

[5] In 14 CFR 25.813 (b)
[6] In 14 CFR 25.813 (b)

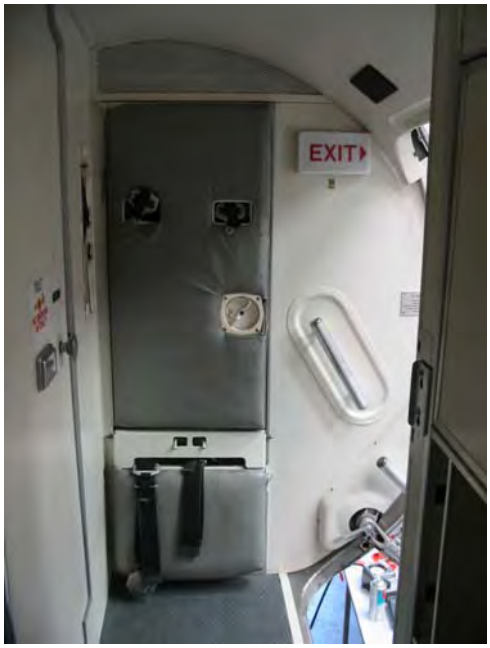


Figure 23. Assist Space at Aft Main Passenger Door/Type C (Airplane D)

Figure 24. Assist Space at Forward Left Passenger Door/Type I and Aft Right Emergency Door/Type II (Airplane F)

Figure 25. Assist Space at Forward Left Passenger Door/Type I
(Airplane G)

5.2.5.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to assist space.

5.2.6 Carry-On Baggage, Stowage Compartment, and Securing of Equipment.

5.2.6.1 Regulation Review.

Carry-on baggage and service/emergency equipment that is spilled or shifted into the aisle or exit passageway during a crash sequence may present an obstruction to the evacuation flow, block access to the exit, or inflict injuries to the evacuees.

Regulations on carry-on baggage are contained in CAR 602.86 (1), CAR 705.42/725.42, 14 CFR 121.589 and 135.89. For 14 CFR Part 91 airplanes, regulations on carry-on baggage are only applicable for operation of airplanes having a seating capacity of more than 19 passengers (14 CFR 91.523).

Only airplanes with passenger capacity of 10 or more are required to have their stowage compartment completely enclosed, as regulated in CAR 525.787 (a)/14 CFR 25.787 (a).

> "(a) Each compartment for the stowage of cargo, baggage, carry-on articles, and equipment (such as life rafts), and any other stowage compartment must be designed for its placarded maximum weight of contents and for the critical load

> distribution at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of 525.561 (b) (§ 25.561 (b)7), except that the forces specified in the emergency landing conditions need not be applied to compartments located below, or forward, of all occupants in the airplane. If the airplane has a passenger seating configuration, excluding pilot seats, of 10 seats or more, each stowage compartment in the passenger cabin, except for underseat and overhead compartments for passenger convenience, must be completely enclosed."

Requirements regarding stowage and securing of equipment are CAR 525.789/14 CFR 25.789, CAR 602.86 (2), 14 CFR 91.535, 121.576, 121.577, 125.333, and 135.122. These requirements are applicable regardless of passenger seating capacity.

5.2.6.2 Airplane Inspection.

From the inspected airplanes, only three airplanes have overhead stowage bins. Airplanes G and H have an overhead bin on one side and Airplane I has an overhead bin on both sides. There is no observable difference between the bins installed on these airplanes and those on large transport airplanes.

Due to the limited space availability in the smaller airplanes, the emergency equipment (first aid kit, fire extinguisher, life rafts, etc.) and additional service equipment are often not stowed in an enclosed compartment. Some equipment is stowed behind the last row seat, which is usually by the passageway leading to an exit (figures 26 and 27).

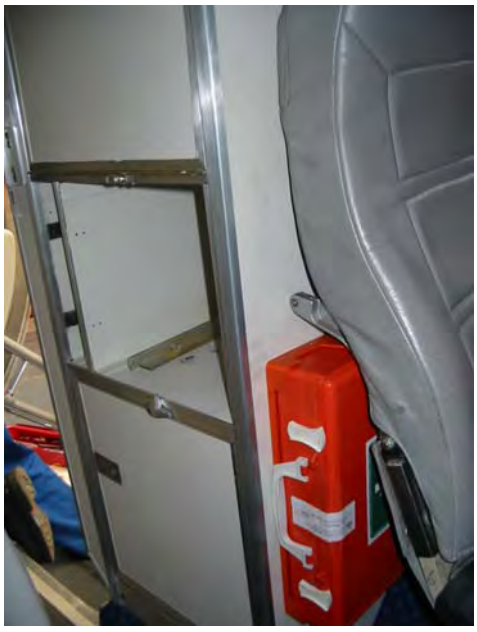


Figure 26. First Aid Kit Stowage (Airplane D)

[7] In 14 CFR 25.787 (a)

Figure 27. Emergency and Service Equipment Stowage
(left: against rear bulkhead, right: behind front bulkhead) (Airplane F)

In Airplane E, the emergency equipment is stowed in a canvas sack with minimum securing means attached to the rear bulkhead between the seats (figure 28).

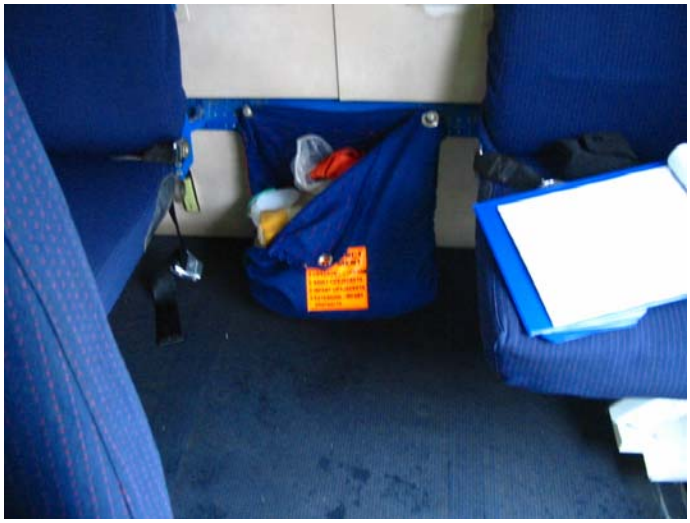


Figure 28. Emergency Equipment Stowage in Airplane E—Emergency Exits are at the Left and the Right

In much smaller airplanes, it is also a common practice to carry cargo in the passenger cabin by utilizing a seat converter.

Figure 29. Seat Converter Used on a Seat in the First Row (Airplane E)

5.2.6.3 Past Accident Evacuation Issues.

In accident reference 19840113A (see appendix C), a small picnic-type cooler containing ice cubes was stowed on the floor between the galley and the cabin separator because it would not fit inside the galley. At impact, the cooler came free and ice cubes spilled into the floor and mingled with galley debris, causing at least one passenger to slip and fall when he was walking to the cargo door.

In accident reference 19840113A (see appendix C), the galley, which was located in the cargo compartment, came free of its attachments, although it remained essentially in its normal location, and some of its contents spilled into the aisle. In the rear cabin, the commode and its fairing had broken free and blocked the floor level emergency exit, which was located inside the lavatory. The articles of clothing in the bins spilled out during the impact.

In accident reference 19981203A (see appendix C), cargo in the forward baggage compartment shifted on impact, blocking access to the port over-wing exit and the crew/freight door.

In accident reference 19950821A (see appendix C), overhead storage bins in the cabin dislodged during the initial ground impact.

5.2.7 Exit Seating.

5.2.7.1 Regulation Review.

Exit seating regulations are contained in 14 CFR 121.585, and are applicable regardless of passenger seating capacity.

For airplanes operating under 14 CFR Part 135, the exit seating requirement (14 CFR 135.129) does not apply to on-demand operations with aircraft having 19 or fewer passenger seats and commuter operations with aircraft having 9 or fewer passenger seats.

Regulations regarding exit seating are mentioned in CAR 604.17 (1)(c) and (2)(b), 703.38 (1)(c), 703.39 (5), 704.33 (1)(d) and (2)(b), 705.40 (1)(d) and (2)(b), 705.43 (5).

5.2.7.2 Airplane Inspection.

No issues relating to exit seating regulation were identified during the airplane inspection.

5.2.7.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to exit seating regulation.

5.3 FLIGHT ATTENDANTS.

5.3.1 Minimum Number of Flight Attendants.

5.3.1.1 Regulation Review.

The required minimum number of flight attendants is regulated by the following requirements: CAR 604.16 (1) and (2), 705.104 (1), 14 CFR 91.533 (a), 121.391 (a), 125.269 (a), 135.107. The CAR requirements for minimum flight attendants are based on the number of passengers onboard, while the 14 CFR requirements are based on the airplane's passenger seating capacity. The different thresholds of these requirements are shown in appendix A.

5.3.1.2 Airplane Inspection.

No issues relating to minimum number of flight attendants were identified during the airplane inspection.

5.3.1.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to minimum number of flight attendants.

5.3.2 Flight Attendants Location and Workload.

5.3.2.1 Regulation Review.

Flight attendant location is addressed in CAR 725.41 (1)(a), 14 CFR 121.391 (d) (and similarly in 14 CFR 125.269 (c)). These requirements state that flight attendants station shall be located near floor level emergency exits and shall be evenly or uniformly distributed throughout the cabin.

5.3.2.2 Airplane Inspection.

Flight attendant locations, for the aircraft inspected, would be as shown in table 5.

Table 5. Flight Attendant Locations

Airplane	No/Type/Location of Exit	Location and direction of Flight Attendant Jumpseat(s)
D	1 Type C (LH aft) 1 Type IV (LH middle) 1 Type III (RH middle)	1 near LH aft main door, facing cabin
F	1 Type I (LH forward) 1 Type II (RH aft) 2 Type III (RH & LH middle)	1 near RH aft emergency exit, facing cabin
G	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	1 near LH forward main door, facing cabin
H	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	1 near LH forward main door, facing cabin (view to cabin is obstructed by forward bulkhead) 1 at the aisle of last row, facing cabin
I	2 Type I (RH & LH forward) 2 Type III (RH & LH middle)	1 near LH forward main door, facing cabin 1 near aft service door, facing cabin

In Airplanes H and I, the flight attendants are seated at the forward and aft of the cabin, both facing the passengers. The aft flight attendant would be responsible for the right-hand (RH) and left-hand (LH) middle emergency exits, but his/her position in the very last seat row does not fully support this duty.

5.3.2.3 Past Accident Evacuation Issues.

When there is only one flight attendant, all other written safety instructions should be designed to minimize his/her workload during an emergency evacuation.

In accident reference 19920701A (see appendix C), the Flight Attendant had to speak aggressively to ask the passengers to leave their hand luggage. There was no instruction in the pre-flight safety briefing and the passenger safety briefing card to inform them that hand baggage should be left in the aircraft in the event of an evacuation.

5.4 Assist Means.

5.4.1 Regulation Review.

CAR 525.810 (a)/14 CFR 25.810 (a), as well as 14 CFR 121.310 (a) and 135.178 (a) state that assist means are only required for non-overwing exits more than 6 feet from the ground with the airplane on the ground and the landing gear extended:

CAR 525.810 (a)/14 CFR 25.810(a)

> "a) Each non over-wing Type A, Type B or Type C exit, and any other non over-wing landplane emergency exit more than 6 feet from the ground with the airplane on the ground and the landing gear extended, must have an approved means to assist the occupants in descending to the ground."

