Aviation Investigation Final Report

Location:	St. Louis, Missouri	**Accident Number:**	DCA15FA073
Date & Time:	February 24, 2015, 06:16 Local	**Registration:**	N584FE
Aircraft:	McDonnell Douglas MD 11F	**Aircraft Damage:**	None
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	1 Serious, 3 None
Flight Conducted Under:	Part 121: Air carrier - Non-scheduled		

Analysis

During cruise flight, the crew received a fire warning from the cargo compartment indicating that the fire suppression system had activated, along with hearing loud sounds from the cargo compartment. The flight crew elected to divert to St. Louis. Although the activation of the fire suppression was a false alarm, the decision to divert was prudent and correct. During the approach the crew made the decision to evacuate the airplane after landing, briefed the passengers in the courier area, and reviewed the evacuation checklist in the Quick Reference Handbook (QRH). The diversion and subsequent landing were performed without issue. After exiting the runway, and bringing the airplane to a stop in a safe area, the crew initiated an emergency evacuation using the left forward door (1L). The door opened, however, the 1L escape slide/raft did not fully deploy, appearing to be hung up on a strap. The first officer attempted to free it and the fire/rescue crew pulled on the slide and it appeared to inflate. However, because the slide inflation sequence had been interrupted, it was significantly underinflated and unable to support the weight of the crewmember, resulting in a serious injury. Post-incident examination of the 1L slide/raft was unable to determine the causes for the slide/raft to not inflate to full extension.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

a partial inflation of the 1L escape slide/raft due to undetermined reasons resulting in insufficient capability to support the weight of the crewmember.

Findings

Aircraft	Escape slide - Failure
Aircraft	Escape slide - Inadequate inspection

Factual Information

History of Flight

Standing	Evacuation
Standing	Sys/Comp malf/fail (non-power) (Defining event)

HISTORY OF FLIGHT

On February 24, 2015, about 0616 central standard time, a FedEx MD-11F, N584FE, landed at Lambert – St Louis International Airport (STL), St Louis, Missouri following automatic activation of the main deck fire suppression system. After landing, the four crewmembers deplaned through the left main cabin door using an evacuation slide. One of the four crewmembers on board was seriously injured during the evacuation; the other three crewmembers were not injured. The flight was operating under the provisions of 14 *Code of Federal Regulations* Part 121 as a cargo flight from Memphis International Airport (MEM), Memphis, Tennessee, to Minneapolis-St Paul International Airport (MSP), Minneapolis, Minnesota.

The captain was the pilot flying. During cruise at FL360 about 80 miles north of STL, lights illuminated on the flight deck glareshield indicating the Fire Suppression System (FSS) had activated on the main cargo deck. About the same time two jumpseat riders in the courier compartment heard a loud metallic bang noise similar to a cargo bin door falling in the cargo compartment and observed the FSS discharge indication lights were illuminated near the forward left (1L) door.

According to the cockpit voice recorder, at 0556:57, one of the crewmembers in the courier area called the flight deck via intercom and advised they heard a sound "like a can [cargo bin] got punctured." The flight crew acknowledged and discussed the indications, and at 0557:33, they declared an emergency with Air Traffic Control (ATC) and coordinated a diversion to STL. During the diversion, the crew reviewed abnormal procedures and planned on evacuating the airplane after clearing the runway. On approach to STL, the flight advised ATC that the fire was not confirmed but the "indications are there, and they're not going away."

At 0609:39 the flight crew notified a crewmember in the courier area they would "get off the aircraft" on the taxiway, and the crewmember acknowledged.

At 0616:00 the airplane landed on runway 12L, exited the runway at taxiway K and came to a stop at the intersection of taxiway K and taxiway F.

At 0616:29, the crew accomplished the evacuation checklist contained in the Quick Reference Handbook and exited the flight deck. The first officer performed the emergency door/slide opening procedure at the 1L door. According to the crewmembers the slide did not appear to deploy completely and one crew member stated that it appeared to be "…caught up…in the straps that are part of the slide."

Airport Rescue and Firefighting (ARFF) personnel pulled on the slide and it then appeared to complete deployment.

The first officer jumped into the slide to exit the airplane. The slide did not slow the first officer as he descended to the tarmac; he impacted the tarmac and sustained a fraction to his L1 vertebrae.

