



National Transportation Safety Board Aviation Accident Final Report

Location:	MEMPHIS, TN	Accident Number:	MIA99LA220
Date & Time:	08/07/1999, 1345 CDT	Registration:	N68058
Aircraft:	McDonnell Douglas DC-10-10F	Aircraft Damage:	Substantial
Defining Event:		Injuries:	5 None
Flight Conducted Under:	Part 121: Air Carrier - Non-scheduled		

Analysis

While on final approach with full flaps selected and indicated, the left inboard trailing edge flap and vane separated. The autopilot was disconnected and approximately 1/2 right aileron input was needed to counter the left banking tendency. The landing was reported to be firm but with less 'controllability'. Structural damage occurred to the left side of the fuselage due to flap and/or vane contact. The four H-11 type bolts of the forward attach point of the outboard hinge of the left inboard trailing edge flap failed due to stress corrosion cracking. Chromium was detected in the fracture origin of bolts Nos. 1-3; no determination was made as to why chromium was present. The two H-11 type bolts of the aft attach point of the outboard hinge of the left inboard trailing edge flap failed due to ductile overload. No material or processing discrepancies were found. H-11 bolts are susceptible to stress corrosion cracking. The FDR readout indicated that the maximum left roll was 8.09 degrees and flap extension speed was exceeded on landing No. 1 for approximately 13 seconds when the flaps were extending from 16 to 20 degrees. No flap overspeed protection is afforded in that range.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The inadequate design by the airplane manufacturer for using bolts to secure the inboard trailing edge flap that are susceptible to stress corrosion cracking. Also, the stress corrosion cracking failure of the four H-11 bolts that secure the left inboard trailing edge flap to the outboard hinge which allowed the separation of the flap and vane while on final approach.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: APPROACH - VFR PATTERN - FINAL APPROACH

Findings

1. (C) FLIGHT CONTROL,FLAP ATTACHMENT - STRESS CORROSION
2. (C) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER
3. (C) FLIGHT CONTROL,FLAP ATTACHMENT - FAILURE,TOTAL
4. FLIGHT CONTROL,FLAP - SEPARATION

Factual Information

On August 7, 1999, about 1345 central daylight time, a McDonnell Douglas DC-10-10F, N68058, registered to Wilmington Trust Company, operated by Federal Express Corporation as flight 3206, experienced separation of the left inboard trailing edge flap and flap vane while on final approach to land at the Memphis International Airport, Memphis, Tennessee. Visual meteorological conditions (VMC) prevailed at the time and an IFR flight plan was filed for the 14 CFR Part 119 domestic cargo flight. The airplane was substantially damaged and there were no reported injuries to the captain, first officer, second officer, or to the two jumpseat occupants. The flight originated about 0845 pacific daylight time from the Los Angeles International Airport, Los Angeles, California.

The first officer was flying the airplane, and while executing a Category 111B approach to runway 18L in VMC with the flaps fully extended, a loud "jolt" was heard. The autopilot was disconnected and the first officer reported having to use 1/2 to 3/4 right aileron input to counter the left banking tendency. The first officer later reported that while on a stabilized approach about 1,000 to 1,500 feet, about 3 miles from the airport, with the flaps extended to 50 degrees and both autopilots activated for a practice Category IIIB approach, he heard a loud sound from the rear of the airplane and the autopilot "struggled to keep the aircraft straight and level." He disconnected the autopilot system and reported that the airplane "wanted to roll left. I countered with right wing down control inputs. About 3/4 of max kept the aircraft straight and level." He continued the approach and landed. After clearing the runway he noted that the flap disagree on the control surfaces instrument, and all engines were secured. The captain later reported that after hearing the jolt, the Category IIIB approach was aborted. The landing was firm with less "controllability", but the rollout was normal.

According to a transcription of communications with Memphis Air Traffic Control Tower (ATCT), the first report by the flight crew to ATCT personnel occurred after the airplane had landed. A copy of the transcriptions of communications is an attachment to this report.

