Aviation Investigation Final Report

Location:	Kenner, Louisiana	**Incident Number:**	DCA24LA330
Date & Time:	December 20, 2023, 14:14 Local	**Registration:**	N8830Q
Aircraft:	Boeing 737-8	**Aircraft Damage:**	Minor
Defining Event:	Birdstrike	**Injuries:**	
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

During initial climbout shortly after takeoff, Southwest Airlines flight 554 struck and ingested a bird into its No. 1 (left) engine, resulting in damage to the left engine fan blades and a partial loss of engine power. The airplane began to "shake violently with a distinct loss of thrust" in the left engine. The engine master caution activated, and the captain reported that he heard the fire bell sound.

The captain called for the Engine Fire or Engine Severe Damage or Separation checklist on the Quick Reference Card (QRC). According to the captain, after the first officer (FO) started the checklist, the cockpit began to fill with "acrid white smoke." The FO called out "masks," the pilots donned their masks, and they resumed performance of the checklist. The flight crew declared an emergency to air traffic control and requested airport rescue and firefighting (ARFF) in preparation for the flight's return to the departure airport.

The flight crew notified the cabin crew and passengers about the emergency. The captain later reported that, due to the smoke, his instrument panel was difficult to see and that he thought he might need to fly the airplane by solely using the heads-up guidance system. However, the captain stated that the smoke began to rapidly dissipate after the FO pulled the engine fire switch.

After flight 554 landed and came to a full stop, ARFF personnel inspected the airplane before the flight crew taxied to the assigned gate. The passengers deplaned normally, and no injuries were reported.

Postaccident examination found that the smoke in the cockpit was a result of the activation of the No. 1 engine's load reduction device (LRD) after the bird ingestion. LRD activation is designed to reduce the severity of the vibration transmitted into the airframe by disconnecting

the left engine's fan blades from the turbomachinery. When the LRD activated, tubes supplying oil to the engine sump became dislodged and the flange from the sump area opened, allowing engine oil to enter the core compressor upstream of the pneumatic bleed ports that supply bleed air to the cabin and cockpit. The oil was exposed to high temperatures and resulted in smoke and fumes that were then fed into the cockpit. About 15 seconds after the bird ingestion, the left engine's core speed (N2) was below 62% rpm, which would have de-energized the engine's running relay and subsequently closed the pressure regulating shutoff valve (PRSOV). Following the closure of the PRSOV, which was the point of access into the cockpit, the smoke and fumes would have quickly dissipated.

Considering that both crewmembers described the airplane as shaking following the bird ingestion, the captain's decision to begin the Engine Fire or Engine Severe Damage or Separation checklist was appropriate (one of the conditions for using the checklist was airframe vibrations).

Although the crew did not report performing the Smoke, Fire or Fumes checklist, the first officer stating "masks" accomplished two of the three memory items by donning their one-piece oxygen masks. Postincident review of this checklist found that it instructed pilots to turn off various switches, including the RECIRC FAN switches at step 9. It is not until step 11 that the checklist instructs that if the smoke or fumes become the greatest threat, pilots should reference another checklist. It is likely that the incident flight crew would have performed the Smoke, Fire or Fumes checklist first if they had not experienced severe airframe vibration following the bird ingestion.

Boeing released a flight crew operations manual (FCOM) bulletin on February 9, 2024, that described the results of the bird ingestion in this incident and the actions a flight crew should take if they experience a similar incident. Boeing also updated the system description in the Boeing 737-8 FCOM on November 15, 2024, and the Quick Reference Handbook (QRH) on November 30, 2024, to include engine failure with smoke or fumes in the flight deck or cabin as a condition to trigger reference to the Engine Fire or Engine Severe Damage or Separation QRC.

Although the NTSB found no clear evidence of significant toxic or irritant exposure to the flight crew resulting from the LRD activation on the incident flight, such an event may pose a toxicological risk. There are insufficient data to reliably determine the nature and magnitude of such risk, especially at what is expected to be limited exposure duration. It is reasonable to consider the potential for irritant effects on the pilots among the threats to the immediate safety of the flight in an LRD-related smoke event.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

A partial loss of engine power due to bird ingestion in the No. 1 (left) engine, which resulted in the activation of the load reduction device to prevent vibration. The load reduction device activation resulted in smoke and fumes entering the cockpit.