ARFF personnel held the base of the slide in place and the remaining crewmembers lowered themselves to the ground using the slide.

INJURIES TO PERSONS

One crew member received serious injury and 3 crewmembers were not injured.

PERSONNEL INFORMATION

The flight crew consisted of two pilots and two additional pilot observers.

The captain, age 55, was hired by Federal Express in January 1997 and completed initial MD-11 training in June 2011.

The captain reported approximately 12,476 hours total time, including about 6,470 hours as pilot-in-command and 2,974 hours in the MD-11. There were no records or reports of any previous aviation incidents or accidents involving the captain. The captain held a valid Federal Aviation Administration (FAA) Airline Transport Pilot (ATP) certificate with type ratings for B-737, B-757/767, and MD-11 and a current FAA first-class medical certificate issued on September 2, 2014. Company records indicated his most recent proficiency check was June 3, 2014. Training and proficiency checks were current and the company reported that the captain had no record of failures during company training events.

The first officer, 51 years old, was hired by Federal Express in June 2006. He reported approximately 9,695 hours total flight time and about 2,642 hours in the MD-11. There were no records or reports of any previous aviation incidents or accidents involving the first officer. He held a valid FAA ATP certificate with type ratings for the B-757/767, MD-11, and B-727 SIC privileges only, and an FAA first-class medical certificate issued on October 7, 2014. The first officer's training and proficiency checks were current and the company reported he had no failures recorded during company training events. He completed initial training in the MD-11 in October 2014 and his most recent proficiency check was completed September 13, 2014.

AIRCRAFT INFORMATION

N584FE, manufacturer serial number 48436, was a McDonnell Douglas MD-11F equipped with three General Electric CF6-80 turbofan engines. The airplane was manufactured in 1992 and the company reported that the airplane had approximately 75,064 hours total time and 16,731 cycles on the airframe. Recorded data and airline records indicated no relevant maintenance issues with the airplane.

Evacuation Slide System

The airplane was equipped with emergency escape slides installed at the two forward doors; the 1L door and the 1R door. The 1L door was equipped with Evacuation System 60289-117, serial number 0406,

manufactured by Air Cruisers in April 1994. The slide/raft assembly was overhauled and recertified to zero time in June of 2013. Maintenance and testing procedures for the evacuation slide/raft were contained in the Component Maintenance Manual 25-61-31.

METEOROLOGICAL INFORMATION

The STL surface observation at 0551 CST reported wind from 210 degrees at 3 knots, visibility 10 miles, clear skies, temperature minus 10 degrees Celsius, dew point temperature minus 17 degrees Celsius, and altimeter setting 30.18 inches of mercury.

AERODROME INFORMATION

The Lambert-St Louis International Airport (STL) was located about 10 miles northwest of the city of St Louis, Missouri. The airport conducted operations using 8 runways for commercial and general aviation. Runway 12L was grooved concrete, 9,003 feet long, 150 feet wide with a touchdown zone elevation of 528 feet. The runway was served by a 4-light precision approach path indicator system (PAPI) with a 3 degree glide path on the right side of the runway, and an approach light system sequenced flashers (ALSF2).

FLIGHT RECORDERS

A Smiths Industries combi Cockpit Voice/Flight Data Recorder (CVFDR), serial number 0000038, was downloaded at the NTSB Vehicle Recorder Division. The cockpit voice portion of the recorder included 2 hours of recording on four audio channels. The audio quality of the channels containing information from the captain's and first officer's audio panels, was characterized as excellent, and the audio quality of the channel containing information from the cockpit area microphone was characterized as fair. The recording included events from the flight beginning prior to engine start in MEM at about 0417 CST, and ending when the CVR was deactivated after landing in STL as the crew performed the evacuation checklist at 0617. Timing on the CVR summary was established by correlating CVR recorded touchdown time to the touchdown time reported by the airplane Aircraft Communications Addressing and Reporting System (ACARS) and adjusting to local CST.

The FDR, a Honeywell SSFDR 980-4700-001, serial number SSFDR-08811, was downloaded at the NTSB Vehicle Recorders Division. The recorder was found to be in good condition, however, data was not extracted from the FDR as it did not record parameters applicable to evacuation slide operation.

WRECKAGE AND IMPACT INFORMATION

The slide and girt bar were removed from the airplane. The slide and associated components were shipped to the manufacturer for further examination and testing.

