



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 31, 2005

In reply refer to: A-05-014 through -018

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On December 18, 2003, about 1226 central standard time, Federal Express Corporation (FedEx) flight 647, a Boeing MD-10-10F (MD-10),¹ N364FE, crashed while landing at Memphis International Airport (MEM), Memphis, Tennessee. The right main landing gear collapsed after touchdown on runway 36R, and the airplane veered off the right side of the runway. After the gear collapsed, a fire developed on the right side of the airplane. Of the two flight crewmembers and five nonrevenue FedEx pilots² on board the airplane, the first officer and one nonrevenue pilot received minor injuries during the evacuation. The postcrash fire destroyed the airplane's right wing and portions of the right side of the fuselage. Flight 647 departed from Metropolitan Oakland International Airport, Oakland, California, about 0832 (0632 Pacific standard time) and was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 on an instrument flight rules flight plan.

The National Transportation Safety Board determined that the probable causes of the accident were 1) the first officer's failure to properly apply crosswind landing techniques to align the airplane with the runway centerline and to properly arrest the airplane's descent rate (flare) before the airplane touched down; and 2) the captain's failure to adequately monitor the first officer's performance and command or initiate corrective action during the final approach and landing.³

¹ An MD-10 is a DC-10 that has been retrofitted with an advanced-technology flight deck. According to Boeing, the retrofit allows for a two-person flight crew (instead of three), weight savings, increased reliability, and commonality with the MD-11 fleet. FedEx received delivery of its first MD-10s on May 9, 2000.

² The five off-duty, nonrevenue FedEx flight crewmembers included a DC-10 captain, who occupied the jumpseat in the cockpit, two DC-10 first officers, an MD-11 first officer, and a DC-10 flight engineer who occupied the courier seats located in the cabin directly aft of the cockpit.

³ For more information about this accident, see National Transportation Safety Board, *Hard Landing, Gear Collapse, FedEx Express Flight 647, Boeing MD-10-10F, N364FE, Memphis, Tennessee, December 18, 2003*, Aircraft Accident Report NTSB/AAR-05/01 (Washington, DC: NTSB, 2005).

Flight Crew Performance—Oversight

The Safety Board's review of FedEx's pilot training procedures and oversight at the time of the accident revealed that, consistent with other operators in the aviation industry, it focused on a pilot's performance on the day of the checkride with little or no review of that pilot's performance on checkrides months or years earlier.⁴ The Board is concerned that this single-event focus does not allow a carrier to monitor changes or patterns in a pilot's performance history that could provide significant information about the competency of a pilot. For example, in this case, the first officer's repeated substandard performances on checkrides were addressed as singular events that did not require further evaluation or monitoring after the checkride was satisfactorily completed. Yet, postaccident review of the first officer's training history and postaccident interviews suggested a pattern of below-standard performance.

In January 2004, as a result of a series of operational accidents and incidents involving FedEx flights, FedEx implemented an enhanced oversight program (EOP) to identify and track pilots who have demonstrated performance deficiencies or failures in the training environment. The EOP provides identified pilots with additional oversight (two additional line checks annually for first officers and one additional line check annually for captains),⁵ thus providing FedEx management and training personnel with an opportunity to evaluate those pilots' proficiency and performance every 90 days. Additionally, the EOP board, which is made up of company training and flight standards directors, meets monthly to review recent events and discuss identified pilots' case histories. This increased level of monitoring a pilot's performance helps the company determine if deficient performance demonstrated during a checkride is indicative of the pilot's overall performance. If FedEx's EOP had been in effect when the first officer failed her checkrides in 1999 and/or 2001, she would certainly have received additional company scrutiny and training.

According to FedEx representatives, the EOP was intended "as a tool to improve our safety and performance" and to allow FedEx training personnel to better focus its training efforts. The company believed that review of a pilot's performance history during checkrides may provide valuable information about the skills and capabilities of that pilot. A pattern of failures and/or inconsistent performance would indicate performance deficiencies that could adversely affect the safety of flight. The EOP allows FedEx training and management personnel to work with pilots to identify the reasons for the deficiencies and better focus the company's resources (oversight, training, etc.) to improve safety. The Safety Board notes that at the time of this writing, FedEx is the only 14 CFR Part 121 air carrier operator that has implemented this type of proactive program.

