



**Association of Flight Attendants (AFA)
Party Submission
Alaska Airlines Flight 1282 Accident January 5, 2024**

Seth Heiple - AFA Party Coordinator, Alaska Airlines Flight 1282 Investigation



Table of Contents

<u>Safety Issue 1 - System for equalization of pressure may be inadequate</u>	<u>3</u>
<u>Safety Issue 2 - Interior damage caused by flight deck door opening during decompression</u>	<u>5</u>
<u>Safety Issue 3 - Flight deck door behavior during cabin decompression is unknown</u>	<u>6</u>
<u>Safety Issue 4 - Flight deck door automatic locking system MMEL</u>	<u>7</u>
<u>Safety Issue 5 - Oxygen generators shifted from installed positions</u>	<u>8</u>
<u>Safety Issue 6 - Portable oxygen bottle masks take too long to don</u>	<u>10</u>
<u>Safety Issue 7 - Portable oxygen bottles not reachable from jumpseats</u>	<u>12</u>
<u>Safety Issue 8 - Deployed oxygen masks are not immediately available to all occupants</u>	<u>13</u>
<u>Safety Issue 9 - Risk of attempting to manually deploy oxygen masks from the aisle</u>	<u>17</u>
<u>Safety Issue 10 - Expected communications from the pilots to the cabin did not occur</u>	<u>21</u>
<u>Safety Issue 11 - QRC was not available following the Alaska 1282 depressurization</u>	<u>23</u>
<u>Safety Issue 12 - Communication to passengers from pilots and Flight Attendants</u>	<u>24</u>
<u>Safety Issue 13 - Pilot inability to communicate using full-face oxygen mask</u>	<u>25</u>
<u>Safety Issue 14 - Pre-recorded announcement not heard by everyone in the cabin</u>	<u>27</u>
<u>Safety Issue 15 - Shouting commands while on oxygen</u>	<u>28</u>
<u>Safety Issue 16 - In-flight communication from cabin crew to ground staff</u>	<u>29</u>

Safety Issue 1 - System for equalization of pressure may be inadequate

The damage to the sidewalls and window panels may indicate the system for equalization of cabin pressure between the cargo compartment and passenger cabin is inadequate. In a decompression with a greater pressure differential, this could result in damage to the cabin floor and flight control hardware and wiring, which transit the area beneath the floor. The three cargo compartment ceiling relief panels failed to open even though the opening in the fuselage caused by the departure of the door plug was nearly twice the size the aircraft was certified to withstand. The pressure differential was 5.73 psi when this occurred, but would have been 8.35 psi had this happened at 37,000 feet.

Recommendation

The FAA should review and revise the certification of the 737 MAX series to ensure that rapid decompressions will not result in damage to critical flight control systems that transit the area beneath the cabin floor.

Discussion

The decorative sidewall panels contain window openings and extend from the overhead bins to about the seat bottom cushion level of the cabin. The ventilation panels extend from the bottom of the sidewall panels to the cabin floor. During normal operation, air flows into the cabin from the ceiling and PSU gasper vents and out through the ventilation panels in the lower cabin area. There are plugs that allow for the controlled equalization of air pressure in a decompression. Should the cabin depressurize, the plugs release to allow air to flow up from the cargo compartment and into the cabin. If the cargo compartment depressurizes, the plugs release to allow air to flow down from the cabin into the cargo area. This protects the floor's structure. The ventilation panels described above should accommodate the rapid airflow that occurs when the air pressure equalizes between the cabin and cargo compartment.

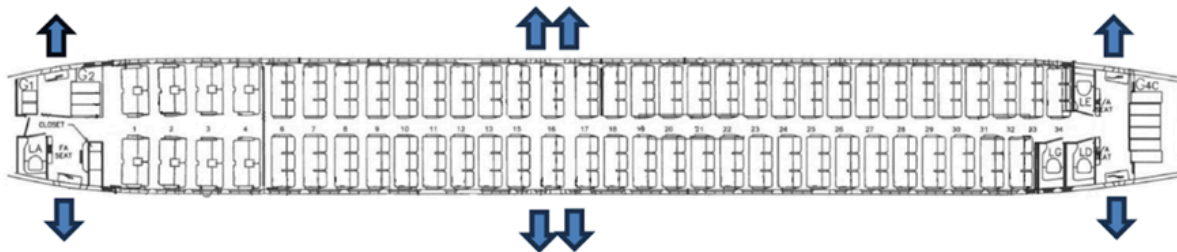


Figure 1. Interior configuration of N704AL. [Source: Alaska Airlines]

Alaska Airlines Flight 1282 (Alaska 1282) suffered a low altitude depressurization, yet individual sidewall panels located above the ventilation panels show displacement into the cabin. For example, the sidewall panels at row 4 left moved 1 cm to 4 cm from their mounted positions, and the sidewall panels at rows 30-32 right separated up to 2 cm from their mounted positions. There were a few other sidewall panels at row 10 right that also showed movement.

We do not know why these panels were partially separated from their mounted positions, but they were near or above the forward and aft cargo compartments. The Structures Group

confirmed that the plugs did open in the cargo compartments and allowed air to vent into the cabin, but has not yet provided the plugs' locations to the Survival Factors Group.

It is also worth noting that the forward ventilation panel end-fitting at row 1 right and the aft ventilation panel end-fitting behind row 32 left blew out/dislodged into the cabin aisle. We were fortunate that no one (to our knowledge) was injured when these panels blew out. We do not think these panels should perform this way in a decompression.

Following the American Airlines DC-10 cargo compartment depressurization over Windsor Ontario, Canada (AA96 12 June 1972), the floor partially collapsed into the cargo area and damaged flight cables. The Turkish Airlines DC-10 accident in Paris (TK981 3 March 1974) had the same issue and, in that case, the collapsed floor severed flight controls. In both accidents, the cabin did not vent quickly enough to protect the floor from the depressurization of the cargo compartment.

In a decompression with a greater pressure differential (at a higher altitude than Alaska 1282), we are concerned that inadequate venting could result in damage to the floor and flight control hardware and wiring, which transit the area beneath the floor.

Safety Issue 2 - Interior damage caused by flight deck door opening during decompression

Both the flight deck and the lavatory doors were damaged when the flight deck door blew open during the decompression. This resulted in the lavatory door being jammed shut.

Recommendation

The FAA should review and revise its standards to ensure the flight deck and lavatory doors do not sustain damage in a decompression. A door stop or snubber on the flight deck frame/door could be installed to prevent the flight deck door from striking the lavatory door with such force. Analyses should also be conducted to determine whether the floor plate mounted inside the flight deck door significantly restricts air movement from the flight deck to the cabin during a cabin decompression.

Discussion

On the floor threshold of the 737 MAX flight deck, there is a plate mounted inside the door sill that appears to be about 1 cm in height and runs the entire width of the flight deck door opening.

The plate on the floor may have interrupted the airflow under the door from the flight deck into the cabin, possibly increasing the force sufficiently to cause a violent opening of the flight deck door, the impact of which caused the forward lavatory door (LAV A) to jam into its frame. This floor plate is not installed on the B737 NG aircraft and may be an enhanced security item added to the 737 MAX. AFA questions whether any analysis or testing has been done to verify that its presence did not create a safety risk by the reduction of airflow following a decompression.



Figure 2. Photograph of entry to flight deck from cabin looking into the flight deck. The striped metal plate was added to the 737 MAX but is not present on the 737 NG.

Safety Issue 3 - Flight deck door behavior during cabin decompression is unknown

The function of the 737 MAX series flight deck door in a decompression was apparently unknown to the regulator, manufacturer, and operators prior to this accident. The fact that the flight deck door opens during a cabin decompression and the latching mechanism becomes disabled was not expected by the crew.

Recommendation

As soon as possible, Boeing should provide operators, NTSB, and FAA with the design specifications and expected functioning of the flight deck door and decompression panels during decompressions on aircraft certified in the past 15 years, including the 787, 777, and 737 MAX series. Subsequently, operators must update emergency procedures, manuals, and training to reflect this information. A review of the MMEL and other related design materials must be accomplished, and any pertinent documents, including flight crew and cabin crew manuals, must be updated. Training for crew members and maintenance personnel must also be updated.

Discussion

In the case of the 737 MAX series aircraft, incorrect flight deck door design and functioning information placed crews at risk in the event of a decompression. AFA is concerned about this issue as it appeared both the FAA and Boeing were unaware of the design and functionality of the new door. Those who approved the Master Minimum Equipment List (MMEL), as well as other stakeholders, also seemed unaware of the function of the flight deck door and made decisions based on inaccurate information. The flight deck doors on other Boeing aircraft (e.g., the 787 and 777), which were certified about the same time as the 737 MAX series, should also be reviewed to ensure their function in a decompression is known and correctly documented.

Safety Issue 4 - Flight deck door automatic locking system MMEL

The [737 MAX MMEL](#) was apparently drafted assuming that the aircraft's flight deck door functioned the same as the 737 NG flight deck door in a decompression. The 737 NG has panels that will open into the flight deck or into the cabin, depending on the location of the depressurization. Following the January 5, 2024, Alaska 1282 rapid decompression accident, it was discovered that the 737 MAX FDD functions differently; it is designed to swing open into the cabin to equalize pressure. As stated on p. 3 of the DCA24MA063 accident investigation preliminary report, the flight crew noted that the "flight deck door was blown open."

Recommendation

The 737 MAX Flight Deck Door Automatic Locking System MMEL relief should be revoked and or limited to unpressurized flights only. If similar unacceptable risks exist on other certified Boeing aircraft, they should also be promptly identified and mitigated.

Discussion

The 737 MAX flight deck door includes metal plating not found on the 737 NG flight deck door, which adds weight to the door. There is also a floor brace to prevent the door from being forced into the flight deck. The additional weight of the door and the lack of airflow under the door affect the force of the door's opening in a decompression.

The 737 MAX MMEL 52-51-01 allows dispatch of the 737 MAX 8/9 with the Flight Deck Door Automatic Locking System inoperative if the door deadbolt operates normally and is used to lock the door. This has been a Category A item (2 flight days) since 7/22/24 (6 months after the Alaska 1282 accident); in [the previous revision](#), it was a Category C item (10 calendar days).

If the flight deck door is locked with a deadbolt and a cabin depressurization occurs, the door is unlikely to swing open as designed; instead, the pressure differential forces would be exerted onto the door hinges and deadbolt. In this scenario, to equalize pressure, the hinges and/or deadbolt may fail, which could result in a violent door separation and possible injuries to crew and/or passengers from flying debris.

Safety Issue 5 - Oxygen generators shifted from installed positions

Following the Alaska 1282 accident, it was observed that oxygen generators in all but two passenger service units (PSUs) had shifted within their positioning cradles. Boeing received at least two prior reports of 737 MAX chemical oxygen generators shifting. One report was on April 19, 2023, and stated that 34 of 60 PSU chemical oxygen generators had migrated on a 737 MAX. The same operator disclosed that on December 12, 2023, another aircraft was found to have 45 of 60 PSU chemical canisters shifted out of position. The first aircraft was built in November 2022, and the second aircraft was built in July 2023.

Unfortunately, Boeing's safety risk assessment (SRA) conducted after receiving these reports did not result in any changes or notifications to operators. As a result of the investigation of Alaska 1282, these failures became widely known, and an FAA airworthiness directive (AD-2024-00252-T) was subsequently issued requiring operators to verify that oxygen generators have not shifted out of position in PSUs.

However, AFA is concerned that other aircraft manufacturers (Airbus, Embraer, etc.) may have purchased and used the same type of pressure-sensitive adhesive (PSA) thermal pad to secure oxygen generator cradles in their aircraft.

Recommendation

The FAA should review and revise its standards to ensure that passenger supplemental oxygen systems are designed, tested, inspected, and maintained to ensure that they do not shift from installed positions during normal operations or due to forces generated by decompressions.

The FAA should verify whether other commercial aircraft companies have installed pressure-sensitive pads in their passenger service unit oxygen generator systems similar to those installed by Boeing in the Alaska 1282 accident aircraft. The FAA should contact the PSA manufacturer and verify that all companies that purchased these pads perform inspections and any needed replacements of these PSA pads on commercial aircraft.

Additionally, Information about defects and other issues should be shared immediately and transparently with all operators and industry stakeholders upon discovery; Safety Management Systems (SMS) should focus on risk reduction, not risk acceptance.

Discussion

Boeing has failed to supply operators with critical, detailed information about certain 737 MAX aircraft systems that may result in accidents or safety risks. Examples we know of include the Maneuvering Characteristics Augmentation System (MCAS), flight deck door response in a decompression, and chemical oxygen generator migration. Investigations of various 737 MAX accidents and incidents have been referred to as "Easter egg hunts," filled with surprises. Boeing's representatives were surprised to learn how the flight deck door would function in a cabin decompression. It appears the door's contract manufacturer did not update the information shared with Boeing's flight operations division.

In the case of Alaska 1282, most oxygen canisters had migrated out of the front stainless-steel strap, and a few canisters were barely held by the aft stainless-steel strap. The tension of the device's firing pin could have caused premature activation. Most firing systems allow very little play; instead of a passenger or crew member pulling the mask to remove the firing pin from the canister, migration out of the strap could have activated the generator. This would have resulted in no oxygen being available in a decompression.

Another concern is that other aircraft with oxygen generator canisters may be at risk of migrating out of their mounted positions and causing accidental activations. If this were to happen, possible safety risks include hidden inflight fires or a lack of oxygen when needed by a passenger or crew member.

Safety Issue 6 - Portable oxygen bottle masks take too long to don

Use of the disposable masks provisioned by Alaska Airlines on the Portable Oxygen Bottles (POBs) is not intuitive, and they are difficult to access and don. Flight Attendants depend on quick access and use of the POBs to perform required emergency procedures, including ensuring pilot consciousness. As of the date of this submission Alaska Airlines had not replaced these masks with the alternate “cup” design used for the passenger oxygen system.

Recommendation

The FAA should review and revise its standards to ensure POB masks for Flight Attendant use are designed and tested for ease of use and quick donning.



Figure 3. POB mask in sealed package

Discussion

During the Alaska 1282 accident, the B Flight Attendant was able to remove the aft POB from its stowage brackets easily but was unable to open the mask packaging. He went to the aft galley, where both he and the C Flight Attendant struggled to open the mask packaging. Once removed, they experienced difficulties in opening and donning the mask because it was folded with outer edges toward its center (in thirds). The Flight Attendants reported that the time required for these steps significantly exceeded the time required to access the mask from the zip lock bag used in recurrent or initial training.

During training, the bag is open, so the mask package used in training does not replicate the force or method needed to open the mask packaging on the airplane. Additionally, the mask on the aircraft was sticking to itself (plastic on plastic), unlike the masks used in training (possibly due to repeated use). The forward Flight Attendants stated they had no issue removing the POB

from the forward equipment stowage compartment, but it took both of them working together to rip open the mask packaging. They then described having difficulties opening and donning the mask. The D Flight Attendant felt time was an issue (because of an unaccompanied minor in row 7), so she instead just held the mask over her nose and mouth rather than donning it properly.

Safety Issue 7 - Portable oxygen bottles not reachable from jumpseats

Portable oxygen bottles (POBs) are not installed close enough for seated and secured Flight Attendants to reach while wearing the supplemental oxygen masks located at jumpseats.

Recommendation

The FAA should review and revise its standards to ensure that a POB for Flight Attendant use is accessible from the jumpseat. The Flight Attendant should be able to reach and remove the POB from its stowage bracket.

POBs should be mounted so that they do not obstruct dedicated assist space for exit door operation or slide inflation, nor above a jumpseat unless encased in structure to prevent falling onto a seated occupant if means of securing the portable oxygen bottle should fail.

Discussion

POBs should be located close to the Flight Attendant jumpseats, and within three feet as is required for portable breathing equipment (PBE), also known as smoke hoods, and Halon extinguishers. In the Alaska 1282 accident, the POBs in the forward equipment storage were readily accessible to both forward Flight Attendants while they were seated on their jumpseats. However, the aft Flight Attendants could not reach the closest POB or the PSU in the last row of passenger seats while wearing masks that dropped from the PSUs above their jumpseats.

Safety Issue 8 - Deployed oxygen masks are not immediately available to all occupants

The introduction of push-up stowage bins on single-aisle aircraft caused the placement of supplemental oxygen compartments to be moved further outboard near the window seat area from the standard center-mounted oxygen compartments seen on shelf-style overhead bin stowage. Each compartment contains one oxygen mask per seat, and in some cases, there is an additional mask for lap-held children.

The regulations do not appear to have considered the need for passengers and crew standing in the aisle to reach and acquire an oxygen mask. Passengers today spend considerable time waiting for a lavatory in lines that are often five to ten deep on longer flights. It is also likely that more infants are flying now than when the regulations were created, and lap children also reduce the number of available spare oxygen masks.

Recommendations

Ensure that oxygen masks are available for crew or passengers standing in the aisle of aircraft equipped with passenger oxygen masks that cannot reasonably be reached from the aisle.

For single-aisle aircraft, cabins with push-up bins with the oxygen passenger service unit positioned with a reach equal to or greater than 30 inches from the aisle armrest to the middle of the oxygen compartment should be equipped with oxygen masks positioned in the center aisle distributed throughout the cabin to meet the anticipated needs of passengers and crew.

Discussion

14 CFR 25.1447 requires airplanes with pressurized cabins expected to fly at or above 10,000 feet to have a source of supplemental oxygen immediately available to every person in the cabin in the event of decompression. (See 4.3.1 page 21 of 56 of the Survival Factors report for more information)

14 CFR 25.1447 also requires airplanes certified to fly in excess of 25,000 feet to be equipped with extra masks throughout the cabin, equal to at least 10 percent more masks than seats. When this regulation was written, most commercial aircraft were equipped with hat racks above the passenger's seats. The hat rack was designed for lightweight objects such as pillows, blankets, coats, and hats. For manufacturers of aircraft that normally cruise above 25,000 feet, retrofitted oxygen systems meet the above-mentioned requirements in two ways: 1) Installed into the seat backs (DC-8 & DC-10), or 2) mounted to the underside of the hat rack (707, 727, 737, DC-9). The hat rack mountings were centered over the middle seats. This design was based on the thought that everyone seated in the row would use the oxygen masks provided.

The regulation was apparently intended to supply oxygen masks for persons seated in the row and not those who were standing in the aisle, such as crew or passengers waiting to use the lavatories. Airlines modified the intent into procedures and training for Flight Attendants to use spare masks to meet the requirement for oxygen to be available to all occupants. The design allowed someone in the aisle to reach over the aisle seat and grab a mask from the center seat location. When manufacturers replaced hat racks with shelf-style bins, the oxygen system remained on the lower face of the shelf and centered over the middle seat. On the 737 NG with

shelf-style bins the distance from the aisle armrest to the center of the oxygen compartment is 34 inches in the main cabin.

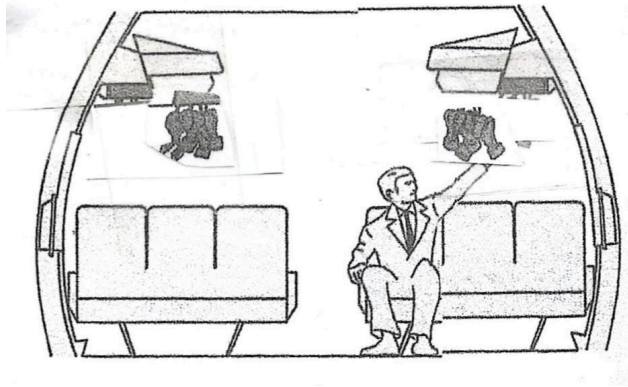


Figure 4. Oxygen mask location on single-aisle aircraft with shelf-style bins

However, Boeing introduced the “Boeing Sky Interior” for the 737 NG with push-up bins; these were also installed on 737 MAX aircraft. The push-up bin design on single-aisle aircraft required the oxygen mask compartment to be moved outboard closer to the window seat, increasing its distance from the aisle. In 737 aircraft with push-up bins, the distance from the aisle armrest to the center of the oxygen compartment is 43 inches in most of the main cabin. This is 10” farther from the aisle than in 737s with shelf-style bins. Crew and passengers in the aisle now have to reach over two seats to obtain the spare oxygen mask above the window seat. This design change did not result in a change to airline procedures even though the distance increased such that most individuals would no longer be able to reach an oxygen mask when standing in the aisle.

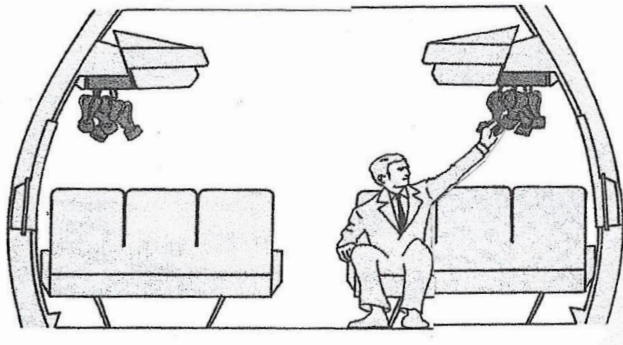


Figure 5. Oxygen mask location on single-aisle aircraft with push-up bins.

On Alaska 1282, both the B and C Flight Attendants reported they could not reach the deployed oxygen masks from the passenger’s PSU due to excessive distance. The C Flight Attendant reported she mimed to the passengers in one row to give her a mask as she held the mask from the row behind on her nose and mouth. They could not understand her request even though she was shouting through the mask she held to her face. She gave up and dashed several rows forward to an available mask.

Time of useful consciousness is as little as 10 to 15 seconds for a Flight Attendant at higher altitudes, but luckily, they were at 16,000 feet, and she could go longer without oxygen. Both the C and D Flight Attendants reported attempting to move without oxygen, and both described the effects of hypoxia and returned to using the masks.

A sample of Flight Attendants' reach measured by AFA staff, from the center of the palm to the armpit, yielded an average of 22". This sample included all seniorities and two Flight Attendant qualified managers. It is assumed that the majority of passengers in the aisle would similarly be unable to reach the oxygen masks on the aircraft with push-up bins.

A small survey of four flight segments to and from Hawaii with flight times of six hours or greater found there were five or more people standing in the aisle waiting for the lavatories on several different occasions during the flight, and on two of the flights, there were multiple instances when more than ten people were lined up in the aisle at the aft of the cabin. These individuals would require the use of the spare masks over the window seats to remain conscious during a loss of cabin pressurization. However, most would not be able to reach them from the aisle. These long lavatory lines are a common occurrence on Alaska Airlines flights.

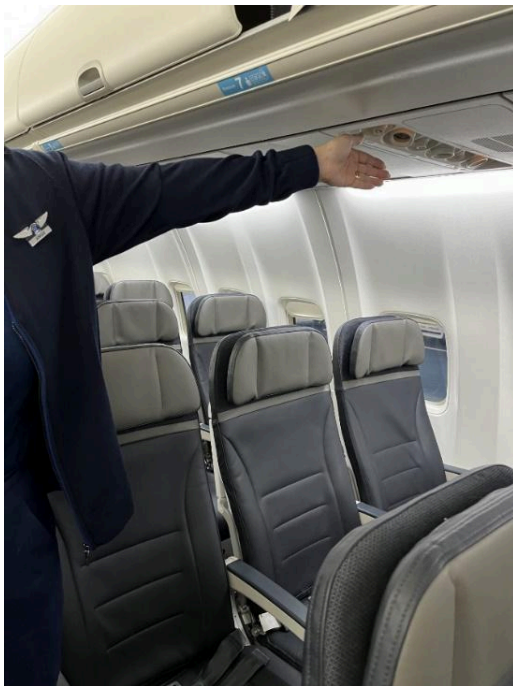


Figure 6. Reach from the aisle in premium class located in the main cabin of a 737 with shelf-style bins. Distance from the aisle armrest to the center of the oxygen mask compartment in the main cabin is 34", and the average measured Flight Attendant reach is 22".



Figure 7. Reach from the aisle in premium class located in the main cabin of a 737 with push-up bins (a piece of blue tape marks the center of the oxygen compartment). Distance from the aisle armrest to the center of the oxygen mask compartment in the main cabin is 43", and the average measured Flight Attendant reach is 22".

Safety Issue 9 - Risk of attempting to manually deploy oxygen masks from the aisle

If there is no indication that the aircraft is descending, the *Flight Attendant Manual* (FAM) requires Flight Attendants to walk through the cabin to ensure all passenger masks are deployed and donned following a decompression. However, in the event of a rapid decompression, where there may be significant damage to the aircraft, having secured Flight Attendants get up and move through the cabin may create an unacceptable risk to operational safety. This procedure introduces a high risk of hypoxia and injury and could compromise a Flight Attendant's ability to evacuate an aircraft.

The inability of a person standing in the aisle to reach and manually deploy the oxygen masks on 737s with the push-up bins is an additional concern when conducting post-decompression checks. We have also observed that even on aircraft with shelf-style overhead bins, where the oxygen masks are 10" closer to the aisle, it is difficult to reach and manually deploy the oxygen masks.

FAA regulations require that Alaska Airlines Flight Attendants drill on manually opening oxygen mask compartments at least once every twenty-four months. However, Alaska Airline's training devices do not accurately represent one's ability to reach and release the oxygen mask located in the passenger service units (PSUs) from the aisle when passengers and passenger seats are present.

If there is No Sign of Descent

- Contact the pilots
 - If the pilots are not reachable, the F/A closest to the F/D should don nearest POB
 - If necessary, move from mask to mask (using extra mask in PSU) to obtain and don a POB
 - Enter the F/D to check that the pilots are on oxygen and taking necessary actions (see [5.400, Emergency Access \(pilot incapacitation\)](#))
 - Relay information to other F/As
- Release any unopened PSU compartments
 - Move from mask to mask (using extra mask in PSU) to obtain and don nearest POB

Note: When moving from mask to mask, hold mask over nose and mouth, inhale before proceeding to next mask.

Figure 8. Alaska Airlines FAM, Decompression 2.200 page 4 dated 8/22/24

	Flight Attendant Manual	Decompression Section: 2.200 Page: 5 Date: 8/22/24
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- Ensure passengers are using oxygen masks correctly and oxygen is flowing
 - Instruct passengers with POCs/MPEDs to use PSU fixed oxygen masks

Note: All POBs may be used to zero in a decompression.

Once A/C Has Levelled Off

Figure 9. Alaska Airlines FAM, Decompression 2.200 page 5 dated 8/22/24

During the Alaska 1282 accident, the Flight Attendants attempted to verify passengers were using oxygen masks and that mask compartments were open. Two of the Flight Attendants reported symptoms of hypoxia even when attempting to take oxygen from passenger masks or portable oxygen bottles.

The priority for cabin crew during a decompression should be to obtain oxygen and remain seated. This was not stressed during their training, and all four voiced concerns about disregarding their oxygen needs to assist passengers when they determined that the aircraft had failed to descend rapidly.

Recommendation

The FAA should provide guidance to operators to ensure that rapid decompression emergency procedures call for Flight Attendants to remain secured in place or, if possible, be seated and wearing appropriate restraints until landing.

Additionally, the FAA should ensure crew training devices are representative of the aircraft operational environment.

