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## Center landing gear failure on landing, McDonnell Douglas MD-11, October 5, 1999

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**Micro-summary:** This McDonnell Douglas MD-11's center landing gear failed on landing.

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**Event Date:** 1999-10-05 at 0540 EDT

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


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


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		NTSB ID: NYC00LA005		Aircraft Registration Number: N606FE	
		Occurrence Date: 10/05/1999		Most Critical Injury: None	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place NEWARK	State NJ	Zip Code 07114	Local Time 0540	Time Zone EDT	
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer McDonnell Douglas		Model/Series MD-11F		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
<p>Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:</p> <p>On October 5, 1999, at 0540 Eastern Daylight Time, a McDonnell Douglas MD-11F, N606FE, operated by Federal Express (FedEx) as flight 1700, was substantially damaged while landing at Newark International Airport (EWR), Newark, New Jersey. There were no injuries to the two certificated pilots. Visual meteorological conditions prevailed for the cargo flight, which had originated from Indianapolis, Indiana. Flight 1700 was operated on an instrument flight rules flight plan under 14 CFR Part 121.</p> <p>In interviews, the flight crew reported that the en route phase of flight, and the approach to Runway 04R, occurred without incident. For landing, the airplane was configured with the wing flaps at 50 degrees, and the auto-brakes were selected to the maximum setting. The captain described the touch down as "firm" but not hard. He said he wanted to touch down in the first 1,500 feet of the runway.</p> <p>As the nose wheel was lowered to the runway, the pilots felt a vibration. They reported that it felt similar to a deflated tire. One of the pilots thought he felt the vibration along the longitudinal axis of the airplane. During the landing rollout, the center landing gear unsafe light illuminated. As the airplane was clearing the runway, the central aural warning system (CAWS) generated a voice warning about unsafe landing gear.</p> <p>After the airplane exited the runway, it crossed Runway 04L, and was stopped on a parallel taxiway. The master caution light was illuminated, and the reservoir for hydraulic system # 3 was empty. After referencing with the checklist, the captain elected to taxi the airplane straight ahead at a slow speed, toward the FedEx ramp area. The airplane was stopped after it entered the ramp area, and the airplane was towed to the gate.</p> <p>Examination of the airplane revealed that the center landing gear, which normally was angled 15 degrees forward of vertical, was angled about 45 degrees aft of vertical. The upper lugs of the lower drag brace were fractured, and the cap on the center landing gear retraction cylinder had been pulled out. Tire marks were found on the aft fuselage above the tires of the center landing gear. The aft side of the landing gear strut was pushed against the aft bulkhead of the center landing gear well. The metal was deformed and torn in the area that had contact with the center landing gear strut.</p> <p>To ferry the airplane for repairs, the center landing gear strut was depressurized and compressed to rotate the strut into the center landing gear wheel well. The center landing gear strut servicing was not recorded prior to depressurization and compression of the strut.</p> <p>A check with Boeing Commercial Airplanes (BCA) - Long Beach Division (formerly the McDonnell-Douglas Aircraft Corp.), revealed five previous events where the center landing gear had entered a divergent oscillation along the longitudinal axis of the airplane, the lower drag brace</p>					
FACTUAL REPORT - AVIATION					
Page 1					

 <p>National Transportation Safety Board <b>FACTUAL REPORT</b> AVIATION</p>	NTSB ID: NYC00LA005
	Occurrence Date: 10/05/1999
	Occurrence Type: Accident

## Narrative (Continued)

had failed at the upper attach lugs, and the retraction cylinder had been pulled apart with the subsequent loss of the number 3 hydraulic system. The first three were in-service events. The last two occurred in instrumented airplanes that were exploring the first three events. Based upon the findings from these events, the anti-skid control box was modified to prevent center landing gear wheel brake application until the nose landing gear was on the ground. In addition, the anti-skid cycle rate was modified to avoid the cyclic range related to the natural frequency of the center landing gear. McDonnell-Douglas issued all operators letters describing the events and the suggested fixes.

The accident airplane was delivered to FedEx in 1993. The airplane and center landing gear had accumulated 22,055:59 hours, and 5,120 cycles. In addition, the airplane carried the modified anti-skid control box.