Over the years, the Safety Board has repeatedly noted the value of using information regarding a pilot's past performance to assess that pilot's current and future performance and overall abilities. For example, as a result of three accidents in the late 1980s/early 1990s, the Board issued three safety recommendations that asked the Federal Aviation Administration (FAA) to require air carriers to conduct substantive background checks of prospective pilots

⁴ Typically, when a pilot fails a checkride, only the failed items are reviewed during the recheck.

⁵ FedEx flight crewmembers normally receive simulator training every 6 months. In addition, captains would normally receive an annual line check; FedEx first officers normally do not receive annual line checks.

before they are hired. Subsequently, as a result of the December 13, 1994, accident involving American Eagle flight 3379,⁶ the Board issued four additional pilot-performance and training-documentation-related safety recommendations. In response to these recommendations, in 1996, the Pilot Records Improvement Act (PRIA) was enacted. In addition, as a result of the July 13, 2003, accident involving an Air Sunshine Cessna 402, the Board issued two more safety recommendations addressing pilot performance, checkride failures, and record-keeping.

These actions, including the PRIA, address a company's responsibility to review a pilot's history of performance when evaluating the candidate for hire. However, the PRIA does not allow use of these preemployment records after a pilot is hired. Additionally, despite the availability of their own postemployment pilot performance and training information, operators have not traditionally used this information to conduct ongoing pilot evaluations. Pilot oversight programs similar in concept to FedEx's EOP, would allow operators to extend the important concept behind the PRIA (gathering all the available information to make informed decisions) to the ongoing evaluation and oversight of pilots in their employment.

On the basis of the value of using information regarding a pilot's past performance to assess that pilot's current and future performance and overall abilities, the Safety Board concludes that a proactive program, similar in concept to FedEx's EOP, in which flight crewmembers who have demonstrated performance deficiencies or experienced training failures are identified and given additional oversight and training, would be beneficial to flight safety. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 air carrier operators to establish programs for flight crewmembers who have demonstrated performance deficiencies or experienced failures in the training environment that would require a review of their whole performance history at the company and administer additional oversight and training to ensure that performance deficiencies are addressed and corrected.

Emergency Exit Door/Slide Operation and Training

All seven FedEx pilots on board the accident airplane had received FedEx's MD-11/-10 emergency exit door/slide training, which consisted of initial and annual recurrent training.⁷ FedEx conducted initial and subsequent biennial recurrent training sessions on its MD-11/-10 emergency exit door/slide trainers, with alternating biennial recurrent training presented in a classroom video presentation. The emergency slide/raft on the door trainer was permanently inflated and deployed, and FedEx crewmembers were required to use the slide during their initial training.

The Safety Board's review of FedEx's MD-11/-10 emergency exit door/slide trainer at its training facility in Memphis revealed significant differences between the trainer and the L1 emergency exit door/slide that the courier seat nonrevenue FedEx pilot operated during the

⁶ For more information, see National Transportation Safety Board, *Uncontrolled Collision with Terrain, Flagship Airlines, Inc., dba American Eagle Flight 3379, BAe Jetstream 3201, N918AE, Morrisville, North Carolina, December 13, 1994*, Aircraft Accident Report NTSB/AAR-95/07 (Washington, DC: NTSB, 1995).

⁷ Federal regulations regarding crewmember emergency training (14 CFR 121.417) state that flight and cabin crewmembers must perform emergency exit drills "in the normal and emergency modes, including the actions and forces required in the deployment of the emergency evacuation slides" during initial training and during biennial recurrent training.

accident evacuation.⁸ Most significantly, there was no girt bar flap assembly (and, thus, no manual inflation or disengage handles) installed on FedEx's MEM MD-11/-10 emergency exit door/slide trainer.⁹ FedEx's door trainer configuration eliminated an opportunity for FedEx crewmembers to become familiar with the location and appearance of these handles, which would have helped them identify the handles under emergency conditions. Additionally, the door trainer did not reinforce the amount of time involved in inflating the slide/raft (6 seconds) because the slide/raft on the trainer door was already inflated and deployed when the training crewmember opened the trainer door.

