

Aviation Investigation Factual Report

Location:	Atlanta, Georgia	Incident Number:	ENG12IA001
Date & Time:	October 10, 2011, 15:03 Local	Registration:	N553NW
Aircraft:	Boeing 757-251	Aircraft Damage:	Minor
Defining Event:	Uncontained engine failure	Injuries:	182 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Factual Information

HISTORY OF FLIGHT

On October 10, 2011 at about 3:04 eastern daylight time, a Delta Air Lines (DAL) Boeing 757-200, N553NW, powered by two Pratt & Whitney PW2037(M) turbofan engines, experienced a left engine failure during takeoff roll at Hartsfield-Jackson Atlanta International Airport, Atlanta, Georgia (ATL). The flight crew reported that, at about 60 kias, they heard a loud bang and noted left engine fire indications. The captain aborted the takeoff and shut down the engine, and the airplane was taxied back to the gate without further incident. The airplane was operating on an instrument flight rules flight plan as domestic passenger flight 2210 in accordance with the provisions of 14 Code of Federal Regulations (CFR) Part 121, from ATL to Dallas Ft. Worth International Airport, Ft. Worth, Texas. No injuries were reported, and there was minor damage to the airplane. Post-incident inspection of the airplane found that the left engine diffuser case had ruptured.

DAMAGE TO THE AIRCRAFT

The leading edge and underside of the airplane's left wing had numerous dents and small impact marks. Both halves of the left engine core cowl, which is hinge-mounted on the pylon, were severely distorted. The core cowl halves could be rotated beyond their normal range of travel until they contacted the left wing, and the location of the wing damage was consistent with having been struck by the core cowl halves during the rupture event.

DIFFUSER CASE RUPTURE

The engine diffuser case, high pressure turbine (HPT) case, and nozzle guide vane (NGV) support joint, referred to as the "M-flange," were fractured at a bolt hole located at 12 o'clock (BH1). A longitudinal fracture extended from BH1 about 15 inches forward into the diffuser case and about 2.5 inches aft into the HPT case. There was a 270° circumferential fracture in the diffuser case about 15 inches forward of the M-flange, and a 120° circumferential fracture in the HPT case about 2.5 inches aft of the M-flange; an approximately 15-inch-wide section of the diffuser case, along with fractured segments of the HPT case and NGV support attached at the M-flange, had unwrapped from the right side of the engine. The engine was disassembled and the diffuser case, NGV support, and HPT case were shipped to the NTSB materials lab for further investigation.

TESTS AND RESEARCH

Materials investigation

Metallurgical examination of the diffuser case, NGV support, and HPT case fracture surfaces revealed that low cycle fatigue cracks had initiated in all three components at the M-flange bolt hole and propagated across the flange surface inboard of the bolt hole (inner strap) and the flange surface outboard of the bolt hole (outer strap). Scanning electron microscopy found discernible fatigue striation marks on the diffuser

case and the HPT case fracture surfaces. Fatigue striations are marks left on a fracture surface as a crack advances with each stress cycle, and the number of engine cycles required to produce a fatigue crack can sometimes be estimated by counting the striations and analyzing the striation counts, along with other data. Analysis of these data determined that the first fatigue crack initiated in the HPT case, followed by crack initiation in the diffuser case. Cracks had propagated through the HPT case M-flange outer and inner straps over approximately 7,305 and 7,384 cycles, respectively, and the cracks in the diffuser case M-flange propagated through the outer and inner straps over approximately 2,471 and 5,159 cycles, respectively.

Continued airworthiness of turbine cases

The continued airworthiness of PW2000 diffuser and HPT cases is ensured by periodic fluorescent penetrant inspection (FPI). FPI is a surface crack detection method that uses a penetrating fluid with a fluorescent suspension that enters crack separations by capillary action. A black light is used to visually detect cracks containing the fluid. Diffuser and HPT cases undergo FPI when completely disassembled in accordance with the manufacturer recommendation. No cracks are permitted.