Discussion

In many detailed ways, training devices significantly differ from the “real” aircraft environment. For example, all recurrent training facilities have similar training devices to simulate the manual opening of oxygen mask compartments. Students reach up and insert the open end of a paperclip into the pinhole to open the oxygen compartment in the PSU. However, the student is significantly closer to the PSU than a Flight Attendant would be in an actual aircraft cabin.



Figure 10. Training device used to simulate manual opening of oxygen mask compartments.



Figure 11. Actual reach to the manual release pinhole used to release the oxygen mask in a 737 with push-up bins (pinhole indicated by blue tape).



Figure 12. Actual reach to the manual release pinhole used to release the oxygen mask in a 737 with shelf-style bins (pinhole indicated by blue tape).



Figure 13. Training device with a row of seats which is more representative of the actual aircraft environment. Note that this does not demonstrate the additional restrictions caused by seat pitch or occupied seats.

Safety Issue 10 - Expected communications from the pilots to the cabin did not occur

Although the pilot procedures appear to have the necessary steps, their use did not result in expected communications from the pilots to the cabin.

Recommendation

The FAA should ensure that the Flight Attendant and pilot procedures following a rapid depressurization lead to an effective and coordinated response.

Discussion

The cabin did not receive an announcement from the pilots telling all occupants to don oxygen and fasten seatbelts; this should have happened prior to the emergency descent. The Flight Attendants were also not notified once supplemental oxygen was no longer necessary.

For reference, Alaska Airlines has two sources of checklists available in the flight deck: the *Quick Reference Checklist* (QRC), which is a folded laminated placard (Figure 14), and the *Quick Reference Handbook* (QRH), which is bound and on the pedestal (Figure 15). Both contain “Rapid Depressurization” and “Emergency Descent” checklists. The QRC is intended for quick access and contains immediate steps, while the QRH contains additional details not listed in the QRC.

737MAX QUICK REFERENCE CHECKLIST		737MAX QUICK REFERENCE CHECKLIST	
Aborted Engine Start 1 Before Start Lever raised to IDLE: START Switch OFF ■ ■ ■ ■ 2 After Start Lever raised to IDLE: Start Lever CUTOFF See QRH - E1.5 Engine Tailpipe Fire 1 Start Lever CUTOFF See QRH - E1.10 ENGINE OVERHEAT ENG 1 OVERHEAT ENGINE OVERHEAT ENG 2 OVERHEAT 1 Autothrottle (if engaged) Disengage 2 Thrust Lever (affected engine) Confirm Retard until engine indications stay within limits or the thrust lever is closed 3 If the ENG OVERHEAT light stays illuminated: ▶ Go to the ENGINE FIRE, Severe Damage or Separation QRC checklist below ■ ■ ■ ■ See QRH - E1.8 ENGINE FIRE, Severe Damage or Separation 1 Autothrottle (if engaged) Disengage 2 Thrust Lever (affected engine) Confirm Close 3 Start Lever (affected engine) Confirm CUTOFF 4 Engine Fire Switch (affected engine) Confirm Pull 5 If the Engine Fire Switch or ENG OVERHEAT light is illuminated: Engine Fire Switch (affected engine) ... Rotate to the stop and hold for 1 second See QRH - E1.1 Loss of Thrust on Both Engines 1 At or above FL270, set airspeed to 275 kts. Below FL270, set airspeed to 300 kts. 2 START Switches (both) FL 3 Start Levers (both) CUTOFF 4 When EGT decreases: Start Levers (both) IDLE detent 5 If EGT reaches a redline or there is no increase in EGT within 30 seconds: Start Lever (affected engine) Confirm CUTOFF Start Lever (affected engine) then IDLE detent If EGT again reaches a redline or there is no increase in EGT within 30 seconds, repeat as needed while continuing the remainder of the checklist. 6 Engines can accelerate to idle very slowly, especially at high altitudes or in heavy precipitation. If N2 is steadily increasing and EGT stays within limits, do not interrupt the start. Do not wait for successful engine start(s) before starting the APU. 7 APU (if available) START & ON buses See QRH - E1.11		Engine Limit / Surge / Stall 1 Autothrottle (if engaged) Disengage 2 Thrust Lever (affected engine) Confirm Retard until engine indications stay within limits or the thrust lever is closed See QRH - E1.6 APU FIRE 1 APU Fire Switch Confirm Pull & Rotate 2 APU Switch OFF See QRH - E2.1 Lower Compartment CARGO FIRE PWD Lower Compartment CARGO FIRE APT 1 CARGO FIRE ARMED Switch Push, verify ARMED 2 CARGO FIRE DISCH Switch Push and hold for 1 second 3 RECIRC FAN Switches (both) OFF See QRH - E2.1 WHEEL WELL WHEEL WELL FIRE 1 270K/82M maximum. 2 Landing Gear Lever DN See QRH - E2.3 Smoke, Fire or Fumes in Passenger Cabin or Flight Deck Caution! A diversion may be needed. 1 Oxygen Masks & Regulators (if required) ON, 100% 2 Smoke Goggles (if required) ON 3 Crew Communications Establish 4 RECIRC FAN Switches (both) OFF 5 HGS (if available) Set See QRH - E3.1	
		Runway Stabilizer 1 Control Column Hold firmly 2 Autopilot (if engaged) Disengage 3 Autothrottle (if engaged) Disengage 4 Control Column and Thrust Levers Control aircraft pitch attitude and airspeed 5 Main Electric Stabilizer Trim Reduce control column forces 6 If the runaway stops after autopilot is disengaged: Do not re-engage autopilot or autothrottle. ■ ■ ■ ■ 7 If the runaway continues after the autopilot is disengaged: STAB TRIM outout switches (both) CUTOFF If the runaway continues: Stabilizer Trim Wheel Grasp & Hold See QRH - E4.1 CABIN ALTITUDE CABIN ALTITUDE WARNING or Rapid Depressurization 1 Oxygen Masks & Regulators ON, 100% 2 Crew Communications Establish 3 Pressurization Mode Selector MAN 4 Outflow VALVE Switch Hold in CLOSE until outflow VALVE indicates fully closed 5 If cabin altitude is uncontrollable: Seat Belt ON If the cabin altitude exceeds or is expected to exceed 14,000 ft: PASS OXYGEN Switch ON ▶ Go to the Emergency Descent QRC checklist below ■ ■ ■ ■ See QRH - E5.1 Emergency Descent 1 Emergency Descent Announce Advise the Cabin Crew, on the PA System, of the impending rapid descent using one of the following choices: "Ladies and Gentlemen, pull and use your oxygen masks and fasten your seat belt please." or "Ladies and Gentlemen, please fasten your seat belts." 2 Seat Belt ON 3 Without delay, descend to the lowest safe altitude or 10,000 ft, whichever is higher. 4 START Switches ON 5 Thrust Levers Reduce thrust to minimum or as needed for anti-ice 6 Speed Brake FLIGHT DETENT 7 If structural integrity is in doubt, limit speed as much as possible and avoid high maneuvering loads. 8 Target Speed Mmo/Vmo 9 ATC Advise Note: If unable to establish immediate communications with ATC, squawk 7700. See QRH - E5.3	
		LANDING CONFIGURATION 1 Ensure proper aircraft landing configuration. ■ ■ ■ ■ Airspeed Unreliable 1 Autopilot (if engaged) Disengage 2 Autothrottle (if engaged) Disengage 3 F/D Switches (both) OFF 4 Set the following gear up pitch attitude and thrust: Flaps Extended 10° and 80% N1 Flaps Up 4° and 75% N1 See QRH - E6.1 Passenger Evacuation On the Captain's command, FO read, Captain do. 1 Parking Brake Set 2 Speed Brake DOWN 3 Flap Lever 40 4 Pressurization Mode Selector MAN 5 Outflow VALVE Switch Hold in OPEN until the outflow VALVE position indicates fully open 6 If time allows, verify that the flaps are 40 before the Start Levers are moved to CUTOFF. 7 Start Levers (both) CUTOFF 8 Advise the cabin to evacuate: Use the PA to initiate evacuation by announcing: "EVACUATE, EVACUATE" 9 Advise the tower. 10 Engine and APU Fire Switches (all) Override & pull 11 If an engine or APU fire warning is observed or indicated: Illuminated Fire Switch Rotate to the stop and hold for 1 second See QRH - E6.8 Time permitting, see QRH - E6.8	

Figure 14. 737 MAX Quick Reference Checklist (QRC)

Alaska. EMERGENCY E5.1	E5.2 EMERGENCY Alaska.	Alaska. EMERGENCY E5.3
CABIN ALTITUDE WARNING or Rapid Depressurization CABIN ALTITUDE Condition: One or more of these occur: • A cabin altitude exceedance • In flight, the intermittent Cabin Altitude / Configuration Warning Horn sounds or a CABIN ALTITUDE light illuminates at an aircraft altitude above 10,000 ft MSL. Note: The warning horn may be silenced by pressing the ALT Horn Cutout switch on the forward overhead panel. 1 Oxygen Masks & Regulators ON, 100% 2 Crew Communications Establish 3 Pressurization Mode Selector MAN 4 Outflow VALVE Switch Hold in CLOSE until outflow VALVE indicates fully closed 5 If cabin altitude is uncontrollable: Seat Belt ON If the cabin altitude exceeds or is expected to exceed 14,000 ft: PASS OXYGEN Switch ON ▶▶ Go to the Emergency Descent checklist on page E5.3 Continued from QRC 6 If cabin altitude is controllable: Continue manual operation to maintain correct cabin altitude. When the cabin altitude is at or below 10,000 ft: Oxygen masks may be removed. 7 Checklist Complete Except Deferred Items. Accomplish Approach Setup and Briefing (TPC). Descent Checklist Recall Checked ▲ PMC Route Verified R/L ▲ Landing Data VREF ____ Minimums ____ ▲ (RNAV) RNP Value ____ Set Continued on next page	▼ CABIN ALTITUDE WARNING or Rapid Depressurization continued ▼ ▲ Pressurization Move outflow VALVE switch to OPEN or CLOSE as needed to control cabin altitude and rate Note: Use momentary actuation of the outflow VALVE switch to avoid large and rapid pressurization changes. START Switches ON Approach Checklist Altimeter ____ Seat Belt ON PA Complete At Pattern Altitude Outflow VALVE Switch . . . Move to OPEN until outflow VALVE indication shows fully open to depressurize the aircraft Landing Checklist Speed Brake Armed, Green Light Gear Down, 3 Green Flaps ____ Green Light ■■■■■ LANDING CONFIGURATION Condition: In flight, the steady warning horn sounds. 1 Ensure proper aircraft landing configuration. ■■■■■	Emergency Descent Condition: One or more of these occur: • Cabin altitude cannot be controlled when the aircraft is above 14,000 ft • A rapid descent is needed Note: If the Cabin Altitude Warning Horn sounds, it may be silenced by pressing the ALT Horn Cutout switch on the forward overhead panel. 1 Emergency Descent Announce Advise the cabin crew, on the PA System, of the impending rapid descent using one of the following choices: "Ladies and Gentlemen, pull and use your oxygen masks and fasten your seat belt please." or "Ladies and Gentlemen, please fasten your seat belts." 2 Seat Belt ON 3 Without delay, descend to the lowest safe altitude or 10,000 ft, whichever is higher. 4 START Switches Reduce thrust to minimum or as needed for anti-ice 5 Thrust Levers FLIGHT DETENT 6 Speed Brake If structural integrity is in doubt, limit speed as much as possible and avoid high maneuvering loads. 7 Target Speed Mmo/Vmo 8 ATC Advise Obtain the area altimeter setting and minimum safe altitude. Note: If unable to establish immediate communications with ATC, squawk 7700. Note: Transition level for oceanic flight is 5500 ft. Continued from QRC Note: If in the Gunnison, CO (KGUC) area, see guidance on next page. 9 When approaching the level off altitude: Smoothly lower the Speed Brake Lever to the DOWN detent and level off. Add thrust and stabilize on altitude and airspeed. 10 Crew Oxygen Regulators NORMAL Flight Crew must use oxygen when cabin altitude is above 10,000 ft. To conserve oxygen, position the NORMAL/100% selector to NORMAL. 11 Advise the cabin crew when the aircraft is at a safe altitude and oxygen masks may be removed. 12 START Switches ON / OFF 13 The new course of action is based on weather, terrain, obstacles, oxygen, fuel remaining and available airports. Use of long range cruise may be needed. ■■■■■
12/19/22 737MAX QRH E5.1	E5.2 737MAX QRH 12/19/22	12/19/22 737MAX QRH E5.3

Figure 15. Rapid Depressurization Quick Reference Handbook (QRH).

Safety Issue 11 - QRC was not available following the Alaska 1282 depressurization

Following the depressurization of Alaska 1282, both the flight deck and the cabin experienced a rapid air exchange which caused objects to be displaced. In particular, the *Quick Reference Checklist* (QRC) became airborne and was not available to the pilots. As a workaround, the captain immediately passed the *Quick Reference Handbook* (QRH) to the first officer.

Fortunately, the first officer correctly opened it to the rapid depressurization checklist, which contains the five immediate action items found in the QRC.

Recommendation

To prevent future displacement of the QRC during a decompression or nose-up stall condition, install a means, such as a Velcro strap on the stowage box, to prevent shifting and ensure that the checklist is immediately accessible to the pilots.

Safety Issue 12 - Communication to passengers from pilots and Flight Attendants

During the Alaska 1282 accident, crew and passengers expressed confusion related to who was speaking and who was relaying critical information.

Recommendation

Alaska Airlines should institute a policy for Flight Attendants to identify themselves at the beginning of any emergency announcements, and the importance of this procedure should be emphasized in Flight Attendant training.

Discussion

On Alaska 1282, both males and females worked in the pilot and Flight Attendant positions; one male and one female pilot were on the flight deck, and two male and two female Flight Attendants were in the cabin.

Historically, Alaska Airlines pilots have started their announcements by stating, "This is your captain or first officer speaking." However, this is not the case for Alaska Airlines Flight Attendants, who rarely start their announcements by informing passengers that the information they are about to hear is coming from a Flight Attendant.

Both forward and aft Flight Attendants were making announcements, and several times, passengers and other Flight Attendants assumed the pilots were making the announcements because they were made in male voices. From the first officer and captain's statements, we know that they did not attempt to make any announcements, and the first officer made no attempt to speak via the interphone with the Flight Attendants. Therefore, all female voices on the communication system were Flight Attendants. Had the first officer made an announcement without stating who was speaking, the cabin occupants may have assumed it was a Flight Attendant.

Safety Issue 13 - Pilot inability to communicate using full-face oxygen mask

Despite communications systems remaining fully operable during the Alaska 1282 decompression, they were only successfully used to communicate between the pilots and the ground and between the pilots themselves. The pilots with their oxygen masks donned were unable to use the interphone or public address (PA) systems to communicate with the cabin.

Recommendation

Reimplement the pre-COVID-19 procedure for pilots to don their oxygen masks when the other pilots leave the flight deck above 25,000 feet to enhance familiarity with the operation of the equipment. The pilot training department should also stress the defogging feature of the oxygen mask, which allows fog to be removed without having to take the oxygen mask off during an emergency.

Discussion

Since the 737-200 introduction of a two-person flight deck at Alaska Airlines in 1981, it has been standard operating procedure above 25,000 feet for the pilot remaining in the flight deck to don their oxygen masks when the other pilot left for physiologic needs. This allowed the remaining pilot to immediately aviate and navigate if a decompression occurred. This procedure was above the minimum standard established by the FAA requirements, which only require this when operating 41,000 feet or higher. The procedure permitted routine communication on the interphone while using the donned oxygen mask when the returning pilot would call and request re-entry. Often during the absence of the other pilot, an announcement would need to be made, which was accomplished while wearing the oxygen mask. This routine daily experience kept pilots familiar with its use and prepared should they ever have to use these communication systems while wearing the oxygen mask in an emergency with depressurization, smoke, or fumes.

During COVID-19, Alaska Airlines changed its operating procedures to the FAA minimum requirement. Now, pilots are only required to don the oxygen mask when the other pilot leaves the flight deck, and the aircraft operates above 41,000 feet. COVID-19 protocols are no longer justified; however, the procedure to don an oxygen mask when one pilot is out of the flight deck at 25,000 feet (and higher) has not been reimplemented despite it representing a higher standard of safety. Although this appeared to be a minor change, it removed the muscle memory and proficiency gained from routinely making PAs and speaking on the interphone with other crew members while wearing an oxygen mask.

The inability to communicate with the cabin while wearing the oxygen mask appears to have been caused by a lack of familiarity with, and possibly insufficient training on, the oxygen mask equipment for communications via the cabin interphone and PA systems, including the ability to toggle between oxygen mask and headset microphones. These communications issues were exacerbated by fogging of the oxygen mask.

Oxygen mask fogging is not an uncommon occurrence, due to the cooler stowage container and the warmer flight deck environment when the mask is removed and donned. Condensation will also commonly occur. Momentarily selecting the EMER mode (positive pressure) on the mask's

regulator control will quickly remove the fogging and dry out the condensation, at which point one would return the regulator to 100 percent oxygen.

Safety Issue 14 - Pre-recorded announcement not heard by everyone in the cabin

On Alaska 1282, not everyone in the cabin heard the pre-recorded decompression announcement. The announcement plays only once in English and Spanish for a total of 33 seconds.

Recommendation

The prerecorded announcement that plays following a decompression should be repeated multiple times.

Discussion

Pilots who have quick-don oxygen masks equipped with announcement capability may or may not be in a position to make PA announcements to the cabin (for example, to don oxygen masks) as their priority is to fly the aircraft, navigate, and coordinate with cabin crew on status and plans of action. Flight Attendants who are not necessarily near any communications systems are unable to make announcements safely while wearing the standard oxygen mask supplied in the cabin or galleys. In addition, shouted commands may not be heard or understood by passengers, and AFA is unaware of any documented testing to support the use of such a procedure.

The Survival Factors Group tested the pre-recorded announcement designed to play after a decompression. The system is designed to go to maximum volume throughout the cabin and lavatories. The announcement is about 33 seconds in length. During interviews, some passengers and Flight Attendants reported hearing it, and some did not. The system played as expected during the test.

The announcement is designed to play as the cabin altitude reaches 14,000 feet, cabin lights default to full bright (white), and oxygen masks deploy from overhead PSUs. It appears all functioned as intended, but distractions (e.g., headphones, children, noise from fuselage opening) may have prevented some passengers and Flight Attendants from hearing the announcement. Programmed systems should continue to repeat announcements. This would provide multiple opportunities for the announcement to be heard and understood.

Safety Issue 15 - Shouting commands while on oxygen

During the Alaska 1282 accident, two of the four Flight Attendants did not hear the prerecorded decompression announcement, and no Flight Attendant heard the prescribed pilot announcement, “Ladies and Gentlemen, pull and use your oxygen masks and fasten your seatbelts please.” Therefore, the Flight Attendants were required to shout commands while on oxygen per the *Flight Attendant Manual* (FAM) 2.200, page 3, “Rapid Decompression,” for an unspecified amount of time. Shouting commands while on oxygen during high-altitude flight is not safe due to the threats of hypoxia and possible incapacitation.

Recommendation

Return to a former procedure used at Alaska Airlines, which required Flight Attendants to secure themselves and don oxygen masks during a decompression, but did not have Flight Attendants attempt to shout commands while on supplemental oxygen.

Discussion

Pilots don oxygen masks that are equipped with PA capability and the aircraft has automatic announcements that can be repeated multiple times to ensure all occupants have heard the instructions without placing the cabin crew at risk of incapacitation.

Prior to the 737 MAX being added to the fleet, the procedure for Flight Attendants during decompression was to don the nearest mask and secure themselves. The standard mask used in passenger service units supplies oxygen for 12 minutes after activation by chemical generation. Three liters per minute will flow into the reservoir bag and collect. As the user inhales, a negative pressure occurs, and the reservoir bag is depleted of oxygen. A secondary valve then opens, filling the remaining lung area with cabin ambient air. Three liters is considered adequate to maintain the consciousness of most individuals at higher altitudes with little exertion. Prior to the 737 MAX being added to the fleet, Flight Attendants were to protect themselves and remain on oxygen until a lower flight level was achieved.

The International Air Transport Association (IATA) Standard 16.3.4-5 stipulates that Flight Attendants shout commands after a decompression occurrence or after the prerecorded announcement has played. Commands to be given after a decompression, while on oxygen, are stated in the Alaska Airlines FAM. This makes Alaska Airlines compliant with the IATA standard. (FAM 2.200-page 3 Rapid Decompression) However, shouting commands while on supplemental oxygen and hearing those commands in a noisy, decompressed cabin are difficult at best.

No documentation has been provided to AFA suggesting that the procedure was ever tested under high altitude, hypoxic conditions. Flight Attendants are not necessarily near a PA when a decompression occurs; additionally, shouting commands while wearing a passenger oxygen mask should be assumed unsafe.

Safety Issue 16 - In-flight communication from cabin crew to ground staff

Following the decompression there were ad hoc electronic communications from the Flight Attendants to support staff. This helped the ground staff understand the severity of the accident and improved their ability to respond appropriately. There is no defined procedure or purpose-built tool for Flight Attendants to communicate with ground staff.

Recommendation

Operators should provide a means for cabin crew to communicate directly with the airline's operations center during an emergency. This will ensure accident notifications are timely and support communicating incident severity details, which may not be contained in pilot communications.

This capability should be included in initial and recurrent training programs and should incorporate crew resource management components. Training should focus on communications skills and concise delivery of quality information under simulated stress scenarios, which could be informed by recorded examples of emergency calls such as 911 calls.

Discussion

Crew coordination during the terrorist attacks of September 2001 demonstrated the importance of facilitating communications pathways between cabin crew and ground support staff. Much of the information known about the hijackings is from direct communications between the Flight Attendants aboard each aircraft and ground staff. Unfortunately, even though communications technology has improved significantly over the last 24 years, the use of the latest electronic devices to facilitate crew communications is not integrated into practices and procedures.

Some non-survivable accidents that occurred since September 2001 have included information and details of the flight that were passed on by computers on the aircraft; Air France flight 447 and Egypt Airlines flight 804 are two examples. Much of what we know about Alaska 1282 is from its onboard automatic computer messages sent to the ground since the onboard flight voice recorders were accidentally erased.

Pilots are primarily focused on trying to fly and navigate the airplane. Time and conditions permitting, they are communicating with the ground, but the information they have about the circumstances in the cabin is limited. Flight Attendants are able to provide a more complete picture of events in the cabin to facilitate a more timely and appropriate response.



April 10, 2025

Doug Brazy
Hearing Officer
Office of Aviation Safety
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

Re: Party Submission of Alaska Airlines re: Alaska Airlines Flight 1282;
January 5, 2024; near Portland, Oregon; NTSB Investigation No. DCA24MA063

Dear Mr. Brazy:

As a supplement to Alaska Airlines' ("Alaska") September 6, 2024 initial party submission letter, and following the conclusion of the National Transportation Safety Board's (NTSB) investigative hearing into the incident involving Alaska Airlines Flight 1282 and additional investigative activities, this letter presents Alaska's final proposed findings and proposed probable cause in accordance with 49 C.F.R. § 845.13. We are privileged to submit these proposals and acknowledge the collaborative efforts of the NTSB and the Federal Aviation Administration (FAA) throughout this investigation, which underscore our mutual dedication to aviation safety.

I. Introduction

On January 5, 2024, Alaska Flight 1282, a newly manufactured Boeing 737-9 MAX, registration number N704AL, was scheduled to fly from Portland International Airport (PDX) in Portland, Oregon, to Ontario International Airport (ONT) in Ontario, California. During the initial climb, at approximately 14,800 feet, the left mid-exit door (MED) plug detached unexpectedly, causing a rapid depressurization event. The flight crew executed emergency protocols promptly, resulting in a safe return to PDX. There were no serious injuries among the 171 passengers, 4 flight attendants, or 2 pilots onboard.

The aircraft, newly manufactured by Boeing, first flew on October 15, 2023, and entered service with Alaska on November 11, 2023. At the time of the incident, the aircraft had completed 154 flights. The NTSB's ongoing investigation has identified that the left MED plug was improperly installed during manufacturing, as the required four retaining bolts were missing when the aircraft was delivered to Alaska Airlines from the Boeing factory. The positions where these bolts should have been installed were obscured by the factory installation of insulation and interior trim, making them undetectable from either the inside or outside of the assembled aircraft.

PO Box 68900, Seattle, WA 98168
P 206.433.3200



Routine pre-flight inspections conducted by pilots and maintenance crews could not have revealed the absence of these bolts, as no movement of the door plug was visible and there was no air gap around the door plug. According to Alaska's FAA-approved maintenance program, door plugs are inspected during scheduled maintenance work between 20 and 24 months after delivery, and at 36-month intervals thereafter. Given that the aircraft had been in operation for less than three months at the time of the accident, it had not yet undergone any such inspections that would have revealed the missing bolts.

While this accident fortunately did not result in loss of life or serious injuries, Alaska recognizes the seriousness of the event and the potential risk to future flights from such manufacturing deficiencies. Alaska has been and will continue to support the investigation into the circumstances which led to the departure of the MED plug. We look forward to the Board's determination of Probable Cause.

II. Summary of Proposed Findings

Alaska submits the following proposed findings based on the NTSB public docket information and insights from the public hearing held on August 6-7, 2024:

1. The left mid-exit door (MED) plug on the aircraft was not correctly installed by Boeing before delivery to Alaska.
2. Boeing personnel did not follow the required documentation processes when they temporarily reopened the left MED plug during manufacturing.
3. Following the temporary reopening, Boeing employees failed to reinstall four bolts essential to secure the left MED plug before the aircraft departed the factory.
4. The positions of the missing bolts were not detectable from inside or outside the aircraft as delivered to Alaska.
5. At the time of the incident, the aircraft had not reached the inspection interval that would have revealed the missing bolts, as per Boeing's Maintenance Program Document requirement.
6. There was no air gap around the left MED plug before the takeoff of Flight 1282 on January 5, 2024.
7. No movement of the left MED plug was observable from within or outside the aircraft before the flight.
8. The pre-incident warnings associated with the cabin pressure controllers (CPC) were fully investigated by the NTSB and were shown to be unrelated to the MED plug's failure and the subsequent cabin depressurization.



9. Boeing did not provide an option for door warning sensors at the MED plug location since the aircraft was configured with a plug instead of a functional exit door.

III. Proposed Probable Cause

Alaska proposes that the NTSB adopt the following probable cause for this accident:

Boeing's failure to follow prescribed manufacturing protocols and procedures associated with removal and reinstallation of the left mid-exit door (MED) plug and the failure of subsequent quality assurance checks during manufacturing led to the aircraft leaving the factory with an unknown and concealed defect which could not have been detected during normal operation or routine maintenance of the aircraft.

IV. Discussion

Safety is Alaska's paramount foundational value, deeply personal to our company and our employees. We prioritize safety and safety culture in all our operations and regularly communicate its importance to every employee. Alaska fosters an open and transparent approach to safety reporting and processes through our Safety Management System (SMS), data sharing, and continuous engagement with FAA safety programs. Safety in aviation requires collaboration among manufacturers, operators, and government, forming the backbone of our country's complex aviation ecosystem.

Alaska thoroughly reviewed the available information related to this accident, including the factual data produced by the NTSB, particularly the Operations and Structures factual reports. Based on our review, we have determined that the aircraft was not properly assembled as the MED plug was not installed according to requirements, and this failure was not and could not have been known by Alaska prior to the accident. Further independent review of pre-accident pressurization system warning indications by Alaska and the NTSB reveals there was no connection between those warnings and the ultimate MED failure.