The failed lower drag brace, P/N AYG 7229-1, S/N AP 181, was forwarded to the Safety Board Materials Laboratory for examination. According to the metallurgists factual report, "...all portions of the fracture surface, including the portions on the reverse slat planes, consisted of elongated ductile dimples, typical of overstress separation...."

The hardness of material was checked and found to average HRC 53.9. According to BCA, the hardness should be between HRC 53 and HRC 55.

The Digital Flight Data Recorder (DFDR) was examined by the Safety Board Vehicle Recorder Division. According to the specialist's factual report, the initial touchdown produced a g-load of +1.39g's, which then reduced to +0.6g's, and then increased again to +1.59g's. The two peaks were separated by about 1.6 seconds. The DFDR also revealed that spoiler extension was initiated, and brake pressure to the left and right main landing gears had increased prior to nose wheel touchdown. No information was available about the application of brake pressure to the center landing gear brakes, as that information was not recorded.

Further, the DFDR report revealed that main landing gear brake pressure started to increase about 2.5 seconds after main landing gear touchdown. At 3.5 seconds after main landing gear touchdown, the nose wheel strut was compressed. At 5.75 seconds after main landing gear touchdown, a vertical oscillation of four cycles, with a duration of 1.25 seconds was recorded. During the last cycle, the vertical acceleration momentarily decreased to 0.48gs, and then returned to 1.03g's. The longitudinal acceleration, which had decreased to a -0.3 to -0.4g's momentarily further decreased to -0.874g's at the same time as the vertical acceleration peak of 0.48g's, and then returned to -0.4g's. After the peaks on the vertical and longitudinal accelerations, the g-readings returned to their previous readings as the airplane continued to decelerate.

The wheel speed sensors and hydraulic brake manifolds were removed from the two wheels of the center landing gear for further examination. The testing was conducted under the supervision of the Federal Aviation Administration (FAA). According to the report of the testing:

"...All units passed the functional test. The Wheel Speed Sensors and Valve Modules functioned as intended on the Aircraft. Although the fluid showed significant signs of contamination it did not appear to have impacted the performance of the units...."

The electronic anti-skid control unit was also examined and passed a functional test.

Following the October 5, 1999, event, FedEx initiated a test program. The test program included the installation of a high-speed recorder onboard the airplane. In addition, the lower drag brace on the center landing gear was instrumented to record strain, both compression and tension, during landing. The test loads were measured on an airplane with a high time center landing gear, which was approaching its scheduled gear removal period. Then the tests were repeated on an airplane with a freshly overhauled center landing gear.

National Transportation Safety Board

## FACTUAL REPORT

AVIATION

NTSB ID: NYC00LA005

Occurrence Date: 10/05/1999

Occurrence Type: Accident

## Narrative (Continued)

According to a memo from the person at FedEx who supervised the testing:


"...The maximum load measured on the CLG [center landing gear] was well below the strength of the Lower Drag Brace. Even though the data was not as reliable after the gear change, there does not appear to be any differences in the loads measured on a new gear and the loads on a high-time gear...There were a few recorded landings where the CLG exhibited an oscillation after touchdown that appears to be unrelated to the brake application. Due to inoperative data parameters, the cause of this oscillation is unknown...The data did not exhibit any high loads that approached the limit load of the drag brace...."


According to a representative from Boeing who reviewed the FedEx report:

"The brake control system performed as expected. In response to brake applications, and tire skids, the center landing gear showed normal periods of fore-aft motion at its natural frequency, with no tendency to diverge as a result of anti-skid brake control inputs."

Further, the report from FedEx stated that in October and November 1999, during the overhaul of two other MD-11 center landing gears, the vendor reported that the lower drag brace from both landing gears had elongated lug holes. However, there was no supporting data to confirm how the lugs became elongated.

According to a representative of Boeing, elongation of the lugs on the lower drag brace could occur for reasons other than the divergent longitudinal cyclic oscillation. Due to the forward slope of the center landing gear, any ground event that applied a fore or aft force to the center landing gear would apply either compression or tension loads respectively to the lower drag brace.

