8. OTHER FAILURE CONDITIONS THAT MAY HAVE STRUCTURAL EFFECTS

AMC 25.1309, point 10(c) 'Considerations When Assessing Failure Condition Effects', states that the applicant should evaluate the severity of failure conditions, considering the effects that potential or consequential effects on structural integrity may have on the aeroplane.

Therefore, the applicant should carefully consider the potential effects on the windshield structural integrity when assessing any failure condition in windshield-related systems (e.g. windshield heating systems).

Unless otherwise shown, the applicant should classify as at least hazardous a system failure condition that leads to a structural failure that could result in partial or complete loss of a windshield.

In addition, it is reminded that CS 25.365(e)(3) requires the applicant to consider the maximum compartment opening, caused by aeroplane or equipment failures (e.g. windshield failures), that is not shown to be extremely improbable.

Service experience has shown that failure or deterioration of windshield installation components (e.g. a degraded seal), combined with environmental conditions (e.g. water accumulation or moisture ingress) or with manufacturing/installation issues, may lead to failure of other components of windshield-related systems (e.g. degradation of, or damage to, the insulation of a heating-system wire). The combination of such failures may lead to a malfunction or failure of the related system, which may cause a structural failure that could result in the partial or complete loss of the windshield or the loss of transparency of the windshield.

Therefore, the applicant should pay attention to common causes of failures when installing windshields and related systems or components, and to the contribution of such common causes to cascading failures. The applicant should identify through common cause analysis appropriate design, manufacturing, installation, and maintenance precautions to mitigate the risk of any failure condition adversely affecting systems or components, which may directly or indirectly lead to a structural failure that could result in the partial or complete loss of the windshield or the loss of transparency of the windshield (refer to AMC 25.1309, Appendix 1).

[Amdt No: 25/27]

CS 25.777 Cockpit controls

ED Decision 2013/010/R

(a) Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.

(b) The direction of movement of cockpit controls must meet the requirements of CS 25.779. Wherever practicable, the sense of motion involved in the operation of other controls must correspond to the sense of the effect of the operation upon the aeroplane or upon the part operated. Controls of a variable nature using a rotary motion must move clockwise from the off position, through an increasing range, to the full on position.

(c) The controls must be located and arranged, with respect to the pilots' seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flight crew (established under CS 25.1523) when any member of this flight crew from 1.58 m (5ft 2 inches) to 1·91 m (6ft 3 inches) in height, is seated with the seat belt and shoulder harness (if provided) fastened.

(d) Identical powerplant controls for each engine must be located to prevent confusion as to the engines they control.

(e) Wing-flap controls and other auxiliary lift device controls must be located on top of the pedestal, aft of the throttles, centrally or to the right of the pedestal centre line, and not less than 25 cm (10 inches) aft of the landing gear control.

(f) The landing gear control must be located forward of the throttles and must be operable by each pilot when seated with seat belt and shoulder harness (if provided) fastened.

(g) Control knobs must be shaped in accordance with CS 25.781. In addition, the knobs must be of the same colour and this colour must contrast with the colour of control knobs for other purposes and the surrounding cockpit.

(h) If a flight engineer is required as part of the minimum flight crew (established under CS 25.1523), the aeroplane must have a flight engineer station located and arranged so that the flight-crew members can perform their functions efficiently and without interfering with each other.

(i) Pitch and roll control forces and displacement sensitivity shall be compatible so that normal inputs on one control axis will not cause significant unintentional inputs on the other.

[Amdt 25/13]

AMC 25.777(c) Full and unrestricted movement of cockpit controls

ED Decision 2019/013/R9/013/R

1. General

CS 25.777(c) requires cockpit controls to be located and arranged so that full and unrestricted movement of each control can be made by the minimum flight crew. The use of the controls shall be evaluated for pilots across the range of statures required by CS 25.777(c). This evaluation should take into account foreseeable normal and failure conditions.

2. Rudder and brake controls

Particular attention should be paid to rudder and brake controls. The control movement of the rudder pedals and brake pedals should be evaluated in order to ensure that full use can be made of all the available controls in the event of an engine failure, including on take-off and including engine failure at low speeds below V_{MCG}.

The evaluation should ensure that each member of the flight crew is always able to apply full rudder and maximum brake pressure on the same side simultaneously (e.g. full right rudder with maximum right brake pressure, and vice versa). Furthermore, the ergonomics of the design should be such that:

a) the flight crew members can, in each condition, continue to apply brake pressure on the opposite side; and

b) inadvertent brake application on the opposite side is precluded.

This evaluation should ideally be performed in a representative simulator, but it may also be performed statically in a representative cockpit.

