



National Transportation Safety Board Aviation Accident Final Report

Location:	NEWARK, NJ	Accident Number:	NYC00FA122
Date & Time:	04/25/2000, 1942 EDT	Registration:	N39081
Aircraft:	McDonnell Douglas DC-10-30	Aircraft Damage:	Substantial
Defining Event:		Injuries:	234 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

At V1, the DC-10-30's number 1 engine, a General Electric CF6-50C2, experienced a casing breach when the 2nd-stage low pressure turbine (LPT) anti-rotation nozzle locks failed. The breach occurred in the turbine plane, between approximately the 3 o'clock and 9 o'clock positions. Debris from the breach resulted in collateral damage to the numbers 2 and 3 engines, the fuselage, and the left landing gear. In May 1993, the engine manufacturer issued a service bulletin to replace existing nozzle locks with ones that had thicker posts and arms. The change required modification of the LPT case nozzle lock holes. In March 1994, the manufacturer issued another service bulletin, SB 72-1082, which introduced a newly designed nozzle lock. The new locks, which were installed on the accident engine, utilized original diameter stud shanks, but were manufactured from a different material, and did not require modification of the LPT case. There were two previously reported failures of SB 72-1082 LPT nozzle locks, discovered during routine under-cowl inspections. In one case, all of the 2nd-stage nozzle locks were broken. The nozzle segments had rotated 120 degrees within the LPT case, but the case itself was not breached. In the second case, two 4th-stage nozzle locks had failed, but there was no collateral damage. According to the engine manufacturer, the failures were intergranular, "suggesting either stress rupture or sustained peak low cycle fatigue." Safety Board examination, of the only two recovered 2nd-stage nozzle locks from the accident engine, along with a section of casing with a nozzle lock stud attached, revealed intergranular fracture features, degradation at the surface of the fracture features, and grain boundaries, typical of oxidation damage. The intergranular fractures and oxidation damage found at the grain boundaries were consistent with stress rupture. An examination of a cracked 2nd stage nozzle lock, from a comparison engine, also revealed oxidation and intergranular fracture features, consistent with stress rupture.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Stress rupture of the 2nd-stage low pressure turbine anti-rotation nozzle locks, resulting from inadequate nozzle lock design.

Findings

Occurrence #1: LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation: TAKEOFF - ROLL/RUN

Findings

1. (C) TURBINE ASSEMBLY,NOZZLE RETENTION - RUPTURED
2. (C) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER

Factual Information

HISTORY OF FLIGHT

On April 25, 2000, at 1942 Eastern Daylight Time, a McDonnell-Douglas DC-10-30, N39081, operating as Continental Airlines flight 60, was substantially damaged when an uncontained engine event occurred during takeoff from Newark International Airport (EWR), Newark, New Jersey. The 3-man cockpit crew, 11-person cabin crew, and 220 passengers were not injured. Visual meteorological conditions prevailed at the time of the accident. An instrument flight rules flight plan had been filed for the flight, between Newark and Brussels Airport (BRU), Brussels, Belgium. The scheduled passenger flight was conducted under 14 CFR Part 121.

The captain stated that he conducted a crew briefing prior to boarding the airplane. Startup and taxi were normal, and during the taxi, the captain again briefed the cockpit crew, and included engine failures, as well as "non-reject" situations. The airplane lined up on Runway 04L, and the captain applied takeoff power slowly and smoothly. At takeoff decision speed (V₁), there was a loud explosion. A white "engine fail" light illuminated in front of the captain, and the number 1 engine N1 decreased by 30 percent. Number 2 and number 3 engines appeared normal.

The captain continued the takeoff, and the landing gear was raised. A red, left main landing gear warning light illuminated on the front panel. The airplane turned to a heading of 010, and slowly climbed to 3,000 feet. During the climb, an airframe vibration developed.

After level-off, the crew began to troubleshoot the emergency, and found that when the number 3 engine N1 was reduced, the vibration disappeared. Both the number 1 and the number 3 engines remained at reduced power, in relation to number 2, for the rest of the flight.

Air traffic control personnel provided vectors for a return to Newark. During the return, the crew dumped about 90,000 pounds of fuel. The crew also ran both 1-engine, and 2-engine inoperative checklists, and prepared data cards for both scenarios.

The captain flew the ILS glideslope down to a full-stop landing, on Runway 04R. The ACARS recorded the landing at 2016. After stopping on the runway, the brakes would not release, so the crew shut down the engines, and the passengers and crew disembarked through the normal deplaning doors. The airplane was later towed to a ramp.