According to Delta Air Lines maintenance records, the diffuser case and the HPT case were last exposed for inspection during overhaul at Pratt & Whitney's Cheshire Engine Center (P&W CEC) in August, 2008, 3,479 cycles before the failure. A review of the P&W CEC shop records found that both the diffuser case and the HPT case underwent FPI during this shop visit, and were returned to service with no cracks found.

Crack growth study findings

The crack growth study found that an approximate 0.46-inch crack was present in the HPT case M-flange inner strap and case wall, an approximate 0.26-inch crack was present in the diffuser case M-flange and case wall, and that both diffuser and HPT case M-flange outer straps were cracked through when the cases were overhaul inspected at P&W CEC. The crack growth study also showed that the first fatigue crack initiated in the HPT case, followed by crack initiation in the diffuser case. The P&W CEC repair station was closed in August 2011. The reason for the ineffective inspection was not determined, but was narrowed to chronological and operator based scenarios. A suspect population of 50 engines was identified that included sub-populations for both possibilities. The FAA published airworthiness directive (AD) 2014-05-32, requiring the M-flanges of PW2037, PW2037D, PW2037M, PW2040, PW2040D, PW2043, PW2143, PW2240, PW2337, PW2643, and F117-PW-100 engines in the identified suspect population to undergo eddy current inspection within 100 flight cycles or 30 days. No additional cracks were found.

ADDITIONAL INFORMATION

Corrective actions

AD 2014-05-32 also requires that, effective May 5, 2014, high-sensitivity FPI penetrant be used when accomplishing FPI of the PW2037, PW2037D, PW2037M, PW2040, PW2040D, PW2043, PW2143, PW2240, PW2337, PW2643, and F117-PW-100 diffuser case aft flange (M-flange) and HPT case forward flange (M-flange). In addition, AD 2014-05-32 makes the performance of diffuser and HPT case M-flange high-sensitivity FPI at every piece part opportunity an airworthiness limitation for PW2037, PW2037D, PW2037M, PW2040, PW2040D, PW2043, PW2146, PW2240, PW2337, PW2643, and F117-PW-100 engines.

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:	N553NW
Model/Series:	757-251	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Transport	Serial Number:	26500
Landing Gear Type:		Seats:	178
Date/Type of Last Inspection:		Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	2 Turbo jet
Airframe Total Time:		Engine Manufacturer:	P & W
ELT:		Engine Model/Series:	PW2037
Registered Owner:	DELTA AIR LINES INC	Rated Power:	37530 Lbs thrust
Operator:	Delta Air Lines Inc	Operating Certificate(s) Held:	Flag carrier (121)
Operator Does Business As:		Operator Designator Code:	DAL

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:		Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:		Visibility	
Lowest Ceiling:		Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:		Temperature/Dew Point:	
Precipitation and Obscuration:			
Departure Point:	Atlanta, GA (ATL)	Type of Flight Plan Filed:	Unknown
Destination:	Dallas, TX (DFW)	Type of Clearance:	Unknown
Departure Time:	15:03 Local	Type of Airspace:	

Airport Information

Airport:	HARTSFIELD - JACKSON ATLANTA I ATL	Runway Surface Type:	
Airport Elevation:	1026 ft msl	Runway Surface Condition:	
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	6 None	Aircraft Damage:	Minor
Passenger Injuries:	176 None	Aircraft Fire:	On-ground
Ground Injuries:	N/A	Aircraft Explosion:	On-ground
Total Injuries:	182 None	Latitude, Longitude:	33.763332,-84.401664(est)

Administrative Information

Investigator In Charge (IIC):	Horgan, Carol
Additional Participating Persons:	Federal Aviation Administration; Washington, DC Steve `Sheely; Federal Aviation Administration; Burlington, MA
Report Date:	October 22, 2014
Last Revision Date:	
Investigation Class:	<u>Class</u>
Note:	The NTSB traveled to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=82022

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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.