NATIONAL TRANSPORTATION SAFETY BOARD
Investigative Hearing
Alaska Airlines Flight 1282
Boeing 737-9, N704AL
Left Mid Exit Door Plug Separation in Portland, OR
January 5, 2024

Docket No.	SA-543
EXHIBIT	
2A	

Operational Factors Group Chairman's Factual Report

(35 Pages)

National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

DCA24MA063

OPERATIONAL FACTORS

Group Chair's Factual Report

June 24, 2024

TABLE OF CONTENTS

A. ACCIDENT

Location: Portland, Oregon
Date: January 5, 2024
Time: 1714 Pacific standard time (PST)
0114 Universal Coordinated Time (UTC)[1]
Airplane: N704AL Boeing 737-9

B. OPERATIONAL FACTORS GROUP

Group Chair	Starr Blum NTSB AS-30 – Operational Factors Washington D.C.
Group Member	Marvin Frantz NTSB AS-30 – Operational Factors Chief Washington, D.C.
Group Member	Gary Pitchford FAA Cascadia Aircrew Program Manager Seattle, WA
Group Member	Ryan Iwasaki Boeing – Senior Safety Pilot Seattle, WA
Group Member	Dennis Vorpahl ALPA – Check Airman Seattle, WA
Group Member	JP Wilson Alaska Airlines – PDX Base Chief Pilot Portland, OR

C. SUMMARY

On January 5, 2024, about 1714 Pacific standard time, Alaska Airlines flight 1282, a Boeing 737-9[2], N704AL, returned to Portland International Airport (PDX),

[1] Pacific standard time. All times within this report are PST unless otherwise noted. At the time of the accident UTC time was PST + 8 hours.
[2] 737-9 is synonymous with MAX in this report. The Boeing Company 737-100, 737-200, 737-200C, 737-300, 737-400, 737-500, 737-600, 737-700, 737-700C, 737-800, 737-900, 737-900ER, 737-8, 737-9. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.

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 International Airport (ONT), Ontario, California.

D. DETAILS OF THE INVESTIGATION

1.0 OPERATIONAL FACTORS GROUP ACTIVITIES

January 5, 2024 -The Operational Factors investigator was notified of the accident and made travel arrangements.

January 6, 2024 – The Operational Factors investigator arrived in Portland, Oregon. An operational factors group was formed at the organizational meeting. The following documents were requested from Alaska Airlines; flight crew schedules, flight crew records, Minimum Equipment List (MEL), Flight Operations Manual (FOM), Flight Handbook (FH), Quick Reference Handbook (QRH), Quick Reference Checklist (QRC), normal checklists, and Aircraft Communication Addressing and Reporting System (ACARS) data.

January 7, 2024 – The operational factors group recorded the interviews with the pilots of the Boeing 737-9 for transcription purposes and participated in the progress meeting. Detailed crew statements from Alaska Airlines flight 1284 on January 3 and Alaska Air flight 356 on January 4, 2024, were requested from the respective pilots. These two flights were made by the accident airplane.

January 8, 2024 – Pilot certification packages from the FAA was requested for the accident pilots. The operational factors group composed supplemental follow-up questions for the captain after his interview. The questions concerned flight deck and flight attendants' communications after the rapid decompression, and autopilot engagement throughout the flight to reconcile reported autopilot use with Flight Data Recorder (FDR) data from the accident flight. Responses from the captain were received and the operational factors group's Field Notes were begun.

January 9, 2024 – The group compiled a history of flight/sequence of events narrative based on crew interviews and FDR data. The operational factors group field notes were completed, and the group members were released.

April 10, 2024 - The operational factors group met at Alaska Airlines Longacres simulator training facility in Seattle, Washington. The group documented the oxygen mask mock-up trainer and the communications and oxygen masks differences in the Boeing 737 New Generation (NG)[3] and 737-9 simulators. A simulator evaluation was conducted, and documentation of various indications were accomplished. Scenarios included normal as well as non-normal procedures (see Operational Factors – Attachment 5 - Simulator Evaluation for further information).

April 11, 2024 – The operational factors group interviewed the Alaska Airlines Managing Director of Flight Training and the Alaska Airlines instructors who conducted the accident pilots' most recent simulator checks. The interview was recorded for transcription purposes.

2.0 HISTORY OF FLIGHT

The accident flight was the first leg of the flight crew's 1-day pairing, which consisted of a round trip from PDX-ONT-PDX. The crew was off duty the day prior to the event. The flight departed PDX about 26 minutes late due to the airplane requiring deicing. According to the dispatch briefing packet[4], the total time for the flight from PDX to ONT was projected to be 1 hour and 44 minutes.

The crew stated that they arrived at the airplane about 1540, with a proposed departure time of 1640, for their first flight of the day. During their preflight they noticed three write-ups in the maintenance logbook[5]. They discussed the airplanes MEL items that were deferred for the flight, which included a forward galley latch and the right main aft fuel boost pump.

According to the crew interviews, the First Officer (FO) stated the external preflight walkaround was normal, except she noticed there was ice on the wing. The crew asked for an ice check to be performed and the airplane was deiced prior to taxiing. The captain conducted the departure briefing which included the threats of de-icing, previous cabin pressure controller auto-fail light write-ups, and the inoperative right main aft fuel boost pump. The flight taxied out to runway 28L and departed about 1706. Visual meteorological conditions were present at the time and the captain conducted the takeoff. Both crewmembers reported the pushback, taxi and takeoff were uneventful.

The captain and FO stated in the interviews that after departure they checked in with the Seattle Air Route Traffic Control Center and were issued a climb clearance to

[3] 737 NG is the name given to the 737-600, 737-700/-700ER, 737-800, and 737-900/-900ER airplanes.
[4] The Alaska Airlines briefing packet contains the dispatch release, flight plan, performance data, weather, and Notice to Air Missions (NOTAM's).
[5] Source: Attachment 1 – Crew Interviews and Statement.

FL 230[6] and to proceed to CHISM[7]. Climbing through 10,000 ft msl[8], the FO verified the pressurization was normal. The captain stated, "climbed to roughly 16,000 ft. Loud bang, ears popping, my head got pushed up into the HUD and my headset got pushed off, not off my head, but almost off my head."[9] The FO first noticed her ears popped and reported that simultaneously her headset blew off, the flight deck door blew open, and the cabin altitude warning horn sounded. She pushed the altitude warning cutout switch to cease the continuous audible alert. She further reported that in her "peripheral view, I saw the door open. I saw the cabin tubes hanging from the ceiling. And at that point my focus was forward, and I yelled get down, get down. And I didn't hear much. It was very loud".[10] The FO stated that she saw the hand of a flight attendant shut the flight deck door, which it remained closed for the remainder of the flight.

The captain and the FO donned their oxygen masks, and the captain asked the FO to declare an emergency and get a lower altitude. The FO did not know where her headset was, so she pushed the 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. ATC instructed them to fly heading 340 degrees to return to PDX. The FO reached to the top of the glareshield panel to retrieve the QRC from its holder but found it was not there. She did not recall seeing loose items in the flight deck fly by her during the rapid depressurization. The captain handed her the QRH from the center pedestal's left side to begin the CABIN ALTITUDE WARNING or Rapid Depressurization checklist. The FO stated the checklist required the crew to verify cabin pressure, which she noted displayed 14,500 ft msl.

The captain described the event as "an explosive experience" and communications "were rough". The FO stated, "it was chaos." It was very loud and difficult to hear each other and air traffic control (ATC). As the FO continued reading the checklist aloud, she heard the interphone chime, signaling the flight attendants calling the flight deck. The captain attempted to communicate with the flight attendants while wearing the oxygen mask. He heard the flight attendants talking about a "hole" over the cabin interphone. He attempted to communicate with the flight attendants a couple of times, but he heard no response. The captain was unsure if the flight attendants could hear him. As the FO completed the checklist, the flight was heading 340°, they were in visual meteorological conditions (VMC) and could see the airport. He continued to hear the flight attendants talking about a hole in the cabin and decided to get the airplane on the ground as soon as possible.

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[6] Flight Level – A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each is stated in three digits that represent hundreds of ft. Example, flight level (FL) 230 represents a barometric altimeter indication of 23,000 ft. Source: FAA Pilot/Controller Glossary.
[7] CHISM is a waypoint on the Cascade 2 RNAV Departure at PDX.
[8] Mean sea level.
[9] Source: Attachment 1 – Crew Interviews and Statement.
[10] Source: Attachment 1 – Crew Interviews and Statement.

