

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA24MA063

STRUCTURES

Group Chair's Factual Report - Supplemental

September 30, 2024

A. ACCIDENT

Location: Portland, Oregon
Date: January 5, 2024
Time: 1714 Pacific Standard Time
0114 Coordinated Universal Time (UTC) January 6, 2024
Airplane: Alaska Airlines flight 1282, Boeing 737-9, N740AL

B. STRUCTURES GROUP

Group Chair	Clinton R. Crookshanks National Transportation Safety Board Aurora, Colorado
Group Member	Leani Benitez-Cardona National Transportation Safety Board Washington, District of Columbia
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Group Member	John Petruzzelli International Association of Machinists Seattle, Washington
Group Member	Ben Hobbs Spirit AeroSystems Wichita, Kansas

C. DETAILS OF THE INVESTIGATION

This supplement to the Structures Group Chair's Factual Report provides additional information on the differences between a Mid Exit Door Plug (Plug) as installed on the accident airplane and an activated or deactivated Mid Exit Door (Door) that can be installed on certain 737 model airplanes.

D. FACTUAL INFORMATION

1.0 Airplane Information

The higher passenger capacity models of the 737 airplane (-900ER, -8200, -9, and yet to be certified -10) are equipped with a rectangular door opening on both sides of the fuselage aft of the wing during manufacture. The opening can accommodate an additional emergency exit door on each side of the fuselage when required by airworthiness authorities for certain passenger seating configurations. In many cases, an activated (operational) or deactivated Door is installed in the fuselage opening during manufacture. The baseline configuration for the 737-9 airplane is to have a deactivated Door installed; however, for the 737-9 airplane only, an operator may elect to have a Plug installed in the fuselage opening. Both Doors and Plugs are considered principle structural elements; however, the Plug is not a door under the airworthiness regulations because it requires tools to open and close it for maintenance and inspection purposes. The deactivated Door is also not a door under the airworthiness regulations. The Plug weighs less and is less complex than an activated or deactivated Door since it eliminates the door actuation mechanisms. An airplane with Plugs installed can later be retrofitted with emergency exit doors at significant cost and Boeing urges purchasers to consider this before choosing the Plug option. The fuselage structure and installed wiring is mostly identical for the 737-9 airplane regardless of whether a Door or Plug is installed during manufacture.

1.1 Door and Plug Visual Differences

The Door and Plug are nominally the same size to fill the opening in the fuselage and share similar interfaces to the fuselage cutout. The differences between a Plug and Door are readily apparent visually from the inside and outside of the airplane.

From the outside of the airplane, the Plug has a standard rectangular passenger window installed in the outer skin and is painted the same color as the fuselage. Only the visible edges of the Plug and cutout skins distinguish the Plug from other fuselage structure. Both activated and deactivated Door installations have a small, circular viewport installed in the outer skin, a pressure relief vent panel installed above the viewport, and a handle to open the exit from the exterior of the airplane. An activated Door will have a 2-inch-wide stripe in a contrasting paint color around the edge of the Door to denote it as an exit. There are also several placards installed

on the exterior of an activated Door to identify it as an emergency exit and provide instructions for opening the exit. A deactivated Door is painted the same color as the fuselage, does not have contrasting paint or placards, and the exterior handle is deactivated by a mechanically fastened strap.

On the inside of the airplane, the Plug has a standard passenger window with an interior sidewall panel that extends about 1-foot forward and aft of the fuselage opening. Due to the additional fuselage structure around the opening, the space between passenger windows is larger than normal between the Plug window and the passenger windows forward and aft of it. The activated Door has a small, circular viewport in the interior sidewall panel, an escape slide installed behind a panel that protrudes further into the cabin than the other sidewall panels, and a handle next to the viewport for opening the exit. There may be a flight attendant seat forward of the activated right Door. The outboard passenger seats and passenger stow bins above the activated Doors may be deleted on both sides depending on seating configuration and emergency exit rating. Exit lighting and placards on the door and surrounding panels are also installed. The deactivated Door has the interior handle and escape slide removed to accommodate a smooth, continuous interior sidewall panel that is installed over the Door structure and mechanism. There are no placards and no viewport opening in the sidewall panel. The blank space between passenger windows in the area of the deactivated Door spans more than one seat row.

1.2 Door Description and Operation

The Door (activated or deactivated) structure is of similar construction to the Plug. Both the Door and Plug have 12 door stop fittings, 6 each on the forward and aft sides, that engage with the 12 stop pads, 6 each on the forward and aft sides, installed on the fuselage frame to react the pressurization loads. The vertical position of the Door when fully closed, latched, and locked is controlled by 2 upper guide fittings, 1 on each side, that engage with the frame mounted upper guide rollers; 2 latches, 1 on each side, that engage with the frame mounted latch tracks; and 2 lower hinge fittings, 1 on each side, that engage with the Door lower hinge assemblies. The hinge assemblies on a Door (activated or deactivated) are more complex six-bar linkages to control the motion of the Door during opening. The Door opening motion is initially inward and upward to clear the stop pads before rotation outboard and down about the lower hinges similar to the Plug. Unlike the Plug, the Door hinge mechanism is designed to control the opening of the Door through 180° allowing it to hang vertically from the hinges outside the fuselage in the fully open position and facilitate deployment of the escape slide and egress of passengers in an emergency. During opening and closing of the Door, rollers on the 2 latches engage with the frame mounted latch tracks to control the latching and vertical motion of the Door unlike the Plug. The deactivated Door latching and locking mechanism is mechanically secured in the closed, latched and locked state preventing movement of the Door and also includes upper guide track bolts as an additional means of

preventing vertical movement similar to the Plug. Similar to the Plug, once the Door is deactivated it no longer meets the regulatory definition of a "door".