[Amdt No: 25/23]

CS 25.779 Motion and effect of cockpit controls

ED Decision 2003/2/RM

Cockpit controls must be designed so that they operate in accordance with the following movement and actuation:

(a) Aerodynamic controls –

(1) Primary.

Controls	Motion and effect
Aileron	Right (clockwise) for right wing down
Elevator	Rearward for nose up
Rudder	Right pedal forward for nose right

(2) Secondary.

Controls	Motion and effect
Flaps (or auxiliary lift devices)	Forward for wing-flaps up; rearward for flaps down
Trim tabs (or equivalent)	Rotate to produce similar rotation of the aeroplane about an axis parallel to the axis of the control

(b) Powerplant and auxiliary controls –

(1) Powerplant.

Controls	Motion and effect
Power or thrust	Forward to increase forward thrust and rearward to increase rearward thrust
Propellers	Forward to increase rpm

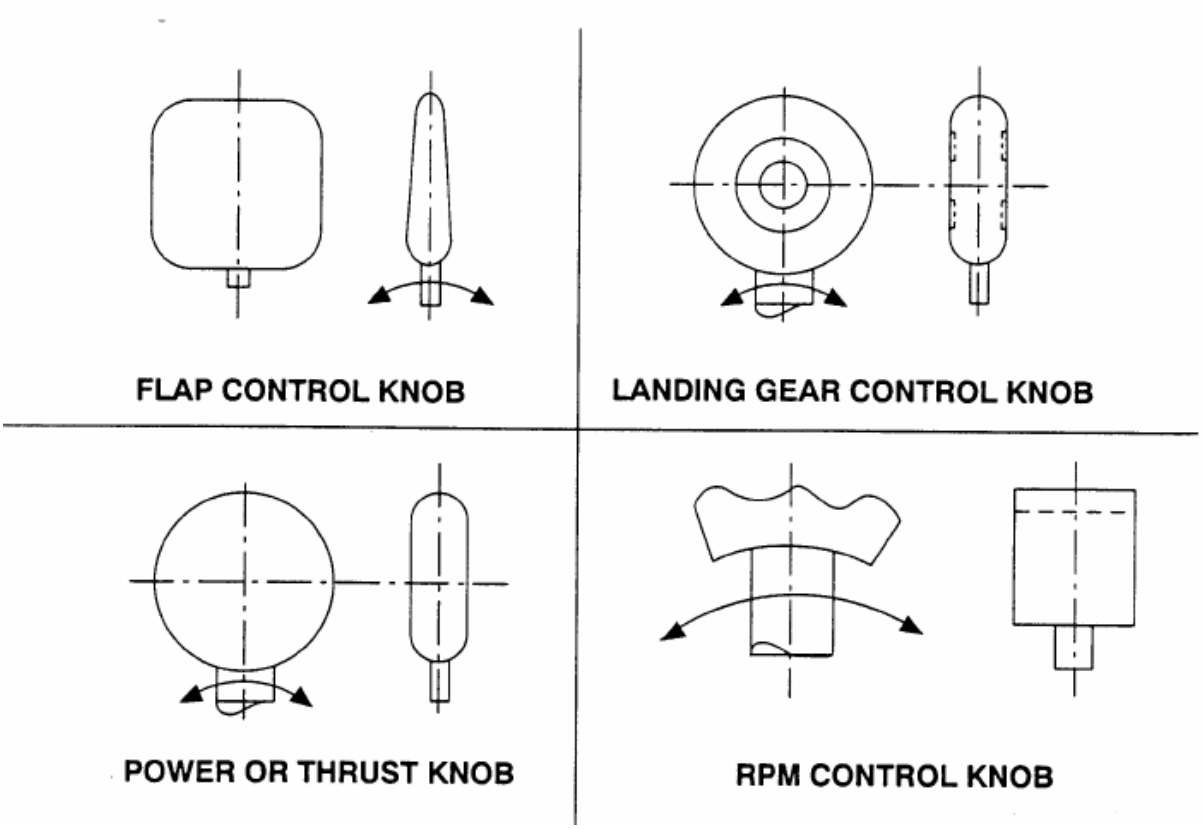
(2) Auxiliary.

Controls	Motion and effect
Landing gear	Down to extend

CS 25.781 Cockpit control knob shape

ED Decision 2003/2/RM

Cockpit control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



CS 25.783 Fuselage Doors

ED Decision 2016/010/R

(See AMC 25.783)

(a) General. This paragraph applies to fuselage doors, which includes all doors, hatches, openable windows, access panels, covers, etc., on the exterior of the fuselage that do not require the use of tools to open or close. This also applies to each door or hatch through a pressure bulkhead, including any bulkhead that is specifically designed to function as a secondary bulkhead under the prescribed failure conditions of CS-25. These doors must meet the requirements of this paragraph, taking into account both pressurised and unpressurised flight, and must be designed as follows:

(1) Each door must have means to safeguard against opening in flight as a result of mechanical failure, or failure of any single structural element.