SURVIVAL ASPECTS

Video footage from an airport ramp camera revealed the airplane came to a complete stop, followed by the 1L door opening. The 1L slide/raft did not fully inflate during the deployment. The slide/raft was held up in the area of the first set of frangible links at the airplane attachment end of the slide/raft. The frangible links are designed to separate at pre-determined inflation tube forces as the slide/raft inflates allowing the slide/raft to fully extend to the ground. Aircraft rescue and firefighting (ARFF) personnel

approached the partially inflated, unusable slide/raft and jumped to grab onto the slide/raft. The slide/raft then continued to unfold onto the ramp surface. The firefighter then pulled the slide/raft into an attitude consistent with normal deployment, but did not hold on to the slide/raft while the first crewmember evacuated. The crewmember jumped out of the 1L door into the slide/raft, which collapsed under his weight resulting in the crewmember forcefully contacting the tarmac. A short time later emergency personnel arrived to assist him. The remaining three crewmembers slid down the slide with the help of the firefighters supporting the slide. The 1R exit was not opened and the slide/raft was not deployed.

Post-incident examination of the 1L slide/raft was unable to determine the causes for the slide/raft to not inflate to full extension.

TESTS AND RESEARCH

A visual inspection of the Evacuation System at the manufacturer indicated the carrying case dated December 13, 1995 was in overall good condition with no notable signs of damage. The maintenance card was not found.

The storage side straps were both found intact and snapped in place on the top side of the carrying case. The strap on the right (airplane forward) side of the slide had no signs of damage. The strap on the left (airplane aft) side showed signs of drag marks across the top of the snap, torn webbing sections, and friction burn marks and melted fibers at the torn edges. Both reservoir attachment straps were torn apart at coincident locations. The torn fibers were soiled and showed signs of abrasion.

The slide/raft system markings indicated the date of manufacture was April, 1996, Girt bar markings/placard indicated the last maintenance overhaul was completed in March, 2013 and the next scheduled maintenance was due in March, 2016.

The inflation cable was not damaged and the quick disconnect was in place. Frangible links were separated and indicated proper color coordination for their respective locations on the escape slide inflatable.

The inflation hose, manufactured October 30, 1992, had dirty abrasion marks and a placard on the hose assembly indicated it was last tested in 2005. The manufacturers CMM indicated an integrity verification test of the inflation hose was recommended to be accomplished every 3 years up to and including 15 years and annually after 15 years.

A visual inspection of the reservoir and valve assembly revealed one of the two sling webbing was torn and the sling sleeve showed signs of abrasion and several holes torn in the fabric coincident with surface scuff marks on the reservoir. The valve assembly pressure gage glass was intact and the hard sleeve gage protector was cracked.

A visual inspection of the left (aft) side aspirator found the interior nozzle array in good condition. There were two scratches tracking down the inside of the aspirator mixing tube starting from the inlet housing junction and ending at the outlet. The inlet ring had some dents and scuffing on the outer edge. The right (forward) aspirator was found to be in good condition, with some signs of denting and scuffing on the inlet ring; although less extensive than the left side aspirator. The pressure relief valves were both intact and secure.

The slide was partially inflated for a preliminary inspection and showed no apparent leaks and no notable damage was found. There were no marks or discoloration indicating slide ingestion in the aspirator. The slide was deflated and the reservoir and valve assembly were pressurized in accordance with the Component Maintenance Manual procedures and successfully completed a leak check.

The reservoir and valve assemble were re-installed on the slide and a floor run functional test was accomplished, inflating the slide successfully. The upper tube was measured at 2.54 psi and the lower tube was measured at 2.43 psi, with no leaks detected in either chamber. The CMM indicated minimum pressure for the slide measured within 5 minutes after inflation during a floor run functional check should be 2.3 psi.

During a calibration check, the valve regulator peak pressure was measured to be 497 psi. The CMM requirement for this calibration check is 550 psi (plus or minus 50 psi). The pressure transducer used to test the regulator was calibrated to an accuracy of within .08%.

The inflation hose was hydro tested in accordance with CMM procedures at 900 psi with no leaks or deformation noted.

