National Transportation Safety Board
Aviation Accident Final Report

Location:	Raymond, PA	**Accident Number:**	DCA08FA075
Date & Time:	06/14/2008, 1415 EDT	**Registration:**	N554FE
Aircraft:	DOUGLAS MD-10	**Aircraft Damage:**	Substantial
Defining Event:	Aerodynamic stall/spin	**Injuries:**	3 None
Flight Conducted Under:	Part 121: Air Carrier - Non-scheduled		

Analysis

According to the captain, the flight was uneventful until shortly before the airplane entered a holding pattern at FL330. The speed calculated by the flight management system (FMS) was 230 knots, 5 knots above the Vmin speed for the configuration and weight of the airplane. Both pilots expected the FMS to automatically default to the ICAO maximum holding speed of 265 knots, as described in the company flight manual. However, the captain decided to command the FMS to maintain 240 knots to increase the buffer between the holding speed and Vmin. Upon reaching the pattern fix, the airplane automatically banked left to enter holding and the captain noticed that the airspeed was lessening from 240 knots. He expected the airspeed to recover once the turn was completed. He also expected the bank to be limited to 15 degrees, but the autopilot actually commanded 23 degrees. Upon completing the turn, the airspeed was approximately 5 knots below Vmin. The captain expected the airspeed to recover now that the airplane was wings level. However, this did not occur, and when appropriate, the airplane started to automatically turn to the inbound holding heading. The crew then requested and was granted a clearance to descend to FL320 in the holding pattern. The captain then selected level change on the FMS to 320 and he also reduced the autobank controller to 15 degrees, from 23 degrees. During the descending turn, with the airspeed at about 220 knots, the first officer recommended extending the slats. The maximum slat extension speed at that juncture was 270 knots, according to the captain. When the slats extended, the maximum slat extension speed indicator on the airspeed indicator fell to below 220 knots. The captain then immediately ordered the first officer to retract the slats. He stated that at this point the airplane began to buffet, and an autoslat extension alert occurred. The first officer requested a further descent and was cleared to FL290. The captain then selected a level change on the FMS to 290. The buffeting ceased when the airplane was passing approximately FL300 during this descent. The flight landed uneventfully; however, the buffeting had caused substantial damage to both elevators and right horizontal stabilizer that was discovered during a post-flight inspection. According to the flight data recorder data and an analysis of that data by the airplane's manufacturer, the slats were extended by the flight crew when the airspeed was 205 knots, well below the maximum slat extension speed of 260 knots. However the Mach number at that time was 0.59, well above the 0.51 Mach minimum slat extension speed. The target Mach then became 0.51, and the autothrottles reduced from

100% N1 rpm to about 50% N1 rpm. When the slats were retracted by the flight crew, the autothrottles advanced the thrust back to 100% N1 rpm. However, by the time the engine thrust had recovered, the airspeed had dropped to about 180 knots. The stick shakers activated about 5 seconds later and continued to operate for approximately one minute.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The flight crew's failure to adequately monitor the airplane's airspeed during the holding pattern, leading to the onset of an aerodynamic stall and subsequent structural damage to the tail from buffet.

Findings

Personnel issues	Expectation/assumption - Pilot (Cause)

Factual Information

HISTORY OF FLIGHT:

On June 14, 2008, at 1015 eastern daylight time, FedEx flight 764, a McDonnell Douglas/Boeing MD-10-10 freighter, experienced aerodynamic buffet and stickshaker while descending from FL330 in a holding pattern near Raymond, Pennsylvania. Damage occurred to both elevators and right horizontal stabilizer. The flight was enroute from Memphis, Tennessee, to John F. Kennedy International Airport, Jamaica, New York. None of the three flightcrew members on board were injured and the flight landed uneventfully.

According to the captain, the flight was uneventful until shortly before the airplane entered the holding pattern at HOXIE with an inbound course of 115 degrees at FL330. The holding pattern legs were 20 nm long. The speed calculated by the flight management system (FMS) was 230 knots, 5 knots above the Vmin speed for the configuration and weight of the airplane. Both pilots expected the FMS to automatically default to the ICAO maximum holding speed of 265 knots, as described in the Fed Ex company flight manual (CFM). However, the captain decided to command the FMS to maintain an airspeed of 240 knots to increase the buffer between the holding speed and Vmin.