According to the pilot interviews, by the time the FO completed the CABIN ALTITUDE WARNING or Rapid Depressurization checklist, the airplane was at 10,000 ft msl, which led them to decide not to conduct the emergency descent checklist. The captain then suggested they take off the oxygen masks and put their headsets back on to try to establish better communications. While descending below 10,000 ft msl with their headsets on, the FO reported hearing an "extremely loud white noise"[11] and communication between themselves and ATC was not possible. The captain stated, "it was a squeal coming from the oxygen mic, which we hadn't closed the doors to the oxygen masks, and so that was producing a squeal. That didn't cross my mind at the time. So, we went back to the oxygen masks." The FO stated she had reached for the mask/mic switch that would be located on the Boeing 737 NG audio control panel to establish communications to her headset. This switch was not part of the 737-9's audio control panel nor the same procedure to reestablish communications in the 737-9. Both crewmembers stated they did not close the oxygen stowage box door. Due to the noise in their headsets, they donned the oxygen masks again. The FO loaded the ILS 28L[12] approach in the flight management computer (FMC), and they prepared for approach and landing.

The pilots reported that the landing was uneventful. Aircraft rescue and firefighting (ARFF) personnel were waiting by the runway. They taxied the airplane to the gate. According to a statement by the D flight attendant, after landing, she and the FO searched the cabin for the QRC. The FO later confirmed she found it in the flight deck behind her seat.[13]

3.0 CREW INFORMATION

3.1 Captain

The captain was 48 years old and been employed at Alaska Airlines since August 2007. He reported he had about 12,700 hours of total flight experience, and of those hours, about 6,500 hours were in the B737. According to Alaska Airlines, 304 hours were in the 737-9 at the time of the accident. Prior to his employment with Alaska Airlines, he was a flight instructor at Embry Riddle and All Nippon Airways. He was hired as a pilot for SkyWest Airlines in 2000 and then Alaska Airlines in 2007. The captain stated in the interview he had three days off prior to the accident flight. During the 72 hours preceding the accident flight, he stated that he had a "good night's sleep and went for a long 3-hour bike ride." The captain was the pilot flying (PF) during the event.

[11] Definition: Noise that has effectively equal energy intensities at all frequencies within a frequency range of interest, typically heard as a hissing sound; continuous, indistinct noise, *esp*. that which obscures other sounds. Source: Oxford English Dictionary
[12] Instrument landing system runway 28L.
[13] Source: Survival Factors Factual Report.

3.1.1 Captain's Certificates and Ratings Held at Time of the Accident

AIRLINE TRANSPORT PILOT
Airplane Multiengine Land
Commercial Privileges
Airplane Single-Engine Land
Type Ratings: B-737, EMB-120[14]
Limitations: English Proficient B-737 Circle Approach VMC only

FLIGHT INSTRUCTOR
Airplane Single-Engine and Multiengine
Instrument Airplane

MEDICAL CERTFICATE
FAA First Class Medical Certificate issued September 8, 2023
Limitations: None

3.1.2 Captain's Pilot Certification Record

FAA records of the captain indicated the following:

Private Pilot – Airplane Single-Engine Land certificate was issued November 3, 1993.

Private Pilot – Airplane Single-Engine Land, Instrument Airplane certificate was issued May 25, 1994.

Notice of Disapproval – Commercial Pilot Airplane Single-Engine Land, Instrument Airplane issued March 15, 1995. Unsatisfactory items: Area IV; short field landings and Area V; lazy 8's.

Commercial Pilot – Airplane Single-Engine Land, Instrument Airplane certificate was issued March 21, 1995.

Flight Instructor – Airplane Single-Engine certificate was issued July 6, 1995.

Flight Instructor – Airplane Single-Engine, Instrument Airplane certificate was issued May 8, 1996.

Commercial Pilot – Airplane Single-Engine and Multiengine Land, Instrument Airplane certificate was issued June 11, 1998.

[14] Embraer S.A. EMB-120, ENV-120RT, EMB-120ER, EMB-120FC, EMB-120QC. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.

Flight Instructor - Airplane Single-Engine and Multiengine Land, Instrument Airplane certificate was issued July 28, 1998. Renewed: 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022.

Airline Transport Pilot – Airplane Multiengine Land, EMB-120; Commercial Privileges – Airplane Single-Engine Land certificate was issued July 9, 2003.

Airline Transport Pilot – Airplane Multiengine Land, EMB-120, B-737; Commercial Privileges – Airplane Single-Engine Land Limitations – B-737 circling approach VMC only; B-737 SIC[15] privileges only certificate was issued October 20, 2007.

Airline Transport Pilot – Airplane Multiengine Land, EMB-120, B-737; Commercial Privileges – Airplane Single-Engine Land Limitations - B-737 circling approach VMC only certificate was issued February 3, 2015.

3.1.3 Captain's Training

According to Alaska Airlines the following training events were recorded for the captain:

Basic Indoctrination for Flight Personnel	August 30, 2007
First Officer Initial (737 NG)	November 16, 2007
Captain Upgrade (737 NG)	November 14, 2018
Initial 737-9 MAX Familiarization Computer Based Training (CBT)[16]	December 17, 2020
Initial 737-9 MAX Familiarization Simulator[17]	January 6, 2021
Most Recent Line Check (737 NG)	February 1, 2023
Continuing Qualification (CQ) 737 Evaluation Period[18]	April 7, 2023
CQ Quarterly Training – Odd year Quarter 3[19]	July 24, 2023

[15] Second in command.
[16] 8 hours of 737-9 differences CBT. Included flight instruments and displays, engines and auxiliary power unit, flight controls, airplane general, air systems, anti-ice rain, fire protection, warning systems, communications, automatic flight, FMS/navigation, electric system, hydraulic system, fuel system, landing gear, and normal operations.
[17] 2 hours simulator training.
[18] Included Line Orientated Flight Training (LOFT), Maneuver Training, and Upset Recovery (UPRT) Maneuver Training, Systems Oral Evaluation and Line Oriented Evaluation (LOE). Source: Attachment 3 Flight Crew Training Records.
[19] Training consists of communications, performance-abnormal, CRM/TEM, emergency equipment – flight deck, security, FOM general, volcanic ash, and instrument procedures – low visibility. "Hands on" oxygen mask training was accomplished in conjunction with CQ simulator events. Source: Attachment 7 CQ Quarterly Training Rotational Schedule.

Last Rapid Depressurization Simulator Scenario[20]	October 2, 2007

3.2 First Officer

The FO was 36 years old and been employed by Alaska Airlines since August 2017. She was previously employed by Virgin America which was subsequently purchased by Alaska Airlines[21]. She reported she had about 8,300 hours of total flight experience which included about 1,500 hours in the B-737. According to Alaska Airlines, 311 hours were in the 737-9 at the time of the accident.

3.2.1 FO's Certificates and Ratings Held at the Time of the Accident

AIRLINE TRANSPORT PILOT
Airplane Multiengine Land
Commercial Privileges Single-Engine Land, Single-Engine Sea
Type Ratings: A-320[22], B737, CE-500[23], CL-65[24], EMB 145[25]
Limitations: English proficient A-320, B-737, CL-65 Circle Approach VMC only
CE-500 Second in Command required

FLIGHT INSTRUCTOR
Airplane Single-Engine and Multiengine
Instrument Airplane

GROUND INSTRUCTOR
Advanced

MEDICAL CERTIFICATE
FAA First Class Medical Certificate issued June 13, 2023
Limitations: None

[20] Occurred during the captain's First Officer Initial Qualification in the B737 NG.
[21] The Alaska Airlines Virgin Airlines acquisition took place in December 2016. Source: Alaska Air Group closes acquisition of Virgin America, becomes the 5th largest U.S. airline | Alaska Air Group Inc.
[22] Airbus SAS A-318, A-319, A-320, A-321. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.
[23] Textron Aviation Inc. 500, 501, 550, S550, 551, 552, 560. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.
[24] Bombardier Inc. CL-600-2B19, CL-600-2C10, CL-600-2D24, CL-600-2D15. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.
[25] Embraer S.A. EMB-135ER, EMB-135LR, EMB-135KE, EMB-135KL, EMB-135BJ, EMB-145, EMB-145ER, EMB-145MR, EMB-145LR, EMB-145XR, EMB145MP, EMB-145EP. Source FAA Order 8900.1, Figure 5-88 dated July 15, 2019.