14 CFR 121.310 (a)

> "(a) Means for emergency evacuation. Each passenger carrying landplane emergency exit (other than over the wing) that is more than 6 feet from the ground with the airplane on the ground and the landing gear extended, must have an approved means to assist the occupants in descending to the ground. The assisting means for a floor-level emergency exit must meet the requirements of § 25.809(f)(1) of this chapter in effect on April 30, 1972, except that, for any airplane for which the application for the type certificate was filed after that date, it must meet the requirements under which the airplane was type certificated. An assisting means that deploys automatically must be armed during taxiing, takeoffs, and landings. However, if the Administrator finds that the design of the exit makes compliance impractical, he may grant a deviation from the requirement of automatic deployment if the assisting means automatically erects upon deployment and, with respect to required emergency exits, if an emergency evacuation demonstration is conducted in accordance with § 121.291(a). This paragraph does not apply to the rear window emergency exit of DC-3 airplanes operated with less than 36 occupants, including crewmembers and less than five exits authorized for passenger use."

5.4.2 Airplane Inspection.

All of the exits on the inspected airplanes have an exit height of less than 6 ft, which means no assist means are required on any of these airplanes. However, it was observed that some of the floor level/non-overwing exits are quite high, to the extent that injuries to evacuees may occur if they have to jump from the exits of an airplane in an adverse attitude (e.g. one main landing gear collapsed or nose wheel collapsed).

The non-overwing/non-airstair emergency exit on Airplane H could be as high as 1.595 m (5.23 ft) from the ground on empty load. On Airplane G, the height of the non-overwing exits on empty load is approximately 1.7 m (5.58 ft).

The non-overwing/non-airstair exit on Airplane F is approximately 5.4 ft high (figure 30). With its location at the aft section of the aircraft, this exit could become very high from the ground in an airplane with a collapsed nose wheel.

Figure 30. Aft Emergency Exit on Airplane F

It is considered that exiting through the Type III/IV non-overwing emergency exit may be more difficult because there is no step down to the wing surface (figures 31, 32, and 33). The height of this type of exit is therefore of particular concern.

Figure 31. Type III Exit on Airplane A (exit height approx. 1.5 m/4.9 ft)

Figure 32. Type IV Exit on Airplane E (exit height approx. 1.75 m/5.77 ft)

Figure 33. Type III Exit on Airplane I (exit height approx. 1.5 m/4.9 ft)

5.4.3 Past Accident Evacuation Issues.

Three smaller airplane accident reports addressed the issue of exit height (see appendix C). In one accident, the passengers were injured jumping out from the rear exit (about 3.5 – 4 meters high) because the nose wheel had collapsed (accident reference 19700506A). In another, several passengers received minor injuries when they dropped about 5.5 ft to the icy taxiway (accident

reference 19880202A). A third accident report noted that the exit was quite high from the ground, because the aircraft was leaning to one side (accident reference 19980209B).

As reported in accident reference 19971207A, evacuees did have difficulty in exiting from underwing Type IV exits (the Flight Attendant had to shout the instruction "Leg first then body"). Instructions on how to get out from the smaller exits in the safety card may help considerably. Figure 34 is an example of this type of instruction, however the illustration shown is for an overwing exit.

Figure 34. An Example of an Instruction to Exit From a Type IV Exit in the Safety Card (Airplane D)

5.5 INTERIOR EMERGENCY LIGHTING AND MARKING.

5.5.1 Interior Emergency Lighting.

5.5.1.1 Regulation Review.

Emergency lighting is regulated by CAR 525.812/14 CFR 25.812. Emergency lighting requirements are also addressed in 14 CFR 121.310 (c) and (d), 135.178 (c), and Appendix A to Part 125 (d).

The floor proximity lighting is specifically addressed in CAR 525.812 (e), 705.78 and 14 CFR 25.812 (e), 121.310 (c)(3), 135.178 (c)(3).

CAR 525.812 (e)/14 CFR 25.812 (e) stated:

> "(e) Floor proximity emergency escape path marking must provide emergency evacuation guidance for passengers when all sources of illumination more than 4 feet above the cabin aisle floor are totally obscured. In the dark of the night, the floor proximity emergency escape path marking must enable each passenger to -
>
> (1) After leaving the passenger seat, 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; and

(2) Readily identify each exit from the emergency escape path by reference only to markings and visual features not more than 4 feet above the cabin floor."

5.5.1.2 Airplane Inspection.

All inspected airplanes have emergency lights powered by battery. In Airplane I, the emergency lights are powered by five nickel-cadmium battery packs permanently mounted behind the wardrobe and in the cabin ceiling. The battery packs are on a continuous trickle-charge from the 28-volt DC right essential bus through the emergency lighting control box, whenever electrical power is applied to the aircraft. Fully charged battery packs (6.4 volts DC) can illuminate the emergency lights for 20 minutes.

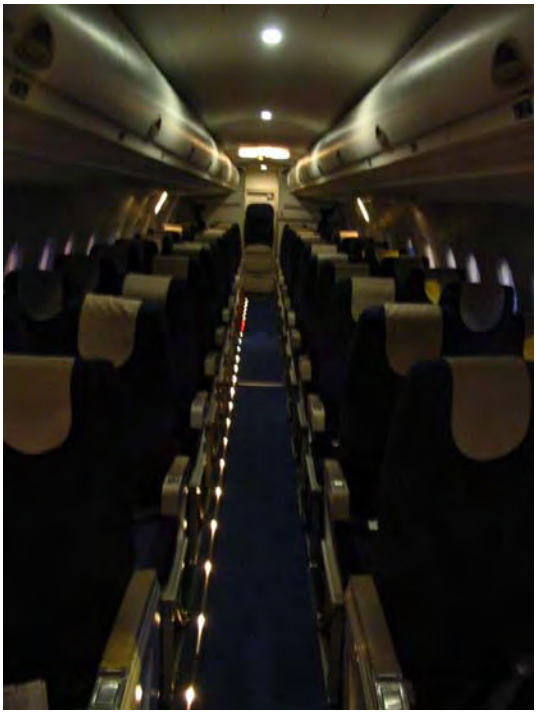


Figure 35. Airplane I Emergency Lighting

In all inspected airplanes except the corporate jets (Airplanes A, B and C) and Airplane E, the cabin crew emergency light switches are located near the flight attendant jumpseat.

5.5.1.3 Past Accident Evacuation Issues.

Accident reference 19981203A (see appendix C) reported that neither the ceiling emergency lights nor the intervalve aisle path lighting system was activated. The flight attendant could not find the switch for the emergency lights in the dark, causing the aft passenger door area to be very dark.

5.5.2 Interior Emergency Exit Marking.

5.5.2.1 Regulation Review.

Interior emergency exit marking requirements are found in CAR 525.811/14 CFR 25.811,

> "(a) Each passenger emergency exit, its means of access, and its means of opening must be conspicuously marked.
> (b) The identity and location of each passenger emergency exit must be recognizable from a distance equal to the width of the cabin.
> (c) Means must be provided to assist the occupants in locating the exits in conditions of dense smoke.
> (d) The location of each passenger emergency exit must be indicated by a sign visible to occupants approaching along the main passenger aisle (or aisles). There must be—
>
> (1) A passenger emergency exit locator sign above the aisle (or aisles) near each passenger emergency exit, or at another overhead location if it is more practical because of low headroom, except that one sign may serve more than one exit if each exit can be seen readily from the sign;
> (2) A passenger emergency exit marking sign next to each passenger emergency exit, except that one sign may serve two such exits if they both can be seen readily from the sign; and
> (3) A sign 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, except that if this is not possible the sign may be placed at another appropriate location.
> (g) Each sign required by paragraph (d) of this section may use the word "exit" in its legend in place of the term "emergency exit"."

Interior emergency exit marking requirements are also contained in 14 CFR 121.310 (b). Similar requirements are found in 135.178 (b), and Appendix A to Part 125 (b)).

The specification for emergency exit signs (CAR 525.812 (b)/14 CFR 25.812 (b)) is different for airplanes having a passenger seating configuration of 9 seats or less, and those with 10 seats or more.

> "(b) Emergency exit signs -
>
> (1) For airplanes that have a passenger seating configuration, excluding pilot seats, of 10 seats or more must meet the following requirements:
>
> (i) Each passenger emergency exit locator sign required by 525.811 (d)(1) (§ 25.811(d)(1)8) and each passenger emergency exit marking sign required by

[8] In 14 CFR 25.812 (b)

525.811 (d)(2) (§ 25.811(d)(2)9) must have red letters at least 1 1/2 inches high on an illuminated white background, and must have an area of at least 21 square inches excluding the letters. The lighted background to letter contrast must be at least 10:1. The letter height to stroke width ratio may not be more than 7:1 nor less than 6:1. These signs must be internally electrically illuminated with a background brightness of at least 25 foot-lamberts and a high to low background contrast no greater than 3:1.

(ii) Each passenger emergency exit sign required by 525.811 (d)(3) (§ 25.811(d)(3)10) must have red letters at least 1 1/2 inches high on a white background having an area of at least 21 square inches excluding the letters. These signs must be internally electrically illuminated or self-illuminated by other than electrical means and must have an initial brightness of at least 400 microlamberts. The colors may be reversed in the case of a sign that is self-illuminated by other than electrical means.

(2) For airplanes that have a passenger seating configuration, excluding pilot seats, of nine seats or less, that are required by 525.811 (d)(1), (2), and (3) (§ 25.811(d)(1), (2), and (3)11) must have red letters at least 1 inch high on a white background at least 2 inches high. These signs may be internally electrically illuminated, or self-illuminated by other than electrical means, with an initial brightness of at least 160 microlamberts. The colors may be reversed in the case of a sign that is self-illuminated by other than electrical means."

5.5.2.2 Airplane Inspection.

The inspected airplanes with a seating capacity of less than 20 do not have an overwing/underwing exit locating sign above the aisle near the exits. The locating signs on these airplanes are located at another ceiling location above the exit (figures 36 and 37).

Figure 36. Overwing Exit Locating Signs on Airplane D—Not Above Aisle (circled)

[9] In 14 CFR 25.812 (b)
[10] In 14 CFR 25.812 (b)
[11] In 14 CFR 25.812 (b)

Figure 37. No Underwing Exit Locating Signs Above Aisle (Airplane E)

5.5.2.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to interior emergency exit marking.

6. FACTORS INDIRECTLY AFFECTING EVACUATION.

6.1 PUBLIC ADDRESS SYSTEM, CREWMEMBER INTERPHONE SYSTEM, AND MEGAPHONE.

6.1.1 Regulation Review.

Only airplanes having a seating capacity of more than 19 passengers are required to have a Public Address System (14 CFR 121.318, 135.150) and a Crewmember Interphone System (14 CFR 121.319, 135.150). In CAR, these regulations are contained in 705.73 (Interphone System) and 705.74 (Public Address System).

The regulation 14 CFR 121.309 (f) states that megaphones are only required for airplanes with a passenger capacity of more than 60. In CAR 705.89, it is required for airplanes with a passenger capacity of 60 or more.

6.1.2 Airplane Inspection.

Some of the inspected airplanes have a PA system that can be powered by the battery during an emergency (Airplane G and Airplane I). Although not required, it was found that the larger category of the inspected airplanes have a megaphone stowed near the flight attendant jumpseat.

6.1.3 Past Accident Evacuation Issues.

Communication problems encountered in smaller airplane past accidents involve:

- Passengers unable to hear flight attendant's shouted commands due to engine noise (see appendix C, accident reference 19830109A).

- The 'Evacuate' command from the pilot-in-command through the PA system was not heard because there was no electrical power (see appendix C, accident reference 19971216A).

- The cabin crew could not establish communication with the cockpit (see appendix C, accident reference 19981025A).

6.2 EMERGENCY EQUIPMENT REQUIREMENTS.

6.2.1 Regulation Review.

Emergency equipment requirements are contained in CAR 602.58/59 and 14 CFR 121.309, 121.310, 135.177, 135.178 and 125.207. The requirements in 135.177, 135.178, and 125.207 are only applicable for airplanes with passenger seating capacity of more than 19.