Several issues, such as the previously reported Cabin Pressure Controller fault and restrictions on flights to Hawaii, that arose during the NTSB investigation have caused confusion or misunderstanding with the media and the general public and should be clarified. Below we discuss these and other topics that we believe are relevant to the NTSB's ultimate analysis of the facts and circumstances of this accident and which clarify and resolve the confusion on issues that did not have any relevance to the cause of the accident.

A. CPC System and Reported Prior Faults

The Boeing 737-9 MAX is equipped with a triple-redundant pressurization controller system to maintain a habitable cabin atmosphere during all flight phases. Two identical Cabin Pressure Controllers (CPCs) alternate control upon takeoff, with one as primary and the other as a backup. If the primary system fails, control automatically switches to the backup, and an "AUTO FAIL" light alerts the



pilots. If both cabin pressurization controllers fail, pilots select “MAN” on the cabin pressurization panel to control cabin pressurization by manually positioning the outvalue value to maintain appropriate cabin pressure for the remainder of the flight.

In the month before Flight 1282, the auto-fail light illuminated during three separate flights, indicating a fault in the primary CPC. In all instances, cabin pressurization remained stable, and the aircraft landed safely. The NTSB’s Systems Group Chair’s Factual Report confirms no disruption to cabin pressure control during these AUTO FAIL events. Following each event, Alaska’s maintenance team inspected and tested the CPCs and, finding no pressurization issues, returned the aircraft to service. Post-accident, the NTSB and CPC manufacturer determined that the faults were due to intermittent UART chip failures unrelated to the incident.

B. ETOPS Restrictions and Inoperative Fuel Boost Pump

The FAA allows commercial aircraft to operate with certain inoperative equipment under specified conditions outlined in the Minimum Equipment List (MEL). Two days before the incident, the aft fuel boost pump became inoperative. Alaska’s MEL permits safe operation with one inoperative pump if conditions are met, which they were. Under the FAA-approved ETOPS program, Alaska’s 737-9 MAX fleet is barred from extended over-water operations with an inoperative aft fuel boost pump, necessitating repairs before resuming such flights. Consequently, the aircraft was restricted from extended over-water flights until repairs were made. This restriction was unrelated to the CPC issues discussed above.

C. Chronics Program and Voluntary ETOPS Restrictions

Alaska’s Chronics program complies with 14 C.F.R. § 121.373, aimed at identifying and addressing recurrent maintenance issues. Going beyond FAA requirements, the program adopts best practices to enhance safety. One precaution is restricting aircraft with multiple resolved maintenance write-ups from extended over-water routes, allowing quick issue resolution if a problem recurs. Alongside the existing ETOPS restriction for the inoperative pump, Alaska’s policy also restricted the aircraft due to prior CPC warnings, ensuring safety for extended over-water flights to Hawaii.

D. Door Sensors on MED Plugs

During the hearing, it was questioned whether door sensors were installed at the MED plug location instead of an exit door. Boeing installs sensors for exit doors to alert the crew if not properly closed, but not for MED plugs, as they are not designed to be opened by the crew. Boeing’s design does not support sensor installation for plugs, and Boeing does not offer this option for plug doors. Following the NTSB hearing, Alaska confirmed that no sensors were installed at the MED location.

E. Post-Accident Oversight of Boeing and Spirit Aerosystems

Post-incident, Alaska engaged with Boeing’s leadership to address quality assurance in the MAX fleet. Alaska expanded its audit team, employed independent inspectors, and enhanced intake inspections for newly delivered aircraft to ensure manufacturing improvements. This includes comprehensive reviews of Boeing’s production quality and control systems, oversight of vendors and



suppliers, and factory non-conformance data. Alaska's proactive measures include bolstering existing inspections, adding new ones, and revamping the supplier inspection program. These expanded teams and enhanced inspection protocols remain in place today.

F. Cockpit Voice Recorder and Flight Data Recorder Retention

Alaska Airlines understands how critical cockpit voice recorders (CVR) and flight data recorders (FDR) are to the NTSB's investigative process. In response to the incident, Alaska Airlines took steps to reinforce prioritization of the preservation of the CVR and FDR in the event of an accident or incident. This includes updating flight crew as well as maintenance and engineering emergency response checklists and training.

Alaska fully supports the 25-hour recorder standards that were enacted into law with the FAA Reauthorization Act of 2024 to address the NTSB's standing safety recommendations. These new standards will put the U.S. airline industry more in line with international regulations, and Alaska is already working with our suppliers to implement. Alaska looks forward to the FAA's rulemakings and will closely monitor to ensure compliance.

G. Crew Training and Manual Changes

In response to the incident, Alaska updated the 737 Systems Handbook to inform pilots about potential effects on the flight deck door during decompression events. Flight Operations leadership highlighted this issue to pilots and included it in the second-quarter training for all pilots, completed by June 30, 2024. Additionally, flight attendant procedures were updated to address the potential for the flight deck door to open unexpectedly during decompression, and these changes were incorporated into flight attendant training.

Beyond the flight deck door, Alaska made several procedural changes, manual updates, and training adjustments based on feedback from the flight crew and lessons learned from the accident. These updates included crew communication, oxygen mask and portable oxygen bottle usage, and flight attendant seating arrangements, as noted in the NTSB's Factual Reports.

H. SMS at Alaska Airlines

Alaska strongly supports a robust Safety Management System (SMS) central to our safety culture. Participating in the FAA's SMS development pilot project in 2006, Alaska integrated SMS concepts into existing safety programs, enhancing our safety culture. Demonstrating compliance with 14 C.F.R. Part 5, Alaska was the first legacy carrier to receive FAA SMS acceptance on October 11, 2016. Our mature SMS continues to improve, fostering a strong reporting culture and proactive safety measures.

Transparency in data sharing is crucial, and Alaska supports the FAA's efforts to enhance industry transparency and information sharing, optimizing hazard identification and mitigation. In 2014, Alaska pioneered a transparency Memorandum of Understanding with the FAA, allowing unfiltered access to operational and safety data. This transparency has bolstered safety risk management. We remain committed to industry collaboration, strengthening safety culture,

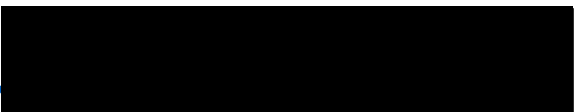


transparency, and compliance processes, ultimately improving safety and quality across the aviation industry.

V. Conclusion

The Flight 1282 incident highlights the need for continuous strengthening of safety layers within the aviation industry. Alaska is dedicated to enhancing our safety culture, training programs, and operational procedures, ensuring robust emergency responses and maintaining the highest safety standards. We continue to extend our sincere gratitude to our crew for their exceptional skill, courage, and extraordinary professionalism in ensuring the safe return of everyone to Portland. We also express our gratitude to the NTSB staff and Board for their diligent work and the collaborative approach throughout this investigation. Anticipating the Board's determination of Probable Cause, we remain committed to advancing aviation safety.

Sincerely,



Max Tidwell
Vice President, Safety and Security
Alaska Airlines





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April 14, 2025

Mr. Doug Brazy
Investigator-In-Charge
National Transportation Safety Board
490 L'Enfant Plaza SW
Washington, DC 20594

Reference: Alaska Flight 1282, NTSB Investigation DCA24MA063

Dear Mr. Brazy:

In accordance with National Transportation Safety Board (NTSB) rules, the Air Line Pilots Association, International (ALPA) submits the attached comments, conclusions, and recommendations concerning the accident involving Alaska Airlines flight 1282, N704AL, a Boeing 737-9 aircraft on January 5, 2024, near Portland, Oregon.

The following contains a synopsis of ALPA's analysis of the facts surrounding the event based on the information obtained through NTSB Investigation DCA24MA063. ALPA's proposed Safety Recommendations are based upon these facts.

HISTORY OF FLIGHT

On January 5, 2024, at about 1712 PST, Alaska Airlines flight 1282, N704AL, a Boeing 737-9 aircraft, experienced a rapid decompression after the left Mid Cabin Exit Door (MED) Plug departed the airplane while in flight. The flight crew declared an emergency and immediately returned to Portland International Airport (PDX), landing on runway 28L at 1726 PST. The airplane taxied to the gate without further incident, where all occupants (2 flight crewmembers, 4 cabin crewmembers, and 171 passengers) deplaned. Seven passengers and one flight attendant received minor injuries.

The flight was operating under Title 14 Code of Federal Regulations (CFR) Part 121 as a scheduled domestic passenger flight from PDX to Ontario International Airport (ONT), in Ontario, California.

After a normal takeoff and initial climb, the Captain and First Officer were issued a climb to FL230 (23,000 ft). Climbing through 10,000 ft MSL, the First Officer verified the pressurization was normal per company procedure.

The Captain stated in his post-accident crew interview that they “climbed to roughly 16,000 ft. Loud bang, ears popping, my head got pushed up into the HUD (Heads Up Display) and my headset got pushed off, not off my head, but almost off my head.” (Crew Interview Transcripts at lines 11:19-21)

The First Officer noticed that her ears popped and reported that simultaneously her headset blew off, the flight deck door blew open, and the cabin altitude warning horn sounded.

The crew donned their full-face oxygen masks and declared an emergency. The First Officer selected the overhead speaker switch and turned the volume up to maximum. The Captain disconnected the autopilot and autothrottles and began a descent to 10,000 ft MSL. The flight crew coordinated an emergency return to PDX. They called for and completed the “CABIN ALTITUDE WARNING or Rapid Depressurization” checklist and noted the cabin altitude displayed 14,500 ft MSL. (Crew Interview Transcripts at lines 12:1-8)

The flight crew described the chaotic and explosive event as being very loud and that it was very difficult to hear each other or Air Traffic Control (ATC). Flight deck communication with the flight attendants using the integrated microphone in the full-face oxygen mask and the overhead speaker was difficult. The flight crew were able to make out the flight attendants discussing a “hole” over the cabin interphone and attempted to communicate with them but heard no response. The flight was in Visual Meteorological Conditions (VMC) and after making the turn back towards PDX could see the airport to return for a visual approach. (Crew Interview Transcripts at lines 12:9-13)

At 10,000 ft MSL, the flight crew removed their oxygen masks and put their headsets back on to try to establish better communications. They noticed an “extremely loud white noise” and that communication with ATC was not possible using their headsets, so they reverted to wearing the oxygen masks to communicate. (Crew Interview Transcripts at lines 50:9-15)

The flight crew reported that the landing was uneventful, and they taxied to the gate.

Weather conditions at PDX

PDX had an Automated Surface Observation System (ASOS) which was augmented by contract weather observers. At the time of departure and the time of the accident the following Meteorological Aerodrome Report (METAR) was current at PDX:

METAR

KPDX 060153Z 18010G19KT 10SM BKN055 OVC150 10/03 A3020

METAR (Plain language)

PDX weather observation at 1753 PST, wind from 180° at 10 kts gusting to 19 kts, visibility 10 miles, ceiling broken at 5,500 ft, overcast at 15,000 ft, temperature 10° C, dew point temperature 3°C, altimeter setting 30.20 inches of mercury.

ANALYSIS

Airline and Flight Crew Provided Unairworthy Aircraft by Boeing

The airline and flight crew were unaware and had no way to know that they were provided an aircraft that was not in an airworthy condition. (NTSB Preliminary Report pg. 15-18)

Mid Cabin Exit Door (MED) Plug Manufacturing Anomalies

At the Boeing assembly line facility in Renton, Washington (Boeing Renton), any work or Non-Conformance Records (NCR) that have not been addressed within the given flow day of the build are known as “traveled work.” This traveled work or discrepancy will continue with the fuselage / aircraft on to the next flow day(s) of the build.

There was traveled work on Boeing 737-9 fuselage 8789 that ultimately became N704AL that led to the left MED Plug being removed during the manufacturing process. This was initiated by the discovery of five rivets needing to be replaced on the fuselage near the left MED Plug. The five rivets were discovered during the “shakedown” of the fuselage during flow days 1 through 3 by Boeing inspectors. This discrepancy was referencing work that was performed by Spirit AeroSystems (Spirit) during the initial fuselage build at the Spirit facility in Wichita, Kansas. Because the original work was not performed by Boeing mechanics, the replacement of these rivets was to be performed by Spirit contract mechanics coordinating with the Spirit representative at Boeing Renton.

Spirit contract mechanics initially did not correct the defective rivets to Boeing's satisfaction. Boeing inspectors did not sign off on the corrective actions of the Spirit mechanics and restated the rivets would need to be replaced. The delay in response from Spirit and the Spirit contract mechanics to address the rivets created the non-standard travelling work. The rivets were replaced just prior to aircraft rollout of the factory at the end of the build process.

The final coordination for the Spirit contract mechanics to perform the rivet replacement required significant coordination with Boeing mechanics and leadership. This repair required removal of previously installed furnishings such as seat rows, side panels, blankets, and the left MED Plug that ultimately departed the aircraft, causing the accident. The investigation uncovered significant breakdowns in communication and processes relating to the coordination between Spirit contract mechanics and Boeing mechanics and their ability to document removals and reinstallations. (NTSB Manufacturing Records Factual Report)

Mid Cabin Exit Door (MED) Plug Installation Anomalies

The proper function of the MED Plug requires three (3) restraints to prevent plug displacement:

1. The MED Plug is secured to the fuselage by two upper guide fittings and two lower hinge fittings which are secured by two arrestor bolts and two upper guide bolts to prevent vertical movement of the MED Plug.
2. 12 stop pins to prevent radial displacement of the MED Plug.
3. Gravity and seal friction to counteract the spring force at the base of the MED Plug.

The first two restraints are the primary restraints to secure the MED Plug into place.

In the case of Alaska Airlines aircraft N704AL, the two arrestor bolts and two upper guide bolts were not re-installed after the rivet repair mentioned above, which required the left MED Plug to be removed and reinstalled at Boeing Renton.

During the FAA mandated inspection of MED Plugs on all Alaska Airlines Boeing 737-9 aircraft, Alaska Airlines Maintenance found variations of incorrectly installed MED Plugs. These results were reported to the FAA and suggest there are anomalies within the aircraft manufacturing and installation process that need greater oversight.

Two qualified pilots in the flight deck

Commercial aviation is the world's safest mode of transportation, and history shows that having at least two fully qualified, highly trained, and well-rested pilots on the flight deck is an airliner's strongest safety asset. Airliners are designed for more than one pilot on the flight deck because safety and operations require it.

Evidence, including more than a decade of study by the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA), shows that the safety risks and challenges associated with single-pilot operations far outweigh any potential benefits.

Pilots on board an aircraft can see, feel, smell, and hear many indications of an impending problem and begin to formulate a course of action before even the most sophisticated sensors and indicators provide positive indications of trouble. A minimum two-person crew is necessary to manage the high workload environment on the flight deck. Two crew members provide a redundancy consistent with redundant mechanical and warning systems on the aircraft, which significantly increases the capacity to mitigate risk while operating a passenger aircraft.

This was especially apparent during this accident. When the MED Plug departed the aircraft, the flight crew described the chaotic and explosive event as being very loud and difficult to hear each other or ATC. They didn't know until they were on the ground whether they had an aircraft control issue and / or had lost part of the airplane. Having two pilots on the flight deck

allowed them to focus on their respective duties, manage the emergency, and bring the airplane and its 2 flight crewmembers, 4 cabin crewmembers, and 171 passengers safely back to PDX.

NTSB Chair Jennifer Homendy said, "...there was a lot going on and I just really want to thank the actions of the flight crew that was equally heroic, and the flight crew entirely did an excellent job." (NTSB media brief, Portland, Oregon, Chairman Jennifer Homendy, January 6, 2024)

"We build in redundancy because we know that relying on a single point of failure is unacceptable. An unacceptable risk to crew members. The number of qualified crew members on the flight deck should be no different." (Jennifer Homendy, NTSB Chair, ALPA Air Safety Forum keynote speech September 12, 2024)

Onboard Communication Difficulty

The flight crew described the chaotic and explosive event as being very loud and very difficult to hear each other, the flight attendants or Air Traffic Control (ATC). In the chaos of dealing with the emergency they found themselves in, when they removed their full-face oxygen masks with integrated microphones and attempted to return to using their traditional headsets, they did not restow them in the oxygen mask stowage box and select TEST/RESET. As a result, the crew was not able to reestablish normal communications using their headsets. (Crew Interview Transcripts at lines 50:9-15). This reestablishment of normal communications procedure was not part of any emergency or abnormal checklist at the time.

The procedure for reestablishing normal communications after utilization of the oxygen masks is different in the Boeing 737-9 than it is on the Boeing 737-900 / ER. For instance, in the Boeing 737-9, the crew must close the oxygen mask storage doors and press the TEST/RESET switch to reestablish normal communication; this is not required on the Boeing 737-900 / ER. Also, there is a mask/mic switch that is located on the Boeing 737-900 / ER audio control panel to reestablish communications to a headset. This switch does not exist on the Boeing 737-9 audio control panel and is replaced by the act of pressing the TEST/RESET switch on the oxygen mask storage box. (Alaska Boeing 737 Systems Handbook) In the hectic situation here, the crew's oxygen mask microphone remained active and their normal headset microphones remained disabled.

FINDINGS AND SAFETY RECOMMENDATIONS

Findings

1. Both Alaska Airlines flight 1282 flight crewmembers were current and qualified.
2. The Boeing 737-9 aircraft N704AL was manufactured by Boeing and entered service with Alaska Airlines on November 11, 2023. It had operated a total of 154 flights at the time of the accident.
3. The NTSB investigation discovered that when aircraft N704AL was delivered to Alaska Airlines, the left MED Plug was not properly installed by Boeing. Four retaining bolts were missing from the left MED Plug on N704AL at the time it left Boeing Renton and was delivered to Alaska Airlines.
4. No pre-accident movement of the left MED Plug was visible on the aircraft and therefore, recurring maintenance inspections did not reveal that the left MED Plug was not properly installed by Boeing.
5. The locations where the missing bolts should have been installed on the left MED Plug were not visible from inside or outside the aircraft and the flight crew or airline would not have known they were missing.
6. Boeing did not provide an option for door warning sensors at the MED position because the aircraft was equipped with a MED Plug, as opposed to a functional exit door.
7. The flight deck crew and cabin crew were surprised by the aircraft flight deck door opening during the event as this was not covered in any systems or training materials supplied by Boeing or Alaska Airlines. This led to cabin crew injury and an unsafe door condition during flight (Survival Factors Factual Report pg. 56, section 6). During the investigation, Boeing subsequently confirmed that the flight deck door operated as Boeing had designed, but not as the crew expected or had been trained.
8. Communication between the flight crew, and between the flight crew and cabin crew, was very difficult due to the significant and loud airflow noise on the flight deck. This was compounded by differences between the rapid decompression communication procedures and the reestablishment of communication procedures between the Boeing 737-9 and the Boeing 737-900 / ER.

Safety Recommendations

To the Federal Aviation Administration:

- Ensure regulations continue to include the requirement of having two current and qualified pilots in commercial airline aircraft. FAA should not allow any deterioration of the current requirements since it will add significant risk.
- Ensure adequate oversight and documentation for all fuselage repairs during the manufacturing process, including removal and reinstallation of previously installed parts.
- Research and mitigate the hazard of full-face oxygen masks fogging up during a rapid depressurization.
- Recommend secondary flight deck barriers on all passenger airliner aircraft, including retrofitting all existing in-service aircraft. This would allow the deployment of the secondary barrier during a similar event and address the security risk of a flight deck door that cannot be closed and secured during a high stress / high workload event.

To Boeing:

- Recommend additional training and documentation of the flight deck oxygen mask communications system, specifically how to reset communications back to normal operation after a depressurization event requiring the use of oxygen masks with integrated microphones. Emergency and abnormal checklists should be updated to include this information.
- Recommend additional training on awareness of the reduction of overhead speaker volume when the interphone / intercom switch is in the on position.
- Recommend documentation and training for flight deck and cabin crews on the automated operation of the flight deck door during a cabin depressurization. Specifically, the fact that on depressurization, the door solenoid will release the door allowing it to swing freely, potentially injuring cabin and flight deck crew, and the inability to immediately close and secure the flight deck door.
- Strongly encourage Boeing to implement a Safety Management System (SMS) as soon as possible in advance of the required implementation date of December 27th, 2025.
- Strongly encourage Boeing to implement an Aviation Safety Action Program (ASAP) as soon as possible and sunset the internal Boeing “Speak Up” program that appears to be an in-house replacement for ASAP with limited functionality.
- Recommend Boeing specifically conduct an SMS review justifying any decision on the operation of a system that is installed but not disclosed to the customer for aircraft models in production. (MCAS, flight deck door operation during depressurization, etc.). Boeing also should perform this function on previously delivered aircraft by conducting a thorough review of all aircraft Flight Crew Operating Manuals (FCOM) for inclusion of applicable and material installed systems that affect the operation of the aircraft.

ALPA appreciates the opportunity to participate in this investigation and hopes that the attached Findings and Safety Recommendations will assist the NTSB as it concludes this investigation.

Sincerely,



Captain Marc K. Henegar
NTSB Investigation DCA24MA63 Party Coordinator
Air Line Pilots Association, International



14 April 2025
66-CB-H220-ASI-19401

Doug Brazy
Senior Aviation Accident Investigator / Hearing Officer
National Transportation Safety Board
Office of Aviation Safety
Air Carrier and Space Investigations Division (AS-10), Room 5349
490 L'Enfant Plaza East, SW
Washington, DC 20594-0003



Subject: Boeing Submission – Alaska Airlines 737-9 N704AL Decompression in
Portland, Oregon on 5 January 2024

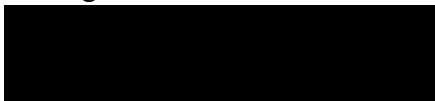
References: (a) E-mail, 18 February 2025, NTSB to Boeing, (canceled / reschedule
forthcoming) RE: DCA24MA063, Alaska Airlines 1282 Tech Review
(b) Meeting, 31 March 2025, NTSB to Boeing, AS1282 MEETING -
Technical Review

Dear Mr. Brazy:

As requested in the reference (a) e-mail and following the conclusion of the reference (b) technical review, please find the attached Boeing submission on the subject accident, NTSB investigation number DCA24MA063.

We would like to thank the NTSB for giving us the opportunity to make this submission. Please feel free to contact us if you have any questions.

Best regards,



Stella Weidner
Director, Product Safety

Enclosure: Boeing Submission to the NTSB on the subject accident



Submission to the
National Transportation Safety Board
for the

**Alaska Airlines 737-9 N704AL
Rapid Depressurization
Portland, Oregon
05 January 2024**

**The Boeing Company
14 April 2025**



INTRODUCTION

On January 5, 2024, approximately 17:12 Pacific standard time (PST), Alaska Airlines flight 1282, a Boeing 737-9, N704AL, returned to Portland International Airport, Portland, Oregon, after the left mid exit door (MED) plug departed the airplane leading to a rapid depressurization. The airplane landed at Portland International Airport without further incident, and all occupants (two flight crewmembers, four cabin crewmembers, and 171 passengers) deplaned at the gate. Seven passengers and one flight attendant received minor injuries.

Submission Abstract

- The Boeing Company, as the airplane's manufacturer, is an invited party to the investigation and provides technical and operational assistance to the National Transportation Safety Board (NTSB) in their investigation.
- The conclusions presented in this submission are based on factual information received from the NTSB, Boeing expertise, the use of analytical tools, and a methodical investigation process.
- The four bolts that prevent upward movement of the MED plug likely were not installed, allowing the plug to translate up and outboard into the air stream.
- The left MED plug had been opened, and the four bolts removed, during airplane final assembly to facilitate the repair of five discrepant rivets in the edge frame forward of the left MED plug.
- A removal record is required to open the MED plug during airplane final assembly. The removal record, in part, would have ensured that removed hardware to gain access to perform rivet replacement were reinstalled and reinspected by Quality Assurance Inspectors. No Boeing removal records associated with opening and closing of the left MED plug during airplane final assembly were found.
- The flight crew successfully returned the aircraft to Portland International Airport with an uneventful landing on Runway 28. All passengers successfully deplaned the aircraft.
- The pressurization fail safe devices, the cabin pressure control system, the passenger service unit oxygen generators, and other aircraft systems all operated as designed during the event. The damage and displacement of cabin interior features found after the accident were consistent with a rapid depressurization event and did not hinder passenger egress.
- Boeing believes that the evidence supports the following conclusion:
This accident occurred when the left MED Plug departed the airplane leading to a rapid depressurization. The left MED plug departed because its two vertical movement arrestor bolts and two upper guide track bolts were not in place. These four bolts had not been reinstalled after the MED plug was removed to allow for rework to certain rivets during the final assembly of the aircraft. The MED plug was not properly reinstalled because the required removal record documents were not created when the MED plug was removed.



BOEING ASSISTANCE WITH THIS INVESTIGATION

The National Transportation Safety Board (NTSB) is conducting the investigation into this Alaska Airlines 737-9 accident. Assisting the NTSB in their investigation are the Federal Aviation Administration (FAA); Alaska Airlines; Air Line Pilots Association (ALPA); Association of Flight Attendants – CWA (AFACWA); the Boeing Company (Boeing); Spirit AeroSystems; and the International Association of Machinists (IAM).

As the manufacturer of the 737-9 airplane, Boeing's specific role in this investigation has been to provide technical information regarding the airplane design, manufacture, and operation to assist the NTSB.

Furthermore, the NTSB requested that all parties submit proposed findings to be drawn from the factual information established during the course of the investigation. Boeing has responded to the NTSB request with this document, which:

- Provides an assessment of the factual information and other pertinent data,
- Identifies knowledge gained from the investigation, and
- Identifies conclusions supported by the knowledge gained from the investigation.

BOEING ASSESSMENT

The Boeing assessment of the accident is based upon the facts as documented in the NTSB's factual reports, Boeing expertise, the use of analytical tools, and a methodical investigation process. These reports contain observations of the airplane and accident site, post-accident examination of airplane systems and components, flight data recorder (FDR) data, quick access recorder (QAR) data, manufacturing records and processes, airline maintenance records, materials and systems laboratory data, crew interview data, and manufacturing personnel interview data and written statements.



WEATHER

The MED plug departed the airplane near latitude 45.5015° N, longitude 122.8312° W, while climbing through 14,800 feet over Portland, Oregon. The Portland International Airport METAR weather observation at 1753 PST were wind from 180° at 10 kts gusting to 19 kts, visibility 10 miles, ceiling broken at 5,500 ft agl, overcast at 15,000 ft, temperature 10°C, dew point temperature 3°C, altimeter setting 30.20 inches of mercury. Remarks: automated observation system with a precipitation discriminator, sea-level pressure 1022.6-hPa, temperature 10.0°C, dew point 3.3°C.¹

THE ACCIDENT AIRPLANE

The Boeing Company delivered the accident airplane (registration N70AL, serial number 67501) on October 31, 2023. The airplane had 510 flight hours and 154 flight cycles in total at the time of the accident.