3.2.2 FO's Flight Certification Record

FAA records of the FO indicated the following:

Private Pilot – Airplane Single-Engine Land certificate was issued December 30, 2004.

Private Pilot – Airplane Single-Engine Land, Instrument Airplane certificate was issued September 12, 2007.

Commercial Pilot – Airplane Single-Engine Land, Instrument Airplane certificate was issued February 13, 2008.

Notice of Disapproval - Flight Instructor – Airplane Single-Engine Land was issued July 23, 2008. Unsatisfactory items: Area VII Power-off 180° accuracy approach and landing.

Flight Instructor – Airplane Single-Engine Land certificate was issued July 25, 2008. Renewed: 2010.

Commercial Pilot – Airplane Single-Engine and Multiengine Land, Instrument Airplane certificate was issued September 12, 2009.

Ground Instructor – Advanced certificate was issued July 10, 2008.

Flight Instructor – Airplane Single-Engine and Multiengine certificate was issued July 16, 2011. Renewed; 2013, 2015, 2017, 2019, 2021, 2023.

Airline Transport Pilot – Airplane Multiengine Land, Commercial Privileges – Airplane Single-Engine Land certificate was issued January 25, 2012.

Airline Transport Pilot – Airplane Multiengine Land, CL-65; Commercial Privileges – Airplane Single-Engine Land; Limitations – CL-65 circling approach VMC only certificate was issued July 20, 2012.

Airline Transport Pilot – Airplane Multiengine Land, CE-500, CL-65; Commercial Privileges – Airplane Single-Engine Land; Limitations – CL-65 circling approach VMC only, CE-500 Second in Command Required certificate was issued August 12, 2013.

Airline Transport Pilot – Airplane Multiengine Land, CE-500, CL-65; Commercial Privileges – Airplane Single-Engine Land, Airplane Single-Engine Sea; Limitations – CL-65 circling approach VMC only, CE-500 Second in Command Required certificate was issued November 25, 2014.

Airline Transport Pilot – Airplane Multiengine Land, CE-500, CL-65, EMB 145; Commercial Privileges – Airplane Single-Engine Land, Airplane Single-Engine Sea;

Limitations - CL-65 circling approach VMC only, CE-500 Second in Command Required certificate was issued July 6, 2016.

Airline Transport Pilot – Airplane Multiengine Land, A-320, CE-500, CL-65, EMB 145; Commercial Privileges – Airplane Single-Engine Land, Airplane Single-Engine Sea; Limitations - A-320, CL-65 circling approach VMC only, CE-500 Second in Command Required certificate was issued September 25, 2017.

Airline Transport Pilot – Airplane Multiengine Land, A-320, B-737, CE-500, CL-65, EMB 145; Commercial Privileges – Airplane Single-Engine Land, Airplane Single-Engine Sea; Limitations – A-320, B-737, CL-65 circling approach VMC only, CE-500 Second in Command Required certificate was issued August 27, 2021.

3.2.3 FO's Training

According to Alaska Airlines, the following training events were recorded for the FO:

Initial 737-9 Familiarization CBT	September 1, 2021
Initial B737-9 MAX Familiarization Simulator	September 7,2021
B737 First Officer Transition	September 22, 2021
CQ B737 Evaluation Period	February 28, 2023
Most Recent Line Check (737 NG)	June 5 ,2023
CQ Quarterly Training – Odd year Quarter 3	July 10, 2023
Last Rapid Decompression Simulator Scenario[26]	August 12, 2021

3.3 Crew

A review of the crewmember's training records revealed they trained a rapid decompression upon employment during initial ground school in a simulator. When the B737-9 was delivered to Alaska, they received an initial familiarization CBT training module on oxygen masks and communication differences. Every other year, in a CQ simulator event, the crew received "hands-on" emergency equipment training on a mockup trainer that contained the oxygen masks and stowage boxes for the B737 MAX and B737 NG. This trainer does not include headset jacks or audio control panels. Due to the COVID-19 pandemic, Alaska Airlines exempted donning oxygen masks during training from June 1, 2020, to December 31, 2020[27]. According to the training records, the captain would have had training exposure to B737-9 oxygen masks and

[26] Initial First Officer Transition Qualification training.
[27] This exemption did not apply to initial qualification pilots.

communications differences four times, and the first officer three times, before the accident.

4.0 AIRPLANE

Figure 1. N704AL accident airplane (Source: Jet Photos)

The aircraft was a Boeing 737-9, Serial No. 67501, manufactured in 2023. A standard airworthiness certificate in the transport category was issued on October 25, 2023. It was powered by two CFM International LEAP-1B28 engines, capable of producing 29,317 lbs. of thrust each. The aircraft had two crew seats, two flight deck jumpseats, four flight attendant seats, 1 flight attendant jumpseat, and 178 passenger seats. The airplane was issued a Standard Airworthiness certificate on October 25, 2023. The airplane had the following MEL deferred maintenance items:

25-70-01C R908 FOREIGN DOCUMENTS MISSING
25-28-01D R7 FWD GALLEY COMP LATCH OR QUARTER TURN
28-22-01A R908 RH MAIN AFT FUEL BOOST PUMP INOP

A review of the MEL's showed none of the items pertained to the accident.

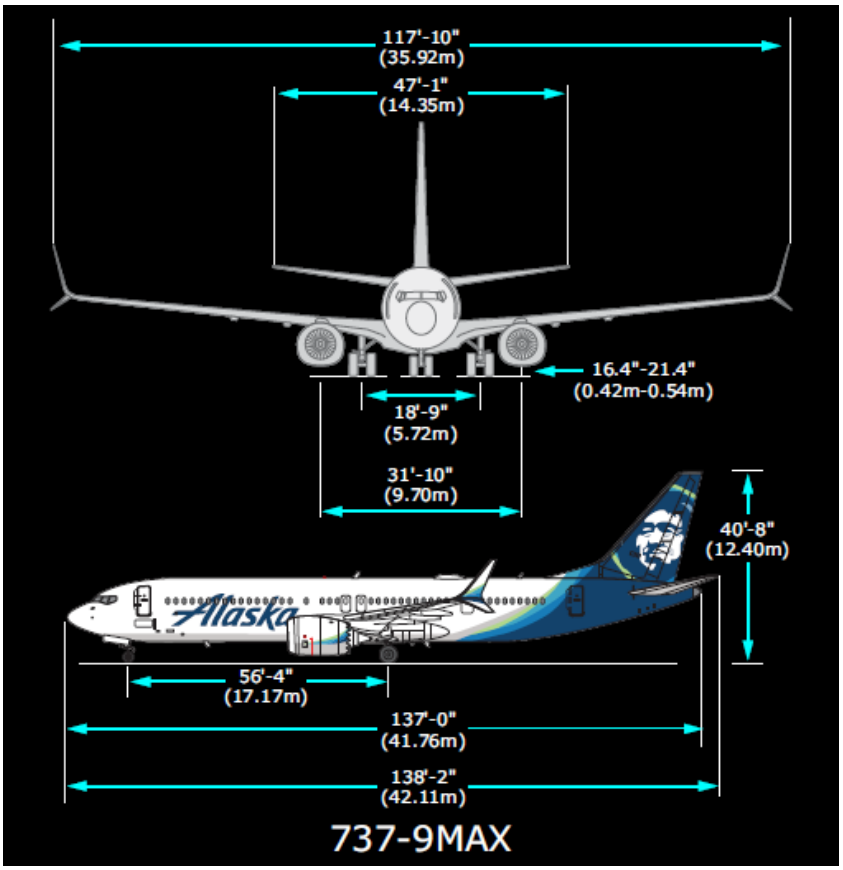


Figure 2. B737-9 Dimensions (Source: Alaska 737 Systems Handbook)

5.0 AIRPLANE WEIGHT AND BALANCE

The following information, unless otherwise noted, was provided from Alaska Airlines weight and balance paperwork. All weights are listed in lbs.[28]:

	Weight
Airplane Empty Weight	107,403
Payload	35,529[29]
Zero Fuel Weight	142,932
Fuel	20,400
Ramp Weight	163,732
Taxi fuel	400
Takeoff Weight	163,332
Maximum Takeoff Weight	191,900
Projected Enroute Fuel Burn	8,858

[28] Source: Attachment 10 – Weight and Balance.
[29] Source: Attachment 10 – Weight and Balance. Weight is based on the "Actual" column not the "Plan" column. Payload included total passenger weight 32,042 lbs. (not including 3 lap children) and cargo weight 3,487 lbs.