Upon reaching HOXIE, the airplane automatically banked left to enter holding and the captain noticed that the airspeed was lessening from 240 knots. He stated that he expected the airspeed to recover once the turn was completed. He also stated that he expected the bank to be limited to 15 degrees, but the autopilot actually commanded 23 degrees of bank. Upon completing the turn, the airspeed was approximately 5 knots below Vmin. The captain expected the airspeed to recover now that the airplane was wings level. However, this did not occur, and when appropriate, the airplane started to automatically turn to the inbound holding heading.

The captain then asked the first officer to request a lower altitude in the holding pattern. The first officer complied and Cleveland ARTCC cleared the flight to descend to FL320. The captain then selected level change on the FMS to 320 and he also reduced the autobank controller to 15 degrees, from 23 degrees.

During the descending turn, with the airspeed at about 220 knots, the first officer recommended extending the slats. The maximum slat extension speed at that juncture was 270 knots, according to the captain. When the slats extended, the maximum slat extension speed indicator on the airspeed indicator fell to below 220 knots. The captain then immediately ordered the first officer to retract the slats. He stated that at this point the airplane began to buffet, and an autoslat extension alert occurred. The first officer requested a further descent and was cleared by ARTCC to descend to FL290. The captain then selected a level change on the FMS to 290. The buffeting ceased when the airplane was passing approximately FL300 during this descent. Visual meteorological conditions existed at the time frame of the buffeting event, and no turbulence was encountered. The flight landed uneventfully.

INJURIES TO PERSONS:

None of the flight crewmembers on board the airplane were injured.

DAMAGE TO AIRCRAFT:

Substantial damage to the right and left elevators and the right horizontal stabilizer tip structure was discovered by maintenance personnel following engine shutdown.

PERSONNEL INFORMATION:

Both the captain and first officer held air transport pilot ratings and were type-rated in the McDonnell Douglas MD-11. These type-ratings also apply to the McDonnell Douglas MD-10-10 due to similarities between the two types. Both held current first class medical certificates with no waivers or limitations. And, both successufully completed FAR 121 flight checks in May of 2008. The captain had accumulated 6814 total flying hours with 2740 hours in the MD-10. The first officer had accumulated 2334 total flying hours with 820 hours in the MD-10.

AIRCRAFT INFORMATION:

The airplane was a McDonnell Douglas (Boeing) MD10-10, serial number 46708. It was registered in the United States as N554FE. The total time on the airframe was 86, 958 hours, and it was last inspected under a continuous airworthiness program on May 8, 2007.

FLIGHT DATA RECORDER INFORMATION:

According to the flight data recorder data and an analysis of that data by Boeing engineers, the slats were extended by the flight crew when the airspeed was 205 knots, well below the maximum slat extension speed of 260 knots. However the Mach number at that time was 0.59, well above the 0.51 Mach minimum slat extension speed. The target Mach then became 0.51, and the autothrottles reduced from 100% N1 rpm to about 50% N1 rpm.

When the slats were retracted by the flight crew, the autothrottles advanced the thrust back to 100% N1 rpm. However, by the time the engine thrust had recovered, the airspeed had dropped to about 180 knots. The stick shakers activated about 5 seconds later and continued to operate for approximately one minute.

About 10 seconds after initial stick shaker activation the airplane pitch reached 12 degrees nose up. 10 seconds later, the pitch was recorded to be 3 degrees nose up, and 17 seconds after that, the pitch was recorded to again be about 12 degrees nose up. Almost immediately after that, the pitch was recorded to be 2 degrees nose up. Pitch then increased to about 7 degrees nose up, then stabilized at about 5 degrees nose up, rapidly decreased to 0 degrees nose up, and then recovered to a stable 5 degrees nose up over the next 40 seconds.

During the period of stick shaker activity, the altitude decreased from FL 340 to FL 306. The airplane continued to descend to FL 290 as the airspeed recovered to 230 knots.

ADDITIONAL INFORMATION:

On January 21, 1988, McDonnell Douglas Aircraft Company (subsequently acquired by Boeing) issued All Operator Letter C1-E60-HHK-99-L033, titled High Altitude Stall Buffet. Although

addressed to all DC-10 operators, it also still applies to the MD-10 which is aerodynamically identical to the DC-10. The subheading in the AOL titled Buffet Characteristics reads in part:

A quick way to determine whether airframe buffet is resulting from high or low speed flight is to check the Mach number. For mach numbers below 0.84 in 1.0g flight, the buffet is related to maximum lift capability or stall. The buffet onset or stick shaker speed, whichever is greater, should be used as the minimum speed below which aircraft structural damage, in the form of wrinkled elevators, could potentially occur.

