Foreign object damage to engine, McDonnell Douglas DC-10, March 6, 2001

Micro-summary: **This McDonnell Douglas DC-10 experienced damage to the #2 engine due to ice ingestion. add FOD**

Event Date: **2001-03-06 at 100 EST**

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

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

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National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: IAD01IA034	Aircraft Registration Number: N375FE
Occurrence Date: 03/06/2001	Most Critical Injury: None
Occurrence Type: Incident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
Boston	MA	02101	0100	EST	

Airport Proximity: On Airport	Distance From Landing Facility:	Direction From Airport:

Aircraft Information Summary

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

Sightseeing Flight: No

Air Medical Transport Flight: No

Narrative

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

HISTORY OF FLIGHT

On March 6, 2001, about 0100 eastern standard time, a McDonnell-Douglas DC-10, N375FE, operated as Federal Express flight 1610, experienced an uncontained (#2) engine failure during takeoff from Boston/Logan International Airport (BOS), Boston, Massachusetts. The three flight crewmembers and one jumpseat passenger were not injured. Instrument meteorological conditions prevailed and an instrument flight rules flight plan was filed for the cargo flight conducted under 14 CFR Part 121.

The Captain prepared a statement that was signed by all three crewmembers. According to the statement:

"After the runway was opened, we had the aircraft anti-iced and taxied to Runway 4R. We accomplished final aircraft configuration approaching the runway and were cleared for takeoff with engine and wing anti-ice on and continuous ignition on. This was the Captain's takeoff. During takeoff roll we felt some vibrations but with cold tires, snow, and runway clutter, we did not feel that was abnormal. There were no abnormal cockpit indications. As we broke ground, tower called that they may have seen "sparks" coming from the number 2 engine. After tower called, we checked again but all cockpit indications were still normal, although we had vibrations from somewhere. The Captain pulled back the number 2 throttle and felt vibrations decrease in intensity. He then felt the start levers but no vibrations were sensed and all engine indications remained normal."

"We elected to declare an emergency and return to BOS. The F/O [First Officer] assumed flying responsibilities while the Captain and Engineer ran the 'One engine inoperative approach and landing checklist' as a precaution. Because there were still no definitive indications of the source of the vibration, we left the number 2 engine at idle and prepared for a CAT II monitored approach to runway 4R."

"On base leg, the Captain noted number 2 engine hydraulic pressure low lights on. We accomplished the phase one action items for 'Hydraulic quantity leak or loss of hyd sys 3 elev off light on'.

"The F/O flew the monitored CAT II to runway 04R and Captain took the aircraft approaching minimums. Winds were approximately 050/22 kts. A normal landing was accomplished."

"The Captain applied brakes and initiated reverse thrust. Simultaneously, the tower and fire trucks said the number 2 engine was on fire. The F/O shut down the number 2 start lever, pulled the number 2 fire handle and discharged one fire bottle while the Captain was stopping the aircraft. The fire department notified us that the fire was still burning, so all fire handles were pulled, all fire bottles were discharged, and the Captain directed an emergency evacuation."

"The Engineer opened the main cabin door and deployed the slide. The winds blew the slide up

National Transportation Safety Board

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Occurrence Date: 03/06/2001

Occurrence Type: Incident

Narrative (Continued)

against the side of the aircraft so the firefighters had to hold it down in order for the crew to evacuate. All four crewmembers (3 operating crew and 1 jumpseater) were unhurt and waited in the fire truck until the emergency was terminated by the fire department."

The accident occurred during the hours of darkness at 42 degrees, 22 minutes north latitude, and 071 degrees, 00 minutes west longitude.

PILOT INFORMATION

The captain held an airline transport pilot certificate with ratings for airplane multi-engine land. He reported 5,716 hours of total flight experience, 98 hours of which were in the 90 days prior to the accident. The captain stated he had 2,124 hours of flight experience in the DC-10.

The first officer held an airline transport pilot certificate with a rating for airplane multi-engine land. He reported 2,442 hours of flight experience, 134 hours of which were in the 90 days prior to the accident. The first officer stated he had 461 hours of experience in the DC-10.

AIRCRAFT INFORMATION

The airplane was a 1972 McDonnell Douglas DC 10-10, and it was owned and operated by the Federal Express Corporation. The previous owner/operator was United Airlines. The airplane had 72,372 hours of flight time and 28,470 cycles accrued. The engine installed in the No. 2 (center) position was a General Electric CF6-6D.