Projected Landing Weight	144,832
Maximum Landing Weight	163,700
%MAC[30]	21.5

6.0 OPERATOR

According to the company's website, McGee Airways and Star Air Service began in 1932. In 1944, after several company mergers, the company became Alaska Airlines. In 2016, Virgin America was acquired by Alaska Airlines, and in 2018, the FAA granted a single operating certificate to operate as a single airline under the Alaska brand. The fleet consisted of 231 Boeing 737s, of which 65 were B737-9s. Other 737 models at Alaska include: 737-900ER, 737-900, 737-8 MAX, 737-800, 737-800F, 737-700, and 737-700F[31].

7.0 AIRPORT INFORMATION

Portland International Airport was a joint civil-military airport located within the city limits of Portland, Oregon. The airport elevation was 31 ft msl with three paved airplane landing surfaces designated as runways 28L/10R, 28R/10L, and 21/3. The paved surface for runway 28L/10R was 11,000 ft long and 150 ft wide, 28R/10L was 9,825 ft long and 150 ft wide, and 21/3 was 6,000 ft and 150 ft wide. The airport was serviced by an air traffic control tower, which was in operation at the time of the accident. Operations in 2023 totaled 14,425. Of that, 869 were considered general aviation, and 120 were military.[32]

[30] Mean Aerodynamic Chord
[31] Source: www.alaskaair.com, accessed May 14, 2024.
[32] Source: www.flypdx.com, accessed May 14, 2024.

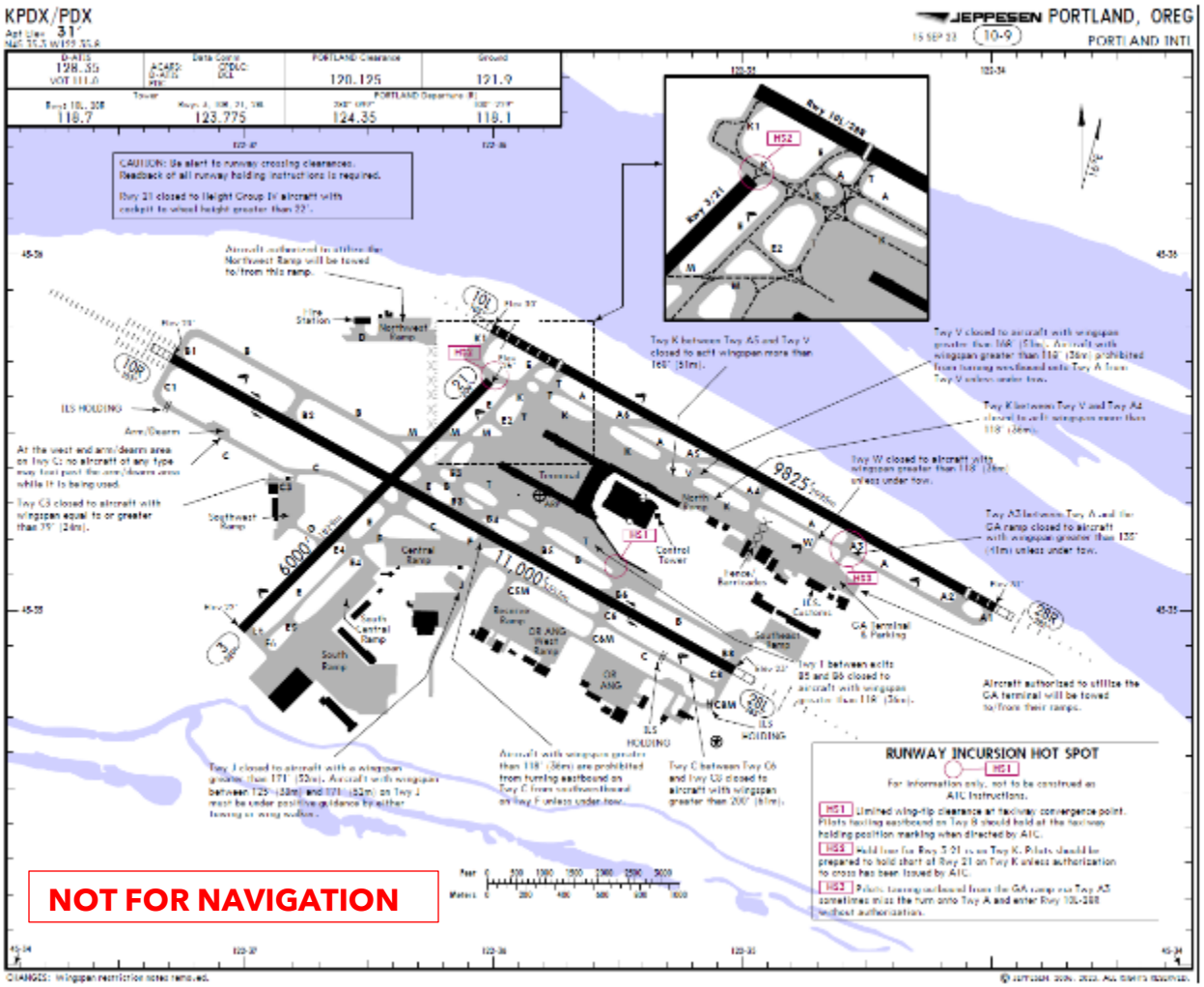


Figure 3. PDX Airport Diagram (Source: Jeppesen)

8.0 METEOROLOGICAL INFORMATION

The PDX airport had an Automated Surface Observation System which was augmented by contract weather observers. At the time of departure and the time of the accident the following conditions were reported.

METAR KPDX 060153Z 18010G19KT 10SM BKN055 OVC150 10/03 A3020 RMK AO2 SLP226 T01000033 $=

The METAR[33] information in plain language:

[33] Aviation Routine Weather Report (METAR) Source: FAA AIM 7-1-28

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 agl[34], 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[35], temperature 10.0°C, dew point 3.3°C.

For further weather information refer to the NTSB Meteorological Specialist Report located in the docket for this accident investigation.

9.0 FLIGHT DECK LAYOUT 737-8/737-9

9.1 Instrument Panels

The normal checklist and QRC were combined on the front and back of a laminated card. These checklists were normally stowed in a holder the center on top of the glareshield panel. The QRH was stowed on the left side of the control stand. The pilot's oxygen masks, and oxygen mask stowage boxes were located on the oxygen mask panel on the left and right sides of the flight deck. (See figure 4 below from SH Section 1.050, Page 9, indicated by blue arrows.)