In 14 CFR 91.513 (e), a crash ax is only required for airplanes with a passenger seating capacity of more than 19. In CAR 705.92 and 14 CFR 121.309 (e), it is required regardless of passenger capacity.

The amount of hand fire extinguishers is determined per number of passengers in CAR 525.851, 705.93 (5) and 604.41 as well as in 14 CFR 25.851 and 121.309 (c)(5).

6.2.2 Airplane Inspection.

No issues relating to emergency equipment requirements were identified during the airplane inspection.

6.2.3 Past Accident Evacuation Issues.

In smaller airplanes, it should be noted that all emergency equipment might be stowed in just one location (as addressed in accident reference 19971216A, see appendix C). If the part of the airplane where the emergency equipment are stowed becomes inaccessible after a crash, no emergency equipment will be available to the crew or passengers.

6.3 SURVIVABILITY FACTORS.

6.3.1 Passenger Seats and Restraint System.

6.3.1.1 Regulation Review.

The requirements for passenger seat and restraint systems are contained in CAR 525.785, 605.22, 605.25, 605.26, and 14 CFR 25.785, 91.107, 121.311, 125.211, and 135.128. The applicability of these requirements is independent of passenger seating capacity.

6.3.1.2 Airplane Inspection.

The issue of front-row passenger head impact clearance is one that probably features more on smaller aircraft. Airplane F has a Special Condition for compliance with front-row passenger head impact requirements, i.e. the installation of an inflatable lapbelt mounted airbag and head pads on the bulkhead (figure 38) due to inadequate clearance to the forward bulkhead. The instruction giving the correct brace position for the front-row occupants was not available on this airplane.

Figure 38. Padded Bulkhead and Inflatable Seat Belt (Airplane F)

In Airplane E, it was found that the seatbacks can be easily folded forward, which makes it unfeasible for the passengers to assume the brace position recommended in the safety card (i.e. leaning forward to the front seatback).

6.3.1.3 Past Accident Evacuation Issues.

In accident reference 19840113A (see appendix C), the seatbacks folded over when the passengers leaned on them, thereby providing no support for the recommended brace position.

Ease of access to the life jackets stowed under the seat may also affect survivability of an emergency evacuation following ditching. A review of accident reference 19790731A (see appendix C) revealed how the method of life jacket installation, and the close proximity of the seat in front, had presented an obstacle to extracting the life jacket.

6.3.2 Compartment Interior Flammability.

6.3.2.1 Regulation Review.

Compartment interior requirements are generally applicable to all airplanes certificated under 14 CFR Part 25 regardless of passenger capacity, with one exception contained in CAR 525.853 (d)/14 CFR 25.853 (d).

> "(d) Except as provided in paragraph (e) of this section, the following interior components of airplanes with passenger capacities of 20 or more must also meet the test requirements of parts IV and V of Appendix F of this Part, or other approved equivalent method, in addition to the flammability requirements prescribed in paragraph (a) of this section:
>
> (1) Interior ceiling and wall panels, other than lighting lenses and windows;
>
> (2) Partitions, other than transparent panels needed to enhance cabin safety;
>
> (3) Galley structure, including exposed surfaces of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried; and
>
> (4) Large cabinets and cabin stowage compartments, other than underseat stowage compartments for stowing small items such as magazines and maps"

6.3.2.2 Airplane Inspection.

No issues regarding compartment interior flammability were identified during the airplane inspection.

6.3.2.3 Past Accident Evacuation Issues.

Evaluation of available evacuation information on accidents to smaller transport airplanes does not disclose any issues in relation to compartment interior flammability.

7. REFERENCES.

1. Transport Canada (2005). *Canadian Aviation Regulations – Amendment 2005-2*, http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/menu.htm.

2. Federal Aviation Administration (2005). *Flight Standard Service – Cabin Safety Subject Index Website*, http://www.faa.gov/avr/afs/cabinsafety/csindex.cfm.

3. RGW Cherry & Associates, Ltd. (2005). Cabin Safety Research Technical Group Accident Database Issue 26.

APPENDIX A—SUMMARY OF REGULATIONS REVIEW

PASSENGER SEATING CAPACITY	EVACUATION DEMONSTRATION	MINIMUM TYPE AND NUMBER OF EXITS (in each side of the fuselage)	EXIT ABOVE WATERLINE (in each side of the fuselage)	OVERHEAD HATCH (if impractical to comply with 25.807 (i)(1) and (2))	FLIGHTCREW EMERGENCY EXIT	LOCATION OF EMERGENCY EXIT	
	FAR 25.803 (c), 121.291 (a), 125.189 (a)	FAR 25.807 (g)	FAR 25.807 (i)	FAR 25.807 (i)(3)	FAR 25.807 (j)	FAR 25.772 (a)	
	CAR 525.803 (c)	CAR 525.807 (g)	CAR 525.807 (i)	CAR 525.807 (i)(3)	CAR 525.807 (j)		CAR 525.772 (a)
1-6	Not required.	One Type IV or larger overwing exit. If there is no overwing exit, at least one Type III.	One exit above the waterline in each side (min dimension: Type IV exit).	Two required Type III side exits need be replaced by only one overhead hatch.	(No requirements)	(No requirements)	(No requirements)
7-9		At least one Type III or larger. Other exit(s) must also be Type III or larger.	One exit above the waterline (min dimension: Type III exit) for each unit of 35 passenger seats but no less than two such exits in the passenger cabin, with one on each side.				
10							
11-12							
13-19							
20		At least two exits, one of which must be a Type II or larger. Other exit(s) must be Type III or larger.			Flightcrew exit shall be located in the flightcrew area. One exit shall be provided on each side of the airplane, or a top hatch. Minimum dimension: rectangular 19 by 20 inches or other satisfactory exit utility as demonstrated by a typical crewmember.	Emergency exit configuration must be designed so that neither crewmembers nor passengers require use of the flightdeck door in order to reach the emergency exits provided for them.	Emergency exit configuration must be designed so that neither crewmembers nor passengers require use of the flightdeck door in order to reach the emergency exits provided for them.
21-30							
31-35							
36-40							
41-44		At least two exits, one of which must be a Type I or larger. Other exit(s) must be Type III or larger.					
45-50	Required.			The side exits must be replaced by an equal number of readily accessible overhead hatches (min dimension: Type III exit)			
51-59							
60							
61-80							
81-99							
100							
101-110							
more than 110		Must include at least two Type I or larger exits. Other exit(s) must be Type III or larger.					

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

PASSENGER SEATING CAPACITY	UNIFORM DISTRIBUTION OF EXITS	DISTRIBUTION OF EMERGENCY EXITS	EMERGENCY EXIT OPENING INSTRUCTIONS	MEANS OF OPENING AND ARRANGEMENT OF EMERGENCY EXIT DOORS	INTEGRAL STAIRS	MIN AISLE WIDTH
	FAR 25.807 (e)	**FAR 25.813**	**FAR 25.811**	**25.809, 25.813 (c)(3)**	**FAR 25.810 (e)**	**FAR 25.815**
	CAR 525.807 (e)	**CAR 525.813**	**CAR 525.811**	**CAR 525.809, 525.813 (c)(3)**	**CAR 525.783 (i)**	**CAR 525.815**
1-6	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	12" (< 25" from floor), 15" (≥ 25" from floor)
7-9						
10						
11-12						12" (< 25" from floor), 20" (≥ 25" from floor)
13-19						
20						
21-30						15" (< 25" from floor), 20" (≥ 25" from floor)
31-35						
36-40						
41-44						
45-50						
51-59						
60						
61-80						
81-99						
100						
101-110						
more than 110						

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

<table>
<tr><th rowspan="3">PASSENGER SEATING CAPACITY</th><th>EMERGENCY EXIT ACCESS (Passageway width for large exits)</th><th>EMERGENCY EXIT ACCESS (Passageway width for Type III or Type IV exit)</th><th>EMERGENCY EXIT ACCESS (Passageway obstruction)</th><th>ASSIST SPACE</th><th colspan="2">CARRY-ON BAGGAGE REGULATIONS</th></tr>
<tr><th>FAR 25.813 (a)</th><th>FAR 25.813 (c)(1)</th><th>FAR 25.813 (c)(2)</th><th>FAR 25.813 (b), 121.310 (f), 135.178 (f)</th><th>FAR 91.523</th><th>FAR 121.589, 135.87</th></tr>
<tr><th>CAR 525.813 (a)</th><th>CAR 525.813 (c)(1)</th><th>CAR 525.813 (c)(2)</th><th>CAR 525.813 (b)</th><th></th><th>CAR 602.86 (1), 705.42/725.42</th></tr>
<tr><td>1-6</td><td rowspan="16">(Non-passenger capacity related)
Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide.</td><td rowspan="11">(Passageway width is not specified)</td><td rowspan="5">There may be minor obstructions in passageway region, if there are compensating factors to maintain the effectiveness of the exit.</td><td rowspan="16">(Non-passenger capacity related)</td><td rowspan="5">Not applicable.</td><td rowspan="16">(Non-passenger capacity related)</td></tr>
<tr><td>7-9</td></tr>
<tr><td>10</td></tr>
<tr><td>11-12</td></tr>
<tr><td>13-19</td></tr>
<tr><td>20</td><td rowspan="11">Projected opening of the exit must not be obstructed and no interference in the opening of the exit by seats, berths, or other protrusions for a distance not less than the width of the narrowest of passenger seat.</td><td rowspan="11">Applicable.</td></tr>
<tr><td>21-30</td></tr>
<tr><td>31-35</td></tr>
<tr><td>36-40</td></tr>
<tr><td>41-44</td></tr>
<tr><td>45-50</td></tr>
<tr><td>51-59</td></tr>
<tr><td>60</td></tr>
<tr><td>61-80</td></tr>
<tr><td>81-99</td></tr>
<tr><td>100</td></tr>
<tr><td>101-110</td><td rowspan="2">Passageway width at least 10" (max 2 seats in adjacent seat row), or 20" (max 3 seats in adjacent seat row). There may be 2 passageways min 6" wide which lead to an unobstructed space adjacent to each exit.</td></tr>
<tr><td>more than 110</td></tr>
</table>

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

PASSENGER SEATING CAPACITY	RETENTION OF ITEMS OF MASS IN PAX/CREW COMPARTMENTS	ENCLOSED STOWAGE COMPARTMENT	STOWAGE OF FOOD AND SERVICE EQUIPMENTS	EXIT SEATING REGULATION		
	FAR 25.789, 121.576	**FAR 25.787 (a)**	**FAR 91.535, 121.577, 125.333, 135.122**	**FAR 135.129**	**FAR 121.585**	
	CAR 525.789	**CAR 525.787 (a)**	**CAR 602.86 (2)**			**CAR 604.17 (1)(c) & (2)(b), 703.38 (1)(c), 703.39 (5), 704.33 (1)(d) & (2)(b), 705.40 (1)(d) & (2)(b), 705.43 (5)**
1-6	(Non-passenger capacity related)	(No requirements)	(Non-passenger capacity related)	Applicable, except for FAR 135 on-demand	(Non-passenger capacity related)	(Non-passenger capacity related)
7-9						
10		Each stowage compartment in the passenger cabin, except for underseat and overhead compartments for passenger convenience must be completely enclosed.		Applicable, except for FAR 135 on-demand operation		
11-12						
13-19						
20				Applicable.		
21-30						
31-35						
36-40						
41-44						
45-50						
51-59						
60						
61-80						
81-99						
100						
101-110						
more than 110						