According to a McDonnell Douglas Service Bulletin dated April 18, 1976:

"Six operators have reported eight instances of foreign object damage (FOD) to engine 2. Damage occurred during operation in severe cold weather and is attributed to blockage of the inlet ring (bellmouth) drain hose by ice. Blockage of the hose prevents drainage of any accumulated water from the engine inlet ring. Subsequent freezing of the water causes formation of ice, which can be ingested into the engine during engine start, resulting in engine damage. Replacing the existing inlet drain hose with a new hose incorporating a heater will prevent blockage of the hose by ice. Installation of the new hose will assure proper drainage of the inlet ring and minimize the possibility of engine damage."

Examination of the airplane by a Federal Aviation Administration (FAA) inspector revealed that the drain line to the #2 engine inlet ring drain was installed, but the line was not equipped with the heat element. Further, the wiring for the heat element was installed, but was capped off behind the circuit breaker panel.

Examination of the maintenance records revealed that the heated drain-line modification was noted as complete, with no mention of capped electrical wiring.

According to written statements by the personnel who de-iced the airplane, the airplane was de-iced and treated with anti-ice solution three times between 21:52 and 23:48. According to the FAA inspector, a member of the de-icing crew reported that a large puddle of deicing fluid was visible in the #2 engine bellmouth.

METEOROLOGICAL INFORMATION

At the time of the accident, the weather reported at Boston/Logan included winds from 010 degrees at 16 knots, gusting to 24 knots. The visibility was 2 miles in fog and snow.

According to the FAA inspector, the airplane was parked outside all day in snowy weather. The snow continued off and on all day, with the airport closing runways periodically for snow removal.

National Transportation Safety Board

FACTUAL REPORT
AVIATION

NTSB ID: IAD01IA034

Occurrence Date: 03/06/2001

Occurrence Type: Incident

Narrative (Continued)

"Blizzard" conditions existed around the time of takeoff.

FLIGHT RECORDERS

The digital flight data recorder was examined, data was extracted, and a Safety Board recorder specialist prepared a report on March 13, 2001.

The cockpit voice recorder was reviewed and a Safety Board recorder specialist prepared a transcript on March 20, 2001.

WRECKAGE INFORMATION

A Safety Board Powerplants specialist examined the airplane at the scene on March 2, 2001. According to the specialist's report:

"An on-site investigation of the airplane in Boston revealed nicks, dents, and punctures in the No.2 engine inlet duct right-hand side, from the aft looking forward (ALF), forward of the front face of the engine. The bellmouth and inlet adapter ring were completely missing. The left-hand side of the fan cowl had a burn-through at the 9 o'clock position. Two stage-1 fan blades had transverse separations below the mid-span shroud.

All of the stage-1 fan blades exhibited both soft and hard body foreign object damage. The forward fan case had a tear in the plane of the stage 1 blades at the 4 o'clock position. All of the forward outer acoustic panels and stage-1 fan abradable shroud material were missing. The fan outlet guide vanes were separated from the inner acoustic panels. The No. 2 engine main fuel supply line and the No. 2 aircraft hydraulic pressure line were severed."

"The weather in Boston prior to departure was reported as rain, sleet, and snow. The aircraft was deiced at 2130 and again at 2345 hours. The delay between the two deicings was due to the runway being closed for snow removal. As required, an inlet inspection of the No. 2 engine was performed following the deicing to assure that there were no accumulations of snow and ice inside the inlet. The personnel performing the inspection reported that the inlet was clear and also noted that there was a pink puddle at the aft end of the inlet."

The Powerplant Specialist also said the accessory gearbox (AGB) was cracked in half, the gear teeth were exposed, and one of the AGB mounts was broken. He said there were three small punctures in the upper surfaces of the horizontal stabilizer.

TESTS AND RESEARCH

The engine was removed from the airplane on March 10, 2001, and was shipped to General Electric Engine Services (GEES) Caledonian Overhaul Shop, located in Prestwick, Scotland. The Powerplant Group reconvened at the GEES Caledonian facility from April 17-20, 2001, and conducted a teardown inspection of the engine.

The Safety Board was not present for this inspection. A representative of the General Electric Aircraft Engines Commercial Flight Safety Office directed the examination under the supervision of the FAA, and submitted a report. The FAA inspector reviewed the report and concurred with its findings.

ADDITIONAL INFORMATION

According to the Safety Board Powerplant Specialist's report:

"Soft body impact damage is characterized by the large radius of curvature of the deformation to

National Transportation Safety Board

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Narrative (Continued)

the blade, typically a fan blade. Soft body impact damage can result from impacts with pliable objects such as birds, ice slabs, tire rubber, and plastic objects. Hard body impact damage is characterized by a serrated appearance and deep cuts or tears to the airfoil's leading and trailing edges. Hard body impact damage can result from the impact with metal parts, concrete, asphalt, and rocks."