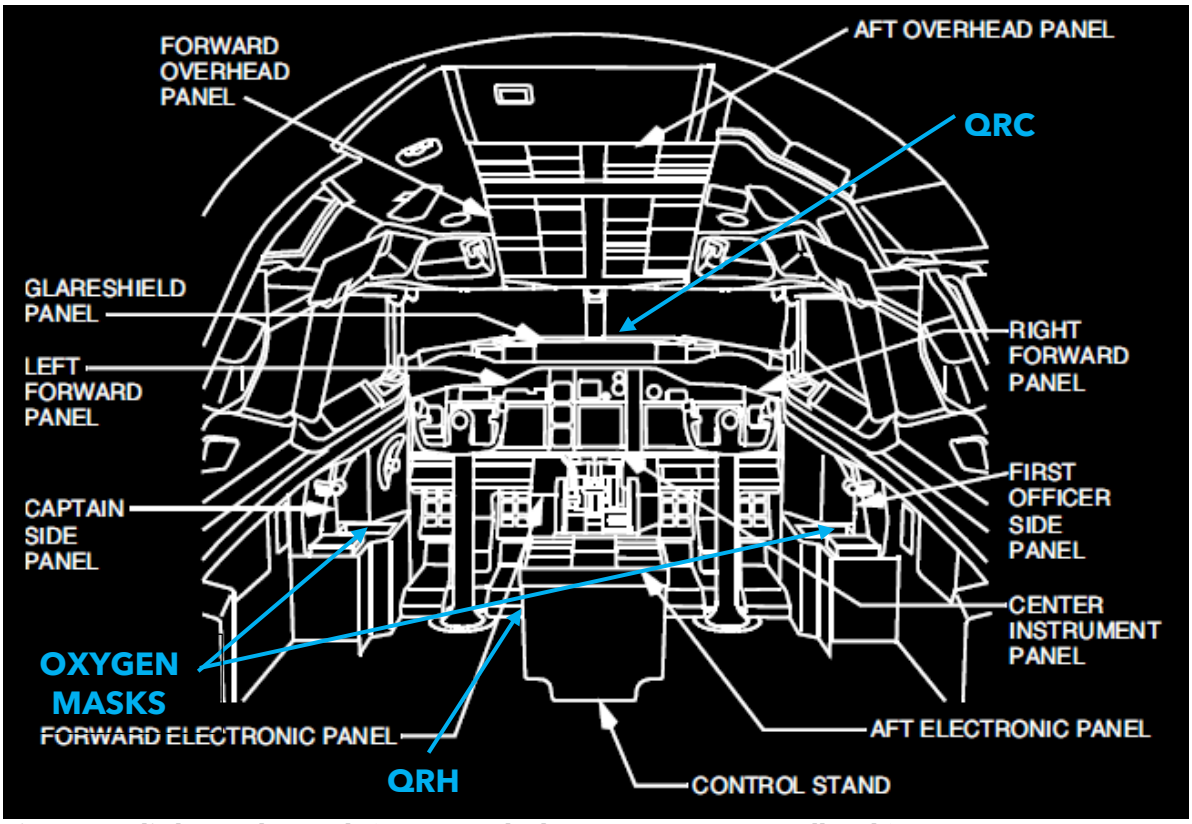


Figure 4. Flight Deck Panels (Source: Alaska 737 Systems Handbook)

[34] Above ground level
[35] Hectopascal

9.2 Flight Deck

Figure 5. Flight deck of accident airplane (Source: NTSB)

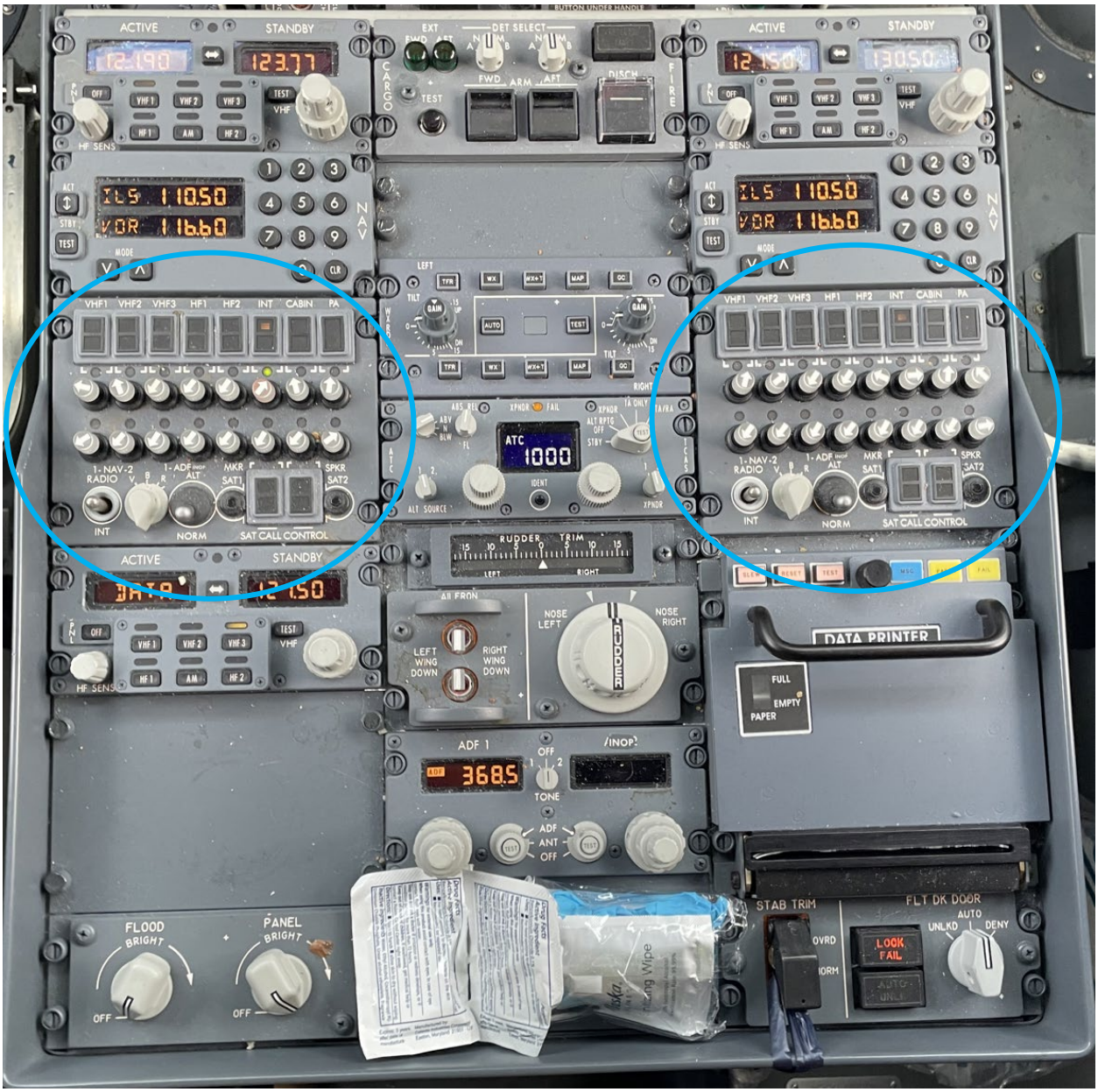


Figure 6. 737-9 control stand and audio control panels of accident airplane indicated by blue circles. (Source: NTSB)

Figure 7. Captain side panel of accident airplane with oxygen mask and stowage box indicated by blue circle. (Source: NTSB)

10.0 RELEVANT SYSTEMS[36]

10.1 737 Flight Crew Oxygen System

The following excerpts are from the Alaska Airlines 737 System Handbook (SH), in Section 1.040, Page 16 – "Emergency Equipment" provided the following about the crew oxygen system.

> ***Flight Crew Oxygen System – B/E Aerospace Full Face Sweep-On Mask[8MAX,9MAX][37]***

[36] For more detailed systems information, see Systems Group Chairman's Factual Report.
[37] The section title *Flight Crew Oxygen System – B/E Aerospace Full Face Sweep-On Mask[8MAX,9MAX]* was a hyperlink to direct the reader to MAX differences. See section 10.2 in this report.

The Flight Crew Oxygen System is equipped with B/E Aerospace Full Face Sweep-On Oxygen Mask at each crew station. The masks are contained in a large stowage box located on the Captain and First Officer side consoles and at both Observer's positions. The mask may be operationally checked while stowed or removed from the stowage box.

The mask incorporates a diluter-demand regulator with a manual control allowing the selection of altitude-controlled diluted automatic oxygen on demand or 100% oxygen and emergency purge for respiratory and visual protection. The mask-mounted regulator utilizes a single knob mode control. In emergencies, using one hand, the mask can be donned and functioning in less than 5 seconds. The face shield includes integral purge valve assemblies that allow oxygen to enter the face shield for purging of smoke and fumes. The purge valves open automatically when the Emergency (EMER) position is selected. An integral, dynamic microphone is installed in the mask for a means of communication via the aircraft audio communication system. An inflatable harness is connected to the regulator and the face shield.