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

<table>
<tr><th rowspan="3">PASSENGER SEATING CAPACITY</th><th colspan="6">FLIGHT ATTENDANT REQUIREMENT</th></tr>
<tr><th>FAR 91.533 (a), 125.269 (a)</th><th>FAR 135.107</th><th>FAR 121.391 (a)</th><th></th><th></th><th></th></tr>
<tr><th></th><th></th><th></th><th>CAR 604.16 (1)</th><th>CAR 604.16 (2)</th><th>CAR 705.104 (1)</th></tr>
<tr><td>1-6</td><td rowspan="5">(No requirements)</td><td rowspan="5">Not required.</td><td>(No requirements)</td><td rowspan="2">(No requirements)</td><td rowspan="2">Not required.</td><td rowspan="6">One flight attendant.</td></tr>
<tr><td>7-9</td><td rowspan="7">One flight attendant.</td></tr>
<tr><td>10</td><td rowspan="8">One flight attendant for each unit of 40 passengers (onboard) or portion thereof.</td></tr>
<tr><td>11-12</td></tr>
<tr><td>13-19</td><td rowspan="8">Required.</td></tr>
<tr><td>20</td><td rowspan="6">One flight attendant.</td><td rowspan="9">Required.</td></tr>
<tr><td>21-30</td></tr>
<tr><td>31-35</td></tr>
<tr><td>36-40</td></tr>
<tr><td>41-44</td></tr>
<tr><td>45-50</td><td rowspan="5">Two flight attendants.</td><td rowspan="5">Two flight attendants.</td><td rowspan="4">Two flight attendants.</td></tr>
<tr><td>51-59</td></tr>
<tr><td>60</td></tr>
<tr><td>61-80</td></tr>
<tr><td>81-99</td></tr>
<tr><td>100</td><td rowspan="2">Two flight attendants plus one for each unit of 50 passengers (capacity) above 100.</td><td rowspan="2">Two flight attendants plus one for each unit of 50 passengers (capacity) above 100.</td><td rowspan="2">One flight attendant for each unit of 40 passengers (onboard) or portion thereof.</td></tr>
<tr><td>101-110</td></tr>
<tr><td>more than 110</td><td></td><td></td><td></td><td></td></tr>
</table>

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

PASSENGER SEATING CAPACITY	FLIGHT ATTENDANT STATION	ASSIST MEANS	INTERIOR EMERGENCY LIGHTING	FLOOR PROXIMITY LIGHTING	INTERIOR EMERGENCY EXIT MARKING	EMERGENCY EXIT SIGNS
	FAR 121.391 (d), 125.269 (c)	FAR 25.810 (a), 121.310 (a), 135.178(a)	FAR 25.812, 121.310 (c)(d), 135.178 (c)	FAR 25.812 (e), 121.310 (c)(3), 135.178 (c)(3)	FAR 25.811, 121.310 (b), 135.178 (b)	FAR 25.812 (b)
	CAR 725.41 (1)(a)	CAR 525.810 (a)	CAR 25.812	CAR 525.812 (e), 705.78	CAR 525.811	CAR 525.812 (b)
1-6	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	(Non-passenger capacity related)	Emergency exit locator sign and exit sign must comply with 525.812(b)(2)/25.812(b)(2).
7-9						
10						Emergency exit locator sign and exit sign must comply with 525.812(b)(1)/25.812(b)(1).
11-12						
13-19						
20						
21-30						
31-35						
36-40						
41-44						
45-50						
51-59						
60						
61-80						
81-99						
100						
101-110						
more than 110						

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

PASSENGER SEATING CAPACITY	PUBLIC ADDRESS SYSTEM AND CREWMEMBER INTERPHONE SYSTEM		MEGAPHONES		EMERGENCY EQUIPMENT REQUIREMENT APPLICABILITY	
	FAR 121.318, 121.319, 135.150		FAR 121.309		FAR 135.177, 135.178, 125.207	FAR 121.309, 121.310
		CAR 705.73, 705.74		CAR 705.89		CAR 602.58/59
1-6	Not required.	(Non-passenger capacity related)	(No requirements)	(No requirements)	Not applicable.	(Non-passenger capacity related)
7-9						
10						
11-12						
13-19						
20	Required.				Applicable.	
21-30						
31-35						
36-40						
41-44						
45-50						
51-59						
60				One megaphone.		
61-80			One megaphone.			
81-99						
100			Two megaphones.	Two megaphones.		
101-110						
more than 110						

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

<table>
<tr><th rowspan="3">PASSENGER SEATING CAPACITY</th><th colspan="3">CRASH AX</th><th colspan="4">REQUIRED NUMBER OF HAND FIRE EXTINGUISHER</th></tr>
<tr><th>FAR 91.513 (e)</th><th>FAR 121.309 (e)</th><th>FAR 135.178 (2)</th><th>FAR 121.309 (c)(5)</th><th></th><th></th><th>FAR 25.851</th></tr>
<tr><th></th><th>CAR 705.92</th><th></th><th></th><th>CAR 604.41</th><th>CAR 705.93 (5)</th><th>CAR 525.851</th></tr>
<tr><td>1-6</td><td rowspan="5">Not required (except if operating under FAR 121).</td><td rowspan="15">(Non-passenger capacity related)</td><td rowspan="5">Not required.</td><td>(No requirements)</td><td rowspan="5">One extinguisher</td><td rowspan="15">Two extinguishers.</td><td>(No requirements)</td></tr>
<tr><td>7-9</td><td rowspan="4">At least one fire extinguisher.</td><td rowspan="4">One extinguisher.</td></tr>
<tr><td>10</td></tr>
<tr><td>11-12</td></tr>
<tr><td>13-19</td></tr>
<tr><td>20</td><td rowspan="14">Required.</td><td rowspan="14">Required.</td><td rowspan="6">At least two fire extinguishers.</td><td rowspan="6">Two extinguishers.</td><td rowspan="6">Two extinguishers.</td></tr>
<tr><td>21-30</td></tr>
<tr><td>31-35</td></tr>
<tr><td>36-40</td></tr>
<tr><td>41-44</td></tr>
<tr><td>45-50</td></tr>
<tr><td>51-59</td></tr>
<tr><td>60</td></tr>
<tr><td>61-80</td><td rowspan="6">Up to 200 passenger seats three extinguishers and then one extra extinguisher for each additional unit of 100 passenger seats.</td><td rowspan="6">Up to 200 passenger seats three extinguishers and then one extra extinguisher for each additional unit of 100 passenger seats.</td><td rowspan="6">Up to 200 passenger seats three extinguishers and then one extra extinguisher for each additional unit of 100 passenger seats.</td><td rowspan="6">Up to 200 passenger seats three extinguishers and then one extra extinguisher for each additional unit of 100 passenger seats.</td></tr>
<tr><td>81-99</td></tr>
<tr><td>100</td></tr>
<tr><td>101-110</td></tr>
<tr><td>more than 110</td></tr>
</table>

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

PASSENGER SEATING CAPACITY	PASSENGER SEAT AND RESTRAINT SYSTEM	COMPARTMENT INTERIOR FLAMMABILITY	ADDITIONAL COMPARTMENT INTERIOR FLAMMABILITY REQUIREMENTS
	FAR 25.785, 91.107, 121.311, 125.211, 135.128	FAR 25.853 (d)	25.853 (d)
	CAR 525.785, 605.22, 605.25, 605.26	CAR 525.853 (d)	CAR 525.853 (d)
1-6	(Non-passenger capacity related)	(Non-passenger capacity related)	Not applicable.
7-9			
10			
11-12			
13-19			
20			Applicable.
21-30			
31-35			
36-40			
41-44			
45-50			
51-59			
60			
61-80			
81-99			
100			
101-110			
more than 110			

Each column of this table should be interpreted as being applicable only within the seating limitations of each 14 CFR Part/CAR Subpart (for example, CAR Subpart 705 only applies to airplanes having an MCTOW >19,000 lb or with a passenger seating capacity of more than 19).

FAR = 14 CFR

APPENDIX B—FUSELAGE CROSS SECTIONS AND CABIN LAYOUTS
OF AIRPLANES INSPECTED

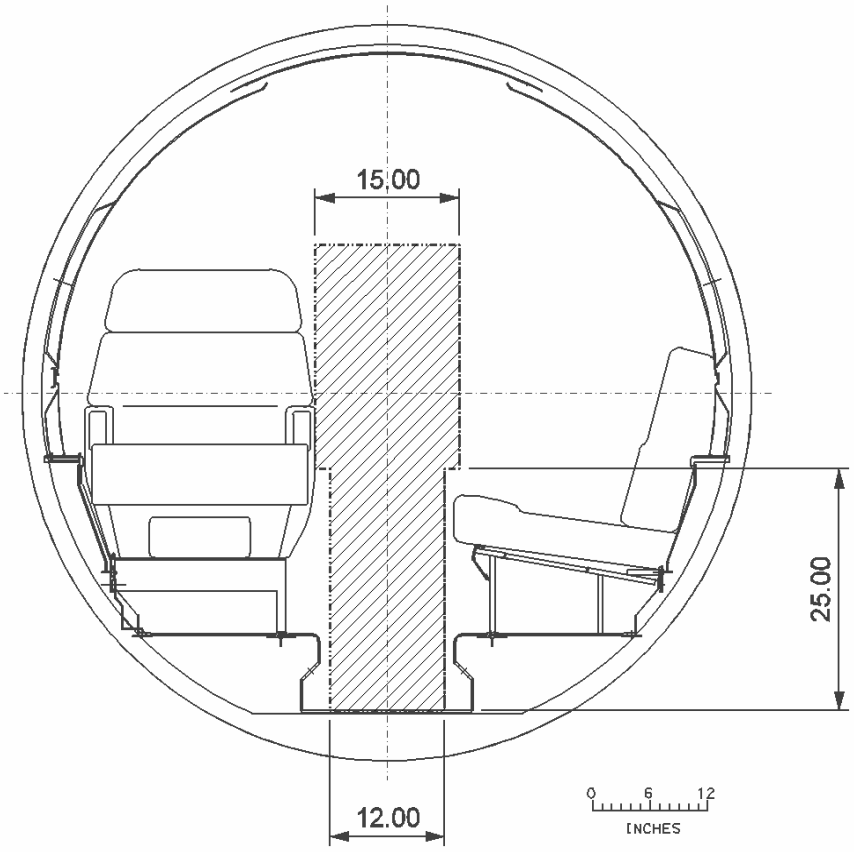


Figure B-1. Airplane B and C—Fuselage Cross Section
(Airplane A has a similar aisle dimension)