Findings

Aircraft	(general) - Damaged/degraded
Environmental issues	Animal(s)/bird(s) - Effect on equipment
Aircraft	(general) - Design
Aircraft	(general) - Design
Organizational issues	(general) - Manufacturer
Aircraft	(general) - Design
Organizational issues	Adequacy of policy/proc - Manufacturer

Factual Information

History of Flight

Takeoff	Birdstrike (Defining event)

On December 20, 2023, about 1414 central standard time, Southwest Airlines flight 554, a Boeing 737-8 airplane, N8830Q, was departing from the Louis Armstrong New Orleans International Airport (MSY), Kenner, Louisiana, when a bird ingestion occurred in the No. 1 engine during the initial climbout. The flight crew returned to the airport. None of the 139 occupants aboard the airplane were injured, and the airplane sustained minor damage. The regularly scheduled passenger flight was operating under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 121 from MSY to Tampa International Airport (TPA), Tampa, Florida. Visual meteorological conditions prevailed for the flight.

The captain was the pilot flying for the incident flight, and the FO was the pilot monitoring. The flight crew reported that, after an uneventful takeoff and while climbing through about 1,000 ft, the FO heard the captain say “bird,” which was followed immediately by a “thump” on the left side of the airplane. The airplane began to “shake violently with a distinct loss of thrust” in the left engine. The engine master caution activated, and the captain reported that he heard the fire bell sound.

The captain called for the Engine Fire or Engine Severe Damage or Separation checklist on the QRC. According to the captain, after the FO started the checklist, the flight deck began to fill with “acrid white smoke.” The FO stated that he could not clearly see the captain. The FO called out “masks,” the pilots donned their masks, and they resumed performance of the checklist.

The flight crew declared an emergency to air traffic control and asked ARFF to roll the trucks in preparation for the airplane’s return to MSY. The captain stated that visibility in the cockpit was restricted and that he could see nothing beyond the FO, who was holding the Quick Reference Handbook (QRH). The captain also stated that his instrument panel was difficult to see and that he thought he might need to fly the airplane by solely using the heads-up guidance system. The captain further stated that, after the engine fire switch had been pulled (by the FO), the smoke began to rapidly dissipate.

The flight crew notified the flight attendants about the emergency and made a public address announcement to notify the passengers that fire trucks would be meeting the airplane. After landing at the airport, the airplane came to a full stop on the arrival runway, and ARFF inspected the airplane before the flight crew taxied the airplane to the assigned gate under its own power. The passengers deplaned normally, and no injuries were reported.

Data from the airplane's digital flight data recorder was sent to the NTSB's Vehicle Recorder Laboratory in Washington, DC, for analysis. The data showed that, after takeoff, while the airplane was climbing through about 600 ft, both the left and right engine fan speed (N1) values were about 83% rpm. About 2 seconds later, the left engine's N1 decreased to 75% rpm. Subsequently, the airborne vibration monitor began to increase, and the left engine's oil tank quantity began to decrease from 16.25 quarts. About 15 seconds after the bird ingestion, the left engine's core speed (N2) was below 62% rpm, which would have de-energized the engine's running relay and subsequently closed the PRSOV. About 28 seconds later, the left engine's N1 stabilized at 6% rpm with an oil tank quantity of 3.5 quarts.

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	62,
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Balloon	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1 Waiver time limited special	**Last FAA Medical Exam:**	September 21, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 27, 2023
Flight Time:	25000 hours (Total, all aircraft), 20000 hours (Total, this make and model), 22000 hours (Pilot In Command, all aircraft), 115 hours (Last 90 days, all aircraft), 44 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport	**Age:**	58
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	August 8, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 1, 2023
Flight Time:	20800 hours (Total, all aircraft), 7000 hours (Total, this make and model), 207 hours (Last 90 days, all aircraft), 76 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N8830Q
Model/Series:	737-8	**Aircraft Category:**	Airplane
Year of Manufacture:	2022	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	67750
Landing Gear Type:	Retractable - Tricycle	**Seats:**	175
Date/Type of Last Inspection:	December 16, 2023 Continuous airworthiness	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	3141.18 Hrs as of last inspection	**Engine Manufacturer:**	CFM INTL
ELT:	C126 installed, not activated	**Engine Model/Series:**	LEAP-1B28 SER
Registered Owner:	SOUTHWEST AIRLINES CO	**Rated Power:**	29317 Lbs thrust
Operator:	SOUTHWEST AIRLINES CO	**Operating Certificate(s) Held:**	Flag carrier (121)

The airplane was equipped with two CFM International LEAP-1B engines, which incorporate an LRD designed to minimize aircraft and engine damage during a significant fan imbalance. The design was intended to enable the fan to be mechanically disconnected from the turbomachinery, thus reducing the severity of the vibration that is transmitted into the airframe. LRD devices are a mechanical design feature and do not require any pilot intervention (see figure 1).