SEQUENCE OF EVENTS

The accident airplane was operating as a 14 CFR Part 121 domestic passenger operation to Ontario International Airport and departed Portland International Airport at 17:06 PST. There were two flight crew members, four cabin crew members, and 171 passengers on board. At 17:12 PST while climbing through 14,830 feet, the left MED plug departed the airplane leading to a rapid depressurization. The master caution and cabin altitude warning indicating that the cabin altitude exceeded 10,000 feet activated at this time. Shortly thereafter, the flight crew donned oxygen masks, observed the flight deck door had opened and cabin oxygen masks deployed. By 17:13 PST, the airplane continued to climb to a maximum altitude of 16,320 feet, before the flight crew declared an emergency and initiated a descent with a return to Portland.² As the airplane descended through 9,050 feet at 17:18 PST, the cabin altitude warning deactivated. At 17:26 PST, the airplane landed on runway 28L at Portland without further incident.³ Seven passengers and one cabin crew received minor injuries.⁴

RAPID DEPRESSURIZATION

The accident airplane was certified to 14 CFR 25.365(e), amendment level 87, to withstand the effects of a sudden release of pressure from a pressurized compartment at any operating altitude. The regulation defines the calculation for the maximum hole size that is based on the maximum cross-sectional area of the fuselage. The calculated hole size is 820 square inches for the 737-9 airplane. The Boeing certification analysis utilized a differential pressure of 8.35 psi between the interior and exterior of the airplane which represents the maximum differential pressure provided by the pressurization system during normal operation. The analysis also used a worst-case scenario with the cabin altitude at sea-level and the maximum differential pressure to represent the maximum mass of air that must escape through the depressurization hole, which is a scenario that cannot occur in normal flight but adds

¹ NTSB Operational Factors Group Chair's Factual Report, dated 24 June 2024, page 18

² NTSB Operational Factors Attachment 6 Sequence of Events, dated 17 April 2024, pages 2-3

³ NTSB Operational Factors Attachment 6 Sequence of Events, dated 17 April 2024, page 4

⁴ NTSB Survival Factors Group Chair's Factual Report. Dated 28 June 2024, page 56



conservatism to the analysis.⁵ By comparison, the left MED plug departure at approximately 14,830 feet created an opening of 1,682 square inches in the fuselage at a differential pressure of 5.73 psid.⁶

The investigation documented the resultant condition of the airplane interior⁷ and pressurization fail safe devices.⁸ The pressurization fail safe devices, including the flight deck door, cargo compartment pressure relief panels, outflow valve, negative pressure relief door, and overpressure relief valves, all operated per design. Damage and displacement of cabin interior features were consistent with a rapid depressurization event and did not hinder passenger egress.

737-9 CABIN PRESSURE CONTROL SYSTEM

The cabin pressure control system maintains a safe cabin pressure altitude during airplane operation, and air conditioning packs continuously supply air to the airplane pressure vessel. Under normal operations, the maximum cabin pressure altitude is around 8,000 feet. There are two identical cabin pressure controllers (CPCs), each with an independent cabin pressure sensor, that are installed in the main electronic equipment (EE) bay. One CPC is identified as the CPC-in-command and the other CPC identified as the alternate. The CPC-in-command function alternates between the two CPCs during landing touchdown at the end of each flight leg. The CPC-in-command regulates the cabin pressure by adjusting the position of the outflow valve (OFV), which changes the rate of air released from the cabin.⁹ If the cabin pressure control system fails, the airplane structure is protected from excessive pressure differentials via two positive pressure relief valves and a negative pressure relief valve.¹⁰

Following the accident flight, the NTSB investigative group observed cabin pressure control system testing, per existing engineering and maintenance procedures on the accident airplane. The system and its components passed all the on-airplane testing.¹¹ The group also observed:

- The cabin pressure outflow valve was approximately in the closed position with no obstructions or anomalies noted.
- The two cabin overpressure relief valves were the normal position with no anomalies noted.
- The negative pressure relief door was observed in the closed position and light hand pressure could open the door, which per design was spring set to the closed position.¹²

To determine if the cabin pressure control system contributed to the left MED plug departure, recorded data from the CPC fault logs, QAR, and maintenance records were reviewed from the accident flight and flights prior to the accident to assess cabin pressure system

⁵ NTSB Structures Group Chair's Factual Report, dated 15 May 2024, page 15

⁶ NTSB Structures Group Chair's Factual Report, dated 15 May 2024, page 15

⁷ NTSB Survival Factors Group Chair's Factual Report, dated 28 June 2024, pages 14-20, 40-44

⁸ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 15

⁹ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 4

¹⁰ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 9

¹¹ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, pages 15-17

¹² NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 15



performance.¹³ Also, as there were four occurrences of the cabin pressure control system AUTO FAIL light illuminating during flights prior to accident flight, the recorded faults were studied to determine if the AUTO FAIL light annunciations may have been an indication that the left MED plug was not securely installed prior to the accident flight.

The two CPCs and OFV were removed from the accident airplane and examined at the component manufacturer's facility in Frankfurt, Germany. Below is a summary of the examination observations:

The two CPCs and the OFV were removed from the accident airplane and examined at the component manufacturer's facility in Frankfurt, Germany. The manufacturer determined the AUTO FAIL events corresponded to a combination of fault codes 039 "RS422_XMIT_FAIL" and 074 "OFV_RS422_CTR_TO_OFV_ACTIV_FAIL." The manufacturer advised the combination of fault codes 039 and 074 were attributed to an intermittent failure of the universal asynchronous receiver-transmitter (UART) microchip internal to the CPCs. Either of these faults will result in the affected CPC automatically transferring cabin pressure control to the alternate CPC and drive a master caution alert and the AUTO FAIL light annunciation in the flight deck. A review of previous flight data from the accident airplane captured the two most recent AUTO FAIL occurrences, and demonstrated that when the fault occurred, the alternate CPC automatically took command and there was no disruption to cabin pressure control.¹⁴

The OFV was visually inspected and damage to two connectors, attributed to shipping, was noted.¹⁵ The OFV, along with both electronic boxes, were tested per the CPC manufacturer's acceptance test procedure. The unit passed all portions of the test except step 5.6. In this test, the unit leakage was 2.5 kg/min at a differential pressure of 550.1 mbar (allowable 2.4 kg/min at differential pressure greater 548.5 mbar). According to the manufacturer, this condition may allow for a slight increase in leakage when the valve is commanded fully closed at high differential pressures, and would have little, if any, effect on the performance of the valve in flight.¹⁶ All faults from the OFV nonvolatile memory were downloaded and reviewed. There were six combined faults recorded in the memory of both units. Four of the faults were labeled "RS422_CTR_OFV_ACTIVITY_FAIL" and corresponded to the "074 OFV_RS422_CTR_TO_OFV_ACTIV_FAIL" faults that were recorded in the CPC memory. The other two faults were labeled "CAB_PRESS_SWITCH_ACTIVATED," and corresponded to the "090 OFV_CAB_PRESS_SWITCH_STATUS" faults that were recorded in the CPC memory that occurred shortly after the accident flight decompression. These faults were recorded when the outflow valve cabin pressure switch activated during the accident sequence.¹⁷

On-airplane visual observations and testing of the cabin pressure control system, along with data compiled during laboratory evaluations of the cabin pressurization components removed after the accident flight, indicate that the system operated as designed and the fuselage was not over-pressurized. Therefore, it is unlikely that the cabin pressure control system contributed to the left MED plug departure. Additionally, as the available CPC fault data and QAR data from flights prior to the accident flight indicate the AUTO FAIL light had

¹³ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, pages 19-25

¹⁴ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 27

¹⁵ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 28

¹⁶ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 30

¹⁷ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, pages 29-30



illuminated due to intermittent internal CPC failures, with no disruption to cabin pressure control, it is unlikely the AUTO FAIL light illumination was an indication that the left MED plug was not securely installed prior to the accident flight.

737-9 FLIGHT DECK DOOR

The 737-9 flight deck door is designed to open to relieve pressure in the flight deck during significant sudden cabin decompression events.¹⁸ During the accident, the flight deck door opened aft under cabin decompression loading per design. Later inspections showed that the door had no external damage with the exception of the door latch security plate that was slightly deformed with a gap between the metal plates. There were no abrasions on the exterior (cabin side) door handle. The door frame was undamaged. The door closed and latched normally but repeatedly failed to lock per design. A pull (from the cabin side) or a push (from the flight deck side) with moderate force caused it to open without difficulty. The door's interior deadbolt locked and unlocked as designed. Both emergency escape decompression panels were present and undamaged. The sliding pins on the door's panels were in the "lock" position and both the top and bottom panels were in proper placement.¹⁹

The Boeing 737 MAX Flight Crew Operations Manual (FCOM) in effect at the time of the accident did not include information that the flight deck door would open in the event of a rapid decompression in the passenger cabin. On January 13, 2024, Boeing issued MOM-MOM-24-0029-01B that notified operators that Boeing intended to release an amendment to the Boeing 737 MAX FCOM, Volume 2, Systems Description Section, Chapter 1: "Airplane General, Emergency Equipment, Doors, Windows - Controls and Indicators" to provide a description of the flight deck door system functionality during a decompression event in the passenger cabin. On January 15, 2024, Boeing published FCOM amendment D6-27370-MAX-TBCNFF which included additional details on the flight deck door function during a decompression event.²⁰

737-9 OXYGEN SYSTEMS

The 737-9 supplies supplemental oxygen to cabin occupants at all passenger seats, flight attendant stations, lavatories, and galleys via chemical oxygen generators. The passenger oxygen generators installed above the seated occupants are mounted within passenger service units (PSUs). Oxygen is activated when pulling down the oxygen masks, which causes the release of the retaining pin from the associated chemical oxygen generator. The masks are designed to deploy automatically when the cabin altitude exceeds approximately 14,000 feet. After the accident, it was documented that all masks deployed and mask and tubing damage was only noted at row 26ABC in proximity to the left MED plug departure.²¹

The accident airplane was equipped with 62 PSUs equipped with chemical oxygen generators. Chemical oxygen generator migration was observed at 60 PSUs that utilized a pressure sensitive adhesive silicon pad under the steel strap that secures the canister in the PSU. A documented example is provided in Figure 1. Two generators that did not migrate were equipped with the c-channel type silicon pad under steel strap and is documented in Figure 2. All oxygen generators remained engaged with supply tubing and were activated

¹⁸ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 9

¹⁹ NTSB Survival Factors Group Chair's Factual Report, dated 28 June 2024, page 40

²⁰ NTSB Survival Factors Group Chair's Factual Report, dated 28 June 2024, page 41

²¹ NTSB Survival Factors Group Chair's Factual Report, dated 28 June 2024, pages 21-23

during the accident. Additionally, there were no reports of passenger injury due to insufficient supplemental oxygen delivery.²² The flight crew oxygen system is independent of the cabin system and was confirmed to have operated per design.^{23 24}

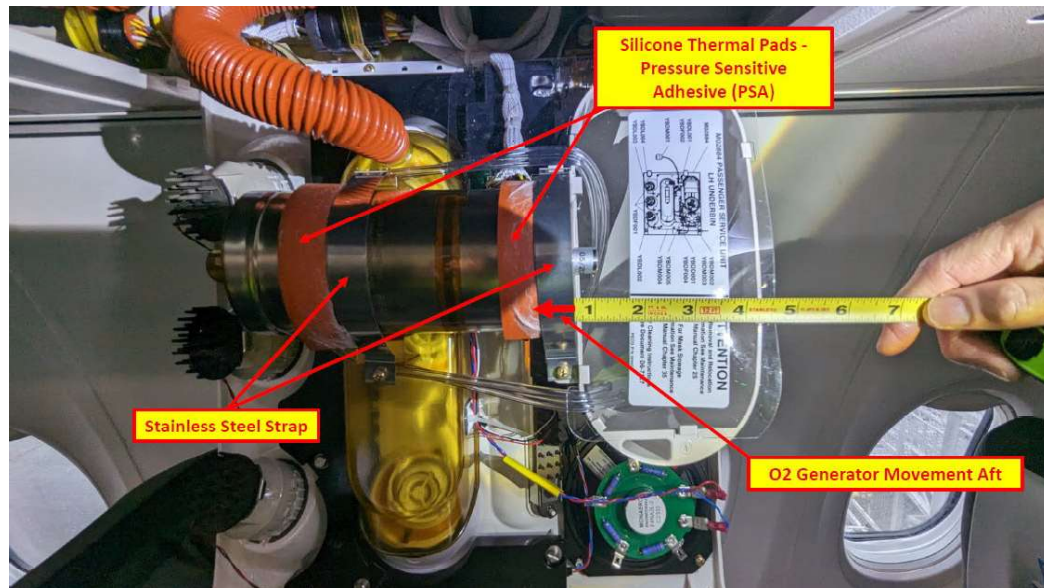


Figure 1. PSU Oxygen Generator Canister Migration Example²⁵

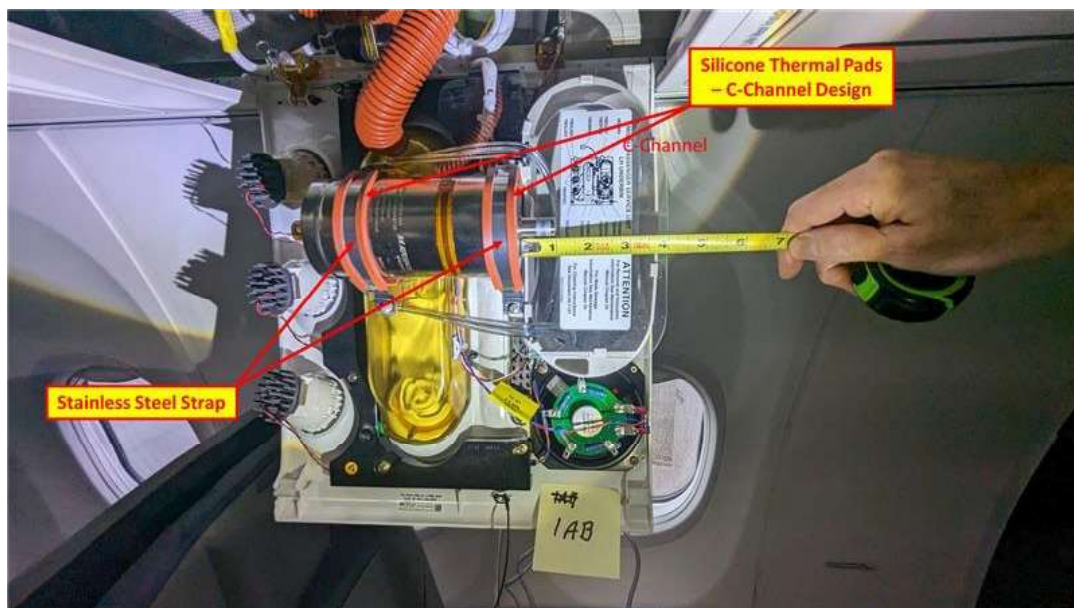


Figure 2. PSU Oxygen Generator Canister Non-Migration Example²⁶

²² NTSB Survival Factors Group Chair's Factual Report. Dated 28 June 2024, pages 26-28, 56

²³ NTSB Operational Factors Group Chair's Factual Report, dated 24 June 2024, pages 7-8

²⁴ NTSB Systems Group Chair's Factual Report, dated 28 June 2024, page 13

²⁵ NTSB Survival Factors Group Chair's Factual Report. Dated 28 June 2024, pages 27

²⁶ NTSB Survival Factors Group Chair's Factual Report. Dated 28 June 2024, pages 27

737-9 MED PLUG

MED Plug Design

Due to the number of passengers allowed by a 737-9 operator's seating configuration and to ensure all passengers can egress the airplane within the time specified by 14 CFR 25.803, mid cabin emergency exit doors may be required on each side of the fuselage at fuselage station 727I+2. MED plugs and deactivated mid cabin emergency exit doors are 737-9 customer selectable options that can be used when an operator's seating configuration does not require mid cabin emergency exit doors. When compared to either an active or deactivated mid cabin emergency exit door, an MED plug is less complex and lighter in weight. MED plugs are principle structural elements, certified to 14 CFR 25.571 for fatigue and damage tolerance, which are only opened for maintenance purposes. Additionally, tools are required to open and close a MED plug. Conversely, in addition to 14 CFR 25.571, the mid cabin emergency exit door is certified to 14 CFR 25.783 which governs opening, closing, latching, locking, and indication for doors and hatches on the exterior of the fuselage that do not require the use of tools to open or close.²⁷

As shown in Figure 3, an MED plug utilizes 12 stops to carry outboard pressure loads, and two upper guide fittings and rollers, as well as two lower hinge fittings, to assist with MED plug opening and closure. The plug is secured vertically by two vertical movement arrestor bolts, installed through the hinge fittings and hinge guide fittings, and two upper guide track bolts, installed through the upper guide fittings, as shown in Figure 4. Castellated nuts and cotter pins secure the four bolts. These four bolts must be removed to allow for the plug to translate upward to clear the 12 stop pads and then rotate outboard pivoting about the lower hinge bolts to open.²⁸ Because the MED plug is installed as primary structure and is only opened with tools for maintenance purposes, no indication system is required for the flight deck. Therefore, the existing wiring associated with the mid cabin emergency exit door configuration is capped and stowed.²⁹

²⁷ NTSB Structures Group Chair's Factual Report – Supplemental, dated 30 September 2024, pages 6-7

²⁸ NTSB Structures Group Chair's Factual Report,, dated 15 May 2024, pages 4-5

²⁹ NTSB Structures Group Chair's Factual Report – Supplemental, dated 30 September 2024, page 6

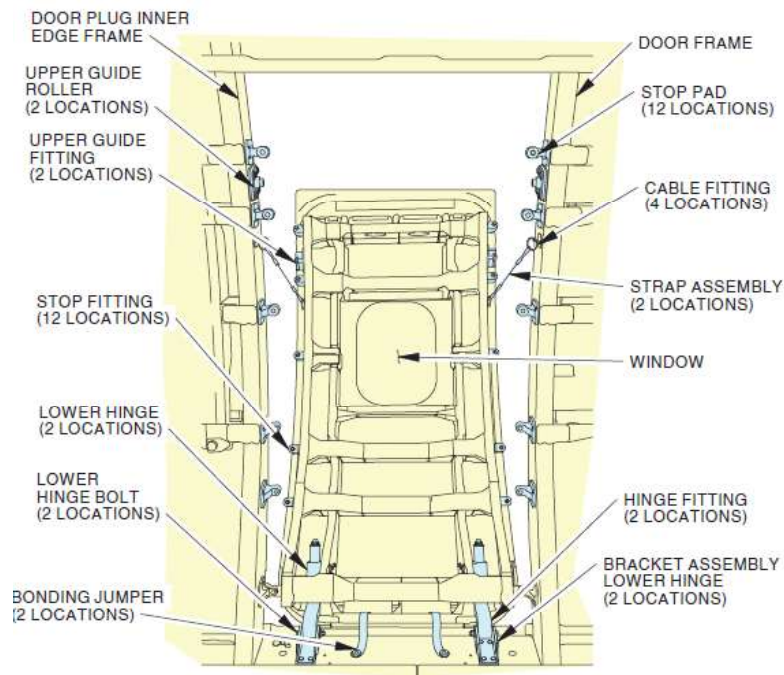


Figure 3. MED plug Hardware Location Reference (Image Copyright © Boeing.)³⁰

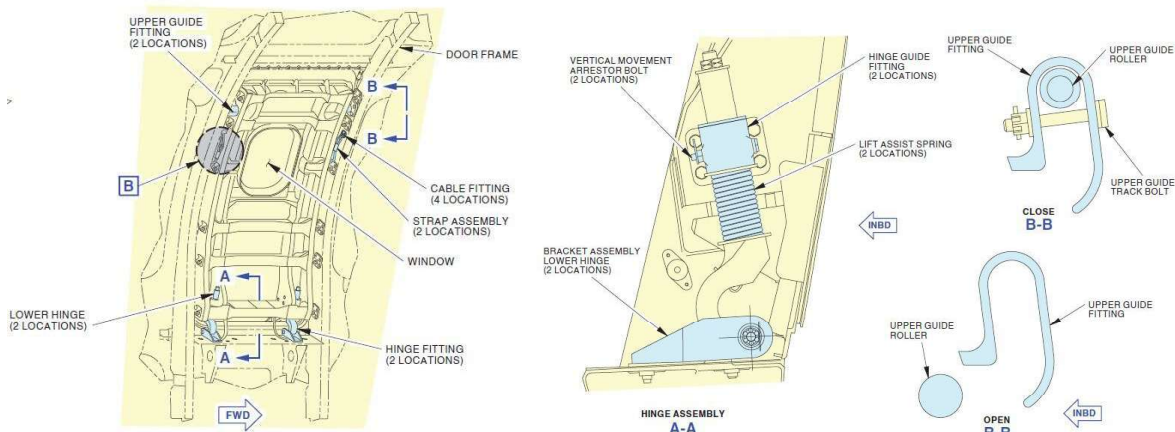


Figure 4. MED plug Vertical Retention Hardware Detail (Image Copyright © Boeing.)³¹

MED Plug Vertical Retention Capability

Following the accident, Boeing performed an engineering assessment on the design capability of the MED plug installation with different combinations of retention hardware installed. The assessment demonstrated that the design is capable of preventing upward translation of the MED plug, and subsequent opening, under operational loads in the following configurations:

- Two vertical movement arrestor bolts and two upper guide track bolts installed;
- One vertical movement arrestor bolt and no upper guide track bolts installed; and
- No vertical movement arrestor bolts and two upper guide track bolts installed.³²

³⁰ NTSB Structures Group Chair's Factual Report,, dated 15 May 2024, pages 5-6

³¹ NTSB Structures Group Chair's Factual Report,, dated 15 May 2024, pages 5-6

³² NTSB Structures Group Chair's Factual Report,, dated 15 May 2024, pages 14-15

Left MED Plug Damage and Departure Evidence

The recovered left MED plug and associated hardware attached to the accident airplane were examined at the NTSB Materials Laboratory in Washington DC. MED plug related components not recovered during the investigation included all upper guide track bolts, vertical movement arrestor bolts, and associated washers, nuts, and cotter pins. Additionally, the lift assist spring, spring washers, stop washer and a portion of the hinge guide fitting were not recovered from the forward assembly.³³ A summary of the damage in Table 1 provides evidence that the left MED plug translated upward, then outboard and aft beyond the fuselage stop fittings on the accident flight when the rapid depressurization occurred.

Table 1. Notable Damage Resulting from Left MED Departure

Component Damage	NTSB Materials Laboratory Factual Report 24-007 Reference
Fwd/Aft stop fitting sliding contact damage	Figures 9-10, 13-14; pages 26-27, 30-31
Fwd/Aft stop pad sliding contact and pin head damage	Figures 11-13; pages 28-30
Fwd/Aft upper guide fitting roller contact and track ductile failure inboard	Figures 16-18, 24-25; pages 32-34, 38-39
Aft lower hinge fitting shaft bend and cracking	Figures 36, 39-40; pages 45, 48-49
Aft lower hinge guide fitting flange ductile failure	Figures 34, 36; pages 44-45
Fwd lower hinge fitting shaft bend	Page 15
MED plug lower beam structure damage relative to hinge fitting assembly damage	Figures 26, 43, 45; pages 40, 51-52
MED plug vertical rib serrated plate attachment hole bearing damage	Figure 30, page 41
Aft lower hinge lift assist spring with enamel and primer material transfer	Figure 44, page 52
MED plug upper region deformation, gusset fractures, and dark deposits at seal contact areas	Figures 46-49; pages 53-55

Observations of the intact outboard upper track guide bolts holes,³⁴ aft lower hinge guide fitting vertical movement arrestor bolt holes,³⁵ and forward lower hinge fitting shaft vertical movement arrestor bolt hole³⁶ indicate no evidence of deformation or damage from bearing

³³ NTSB Materials Laboratory Factual Report 24-007, dated 31 March 2024, page 5

³⁴ NTSB Materials Laboratory Factual Report 24-007, dated 31 March 2024, pages 11, 32-33

³⁵ NTSB Materials Laboratory Factual Report 24-007, dated 31 March 2024, pages 15 and 47

³⁶ NTSB Materials Laboratory Factual Report 24-007, dated 31 March 2024, pages 15 and 46

contact with their respective vertical retention hardware. For comparison, the intact right MED plug was also inspected per Boeing multi-operator message MOM-MOM-24-0010-01B(R4), as required by AD 2024-02-51, which indicated all vertical retention hardware was present in the right MED plug installation.³⁷ Based on Boeing's MED plug design capability assessment and the evidence available from the accident airplane, the MED plug departure could only have occurred if the left MED plug two vertical movement arrestor bolts and two upper guide track bolts were not installed at the time of the accident.

737-9 MANUFACTURING

The 737-9 is manufactured by Boeing, and the airplane's final assembly is performed in Boeing's Renton, Washington, facility. Boeing suppliers manufacture some 737-9 components, which are shipped to Renton and installed by Boeing during the final assembly process. Spirit AeroSystems is the sole Boeing supplier of 737 fuselages, which are manufactured in Spirit AeroSystems' Wichita, KS, facility. The MED plug and surrounding structure are installed by Spirit AeroSystems before the fuselage is shipped to Boeing.

Spirit AeroSystems MED Plug Manufacturing and Installation

Spirit AeroSystems had design responsibility for the MED plug.³⁸ The design includes the MED plug and the MED plug edge frame components that secure the MED plug to the fuselage. Spirit AeroSystems Malaysia manufactures the MED plug, and the MED plug edge frames are manufactured by Quik Tek, a Spirit AeroSystems supplier. Figure 5 shows a MED plug edge frame prior to installation and Figure 6 shows MED plug edge frames, as installed during fuselage manufacturing at Spirit AeroSystems.



Figure 5. MED plug Edge Frame ³⁹

³⁷ NTSB Structures Group Chair's Factual Report, dated 15 May 2024, pages 9-13

³⁸ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 10

³⁹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 11



Figure 6. MED plug Edge Frames Installed ⁴⁰

MED plugs are installed during fuselage manufacturing at Spirit AeroSystems Wichita, KS, facility. The installation process includes a pre-rig process. Later in the fuselage production process, Spirit AeroSystems verifies the MED plug pre-rig, closes the MED plug, and installs the four bolts that prevent upward movement of the MED plug.

Spirit AeroSystems Production documentation includes the following:

- Production Orders — Manufacturing Execution System containing only parts and operations applicable to the specific line unit configuration. These are where operation labor is started, characteristic information is recorded (i.e., torque tools, seal information, etc.), Quality Notifications are written, and operations are confirmed.
- Rework Orders — Created from a Material Review Board Quality Notification disposition to accomplish engineering required rework or repair of a noted defect.
- Quality Notification (QN) — A nonconformance that is used to record and document conditions that cannot be reworked within the process specifications and require Material Review Board disposition by Liaison Engineering. Requires a rework order to be created and released.

A review of the Spirit AeroSystems manufacturing records for the accident airplane fuselage found:

MED plug manufacturing

The left MED plug installed on the accident airplane was manufactured by Spirit AeroSystems Malaysia on March 24, 2023, and received by Spirit AeroSystems Wichita on May 10, 2023. The Spirit AeroSystems Malaysia Production Order showed discrepancies for the left MED plug during manufacture. One discrepancy

⁴⁰ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 11



was for mechanics not recording torque wrench serial numbers in the production order and another discrepancy was for mechanics not providing the sealant/paint information in the production orders. Both discrepancies were later corrected per the Spirit AeroSystems process.⁴¹ It is unlikely these noted discrepancies were contributing factors to the accident.