10.1.1 B/E Aerospace full face sweep-on oxygen mask

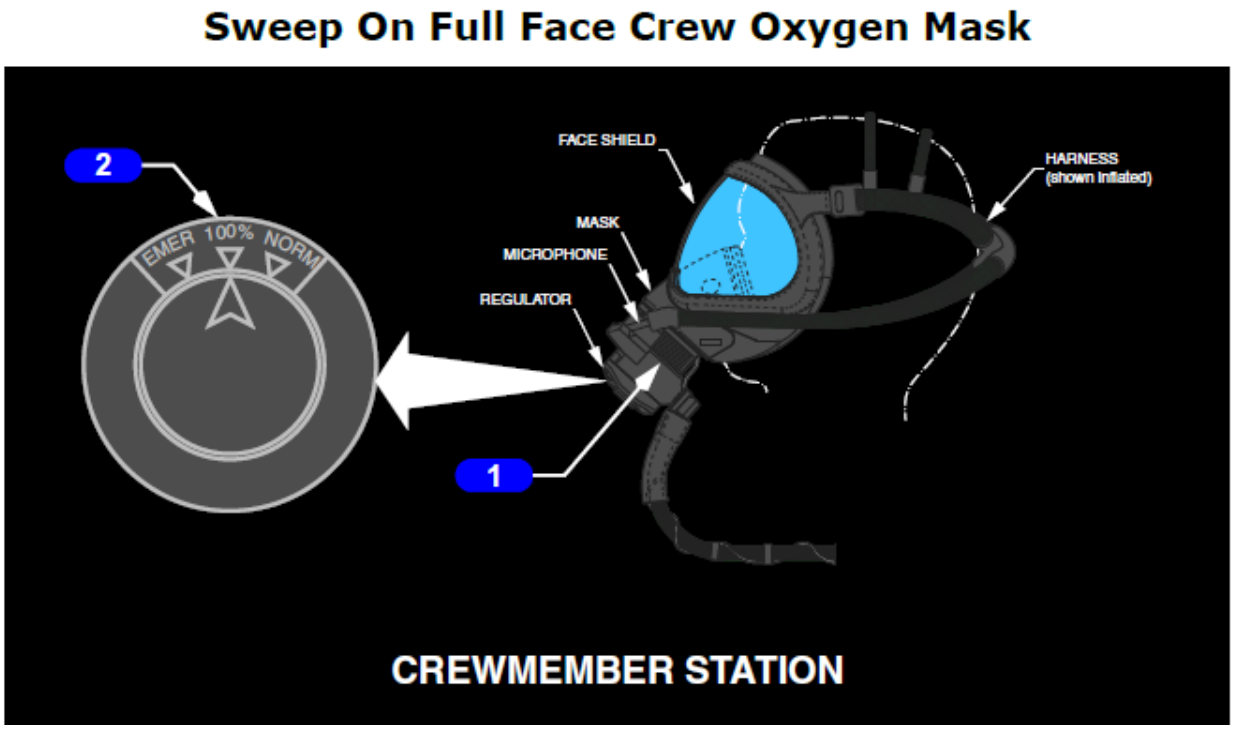


Figure 8. B/E Aerospace Full Face Sweep-ON Mask (Source: Alaska SH)

(1) *The* ***Harness Inflation (red) Switches****, located on each side of the Mode*
Selector Knob, inflate the harness when depressed. The flow indicator will display a colored (yellow) cross momentarily as harness inflates. Releasing the Harness Inflation Switches allows the harness to deflate (See Figure 8).

(2) *The* ***Regulator Control*** *is located on the nose of the mask and is rotated to select the appropriate setting. A Mode Indicator (arrow) provides a reference to determine what mode has been selected (See Figure 8). The regulator selections are as follows:*

NORM (NORMAL) *– With the regulator set to the "NORM" position, the regulator provides an automatic oxygen dilution schedule. At lower cabin altitudes ambient air is allowed to enter the regulator and mix with the added oxygen during inhalation. As the cabin altitude increases the percentage of ambient air entering the regulator is reduced until at a preset point 100% oxygen is inhaled by the user. The automatic dilution feature ensures conservation in the amount of oxygen consumed while still maintaining a safe physiological level. In the event of an emergency depressurization, the regulator will automatically provide 100% oxygen when the cabin altitude exceeds the preset point.*

100% *– This setting provides 100% oxygen to the user upon inhalation regardless of the cabin altitude. The regulator should always be stowed in the 100% mode.*

After the emergency and to conserve oxygen when altitudes do not require 100%, the regulator may be set to the NORM position.

EMER (EMERGENCY) *– The "EMER" control setting, like the 100% setting, provides 100% oxygen regardless of cabin altitude. In addition, oxygen is supplied at a slight positive pressure to the mask face cone and may result in a maximum flow rate of 9.0 liters per minute. This emergency safety pressure prevents toxic gas contaminates from entering the mask by venting through the purge valves mounted on the nose cone. The positive pressure purges smoke and toxic fumes from the face shield and removes condensation or fogging to maintain visual protection.*

CAUTION! *Use of EMER mode depletes oxygen supply at a higher rate than 100% or NORM mode. Use EMER mode only as conditions require.*
NOTE: *Communications in EMER mode may be difficult. Switch to 100% or NORM if conditions allow.*
WARNING! *To avoid the risk of combustion in an oxygen-enriched*

environment, the mask should be kept free of oil, grease, and other forms of petroleum products.

10.1.2 Oxygen Mask Stowage Box

Figure 9. FO's oxygen mask stowage box indicated by blue circle (Source: NTSB)

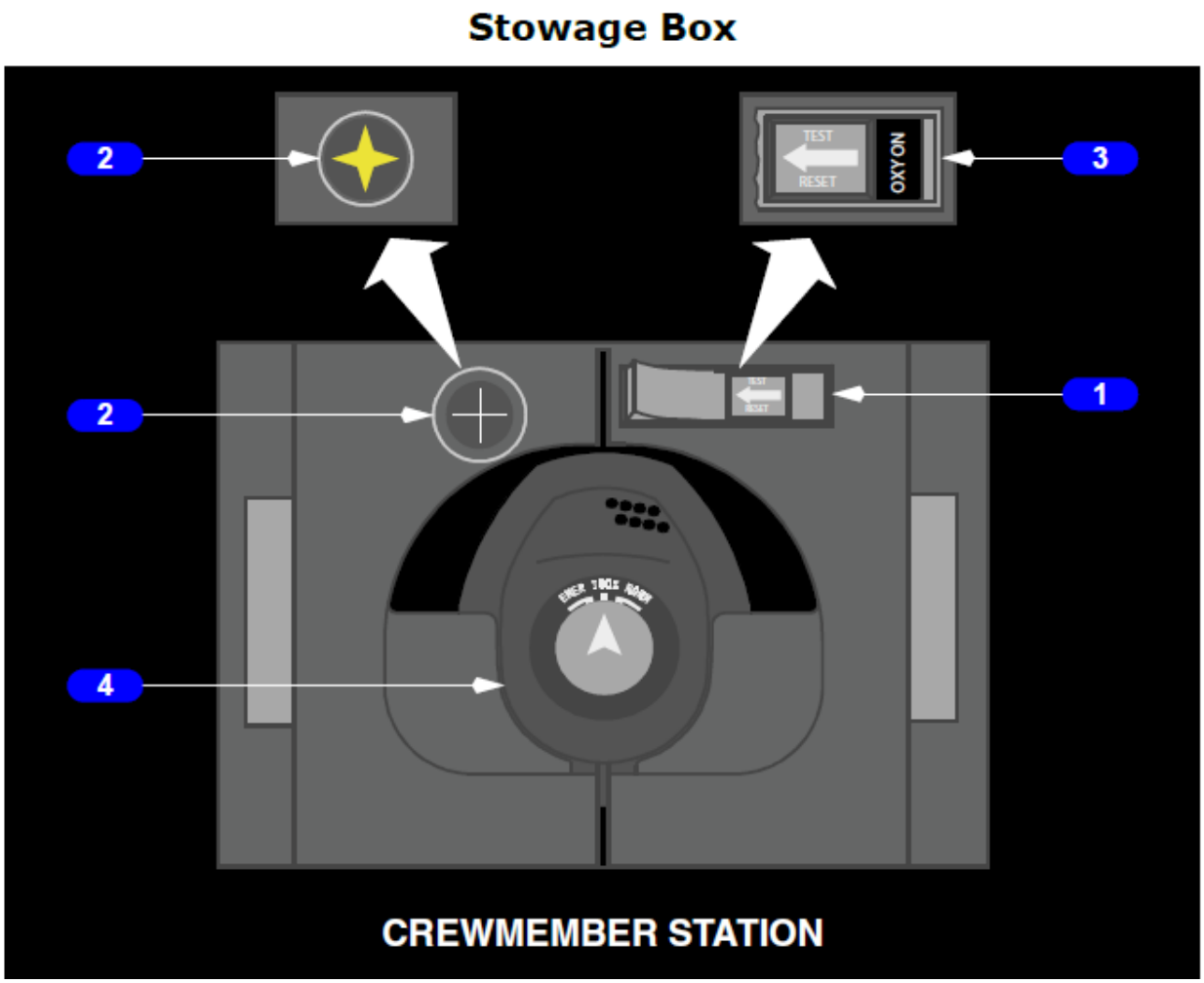


Figure 10. Oxygen Mask Stowage Box (Source: Alaska SH)

(1) *The* ***RESET/TEST Switch*** *(spring-loaded to RESET position) when positioned to TEST and released with the mask right Stowage Door closed and the:*

- *OXY ON flag not displayed, will activate the oxygen flow and Mask Microphone momentarily to operationally test the regulator*
- *OXY ON flag displayed, shuts off oxygen flow to the mask*

