Separation of left inboard trailing edge flap and vane separation, McDonnell Douglas DC-10-10F, August 7, 1999

Micro-summary: **While this McDonnell Douglas DC-10-10F was on approach, the left inboard trailing edge flap and vane separated.**

Event Date: **1999-08-07 at 1345 CDT**

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

Investigative Body's Web Site: **http://www.ntsb.gov/**

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2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***

3. Reports may or may not represent reality. Many many non-scientific factors go into an investigation, including the magnitude of the event, the experience of the investigator, the political climate, relationship with the regulatory authority, technological and recovery capabilities, etc. It is recommended that the reader review all reports analytically. Even a "bad" report can be a very useful launching point for learning.

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National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB ID: MIA99LA220	Aircraft Registration Number: N68058
Occurrence Date: 08/07/1999	Most Critical Injury: None
Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
MEMPHIS	TN	38118	1345	CDT	

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility: 4	Direction From Airport: 360

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
McDonnell Douglas	DC-10-10F	Airplane

Sightseeing Flight: No Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

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.

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Occurrence Type: Accident

Narrative (Continued)

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

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Occurrence Date:	08/07/1999
Occurrence Type:	Accident

Narrative (Continued)

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.

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: MIA99LA220

Occurrence Date: 08/07/1999

Occurrence Type: Accident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
MEMPHIS INTERNATIONAL	MEM	335 Ft. MSL	0		

Runway Surface Type:

Runway Surface Condition:

Type Instrument Approach: ILS-complete; Practice

VFR Approach/Landing:

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
McDonnell Douglas	DC-10-10F	46705

Airworthiness Certificate(s): Transport

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	5	449000 LBS	3

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Fan	GE	CF6-6	41500 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	08/1999	10 Hours	40552 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?	ELT Operated?	ELT Aided in Locating Accident Site?
Yes	No	

Owner/Operator Information

Registered Aircraft Owner	Street Address	City	State	Zip Code
WILMINGTON TRUST COMPANY	RODNEY SQ., N., C/O CORP TRUST	WILMINGTON	DE	19890

Operator of Aircraft	Street Address	City	State	Zip Code
FEDERAL EXPRESS CORPORATION	3131 DEMOCRAT	MEMPHIS	TN	38118

Operator Does Business As: FEDERAL EXPRESS

Operator Designator Code: FDEA

- 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: Non-scheduled; Domestic; Cargo

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: MIA99LA220

Occurrence Date: 08/07/1999

Occurrence Type: Accident

First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	47

Sex: M | Seat Occupied: Left | Principal Profession: Civilian Pilot | Certificate Number: On File

Certificate(s): Airline Transport; Private

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

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): None

Type Rating/Endorsement for Accident/Incident Aircraft? Yes | Current Biennial Flight Review?

Medical Cert.: Class 1 | Medical Cert. Status: Valid Medical--w/ waivers/lim. | Date of Last Medical Exam: 04/1999

- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	5598	2215								
Pilot In Command(PIC)	2150	476								
Instructor										
Last 90 Days	63	63								
Last 30 Days	36	36								
Last 24 Hours	9	9								

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? Yes

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
LOS ANGELES	CA	LAX	0845	PDT

Destination	State	Airport Identifier
Same as Accident/Incident Location		MEM

Type of Clearance: IFR

Type of Airspace: Class B

Weather Information

Source of Briefing: Company

Method of Briefing:

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: MIA99LA220

Occurrence Date: 08/07/1999

Occurrence Type: Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
MEM	1353	CDT	335 Ft. MSL	4 NM	180 Deg. Mag.

Sky/Lowest Cloud Condition: Clear 0 Ft. AGL

Condition of Light: Day

Lowest Ceiling: None 0 Ft. AGL

Visibility: 10 SM

Altimeter: 29.00 "Hg

Temperature: 36 °C

Dew Point: 18 °C

Wind Direction: 220

Density Altitude: Ft.

Wind Speed: 7

Gusts:

Weather Condtions 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: Substantial

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					
Other Crew				2	2
Passengers					
- TOTAL ABOARD -				5	5
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	5	5

National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB ID: MIA99LA220

Occurrence Date: 08/07/1999

Occurrence Type: Accident

Administrative Information

Investigator-In-Charge (IIC)

TIMOTHY W. MONVILLE

Additional Persons Participating in This Accident/Incident Investigation:

LARRY D MOORE
FAA FSDO
MEMPHIS, TN

WILLIAM C STEELHAMMER
THE BOEING COMPANY
LONG BEACH, CA

WERNER J ROSE
FEDERAL EXPRESS CORPORATION
MEMPHIS, TN

JOHN A NYLAND
MOOG AIRCRAFT GROUP
TORRANCE, CA