Further, at the time of the accident, FedEx's emergency exit training program did not require crewmembers to simulate pulling a manual inflation handle during the training sessions.¹⁰ All of the FedEx pilots on the accident airplane observed a video presentation showing the use of the manual inflation handle during training every year (which helps provide crewmembers with knowledge about door operation); however, this method of training does not adequately provide crewmembers with the skills required to operate the door/slide. For example, without hands-on training on a door trainer equipped with a manual inflation handle, it would be difficult for crewmembers to gain experience with the specific physical steps associated with opening the door and use of the manual inflation handle. Direct hands-on experience is beneficial in the development of the skills and habit patterns a crewmember needs to open the door and use the handle during emergency conditions.

In addition, although the manual inflation and disengage handles are located near each other, they are separated by the girt bar flap, which must be lifted to access the disengage handle. Use of the disengage handle causes the slide/raft to separate from the airplane, which would not be desirable in this case (use of the disengage handle normally occurs only during emergency evacuations after water landings). Therefore, the Safety Board concludes that the nonrevenue FedEx pilot who opened the L1 emergency exit mistakenly pulled both the manual inflation and slide/raft disengage handles because he was not sufficiently familiar with their location and operation, thus separating the slide/raft from the L1 doorsill.

Although the FAA confirmed in a November 2003 memorandum that the flight and cabin crewmember emergency exit training requirements should be equivalent, the guidance contained in FAA Order 8400.10, *Air Transportation Aviation Inspector's Handbook*, includes a more detailed description of the emergency exit training requirements for cabin crew than for flight crew, including the requirement to pull the manual inflation handle. During postaccident interviews, the FAA principal operations inspector (POI) assigned to FedEx stated that his interpretation of this regulation was that flight crews did not have to pull the manual inflation handle during training. However, in a December 2004 memo, the FAA confirmed that 14 CFR 121.417 requires both flight and cabin crews to pull the manual inflation handle during training.

⁸ The Safety Board notes that the R1 emergency exit door/slide was not usable because of the fire and smoke on the right side of the airplane.

⁹ FedEx had MD-11/-10 emergency exit door/slide trainers in MEM and Anchorage, Alaska.

¹⁰ FedEx has since modified its procedures and requires crewmembers to pull, or simulate pulling, the manual inflation handle.

The Safety Board concludes that the guidance contained in the flight crew emergency training section of FAA Order 8400.10 (Air Transportation Aviation Inspector's Handbook) is not adequate for POIs to use in ensuring that emergency exit door/slide training for flight crewmembers is as comprehensive as that which cabin crewmembers receive and is as comprehensive as intended by the regulation. Therefore, the Safety Board believes that the FAA should amend the emergency exit training information contained in the flight crew and cabin crew sections in FAA Order 8400.10, *Air Transportation Aviation Inspector's Handbook*, to make the emergency exit door/slide training described in the flight crew section as comprehensive as the cabin crew emergency training section of the POI handbook.

The Safety Board further concludes that FedEx's inadequate hands-on emergency procedures training and the differences between the trainer and the door/slide installation on the accident airplane contributed to the unintentional release of the slide/raft. Further, the Safety Board is concerned that pilots flying for other Part 121 operators may not be receiving the proper emergency exit training (since it is possible that other POIs may also have erroneously interpreted the regulations). Therefore, the Safety Board believes that the FAA should verify that all Part 121 operators' emergency door/slide trainers are configured to accurately represent the actual airplane exit door/slide and that their flight crew emergency exit door/slide training provides the intended hands-on emergency procedures training as described in 14 CFR 121.417, to include pulling the manual inflation handle.

Memphis Air Traffic Control Tower Actions and Issues

Although the MEM air traffic control tower (ATCT) controllers were not a factor in this accident or the effectiveness of the emergency response, the Safety Board notes that in different accident circumstances, some MEM ATCT controller actions might have had more serious consequences. For example, after the accident, the MEM ground controller held the Rural/Metro Fire Department (RMFD) aircraft rescue and firefighting (ARFF) vehicles, which were responding to the accident from FedEx's ramp on the north side of the airport, short of runway 27 because of landing traffic. This delay was exacerbated when the controller did not clear the RMFD vehicles to cross runway 27 immediately after the landing airplane was clear of the intersection.¹¹ The ground controller subsequently cleared two airplanes to cross after the landing airplane and before he cleared the RMFD vehicles to the accident site. The RMFD vehicles were delayed by almost 2 minutes after the initial request to cross the runway. It should be noted that the MEM ground controller did immediately clear all Memphis Fire Department (MFD) vehicles to the accident site.