(2) Each door that could be a hazard if it unlatches must be designed so that unlatching during pressurised and unpressurised flight from the fully closed, latched, and locked condition is extremely improbable. This must be shown by safety analysis.

(3) Each element of each door operating system must be designed or, where impracticable, distinctively and permanently marked, to minimise the probability of incorrect assembly and adjustment that could result in a malfunction.

(4) All sources of power that could initiate unlocking or unlatching of any door must be automatically isolated from the latching and locking systems prior to flight and it must not be possible to restore power to the door during flight.

(5) Each removable bolt, screw, nut, pin, or other removable fastener must meet the locking requirements of CS 25.607.

(6) Certain doors, as specified by CS 25.807(h), must also meet the applicable requirements of CS 25.809 through CS 25.812 for emergency exits.

(b) Opening by persons. There must be a means to safeguard each door against opening during flight due to inadvertent action by persons. In addition, for each door that could be a hazard, design precautions must be taken to minimise the possibility for a person to open the door intentionally during flight. If these precautions include the use of auxiliary devices, those devices and their controlling systems must be designed so that:

(1) no single failure will prevent more than one exit from being opened, and

(2) failures that would prevent opening of any exit after landing must not be more probable than remote.

(c) Pressurisation prevention means. There must be a provision to prevent pressurisation of the aeroplane to an unsafe level if any door subject to pressurisation is not fully closed, latched, and locked.

(1) The provision must be designed to function after any single failure, or after any combination of failures not shown to be extremely improbable.

(2) Doors that meet the conditions described in sub-paragraph (h) of this paragraph are not required to have a dedicated pressurisation prevention means if, from every possible position of the door, it will remain open to the extent that it prevents pressurisation or safely close and latch as pressurisation takes place. This must also be shown with any single failure and malfunction except that:

(i) with failures or malfunctions in the latching mechanism, it need not latch after closing, and

(ii) with jamming as a result of mechanical failure or blocking debris, the door need not close and latch if it can be shown that the pressurisation loads on the jammed door or mechanism would not result in an unsafe condition.

(d) Latching and locking. The latching and locking mechanisms must be designed as follows:

(1) There must be a provision to latch each door.

(2) The latches and their operating mechanism must be designed so that, under all aeroplane flight and ground loading conditions, with the door latched, there is no force or torque tending to unlatch the latches. In addition, the latching system must include a means to secure the latches in the latched position. This means must be independent of the locking system.

(3) Each door subject to pressurisation, and for which the initial opening movement is not inward, must:

(i) have an individual lock for each latch;

(ii) have the lock located as close as practicable to the latch; and

(iii) be designed so that, during pressurised flight, no single failure in the locking system would prevent the locks from restraining the latches necessary to secure the door.

(4) Each door for which the initial opening movement is inward, and unlatching of the door could result in a hazard, must have a locking means to prevent the latches from becoming disengaged. The locking means must ensure sufficient latching to prevent opening of the door even with a single failure of the latching mechanism.

(5) It must not be possible to position the lock in the locked position if the latch and the latching mechanism are not in the latched position.

(6) It must not be possible to unlatch the latches with the locks in the locked position. Locks must be designed to withstand the limit loads resulting from:

(i) the maximum operator effort when the latches are operated manually;

(ii) the powered latch actuators, if installed; and

(iii) the relative motion between the latch and the structural counterpart.

(7) Each door for which unlatching would not result in a hazard is not required to have a locking mechanism meeting the requirements of sub-paragraphs (d)(3) through (d)(6) of this paragraph.

(8) A door that could result in a hazard if not closed, must have means to prevent the latches from being moved to the latched position unless it can be shown that a door that is not closed would be clearly evident before flight.

(e) Warning, caution, and advisory indications. Doors must be provided with the following indications:

(1) There must be a positive means to indicate at the door operator's station that all required operations to close, latch, and lock the door(s) have been completed.

(2) There must be a positive means, clearly visible from each operator station for each door that could be a hazard if unlatched, to indicate if the door is not fully closed, latched, and locked.

(3) There must be a visual means on the flight deck to signal the pilots if any door is not fully closed, latched, and locked. The means must be designed such that any failure or combination of failures that would result in an erroneous closed, latched, and locked indication is remote for:

(i) each door that is subject to pressurisation and for which the initial opening movement is not inward; or

(ii) each door that could be a hazard if unlatched.