MED plug edge frame components manufacturing

During the final assembly of the accident airplane, Boeing identified five rivets in the edge frame forward of the left MED plug, which were mis-installed by Quik Tek.⁴² After the accident Spirit AeroSystems notified Quik Tek of the workmanship issues identified by Boeing during the accident airplane's final assembly in Renton. A review of the Quik Tek production process for the edge frames was started by Spirit AeroSystems as well as a complete inspection of the door edge frames installed at Spirit, in stock at Spirit, and in stock at Quik Tek. None of the edge frames exhibited conditions consistent with those reported by Boeing on the accident airplane.⁴³

MED plug edge frame components installation

On the accident airplane fuselage, the left MED plug edge frame components were first installed on a MED edge frame locating jig and then installed on the fuselage, per Spirit AeroSystems Production Order 46534209. There were no QNs associated with the installation.⁴⁴

MED plug installation

The left MED plug was installed and pre-rigged on the accident airplane fuselage on July 18, 2023, per Production Order 46554596. There was one Quality Notification, specific to the left MED plug. The discrepancy was for the seal flushness being out of tolerance by 0.01 inches. No manufacturing rework was required as Spirit AeroSystems Engineering determined the condition was structurally and functionally acceptable, and did not adversely affect the fit, form, or function of the installation. It is unlikely this noted discrepancy was a contributing factor to the accident.

The close and verify pre-rig of the left MED plug on the accident airplane fuselage was accomplished on July 28, 2023, per Production Order 46606906. The four bolts that prevent upward movement of the MED plug were installed during the accomplishment of this production order. There were no additional QNs or pick-ups for the left MED plug during the manufacturing process prior to the accident airplane's fuselage leaving Spirit AeroSystems.⁴⁵

Boeing Factory Positions and Manufacturing Process Documentation

Boeing Renton factory positions

There are typically ten factory positions referred to as Flow Days (FD) in the 737-9 final assembly process in Boeing's Renton factory, and specific work scope is performed at each flow day position. The flow day work scopes that are typically associated with the MED plug areas include Load Fuselage (FD 1), Check Plug Rigging (FD 1-3), OK to Install Blankets (FD 1), High/Low Blow (FD 7), Mid Exit Door Plug Fit and Fair (FD 9), and Pre-Flight Low-

⁴¹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 11

⁴² NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 23

⁴³ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 12

⁴⁴ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 12

⁴⁵ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 12

Pressure Test (airplane outside).⁴⁶ Refer to Figure 7 for a representation of an airplane's position in the factory relative to the flow days.

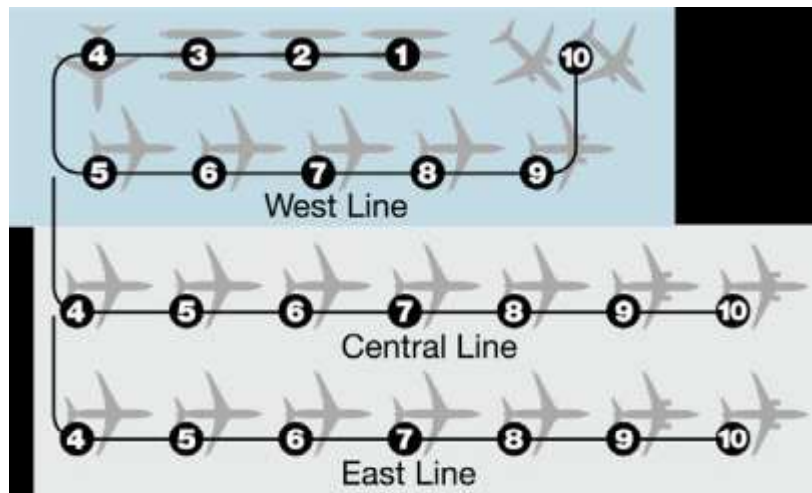


Figure 7. 737 Renton production line. Note: East, Central and West lines are collocated at Flow Days 1–3 positions. (Image Copyright © Boeing)⁴⁷

Boeing engineering requirements used in the 737 Manufacturing process

- Engineering Drawings – contain the product definition data. This includes Computer-Aided Three-Dimensional Interactive Application (CATIA) Models, Supplier Module Parts Lists, and Picture Sheet Data Lists.
- Boeing Product Standards – documents called out in engineering drawings (e.g. Boeing Process Specifications, Boeing Material Standards, Boeing Specification Support Standard)⁴⁸

Boeing work instruction documents used in the 737 manufacturing process

Boeing's Common Manufacturing Execution System (CMES) is a web-based tool that provides 737 manufacturing personnel access to work instruction documents, engineering requirements, and other information required to support the production process. When an airplane is in the production process all work instructions, including inspections, are signed off and recorded in CMES.

The following documents, among others, were used in the 737 Manufacturing process within CMES.

- Installation Plan (IP) – baseline work instructions that manufacturing and quality personnel follow to build to engineering drawings and product standards.
- Rework NCR – A nonconformance record (NCR) used to record conditions that exist on material, parts, assemblies, installations, data sheets, equipment, or test operations, that are not satisfactory, or do not conform with engineering drawings or specification requirements but may be corrected without an engineering disposition that changes type design data. A Rework NCR was also referred to as a Pick-Up or P/U.
- Disposition Required NCR – An NCR that documents a condition that requires an

⁴⁶ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 18

⁴⁷ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 19

⁴⁸ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 16



engineering disposition that may impose additional or new engineering requirements, which becomes part of the type design.

- Nonconformance Order (NCO) – Work instruction document that manufacturing and quality personnel follow to perform rework or a repair required by an NCR.⁴⁹
- Removal Record – removal records document pertinent information related to removing, partially removing, loosening, or disassembling a previously installed and accepted component, part, or assembly. Removal records, in part, ensure that removed items are reinstalled and reinspected by Quality Assurance Inspectors.⁵⁰

Accident Airplane's Final Assembly

The Final Assembly documentation for the accident airplane associated with the MED plug and surrounding area is described below, along with the final assembly Flow Day and preflight positions where the work took place.⁵¹ Only work (IPs, Inspections, NCRs, etc) related the MED plug or plug area will be described in this section. In instances where work was completed at a position other than the position where the work was initiated, the work completion date and position are notated.

Fuselage arrives in Renton – August 31, 2023

Boeing received the fuselage for the accident airplane from Spirit AeroSystems on August 31, 2023, and the fuselage entered the 737-production line in Renton, WA.

Flow Days 1-3 – September 1-6, 2023

IP–Fuselage Load, Attach Static Ground (completed September 1, 2023)⁵²

The fuselage was loaded onto fixtures at the beginning of the production line, in which Static Ground Cables were attached to the fuselage and access stands and ladders were put in place. This IP's work scope also included inspections of the fuselage's general condition.

- There were no NCRs noted against the MED plugs.

IP–Verify Rigging of Mid Exit Doors (completed September 5, 2023)⁵³

This IP checked that the MED plugs conformed to rigging drawing requirements, which included skin gaps, door flushness, stop pin alignment, guide roller gap, guide track serrated plate to body frame gap, visual inspection of exterior and interior, and serrated plate engagement. The MED plugs remain in the closed position when this IP is performed unless defects were found and required the MED plug to be opened for rework access.

- An NCR was initiated on August 31, 2023, to document and address six loose fasteners on the right MED plug. This NCR was completed on September 5, 2023.

⁴⁹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 17

⁵⁰ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 24

⁵¹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 19

⁵² NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 19

⁵³ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 20



- The rigging drawing's Sheet 17, Section 5.2 *Final Inspection Criteria* and Section 5.2.1 *Operational Check* note that inspections were to be conducted with aircraft at a minimum on its landing gear (not jacked) and then the completed MED plug should be operated and its smooth operation be verified.⁵⁴ This inspection was not completed on the accident aircraft. Following the accident, a Boeing engineering evaluation determined it was acceptable to omit the MED plug operational check as the MED plug was not intended to be operable in the final installed configuration and cannot be used for egress. Boeing coordinated with Spirit Aerosystems to update the drawing in October 2024 and section 5.2.1 was deleted.⁵⁵

IP–OK to Install Blankets – STA 727-887, STR 17L-17R Upper (work began September 1, 2023 and stamped complete September 20, 2023 at Renton Preflight B Ramp Stall B4)⁵⁶

Prior to the installation of insulation blankets, an area of the fuselage that included the MED plugs was visually inspected for workmanship discrepancies (i.e., bent brackets/structures, riding conditions, open holes, fastener conditions, tool marks, corrosion inhibiting compound, seal voids, integrity of tamper proof seals).

- NCR N1450292531 and NCO 145-8789-RSHK-1296-002NC were initiated on September 1, 2023, to document and address five discrepant rivets on the edge frame forward of the left MED plug.
 - On September 6, 2023, at Flow Day 3, Spirit AeroSystems Renton contract mechanic and quality personnel documented the rivets were removed and replaced (per instructions in NCO 145-8789-RSHK-1296-002NC).
- Another NCR was initiated on September 3, 2023, to document and address a tooling mark on the edge frame forward of the left MED plug surround structure. This NCR was completed on Sept 15, 2023, during Flow Day 10

Flow Day 4 (Wing/Body Join, Tail & Gear Install) – September 7, 2023

- On September 7, 2023, Boeing Quality initiated NCR N1450293199 and NCO 145-8789-RGEN-RSHK-001NC during Flow Day 4 to document unauthorized work performed by Spirit AeroSystems Renton contract personnel related to the closure of rivet related NCO 145-8789-RSHK-1296-002NC.
 - Boeing Quality found the rivets had not been replaced but had been painted over.
 - Boeing Quality removed the supplier acceptance from NCO 145-8789-RSHK-1296-002NC.

Flow Day 5 (Power On) – September 8-10, 2023

- On September 8, 2023, at Flow Day 5, Spirit AeroSystems Renton contract mechanic and quality personnel applied supplier acceptances again to NCO 145-8789-RSHK-

⁵⁴ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum, dated 13 March 2025, page 2

⁵⁵ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum, dated 13 March 2025, page 3

⁵⁶ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, pages 20-21



1296-002NC noting the rivets bucktail damage was acceptable per Boeing specification.

- Later that same day, Boeing Quality determined the rivets were not acceptable and needed to be removed and replaced per Boeing specification. The rivets were replaced and the NCRs closed on September 19, 2023, during Flow Day 10.

Flow Day 6 (Functional Test) – September 11, 2023

The tool mark NCR, initiated on September 3, 2023, had the following actions taken on September 11, 2023, in Flow Day 6.

- A Disposition Required NCR was initiated to provide an engineering disposition with work instructions to address the tool mark. The instructions included blend out instructions and a subsequent ultrasonic inspection.
- This NCR was later stamped complete on September 16, 2023, at Flow Day 10, and indicated the tool mark had been addressed by the Disposition Required NCR.

Flow Day 7 – September 12, 2023

IP–Cabin Proof Pressure, Leakage and Low Blow Test (completed September 12, 2023)⁵⁷

This IP performed a System Functional Test of Body Drain Test, a Structural Proof Pressure Test, a Cabin Leakage Test, and an Internal Cabin Leakage Test

- There were no NCRs noted against the MED plugs.

Flow Day 9 – September 14, 2023

IP–Exterior Door Operational Check (completed at Renton Preflight B Ramp Stall B4 on September 21, 2023)⁵⁸

This IP accomplished checks of the entry and galley exterior doors and the MED plugs. The MED plugs were not opened when this IP was performed. The gaps around the plugs were measured and the plugs were checked for proper flushness to the fuselage.

- There were no NCRs noted against the MED plugs.

Flow Day 10 (Final Prep for Roll-out) – Sept 15-19, 2023

- The tool mark Disposition Required NCR, opened in Flow Day 6, was completed by Boeing personnel on September 15, 2023 at Flow Day 10.
- The NCR was stamped complete on September 16, 2023, and indicated the tool mark had been addressed by the Disposition Required NCR worked on September 15, 2023.
- Boeing personnel likely opened the MED plug on September 18, 2023 to allow Spirit contract mechanics to rework the discrepant rivets.
- The discrepant rivets were replaced by Spirit contract mechanics. NCO 145-8789-

⁵⁷ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 21

⁵⁸ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 21



RGEN-RSHK-001NC and NCO 145-8789-RGEN-RSHK-002NC related work was reported completed on September 19, 2023, at Flow Day 10. The *OK to Install Blankets* IP could then be closed and was closed on September 20, 2023.

IP–Airplane Protection Requirements

This IP prepares the airplane for movement and storage/work outside of the factory. This is a multi-step IP that is completed and verified over multiple days and positions in the build process. Key steps relevant to this investigation were closed on September 19, 2023.

- One key work step in the IP ensures all doors and hatches were closed when the airplane was unattended.
 - This work step was completed on September 19, 2023, at 21:03.
- Another key work step in the IP reviewed the airplane for missing parts such as doors, windows, panels, fairings, antennas, and fasteners prior to rollout.
 - Original Shop acceptance was on September 19, 2023, at 18:14.
 - This acceptance was later removed, and the work step was reaccepted on September 20, 2023, at 15:31, to correctly document missing stabilizer panels and a temporary nose wheel well camlock.
- No NCRs were noted against this IP.
- The airplane rolled out of the factory late second shift on September 19, 2023

Pre-Flight Low-Pressure Test (Renton Preflight B Ramp Stall B4)

Work stamped completed the day of rollout included:

- *IP-Ok to Install Blankets* was completed on September 20, 2023, at Renton Preflight B Ramp Stall B4 (open from Flow Day 1)⁵⁹

IP–Cabin Leakage Test Pre-Flight (completed October 13, 2023)⁶⁰

The baseline preflight IP accomplished a fuselage pressurization test where the auxiliary power unit was used to pressurize the airplane. After 5 minutes, it was verified no door warning indications were present in the flight deck.

- There were no NCRs noted against the MED plugs.

Additional IPs and NCRs

IP–Customer Paint Inspection Requirements (completed at the Seattle Delivery Center on October 24, 2023)⁶¹

Technicians reviewed airplane paint condition prior to customer acceptance.

- No NCRs were noted against the left MED plug.

IP-Customer Inspection Requirements (completed at the Seattle Delivery Center, October

⁵⁹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, pages 20-21

⁶⁰ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 22

⁶¹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 22



30, 2023)⁶²

Technicians reviewed the airplane's overall condition prior to customer acceptance.

- An NCR documented cracked sealant on the left MED plug on October 26, 2023. Aerosmooth seal and touch up paint were applied per Boeing specifications. The NCR was closed with customer acceptance on October 30, 2023.
- An NCR documented a dent on skin panel assembly located 9.5 inches under the bottom of the right MED plug.
 - Initiated on October 25, 2023. Engineering disposition was to eddy current inspect the dent. Measurements were taken that suggested the skin blend was within aerodynamic smoothness limits per engineering drawings.
 - The NCR was closed on October 29, 2023, with Customer acceptance.

Opening of Left MED Plug

The following includes both the Boeing and Spirit AeroSystems responsibilities when Spirit AeroSystems representatives performed work in Boeing's Renton factory, at the time of the accident airplane's final assembly:

- Boeing was responsible for removing any parts required to access and complete the requested work. Spirit AeroSystems personnel were not authorized to remove completed installations.
- Boeing and/or Spirit AeroSystems were responsible for controlling and processing non-conforming parts.
- Spirit AeroSystems was required to coordinate a time for Spirit AeroSystems personnel to perform the required work.
- Boeing was typically responsible for supplying Spirit AeroSystems representatives any additional supplies or paperwork (i.e., additional removals or removing parts for access) required.⁶³

As noted above, during Flow Days 1-3 NCR N1450292531 and NCO 145-8789-RSHK-1296-002NC were initiated to document and address five discrepant rivets in the edge frame forward of the left MED plug. As these rivets were mis-installed by Quick Tek (a supplier to Spirit AeroSystems), Boeing contacted Spirit AeroSystems' representatives in Boeing's Renton facility. Spirit AeroSystems' representatives agreed to correct the discrepancies.

To provide access for Spirit AeroSystems personnel to replace the five discrepant rivets, Boeing manufacturing personnel were responsible for the opening and closure of the completed MED plug installation. Opening the MED plug required the removal of the four bolts that prevent upward movement of the MED plug. Per the Boeing process *Perform a Part or Assembly Removal*, removal of the bolts would have required a removal record to be initiated.⁶⁴

After an extensive search, Boeing and the NTSB investigative group determined that when work associated with NCR N1450292531 was performed, no removal records were created to

⁶² NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, pages 22-23

⁶³ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 23

⁶⁴ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 24

document the removal of existing installations, such as the insulation blankets⁶⁵ or the four bolts that prevent upward movement of the MED plug to facilitate the opening of the left MED plug on the accident airplane.⁶⁶ In the absence of removal records, there were no documented requirements for the four bolts to be reinstalled and reinspected by Quality Assurance Inspectors.

As a removal record was not available, the timeline in Figure 8 was developed to determine the approximate times the Left MED plug was opened and closed. Different types of data were used to construct the timeline, including the Shippside Action Tracker (SAT), Installation Plans, NCRs, NCOs, Shop and Quality Signoffs, computer time stamps, Boeing employee communication records (i.e., email, text), employee airplane entry and exit time records (Barge Log), employee timecards, written statements and interviews of Boeing and Spirit AeroSystems employees, and photographs from both Spirit AeroSystems and Boeing employees.⁶⁷ The timeline indicates the MED plug was likely opened on September 18 or 19 and closed on September 19.

LN 8789 Renton Factory Timeline

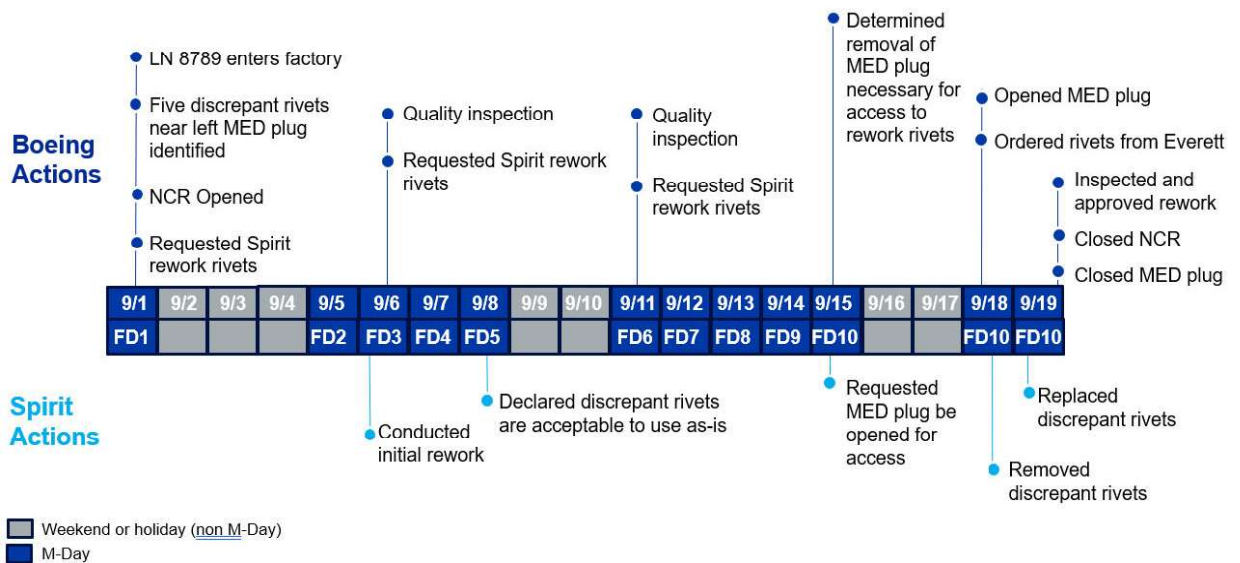


Figure 8. Sequence of event for the opening and closing of LEFT MED plug (Image Copyright © Boeing).⁶⁸

Based on the data noted above, the NTSB investigative group requested statements from both Spirit AeroSystems and Boeing personnel who may have knowledge of the removal or closure of the Left MED plug.⁶⁹ All of the 47 employees who were asked to provide written statements complied with the request. The NTSB reviewed all statements and 13 employees were interviewed by the NTSB investigative group before the July 3, 2024 publication of the

⁶⁵ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum, dated 13 March 2025, page 4

⁶⁶ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 24

⁶⁷ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 24

⁶⁸ NTSB Public Hearing August 6-7 2024, Boeing Presentation, slide 4

⁶⁹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 27



NTSB Manufacturing Records and Human Performance Report. None of the Boeing or Spirit AeroSystems employees stated they had knowledge of the opening or closure of the Left MED plug.⁷⁰

Based on all the information gathered, it is likely that Boeing personnel opened the MED plug to facilitate the replacement by Spirit AeroSystems personnel of the five discrepant rivets in the edge frame forward of the left MED plug.

Closure of Left MED Plug

Boeing IP *Airplane Protection Requirements* prepares the airplane for movement and storage outside of the factory. As noted above, one work step in the IP ensures all doors and hatches are closed. On the accident airplane, this work step was completed on September 19, 2023, at 21:03. Based on all the information gathered, it is likely Boeing personnel closed the left MED plug while the IP *Airplane Protection Requirements* was completed.

Previous MED Plug Removal Documentation

Since the first production installation of a MED plug on 737-9 airplane in 2018, there have been 62 instances where documentation was generated (NCRs and NCOs) and recorded in CMES to account for the opening or full removal of an MED plug during the airplane manufacturing process.

NCRs, NCOs, and removal records were created in accordance with Boeing process *Perform Part or Assembly Removal*, to document the opening/removal and/or closing/installation of the MED plugs. The majority (57 instances) were initiated to gain access to facilitate other work, while others (5 instances) were for removals/installations for use on other airplanes.⁷¹

Boeing Process Perform Part or Assembly Removal

Boeing process *Perform Part or Assembly Removal* details the record requirements for removals and is applicable to all Boeing Commercial Airplane production lines. Removal records:

- Ensure the product is restored according to all released engineering requirements.
- Make certain there is a production record within a Common Manufacturing Execution System (CMES) for previously accepted parts, assemblies, or installations that have been subsequently disturbed.
- Safeguard prior part, assembly, or installation acceptances from legal liability due to subsequent tampering of an accepted part, assembly, or installation.
- Confirm configuration accountability through completed records of all activity occurring on airplane parts, assemblies, and installations.

There were 11 notable revisions/enhancements to the Boeing process *Perform Part or Assembly Removal* that occurred from 2013 through 2023, which resulted from a variety of sources, including scheduled periodic process reviews, Boeing internal reporting and audit findings, as well as FAA findings and Boeing commitments to the FAA.⁷²

In June 2023 Boeing initiated a Safety Risk Management activity regarding the *Perform Part*

⁷⁰ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 28

⁷¹ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 28

⁷² NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 29



or *Assembly Removal* process. The actions that resulted from the activity include:

- The release of additional training to emphasize when and why removal documentation was required.
- A June 12, 2024, revision to the Boeing process *Perform Part Assembly or Removal*, to include a quality inspector involvement when a part is removed, enhanced requirements for corrective actions if the process was not followed, and a simplified and strengthened process for engineering support.
- A January 2025 revision to the process that changed the name of the process to *Perform Emergent Part or Assembly Removal*. The process was simplified, its length was reduced by more than half, and a new requirement was established to relate all removals to the authorizing work instruction document
- The requirement that all manufacturing employees receive annual training regarding Boeing's *Perform Emergent Part or Assembly Removal* process.

Effect of Verification Optimization on the MED Plug during Final Assembly of the Accident Airplane

Beginning in 2018 and concluding in 2021, Boeing initiated a strategy to focus on the methods to verify completed work throughout the production system. Formally referred to as "Verification Optimization" (VO), the initiative was intended to reduce redundant inspections and allow quality inspectors to focus on the areas of production most in need of additional inspection. The strategy was part of a broader shift toward "designed-in" and "built-in quality," which included implementation of technology capabilities and a focus on "error-proofing" engineering requirements.⁷³

The implementation of VO resulted in streamlining of certain secondary inspections for processes which were reviewed for performance and stability. The intent was to allow quality inspectors to focus on critical or higher risk processes, new or unique build processes, and processes that resulted in higher rates of defects according to data. In some areas, it resulted in changes to inspections to sampling-based methods, and in other areas, the work was verified by manufacturing personnel who were experts in the work being performed. Redundant inspections for safety critical processes were not eligible for VO consideration.⁷⁴

Based on feedback from FAA and internal stakeholders, Boeing ceased Verification Optimization activities in late 2020 and through 2021 and, beginning then, significantly increased the total number of inspections. Specifically, the number of inspections on delivered MAX airplanes now is higher than it was prior to Verification Optimization. In 2017, Boeing performed more than 12,000 inspections per 737 delivered; today it is more than 15,000 inspections.⁷⁵

Boeing has more quality inspectors working on the 737 than before Verification Optimization. During the years of VO, there were no plans to reduce the number of quality inspectors due to the reduced inspections; rather, VO anticipated redeploying quality personnel to focus on critical inspections and efforts to proactively identify issues and prevent defects throughout the build process. In February 2019, Boeing and the IAM entered into an

⁷³ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 5

⁷⁴ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6

⁷⁵ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6



agreement ensuring that no IAM employee would be laid off as a direct result of VO. Since the end of VO, due to the increased number of inspections, Boeing has increased the number of inspectors.⁷⁶

The NTSB Investigative Group identified the Installation Plans that were associated with the MED plug installation when the accident airplane was manufactured in 2023 and requested that Boeing conduct a review of the Installation Plans' baseline inspection histories. Boeing performed the review and tabulated the Installation Plans' quality inspection counts for the periods of time "Prior to-VO," "During-VO," "Post-VO," as well as the number of quality inspection operations for the accident airplane.⁷⁷

Below is a summary of the Installation Plans for which the inspection counts had changed During-VO or Post-VO. The number of Post-VO quality inspection operations performed for these Installation Plans is equivalent to the number performed during the manufacture of the accident airplane.⁷⁸

- Installation Plan – *OK to Install Blankets* (FD1)
 - Inspection counts from Prior to-VO to During-VO remained at 7 inspections.
 - Post-VO, in 2021, the work instructions included in this Installation Plan were divided among the original Installation Plan and four new Installation Plans. The work was divided by fuselage sections. Following the division, the original Installation Plan contained 4 inspections, and each of the new Inspection Plans contained 3 inspections, for a total of 16 inspection operations.⁷⁹
- Installation Plan – *Check Plug Rigging* for FD 1-3.
 - This Installation Plan was created Post-VO and contains 9 inspections.⁸⁰
- Installation Plan – *Mid Exit Door Plug Fit and Fair* (FD-9)
 - Inspection counts from Prior to-VO to During-VO changed from 6 inspections to 5. In 2018, an inspection at the Forward Entry Door was changed from a quality inspection to a manufacturing verification. No inspections for the MED plug were removed or changed.⁸¹
- Installation Plan – *Pre-Flight Low-Pressure Test* (airplane outside).
 - This Installation Plan was created in 2023 and contains 5 inspections.⁸²
- Installation Plan – *Airplane Protection Requirements*

⁷⁶ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6

⁷⁷ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6

⁷⁸ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6

⁷⁹ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 6

⁸⁰ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 7

⁸¹ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 7

⁸² NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 7



- This Installation Plan was created During-VO and contained one inspection.
- Boeing added an additional 8 inspections Post-VO, for a total of 9 inspections.⁸³

Verification optimization did not contribute to the left MED plug departing the accident airplane. As shown above, except for one installation plan, there were no reductions in the number of inspections before, during, and after Verification Optimization. The only installation plan modification through a Verification Optimization activity was to Installation Plan – *Mid Exit Door Plug Fit and Fair*. In 2018, one inspection related to the forward entry door was changed from a quality inspection to a manufacturing inspection. That inspection was not related to the MED plug.