Although RMFD is staffed 24 hours a day/7 days a week and has routinely participated in MEM airport emergency drill exercises, there was no formal mutual aid agreement between Memphis/Shelby County Airport Authority (MSCAA) and RMFD addressing RMFD responsibilities and involvement in emergency situations. However, RMFD vehicles operated routinely on the airport, and the ground controller was not unaccustomed to handling those vehicles. Therefore, the Safety Board questions the MEM ground controller's decision to delay the RMFD ARFF vehicles' response to a burning airplane on the airport. The Board considers it

¹¹ The Safety Board notes that during this delay the ground controller was briefing a relief ground controller so the ground controller could participate in postaccident activities.

important that controllers give priority to all ARFF vehicles assisting in fire-related emergencies on the airport even if some ARFF vehicles are not officially incorporated into the airport's emergency plan. Any traffic conflict that the controller perceived between the landing airplane and the RMFD ARFF vehicles should have been resolved (possibly by delaying the airplane's landing) so that the RMFD ARFF could proceed to the accident scene without delay. Although RMFD ARFF vehicles were not a required component of MEM emergency responses, the availability of such support was a benefit that should have been utilized optimally.

Additionally, the Safety Board noted that, after the accident captain advised MEM ATCT controllers of the number of people on board the airplane, the local controller announced this information to others in the tower cab, but neither he nor the ground controller relayed this information to ARFF personnel. The evacuation was in progress when the ARFF responders arrived, and this information would have assisted them in accounting for all occupants, if needed. In this case, because none of the occupants were incapacitated, the only result was that the ARFF responders reported being surprised to see more people evacuating the airplane than they had expected. However, in other circumstances, this lack of pertinent information could have resulted in delayed rescue efforts. When ARFF responders arrive at an accident site involving a passenger-carrying flight, they would expect occupants in the cabin, whereas with a cargo flight they may not. In such a case, if the flight crew was incapacitated and unable to advise ARFF personnel of additional occupants on board the airplane, ARFF personnel might assume that only the primary crewmembers were aboard the cargo flight, thereby endangering anyone remaining on board and unable to self-evacuate.

The Safety Board concludes that the RMFD ARFF response vehicles were unnecessarily delayed in providing ARFF assistance because the MEM ATCT ground controller did not give them priority over other nonemergency airport traffic; under other circumstances, this could have adversely affected ARFF efforts. The Safety Board further concludes that ATCT controllers should recognize the importance of relaying all available pertinent information, including airplane occupant information, to ARFF personnel to assist them in ARFF efforts and decision-making. Therefore, the Safety Board believes that the FAA should inform all ATCT controllers of the circumstances of this accident, including the need to ensure that ARFF vehicles are not delayed without good cause when en route to an emergency and the need to relay the number of airplane occupants to ARFF responders. Further, the Safety Board believes that the FAA should, in cooperation with the MSCAA and MFD, modify the November 1, 2001, letter of agreement, titled, "Airport Emergency Procedures," to fully describe the protocol to be used for emergency responses, including RMFD ARFF equipment and personnel.

Flight Data Recorder Aileron Update Rate Issues

During its investigation of this accident, the Safety Board observed that the flight data recorder (FDR)-recorded aileron position data was not being updated at the rate required by Federal regulations. The Board's flight data study showed that the data for all four ailerons (inboard and outboard on the right and left wings) were being sampled once per 250 milliseconds (ms), more frequently than required by Federal regulations, but were only being updated at a rate of about once per 700 ms instead of once per 500 ms. The Safety Board has previously issued two related safety recommendations, recommending the following to the FAA:

Require that all Embraer 145, Embraer 135, Canadair CL-600 RJ, Canadair Challenger CL-600, and Fairchild Dornier 328-300 airplanes be modified with a digital flight data recorder system that meets the sampling rate, range, and accuracy requirements specified in 14 *Code of Federal Regulations* 121.344, Appendix M. (A-03-015)