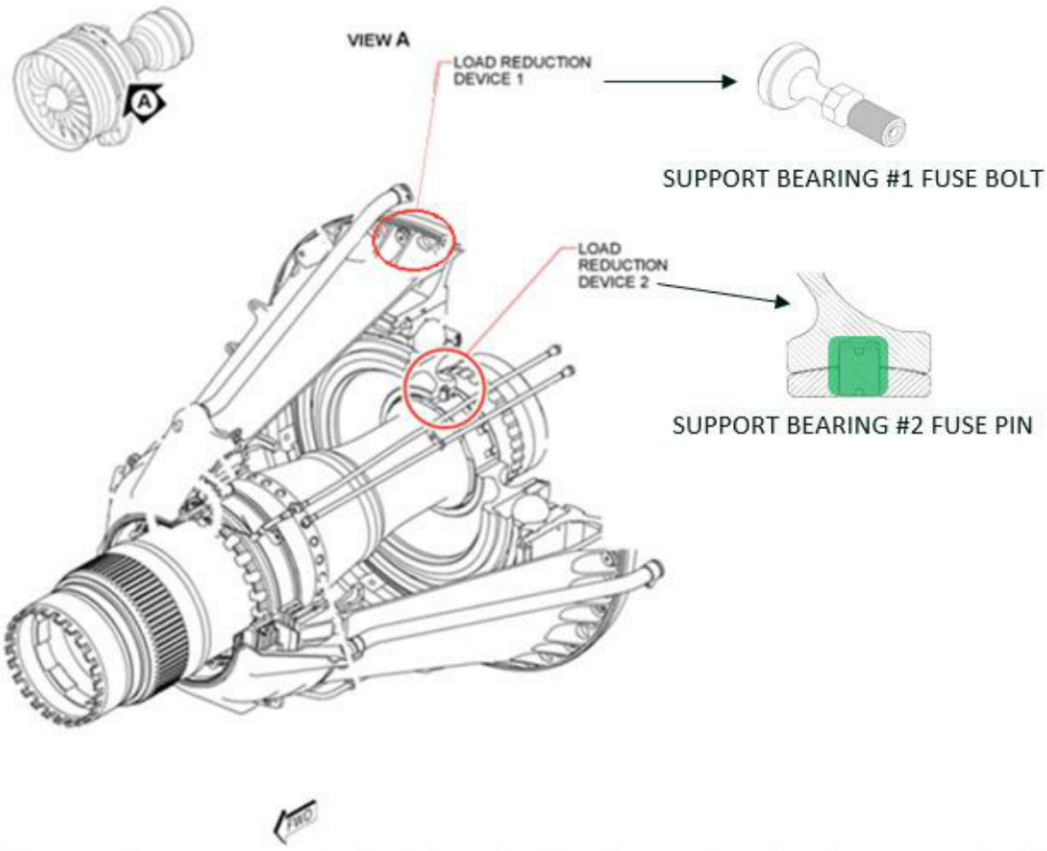


Figure 1. The location of the LRD on the LEAP-1B engine. (Source: CFM)

Postincident examination found that the No. 1 engine LRD was activated in this event, causing tubes supplying oil to the engine sump to become dislodged and the flange from the sump area to open. The open flange allowed oil to enter the core compressor upstream of the pneumatic bleed ports that supply bleed air to the cabin and cockpit. The oil was exposed to high temperatures and resulted in smoke and fumes that were then fed into the cockpit.

Each engine has a PRSOV that, when closed, prevents bleed air from entering the airplane (see figure 2). Pulling the engine fire switch, causes the PRSOV to automatically close.