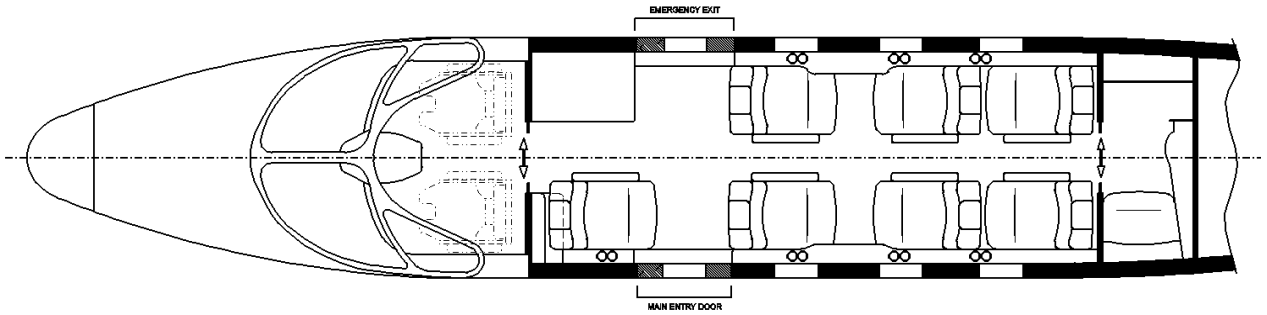


Figure B-2. Airplane A—Cabin Layout

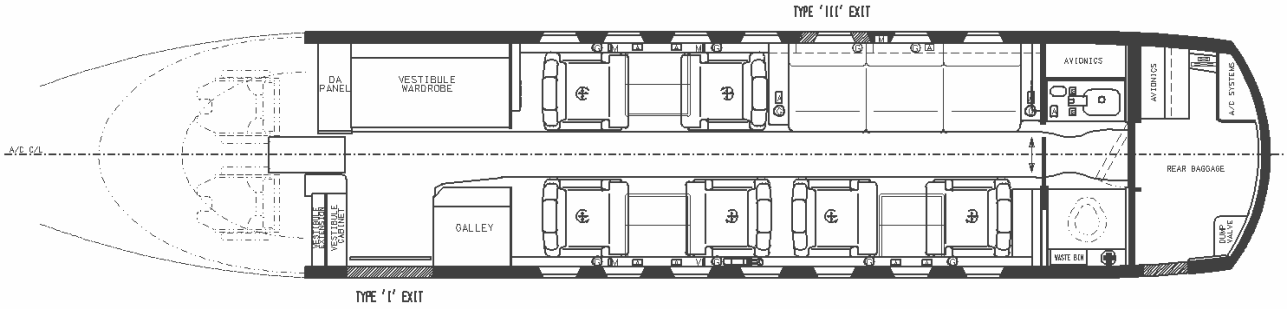


Figure B-3. Airplane C—Cabin Layout

Note: Cabin layout diagram for Airplane B is not available

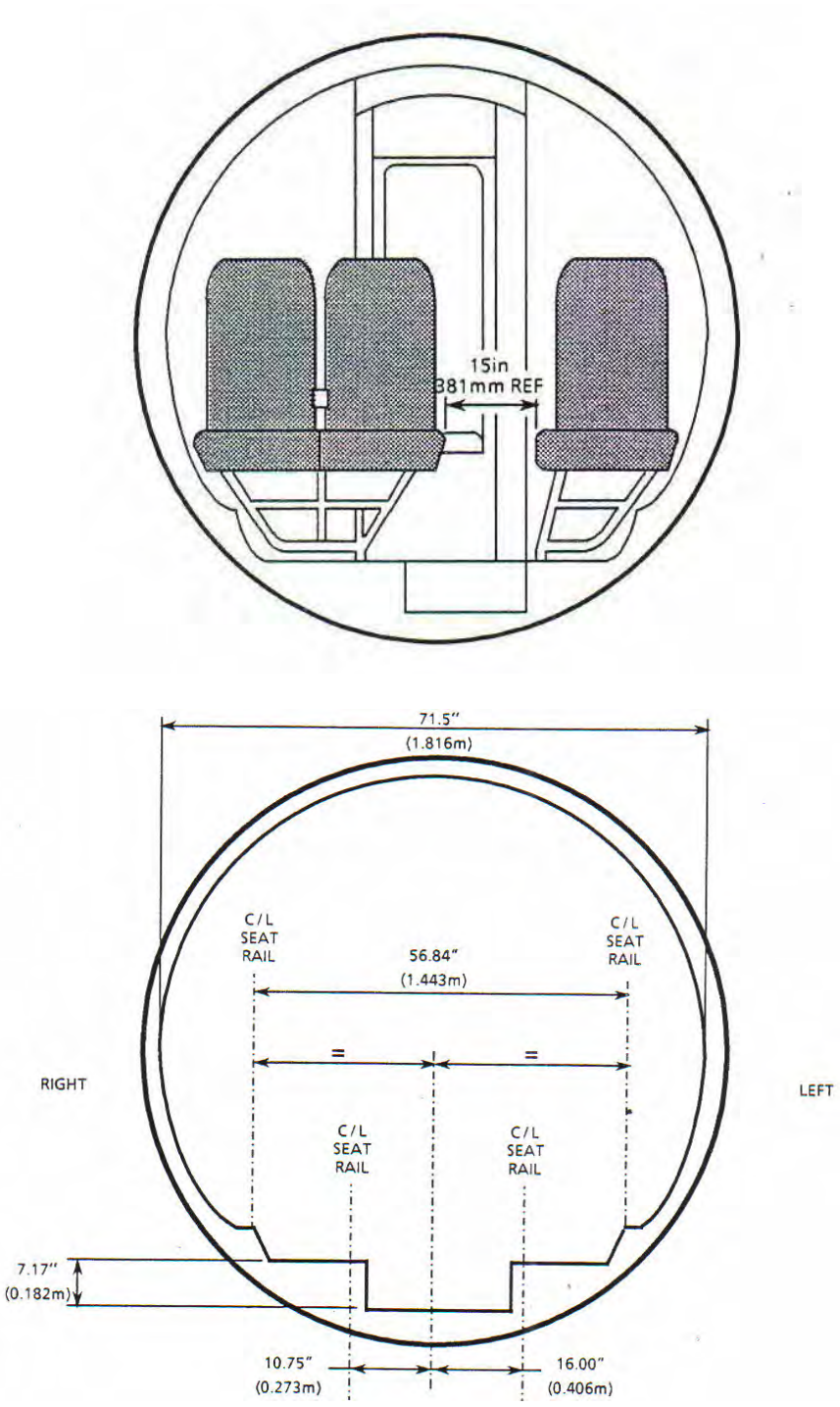


Figure B-4. Airplane D—Fuselage Cross Section

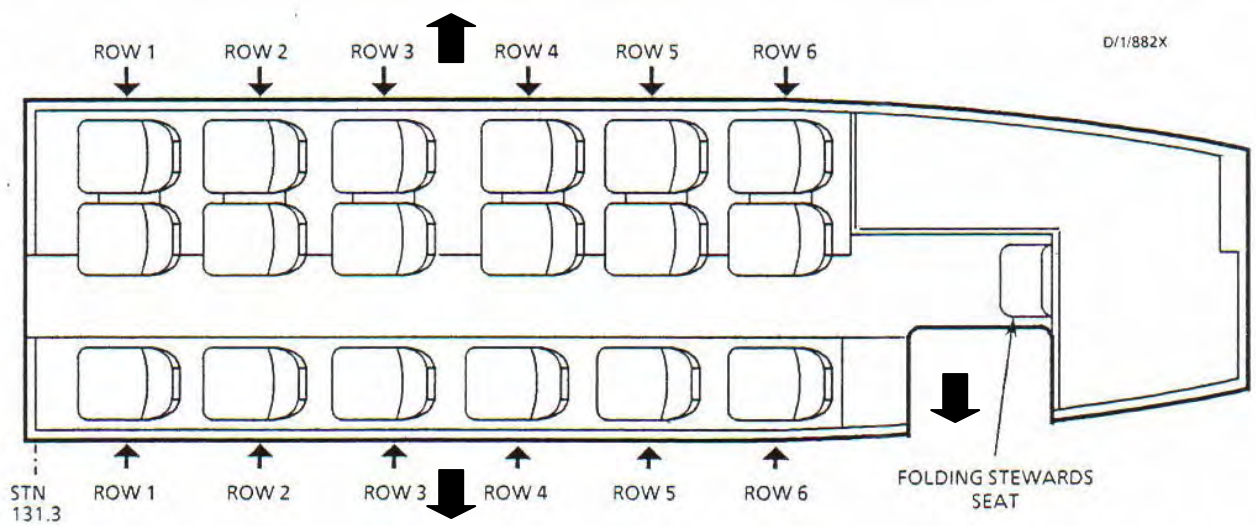


Figure B-5. Airplane D—Cabin Layout

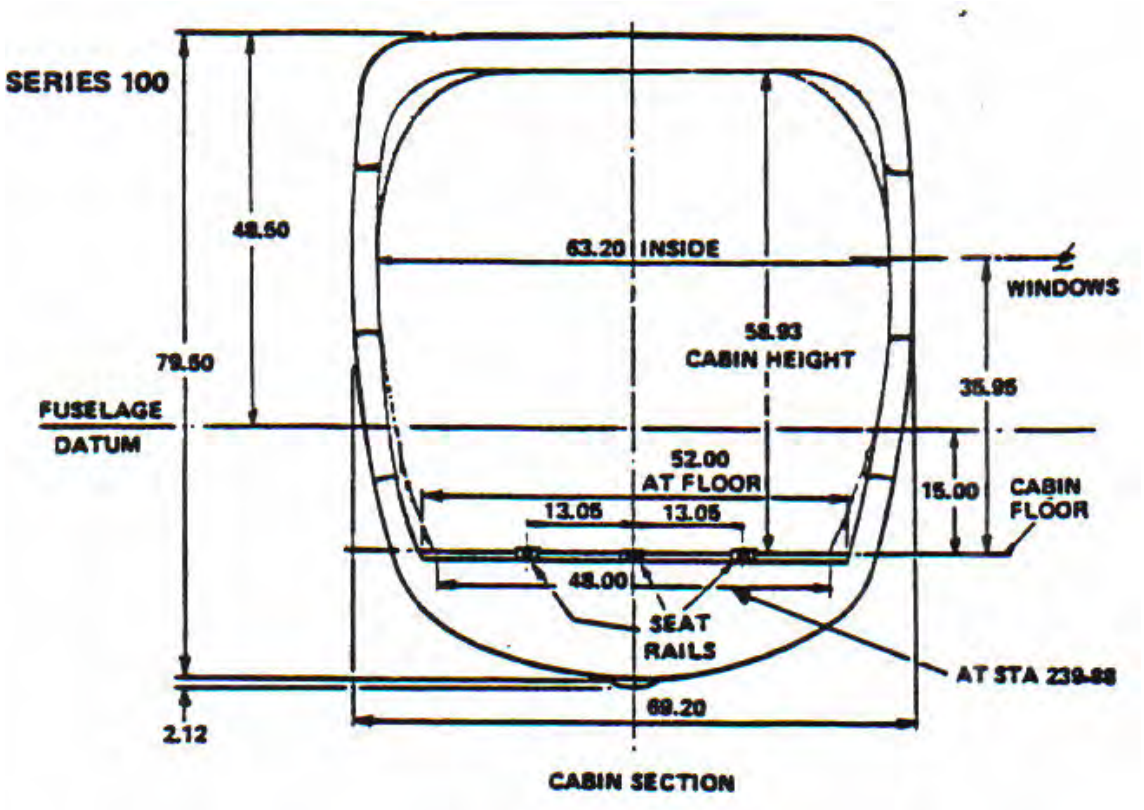


Figure B-6. Airplane E—Fuselage Cross Section

