



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure

DCA18MA142 SWA1380 INVESTIGATIVE UPDATE

On April 17, 2018, at 1103 eastern daylight time, Southwest Airlines flight 1380, a Boeing 737-700, N772SW, experienced a failure of the left CFM International CFM-56-7B engine and loss of engine inlet and cowling during climb about flight level 320. Fragments from the engine inlet and cowling struck the wing and fuselage, resulting in a rapid depressurization after the loss of one passenger window. The flight crew conducted an emergency descent and diverted into Philadelphia International Airport (KPHL), Philadelphia, Pennsylvania. Of the 144 passengers and five crewmembers onboard, one passenger received fatal injuries and eight passengers received minor injuries. The airplane sustained substantial damage. The regularly scheduled domestic passenger flight was operating under Title 14 *Code of Federal Regulations* Part 121 from LaGuardia Airport (KLGA), Queens, New York, to Dallas Love Field (KDAL), Dallas, Texas.

The NTSB launched a go-team consisting of an investigator-in-charge from the major investigations division and specialists in powerplants, structures, survival factors and operations. Specialists in meteorology, maintenance records, air traffic control, flight recorders, and materials supported the investigation from other locations. Chairman Robert Sumwalt accompanied the team.

Parties to the investigation include the Federal Aviation Administration, Southwest Airlines, GE Aviation, Boeing, the Aircraft Mechanics Fraternal Association, the Southwest Airlines Pilots Association, Transport Workers Union Local 556, and UTC Aerospace Systems. The CFM-56 engine is a joint product of GE Aviation and Safran Aircraft Engines of France; therefore the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile appointed an accredited representative supported by technical advisors from Safran and the European Aviation Safety Agency.

Initial examination of the airplane revealed that the majority of the inlet cowl was missing, including the entire outer barrel, the aft bulkhead, and the inner barrel forward of the containment ring. The inlet cowl containment ring was intact but exhibited numerous impact witness marks. Examination of the fan case revealed no through-hole fragment exit penetrations; however, it did exhibit a breach hole that corresponded to one of the fan blade impact marks and fan case tearing. (See figure 1.)



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure



Figure 1. Damage to cowl - inboard

The No.13 fan blade had separated at the root; the dovetail remained installed in the fan disk. Examination of the No. 13 fan blade dovetail exhibited features consistent with metal fatigue initiating at the convex side near the leading edge. Two pieces of fan blade No. 13 were recovered within the engine between the fan blades and the outlet guide vanes. One piece was part of the blade airfoil root that mated with the dovetail that remained in the fan disk; it was about 12 inches spanwise and full width and weighed about 6.825 pounds. The other piece, identified as another part of the airfoil, measured about 2 inches spanwise, appeared to be full width, was twisted, and weighed about 0.650 pound. All the remaining fan blades exhibited a combination of trailing edge airfoil hard body impact damage, trailing edge tears, and missing material. Some also exhibited airfoil leading edge tip curl or distortion. After the general in-situ engine inspection was completed, the remaining fan blades were removed from the fan disk and an ultrasonic inspection was performed consistent with CFM International Service Bulletin 72-1033. No cracks were identified on the remaining blades.

The No. 13 fan blade was examined further at the NTSB Materials Laboratory; Figure 2 shows a portion of the blade in detail. Fatigue fracture features emanated from multiple origins at the convex side and were centered about 0.568 inch aft of the leading edge face of the dovetail and were located 0.610 inch outboard of the root end face. The origin area was located outboard of



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure

the dovetail contact face coating, and the visual condition of the coating appeared uniform with no evidence of spalls or disbonding. The fatigue region extended up to 0.483 inch deep through the thickness of the dovetail and was 2.232 inches long at the convex surface. Six crack arrest lines (not including the fatigue boundary) were observed within the fatigue region. The fracture surface was further examined using a scanning electron microscope, and striations consistent with low-cycle fatigue crack growth were observed.