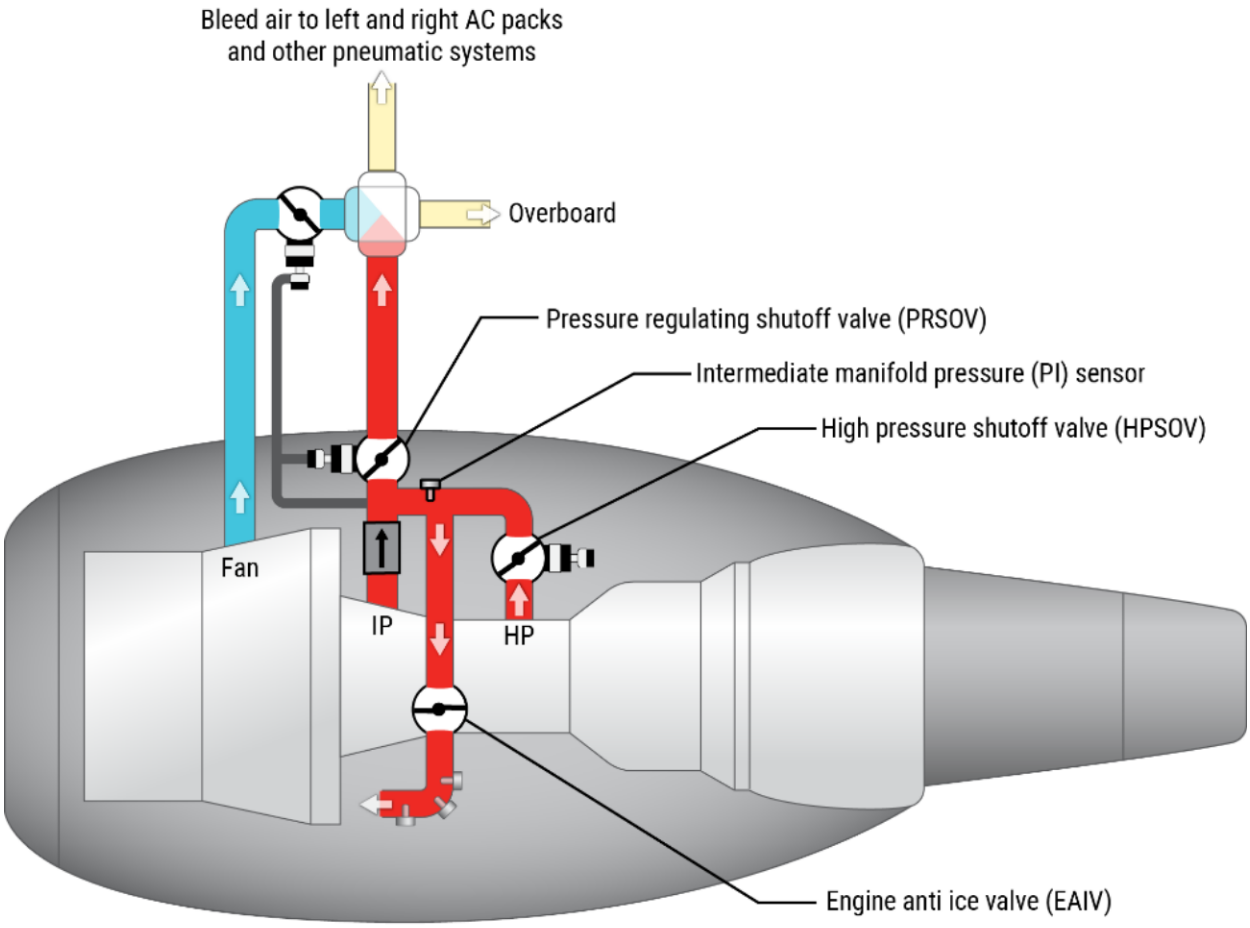


Figure 2. Simplified engine bleed air diagram with PRSOV depicted. (Image Copyright © Boeing. Reprinted with permission.)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KMSY,0 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	14:31 Local	**Direction from Accident Site:**	272°
Lowest Cloud Condition:	Few / 3000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	50°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.32 inches Hg	**Temperature/Dew Point:**	16°C / 9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Kenner, LA	**Type of Flight Plan Filed:**	IFR
Destination:	Tampa , FL (KTPA)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	Class B

Airport Information

Airport:	LOUIS ARMSTRONG NEW ORLEANS INTL MSY	**Runway Surface Type:**	Concrete
Airport Elevation:	3 ft msl	**Runway Surface Condition:**	
Runway Used:	11/29	**IFR Approach:**	None
Runway Length/Width:	10104 ft / 150 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	N/A	**Aircraft Damage:**	Minor
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	N/A	**Latitude, Longitude:**	29.997399,-90.261693

Damage to Aircraft

Postincident examination of the airplane found damage to the left engine fan blades consistent with a bird ingestion (see figure 3).