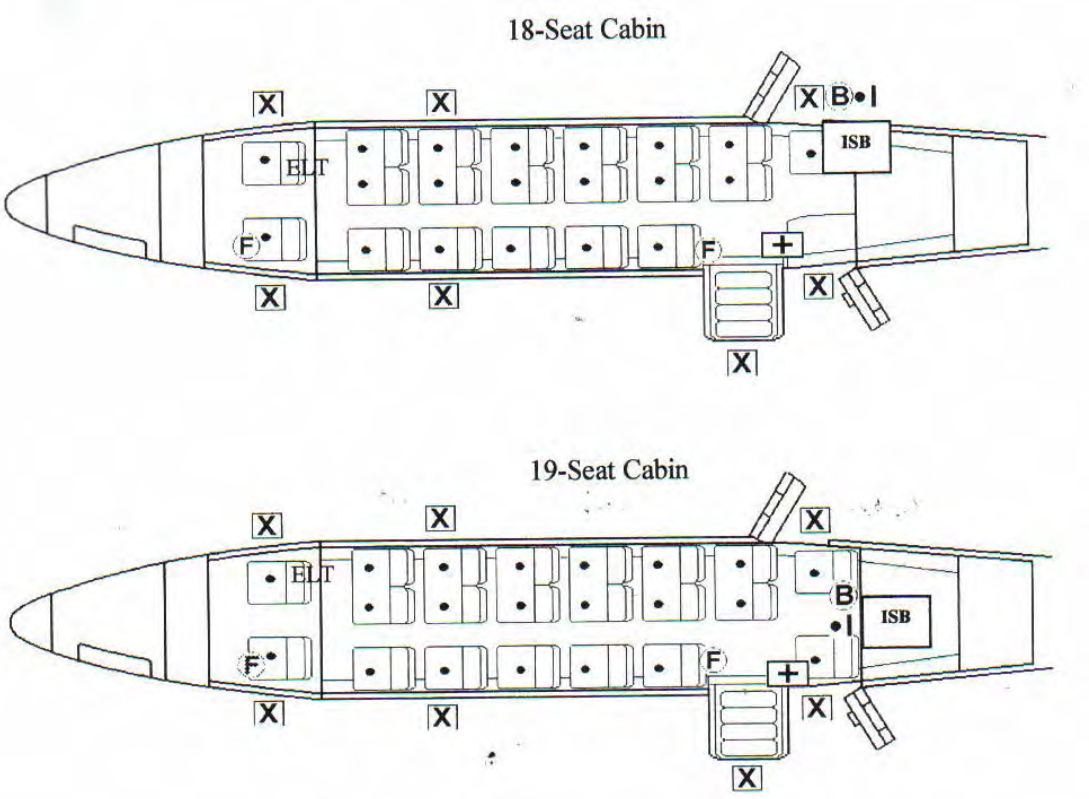


Figure B-7. Airplane E—Cabin Layout

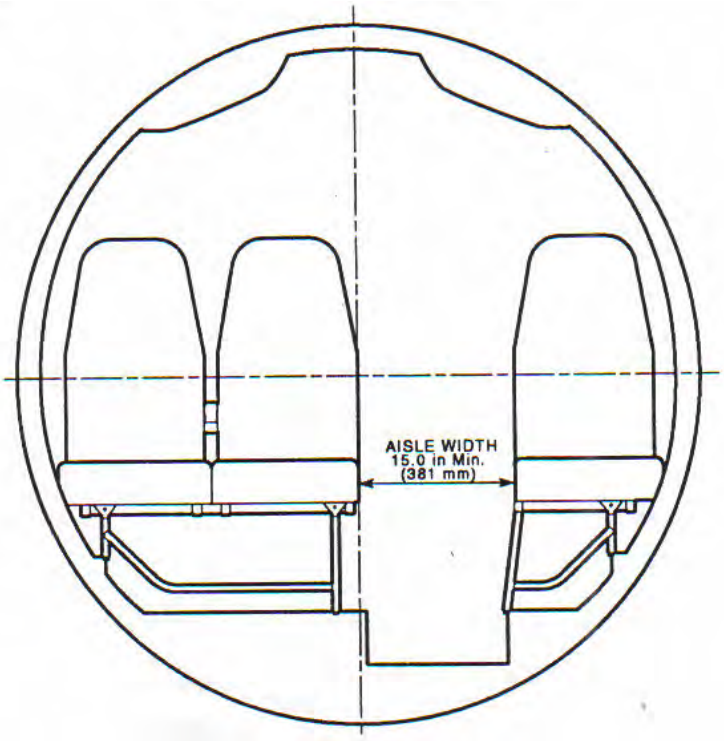


Figure B-8. Airplane F—Fuselage Cross Section

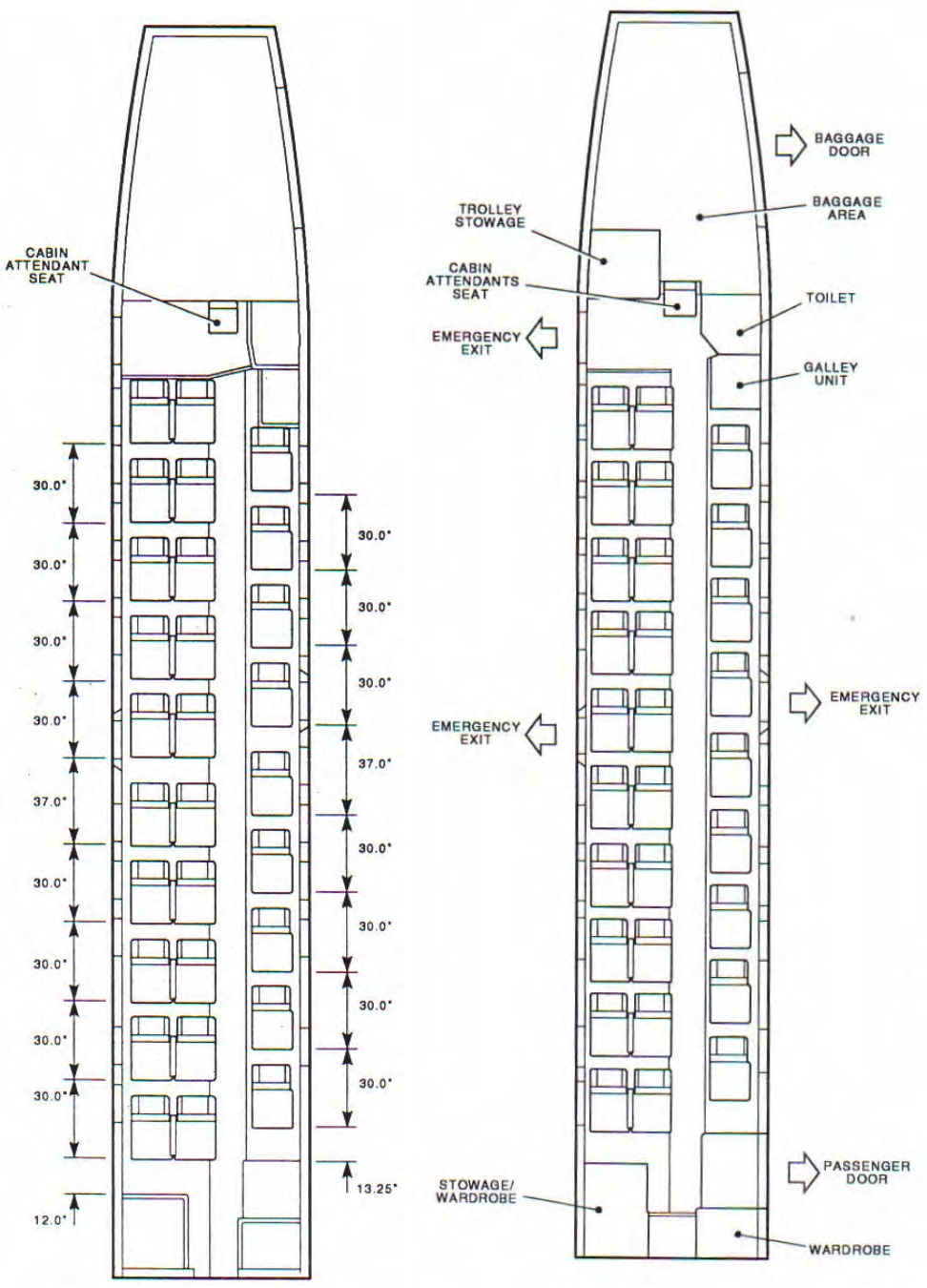
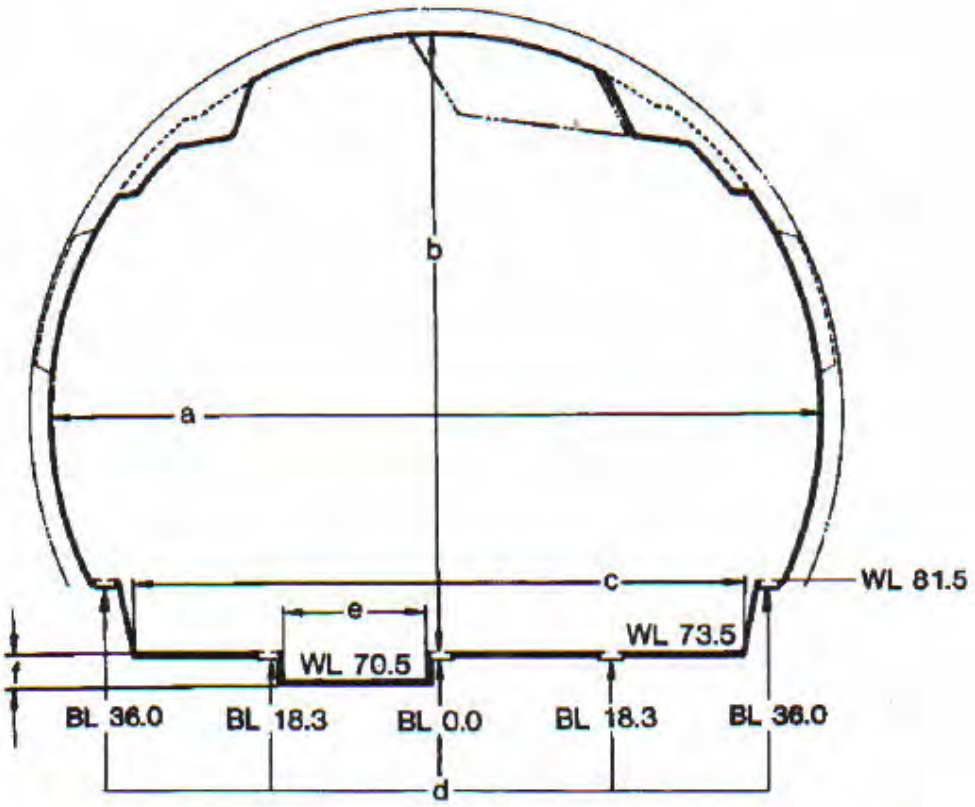


Figure B-9. Airplane F—Cabin Layout



Ref	in	m	Floor area STA 298–STA 621	Volume approx.
a	85	2.16		
b	69	1.75		
c	67	1.70	150 ft² (14.0 m²)	900 ft³ (25.5 m³)
e	17	0.43		
f	3	0.08		
d	Seat tracks with cargo tie down capacity			