NOTE: *Oxygen flow may be re-established by simply lifting the Right Stowage Box Door to the open position.*

(2) *The* ***Flow Indicator*** *displays a (yellow) cross when oxygen is flowing to the mask through the supply hose as a result of the:*

- *RESET/TEST Switch is activated with the mask stowed, or*
- *when the mask is donned and the user is inhaling*

(3) *The* ***OXY ON Flag*** *(white tab), when visible, indicates the Oxygen Shutoff Valve is open allowing oxygen to flow to the mask. When the OXY ON Flag is retracted out of view, the Oxygen Shutoff Valve is closed*

> ***NOTE:*** *Ensuring the stowage box oxygen shutoff valve is closed (indicated by the OXY ON Flag not being visible) by activating the RESET TEST Switch, terminates oxygen flow to the mask and ensures the Flight Crew Oxygen quantity will not continue to bleed overboard through a suspected leak in a mask regulator, harness, or supply hose.*

The Oxygen Shutoff Valve is open when the Right Stowage Box Door is:

- *open, or*
- *closed and the OXY ON flag is visible, or*
- *closed with the OXY ON flag not visible, but the RESET/TEST switch is positioned to TEST*

With the regulator selected to 100% or NORM, the Oxygen Shutoff Valve will open momentarily when the RESET/TEST switch is positioned to TEST. In EMER, the Oxygen Shutoff Valve will remain open as long as the RESET/TEST switch is positioned to TEST.

(4) *The* ***Regulator Control*** *(previously discussed).*

10.2 737(MAX) Flight Crew Oxygen System Differences

The following excerpt are from the Alaska Airlines 737 System Handbook (SH), in Section 1.050, Page 105 – "Airplane General Differences" provided the following about the crew oxygen system.

The mask microphone is enabled when the mask is removed from the Stowage Box. Transmission selection is made on ACP[38].

There is no MASK-BOOM switch on the Audio Control Panel. With the Flight Crew Oxygen Mask removed from the stowage box (right stowage box door open), the mask microphone is automatically selected and the boom microphone is deselected. When the right stowage box door is closed, the TEST/RESET switch is actuated, and the OXY ON flag is no longer displayed, the mask microphone will be deselected and the boom microphone[39] will be selected.

Stowage Box

[38] Audio Control Panel

[39] Boom microphone refers to the microphone on the pilot's headset.

*The **TEST/RESET Switch** (spring-loaded) when positioned to TEST/RESET and released with the mask right Stowage Door closed and the:*

- OXY ON flag not displayed, will activate the oxygen flow and Mask Microphone momentarily to operationally test the regulator

- OXY ON flag displayed, shuts off oxygen flow to the mask and disables the Mask Microphone and enables the Boom Microphone

***NOTE:** Oxygen flow may be re-established by simply lifting the Right Stowage Box Door to the open position.*

10.3 737-9 AUDIO CONTROL PANEL

An ACP was installed at the captain, FO, and observer stations. This allowed the selection of the desired radios, navigation aids, interphones, and passenger address (PA) systems for monitoring and transmitting. Any microphone at that crew station may be keyed to transmit on the selected system. The following excerpts are from the Alaska Airlines 737 System Handbook (SH), in Section 5.030, Page 2 – "Communications Differences" provided the following about the ACP.

Figure 11. 737-9 Audio Control Panel (Source: Alaska SH)

(1) *The* ***Transmitter Selector (MIC SELECTOR) Switches****, when illuminated, indicate respective switch is active. When pushed:*

- *selects respective communication system for subsequent transmission*
- *only one switch may be selected at a time*
- *pushing a second switch deselects first switch*
- *reception possible over selected system regardless of whether respective receiver switch is on*

(2) *The* ***Receiver Switches****, when illuminated (white), indicate the respective switch is active.*
When pushed:

- *allows reception of respective communication system or navigation receiver*
- *multiple switches may be selected*
- *push again deselects respective system or receiver*

Rotate switch to adjust volume level.

When the Receiver switch is pushed to select audio, the LED (green) light above the Receiver switch will also illuminate. The LED light provides indications of selection under certain Flight Deck lighting situations where the internally illuminated Receiver switch may not be discernible.

(3) Push-to-Talk Switch *(Radio-Interphone Switch latched in the Interphone position) – RADIO (radio-transmit) – keys oxygen mask or boom microphone for transmission as selected by transmitter selector.*

INT (Interphone) – keys oxygen mask or boom microphone for direct transmission over Flight Interphone and bypasses Transmitter Selector.

(4) *The* ***Filter Switch****, when positioned to:*

- *V (Voice) – receives NAV and ADF voice audio*
- *B (Both) – receives NAV and ADF voice and range audio*
- *R (Range) – receives NAV and ADF station identifier range (code) audio*

(5) *The* ***CALL light****, when illuminated (white), is accompanied by a chime and indicates call received by:*

- *SELCAL (VHF 1, 2, 3/HF1, HF2)*
- *SATCOM Call (SAT1, SAT2)*
- *Ground Crew/Flight Crew Call (INT)*
- *Flight Attendant Call (CABIN)*

Resets when transmitter is selected and microphone is keyed.
NOTE: PA does not have a CALL indication.

(6) *The* ***Speaker (SPKR) Switch****, when illuminated (white), indicates that the SPKR switch is active. When pushed allows audio from selected receiver to be heard on overhead speaker. When pushed again, it deselects audio from selected receiver to be heard on overhead speaker. Rotate switch to adjust overhead speaker volume.*

(7) *The* ***SAT Switch****, when pushed, terminates the SATCOM call connection.*

(8) *The* ***Alternate-Normal (ALT-NORM) Switch****, when positioned to:*

- *NORM (Normal) – ACP operates normally*
- *ALT (Alternate) – ACP operates in degraded mode*

10.4 RELEVANT 737 NG VS MAX ACP DIFFERENCES

The B737-9 has no MASK-BOOM switch on the ACP (See Figure 11.) The mask microphone is automatically selected, and the pilot's headset boom microphone is deselected when the oxygen mask is removed from the stowage box and the right stowage box door is open. For the pilot to reestablish headset boom microphone communications after discontinued use of the oxygen mask, the right stowage box door must be closed[40], the TEST/RESET switch (See Figure 10) actuated, and the OXY ON flag no longer displayed. Only then will the mask microphone be deselected and the boom microphone be selected.

In the B737 NG models, the ACP can have a MASK-BOOM switch that allows selection of the oxygen mask microphone for transmissions with MASK selected or headset boom microphone for transmissions with BOOM selected. (See figure 13.) The oxygen mask microphone is not automatically selected, the switch must be placed to MASK.

[40] On the B/E Aerospace mask configuration.

Figure 12. 737 NG ACP. Mask/Boom switch indicated by blue circle (Source: NTSB)

11.0 RELEVANT DIFFERENCES TRAINING

11.1 COMPUTER BASED TRAINING

The Alaska Airlines initial familiarization CBT module[41] contains the following slide concerning B737-9 differences:

> *If the flight **Crew Oxygen Mask is removed from the stowage box or the right stowage door is open**, the mask mic is automatically selected and boom mic is deselected.*
> *TO RESET:*
> - *Right stowage box door must be closed*
> - *TEST/RESET switch (on O2 stowage) actuated*
> - *OXY ON flag is no longer displayed*
>
> *Then the mask mic will be deselected and boom mic selected.*

[41] Source: Attachment 8 – CBT Training Modules [Excerpts]

12.0 FLIGHT DECK DOOR

According to the crew interviews, the pilots were not aware that the 737-9 flight deck door would open aft during a cabin rapid depressurization. This aspect of the door operation during cabin decompression was not documented in either Boeing or Alaska's manuals. In response, Boeing issued a Multi-Operator-Message (MOM) on January 13, 2024, to inform owners and operators of Boeing 737MAX airplanes of an amendment to the Flight Crew Operations Manual (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. Boeing reviewed their documentation after the accident and provided investigators with a statement that the 737 MAX Flight Crew Operations Manual (FCOM) was based on the 737 NG FCOM. The difference in flight deck door design was not captured in the 737 MAX FCOM. Crew procedures were unaffected and remain common between the 737 MAX and 737 NG[42].