According to the FedEx Maintenance Technical Training Manual published July 1999, DC-10-10 Aircraft De/Anti-Icing Information, WARNING:

"It is possible to sustain damage to the No. 2 engine due to ice accumulation in the duct area. This warning is in compliance with airworthiness directive 94-22-01. Check and remove any snow or ice accumulation from both the top of the fuselage and No. 2 engine inlet and make entry in the aircraft log or aircraft de/anti-icing log, FedEx M-0493, or on the equipment inspection/record of aircraft service, FedEx M-3025, which must be signed off by a certified mechanic, AD 94-22-01 is not complete until the electronic AML entry is made."

At the conclusion of the investigation, FAA Airworthiness Directive 94-22-01 remained unchanged. However, FedEx published a detailed inspection procedure to augment and ensure compliance with AD 94-22-01. The inspection procedure included diagrams of the #2 engine inlet, bellmouth, front flange, and fan blade areas where ice accumulation has occurred. According to a caution statement in the procedure:

"All fluid should be drained from the bellmouth area within approximately 1 minute after deicing. If the fluid has not drained, examine further to determine why the fluid is collecting. Also, check the drain outlet to determine if fluid is draining from it. A collection of fluid could indicate ice has formed in the drain hose or the bellmouth area."

"If you cannot determine that the fluid or contamination has been removed, the aircraft should be considered unairworthy."

National Transportation Safety Board

FACTUAL REPORT AVIATION

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Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
Boston Logan	BOS	20 Ft. MSL	04R	10005	150

Runway Surface Type: Asphalt

Runway Surface Condition: Rough; Slush covered; Snow--wet; Wet

Type Instrument Approach: ILS-complete

VFR Approach/Landing: None

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
McDonnell Douglas	DC-10	46613

Airworthiness Certificate(s): Transport

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	7	443000 LBS	3

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Fan	GE	CF6-6D	40000 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	02/2001	35 Hours	72372 Hours

- Emergency Locator Transmitter (ELT) Information

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

Owner/Operator Information

Registered Aircraft Owner	Street Address	City	State	Zip Code
FEDERAL EXPRESS CORP	3131 Democrat	Memphis	TN	38118

Operator of Aircraft	Street Address	City	State	Zip Code
Same as Reg'd Aircraft Owner	Same as Reg'd Aircraft Owner			

Operator Does Business As:

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: Scheduled; Domestic; Cargo

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: IAD01IA034

Occurrence Date: 03/06/2001

Occurrence Type: Incident

First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	59

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

Certificate(s): Airline Transport

Airplane Rating(s): Multi-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? 03/2001

Medical Cert.: Class 1 | Medical Cert. Status: Valid Medical--no waivers/lim. | Date of Last Medical Exam: 11/2000

- 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	5762	2124								
Pilot In Command(PIC)										
Instructor										
Last 90 Days	98	98								
Last 30 Days										
Last 24 Hours										

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
Same as Accident/Incident Location		BOS	0015	EST

Destination	State	Airport Identifier
Memphis	TN	MEM

Type of Clearance: IFR

Type of Airspace: Class B

Weather Information

Source of Briefing: Company; National Weather Service

Method of Briefing: Aircraft Radio; In Person

National Transportation Safety Board

FACTUAL REPORT AVIATION

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Occurrence Date: 03/06/2001

Occurrence Type: Incident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
BOS	0100	EST	20 Ft. MSL	NM	Deg. Mag.

Sky/Lowest Cloud Condition: Few 1200 Ft. AGL

Condition of Light: Night/Dark

Lowest Ceiling: Broken 1900 Ft. AGL

Visibility: 2 SM

Altimeter: 29.56 "Hg

Temperature: -2 °C

Dew Point: -2 °C

Wind Direction: 10

Density Altitude: -1660 Ft.

Wind Speed: 16

Gusts: 24

Weather Condtions at Accident Site: Instrument Conditions

Visibility (RVR): Ft.

Visibility (RVV) SM

Intensity of Precipitation: Heavy

Restrictions to Visibility: Blowing Snow; Fog

Type of Precipitation: Snow

Accident Information

Aircraft Damage: Minor

Aircraft Fire: Ground

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					
Passengers				1	1
- TOTAL ABOARD -				4	4
Other Ground					
- GRAND TOTAL -				4	4

National Transportation Safety Board

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Occurrence Date: 03/06/2001

Occurrence Type: Incident

Administrative Information

Investigator-In-Charge (IIC)

Brian C. Rayner

Additional Persons Participating in This Accident/Incident Investigation:

John A Donahue
Aviation Safety Inspector (Airworthiness)
Federal Aviation Administration
Logan International Airport
Boston, MA 02128

Alan W Ray
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