Figure 3. Close-up photo of damage to the left engine. (Source: Southwest Airlines)

Medical and Pathological Information

The NTSB conducted a study to evaluate the potential for toxic and irritant effects of smoke entering the cockpit or cabin after activation of the LRD. Because there was no direct measurable evidence of the chemical composition of the smoke or the concentrations of chemicals in the cockpit air over time during the incident, and because there was no practical experimental approach by which to reliably determine the chemical composition of the smoke or the concentrations of chemicals in the cockpit or cabin air, the study was limited to

characterizing the incident exposure from available information, and to examining the potential toxicity of future LRD-related smoke events from a theoretical perspective.

The study found no evidence that the captain or first officer experienced impairing irritant or toxic symptoms of smoke exposure during the incident flight. After the flight, no adverse health effects of smoke exposure were conclusively identified for either pilot, although the captain experienced some incompletely characterized respiratory symptoms in the months following the flight.

Organizational and Management Information

The Engine Fire or Engine Severe Damage or Separation checklist, current at the time of the event, in the Boeing 737-8 QRH stated the following:

Condition:

One or more of these occur:

- Engine fire warning
- Airframe vibrations with abnormal engine indications
- Engine separation

1. Autothrottle (if engaged) ..... Disengage
2. Thrust lever (affected engine) ..... Confirm ..... Close
3. Engine start lever (affected engine) ..... Confirm ..... CUTOFF
4. Engine fire switch (affected engine) ..... Confirm ..... Pull

To manually unlock the engine fire switch, press the override and pull.

5. If the engine fire switch or ENG OVERHEAT light is illuminated:

Engine fire switch ..... Rotate to the stop and hold for 1 second

If after 30 seconds the engine fire switch or ENG OVERHEAT light stays illuminated:

Engine fire switch ..... Rotate to the other stop and hold for 1 second

6. Choose one:

- High airframe vibration occurs and continues after the engine is shut down:

Without delay, reduce airspeed and descend to a safe altitude which results in an acceptable vibration level.

Note: If high vibration returns and further airspeed reduction and descent are not practical, increasing airspeed may reduce the vibration.

- Go to step 7

- High airframe vibration does not occur or does not continue after the engine is shut down:

- Go to step 7

7. ISOLATION VALVE switch ..... CLOSE

8. PACK switch (affected side) ..... OFF

This step causes the operating pack to regulate to high flow in flight with the flaps up.

9. APU BLEED air switch ..... OFF

10. Choose one:

- APU is available for start:

APU ..... START

When APU is running:

APU GEN switch (affected side) ..... ON

- Go to step 14

- APU is not available:

- Go to step 11

11. Advise the Cabin Crew that the cabin lighting will be extinguished, but passenger reading lights will continue to work.

12. CAB/UTIL switch ..... OFF

13. IFE/PASS SEAT switch ..... OFF

14. Balance fuel as needed.

15. Transponder mode selector ..... TA

This step prevents climb commands which can exceed single engine performance capability.

16. ISOLATION VALVE switch (after the fire has been extinguished) ..... AUTO

This step ensures bleed air is available to both wings if wing anti-ice is needed.

Note: If wing anti-ice is needed above FL220, maintain a minimum of 50% N1.

17. Plan to land at the nearest suitable airport.

Note: Do not use FMC performance predictions.

The Smoke, Fire or Fumes checklist, current at the time of the event, in the Boeing 737-8 QRH stated the following:

Condition:

Smoke, fire, or fumes occur.

1. Diversion may be needed.

2. Don oxygen masks and set regulators to 100%.

3. Don smoke goggles, as needed.

4. Establish Crew and cabin communications.

5. BUS TRANSFER switch ..... OFF

6. Advise the Cabin Crew that the cabin lighting will be extinguished, but passenger reading lights will continue to work.

7. CAB/UTIL switch ..... OFF

8. IFE/PASS SEAT switch ..... OFF

9. RECIRC FAN switches (both) ..... OFF

10. APU BLEED air switch ..... OFF

11. Anytime the smoke or fumes become the greatest threat:

    - Go to the Smoke or Fumes Removal checklist on page 8.18

12. Choose one:

- Source of the smoke, fire, or fumes is obvious and can be extinguished quickly:

Isolate and extinguish the source.

If possible, remove power from the affected equipment by switch or circuit breaker in the flight deck or cabin.

    - Go to step 13

- Source of the smoke, fire, or fumes is not obvious or cannot be extinguished quickly:

    - Go to step 14

13. Choose one:

- Source is visually confirmed to be extinguished and the smoke or fumes are decreasing:

Continue the flight at the Captain’s discretion.

Restore unpowered items at the Captain’s discretion.

