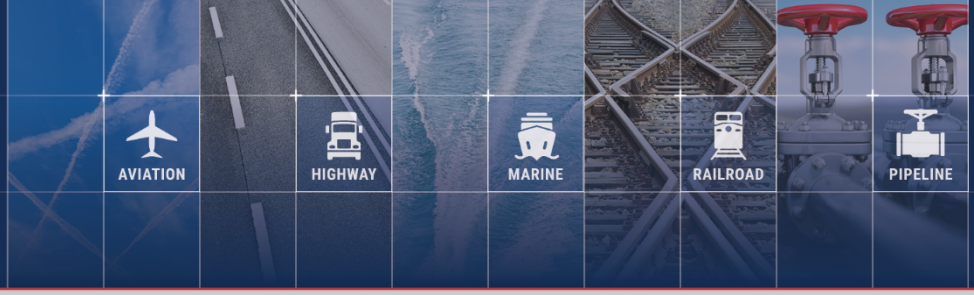

Aviation Investigation Final Report

Location:	Greenville, Texas	**Incident Number:**	ENG08IA002
Date & Time:	November 17, 2007, 14:55 Local	**Registration:**	N676SW
Aircraft:	Boeing 737-300	**Aircraft Damage:**	Minor
Defining Event:		**Injuries:**	138 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The airplane experienced a failure of the No. 2 engine while climbing through flight level (FL) 250 to FL 330. The flight crew reported feeling severe vibration, pulled both throttles back to idle, declared an emergency, made an air turn back and performed an uneventful single-engine landing. Examination of the engine revealed that all the fan blades exhibited heavy airfoil damage, with several fractured near the platform. The forward and rear spinner cones were no longer attached to the fan disk and a large penetration hole was noted on the right-hand side of the fan cowl, just forward of the engine fan case. Examination of the airplane revealed impact marks along the right side of the fuselage and the right-hand horizontal stabilizer. None of the fuselage impacts were through to the cabin. The pieces of the forward and rear spinners cones that exited the engine were never recovered. Metallurgical examination of the fracture surfaces of the fan blades and the fragments of the rear spinner aft flange revealed no preexisting fatigue-type mechanism and all the fractures were consistent with overstress. Four sequential fan blade spacers were distorted consistent with a severe axial load rearward applied to the spacers by the rear spinner cone prior to the spinner cone release; however, no determination could be made as to the initial failure or what may have impacted the spinner cone.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: A total loss of engine power due to the No. 2 engine experiencing a release of its fan spinner through the fan cowl as a result of an unidentified object striking the spinner, separating it from the fan disk and causing the spinner to be ingested into the fan blades.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: CLIMB - TO CRUISE

Findings
1. (C) COMPRESSOR ASSEMBLY - FRACTURED
2. (C) COMPRESSOR ASSEMBLY - SEPARATION
3. FUSELAGE,SKIN - PENETRATED
4. COMPRESSOR ASSEMBLY - UNDETERMINED

Factual Information

On November 17, 2007, a Southwest Airlines' Boeing 737-300, registration number N676SW, flight number 438, experienced a failure of the No. 2 engine, a CFM CFM56-3B1 while climbing through FL250 to FL330. The flight crew reported feeling severe vibration, pulled both throttles back to idle, declared an emergency, and started an air turn back to Love Field (DAL), Dallas, TX. While heading back to DAL, the pilot reported seeing the following cockpit warnings: a No. 2 constant speed drive (CSD) low oil pressure, No. 2 engine low oil pressure, No. 2 generator bus OFF, No. 2 pack trip OFF lights, and No. 2 engine vibration meter at 5 units. The pilot also reported that while heading back to DAL, the start lever on the No. 2 engine was CLOSED. An uneventful single engine landing was performed and no injuries were reported to any of the occupants. The incident flight was an IFR flight conducted under 14 CFR Part 121 from Dallas, Love Field, TX, to Little Rock (LIT), AR and was the third flight of the day for the aircraft. None of the 133 passengers and 5 on board were injured.

Examination of the airplane revealed impact marks along the fuselage from about 10 feet aft of the right-hand forward entry door to about 6 feet forward of the right-hand aft entry door and along almost the entire length of right wing leading edge. The right horizontal stabilizer also exhibited impact marks along almost the entire leading edge. None of airframe impact marks were punctures through the fuselage's pressure vessel.