(4) There must be an aural warning to the pilots prior to or during the initial portion of take-off roll if any door is not fully closed, latched, and locked, and its opening would prevent a safe take-off and return to landing.

(f) Visual inspection provision. Each door for which unlatching could be a hazard must have a provision for direct visual inspection to determine, without ambiguity, if the door is fully closed, latched, and locked. The provision must be permanent and discernible under operational lighting conditions, or by means of a flashlight or equivalent light source.

(g) Certain maintenance doors, removable emergency exits, and access panels. Some doors not normally opened except for maintenance purposes or emergency evacuation and some access panels need not comply with certain sub-paragraphs of this paragraph as follows:

(1) Access panels that are not subject to cabin pressurisation and would not be a hazard if open during flight need not comply with sub-paragraphs (a) through (f) of this paragraph, but must have a means to prevent inadvertent opening during flight.

(2) Inward-opening removable emergency exits that are not normally removed, except for maintenance purposes or emergency evacuation, and flight deck-openable windows need not comply with sub-paragraphs (c) and (f) of this paragraph.

(3) Maintenance doors that meet the conditions of sub-paragraph (h) of this paragraph, and for which a placard is provided limiting use to maintenance access, need not comply with sub-paragraphs (c) and (f) of this paragraph.

(h) Doors that are not a hazard. For the purposes of this paragraph, a door is considered not to be a hazard in the unlatched condition during flight, provided it can be shown to meet all of the following conditions:

(1) Doors in pressurised compartments would remain in the fully closed position if not restrained by the latches when subject to a pressure greater than 3.447 kPa (0.5 psi). Opening by persons, either inadvertently or intentionally, need not be considered in making this determination.

(2) The door would remain inside the aeroplane or remain attached to the aeroplane if it opens either in pressurised or unpressurised portions of the flight. This determination must include the consideration of inadvertent and intentional opening by persons during either pressurised or unpressurised portions of the flight.

(3) The disengagement of the latches during flight would not allow depressurisation of the cabin to an unsafe level. This safety assessment must include the physiological effects on the occupants.

(4) The open door during flight would not create aerodynamic interference that could preclude safe flight and landing.

(5) The aeroplane would meet the structural design requirements with the door open. This assessment must include the aeroelastic stability requirements of CS 25.629, as well as the strength requirements of Subpart C.

(6) The unlatching or opening of the door must not preclude safe flight and landing as a result of interaction with other systems or structures.

[Amdt 25/4]
[Amdt 25/18]

AMC 25.783 Fuselage Doors

ED Decision 2011/004/R

1. PURPOSE.

This Acceptable Means of Compliance, which is similar to the FAA Advisory Circular AC 25.783-1A describes an acceptable means for showing compliance with the requirements of CS-25 dealing with the certification of fuselage external doors and hatches.

The means of compliance described in this document is intended to provide guidance to supplement the engineering and operational judgement that must form the basis of any compliance findings relative to the structural and functional safety standards for doors and their operating systems

This document describes an acceptable means, but not the only means, for demonstrating compliance with the requirements. Terms such as “shall” and “must” are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used.

2. RELATED CS PARAGRAPHS.

The contents of this AMC are considered by the EASA in determining compliance of doors with the safety requirements of CS 25.783. Other related paragraphs are:

CS 25.571, “Damage-tolerance and fatigue evaluation of structure”

CS 25.607, “Fasteners”

CS 25.703, “Take-off warning system”

CS 25.809, “Emergency exit arrangement”

3. DEFINITIONS OF TERMS.

Inconsistent or inaccurate use of terms may lead to the installation of doors and hatches that do not fully meet the safety objectives of the regulations. To ensure that such installations fully comply with the regulations, the following definitions should be used when showing compliance with CS 25.783:

a. “Closed” means that the door has been placed within the door frame in such a position that the latches can be operated to the “latched” condition. “Fully closed” means that the door is placed within the door frame in the position it will occupy when the latches are in the latched condition.

b. “Door” includes all doors, hatches, openable windows, access panels, covers, etc. on the exterior of the fuselage which do not require the use of tools to open or close. This also includes each door or hatch through a pressure bulkhead including any bulkhead that is specifically designed to function as a secondary bulkhead under the prescribed failure conditions of CS-25.

c. “Door operator’s station” means the location(s) where the door closing, latching and locking operations are performed.

d. “Emergency exit” is an exit designated for use in an emergency evacuation.

e. “Exit” is a door designed to allow egress from the aeroplane.