- Go to the Smoke or Fumes Removal checklist on page 8.18, if needed

- Source is not visually confirmed to be extinguished or smoke or fumes are not decreasing:

- Go to step 14

14. EQUIP COOLING SUPPLY and EXHAUST switches (both) ..... ALTN

15. Instruct the Cabin Crew to:

- Turn on cabin reading lights.

- Turn on galley attendants work lights.

16. Divert to the nearest suitable airport while continuing the checklist.

17. Consider an immediate landing if the smoke, fire, or fumes situation becomes uncontrollable.

18. Do not delay landing in an attempt to complete all of the following steps.

19. ISOLATION VALVE switch ..... CLOSE

20. R PACK switch ..... OFF

21. Wait 2 minutes unless the smoke or fumes are increasing. This allows time for the smoke or fumes to clear.

22. Choose one:

- Smoke or fumes are decreasing:

- Go to the Smoke or Fumes Removal checklist on page 8.18, if needed

- Smoke or fumes continue or are increasing:

R PACK switch ..... AUTO

L PACK switch ..... OFF

- Go to step 23

23. Wait 2 minutes unless the smoke or fumes are increasing. This allows time for the smoke or fumes to clear.

24. Choose one:

- Smoke or fumes are decreasing:
    - o Go to the Smoke or Fumes Removal checklist on page 8.18, if needed
- Smoke or fumes continue or are increasing:

L PACK switch ..... AUTO

Consider an immediate landing.

Additional Information

According to the FAA, there have been "*about 292,000 reported wildlife strikes with civil aircraft between 1990 and 2023. In 2023, reported bird strikes occurred at 780 U.S. airports*." Of note, the "Wildlife Strike Database" indicated that in 2023 there were 19,400 strikes that occurred at 713 U.S. airports. Over half of the bird strikes occurred between July and October with over 30 percent of the bird strikes occurring during the take-off run and initial climb. The database entry associated with the incident flight reported the species of bird struck as a bald eagle.

Title 14 *Code of Federal Regulation* Part 139.337 provides regulatory guidance for airports to alleviate wildlife hazards. A letter dated February 8, 2024, from the New Orleans Wildlife Control Coordinator to the FAA Airport Safety and Standards Division stated that MSY had completed a review and evaluation of their Wildlife Hazard Management Plan (WHMP) and they believed that the section that referred to eagle permits provided the best overall consideration for eagle hazards and mitigation that the law provides for the harassment of such a species.

Boeing released an FCOM bulletin on February 9, 2024, that described the results of the bird ingestion in the MSY incident and the actions a flight crew should take if they experience a similar incident. Boeing also updated the system description in the Boeing 737-8 FCOM on November 15, 2024, and the QRH on November 30, 2024, to include engine failure with smoke or fumes in the flight deck or cabin as a condition to trigger reference to the Engine Fire or Engine Severe Damage or Separation QRC.

In addition, on February 14, 2024, Southwest Airlines issued a Read Before Fly brief to its pilots describing the event and incorporating Boeing's updates from its FCOM bulletin. The brief indicated that section 5.5.4 Engine Failure or Shutdown in the aircraft operating manual would

be updated to indicate that if smoke enters the flight deck or cabin, flight crews should accomplish the Engine Fire or Engine Severe Damage or Separation steps of the QRC.

The NTSB is aware that CFM International, in collaboration with Boeing, has begun work on an engine software design update that they anticipate completing in the first quarter of 2026. The update will mitigate the presence of smoke or fumes in the cockpit or airplane cabin by closing the PRSOV when the LRD activates. This update will be entirely software-based and made available through a service bulletin upon certification.

The NTSB is also aware the FAA convened a corrective action review board in November 2024 to evaluate the potential for smoke in the cockpit and cabin resulting from LRD activation; the corrective action review board determined the issue did not warrant immediate action and that any corrective action would be taken through the usual regulatory process.

As a result of findings during this investigation, on June 18, 2025, the NTSB issued Safety Recommendations A-25-10 through -14.

Administrative Information

Investigator In Charge (IIC):	Banning, David
Additional Participating Persons:	Heidi Kemner; FAA; Washington , DC Erin Carroll; Southwest Airlines; Dallas, TX Eric East ; Boeing ; WA Craig Jakubowski; SWAPA Alvaro Hernandez; CFM International
Original Publish Date:	February 25, 2026
Last Revision Date:	February 26, 2026
Investigation Class:	Class 2
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=195527

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available here.