The subheading in the AOL titled Stall Recovery Procedure reads in part:

Should a crew encounter buffet in the clean configuration below 0.84 Mach, prompt stall recovery corrective action should be taken. Maximum continuous thrust… should be applied and pitch attitude reduced as required to minimize altitude loss. If below the slat limit speed, slats should be extended. At heavy weights or high altitudes, if the airspeed/Mach has become low, this technique alone may not be adequate for recovery and altitude should be traded for airspeed to accelerate out of the buffet. Incomplete recovery may result in a secondary stall or inability to accelerate to cruise mach with thrust available. If recovery action is not promptly initiated, a substantial loss of altitude may result…

The Boeing MD-10 Flight Crew Operations Manual (FCOM) section titled Recovery from Approach to Stall reads in part:

At first indication of approach to stall, simultaneously apply maximum available thrust, level wings and adjust pitch as required to minimize altitude loss.

First indication of approach to stall may be one or any combination of the following:

- Rapid decrease below selected airspeed or digital airspeed turns amber.
- Airspeed decay below the Vmin indicator toward the Vs indicator on the airspeed tape.
- Pitch Attitudes approaching the PLI
- Stick shaker or initial stall buffet (light wing rock may be present)

At first indication of a stall with auto flight engaged immediately disconnect auto flght and initiate stall recovery. Be alert to counteract excessive nose-up trim condition.

Above 25, 000 feet, stall can occur prior to stick shaker with buffet serving as the only stall warning.

The FCOM section titled Automatic Flight – Description and Operation states in part:

The commanded speed will be the FMS speed if the FMS SPD is engaged.

If the Bank angle limit selector is set to the AUTO position, the bank angle limit value will vary as follows:

Limited to 25 degrees between Mach 0.17 and Mach 0.55.

History of Flight

Enroute-holding (IFR)	Aerodynamic stall/spin (Defining event)

Pilot Information

Certificate:	Airline Transport; Commercial; Flight Engineer	**Age:**	50, Male
Airplane Rating(s):	Multi-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 Without Waivers/Limitations	**Last FAA Medical Exam:**	06/01/2008
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	05/01/2008
Flight Time:	6814 hours (Total, all aircraft), 2740 hours (Total, this make and model), 488 hours (Pilot In Command, all aircraft), 58 hours (Last 90 days, all aircraft), 24 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport; Commercial; Flight Engineer	**Age:**	50, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
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 Without Waivers/Limitations	**Last FAA Medical Exam:**	01/01/2008
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	05/01/2008
Flight Time:	2334 hours (Total, all aircraft), 820 hours (Total, this make and model), 100 hours (Last 90 days, all aircraft), 23 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	DOUGLAS	**Registration:**	N554FE
Model/Series:	MD-10 -10	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	46708
Landing Gear Type:	Retractable - Tricycle	**Seats:**	
Date/Type of Last Inspection:	05/01/2007, Continuous Airworthiness	**Certified Max Gross Wt.:**	440000 lbs
Time Since Last Inspection:		**Engines:**	3 Turbo Fan
Airframe Total Time:	86958 Hours as of last inspection	**Engine Manufacturer:**	General Electric
ELT:	Not installed	**Engine Model/Series:**	CF6-6D
Registered Owner:	FEDERAL EXPRESS CORP	**Rated Power:**	
Operator:	FEDERAL EXPRESS CORP	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:	Federal Express Corp	**Operator Designator Code:**	FDEA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	
Observation Facility, Elevation:		**Observation Time:**	
Distance from Accident Site:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Temperature/Dew Point:**	
Lowest Ceiling:		**Visibility**	
Wind Speed/Gusts, Direction:		**Visibility (RVR):**	
Altimeter Setting:		**Visibility (RVV):**	
Precipitation and Obscuration:			
Departure Point:	Memphis, TN (MEM)	**Type of Flight Plan Filed:**	IFR
Destination:	Jamaica, NY (JFK)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	

Airport Information

Airport:	John F. Kennedy International (JFK)	**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	N/A	**IFR Approach:**	
Runway Length/Width:		**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	41.865000, -77.852500 (est)

Administrative Information

Investigator In Charge (IIC):	Robert P Benzon	**Adopted Date:**	09/27/2010
Additional Participating Persons:			
Publish Date:	09/27/2010		
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.ntsb.gov/pubdms/.		