BOEING QUALITY MANAGEMENT SYSTEM (QMS)

Boeing's QMS is overseen by Boeing's Total Quality Team. The organization is divided into four functional groups: Core Quality, Airplane Program Quality, Supplier Quality, and Delivery Centers.

Production Certificate 700 was issued by the FAA and is Boeing's authorization to manufacture the listed type-certificated products and articles. The Boeing Quality Management System is defined in the Boeing Commercial Airplanes (BCA) Quality Manual, complies with AS9100, and is approved by the FAA.

QMS is the organizational structure, processes, procedures, records, and resources needed to integrate, document, implement, and maintain the various components of an effective business system that meets or exceeds Boeing Commercial Airplanes' requirements. It is intended to ensure that each product that is presented for airworthiness certification meets its approved design and is in a condition that is safe for operation. Boeing's QMS covers:

- Design data control
- Document control
- Supplier control
- Manufacturing process control
- Inspecting and testing
- Inspection, measuring, and test equipment control
- Inspection and test status
- Nonconforming product and article control
- Corrective and preventive actions
- Handling and storage
- Control of quality records
- Internal audits
- In-service feedback

⁸³ NTSB Manufacturing Records and Human Performance Report-Supplemental Addendum dated 13 March 2025, page 7



- Quality escapes

In addition to the BCA Quality Manual, Boeing uses an internal software platform to house its process documents and maintains a Code of Federal Regulation (CFR)/QMS matrix that maps BCA QMS compliance to applicable CFRs. The QMS is externally audited by the FAA, in accordance with FAA Order 8120.23A, and is internally audited as stipulated by the BCA Quality Manual.⁸⁴

BOEING SAFETY MANAGEMENT SYSTEM (SMS)

Prior to establishing a new rule on May 28, 2024, that mandated the requirement for an SMS program, the FAA established a voluntary SMS (VSMS) program for companies certificated under 14 CFR Part 21 Certification Procedures for Parts and Articles (and others). After assessing an applicant's VSMS to determine if it met the requirements established by the 14 CFR Part 5, the FAA would award a letter stating the VSMS Program had been accepted.⁸⁵ Boeing's VSMS implementation was approved by the FAA in December of 2020 and became operational in June of 2021. Boeing's VSMS provides structure, policies, and procedures for ensuring compliance (design), conformity (quality), and operational (safety) assurances.⁸⁶

The FAA's new rule requiring an SMS (14 CFR Part 5) for Part 21 took effect on May 28, 2024, and mandated full implementation within 36 months. During interviews with the NTSB investigative group, the FAA aviation safety inspectors/engineer and the principal inspector assigned to Boeing, and the product manager assigned to aid in the development of Boeing's SMS reported to the NTSB investigative group that Boeing had performed well in developing and implementing its VSMS and was poised and ready to implement their regulatory SMS program. The regulators professed no concerns about the company's ability to successfully implement the change in the timeline required.⁸⁷

KNOWLEDGE GAINED DURING THE INVESTIGATION (Findings)

The following knowledge gained is pertinent to drawing conclusions:

- While climbing after takeoff, the airplane experienced a rapid depressurization at approximately 14,830 feet when the left MED plug departed the airplane.
- The airplane returned to the departure airport and made an uneventful landing.
- All passengers successfully deplaned the aircraft at the gate.
- Seven passengers and one flight attendant received minor injuries.
- The pressurization fail safe devices, including the flight deck door, cargo compartment pressure relief panels, outflow valve, negative pressure relief door, and overpressure relief valves, all operated per design.
- The passenger service unit oxygen generators remained engaged with the supply tubing, were activated during the accident, and provided supplemental oxygen as intended.
- The cabin pressure control system operated per design and was not a contributing factor to the left MED plug departure.

⁸⁴ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, pages 33-34

⁸⁵ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 35

⁸⁶ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 35

⁸⁷ NTSB Manufacturing Records and Human Performance Report, dated 03 July 2024, page 49



- The damage and displacement of cabin interior features noted after the accident were consistent with a rapid depressurization event and did not hinder passenger egress.
- The left MED plug was recovered, and based on the laboratory examination and engineering analysis, led to the conclusion that the four bolts that prevent upward movement of the MED plug (two vertical movement arrestor bolts and two upper guide track bolts) likely were not installed, which would allow the plug to translate up and outboard into the air stream.
- A removal record is required during airplane final assembly to open the MED plug after it has been installed.
- The left MED plug was opened and one or more insulation blankets were removed during airplane final assembly to facilitate the replacement five discrepant rivets in the edge frame forward of the left MED plug. To open the plug, the four bolts that prevent upward movement of the MED plug must be removed. Removal records are required during airplane final assembly to open the MED plug and to remove insulation blankets after they had been installed.
- No Boeing removal records associated with opening and closing of the left MED plug during airplane final assembly were found.
- A MED plug removal record, in part, would have ensured that removed hardware to gain access to perform rivet replacement were reinstalled and reinspected by Quality Assurance Inspectors.
- The engineering requirements and installation plans to install the MED plug assembly were not a contributing factor in the MED plug departure.
- The VO initiative occurred from 2018 to 2021. The number of inspections on delivered MAX aircraft after VO ceased is higher than it was prior to VO. There was no material reduction in inspections related to the MED plug installation as a result of VO. VO was not a contributing factor to the MED plug departure.

CONCLUSIONS

Boeing believes that the evidence supports the following conclusion with respect to the Alaska Airlines Flight 1282 accident:

This accident occurred when the left MED Plug departed the airplane leading to a rapid depressurization. The left MED plug departed because its two vertical movement arrestor bolts and two upper guide track bolts were not in place. These four bolts had not been reinstalled after the MED plug was removed to allow for rework to certain rivets during the final assembly of the aircraft. The MED plug was not properly reinstalled because the required removal record documents were not created when the MED plug was removed.

BOEING SAFETY ACTIONS

As a result of the information and learnings gained during this investigation and other reviews, Boeing has undertaken the following safety actions:

Immediate actions taken post-accident

- Boeing issued instructions through Boeing multi-operator message MOM-MOM-24-0010-01B(R4) for inspecting MED plugs on all potentially affected aircraft. Those inspections were required by the FAA through Airworthiness Directive 2024-02-51.



- Boeing amended the Boeing 737 MAX Flight Crew Operations Manual to provide a description of the flight deck door system functionality during a decompression event in the passenger cabin.
- Boeing implemented the use of MED plug removal caution placards during manufacturing.
- Boeing developed and is implementing a comprehensive Product Safety and Quality Plan that will improve its safety management and quality assurance, including in the supply chain. The immediate actions taken included, but are not limited to:
 - Revising the build plans, training, maintenance planning, aircraft manual documentation, removal requirements, and inspection criteria for the MED plug;
 - Instituting additional controls to prevent defects in the MED plug and similar structures and assemblies;
 - Publishing alerts on removals and rework that must be acknowledged by all factory employees;
 - Adding conformance inspections to nine critical build points; and
 - Processing fleet and production inspection findings through Boeing's SMS and Quality Management System (QMS).
- Boeing undertook a major effort—including consultation with experts, airline customers, and stakeholders—to identify additional short- and long-term improvements in specific areas, as noted in the following examples:
 - Improving the Boeing Safety Management System (SMS)
 - Developed and incorporated the Move Ready Safety Risk Assessment process, which establishes SMS controls to mitigate risks associated with traveled work.
 - Implemented easier and more accessible employee reporting through an updated Speak Up reporting tool.
 - Integrated SMS/QMS to better enable employee identification and reporting of potential hazards.
 - Simplifying and enhancing quality and safety processes and procedures
 - Simplified and shortened the written procedures for removals, previously known as Boeing process *Perform Part or Assembly Removal*, to make the requirements easier to understand and follow.
 - Deployed new removals training and implemented system controls for employees involved in initiating removals.
 - Instituted daily audits of removals to assess and oversee process adherence.
 - Reducing incoming defects from suppliers
 - Increased onsite presence at Spirit of Boeing manufacturing and operations leaders.
 - Instituted Boeing Final Product Verification for all 737 fuselages at Spirit before shipment is authorized.
 - Strengthening Boeing's culture of safety through employee engagement and communication
 - Conducted numerous employee standdowns across all BCA programs, reaching over 70,000 employees.
 - Deployed ~1,300 Employee Involvement teams across BCA, providing manufacturing and quality teammates dedicated time each week to identify and address safety and quality improvements.
 - Initiated new training for all manufacturing and quality first line and senior managers, with multiple modules focuses on safety culture and employee engagement.



- Simplifying installation and build plans
 - Developed and implemented a Design Build Assessment process to enhance product safety controls for the most critical phases of the airplane build.
- In addition to the elements listed above, the Comprehensive Product Safety and Quality Plan includes initiatives focused on increasing employee proficiency through improvements in new employee training, workplace coaching support, and more rigorous on the job training with additional competency assessments. BCA has also instituted enhanced part and tool control measures that have led to improvements in tool management and tracking work in progress parts.
- Boeing identified six Key Performance Indicators (“KPIs”) of production system health and established and operationalized those KPIs across BCA programs. These KPIs are: (1) employee proficiency, (2) notice of escape rework hours, (3) supplier shortages, (4) rework hours per airplane, (5) travelers at factory rollout, and (6) ticketing performance. Control limits have been established for each KPI, as well as defined criteria that will trigger corrective action and SMS risk monitoring. These critical, safety-focused metrics will enable continuous assessment of production system health and serve as an early warning of emerging quality and safety risks.

Additional actions during the investigation

- Boeing is developing design enhancements to the MED plugs intended to prevent recurrence of this accident. The enhancements are expected to include secondary retention devices to inhibit vertical movement of the MED plug and lanyards to ensure that critical bolts and fasteners are attached to the MED plug structure.
- Boeing issued service bulletin 737-35-1210 and multi-operator message MOM-MOM-24-0316-01B notifying operators of the need and means to inspect and replace (as needed) the PSU chemical oxygen generator retention straps on affected aircraft. The FAA then required compliance through Airworthiness Directive 2024-13-02.



U.S. Department
of Transportation

**Federal Aviation
Administration**

Aviation Safety
*Office of Accident Investigation
and Prevention*

800 Independence Ave SW
Washington, DC 20591

April 2025

Mr. John Lovell
Investigator-in-Charge
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

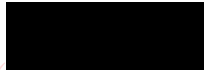
Subject: Alaska 1282 Boeing 737-9 (N704AL) Left mid exit door (MED) plug departed
the airplane leading to a rapid decompression January 5, 2024.

Dear Mr. Lovell

Enclosed, please find the FAA's party submission on the subject accident. This package is
being sent to your attention via electronic mail.

Sincerely,

DAVID A
GERLACH



David A. Gerlach
Manager, Accident Investigation Branch

Enclosure: FAA Party Submission to NTSB for NTSB Case # DCA24MA063



**Federal Aviation Administration
Office of Accident Investigation & Prevention
Accident Investigation Division, AVP-110**

Party Submission to the National Transportation Safety Board

**Aircraft Accident
Alaska 1282
Boeing 737-9 (N704AL)
Left mid exit door (MED) plug departed the airplane
leading to a rapid decompression
Portland, OR USA
January 5, 2024**

**FAA Case Number: 24-12
NTSB Case Number: DCA24MA063**

**Submitted
April 14, 2025**

Accident Summary

On January 5, 2024, about 1714 Pacific standard time, Alaska Airlines flight 1282, a Boeing 737-9, N704AL, returned to Portland International Airport (PDX), Portland, Oregon, after the left mid exit door (MED) plug departed the airplane leading to a rapid decompression. The airplane landed on runway 28L at PDX without further incident, and all occupants (2 flight crewmembers, 4 cabin crewmembers, and 171 passengers) deplaned at the gate. Seven passengers and one flight attendant received minor injuries.

The flight was operated under Title 14 Code of Federal Regulations (CFR) Part 121 as a scheduled domestic passenger flight from PDX to Ontario, California (ONT).

The accident airplane, N704AL, a B737-9 (serial number 67501), was delivered to Alaska Airlines on October 31, 2023. Alaska Airlines put the airplane into service on November 11, 2023. At the time of the accident, the airplane had accumulated 510 total hours and 154 cycles.

A Senior Air Accident Investigator from the Federal Aviation Administration (FAA) Office of Accident Investigation and Prevention was deployed to Portland, OR. to conduct the FAA's parallel safety investigation, and to support the of the National Transportation Safety Board (NTSB) investigation as FAA Party Coordinator.

Party Status

The FAA, by statute, is automatically granted party status to an NTSB aircraft accident investigation. As regulator, the FAA is uniquely positioned to support an accident investigation as the authority on the aircraft's type design and certification, as well as oversight responsibility for the Production Certificate.

Additionally, if immediate safety concerns are discovered during an investigation, the FAA can quickly respond with the appropriate actions (Airworthiness Directives, for example).

Also supporting this investigation were party members from:

- The Boeing Aircraft Company,
- Spirit Aero Systems,
- Alaska Airlines,
- The Air Line Pilots Association,
- Association of Flight Attendants-CWA, and
- International Association of Machinists & Aerospace Workers

Event Timeline

The captain was the pilot flying and the FO was the pilot monitoring. The flight crew stated that the preflight inspection, engine start, taxi, takeoff, and departure climb were

unremarkable.

After takeoff, the flight crew checked in with Seattle Air Route Traffic Control Center and was cleared to flight level (FL)230 [23,000 feet]. The captain said that, while climbing through about 16,000 ft, there was a loud bang. The flight crew said their ears popped, and the captain said his head was pushed into the heads-up display (HUD) and his headset was pushed up, nearly falling off his head. The FO said her headset was completely removed due to the rapid outflow of air from the flight deck. Both flight crew said they immediately donned their oxygen masks. They added that the flight deck door was blown open and that it was very noisy and difficult to communicate.

The flight crew immediately contacted air traffic control (ATC), declared an emergency, and requested a lower altitude. The flight was assigned 10,000 ft. The captain said he then requested the rapid decompression checklist, and the FO executed the required checklist from the Quick Reference Handbook (QRH). As the FO completed the checklist, the captain flew the airplane as they coordinated with ATC to return to the PDX airport. The flight landed on runway 28L without further incident and taxied to the gate.

The CVR and FDR were removed from the airplane and brought to the NTSB's Vehicle Recorder Laboratory in Washington, DC, for download of the data. The accident airplane was required to be equipped with a CVR that retained, at minimum, the last 2 hours of audio information, including flight crew communications and other sounds inside the cockpit. A CVR starts recording when the aircraft is powered on and will continue to record until the aircraft is powered down or the CVR is deactivated, either by a loss of electrical power after a major event or by manually deactivating the CVR's circuit breaker after a less severe event.

The CVR was downloaded successfully; however, it was determined that the audio from the accident flight had been overwritten. The CVR circuit breaker had not been manually deactivated after the airplane landed following the accident in time to preserve the accident flight recording.

The accident airplane's FDR was successfully downloaded and had about 1800 parameters and was 68 hours in length. It contained 16.5 flights, and the oldest recorded flight was from December 30, 2023.

A summary of the FDR data for this accident is as follows:

- 17:06:47 PST: The airplane departed runway 28L at PDX.
- 17:12:33 PST: The recorded cabin pressure dropped from 14.09 to 11.64 pounds per square inch (psi) when the airplane was at an altitude of about 14,830 ft and speed of 271 knots (kts). The "Cabin Altitude Greater than (>) 10k ft Warning" activated. Differential pressure was at 5.7 psi and rapidly decreased to 0 psi over the next few seconds.

- 17:12:34 PST: The Master Caution activated. The cabin pressure dropped to 9.08 psi at approximately 14,850 ft and 271 kts. The airplane magnetic heading was 123°.
- 17:12:52 PST: The Master Caution deactivated.
- 17:13:41 PST: The airplane continued to climb and reached a maximum altitude
- of 16,320 ft and began to descend. The airspeed was 276 kts on a magnetic heading of 120°.
- 17:13:56 PST: The Selected Altitude changed from 23,000 ft to 10,000 ft.
- 17:14:35 PST: The Master Caution activated for 3 seconds.
- 17:16:56 PST: The airplane began a left turn from 121°. The altitude was
- approximately 10,120 ft.
- 17:17:00 PST: The airplane descended below 10,000 ft.
- 17:18:05 PST: The airplane altitude was approximately 9,050 ft and the airspeed was 271 kts. The “Cabin Altitude Greater than (>) 10k ft Warning” deactivated. The cabin pressure was 10.48 psi.
- 17:26:46 PST: The airplane landed on runway 28L at PDX.

Investigation Findings

The Investigation revealed that the left mid exit door (MED) plug on the Alaska Airlines 1282 was missing four bolts intended to secure left mid exit door plug to the fuselage. These bolts were absent following a repair performed by contractors to Spirit AeroSystems at Boeing’s Renton, Washington facility. In September 2023, where the door plug was removed/opened by Boeing mechanics to address defective rivets identified on the fuselage. The NTSB’s preliminary report, released in February 2024, indicated that Boeing mechanics failed to reinstall the bolts after Spirit AeroSystems contractors completed the repair of rivets around the door frame. Once the repairs were completed, Boeing personnel were notified the door/plug was ready to be closed. Review of records indicates no documentation and or existing quality control processes were used to document the work, nor was the left MED plug closure properly recorded, subsequently bypassing required quality inspections. The aircraft was delivered to Alaska Airlines in October 2023, entering revenue service in November 2023 and fly until January 5, 2024, when this accident occurred.

Immediate FAA Safety Actions

The FAA Investigator-in-Charge (IIC) (NTSB Party Coordinator) arrived on scene at approximately 1000 local time on January 6, along with FAA specialists from Aircraft Certification Service Office and Flight Standards Service Office to assist in the investigation.

As a precaution, Alaska Airlines grounded its fleet of B737-9 airplanes to inspect the MED plugs soon after the event. Their inspections began January 6, 2024.

The FAA released Emergency Airworthiness Directive (EAD) 2024-02-51 on January 6 requiring all operators of 737-9 airplanes to conduct specific inspections before returning the airplanes to service. This immediately grounded 171 Boeing 737-9 MAX aircraft operated by U.S. airlines or in U.S. territory.

On January 21, 2024, the FAA published Safety Alert for Operators (SAFO) 24001 for operators that have the same MED plug as the accident airplane but on a different model of airplane. The SAFO is for Boeing 737-900ER airplanes and recommends that operators inspect, as soon as possible, the four locations where the retaining hardware secures the door to the airframe. Boeing issued multiple multi-operator messages (MOMs). The most recent, MOM-24-0010- 01B(R4) dated January 25, 2024, contains revised instructions for inspecting 737-9 airplanes that have the MED plugs

Follow on/Continuing FAA Actions

- Halted production expansion of the Boeing 737 MAX.
- Increased staffing to provide additional on-site presence and oversight activities at Boeing facilities. Bolstered onsite presence at Boeing's key facilities (Renton, Washington; Everett, Washington; Charleston, South Carolina) and the Spirit AeroSystems' facility in Wichita, Kansas. Added new positions to comprehensively address systemic issues across the Boeing production system that are identified through oversight of the quality system, airworthiness ticketing, or related compliance and enforcement actions.
- Conducted a comprehensive audit of Boeing's 737 production line. The FAA identified non-compliance issues in Boeing's manufacturing process control, parts handling and storage, and product control.
- Implemented and continuing increased principal inspector audits, focusing on no- or short-notice audits, and targeting off-shift activities to ensure inspectors gather the most accurate and comprehensive data.
- Communicated with Boeing officials in the months following the accident to reinforce the administration's expectations, requiring Boeing to provide a detailed update on completed actions as well as mid- and long-term actions. These actions include but were not limited to:
- Strengthening its Safety Management System, including employee safety reporting
- Simplifying production processes and procedures and clarifying work instructions
- Enhancing oversight of their suppliers
- Enhancing employee training and communication
- Increasing internal audits
- Required Boeing to identify the results of completed actions and how it will validate progress and sustain the changes.
- Stood up the Organization Designation Authorization Office (ODA) Expert Panel in response to Section 103 of the Aircraft Certification, Safety, and Accountability Act (ACSAA). The panel completed their review of Boeing's safety management

processes, how those processes contribute to Boeing's safety culture, the effectiveness of measures instituted by Boeing to instill a commitment to safety above all other priorities, and Boeing's capability to make reasonable and appropriate decisions regarding functions delegated to them by the FAA. The panel issued their final report on February 26, 2024.

- Actively monitoring Boeing's progress and the effectiveness of their changes in addressing the audit findings and ODA Expert Panel recommendations.
- Senior FAA leaders meet with Boeing on a weekly basis to review performance metrics, progress, and any challenges in implementing the changes.
- Leaders conduct bi-monthly "deep dive" reviews to gauge Boeing's progress.
- FAA continues targeted auditing and surveillance of manufacturing and quality activities at critical points of the production process.
- FAA monitors quality system metrics to identify any areas of concern, to include targeting auditing activities and additional oversight at Boeing manufacturing locations and suppliers.
- FAA continues heightened oversight of Boeing and its suppliers.



IAM & AW AFL-CIO

JON HOLDEN
District President
Directing Business Representative

RICHARD E. JACKSON
District Secretary-Treasurer

AEROSPACE MACHINISTS INDUSTRIAL DISTRICT LODGE 751

9125 - 15TH PLACE SOUTH
SEATTLE, WASHINGTON 98108-5100

FAX NUMBER
EXECUTIVE OFFICE (206) 764-0303
FINANCIAL OFFICE (206) 764-0358
www.iam751.org

SEATTLE (206) 763-1300
RENTON (425) 235-3777
EVERETT (425) 355-8821
AUBURN (253) 833-5590

April 21, 2025

Doug Brazy
Investigator-In-Charge
National Transportation Safety Board
490 L'Enfant Plaza SW
Washington, DC 20594

Re: Alaska Flight 1282, NTSB
Investigation No. DCA24MA063

Dear Mr. Brazy:

In accordance with National Transportation Safety Board ("NTSB") rules, the International Association of Machinists and Aerospace Workers ("IAM") submits the following comments concerning the accident involving Alaska Airlines Flight 1282 on January 5, 2024. The IAM appreciates the opportunity to participate in the investigation as a designated party and we hope these comments assist in the investigatory process.

Accident Summary

The Boeing Company ("Boeing" or "Company") manufactured the 737-9 MAX aircraft that was involved in the accident. Final assembly of the airplane took place at the Company's site in Renton, Washington. The accident occurred when the airplane's left mid exit door (MED) plug blew out shortly after takeoff. The blowout occurred due to a failure to reinstall four bolts that secure the MED plug to the plug frame. MED plugs are located on the airplane's fuselage. Boeing received the fuselage of the accident airplane from Spirit AeroSystems ("Spirit") on August 31, 2023 and the fuselage entered Boeing's 737 final assembly line in Renton on September 1, 2023. Upon arrival of the fuselage to Boeing's factory, the Company identified nonconforming parts of both the left and right MED plugs and a need for rework. Boeing performed work on and around the MED plugs over the course of several weeks until the airplane rolled out of final assembly on September 19, 2023.

Systemic Issues and Multiple Process Failures

Systemic issues within Boeing caused process breakdowns at multiple points during the final assembly of the airplane accident. The failure to generate required paperwork and comply with process requirements occurred throughout the final assembly process - from the first days the fuselage was placed on the assembly line to the airplane's factory roll-out. As a result of these failures, required inspections that could have identified the missing bolts were not performed. Throughout the build process, management failed to ensure production work was properly documented, tracked, and inspected. This lack of traceability violated Boeing's internal safety and quality protocols, revealing a systemic breakdown in oversight and regulatory compliance.

Process Failures Occurred Throughout the Final Assembly Process

Removal of the MED structural plug to allow access so other work could be performed required formal removal documentation, pursuant to Boeing's applicable policy document, Perform a Part or Assembly Removal. A main reason the requirement is in place is to ensure removed items are reinstalled and reinspected by Boeing Quality Assurance ("QA") inspectors. Based on documentation collected during the investigation, including in Boeing's Common Manufacturing Execution System ("CMES") and Shipside Action Tracker ("SAT"), the left MED plug on the accident airplane was opened during the final assembly process without proper removal documentation. Based on SAT entries, including multiple Boeing managers - from first line supervisors to upper-level managers - appear to have been aware that the left MED plug needed to be opened to perform rework. There appears to have been dialogue between many employees about whether formal removal paperwork was required. Ultimately, removal documentation was not generated. If proper removal documentation had been generated, QA inspectors would have been required to reinspect the structure and the MED plug, providing a key opportunity to identify the missing MED plug bolts.

In addition to the failure to generate removal paperwork regarding the actual MED plug rework, there was an equally significant failure to generate required paperwork related to work in areas surrounding the MED plugs, including work performed on insulation blankets. Based on CMES and SAT records, there were multiple points where insulation blankets surrounding the left and right MED plugs were removed, partially removed, or loosened, which should have resulted in formal removal documentation and reinspection of the associated structure and MED plug areas by QA inspectors, as well as inspection by the airline customer. Instead, work was completed and no reinspection of the structure and MED plug areas took place. Adherence to process requirements would have led to multiple opportunities to identify the missing MED plug bolts.

An additional breakdown involved the failure to follow required procedures for a final rigging and operational check of the MED plugs. Boeing's own process documents called for the plugs to be opened and closed prior to its factory roll-out. However, it seems the practice was to disregard this requirement and instead merely measure the gaps around the MED plugs, without opening or closing them. This was another critical opportunity to identify the missing bolts that was lost due to Boeing's failure to follow its own written process requirements.

Repeated Failures to Identify Process Violations

Multiple employees from several employee groups throughout the final assembly process either did not recognize requirements to generate removals or disregarded the requirements. The lack of documentation and traceability - and the failure to adhere to process requirements - supports a conclusion that the accident was caused by a larger breakdown in training and oversight. Multiple process failures at different stages of the assembly line demonstrate not only a passive failure to supervise but also a disregard for process compliance and an unwillingness to intervene when process violations occur.

Exacerbating these issues has been Boeing's frequent revisions to key policy documents and the lack of work time set aside for employees to stay updated about new requirements. This has caused tremendous confusion within management ranks and the shop floor. For example, the removal policy document referenced above has been revised dozens of times over the last decade and is difficult to understand regardless of education level. In the past, Boeing had a practice of issuing and setting aside time during work hours for "Required Reading" and other forms of continuing education material related to policy and process changes. This practice was discontinued in 2017. Since then, employees have been expected to keep up with changes without tailored material and time set aside during work hours.

Tri-Party Speak Up Process

The IAM remains concerned that Boeing employees do not feel confident that raising issues about potential violations regarding safety and quality will have a positive result. Process failures detailed above are a symptom of systemic issues that discourage employees from raising concerns in real time. In efforts to improve the production culture, the IAM in June 2023 entered into a tri-party agreement with the Company and the Federal Aviation Administration (“FAA”) to establish a system for employees to raise safety and quality concerns without fear of retaliation, similar to ASAP programs used in the airline industry.¹

An ASAP program is meant to provide employees with the opportunity to raise concerns, self-report mistakes they have made, identify safety hazards, and protect themselves from corrective action.