According to the captain, the use of crew resource management (CRM) by both the cockpit and cabin crews was a major factor in the successful handling of the emergency.

The accident occurred approximately 5 minutes before sunset, about 40 degrees, 41.5 minutes north latitude, 74 degrees, 10.2 minutes west longitude.

PERSONNEL INFORMATION

The captain held an airline transport pilot certificate with a DC-10 type rating. His latest first class medical certificate was dated November 12, 1999. His last formal cockpit resource management training was completed on August 14, 1997.

The first officer also held an airline transport pilot certificate. His latest first class medical certificate was dated June 15, 1999.

The second officer also held an airline transport pilot certificate.

DAMAGE TO AIRCRAFT

Examination of the airplane revealed that all three General Electric Aircraft Engine (GEAE) CF6-50C2 engines were damaged. The number 1 (left) engine low pressure turbine (LPT) case was breached in the vicinity of the 2nd-stage nozzles, between approximately the 3 o'clock and 9 o'clock positions. The breach was about the width of the 2nd-stage nozzle segments, all of which were missing from the engine.

Nine of the 16 nozzle segments were recovered intact, and additional portions of 5 segments were found, for a total recovery of about 85 percent of the nozzle material. The majority of nozzle material was found on the departure runway; however, one nozzle segment was found in the left main landing gear wheel well.

All eight of the 2nd-stage LPT nozzle locks were missing from the engine. A single nozzle lock stud and nut remained attached to the LPT case lower half, but the lock itself was missing. Two of the eight anti-rotation nozzle locks were recovered from a debris field along the runway. The 1st-stage LPT blades had minor trailing edge airfoil damage, and the 2nd-stage LPT blades exhibited circumferential rub marks on the inner platform leading edge, and on the airfoils near the blade root.

The number 2 (center) engine exhibited leading edge damage to two fan blades.

The number 3 (right) engine had leading edge damage to all of the fan blades, consisting of tears, rips and material loss. Pieces of fan blade, and material similar to that of the 2nd-stage nozzles from the number 1 engine, were found embedded in the engine inlet acoustic panels.

The front inboard tire of the left main landing gear was ruptured, and the front outboard tire exhibited tread separation, but remained inflated. Impact marks, including punctures and scrapes, were noted on the outboard side of the left engine pylon, the left wing outboard flap, the underside of the fuselage, the left main landing gear access door, the left side of the fuselage aft of the left wing, and a right wing panel outboard of the flap actuator housing.

TESTS AND RESEARCH

According to the Powerplants Group Chairman's Factual Report:

The GEAE CF6-50C2 engine was a dual-rotor, high-bypass, axial flow turbofan, which produced approximately 50,000 pounds of thrust. It featured a 14-stage high pressure compressor, driven by a 2-stage high pressure turbine; an annular combustor; and an integrated front fan and low pressure compressor, driven by a 4-stage LPT.

The LPT included eight 2nd-stage nozzle locks, one for every two nozzle segments, and ten 3rd- and 4th-stage nozzle locks, one for every six segments. All of the nozzle locks were of the same configuration and material.

On May 4, 1993, GEAE issued CF6-50 service bulletin (SB) 72-1065, to replace existing nozzle locks with ones that had thicker posts and arms, to prevent cracking and breaking. The increased diameter of the stud shank required modification of the LPT case nozzle lock holes. Before SB 72-1065 could be incorporated into the accident engine, a new service bulletin was issued.

On March 30, 1994, GEAE issued CF6-50 SB 72-1082, which discontinued SB 72-1065, and introduced a newly designed nozzle lock. SB 72-1082 returned to the use of original-diameter

stud shanks, but the material was changed. The new nozzle lock did not require modification of the LPT case.

In March 1997, Greenwich Caledonian Limited, Prestwick, Scotland, incorporated SB 72-1082 into the accident engine. The engine was subsequently installed on another DC-10, in position number 3, where it remained until July 6, 1999. At that time, it was removed due to high pressure turbine damage, and shipped to GE Caledonian Limited (name change for the same company) for repair. The LPT nozzle segments were not removed from the case, but were visually inspected, on July 26, 1999. On December 16, 1999, the operator installed the engine in position number 1 on the accident airplane.

