
Uncontained engine failure, McDonnell Douglas DC-10-30, January 5, 2000

Micro-summary: The uncontained failure of the #2 engine on this DC-10-30 resulted in a successful rejected takeoff.

Event Date: 2000-09-05 at 1919 EDT

Investigative Body: National Transportation Safety Board (NTSB), USA

Investigative Body's Web Site: <http://www.nts.gov/>

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		NTSB ID: NYC00IA250		Aircraft Registration Number: N14090	
		Occurrence Date: 09/05/2000		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place NEWARK		State NJ	Zip Code 07114	Local Time 1919	Time Zone EDT
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer McDonnell Douglas		Model/Series DC-10-30		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
<p>On September 5, 2000, at 1919 Eastern Daylight Time, a McDonnell-Douglas DC-10-30, N14090, operated by Continental Airlines as flight 60, received minor damage when the number two engine experienced an uncontained engine failure during a takeoff roll at Newark International Airport (EWR), Newark, New Jersey. There were no injuries to the 3-man cockpit crew, 11 flight attendants, or 230 passengers. Visual meteorological conditions prevailed for the international flight destined for Brussels, Belgium. Flight 60 was on an instrument flight rules (IFR) flight plan conducted under 14 CFR Part 121.</p> <p>According to a written statement from the captain:</p> <p>"...[The first officer (F/O)] was the flying pilot for this flight. At the start of the takeoff roll...[the F/O] manually pushed the throttles to the vertical position and the engines accelerated to 60% N1...[The F/O] then called for 'auto-throttles on', I turned the auto-throttles to the on position. The engines accelerated smoothly to the target N1 of 104%. Approximately five seconds after stabilizing at 104%, the number two engine N1 decreased to 78%, the engine fail illuminated and the master warning light illuminated. I called 'power loss, reject', I then took control of the aircraft and initiated a rejected takeoff. The maximum IAS was approximately 90 Kts...."</p> <p>The number 2 engine was shut down. After clearing the runway, the airplane was stopped on the taxiway. Emergency personnel reported damage to the number 2 engine. The remaining engines were shut down, and the airplane was towed to the gate where the passengers deplaned through the jetway.</p> <p>Examination of the engine revealed that the low pressure turbine case was fractured around its circumference, at the back side of the second stage vanes. In addition, from the 9 o'clock position to the 2 o'clock position, a 2 1/4 inch-wide strip of the metal case was missing, from over the top of 2nd stage vanes. A visual examination through the opening in the case revealed that all of the 2nd stage vanes were missing.</p> <p>The 2nd stage low pressure vanes consisted of 16 segments held in place by 8 nozzle locks. Thirteen segments were recovered, from the runway and adjacent areas. One additional piece was jammed into the aerodynamic boat-tail located above the engine. Several pieces of engine cowling and assorted hardware were also recovered</p> <p>Damage was confined to the engine, engine cowling, and aerodynamic boat-tail above the engine.</p> <p>According to the powerplant group chairman's report, the engine, a General Electric Aircraft Engine (GEAE) CF6-50C2, serial number 455-276, was examined at the General Electric Facility in the United Kingdom from September 25, 2000 through September 29, 2000, under the supervision of the Safety Board. The engine had accumulated 83,707 hours since new (TSN), 15,375 cycles since new (CSN), 11,568 hours time since last shop visit (TSLSV), and 1,648 cycles since last shop visit (CSLSV). The</p>					
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module of the engine that contained the 2nd stage low pressure vanes and their associated nozzle locks had previously been installed on two other engines, and had accumulated 14,241 hours TSN and 2,741 CSN at the time of the incident. This was the second known uncontained failure of a CF6-50C2 engine.

The Powerplant Group Chairman's report also stated:

"No engine damage was observed forward of the LPT area and none of the external engine cases exhibited damaged or exit wounds except for the LPT case."

"...The LPT case bottom half was not breached. Two whole 2nd-stage nozzle lock bodies - base and both arms - and a half-body were recovered. The nozzle lock fracture surfaces indicated that the nozzle locks failed intergranularly consistent with stress rupture."

"None of the 2nd-stage nozzle locks remained attached to either the top or bottom LPT case halves...All the 3rd- and 4th-stage nozzle locks were still installed and felt secure when attempted to be moved by hand...The 3rd- and 4th-stage LPT nozzle locks were ultrasonically inspected still installed in the LPT case using GEAE nozzle lock inspection kit GE-FQAP-444. No crack indications were noted using this ultrasonic inspection."