ADDITIONAL INFORMATION

The manufacturer recommended maintenance overhaul interval for the evacuation slide/raft was listed in the CMM. The recommendation stated in part;

"For Evacuation Systems perform the following every three years up to and including 15 years. After system has been in service for more than 15 years the following should be done each year, if the inflatable and hose are not replaced at 15 years." The table of recommended tests and inspections included a Functional Deployment Test, Inflatable Integrity Verification tests, Hose Integrity Verification Test, Light System Test, a check of various evacuation system components, and verification of compliance with all Service Bulletins and Service Information Letters.

The FedEx Maintenance Specification Item contained in their approved MD-11 Aircraft Maintenance Program indicated the evacuation slide/raft was to be overhauled every 3 years.

The manufacturers CMM indicated an integrity verification test of the inflation hose was recommended to be accomplished every 3 years up to and including 15 years and annually after 15 years.

Manufacturer records indicated three previous instances of a slide/raft that did not fully deploy inflation issue. None of the three previous incidents occurred on an airplane in service.

In 2005, a slide/raft was inadvertently deployed during a maintenance procedure and did not fully deploy. An investigation by the manufacturer found that the container assembly straps had not been properly stowed during installation and prevented complete deployment of the slide/raft.

In 2011, there were two separate incidents that occurred during functional tests of the slide/raft during scheduled maintenance. In one incident, although the root cause was not determined, evidence during an investigation by the manufacturer indicated that an unsecured assembly strap led to the slide/raft carrying case partially obstructing one of the aspirators preventing complete inflation of the lower slide chamber.

In the second incident in 2011, an investigation by the manufacturer concluded that a release strap which is required to trigger slide deployment, was not correctly attached and caused a delayed deployment. The delay in deployment displaced the slide/raft carrying case close to one of the aspirators resulting in partial blockage of the aspirator and insufficient airflow to inflate the lower chamber of the slide/raft.

Pilot Information

Certificate:	Airline transport	**Age:**	55
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Unknown	**Last FAA Medical Exam:**	March 9, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 3, 2014
Flight Time:	(Estimated) 12476 hours (Total, all aircraft), 2974 hours (Total, this make and model), 6470 hours (Pilot In Command, all aircraft), 184 hours (Last 90 days, all aircraft), 64 hours (Last 30 days, all aircraft)		

Co-pilot Information

Certificate:	Airline transport	**Age:**	51
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	Unknown
Instrument Rating(s):		**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	No
Medical Certification:	Class 1 Unknown	**Last FAA Medical Exam:**	October 7, 2014
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 14, 2012
Flight Time:	(Estimated) 9695 hours (Total, all aircraft), 2642 hours (Total, this make and model), 2509 hours (Pilot In Command, all aircraft), 39 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	McDonnell Douglas	**Registration:**	N584FE
Model/Series:	MD 11F UNDESIGNAT	**Aircraft Category:**	Airplane
Year of Manufacture:	1992	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	48436
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	630010 lbs
Time Since Last Inspection:		**Engines:**	3 Turbo fan
Airframe Total Time:		**Engine Manufacturer:**	GE
ELT:		**Engine Model/Series:**	CF6-80 SERIES
Registered Owner:	US BANK NA TRUSTEE	**Rated Power:**	0 Horsepower
Operator:	FEDERAL EXPRESS CORP	**Operating Certificate(s) Held:**	Flag carrier (121), Supplemental
Operator Does Business As:	3131 Democrat Rd	**Operator Designator Code:**	FDEA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Dawn
Observation Facility, Elevation:	STL,618 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	05:51 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots / None	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	210°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.18 inches Hg	**Temperature/Dew Point:**	-10°C / -17°C
Precipitation and Obscuration:			
Departure Point:	Memphis, TN (MEM)	**Type of Flight Plan Filed:**	IFR
Destination:	Minneapolis, MN (MSP)	**Type of Clearance:**	IFR
Departure Time:		**Type of Airspace:**	

Airport Information

Airport:	Lambert-St Louis International KSTL	**Runway Surface Type:**	Concrete
Airport Elevation:	618 ft msl	**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	ILS
Runway Length/Width:		**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious, 3 None	**Aircraft Damage:**	None
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 3 None	**Latitude, Longitude:**	38,-90(est)

Administrative Information

Investigator In Charge (IIC):	English, William
Additional Participating Persons:	Eric West; Federal Aviation Administration Scott Reeves; FedEx Jim Talay; Boeing John Gabriele; Air Line Pilot's Association Mike Kret; Air Cruisers
Original Publish Date:	May 26, 2017
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=90773