The Door has two mechanisms installed to control the opening, closing, latching, and locking functions. The upper mechanism includes the interior and exterior handles that are connected to various cams and links to control the vent panel, pressure lock, and latches. The flight lock is included on the upper mechanism but is not controlled by handle movement. The lower mechanism includes the lower hinge assemblies, lift assist springs, and hydraulic dampers to control the lifting and opening motion of the Door. Indication switches are installed on the upper mechanism, flight lock mechanism, and latch tracks to provide status information to the flight crew. The flight lock system on the activated Door prevents unlatching of the upper mechanism during flight via a solenoid activated lock that engages with the latch shaft. The flight lock solenoid activation and deactivation are dependent on several conditions; however, the primary condition is related to thrust lever position. At the start of the takeoff roll, flight lock activation occurs when the thrust lever angle exceeds 53° and deactivation occurs on landing when the thrust lever angle decreases below 53°. There is an emergency escape slide installed on the activated Door that is always armed.

In the event of an emergency requiring the use of the Doors for evacuation, the Doors can be opened from either the inside or the outside using the handles. The initial movement of either handle allows the vent panel to open if the cabin pressure is at or below a safe level, which disengages the pressure lock. Continued movement causes the upper mechanism to unlock and unlatch the Door. Further movement of the handle begins to translate the Door inward and upward when the lift assist springs on the lower hinges engage. Once fully lifted off the pressure stops the door is pushed outboard rotating about the lower hinges. The hydraulic dampers control the speed of the door as it opens. During the opening of the Door, the escape slide deployment sequence (inflation) begins when the Door has opened about 90°. With the Door fully open, it hangs upside down from the hinges on the lower sill behind the deployed escape slide.

There are several features that protect the airplane from an unsafe condition in-flight resulting from an unsecured, activated Door. These are in addition to the flight crew indications described below. While still on the ground, if the Door is not closed, the interior handle is extended and visible to the cabin crew, large gaps around the exterior of the Door will be visible, the vent panel on the exterior will be open, and the Door may open due to gravity, deploying the escape slide. If the Door is closed, but not fully latched or fully locked, the interior handle remains extended and visible to cabin crew and the vent panel remains open and visible from the exterior. The design of the lower hinge assemblies on a Door restrains a closed but not fully latched or locked door from lifting and opening until handle movement occurs. If the flight and cabin crew indications and warnings are ineffective and the airplane departs with the Door in a closed but unlatched or unlocked state, the open

vent panel ensures the airplane cannot be pressurized. A lack of pressurization results in additional flight crew indications and ensures that a Door that is not locked will not also cause a rapid decompression in the improbable event that it opens in flight.

1.3 Flight Crew Indications

There are no flight crew warning or indication lights installed on an airplane equipped with Plugs since there are no sensors installed. All the wiring associated with the Doors is installed but capped and stowed on airplanes equipped with Plugs.

For an airplane equipped with activated Doors, the status is displayed to the flight crew on the DOORS panel located on the overhead console. The LEFT MID EXIT or RIGHT MID EXIT light will illuminate if the system senses that either of the Doors is not closed, latched, or locked. In addition, if an activated Door is detected as not fully closed, not latched, or not locked, the airplane is on the ground, and the throttles are at take-off thrust (greater than 53° Thrust Resolver Angle), a red TAKEOFF CONFIG indicator light on the main forward panel will be displayed along with an aural warning (intermittent horn) on the flight deck during takeoff. If there is a fault with the flight lock system or if a flight lock fails to engage or disengage when commanded, the MASTER CAUTION, LEFT MID EXIT or RIGHT MID EXIT, and the MAINT warning light will illuminate; however, these warnings are inhibited until after landing.

For an airplane equipped with deactivated Doors, the left and right warning lights are installed but placarded INOP. In addition, the flight locks are disconnected and wiring capped and stowed along with other indication related wiring.

1.4 Certification Requirements for MED and MED Plug

The 737-9 with activated Doors is certified under the requirements of 14 *Code of Federal Regulations (CFR)* 25.571 and 25.783, among other applicable requirements. Damage-tolerance and fatigue evaluation of structure, 14 *CFR* 25.571, provides the requirements for an evaluation of the strength, detail design, and fabrication of structure to prevent the catastrophic failure due to fatigue, corrosion, manufacturing defects, or accidental damage throughout the operational life of the airplane. Fuselage doors, 14 *CFR* 25.783, provides the requirements for the design of all doors that do not require the use of tools to open or close. In addition to the general requirements, the fuselage doors regulation provides the requirements for prevention of opening during flight, prevention of pressurization if not fully closed, latched, and locked, the provisions for latching and locking, the required warning, cautions, and advisory indications, and visual inspection requirements. The deactivated Door configuration is not subject to 14 *CFR* 25.783 but retains many of the features that support compliance to 14 *CFR* 25.783, and these features are employed in securing the deactivated Door as described previously.

The 737-9 Plug is certified under the requirements of 14 *CFR* 25.571. It is not subject to the requirements of 14 *CFR* 25.783 since it is not classified as a door and requires tools to open or close it.

Submitted by:

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