"All sixteen of the 2nd-stage nozzle segments exited the engine...Fourteen complete 2nd-stage LPT nozzle segments - 6 vane airfoils comprise a complete nozzle segment - were recovered in the debris field. One of the recovered nozzle segments included the segment with the borescope port. The leading and trailing edges of all the airfoils exhibited some impact damage, scrape marks, tears, or missing material. Each nozzle segment exhibited heavy wear and was missing the majority of the forward inner platform lip. All the nozzle segments exhibited wear and material transfer on the forward and aft outer rails with the leading edge outer attachment lip fractured and missing material. All the nozzle segments, although they exhibited wear on the aft rail, retained their nozzle lock slots intact...Eight of the fourteen recovered 2nd-stage LPT nozzle segments exhibited cracks in corners of the nozzle lock slots. Typically, the cracks appeared in the left slot (aft looking forward) near the slot right edge. All the interstage seals that are mounted on the nozzle inner platform were heavily grooved, gouged, distorted, twisted, and damaged. All the interstage seal attachment bolts used to secure the seals to the nozzle segments were still in place."

"The LPT case in the area of the 2nd-stage nozzle segments exhibited metal transfer, bluing, scrape marks, and impact damage similar to the case top half. The 360 circumferential semi-circular shaped rub observed on the case top half was also observed on the case bottom half with the wear depth and location similar. The foot prints observed at every 3rd- and 4th-stage nozzle lock location on the LPT case top half were also observed in the LPT case bottom half with the wear patterns similar as well. "

"The LPT nozzle locks prevent the LPT nozzle segments from rotating within the LPT case. This is accomplished by interlocking one of the two nozzle lock arms into a slot in the outer aft rail of the nozzle segments and securing the nozzle lock to the case by means of a stud (integral to the nozzle lock) and a self-locking nut. The 2nd-, 3rd-, and 4th-stage LPT nozzle locks are all the same configuration and material. There are eight 2nd-stage nozzle locks - one for every two nozzle segments - and ten for the 3rd- and 4th-stage nozzle locks - one for every six nozzle segments."

"There have been five reported failures of the SB 72-1082 configuration LPT nozzle locks - January 1999, December 1999, April 2000, and two in September 2000 [September 5, 2000 - this incident, and September 6, 2000]. According to GEAE metallurgical reports for each of the 1999 failed nozzle lock events, the failures were not caused by a material anomaly but failed intergranularly, suggesting either stress rupture or sustained peak low cycle fatigue."

"The April 2000 event, which was investigated by the Safety Board, NTSB No. NYC-00-FA-122, occurred

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during the takeoff roll just after V1 on a DC-10-30 airplane...This was the first documented uncontained event of a SB 72-1082 configuration nozzle lock...The results of the metallurgical report indicated that again the nozzle locks failed intergranularly either through stress rupture or sustained peak low cycle fatigue."

"On May 24, 2000, following their April 2000 nozzle lock failure incident, Continental issued a Fleet Campaign Directive (FCD) No. 7200-01809 (Attachment 16), to inspect for broken nozzle locks using visual and tactile techniques... Continental FCD No. 7200-01809 paperwork indicated that the inspection was performed on engine SN 455-276 on May 29, 2000, with no nozzle lock discrepancies detected (Attachment 17). Engine SN 455-276 had accumulated 82,632 hours TSN and 15,210 CSN at the time of the inspection. GEAE AOW 00/CF6/011, dated May 12, 2000, recommended that the inspection be continued at every "letter" [inspection] for the current nozzle lock design. No other tactile nozzle inspections were performed [or required] between May 5, 2000, and the date of the incident."

"As a result of the April 2000 incident [NYC00FA122], Continental issued TR No. 00-72-01, dated August 4, 2000, to the DC-10 MM [maintenance manual] that permitted the engine to continue in service until the next shop visit with one 3rd- and 4th-stage nozzle lock broken; however, it did not permit continued service of the engine if any 2nd-stage nozzle locks were broken (Attachment 19)...."

"At the time that LPT stator EMU 56X28266 was last built-up, summer of 1997, the CF6-50 engine manual, task 72-56-05-200-000, required that the 2nd- through 4th-stage LPT nozzle locks to be fluorescent penetrant inspected (FPIed), and if found cracked, were to be replaced. If the nozzle locks were not damaged and the wear limit not exceeded, the nozzle locks could be reused. Also included in the maintenance instructions were NOTES and CAUTIONS permitting only the use of the nozzle lock PN 1862M55P01, the SB 72-1082 configuration. Subsequently, after the April 2000 nozzle lock failure incident, GEAE issued TR 72-969 to the CF6-50 engine manual, dated on May 20, 2000, removing the FPI requirement and changing the maximum serviceable limit to reflect that the nozzle locks are not to be reused, they are a one-time use item and are to be replaced with new parts."