f. “Flight” refers to that period of time from start of the take-off roll until the aeroplane comes to rest after landing.

g. "Inadvertent action by persons" means an act committed without forethought, consideration or consultation.

h. "Initial inward opening movement". In order for a door design to be classified as having inward initial opening movement the design of its stops, guides and rollers and associated mechanism, should be such that positive pressurisation of the fuselage acting on the mean pressure plane of the fully closed door must always ensure a positive door closure force. (See AMC 25.783 Paragraph 5, (d) (4)).

i. "Initial opening movement," refers to that door movement caused by operation of a handle or other door control mechanism, which is required to place the door in a position free of structure that would interfere with continued opening of the door.

j. "Inward" means having a directional component of movement that is inward with respect to the mean (pressure) plane of the body cut-out.

k. "Latched" means the latches are engaged with their structural counterparts and held in position by the latch operating mechanism.

l. "Latches" are movable mechanical elements that, when engaged, prevent the door from opening.

m. "Latching system" means the latch operating system and the latches.

n. "Locked" means the locks are engaged and held in position by the lock operating mechanism.

o. "Locking system" means the lock operating system and the locks.

p. "Locks" are mechanical elements in addition to the latch operating mechanism that monitor the latch positions, and when engaged, prevent latches from becoming disengaged.

q. "Stops" are fixed structural elements on the door and door frame that, when in contact with each other, limit the directions in which the door is free to move.

4. BACKGROUND.

4.1 History of incidents and accidents.

There is a history of incidents and accidents in which doors, fitted in pressurised aeroplanes, have opened during pressurised and unpressurised flight. Some of these inadvertent openings have resulted in fatal crashes. After one fatal accident that occurred in 1974, the FAA and industry representatives formed a design review team to examine the current regulatory requirements for doors to determine if those regulations were adequate to ensure safety. The team's review and eventual recommendations led to the FAA issuing Amendment 25-54 to 14 CFR part 25 in 1980, that was adopted by the JAA in JAR-25 Change 10 in 1983, which significantly improved the safety standards for doors installed on large aeroplanes. Included as part of JAR-25 Change 10 (Amendment 25-54) was JAR 25.783, "Doors," which provides the airworthiness standards for doors installed on large aeroplanes.

Although there have been additional minor revisions to JAR 25.783 subsequent to the issuance of Change 10 (Amendment 25-54), the safety standards for doors have remained essentially the same since 1980.

4.2 Continuing safety problems.

In spite of the improved standards brought about in 1980, there have continued to be safety problems, especially with regard to cargo doors. Cargo doors are often operated by persons having little formal instruction in their operation. Sometimes the operator is required to carry out several actions in sequence to complete the door opening and closing operations. Failure to complete all sequences during closure can have serious consequences. Service history shows that several incidents of doors opening during flight have been attributed to the failure of the operator to complete the door closure and locking sequence. Other incidents have been attributable to incorrect adjustment of the door mechanism, or failure of a vital part.

4.3 Indication to the flight crew.

Experience also has shown that, in some cases, the flight deck indication system has not been reliable. In other instances, the door indication system was verified to be indicating correctly, but the flight crew, for unknown reasons, was not alerted to the unsafe condition. A reliable indication of door status on the flight deck is particularly important on aeroplanes used in operations where the flight crew does not have an independent means readily available to verify that the doors are properly secured.

4.4 Large cargo doors as basic airframe structure.

On some aeroplanes, large cargo doors form part of the basic fuselage structure, so that, unless the door is properly closed and latched, the basic airframe structure is unable to carry the design aerodynamic and inertial loads. Large cargo doors also have the potential for creating control problems when an open door acts as an aerodynamic surface. In such cases, failure to secure the door properly could have catastrophic results, even when the aeroplane is unpressurised.

4.5 NTSB (USA) recommendations.

After two accidents occurred in 1989 due to the failure of cargo doors on transport category aeroplanes, the FAA chartered the Air Transport Association (ATA) of America to study the door design and operational issues again for the purpose of recommending improvements. The ATA concluded its study in 1991 and made recommendations to the FAA for improving the design standards of doors. Those recommendations together with additional recommendations from the National Transportation Safety Board (NTSB) were considered in the development of improved standards for doors adopted by Amendment 25-114.

5. DISCUSSION OF THE CURRENT REQUIREMENTS.

Service history has shown that to prevent doors from becoming a hazard by opening in flight, it is necessary to provide multiple layers of protection against failures, malfunctions, and human error. Paragraph 25.783 addresses these multiple layers of protection by requiring:

— a latching system;

— a locking system;

— indication systems;

— a pressure prevention means.