Examination of the airplane by FAA personnel revealed that the left inboard trailing edge flap and vane separated from the airplane. The separated left inboard trailing edge flap and vane were found in a residential area approximately 4 miles north of the airport. The vane was noted to be missing an approximate 2-foot segment, which was found several days after the accident about 1 block from where the flap and vane were found. Further examination of the airplane revealed that the four bolts (1 each P/N BM 3306-7-44 and 3 each P/N BM3306-8-44) of the forward attach point of the outboard hinge of the left inboard trailing edge flap, were failed. Six segments of these failed four bolts were recovered and marked "1-4", and also marked whether it was from the flap or hinge side. The two bolts (1 each P/N BM 3306-7-56 and 1 each P/N BM3306-7-54) of the aft attach point of the outboard hinge of the left inboard trailing edge flap, were fractured. Four segments of these fractured two bolts were recovered and marked "5-6", and also whether it was from the flap or hinge side. The left inboard actuator of the left inboard trailing edge flap was extended 3 inches; the right inboard actuator of the right inboard trailing edge flap was extended 15 inches. Damage to seven frames on the left side of the fuselage starting at fuselage station 1561 and ending at fuselage station 1681 was noted; also six longerons were damaged. The NTSB retained the recovered 10 segments of the six failed or fractured bolts, the flight data recorder, and the inboard flap actuator for the left inboard trailing edge flap. The cockpit voice recorder was not retained for readout.

Metallurgical examination of the failed and fractured bolts was performed by the NTSB Materials Laboratory in Washington, D.C. The results of analysis of the fractured segments of bolts that were marked Nos. 5 and 6 which were from the aft attach point of the outboard hinge of the left inboard trailing edge flap revealed they exhibited fracture features associated with "overstress bending/tensile separations." The results of analysis of the failed segments of bolts that were marked as Nos. 1 through 4, which were from the forward attach point of the outboard hinge of the left inboard trailing edge flap showed minimal deformation. Intergranular stress corrosion cracking that initiated from corrosion pits was detected on three of the four bolts; stress corrosion cracking was detected on all of the four bolts marked 1-4. Additionally, X-ray energy dispersive spectroscopy (EDS) of the fracture origin area of bolt Nos. 1, 2, and 3 indicated the presence of chromium (Cr). No determination was made as to the reason the chromium was present in the fracture origin areas. No nickel was detected in the fracture origin area of bolt No. 1. The NTSB Materials Laboratory did not prepare a metallographic cross section of any of the bolts. A copy of the Materials Laboratory Factual Report is an attachment to this report.

Metallurgical examination of the failed and fractured bolts was also performed by Materials and Process Engineering division of Boeing-Long Beach. The results of analysis of examination of the six segments of bolts marked 1-4 indicate the failure was due to stress corrosion cracking. The results of analysis of examination of the four segments of bolts marked 5-6 indicated failure was due to ductile overload. The report also indicates no evidence of material or processing discrepancies were found. SEM analysis of a metallographic specimen mount in plastic was performed on the bolt marked No. 1. The examination determined there were two distinct layers. The inner layer was comprised of a high concentration of Nickel (Ni), and the outer layer was comprised of a high concentration of Cadmium (Cd). No evidence of a layer of chromium plating was found. The report confirms the NTSB's report of the finding of Chromium (Cr) in the fracture origin of bolt No. 1. According to Boeing personnel, they do not allow or approve reworking of the accident type bolts. A copy of the report is an attachment to this report.

On October 16, 1990, McDonnell Douglas issued an All Operator Letter (AOL) 10-2008B to operators of DC-10 and KC-10 type airplanes stating that H-11 steel tension bolts have been susceptible to stress corrosion failures and McDonnell Douglas had conducted a design review; the AOL provided locations where H-11 steel tension head bolts are installed. The AOL indicated that, "Based on this evaluation, certain structural joint locations were identified where a change in bolt material to one made from a corrosion resistant steel was recommended." The AOL also indicated that, "In H-11 steel bolt/nut applications in which a single failure could affect aircraft safety or where in-service history indicates a need for replacement, Service Bulletins and AOL's have been issued to inform operators of each specific problem and to provide recommendations." The AOL listed the location of the failed and fractured H-11 bolts. At the time of the accident, there was no Service Bulletin in effect issued by either McDonnell Douglas or Boeing requiring the replacement of the H-11 bolts with Inconel type bolts in the failed or fractured flap bolt locations.

According to personnel from Federal Express, review of their FAA approved maintenance schedule pertaining to the inspection of the failed or fractured bolt locations revealed no inspection of the four forward hinge bolts of the outboard hinge of the inboard flap. Inspection of the lower two hinge bolts of the outboard hinge of the inboard flap occurs at the 2C interval.