"According to Continental DC-10 airplane zonal inspection requirements at the time the incident, the fan thrust reverser and core cowls are to be opened every 1,650 hours or 400 cycles to perform visual inspections of the engine and pylon (Attachment 18). As part of the engine/pylon zonal inspection, the nozzle locks are visually inspected in accordance with the DC-10 maintenance manual (MM). According to the Continental work card engine SN 455-276 (aircraft No. 90, position 2), the zonal inspection was performed on September 5, 2000, the same day as the incident (Attachment 18). The zonal inspection work card did not indicate that there were any anomalies with the nozzle locks."

Examination of the zonal inspection work card revealed that the inspection was listed as a general visual and servicing inspection. No specific reference was found for examination of the nozzle locks. However, the work card did state:

"Zonal Inspection is a general visual inspection of all components, systems, installations, and structure including but not limited to, electrical, hydraulic, pneumatic, fuel and mechanical systems, including but not limited to, wiring, tubing, plumbing, ducting, clamps, fittings and brackets, primary and secondary structure as applicable within the zone boundaries...but not limited to, inspecting for conditions such as cracking, corrosion, chafing, leaks, loose/missing fasteners, damage, delamination, dust and lint accumulation, inadequate drainage or insufficient corrosion inhibiting coatings and for other circumstances which could lead to the above conditions."

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		Occurrence Date: 09/05/2000			
		Occurrence Type: Incident			
Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
NEWARK INTL	EWR	18 Ft. MSL	4L	11000	150
Runway Surface Type: Asphalt					
Runway Surface Condition: Dry					
Type Instrument Approach: NONE					
VFR Approach/Landing: None					
Aircraft Information					
Aircraft Manufacturer		Model/Series		Serial Number	
McDonnell Douglas		DC-10-30		46553	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 256	Certified Max Gross Wt.	514100 LBS	Number of Engines: 3	
Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:		
Turbo Fan	GE	CF6-50C2	51800 LBS		
- Aircraft Inspection Information					
Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time		
Continuous Airworthiness	09/2000	38 Hours	98707 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? No	ELT Operated?	ELT Aided in Locating Accident Site?			
Owner/Operator Information					
Registered Aircraft Owner		Street Address			
CONTINENTAL AIRLINES		1600 SMITH STREET			
		City	State	Zip Code	
		HOUSTON	TX	77002	
Operator of Aircraft		Street Address			
Same as Reg'd Aircraft Owner		Same as Reg'd Aircraft Owner			
		City	State	Zip Code	
Operator Does Business As:			Operator Designator Code: CALA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Flag Carrier/Domestic					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Scheduled; International; Passenger/Cargo					
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	Occurrence Date: 09/05/2000
	Occurrence Type: Incident

First Pilot Information

Name On File	City On File	State On File	Date of Birth	Age 54
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number:
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Certificate(s): Airline Transport; Flight Instructor; Commercial; Flight Engineer

Airplane Rating(s): Multi-engine Land; Single-engine Land

Rotorcraft/Glider/LTA: Glider

Instrument Rating(s): Airplane

Instructor Rating(s): Airplane Multi-engine; Airplane Single-engine; Instrument Airplane

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 08/2000
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time	18700	5000	3200	15500	2800		250			
Pilot In Command(PIC)	16800	5000	3000	13800	3700					
Instructor	2100		1900	200						
Last 90 Days	230	230		230	180					
Last 30 Days	86	86		86	60					
Last 24 Hours										

Seatbelt Used? Yes	Shoulder Harness Used? Yes	Toxicology Performed? No	Second Pilot? Yes
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Flight Plan/Itinerary

Type of Flight Plan Filed: IFR	
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Departure Point Same as Accident/Incident Location	State	Airport Identifier EWR	Departure Time 1919	Time Zone EDT
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Destination BRUSSELS	State OF	Airport Identifier EBBR	
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Type of Clearance: IFR

Type of Airspace: Class A

Weather Information

Source of Briefing:
Company

Method of Briefing:

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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
EWR	1851	EDT	18 Ft. MSL	0 NM	0 Deg. Mag.
Sky/Lowest Cloud Condition: Scattered			25000 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: None		0 Ft. AGL	Visibility: 10	SM	Altimeter: 30.00 "Hg
Temperature: 18 °C	Dew Point: 7 °C	Wind Direction: 30		Density Altitude: 0 Ft.	
Wind Speed: 13	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0	SM	Intensity of Precipitation: Unknown		
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information		
Aircraft Damage: Minor	Aircraft Fire: None	Aircraft Explosion: None

Classification: U.S. Registered/U.S. Soil					
- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer				1	1
Cabin Attendants				11	11
Other Crew					
Passengers				230	230
- TOTAL ABOARD -				244	244
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	244	244

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Administrative Information

Investigator-In-Charge (IIC)
ROBERT L. HANCOCK

Additional Persons Participating in This Accident/Incident Investigation:

JOHN HO
FAA FSDO
TETERBORO, NJ

TOBY CARROLL
CONTINENTAL AIRLINES
HOUSTON, TX