At the time of the accident, the nozzle locks had attained 9,226 hours of operation since new, and 1,302 cycles since new. They had not been inspected after the last shop visit, since maintenance inspection frequency required that the fan, thrust reverser, and core cowls be opened and visually inspected every 1,650 hours, or 400 cycles. Since the last shop visit, the engine had attained 1,339 hours, and 191 cycles of operation.

There were two previously reported failures of SB 72-1082 LPT nozzle locks. Those two were discovered during routine under-cowl inspections. The first failure resulted in all the 2nd-stage nozzle locks being broken. The nozzle segments had rotated 120 degrees within the LPT case, but the case itself was not breached. In the second event, two 4th-stage nozzle locks had failed, but there was no collateral damage. According to GEAE metallurgical reports, the failures were intergranular, "suggesting either stress rupture or sustained peak low cycle fatigue."

The two recovered 2nd-stage nozzle locks, and a section of the LPT case with part of the 2nd-stage nozzle lock stud attached, were sent to the Safety Board Materials Laboratory for evaluation. According to the metallurgist's factual report,

"Examination of the fractures from the submitted locks and studs revealed intergranular fracture features. Some of these fractures also contained degradation at the surface of the fracture features and grain boundaries typical of oxidation damage. No evidence of a fatigue crack was noted on the fracture surfaces. The area around the studs appeared to contain no elongation deformation."

The report further stated:

"The intergranular fractures and oxidation damage found at the grain boundaries (both at the surface of the fracture and those adjacent to the fracture surface) are consistent with stress rupture."

During the Powerplants Group visit to GE Caledonian, the inspection of a comparison engine revealed that a 2nd-stage nozzle lock was also cracked. "The crack progressed around the stud recess - between the stud and the base plate interface - and into the plate." The stud was forwarded to the Safety Board Materials Laboratory for examination, with the results being the same as those from the accident engine, with oxidation and intergranular fracture features, consistent with stress rupture.

ADDITIONAL INFORMATION

The airplane was released to the operator on April 27, 2000.

Pilot Information

Certificate:	Airline Transport	Age:	49, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last Medical Exam:	11/12/1999
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	22000 hours (Total, all aircraft), 1000 hours (Total, this make and model), 17000 hours (Pilot In Command, all aircraft), 165 hours (Last 90 days, all aircraft), 38 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	McDonnell Douglas	Registration:	N39081
Model/Series:	DC-10-30 DC-10-30	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	47861
Landing Gear Type:	Retractable - Tricycle	Seats:	256
Date/Type of Last Inspection:	03/31/2000, Continuous Airworthiness	Certified Max Gross Wt.:	491521 lbs
Time Since Last Inspection:	217 Hours	Engines:	3 Turbo Fan
Airframe Total Time:	13346 Hours	Engine Manufacturer:	GE
ELT:	Not installed	Engine Model/Series:	CF6-50C2
Registered Owner:	CIT LEASING CORP	Rated Power:	51800 lbs
Operator:	CONTINENTAL AIRLINES, INC.	Air Carrier Operating Certificate:	Flag carrier (121)
Operator Does Business As:		Operator Designator Code:	CALA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Dusk
Observation Facility, Elevation:	EWR, 18 ft msl	Observation Time:	1951 EDT
Distance from Accident Site:	0 Nautical Miles	Direction from Accident Site:	0°
Lowest Cloud Condition:	Unknown / 0 ft agl	Temperature/Dew Point:	48° C / 40° C
Lowest Ceiling:	Broken / 11000 ft agl	Visibility	10 Miles
Wind Speed/Gusts, Direction:	6 knots, 130°	Visibility (RVR):	0 ft
Altimeter Setting:	29 inches Hg	Visibility (RVV):	0 Miles
Precipitation and Obscuration:			
Departure Point:	(EWR)	Type of Flight Plan Filed:	IFR
Destination:	BRUSSELS, OF (BRU)	Type of Clearance:	IFR
Departure Time:	1942 EDT	Type of Airspace:	Class B

Airport Information

Airport:	NEWARK INTERNATIONAL (EWR)	Runway Surface Type:	Asphalt
Airport Elevation:	18 ft	Runway Surface Condition:	Dry
Runway Used:	4L	IFR Approach:	None
Runway Length/Width:	10000 ft / 150 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	14 None	Aircraft Damage:	Substantial
Passenger Injuries:	220 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	234 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC):	PAUL R COX	Adopted Date:	12/14/2001
Additional Participating Persons:	SAM WALL; TETERBORO, NJ TOBY CARROLL; HOUSTON, TX KEN WOLSKI; CINCINNATI, OH		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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