Figure B-10. Airplane G—Fuselage Cross Section

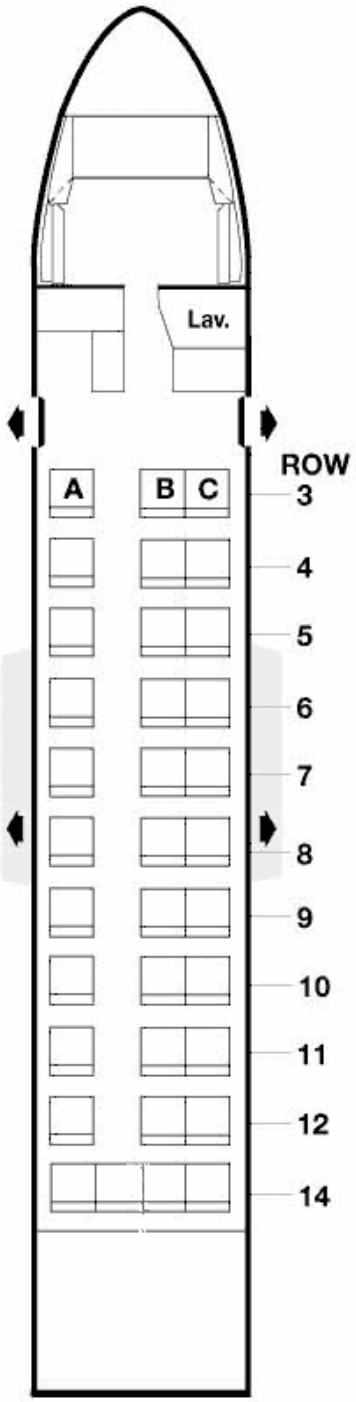
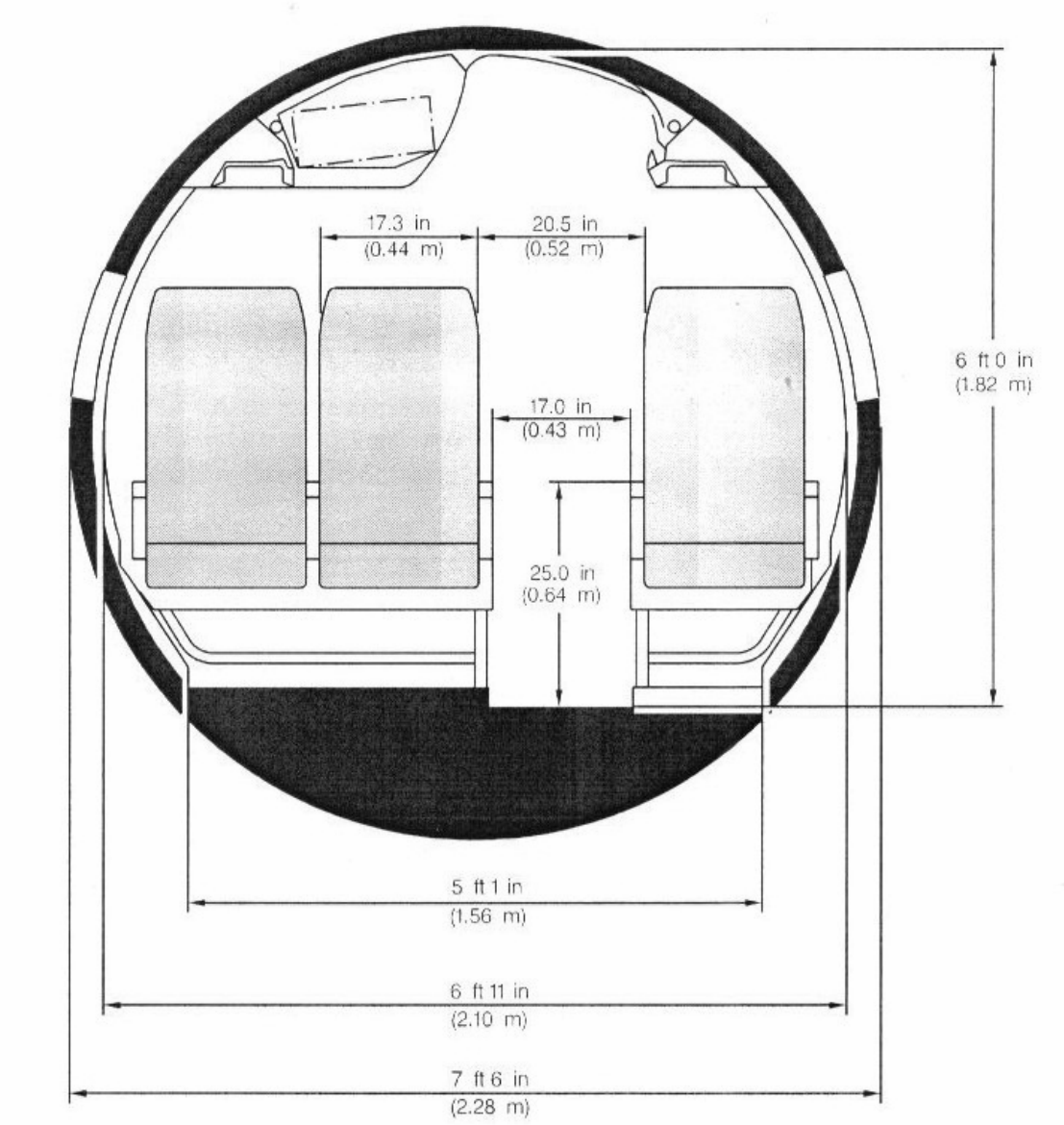