This also allows the employer to quickly identify potential hazards, damage, and other policy violations and be protected against enforcement actions from the regulator, while ensuring the safety and quality of the aircraft and the flying public.

Additionally, a tri-party agreement provides access to the FAA that they would not otherwise have, to be a part of and help steer any investigations of hazards, unsafe actions, or procedure violations that when fully investigated, evaluated and solved lead to a safer aviation system for everyone.

All parties benefit from investigating the circumstances that either led to an airworthiness concern, actual damage of the aircraft, or other process violations that, with all the facts in front of them, allow all parties to implement a solution to solve the problem.

This Tri-Party agreement is the first time an ASAP type system, designed to address employee concerns, has been utilized in a manufacturing environment, so we know there will be challenges in implementing this system. It is working very well for the airlines, however, Boeing’s “Speak Up” system does not yet provide an equal footing or allow the Event Review Committee (ERC) to proactively address employee concerns. Boeing has inserted an entity to triage or determine which “Speak Up” reports the Tri-Party ERC team are allowed to view. The ones they are allowed to view often contain redacted language. The IAM ERC members are also limited in their opportunity to investigate issues brought forward. Additionally, Boeing implemented an SMS Panel that takes any ERC direction only as a recommendation that they can ignore.

For employees to gain the confidence necessary to count on and utilize this system, they must believe their concerns will be addressed without fear of retaliation.

The ERC must have access to all Speak Up reports, without redactions, and have an opportunity to review and investigate any proactive concerns brought forward. The parties need to work towards a process that identifies hazards or violations, transparently investigates the issues, and implements solutions that make the manufacturing process stronger for the safety of the carriers and the flying public.

¹ The tri-party agreement was based on Aviation Safety Action Plan (ASAP) agreements already in use by the FAA, airline carriers, and unions.

Boeing's Conduct During the NTSB Investigation

The IAM remains concerned about Boeing's conduct over the course of the NTSB investigation. Ensuring a voluntary, noncoercive NTSB investigatory process is critical. Boeing's actions, however, damaged the investigatory process and chilled employees and potential witnesses from participating free of coercion and without fear of retaliation.

Among the areas of concern is that Boeing in June 2024 was found to have violated rules associated with its role as a designated party to the NTSB investigation. The NTSB formally sanctioned the Company for sharing non-public investigative information and publicly speculating about possible causes of the accident. One incident involved a Boeing executive asserting to a group of reporters that "one or more" employees were to blame for failing to fill out paperwork and ultimately causing the blowout - a statement meant to emphasize errors by individuals on the shop floor and deflect attention away from systemic failures and mismanagement.

Additionally, IAM members received discipline or were moved from their assigned areas during the NTSB investigation, which has reinforced the same cultural issues referenced above. We believe this occurred not based on actual evidence of misconduct, but rather in efforts to deflect attention away from wider systemic issues and mismanagement. Instead of supporting a collaborative, safety-focused investigatory process, Boeing's conduct had a chilling effect and made it less likely that employees felt comfortable speaking freely about safety and quality issues. Employees remain concerned that speaking up will lead to discipline and other forms of retaliation.

Sincerely,



Jon Holden
District President and
Directing Business Representative
IAM&AW District Lodge 751

PARTY SUBMISSION OF SPIRIT AEROSYSTEMS, INC.

In the Matter of the Investigation of
Alaska Airlines Flight 1282, January 5, 2024

Heather Meyer
Sr Director, Core & Supply Chain Quality
Party Coordinator
Spirit Aerosystems, Inc.

Spirit Aerosystems, Inc. (“Spirit”) presents this party submission under 49 C.F.R. § 831.14. For ease of reference, it is organized as follows:

Table of Contents

Introduction

1.	Factual Information.....	1
1.1	B737-9 Aircraft Information.....	1
1.1.1	General.....	1
1.1.2	Certification	1
1.1.3	Role of Spirit in Manufacture of B737-9 Aircraft	1
1.1.3.1	Organizational Information.....	1
1.1.3.2	Fuselage Manufacturing Process	1
1.1.3.3	Spirit Contractors in Renton	3
1.1.3.4	Training.....	3
1.2	MED Plug	4
1.2.1	History.....	4
1.2.2	Design and Function	5
1.2.3	Sourcing, Manufacturing and Inspection.....	5
1.2.4	MED Plug Frame	5
1.2.4.1	Rivet Specifications	5
1.2.4.2	Sourcing, Manufacturing and Integration	6
1.2.5	Pre-Rigging of MED Plug by Spirit.....	6
1.2.6	Process for Rework and Associated Removals.....	6
1.2.7	Boeing Inspections and Final Rigging of MED Plug	7
1.2.8	Documentation and Recordkeeping.....	8
1.3	Left-Hand MED Plug and Door Frame of N704AL.....	9
1.3.1	Manufacture and Pre-Rigging.....	9
1.3.2	Replacement of Five Door Frame Rivets.....	10
1.3.3	Removal of the MED Plug by Boeing	12
1.4	Post-Accident Examinations and Observations.....	13
1.5	FAA Oversight	13
1.6	Boeing Oversight of Spirit.....	14

1.7	Spirit’s QMS and Supplier Source-Inspections and Delegated Authority	14
1.7.1	Overview of Spirit’s QMS	14
1.7.2	System Enhancements Implemented 2019-2023	14
1.7.3	Supplier Source-Inspections and Delegated Authority	15
1.8	Spirit’s Safety Actions.....	15
2.	Analysis.....	16
2.1	The Arrestor Bolts Were in Place When the Left-Hand MED Plug Entered Boeing’s Factory in Renton	16
2.2	Boeing Removed the Arrestor Bolts of the Left-Hand MED Plug in Renton	17
2.3	Boeing Failed to Generate Removal Paperwork Showing It Had Removed the Arrestor Bolts of the Left-Hand MED Plug.....	18
2.4	Boeing Failed to Perform a Final Rigging and Operational Check of the Left-Hand MED Plug.....	18
3.	Conclusions.....	19
3.1	Findings.....	19
3.2	Probable Cause.....	20

1. Factual Information

1.1 B737-9 Aircraft Information

1.1.1 General

On January 5, 2024, Alaska Airlines Flight 1282, a Boeing 737-9, N704AL, returned to Portland International Airport (“PDX”) after the left-hand (or “LH”) mid exit door (“MED”) plug departed the airplane. The flight was a Title 14 CFR Part 121 scheduled domestic passenger flight from PDX to Ontario, California.

1.1.2 Certification

Boeing is the holder of the type certificate for the 737 MAX 9. A type certificate includes the type design, the operating limitations, the type design data sheet, the applicable regulations, and other conditions or limitations prescribed by the FAA Administrator. *See* Manufacturing Records and Human Performance Factual Report (“MRHP”), n. 2, citing 14 CFR 21.41.

The FAA also issued Boeing Production Certificate, No. 700. *See* MRHP, p. 34. The production certificate was Boeing’s authorization to manufacture the 737-9. Accordingly, as the holder of both the type certificate and the production certificate, Boeing was subject to FAA oversight with respect to the aircraft’s design and manufacture. As a supplier to Boeing, Spirit fell under Boeing’s quality program but was not issued certificates for the 737-9 design or manufacture and was not directly regulated by the FAA. Kilgroe 292:10-20 (August 7)¹.

1.1.3 Role of Spirit in Manufacture of B737-9 Aircraft

1.1.3.1 Organizational Information

Spirit is one of the world’s largest manufacturers of aerostructures for commercial airplanes, business/regional jets, and defense platforms. The company is a major supplier of the 737 and 787 fuselage to Boeing. Spirit is headquartered in Wichita, Kansas, and has facilities in the US, UK, France, Malaysia and Morocco.

1.1.3.2 Fuselage Manufacturing Process

Spirit manufactures the fuselage of the Boeing 737. George 27:15 (August 6). The fuselage is comprised of six independent sections that become one part number. Grabon 28:20-22 (August 6). The fuselage is approximately 70 percent of the total structure of the 737. *Id.* at 28:22-23.

¹ Page:line citations herein refer to the transcripts of the NTSB’s Public Hearing, August 6-7, 2024, with the date of the cited testimony in parentheses.² Traveled work refers to jobs/tasks which are delayed and/or completed in a factory location other than what was originally planned. MRHP, n. 5. Traveled work takes longer to complete in terms of labor hours, and incomplete work can interfere with manufacturers’ ability to complete other planned work causing cascading delays. *Id.*

At the time of the accident, Spirit produced 38 fuselages per month. George 36:17 (August 6). At the time of the NTSB Public Hearing in August 2024, the production rate had dropped to 31 per month. *Id.* at 36:19. The production rate and delivery schedules are set by Boeing. *Id.* at 36:22-37:1. To adjust to changes in the production demand, Spirit employs a rate readiness process and adds personnel and equipment as needed. *Id.* at 37:5-10.

Spirit's Work Statement for a single fuselage includes approximately 18,000 unique part numbers from 288 suppliers. Grabon 29:1-5 (August 6). It also includes approximately 20,000 fasteners per fuselage. *Id.* At the production rates in place at the time of the NTSB Public Hearing, this equates to approximately 6.2 million fasteners per month and 74 million fasteners per year. *Id.* at 29:2-4.

At Spirit's global logistics center in Wichita, Spirit receives detailed parts and receives raw material for processing. Grabon 29:18-23 (August 6). The detailed parts are assembled on the floor of Spirit's production facility. *Id.* at 29:24-25. Spirit uses auto-fastening machinery, with most of the drilling and filling done by hand. *Id.* at 30:8-11.

Each section, after it is complete, is brought by crane to the integration area. Grabon 30:12-14 (August 6). Lasers are used to align the sections. *Id.* at 30:15-16. Once the laps and joints are completed, the fuselage is a single piece and is lifted out of integration to the seal bay area. *Id.* at 30:19-22.

In the seal bay area, interior and exterior seals are applied. Grabon 30:23-24 (August 6). Then the fuselage is carried by crane to the camo area where it is primed, painted and corrosion inhibitor is applied. *Id.* at 30:24-25. The fuselage manufacturing process takes about 12 months from receiving raw materials and parts to completion. *Id.* at 32:2-6.

Spirit has inspection points (or "IP's") in place throughout the fuselage build. Grabon 34:15-17 (August 6). Spirit Quality Assurance personnel conduct the inspections. *Id.* at 34:24-35:2. For example, throughout the build, hole diameters and shim gaps are inspected and recorded to confirm conformance with engineering requirements. *Id.* at 88:9-17.

Spirit also inspects its work using advanced technology such as Spiffy. Grabon 116:17-18 (August 6). Spiffy measures fastener head heights in several sections of the fuselage. *Id.* at 116:18-24. Spirit also uses an 8tree scanner that creates a topographical map of the fuselage skin to detect surface imperfections as minute as a thousandth of an inch and uses auto-fastening equipment to enhance product quality. *Id.* at 116:25-117:4-8.

Final inspections validate the completion of the fuselage. Grabon 135:15-18 (August 6). The final inspection incorporates additional inspection points because of its wide scope. *Id.* at 135:19-21. At the end of the line, a final Foreign Object Debris (FOD) walk is performed by Spirit and Boeing to validate there is no FOD in the fuselage. *Id.* at 88:18-25.

The fuselage is then placed on a rail car and prepped to ship. Grabon 31:6-7 (August 6). Boeing then transports the fuselage approximately 2,000 miles to its Renton facility, a journey that typically takes 12 days. *Id.* at 31:9-10. Spirit and Boeing coordinate with respect to any nonconformances detected once the fuselage is shipped to Renton. *Id.* at 119:13-21. Issues are discussed in joint meetings between Boeing and Spirit known as Grinder meetings. *Id.* Feedback

from Boeing to Spirit is formally documented through Boeing's Supplier Quality Information System (SQIS). *Id.*

At Renton, Boeing adds the interior (seats, restrooms, galleys, etc.) into the empty fuselage and integrates aircraft systems such as electrical and hydraulics into the fuselage. Grabon 31:11-13 (August 6). Spirit is not permitted to open or close anything, such as doors or MED plugs, and must instead request access from Boeing. Lund:159:18-160:4 (August 6). All the work that takes place in Renton is under the auspices of Boeing's Quality Management System. MRHP, p 15.

1.1.3.3 Spirit Contractors in Renton

At the time of the manufacture of the subject aircraft in Renton, Spirit's Senior Manager for Manufacturing worked full time in Renton and served as a liaison between Boeing and the following employees of Spirit's contractors – four managers, 20 mechanics and two quality assurance inspectors. Riney 197:5-16; 204:22-23 (August 6). Spirit used contractors in Renton because there is a large availability of skilled mechanics in Washington which allows Spirit to adjust its workforce up or down based on Boeing's requirements. *Id.* at 205:16-19. Spirit's use of contractors is consistent with industry practice.

The role of the managers was to receive requests for rework assistance from Boeing. MRHP, p. 15. The managers would coordinate a plan to rework the parts/assemblies at issue. *Id.* The mechanics would perform the rework per Boeing processes and work instruction documents. *Id.* Boeing quality personnel perform the final inspection of the mechanics' rework. *Id.*

1.1.3.4 Training

Employees of Spirit's contractors in Renton receive mandatory training on Spirit's processes and procedures. MRHP, p. 14. Spirit trainers travel to Renton to provide training on:

- Drilling and Countersinking Sheet Metal Material
- Hazardous Waste Training
- Export Awareness
- Introduction to Hazardous Communications
- Certification Training Requirements and SLS Overview
- Control of Nonconforming Material
- Foreign Object Prevention Program
- Insider Trading
- Counterfeit Parts Training

- Overhead Cab Crane Safety
- Boeing Assembly Sealing of Aircraft Structures
- Boeing Post Assembly Sealing of Aircraft Structures

Id. at 14.

Additionally, Spirit's contractors were provided Boeing and Spirit site-specific processes and procedures training in Renton prior to being allowed to work on the production line. The Boeing/Spirit training includes:

- Boeing Quality System Audits Overview
- Boeing Foreign Object Debris Prevention
- Boeing Hazardous Energy Training
- Boeing Certified Tools Requirement
- Boeing FOD Prevention
- Boeing Standard Methods for Inspections
- Spirit Quality Policy
- Spirit Renton Mechanic Overview and Sign of FAA Encounters
- Spirit Practical Test of Assemblies and Components

Id. at 14-15.

As part of enhancements put in place in mid-2023, Spirit's training process utilizes both a pre-test and a post-test to determine mechanic proficiency and to match mechanics to certain tasks based on their proficiency level. Grabon 117:16-118:1. So, for example, those fasteners requiring hand-drilling are done by more proficient mechanics. *Id.* at 118:2-7. Spirit also began using workplace coaches to help mechanics understand the build and those facets requiring improvement. *Id.* at 118:8-12; 79:23-24. The trainers are usually retired mechanics, familiar with the installation plans being performed. *Id.* at 79:24-80:3.

Spirit's contractors do not receive training on opening and closing exit doors or door plugs because Boeing, not Spirit, performs those functions in Renton.

1.2 MED Plug

1.2.1 History

The MED plug was first introduced on a 737-900ER that was delivered on January 14, 2008. MRHP, p. 4. The first 737-9 with a MED plug installed was delivered on April 23, 2018. *Id.* The MED plugs have always been manufactured by Spirit in Malaysia. Grabon 151:20 (August 6).

1.2.2 Design and Function

At the time of manufacture, Spirit had design responsibility for the MED plug. MRHP, p. 10. This included the build standards and Engineering Drawings. *Id.* The LH MED plug installed on the accident airplane was built per applicable engineering drawings. *Id.* Benefits of using an MED plug include that an MED plug weighs less than a mid-exit door (reduced operating costs), has a full-sized passenger window, and is less structurally complex. NTSB Prelim Report, p. 4.

The MED plug was primarily constructed of aluminum and was installed in the fuselage by means of two upper guide fittings and two lower hinge fittings. MRHP, p. 4. The two upper guide fittings were located on the upper sides of the plug and engage with two upper guide rollers that were fixed to the upper sides of the forward and aft frames common to the fuselage opening. *Id.* Two lower hinge guide fittings were fixed to the lower section of the MED plug and engaged with the two lower hinge fittings that were attached to the frame common to the bottom of the fuselage opening at the lower hinge bracket assemblies. *Id.*

Once the MED plug was in place, it was secured from moving vertically by a total of four bolts. MRHP, p. 4. There was a bolt installed through each upper guide fitting and each lower hinge guide fitting. *Id.* Once these bolts were installed, they were secured using castle nuts and cotter pins. *Id.* Outboard motion of the MED plug was prevented by 12 stop fittings (6 along each forward and aft edge) installed on the fuselage frame structure common to the MED plug. *Id.*

The MED plug was only intended to be opened for maintenance and inspection, which required removing the vertical movement arrestor bolts and upper guide track bolts. MRHP, p. 5. The strap assemblies below the second stop pad from the top restrict the plug from opening further than 15 degrees, suitable for maintenance and inspection purposes. *Id.*

1.2.3 Sourcing, Manufacturing and Inspection

The MED plug was manufactured by Spirit Aerosystems Malaysia in Subang, Malaysia. Grabon 31:1 (August 6). The facility in Subang produces detailed parts as well as assemblies. *Id.* at 31:1-2. After manufacturing, the plug is packaged and shipped to Wichita. *Id.* at 31:2-4. After the door plug is uncrated in Wichita, Spirit's mechanics and quality personnel can raise any identified items or discrepancies to Spirit QA. *Id.* at 198:12-15.

1.2.4 MED Plug Frame

1.2.4.1 Rivet Specifications

Boeing's specification for the rivets governed whether the rivets were conforming. *See* Lund 209:21–210:6; 215:2-5 (August 6). The rivet specifications are set forth in a Boeing drawing, BAC 5004-1.

1.2.4.2 Sourcing, Manufacturing and Integration

The LH MED plug edge frame components installed on Fuselage 8789 (the fuselage of N704AL) were manufactured by Quik Tek Machining, LLC, a Spirit supplier located in Wichita. MRHP, p. 12. Spirit's edge frame supplier has inspection authorization, allowing the supplier to inspect the entire build of the frame prior to its shipment to Spirit. Grabon 138:1-4 (August 6).

Spirit's delegation of inspection authority to external suppliers is contingent on several requirements including but not limited to whether: 1) the supplier has current International Aerospace Quality Group (IAQG) 9100 certification and is in good standing with the IAQG (the IAQG sets the standards for quality within the worldwide aerospace supply chain); 2) the supplier has a quality system which meets the approval of Spirit's Supplier Quality Assurance group; 3) all Spirit Supplier Audit Reports and Root Cause Corrective Actions are completed and closed; and 4) the supplier's First Article Inspection First Pass Yield is over 98% and that level is maintained for a minimum of six consecutive months (or, depending on rate, exceeds 98% over six consecutive receipts). Thereafter, the supplier's maintenance of this delegation authority and the extent of auditing activity by Spirit of the supplier is based upon the supplier's ongoing quality performance. Delegation of inspection authority is common in aircraft manufacturing.

1.2.5 Pre-Rigging of MED Plug by Spirit

Spirit pre-rigs the MED plug. Riney 254:2 (August 6); Lund 254:5 (August 6). Pre-rigging occurs at the end of the fuselage integration process in Wichita. Grabon 136:10-11 (August 6). Spirit does not perform the final rig because the final rigging must be done after the wings are joined to the aircraft and the aircraft is "weight on wheels," with engines installed. Riney 199:9-15 (August 6).

1.2.6 Process for Rework and Associated Removals

Although it is a door crew responsibility, other Boeing employees are permitted to remove and reinstall door plugs. Lund 259:15-18 (August 6). Before removing/opening a door plug, the Boeing employee needs to have a "removal" written by Boeing. *Id.* at 260:11-13. The Spirit contractors do not have access to see whether a removal was written and are not authorized to open or remove doors or door plugs. Riney 261:3 (August 6); Lund 261:6-8 (August 6).

When Boeing raises an issue in Renton, a packet is requested prior to beginning any rework. Riney 203:12-13 (August 6). The packet includes the rework materials including the non-conformance record ("NCR") pickup, drawings associated with the defect, and any associated parts. *Id.* at 203:13-15. When the packet is received, after confirming that all appropriate items are in the packet, Spirit's contractors' managers identify a mechanic to begin the rework. *Id.* at 203:16-20.

The mechanic will go to the aircraft and determine if they have access to the area that needs rework. Riney 203:20-22 (August 6). If there is insufficient access, the mechanic will

request access from Boeing. *Id.* at 203:23-204:3. Spirit contractors do not open and close MED plugs. *Id.* at 221:8; 252:21-22. Instead, Boeing opens the plugs. *Id.* at 221:10-12. Boeing also performs the removals. Lund 211:1-3 (August 6). Similarly, for MED plugs, Boeing performs the reinstallations. *Id.* at 211:9-12.

Regarding work performed in Boeing's Renton factory, Boeing and Spirit have the following responsibilities:

- Boeing was responsible for removing any parts required to access and complete the requested work. Spirit's contractors' personnel were not authorized to remove completed installations.
- Boeing and/or Spirit's contractors were responsible for controlling and processing non-conforming parts.
- Spirit's contractors were required to coordinate a time for their mechanics to perform the required work.
- Boeing was typically responsible for supplying Spirit contractors with any additional supplies or paperwork (i.e. additional removals or removing parts for access) required.

MRHP, p. 23.

After performing the rework, a quality inspector (a Spirit contractor) will inspect the work at the request of Boeing. Riney 204:6-11 (August 6). The work that was performed will be stamped in Boeing's CMES system and Boeing quality personnel will perform the final review of the rework. *Id.* at 204:12-14. Every day an Excel spreadsheet is circulated coding all the work that Boeing requests. *Id.* at 206:25-207:3.

1.2.7 Boeing Inspections and Final Rigging of MED Plug

The flow day work scopes that were typically associated with the MED plug areas include Load Fuselage (Flow Day 1), Check Plug Rigging (Flow Days 1-3), OK to install blankets (Flow Day 1), High/Low Blow (Flow Day 7), MED Plug Fit and Fair (Flow Day 9), and Pre-Flight Low-Pressure Test (aircraft outside). MRHP, pp. 18-19.

Boeing Door Crews are involved with fuselage inspections in Flow Days 1, 2 and 3. MRHP, p. 18. Boeing Door Masters cover Flow Day 10. *Id.* The Door Crew and Door Masters team members are tasked with installing, rigging, and adjusting door parts and assemblies, including MED plugs. *Id.* Door Team members were typically assigned to work MED plug issues as they arose. *Id.*

Boeing door crews/teams "fundamentally do all of the aspects associated with our doors," and perform rig checks on the MED plugs. Lund 212:11-15 (August 6). The MED plug is checked twice at Boeing. *Id.* at 230:17-18. In Flow Day 1 or 2, a rig check is performed on the plug both from the outside of the fuselage and from the inside of the fuselage. *Id.* at 230:19-22. After weight on wheels, on Flow Day 9, Boeing conducts a final inspection of the MED plug. *Id.*

at 227:19-20; 231:1-2. Both inspections and the final rigging of the MED plug are done by Boeing's "door experts." *Id.* at 231:4-6, 254:5-8.

Boeing's final inspection and rigging of the MED plug is dictated by its documented process set out in its Rigging Drawing, which states, in part, "To prepare the body and door plug for plug installation and rigging the fuselage must be on its landing gear or in a stable jig position or an equivalent documented fixture." *See* Rigging Drawing, Section 2.0, NTSB Exhibit 11-U ("Excerpts from Boeing Mid Exit Door Plug Rigging Drawing"). Similarly, Section 5.2 of the Rigging Drawing, labeled "Final inspection criteria," notes that the final inspections "are to be checked with the aircraft at a minimum on its landing gear (not jacked)." *See id.* at Section 5.2.

Boeing's Rigging Drawing also mandates that an operational check of the plug be performed. *See* Section 5.2.1. This section of the rigging Drawing is labeled "Operational Check," and instructs Boeing to "Operate the completed plug and verify that it operates smoothly while clearing all body structure." *See id.*

Accordingly, the governing process document requires that Boeing: 1) install and rig the MED plugs after "weight on wheels," at the end of the production line in Renton; and 2) open and close the plug to ensure it does so smoothly and without interference from the surrounding fuselage. The MED plug cannot be operated without first removing the arrestor bolts. Thus, adherence to its Rigging Drawing ensures that any missing arrestor bolt would be identified and corrected by Boeing.

Boeing's practice, however, was not to open the MED plugs when this IP was performed. Instead, the gaps around the plugs were measured and the plugs were checked for proper flushness to the fuselage. Following the accident, Boeing changed the drawing to make it clear that the MED plug would not be operated during this IP.

1.2.8 Documentation and Recordkeeping

Engineering requirements for the manufacture of the fuselage are contained in engineering drawings and Boeing Product Standards. MRHP, p. 8. Spirit's work is governed by Installation Plans (containing the work instructions and components to build the fuselage specific to customer requirements). *Id.* Regarding quality assurance, quality notification documents include pickups (nonconformance records generated when parts and assemblies can be reworked to conformance), quality notifications (used to record nonconforming conditions that cannot be reworked to conformance and require engineering disposition), supplier non-conformance notifications (a nonconformance that is not completed at Spirit and requires reworks at Boeing), and ship shorts (when hardware, parts or material are not available to complete work prior to the unit shipping). *Id.* at 9.

Spirit complies with Boeing's contractual requirements regarding record retention. MRHP, p. 9. Spirit makes records available to Boeing and regulatory authorities as required. *Id.* Engineering documents are typically kept for the life of the type certificate and non-conformance records are kept for the life of the product. *Id.* Manufacturing Process and Evaluation Records, Quality Assurance Production Records, and FAA Certificates of Airworthiness and Conformity are kept for the calendar year plus 10 years from the date of shipment. *Id.*

After the fuselage arrives in Renton, any quality notifications are entered into Boeing's CMES. Boeing's process documents include items such as Initiate Rework Nonconformance Records, Initiate or Revise a Disposition Required Nonconformance Record, and Perform Part or Assembly Removal. MRHP, pp. 15-16. Opening an MED plug, even slightly, requires removing the bolts and constitutes a removal. Lund 274:4-13 (August 6). All removals must be recorded in CMES. *Id.* at 274:18.

1.3 Left-Hand MED Plug and Door Frame of N704AL

1.3.1 Manufacture and Pre-Rigging

The left-hand MED plug of N704AL was manufactured by Spirit AeroSystems Malaysia on March 24, 2023, and was received at Spirit AeroSystems Wichita on May 10, 2023. MRHP, p. 4.