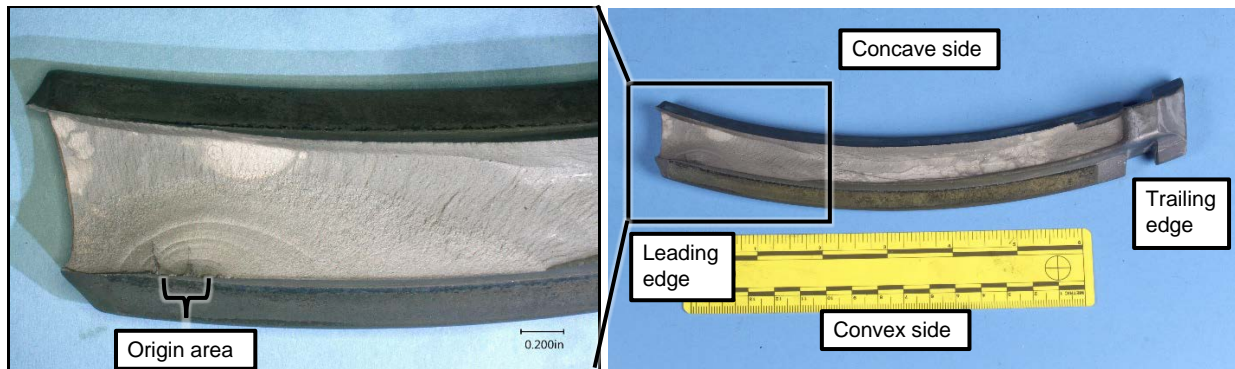


Figure 2. Fracture surface with fatigue indications

The accident engine fan blades had accumulated more than 32,000 engine cycles since new. Maintenance records indicated the accident engine fan blades had been periodically lubricated as required per the Boeing 737-600/700/800/900 Aircraft Maintenance Manual.

According to maintenance records, the fan blades from the accident engine were last overhauled 10,712 engine cycles before the accident. At the time of the last blade overhaul (November 2012), blades were inspected using visual and fluorescent penetrant inspections. After an August 27, 2016, accident in Pensacola, Florida, in which a fan blade fractured, eddy current inspections were incorporated into the overhaul process requirements.

In the time since the fan blade overhaul, the accident engine fan blade dovetails had been lubricated 6 times. At the time each of these fan blade lubrications occurred, the fan blade dovetail was visually inspected as required for the fan blades installed in the accident engine.

The NTSB materials group is working to estimate the number of cycles associated with fatigue crack initiation and propagation in the No. 13 fan blade and to evaluate the effectiveness of inspection methods used to detect these cracks.

On April 20, 2018, CFM International issued Service Bulletin 72-1033 applicable to CFM International CFM 56-7B-series engines recommending ultrasonic inspections of all fan blades on engines that have accumulated 20,000 engine cycles and subsequently at intervals not to exceed 3,000 engine cycles.

On April 20, 2018, the FAA issued emergency AD (EAD) 2018-09-15 based on the CFM International service bulletin. The EAD required CFM56-7B engine fleet fan blade inspections



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure

for engines with 30,000 or greater cycles. The EAD required that within 20 days of issuance that all CFM56-7B engine fan blade configurations to be ultrasonically inspected for cracks per the instructions provided in CFM International SB 72-1033, and, if any crack indications were found, the affected fan blade must be removed from service before further flight. On the same day, EASA also issued EAD 2018-0093E (superseding EASA AD 2018-0071) that required the same ultrasonic fan blade inspections to be performed.

The remainder of the accident airplane's airframe exhibited significant impact damage to the leading edge of the left wing, left side of the fuselage, and left horizontal stabilizer. (See figure 3.) A large gouge impact mark, consistent in shape to a recovered portion of fan cowl and latching mechanism, was adjacent to the row 14 window (see figure 4; the window was entirely missing. No window, airplane structure, or engine material was found inside the cabin.



Figure 3. Damage to leading edge of left wing

Three flight attendants were assigned to the flight, and an additional SWA employee was in a jumpseat in the cabin. During interviews, the flight attendants and the employee reported that they heard a loud sound and experienced vibration. The oxygen masks automatically deployed in the cabin. The flight attendants retrieved portable oxygen bottles and began moving through the cabin to calm passengers and assist them with their masks. As they moved toward the mid-cabin, they found the passenger in row 14 partially out of the window and attempted to pull her into the cabin. Two male passengers helped and were able to bring the passenger in.



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure



Figure 4. Picture of window 14 with portion of engine inboard fan cowl.

During interviews, the flight crew stated the climbout from LaGuardia was normal with no indications of any problems; the first officer was the pilot flying and the captain was the pilot monitoring. They reported experiencing a sudden change in cabin pressure, aircraft yaw, cockpit alarms, and a “gray puff of smoke.” They donned their oxygen masks, and the first officer began a descent. Flight data recorder data showed that the left engine parameters all dropped simultaneously, vibration increased, and, within 5 seconds, the cabin altitude alert activated. The FDR also indicated that the airplane rolled left to about 40 degrees before the flight crew was able counter the roll with control inputs. The flight crew reported that the airplane exhibited handling difficulties throughout the remainder of the flight. The captain took over flying duties and the first officer began running emergency checklists. The captain requested a diversion from the air traffic controller; she first requested the nearest airport but quickly decided on Philadelphia. The controller provided vectors to the airport with no delay. The flight crew reported initial communications difficulties because of the loud sounds, distraction, and wearing masks, but, as the airplane descended, the communications improved. The captain initially was planning on a long final approach to make sure they completed all the checklists, but when they learned of the passenger injuries, she decided to shorten the approach and expedite landing.



National Transportation Safety Board
Investigative Update
Southwest Airlines Flight 1380 Engine Failure

A cockpit voice recorder (CVR) group was convened and has completed a draft transcript of the entire event. The CVR transcript will be released when the public pocket is opened.

Additional information will be released as warranted.