Examination of the No. 2 engine revealed that all the fan blades exhibited heavy airfoil damage, all the fan blade roots remained installed in the disk, and several fan blades fractured near the platform. The forward and rear spinner cones were no longer attached to the fan disk and a large penetration hole was noted on the right-hand side of the fan cowl just forward of the engine fan case. No breaches of any of the engine cases or signs of fire damage were noted.

Metallurgical examination of the fracture surfaces of the fan blades and the fragments of the rear spinner aft flange at the Safety Board revealed no pre-existing fatigue type mechanism and all the fractures were consistent with overstress. Examination of all thirty-eight (38) fan blade spacers revealed no fretting marks on any of the front faces; however, four sequential spacers exhibited axial distortion of their lug in the forward direction. The engine manufacturer, CFM, concluded that a severe axial load rearward was applied to the spacers by the rear spinner cone prior to the spinner cone release and that the maximum force was localized where the distorted spacers were located.

Based on the lack of evidence for a pre-existing fatigue type fan blade or rear spinner fractures, and the physical evidence suggesting a possible single hard impact to the rear spinner as the initiating event causing the engine failure, possible external sources of foreign object ingestion were examined. A visual and fluorescent black light inspection was performed on all the fan blades, the fan inlet case, and the basic fan frame structure while the engine was still installed

on the airplane, and the fan blades were again examined at the CFM Investigation Laboratory after they were removed from the fan disk. No bird remains or evidence of a bird ingestion event were found.

The Boeing 737 has had prior events where water leaking from the forward lavatory was suspected to have turned into ice during flight. This ice would depart from the airplane's forward service panel and be ingested into the No. 2 engine resulting in an in-flight shutdown of the No. 2 engine. Airworthiness Directives (AD) were issued to address the source of the leaks and to require periodic inspections to detect potential leaks. Review of Southwest Airlines' maintenance records for airplane N676SW revealed that the airplane had been modified and was inspected in accordance with the AD requirements. Examination of the maintenance write-ups prior to the No. 2 engine failure and after the airplane was returned to service showed no history or problems related to a leaky forward lavatory. Examination of the forward lavatory panel and the airplane skin in the vicinity of the forward lavatory panel revealed no signs of fluid streaks or leaks. Furthermore, the fan blades were subjected to an energy dispersive spectroscopy (EDS) analysis to document material transferred and deposited onto the fan blades. No unrecognizable material was found and all the material identified was consistent with material coming from either the inlet cowl or the spinner cone.

Information

Certificate:	**Age:**
Airplane Rating(s):	**Seat Occupied:**
Other Aircraft Rating(s):	**Restraint Used:**
Instrument Rating(s):	**Second Pilot Present:**
Instructor Rating(s):	**Toxicology Performed:**
Medical Certification:	**Last FAA Medical Exam:**
Occupational Pilot:	**Last Flight Review or Equivalent:**
Flight Time:	

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N676SW
Model/Series:	737-300	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:		**Engine Manufacturer:**	CFM
ELT:	Installed, not activated	**Engine Model/Series:**	CFM56-3B1
Registered Owner:	On file	**Rated Power:**	
Operator:	On file	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	On file	**Operator Designator Code:**	SWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	
Observation Facility, Elevation:	DAL	**Distance from Accident Site:**	
Observation Time:	14:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Scattered / 12000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 25000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	210°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	25°C / 12°C
Precipitation and Obscuration:			
Departure Point:	DALLAS, TX (DAL)	**Type of Flight Plan Filed:**	IFR
Destination:	LITTLE ROCK, AR (LIT)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	Class C

Airport Information

Airport:	Love Field DAL	**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:		**IFR Approach:**	ILS
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	5 None	**Aircraft Damage:**	Minor
Passenger Injuries:	133 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	138 None	**Latitude, Longitude:**	33.191112,-95.978332

Administrative Information

Investigator In Charge (IIC):	Scarfo, Jean-Pierre
Additional Participating Persons:	David Keenan; AAI-100; Washington, DC
Original Publish Date:	June 22, 2009
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=67094