The Spirit AeroSystems Malaysia Production Order showed discrepancies for the LH MED plug during manufacture. MRHP, p. 11. One discrepancy was for mechanics not recording torque wrench serial numbers in the production order and another discrepancy was for mechanics not providing the sealant/paint information in the production orders. *Id.* Both discrepancies were fully corrected per Spirit's process. *Id.*

Both the LH and RH MED plug edge frames components installed on the fuselages during production were manufactured by a Spirit supplier, Quik Tek. MRHP, p. 12. The edge frame components were delivered to Spirit, placed in inventory, and stored in the factory. *Id.*

On Fuselage 8789 the LH edge frame components were first installed on a MED edge frame locating jig and then installed on the fuselage, per Spirit AeroSystems Production Order 46534209. MRHP, p. 12. There were no Quality Notifications ("QNs") associated with the installation. *Id.* The LH edge frame installation on Fuselage 8789 was started on June 16, 2023, and finished on June 19, 2023. *Id.*

The LH MED plug was installed and pre-rigged on fuselage 8789 on July 18, 2023, per Production Order 46554596. MRHP, p. 12. There was one Quality Notification, QN NW0002407062, "Route Fuselage Opening – LH Mid Exit Door," specific to the LH MED plug. *Id.* The discrepancy was for the seal flushness being out of tolerance by 0.01 inches. *Id.* No manufacturing rework was required as Spirit Engineering determined the condition was structurally and functionally acceptable, and did not adversely affect the fit, form, or function of the installation. *Id.*

The LH MED plug installed on the accident airplane had the following data plate and written marking information:

Data Plate:

Aircraft Mod. 737
MFR Code: Y0279
Part No. 146A6202-9101
Serial No. Y0279-000153
Cont. Insp. SAA 101 QU (Stamp)

Marking:

Aircraft Mod: 737
MFR: Y0279
Part No.: 146A6202-9101
Serial No. Y0279-0000153 (sic)
Line Unit: 8799
Made in Malaysia

MRHP, p. 10.

The close and verify pre-rig of the LH MED plug on Fuselage 8789 was accomplished on July 28, 2023, per Production Order 46606906. MRHP, p. 12. The four arrestor bolts that prevent upward movement of the MED plug were installed during the accomplishment of this production order. *Id.* There was no “traveled work²” for Fuselage 8789 prior to shipment. *Id.* at 13. The fuselage arrived at Boeing’s Renton, Washington, facility on August 31, 2023. *Id.* at 19.

1.3.2 Replacement of Five Door Frame Rivets

On September 1, 2023, Boeing issued NCR N1450292531. *See* NTSB Investigative Hearing Exhibit 11B. The record type of the NCR was listed as “rework – shake” and, under a column labeled “discrepancy,” enumerates five “defects.” *Id.* Each “defect” is described as a “clinched” fastener rivet. *Id.* The rivets are noted as “damaged” and “marked with orange tape.” The location is “edge frame – mid exit door.” *Id.* Boeing also issued a non-conformance order for the NCR - NCO 145-8789-RGEN-RSHK-002NC, titled “Damaged Rivets.” *Id.* Entries under a column labeled “Narrative,” correspond to the five “defects” listed in the NCR. *Id.*

The rivet issue raised by Boeing in Renton was not detected by Spirit in Wichita; conforming items do not generate documentation. Riney 201:21-24 (August 6). An on-site audit of the door frame supplier was performed in January 2024 and did not reveal any discrepancies. *Id.* at 202:2-18.

On September 7, 2023, Boeing issued NCR N1450293199, which they listed as “Rework-General.” *See* NTSB Investigative Hearing Exhibit 11C. It states:

Supplier stamped all inspection points stating removed and replaced rivets per [REDACTED]. Rivets were not replaced and was just painted over. There was no access on the other side of the part to replace those rivets and no removals were made.

Elizabeth Lund, Chair, Quality Operations Council, Senior Vice President, Quality at Boeing Commercial Airplanes, testified that Boeing personnel disagreed with “Spirit” personnel

² Traveled work refers to jobs/tasks which are delayed and/or completed in a factory location other than what was originally planned. MRHP, n. 5. Traveled work takes longer to complete in terms of labor hours, and incomplete work can interfere with manufacturers’ ability to complete other planned work causing cascading delays. *Id.*

(the “Spirit” personnel were Spirit contractors) as to whether the replaced rivets were conforming:

.... The five discrepant rivets were identified on September 1st and the nonconformance was written.

....On September 8th, Spirit replied in the system to that tag that the rivets were acceptable as is, and did not need to be removed and replaced, that they were compliant with the process specification.

See Lund 214:9–215:5 (August 6). This testimony was consistent with remarks Ms. Lund had made in statements prior to the hearing wherein she noted there was a dispute as to whether the replaced rivets were conforming.³ Ms. Lund further stated that the rivets that were replaced “did not create a safety hazard.”⁴

The disagreement with Boeing as to whether the rivets were conforming or required replacement was also discussed in the testimony of Mike Riney, Spirit’s Senior Manager – Manufacturing:

Based on the discussion with the mechanics, I believe they felt the rivets were acceptable. That may have required removal of paint or the secondary primer application. And then to reapply paint. And then that's why they then stated on the Boeing's unauthorized rework pickup that they believe that the rivets met the requirements. I think that's image three. I think I was referring to image four, but yeah. So that's why -- that -- based on that image, that's why I believe that felt the rivets -- and that's a number five rivet, that's a very small rivet. So, you're looking at a blown up image. But that's why I believe that they felt that the rivet tails were acceptable.

[The contract mechanic] believed that the rivets met the BAC 5004-1 specification. When that was identified by the Boeing quality individual, they had written a[n] unauthorized rework pickup because the incorrect information was identified on the original pickup. And at that point, the mechanic working with the Spirit contract manager ... stated that they had believed that the rivets met the BAC 5004-1 specification. In the Boeing timeline, this is also shown, and that's where the disagreement with the Boeing QA was identified. And then, they in turn rejected Spirit's statement, and requested the rivets be removed and replaced.

See Riney 229:1-12; 220:7-25 (August 6).

The Non-Conformance Record and Non-Conformance Order produced by Boeing, do not indicate whether Boeing personnel ever measured the replaced rivets to determine whether they conformed to the relevant Boeing specification – BAC 5004-1. *See* NTSB Investigative Hearing

³ *See Boeing’s Unforced Error*, The Air Show Podcast, June 28, 2024, 4:25-4:57 (minutes:seconds).

⁴ *See* NTSB Memorandum for Record from Doug Brazy dated August 4, 2024, p. 15.

Exhibit 11B – NCR N1450292531 and NCO 145-8789-RSHK-1296-002NC. Instead, the documents merely state, “rivet is damaged” and “damaged rivets are not acceptable.” *See id.*

BAC5004-1 is a Boeing Process Specification for Solid Rivet Installation. A diagram of a clinched rivet – the “defect” described by Boeing in NCR N1450292531 – is shown in Figure 10 – Deformed Driven Button Conditions - under Section 11.2.4, “Deformed Driven Button.” Section 11.2.1b(1)(c) states “Accept small clinching of the rivet if the minimum rivet driven button dimensions are met.”

Specific measurements are needed in the write-up to assess conformance. Riney 243:11-16 (August 6). In fact, it was the Spirit contractors, not Boeing, who documented that the rivet holes were measured. *See* NTSB Investigative Hearing Exhibit 11B, NCO 145-8789-RSHK-1296-002NC, September 18 entry. The September 18 entry by the Spirit contractors, however, documented the results of the replacement of the rivets and therefore does not shed light on whether the original rivets were conforming.

The fact that the Boeing specification, and not a subjective aesthetic determination, governs whether the rivets were conforming, was further made clear by the testimony of Scott Grabon, the Senior Director, 737/P8 Quality for Spirit:

MR. CRUZ: So, in discussions with Spirit personnel, the investigative team heard the term defect and nonconformity in manufacturing. Can you describe the difference?

MR. GRABON: Nonconformance is a -- it's an item that does not meet the engineering requirements. The term defect, it's difficult with the word defect. Everything is a nonconformance in the quality. A defect can be a nonconformance. But just because there is a defect, it doesn't necessarily mean there's a nonconformance. And I think that's a, that's an important note we can -- you can see something that is ugly, but it doesn't mean it's a nonconformance.

See 33:25–34:11 (August 6). *See also* Riney 243:11-16 (August 6) (noting some conforming parts might not be aesthetically appealing).

Despite the disagreement regarding the rivets’ conformance, the rivets were replaced, because Boeing’s QMS governs work in Renton and Boeing requested the rework. Riney 243:20-21; 220:20-23 (August 6); Lund 213:24-215:5 (August 6). Boeing issued NCO 145-8789-RSHK-1296-001NC with respect to NCR N1450293199. *See* NTSB Investigative Hearing Exhibit 11C. Under a heading labeled “Final Acceptance,” the NCO notes that on September 19, Boeing applied its Final Quality Acceptance, noting “Final quality acceptance per [REDACTED]. All prior inspection and work performed by supplier.”

1.3.3 Removal of the MED Plug by Boeing

To provide access for Spirit’s contractors to replace the five rivets that Boeing wanted replaced, Boeing manufacturing personnel were responsible for opening and closing the completed MED plug installation. MRHP, p. 24. Opening the MED plug required the removal of

the four arrestor bolts that prevent upward movement of the MED plug.⁵ *Id.* Per the Boeing process “Perform a Part or Assembly Removal,” removal of the bolts would have required a removal record to be initiated. *Id.*

In Boeing’s Shiplside Action Tracker⁶, Boeing noted that it would need to remove the MED plug so Spirit’s contractors’ mechanics could remove and reinstall the rivets. Lund 215:17-21 (August 6). Boeing generally relays the need to remove the plug by asking a Boeing door team member to remove the plug and provide access to the area. *Id.* at 217:23-24.

Notwithstanding the requirement to the contrary, there is no paperwork documenting Boeing’s opening or removal of the aircraft’s left-hand MED plug. Lund 219:6 (August 6). If the paperwork had been generated by Boeing as its own procedures required, Boeing would have discovered that it had not reinstalled the arrestor bolts. *Id.* at 218:20-219:2.

When the Boeing quality inspector approved the rivet rework done by the Spirit contractors on September 19, the door plug would have still been open. Lund 262:5 (August 6). At that point, the Boeing manager or team lead would identify Boeing’s next task as the reinstallation of the plug. *Id.* at 262:8-14. Upon reinstallation of the door, the quality stamp should be applied to the removal paperwork. *Id.* at 277:9-12.

1.4 Post-Accident Examinations and Observations

The NTSB’s investigative team conducted a post-accident examination of the left-hand MED plug and its installation hardware. MRHP, p. 6. Observed damage patterns and absence of contact damage or deformation around holes associated with the vertical movement arrestor bolts and upper guide track bolts in the upper guide fittings, hinge fittings, and recovered aft lower hinge guide fitting indicated that the four bolts that prevent upward movement of the MED plug were missing before the MED plug moved upward off the stop pads. *Id.*

1.5 FAA Oversight

At Spirit’s facility in Wichita, the FAA audits Boeing’s oversight of Spirit to ensure Spirit builds articles that conform to the product design and the contractual flow-down requirements. Kilgroe 292:10-13 (August 7). This is because Boeing, as the production approval holder, is responsible to ensure Spirit is complying with the applicable quality requirements. *Id.* at 292:16-20. The FAA has always had personnel at Spirit and now they have a dedicated office within Spirit’s facility in Wichita. *Id.* at 291:13-20.

Scheduled FAA surveillance audits of Spirit are communicated by the FAA to Boeing and Boeing advises Spirit. These audits are performed with the assistance of Boeing and Spirit. Brown 255:13-18 (August 7). At the end of the audit, there is a briefing, the audit findings are provided by the FAA to Boeing, and follow-up communications with the FAA were done through

⁵ There is no evidence the door plug was opened between July 28, 2023, and the date the fuselage was delivered to Boeing on August 31, 2023. Lund 263:23 (August 6); Riney 263:24 (August 6). At the time the fuselage was delivered to Boeing, the four arrestor bolts were properly installed and in place. Lund 264:3 (August 6).

⁶ Spirit does not have access to the Shiplside Action Tracker. Riney 206:20-22 (August 6).

Boeing. *Id.* at 255:17-21. The FAA would also conduct surprise audits of Spirit. *Id.* at 255:24. The FAA conducted 18 audits of Spirit in 2023. *Id.* at 255:12-13.

1.6 Boeing Oversight of Spirit

Boeing has an onsite team at Spirit in Wichita. Brown 279:21 (August 7). In 2023, Boeing conducted approximately 95 audits of Spirit. *Id.* at 279:21-23.

1.7 Spirit's QMS and Supplier Source-Inspections and Delegated Authority

1.7.1 Overview of Spirit's QMS

Spirit is an AS9100 certified facility, meaning that its quality management system conforms to the international standards for aerospace manufacturing. Grabon 29:7-10 (August 6). Spirit accomplishes this by using approximately 250 quality inspectors who perform both in-process as well as final inspections. *Id.* at 29:9-11. In addition, Boeing and the FAA had, at the time Fuselage 8789 was built, and currently, personnel on site at Wichita to oversee quality and regulatory compliance. *Id.* at 29:12-14. Boeing's on-site personnel and Spirit personnel have multiple discussions a day that are focused on information-sharing and product quality. Gregg Brown 25:13-18 (August 7).

Spirit's QMS also details the roles and responsibility for conducting inspections, tests, and audits. Gregg Brown 32:8-9 (August 7). It also defines the processes to be audited across the entire business plan and helps drive the development of work instructions and the insertion of inspection points. *Id.* at 25:19-23. All Spirit employees have access to the QMS policies and procedures and are taught how to access them in initial training. *Id.* at 32:1-3. And then the inspection points are made available to mechanics and inspectors as they are assigned job tasks. *Id.* at 32:3-5.

Spirit's quality system includes multiple tools such as compliance walks, inspections, audits, and Quality 360, Spirit's voluntary reporting system. The information that is obtained inputs into Spirit's risk mitigations. Gregg Brown 22:18-21 (August 7). The data is aggregated within Spirit's Quality department and is disseminated to the production leaders and program leaders. *Id.* at 23:2-5. Weekly corrective action boards review any adverse trends. *Id.* at 23:5-6. The data are compared to the control limits, corrective action plans are developed with the relevant process owner and are then monitored to achieve the desired result. *Id.* at 23:7-10.

1.7.2 System Enhancements Implemented 2019-2023

The main elements of Spirit's QMS that are part of AS9100 and ISO9001 have stayed the same and are verified through auditing. William Brown 44:24-45:2 (August 7). Within the QMS, however, over the last five years, system enhancements have been made through automated drilling improvements, increased investment into the Manufacturing Execution System (MES) throughout the 737 system, and increased investments into process product verifications. *Id.* at 44:23-45:7.

Spirit also brought in an outside auditor to audit the training program which resulted in an employee proficiency verification process. William Brown 45:14-18 (August 7). During that

two-to-three-month process, Spirit audited employees' ability to understand the manuals, tools, engineering, and standard processes that were applicable to the tasks they perform. *Id.* at 45:19-22. That information was then provided to help inspectors inspect the critical process points. *Id.* at 46:3-4.

In the second quarter of 2023, Spirit also incorporated by a feedback loop by developing its Quality 360 program, which allows for feedback both anonymously and non-anonymously. William Brown 46:3-13 (August 7); Gregg Brown 132:10-13 (August 7). There has been a steady increase in reports, demonstrating Spirit's effort to promote the use of Quality 360, is succeeding. Gregg Brown 132:12-13 (August 7). Also, the percentage of reports that are being submitted non-anonymously increased, demonstrating increased trust from Spirit's workforce. *Id.* at 132:13-16.

1.7.3 Supplier Source-Inspections and Delegated Authority

For a description of Spirit's inspection authorization process, please see Section 1.2.4.2, above. If the supplier has delegated authority to inspect, Spirit's Supplier Quality Audit Team will audit their inspection processes and procedures. Grabon 72:14-23 (August 6). The Supplier Quality Audit Team visits suppliers on a regular basis to review their processes and procedures similar to how Boeing audits Spirit. *Id.* at 72:15-18.

1.8 Spirit's Safety Actions

In 2024, after the Alaska Airlines accident, Spirit implemented several safety initiatives, including:

- Added inspection points on MED plugs;
- Replicated inspections documented by MOM-MOM-24-0010-01B(R4);
- Changed manufacturing planning build validation for the MED plugs (to ensure the upper guide track bolts and vertical movement arrestor bolts have been installed correctly and cotter-pinned per procedures);
- Jointly performed Safety Management Risk Assessment(s) with Boeing, which identified and prioritized critical installation plans to incorporate mitigating actions;
- Targeted employee communications (e.g. Quality Standdown/Town Hall with Boeing/Customer Messaging);
- Received and analyzed regulatory and Boeing audit data, airline customer feedback to improve the quality management system; and

- Implemented final product acceptance jointly with Boeing to improve quality and reduce ‘traveled work.’⁷

MRHP Report, p. 52.

Moreover, prior to the accident, Spirit had voluntarily undertaken the implementation of the fundamentals of an SMS program throughout the company. MRHP Report, p. 52. After the accident, the implementation plan for the SMS program was accepted by the FAA. In addition, Spirit conducted a focused assessment of the skills, performance and training of production/audit/inspection of personnel. MRHP Report, p. 52.

Other changes include: 1) expanding training to six to eight weeks (George 103:18-19⁸) (August 6); adding another two weeks of on-the-job (OJT) training specific to the job to be performed (*id.* at 103:20-23); and 3) Spirit’s training now also provides greater alignment to Boeing specifications to reduce disagreement regarding non-conformances. Gregg Brown 49:8-13 (August 7).

2. Analysis

2.1 The Arrestor Bolts Were in Place When the Left-Hand MED Plug Entered Boeing’s Factory in Renton

Spirit performs a pre-rig at the end of the fuselage integration process in Wichita, at which time the arrestor bolts are installed. Grabon 136:10-19 (August 6); Lund 254:5 (August 6). Final inspections validate that the pre-rig has been completed. Grabon 135:15-18 (August 6). At the end of the line, a final FOD walk is performed by Spirit and Boeing to validate there are no parts or other FOD in the fuselage. *Id.* at 88:18-25.

For Fuselage 8789, the close and verify pre-rig of the LH MED plug was accomplished on July 28, 2023, per Production Order 46606906. MRHP, p. 12. The four bolts that prevent upward movement of the MED plug were installed during the accomplishment of this production order. *Id.*; Lund 263:16 (August 6).

The fuselage arrived at Boeing’s Renton, Washington, facility on August 31, 2023. MRHP, p. 19. Boeing admits that there is no evidence the door plug was opened between July 28, 2023, and the date the fuselage was delivered to Boeing on August 31, 2023. Lund 263:23

⁷ Beginning on March 1, 2024, after Spirit finalizes the build and final inspections of the aircraft, the fuselage undergoes a final product verification. Grabon 89:11-14 (August 6); Ackerman 154:21-24 (August 6). In final product verification, the completed fuselage is inspected by both the Boeing team and the Spirit team. Grabon 89:15-16 (August 6). These are known as “shoulder-to-shoulder” inspections because the two teams inspect the entire fuselage together. Gregg Brown 49:5-8 (August 7). Any discrepancies are documented in Spirit’s Quality Management System, reworked, and then re-inspected by Boeing. Ackerman 155:2-3 (August 6); Grabon 89:18-21 (August 6). The changes made since the accident have resulted in a significant reduction in re-work hours in Renton. Ackerman 155:11-14 (August 6).

⁸ The public hearing transcript erroneously reads “six day a week” instead of “six to eight weeks.” See George 79:1 (August 6), for another reference to the “six to eight week training.”

(August 6); Riney 263:24 (August 6). At the time the fuselage was delivered to Boeing, the four arrestor bolts were properly installed and in place. Lund 264:3 (August 6).

Boeing's inspections confirmed that the MED plug was properly configured, with arrestor bolts intact, when Fuselage 8789 arrived at Boeing's facility in Renton. Upon arrival, the fuselage went into Boeing Flow Days 1-3. MRHP, p. 18. During Flow Days 1-3, Boeing Door Crews inspect the fuselage. *Id.* During Flow Day 1 or 2, Boeing performs a rig check of the MED plug from both the inside and outside of the fuselage. Lund 44:17-47: 1, 254:3-10, and 230:11-231:6 (August 6). No defects were noted on the left-hand MED plug. Riney 200:14-15 (August 6). The IP for Boeing for that rig verification was closed out on September 5. *Id.* at 200:15-16.

2.2 Boeing Removed the Arrestor Bolts of the Left-Hand MED Plug in Renton

In Renton, Spirit is not permitted to open and/or close anything, such as doors or MED plugs, and must instead request access from Boeing. Lund:159:18-160:4 (August 6). Although it is a door crew responsibility, certain other Boeing employees are permitted to remove and reinstall door plugs. *Id.* at 259:15-18. Before removing/opening a door plug, the Boeing employee needs to have Boeing write a removal. *Id.* at 260:11-13. The Spirit contractors do not have access to see whether a removal was written. Riney 261:3 (August 6); Lund 261:6-8 (August 6).

To provide access for Spirit contractors to replace the five rivets that Boeing wanted replaced, Boeing manufacturing personnel were responsible for opening and closing the completed MED plug installation. MRHP, p. 24. Opening the MED plug required the removal of the four bolts that prevent upward movement of the MED plug. *Id.* If rework is requested by Boeing, and a mechanic employed by a Spirit contractor requires access, the mechanic will request access from Boeing. Riney 203:23-204:3 (August 6).

Spirit contractors do not open and close MED plugs. Riney 221:8; 252:21-22 (August 6). Instead, Boeing is asked to open the plugs. *Id.* at 221:10-12. Boeing personnel perform the removals. Lund 211:1-3 (August 6). Similarly, for MED plugs, Boeing performs the reinstallations. *Id.* at 211:9-12.

Regarding rework performed in Boeing's Renton factory, Boeing and Spirit had the following responsibilities:

- Boeing was responsible for removing any parts required to access and complete the requested rework. Spirit's contractors were not authorized to remove completed installations.
- Boeing and/or Spirit's contractors were responsible for controlling and processing non-conforming parts.
- Spirit's contractors were required to coordinate a time to perform the requested rework.

- Boeing was typically responsible for supplying Spirit’s contractors with any additional supplies or paperwork (*i.e.* additional removals or removing parts for access) required.

MRHP at 23.

2.3 Boeing Failed to Generate Removal Paperwork Showing It Had Removed the Arrestor Bolts of the Left-Hand MED Plug

Per the Boeing process, *Perform a Part or Assembly Removal*, removal of the arrestor bolts to allow the rivets of the door frame to be reworked would have required a removal record to be initiated. MRHP, p. 24. One of the purposes of this requirement is to ensure removed items are reinstalled and reinspected by Boeing’s Quality Assurance Inspectors.⁹ *Id.* Boeing, however, failed to generate the removal paperwork for its removal of the arrestor bolts of the left-hand MED plug. *Id.* This failure to generate removal paperwork was a quality assurance breakdown resulting in a missed opportunity for Boeing to notice that its mechanics had failed to reinstall the arrestor bolts that they had removed.¹⁰

2.4 Boeing Failed to Perform a Final Rigging and Operational Check of the Left-Hand MED Plug

The final rigging of the MED plug is dictated by Boeing’s documented process set forth in its Rigging Drawing. The Rigging Drawing states, in part, “To prepare the body and door plug for plug installation and rigging the fuselage must be on its landing gear or in a stable jig position or an equivalent documented fixture.” *See* Rigging Drawing, Section 2.0, NTSB Exhibit 11-U (“Excerpts from Boeing Mid Exit Door Plug Rigging Drawing”). Similarly, Section 5.2 of the Rigging Drawing, labeled “Final inspection criteria,” notes that the final inspections “are to be checked with the aircraft at a minimum on its landing gear (not jacked).” *See id.* at Section 5.2.

Boeing’s Rigging Drawing also mandates that an operational check of the plug be performed. *See* Section 5.2.1. This section of the rigging Drawing is labeled “Operational Check,” and instructs Boeing to “Operate the completed plug and verify that it operates smoothly while clearing all body structure.” *See id.*

Accordingly, the governing process document requires that Boeing: 1) install and rig the MED plugs after “weight on wheels,” at the end of the production line in Renton; and 2) open and close the plug to ensure it does so smoothly and without interference from the surrounding fuselage. The MED plug cannot be operated without first removing the arrestor bolts. Thus, adherence to the Rigging Drawing ensures that any missing arrestor bolt would be identified and corrected.

⁹ When the Boeing quality inspector approved the rivet rework done by the Spirit contractors on September 19, the door plug would have still been open. Lund 262:5 (August 6). At that point, the Boeing manager or team lead should identify Boeing’s next task as the reinstallation of the plug. *Id.* at 262:8-14. Upon reinstallation of the door, the quality stamp should be applied to the removal paperwork. *Id.* at 277:9-12.

¹⁰ Boeing is responsible for reinstalling MED plugs that it removes. Lund 211:9-12.

Boeing's practice, however, was, contrary to its own requirements, not to open the MED plugs when this IP was performed. Instead, the gaps around the plugs were measured and the plugs were checked for proper flushness to the fuselage. Following the accident, Boeing revised the drawing to make it clear that the MED plug would not be operated during this IP.

The fact Boeing did not notice that the arrestor bolts were missing during the operational check of the plug, indicates that Boeing followed its practice of disregarding the language of its own inspection process with respect to its final assembly of the aircraft. Had Boeing followed its published procedure, Boeing would have noticed that it had failed to replace the arrestor bolts it had removed.

3. Conclusions

3.1 Findings

- 3.1.1 Whether the Rivets on the Left-Hand MED Plug Frame Required Replacement Depended on Conformance to Boeing's Specifications
- 3.1.2 Boeing Personnel and Spirit Contractors Disagreed on Whether the Original Left-Hand MED Plug Frame Rivets Conformed to Boeing's Specifications
- 3.1.3 Boeing Records Do Not Demonstrate that the Original Rivets of the Left-Hand MED Plug Frame Were Non-Conforming
- 3.1.4 The Replaced Rivets on the Left-Hand MED Plug Frame Did Not Present a Safety Issue
- 3.1.5 The Rivets on the Left-Hand MED Plug Frame Did Not Contribute to the Left-Hand MED Plug Disengaging During Alaska Airlines Flight 1282
- 3.1.6 The Left-Hand MED Plug Disengaged During Alaska Airlines Flight 1282 Because the Arrestor Bolts Were Missing
- 3.1.7 The Arrestor Bolts Were Present and Functioning as Intended When the Fuselage of N704AL Arrived in Renton
- 3.1.8 The Arrestor Bolts Were Removed by Boeing in Renton
- 3.1.9 Boeing Failed to Generate Removal Records for its Removal of the Arrestor Bolts Which Would Have Triggered a Boeing Quality Inspection of the Plug and the Reinstallation of the Arrestor Bolts
- 3.1.10 Boeing Failed to Reinstall the Arrestor Bolts

- 3.1.11 Boeing's Manufacturing Process Specifies that Boeing Must Perform a Final Rigging and Operational Check of the MED Plug Before it Delivers the Aircraft to its Customer
- 3.1.12 Boeing Failed to Follow its Own Final Rigging and Operational Check of the Plug Which Would Have Revealed the Arrestor Bolts were Missing
- 3.1.13 Investigation Did Not Reveal That Any Spirit Process, Employee or Contractor Played a Role in the Left-Hand MED Plug Separation

3.2 Probable Cause

The separation of the left-hand MED plug during Alaska Airlines Flight 1282 was caused by Boeing's failure to re-install the arrestor bolts it had removed. Contributing to this failure was Boeing's failure to generate a removal record for its removal of the arrestor bolts and its failure to follow its own published procedure for a final rigging and operational check of the plug.