 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>		NTSB ID: NYC00LA005				
		Occurrence Date: 10/05/1999				
		Occurrence Type: Accident				
<b>Landing Facility/Approach Information</b>						
Airport Name NEWARK INTERNATIONAL		Airport ID: EWR	Airport Elevation 11 Ft. MSL	Runway Used 4R	Runway Length 9980	Runway Width 150
Runway Surface Type: Asphalt						
Runway Surface Condition: Dry						
Type Instrument Approach: ILS-complete						
VFR Approach/Landing: None						
<b>Aircraft Information</b>						
Aircraft Manufacturer McDonnell Douglas		Model/Series MD-11F		Serial Number 48602		
Airworthiness Certificate(s): Transport						
Landing Gear Type: Retractable - Tricycle						
Homebuilt Aircraft? No		Number of Seats: 5	Certified Max Gross Wt. 633000 LBS		Number of Engines: 3	
Engine Type: Turbo Fan		Engine Manufacturer: GE		Model/Series: CF6-80C2	Rated Power: 60240 LBS	
- Aircraft Inspection Information						
Type of Last Inspection Continuous Airworthiness		Date of Last Inspection 09/1999	Time Since Last Inspection 34 Hours		Airframe Total Time 22055 Hours	
- Emergency Locator Transmitter (ELT) Information						
ELT Installed? Yes		ELT Operated? No		ELT Aided in Locating Accident Site?		
<b>Owner/Operator Information</b>						
Registered Aircraft Owner WILMINGTON TRUST COMPANY		Street Address 1100 N MARKET ST.				
		City WILMINGTON		State DE	Zip Code 19890	
Operator of Aircraft FEDEX		Street Address 3131 DEMOCRAT ROAD				
		City MEMPHIS		State TN	Zip Code 38118	
Operator Does Business As:				Operator Designator Code: FDEA		
- Type of U.S. Certificate(s) Held:						
Air Carrier Operating Certificate(s): Supplemental						
Operating Certificate:			Operator Certificate:			
Regulation Flight Conducted Under: Part 121: Air Carrier						
Type of Flight Operation Conducted: Non-scheduled; Domestic; Cargo						

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: NYC00LA005
	Occurrence Date: 10/05/1999
	Occurrence Type: Accident

**First Pilot Information**

Name On File	City On File	State On File	Date of Birth	Age 53
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number:
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Certificate(s): Airline Transport; Commercial; Flight Engineer

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?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 09/1999
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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	12000	4621								
Pilot In Command(PIC)		2315								
Instructor										
Last 90 Days		84								
Last 30 Days		23								
Last 24 Hours		3								

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 INDIANAPOLIS	State IN	Airport Identifier IND	Departure Time 0424	Time Zone EDT
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Destination Same as Accident/Incident Location	State	Airport Identifier EWR	
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Type of Clearance: IFR

Type of Airspace: Class B

**Weather Information**

Source of Briefing:  
Company

Method of Briefing:

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: NYC00LA005
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**Weather Information**

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
EWR	0550	EDT	11 Ft. MSL	0 NM	0 Deg. Mag.

Sky/Lowest Cloud Condition: Unknown 0 Ft. AGL Condition of Light: Night/Dark

Lowest Ceiling: Overcast 1500 Ft. AGL Visibility: 10 SM Altimeter: 30.00 "Hg

Temperature: 9 °C Dew Point: 7 °C Wind Direction: 10 Density Altitude: 0 Ft.

Wind Speed: 12 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: 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					
Cabin Attendants					
Other Crew					
Passengers					
- TOTAL ABOARD -				2	2
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	2	2

National Transportation Safety Board

**FACTUAL REPORT**

**AVIATION**



NTSB ID: NYC00LA005

Occurrence Date: 10/05/1999

Occurrence Type: Accident

Administrative Information

Investigator-In-Charge (IIC)

ROBERT L. HANCOCK

Additional Persons Participating in This Accident/Incident Investigation:

NATE GLINBIZZI  
FAA FSDO  
TETERBORO, NJ

ALAN W RAY  
FEDEX  
MEMPHIS, TN