13.0 ALASKA AIRLINES CHANGES POSTACCIDENT

In response to the accident, Alaska Airlines has done the following:

- Published a bulletin to flight crews to improve language regarding the oxygen mask system and operation in the Alaska Airlines 737 Systems Handbook (SH), Volume 1 (MAX), Section 1.050 – "Airplane General" and Volume 2 (NG Differences), Section 1.010 – "Airplane General."
- Published a bulletin requesting crews to inspect and clean oxygen masks on the first flight of the day.
- Added microphone test description in the SH, Volume 1 (MAX), Section 1.050 – "Airplane General."
- Updated flight deck door description and added cabin decompression information in SH, Volume 1 (MAX), Section 1.202 – "Airplane General" and Volume 2 (NG Differences), Section 1.010 – "Airplane General."
- Added microphone preflight check procedure in the 737 Flight Handbook (FH), Section 3.040 – "Normals."
- Updated the Flight Operations Duty Officer and Dispatch Debrief Checklist for post incident/accident to remind crews to pull CVR[43] circuit breaker[44].
- Updated language in Flight Operations Manual (FOM), Section 11.200 – "Emergency/Abnormal" requiring crews to pull CVR/FDR[45] circuit breaker after incident/accident.

[42] Source: Attachment 11 – Boeing Response to Flight Deck Door Information Request.
[43] Cockpit Voice Recorder
[44] Source: Attachment 4 – Alaska Airlines Checklists.
[45] Flight Data Recorder

- Added CVR/FDR circuit breaker information on the circuit breaker list in the QRH.[46]
- Created new CBT slides relating to oxygen mask communications that are taught during initial ground school, captain upgrade training, and 2024 CQ Quarter 2 training cycle for all pilots.[47]
- Created a new training video consisting of information on rapid decompression, emergency descent, oxygen masks, communications and flight deck door operations which will be trained in Quarter 3 CBTs for all pilots.[48]
- Included scenarios which will require the crew to don the oxygen mask, communicate, and subsequently doff the oxygen mask and continue with the event including all communications required in the 2025 CQ Evaluation LOFT simulator training.[49]
- Added verbiage in the Instructor Guide on restoring boom mic communications in the 737 MAX.

14.0 RELEVANT PROCEDURES

14.1 CABIN ALTITUDE WARNING or Rapid Depressurization Checklist

The Alaska Airlines 737-9 QRH dated December 29, 2022, Section, Communications, page E5.1 provided the following guidance for a CABIN ALTITUDE WARNING or Rapid Depressurization Checklist:

[46] Source: Attachment 4 – Alaska Airlines Checklists
[47] Source: Attachment 8 - CBT Training Modules [Excerpts.]
[48] Source: Docket Quarter 3 Training Video.
[49] Source: Attachment 9 Alaska Airlines Continuing Qualification 2025 LOFT Simulator Profile.

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.**

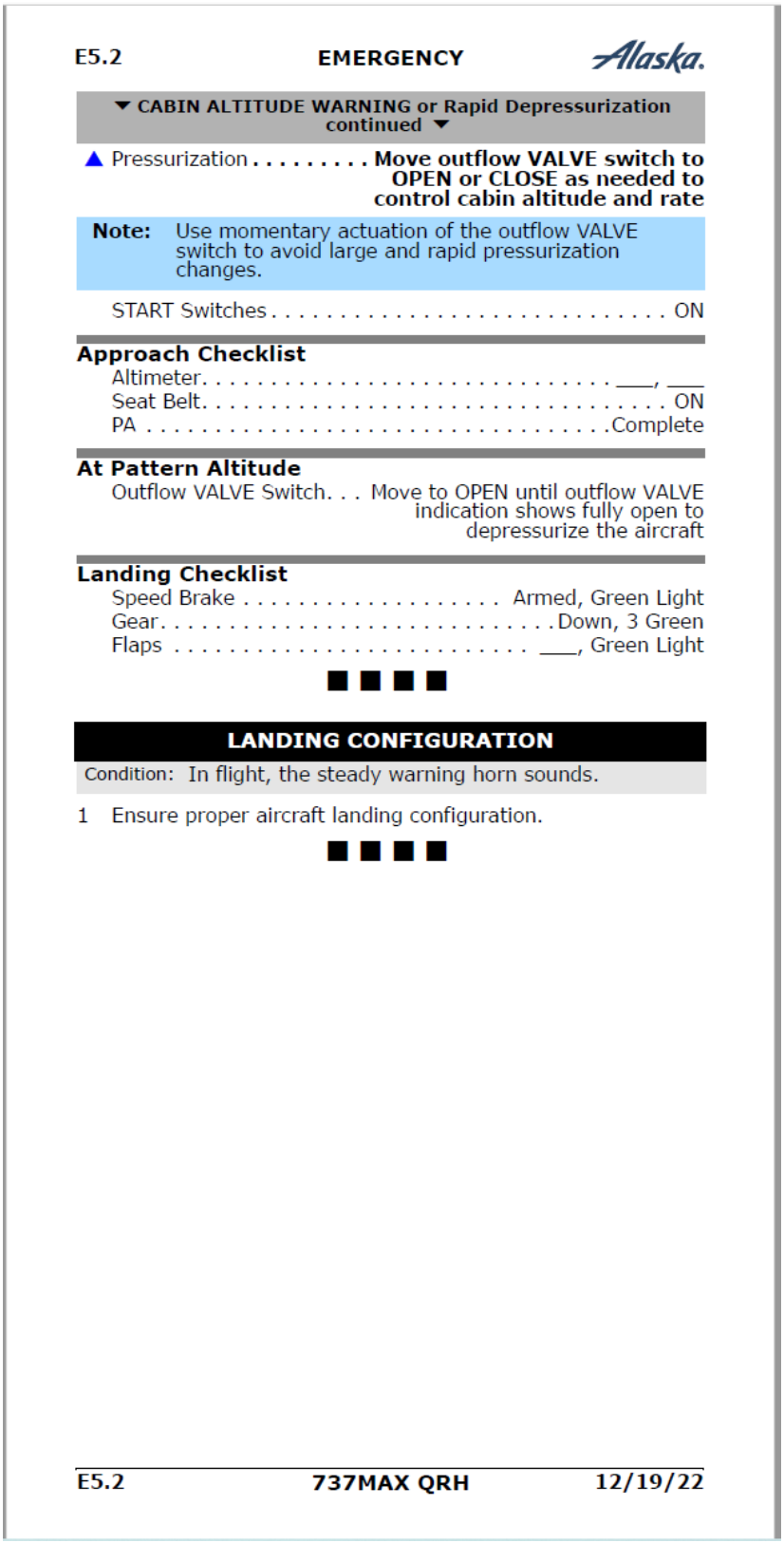
Deferred Items

Accomplish Approach Setup and Briefing (TPC).

Descent Checklist

Recall . . . . . Checked
▲ FMC Route . . . . . Verified R,L
▲ Landing Data . . . . . VREF ___, Minimums ___
▲ (RNAV) RNP Value . . . . . ___ Set

▼ Continued on next page ▼



E5.2 EMERGENCY Alaska.

▼ 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.

■ ■ ■ ■

E5.2 737MAX QRH 12/19/22

Figure 13. Cabin altitude or rapid depressurization checklist (Source: Alaska B737-9 Quick Reference Handbook)

15.0 NASA ASRS[50] REPORTS

A review of NASA ASRS data reports five years prior to the date of the accident, revealed that three reports mentioned pressurization problems in the 737-8 MAX. One of the reports (ACN: 1892978) mentioned the cabin pressure panel went "blank on climb out; however, the pressurization appeared to be operating normally."[51]

E. LIST OF ATTACHMENTS

Attachment 1 - Crew Interview Transcripts and Statement
Attachment 2 - Alaska Personnel Interview Transcripts
Attachment 3 – Flight Crew Training Records
Attachment 4 - Alaska Airlines Checklists
Attachment 5 - Simulator Evaluation
Attachment 6 – Sequence of Events
Attachment 7 – Continuing Qualification Training Rotational Schedule
Attachment 8 - CBT Training Modules [Excerpts]
Attachment 9 – Alaska Airlines Continuing Qualification 2025 LOFT Simulator Profile
Attachment 10 – Weight and Balance
Attachment 11 – Boeing Response to Flight Deck Door Information Request
Attachment 12 – NASA ASRS Database Query Results
Attachment 13 – Flight Ops Training Bulletin (postaccident)
Attachment 14 – Alaska Airlines Cabin Altitude Warning and Emergency Descent Training Video (postaccident)

Submitted by:
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Operational Factors AS-30
NTSB

[50] National Aeronautical and Space Administration Aviation Safety Reporting System
[51] Source: Attachment 12 – NASA ASRS Database Query Results.