The flight data recorder which was retained was read out by the NTSB Vehicle Recorders Laboratory in Washington, D.C. The read out indicated that seven takeoffs and eight landings including the accident landing, were recorded. The readout determined in part that the flap extension speed was exceeded for a total of 13 seconds during landing No. 1 when the flaps were extending between approximately 16 and 20 degrees. The time between the flap overspeed and the flap separation was approximately 21.8 hours. The read out also determined that after the flap separation, the maximum left roll was 8.09 degrees. At that time the right outboard aileron was deflected up 9.05 degrees and the left inboard aileron was deflected down 10.99 degrees. According to Boeing personnel, the inboard and outboard aileron travel is 20.2 and 20.0 degrees, respectively. Flap position was only recorded for the right flap. A copy of the Flight Data Recorder Factual Report is an attachment to this report.

According to the airplane Flight Crew Operating Manual pertaining to the flap system, "When the flaps are extended between 20 and 50 degrees, the system provides automatic retraction (or prevents extension), to protect structural integrity in the event that selected flap position airspeed limitations are exceeded. As airspeed is reduced, the flaps automatically return to their original selected position. The system has a manual override capability in the event of malfunction."

Functional testing of the inboard actuator of the left inboard trailing edge flap trailing was performed with no discrepancies noted. Disassembly of the actuator was performed which revealed no evidence of side loading of the piston against the barrel. A copy of the report is an attachment to this report.

Additional participants to the investigation were Ms. Ricka Jain, of Moog Aircraft Group, Torrance, California; and Mr. Louis DeBiase of Federal Express Corporation, Los Angeles, California.

Pilot Information

Certificate:	Airline Transport; Private	Age:	47, 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:	04/15/1999
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	5598 hours (Total, all aircraft), 2215 hours (Total, this make and model), 2150 hours (Pilot In Command, all aircraft), 63 hours (Last 90 days, all aircraft), 36 hours (Last 30 days, all aircraft), 9 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	McDonnell Douglas	Registration:	N68058
Model/Series:	DC-10-10F DC-10-10F	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	46705
Landing Gear Type:	Retractable - Tricycle	Seats:	5
Date/Type of Last Inspection:	08/06/1999, Continuous Airworthiness	Certified Max Gross Wt.:	449000 lbs
Time Since Last Inspection:	10 Hours	Engines:	3 Turbo Fan
Airframe Total Time:	40552 Hours	Engine Manufacturer:	GE
ELT:	Installed, not activated	Engine Model/Series:	CF6-6
Registered Owner:	WILMINGTON TRUST COMPANY	Rated Power:	41500 lbs
Operator:	FEDERAL EXPRESS CORPORATION	Air Carrier Operating Certificate:	Flag carrier (121)
Operator Does Business As:	FEDERAL EXPRESS	Operator Designator Code:	FDEA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	MEM, 335 ft msl	Observation Time:	1353 CDT
Distance from Accident Site:	4 Nautical Miles	Direction from Accident Site:	180°
Lowest Cloud Condition:	Clear / 0 ft agl	Temperature/Dew Point:	36° C / 18° C
Lowest Ceiling:	None / 0 ft agl	Visibility	10 Miles
Wind Speed/Gusts, Direction:	7 knots, 220°	Visibility (RVR):	0 ft
Altimeter Setting:	29 inches Hg	Visibility (RVV):	0 Miles
Precipitation and Obscuration:			
Departure Point:	LOS ANGELES, CA (LAX)	Type of Flight Plan Filed:	IFR
Destination:	(MEM)	Type of Clearance:	IFR
Departure Time:	0845 PDT	Type of Airspace:	Class B

Airport Information

Airport:	MEMPHIS INTERNATIONAL (MEM)	Runway Surface Type:	
Airport Elevation:	335 ft	Runway Surface Condition:	
Runway Used:	0	IFR Approach:	ILS; Practice
Runway Length/Width:		VFR Approach/Landing:	

Wreckage and Impact Information

Crew Injuries:	5 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	5 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC):	TIMOTHY W MONVILLE	Adopted Date:	05/17/2001
Additional Participating Persons:	LARRY D MOORE; MEMPHIS, TN WILLIAM C STEELHAMMER; LONG BEACH, CA WERNER J ROSE; MEMPHIS, TN JOHN A NYLAND; TORRANCE, CA		
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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