Figure B-11. Airplane G—Cabin Layout



B-12. Airplane H—Fuselage Cross Section

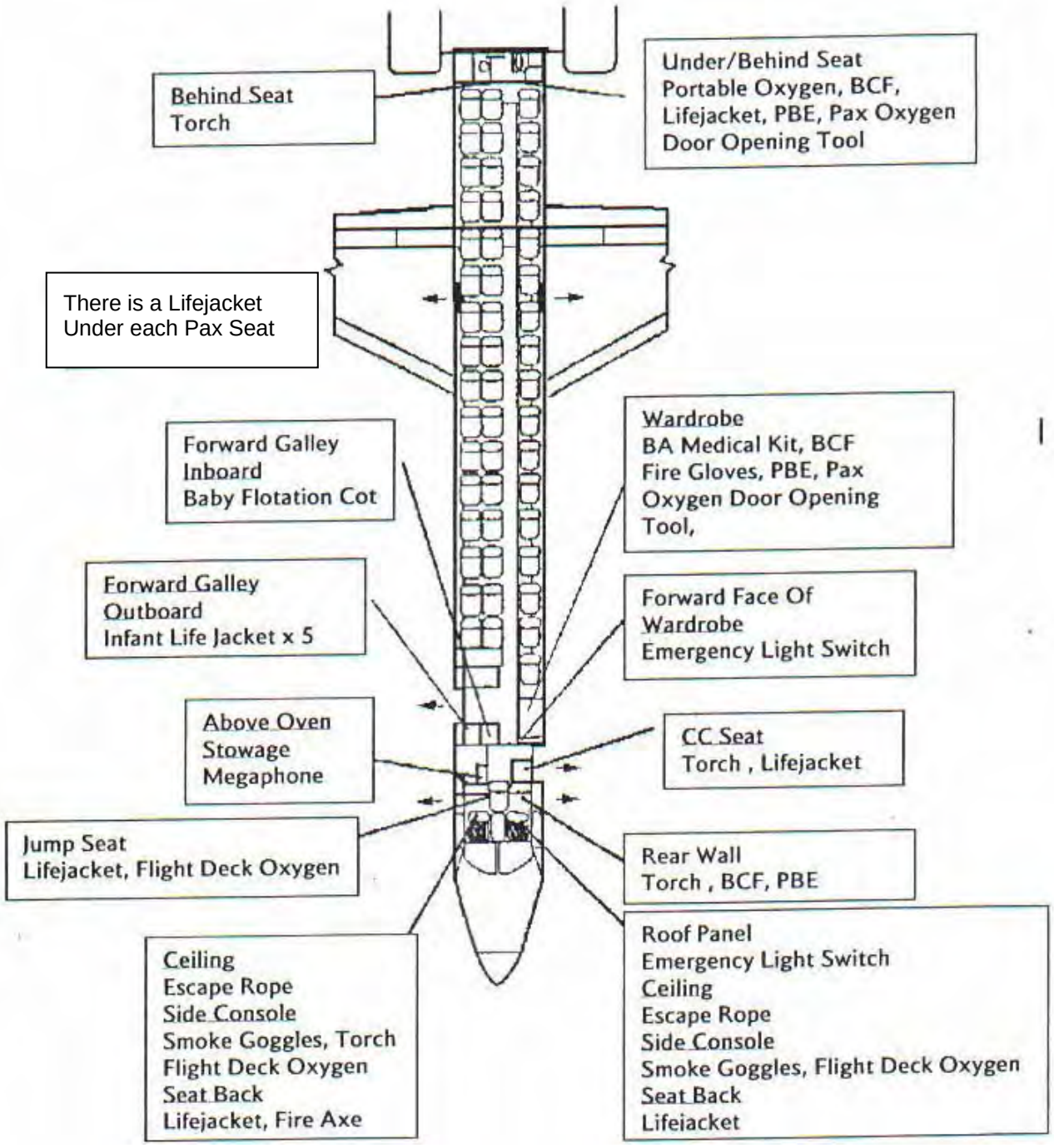


Figure B-13. Airplane H—Cabin Layout

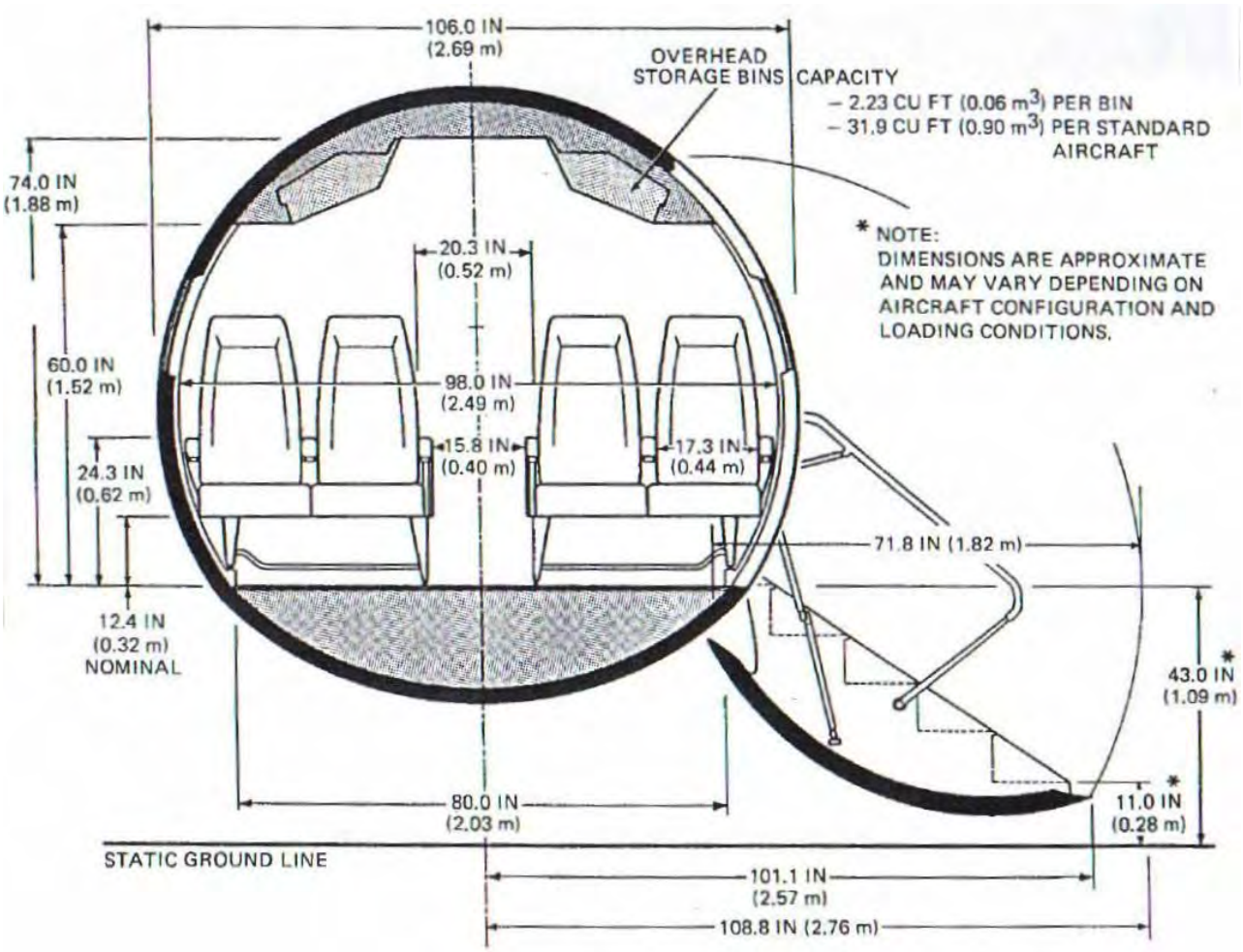


Figure B-14. Airplane I—Fuselage Cross Section

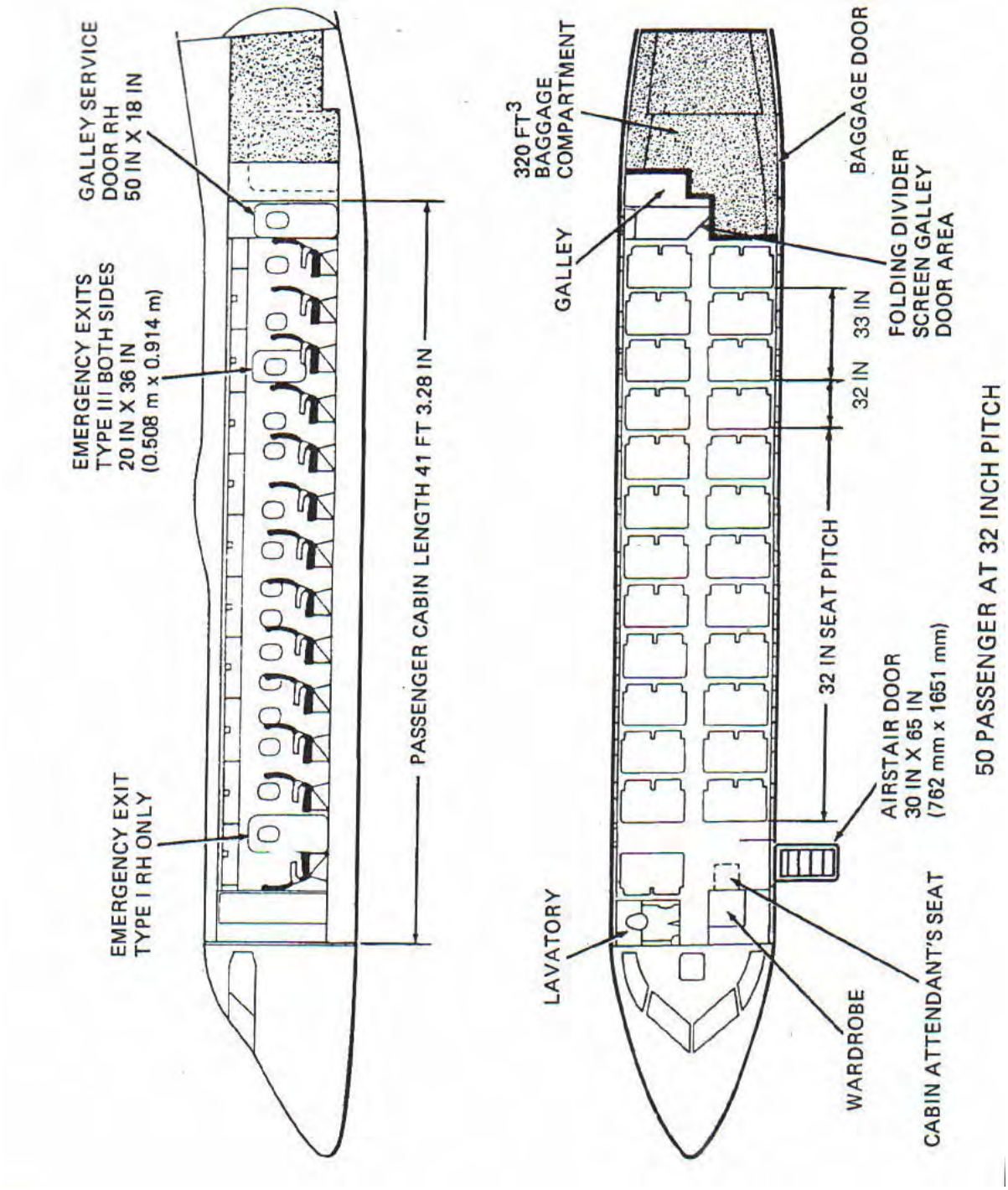


Figure B-15. Airplane I—Cabin Layout

APPENDIX C—SUMMARY OF SMALL AIRPLANE ACCIDENTS REVIEW

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES
19700506A	VISCOUNT 6O-AAJ	06-MAY-1970 MOGADISCIO, SOMALIA	[After the impact sequence, the airplane rested on a nose-down attitude because the nose landing gear had collapsed.] Passengers had to jump out from the rear exit [which was] 3.5 - 4 meters high.
19790731A	HS748-1 – 105 G-BEKF	31-JUL-1979 SUMBURGH, SHETLAND ISLANDS, U.K.	Several passengers had difficulty in reaching back under their seats 14 CFR enough to extract their lifejackets or in opening the pouch to release the lifejacket and valise. The design of the installation of the lifejacket was approved for the type of seat installed on the type of aircraft. It was noted that the close proximity of the seat in front presented an obstacle to bending forward sufficiently to reach the pouch. In addition, because the pouch was difficult to see, release of the valise was made more awkward, often requiring the use of both hands.
19820221A	DHC6 N127PM	21-FEB-1982 PROVIDENCE, RHODE ISLAND, U.S.A.	The safety briefing card did not show the location of the overhead escape hatch in the cabin.
19830109A	CV-580-11-A N8444H	09-JAN-1983 BRAINERD, U.S.A	The noise from the No. 2 engine interfered with the ability of some passengers to hear the flight attendant's shouted command to evacuate through the rear service door.
19831123A	DHC6 C-GTLA	23-NOV-1983 LANSDOWNE HOUSE, ONTARIO, CANADA	[The left rear door could not be opened from the inside (it was later opened from the outside by the Captain. A surviving passenger had to leave the aircraft through the cockpit door.]

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES
19840113A	F27-100 N148PM	13-JAN-1984 JFK INTL AIRPORT, JAMAICA, NEW YORK, U.S.A	The seatbacks folded over when the passengers leaned on them thereby providing no support for the recommended brace position. The articles of clothing in the bins spilled out during the impact. The galley, which was located in the cargo compartment, came free of its attachments, although it remained essentially in its normal location, and some of its contents spilled into the aisle. The cargo door, a designated emergency exit, was opened by the captain with difficulty. Investigation showed that the door could be opened partially until it jammed about 35 inches from its fully closed position. The cockpit observer jumpseat had separated from its attachments and had come to rest in the aisle, which led to the cargo door. A small picnic-type cooler containing ice cubes was stowed on the floor between the galley and the cabin separator because it would not fit inside the galley. At impact, the cooler came free and ice cubes spilled into the floor and mingled with galley debris, causing at least one passenger to slip and fall when he was walking to the cargo door. A passenger attempted to remove the left cabin emergency exit door at seat 8A. Despite having read the instructions about the door and listening to the verbal instructions of the flight attendant, he could not remove the exit door.
			The investigation also disclosed that pulling emergency exits into the aircraft was further restricted by the rearward angle of the seatback in front and the armrest of seat 8A. Similar difficulties were encountered during the removal of the emergency exit on the opposite side of the cabin at seat 8D. In the rear cabin, the commode and its fairing had broken free and blocked the floor level emergency exit, which was located inside the lavatory.

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES
19870304A	CASA 212 N160FB	04-MAR-1987 ROMULUS, U.S.A	Surviving passengers stated that fire and smoke were in the cabin soon after the airplane came to rest. The conditions inside the inverted cabin rapidly deteriorated due to smoke and fire. [The Flight Attendant] reported that she had difficulty opening the left forward emergency exit door because she was disoriented. She initially tried to open the door by pushing the handle down before she realised the handle had to be pulled upward because the airplane was upside down.
19880202A	SAAB SF340A N322PX	02-FEB-1988 FAYETTEVILLE, ARKANSAS, U.S.A.	The flight attendant had difficulty opening the floor-level emergency exit. No slide or rope was available for exiting the aircraft; 3 passengers received minor injuries when they dropped about 5.5 ft to the icy taxiway.
19880415A	DHC8-102 N819PH	15-APR-1988 SEATTLE AIRPORT, U.S.A	The captain attempted to open the cockpit door and the overhead emergency exits, both of which were jammed. The First officer then attempted to break the captain's side window with the fire axe, but he was not successful. Subsequently, the firefighters opened the jammed cockpit door and assisted the pilots off the aircraft.
19890927A	DHC6-300 N75GC	27-SEP-1989 GRAND CANYON, U.S.A	Two survivors stated that they had to crawl out of the window on the main cabin entrance door, which was against the ground. They then had to crawl between the fuselage and the ground to egress the airplane. Other passengers stated that they were unable to egress the wreckage, due to injuries, or that they were pinned in by the bodies of other passengers.

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES
19920701A	SAAB SF340A VH-EKT	01-JULY-1992 TASMANIA, AUSTRALIA	[The Flight Attendant] was forced to speak aggressively to [the passengers] to ensure that the hand baggage was not brought to the front of the aircraft where it could impede the progress of the evacuation. No written or verbal instructions (e.g. the pre-flight safety briefing or the passenger safety briefing card) were available to passengers to inform them that hand baggage should be left in the aircraft in the event of an evacuation.
19940201A	SAAB SF340B N3495B	01-FEB-1994 FALSE RIVER AIR PARK, NEW ROADS, LOUISIANA, U.S.A.	The flight attendant later reported a back injury (an inflamed disc) sustained while she opened a door during the evacuation.
19950821A	EMB120RT N256AS	21-AUG-1995 NR. CARROLLTON, GEORGIA, U.S.A.	Overhead storage bins in the cabin dislodged during the initial ground impact and that passenger seat structures separated and/or became deformed. Movement of the right and left cockpit sliding windows was restricted by airframe damage.
19971207A	F27-500 G-BNCY	07-DEC-1997 LA VILLIAZE AIRPORT, ST PETER PORT, GUERNSEY, U.K.	[Door handle of left rear door could not be turned sufficiently.] [Passengers experienced difficulty of getting out from underwing exit windows (Flight Attendant had to shout instruction “Legs then body").]
19971216A	CL600-2B19 C-FSKI	16-DEC-1997 FREDERICTON AP., NEW BRUNSWICK, CANADA	When the aircraft came to a stop, the captain made an announcement on the PA system: "Evacuate. Evacuate." but because there was no electrical power the announcement was not heard. It was noted that the emergency flashlights are all stored in the same general area, three in the flight deck and one just outside the flight deck, in the storage area under the flight attendant's seat.
19980209B	SD360 G-BLGB	09-FEB-1998 STORNAWAY, U.K.	With the aircraft leaning to the left, it was quite high from the emergency exit to the ground.
19981025A	ATR42-300	25-OCT-1998	[The Flight Attendant] received no notification from the cockpit of an

CSRTG ACCIDENT REFERENCE	AIRCRAFT	DATE/LOCATION	RELEVANT EVACUATION ISSUES
	N143DD	LUIS MUNOZ MARIN INTL, AP., SAN JUAN, PUERTO RICO	emergency, or of any evacuation signals. The three passenger injuries were sustained from falling off the steps of the rear main passenger loading door during deplanement.
19981203A	HS748-2A C-FBNW	03-DEC-1998 IQALUIT AIRPORT, IQALUIT, NWT, CANADA.	Neither the ceiling emergency lights nor the intervalve aisle path lighting system activated. [The Flight Attendant] was unable to find [the emergency light switch] in the dark. The aft passenger door area was very dark. The stowed airstairs has dislodged on impact and were partially blocking the [aft passenger] exit door. The cargo in the forward baggage compartment shifted on impact, blocking access to the port over-wing exit and the crew/freight door.
20010625A	EMB110 VH-OZG	25-JUN-2001 COOTAMUNDRA, AUSTRALIA	One of the other passengers seated near the front of the cabin attempted to open the cabin door but experienced difficulty with the latching mechanism.