Survey all aircraft required by Federal regulation to have a flight data recorder to ensure that the data recorded meets the rate, range, and accuracy requirements specified in 14 *Code of Federal Regulations* 121.344, Appendix M. (A-03-016)

In an August 11, 2003, letter, the FAA indicated that it was working with the airplane manufacturers and airworthiness authorities involved to address the issues discussed in Safety Recommendation A-03-015 and that it would take appropriate action to correct any deficiencies. With regard to Safety Recommendation A-03-016, the FAA stated that it would ask all airplane manufacturers not addressed in Safety Recommendation A-03-015 to provide FDR design criteria information for obtaining data in accordance with Section 121.344, Appendix M requirements. Upon review of the design criteria, the FAA would identify necessary changes to bring any affected airplanes into compliance. On the basis of the FAA's subsequent response and pending additional action, on January 28, 2004, the Safety Board classified Safety Recommendation A-03-015 "Open—Acceptable Response" and Safety Recommendation A-03-016 "Open—Acceptable Alternate Response."

The FAA is continuing its efforts to assess the FDR design criteria of all airplanes that are required to comply with the parameter requirements specified in Section 121.344, Appendix M. This investigation further demonstrates that FDR sampling problems exist in large, older airplanes (the MD-10 is a DC-10 that has been retrofitted with an advanced-technology flight deck) as well as newly designed, small regional jets.¹² The discovery of improper FDR sampling/update rates in the MD-10 confirms that this issue is likely as widespread as originally believed.

Because in some circumstances, inadequate and/or inaccurate recorded aileron position could adversely affect the Safety Board's ability to identify and address the related safety issues involved in an accident, possibly allowing an unsafe condition to go unrecognized, the Safety Board concludes that the required recorded FDR data on the MD-10 should meet the rate, range, and accuracy requirements specified in 14 CFR Section 121.344, Appendix M. Therefore, the Safety Board reiterates Safety Recommendation A-03-016.

As a result of its investigation of the FedEx flight 647 accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require all 14 *Code of Federal Regulations* Part 121 air carrier operators to establish programs for flight crewmembers who have demonstrated performance deficiencies or experienced failures in the training environment that would require

¹² Safety Recommendations A-03-015 and -016 were issued as a result of improper FDR sampling/update rates observed in newly designed, small regional jets.

a review of their whole performance history at the company and administer additional oversight and training to ensure that performance deficiencies are addressed and corrected. (A-05-014)

Amend the emergency exit training information contained in the flight crew and cabin crew sections in Federal Aviation Administration Order 8400.10, *Air Transportation Aviation Inspector's Handbook*, to make the emergency exit door/slide training described in the flight crew section as comprehensive as the cabin crew emergency training section of the principal operations inspector handbook. (A-05-015)

Verify that all 14 *Code of Federal Regulations* (CFR) Part 121 operators' emergency door/slide trainers are configured to accurately represent the actual airplane exit door/slide and that their flight crew emergency exit door/slide training provides the intended hands-on emergency procedures training as described in 14 CFR 121.417, to include pulling the manual inflation handle. (A-05-016)

Inform all air traffic control tower controllers of the circumstances of this accident, including the need to ensure that aircraft rescue and firefighting (ARFF) vehicles are not delayed without good cause when en route to an emergency and the need to relay the number of airplane occupants to ARFF responders. (A-05-017)

In cooperation with the Memphis/Shelby County Airport Authority and Memphis Fire Department, modify the November 1, 2001, letter of agreement, titled, "Airport Emergency Procedures," to fully describe the protocol to be used for emergency responses, including Rural/Metro Fire Department aircraft rescue and firefighting equipment and personnel. (A-05-018)

In addition, the National Transportation Safety Board reiterates the following recommendation to the Federal Aviation Administration:

Survey all aircraft required by Federal regulation to have a flight data recorder to ensure that the data recorded meets the rate, range, and accuracy requirements specified in 14 *Code of Federal Regulations* 121.344, Appendix M. (A-03-016)

Acting Chairman ROSENKER and Members ENGLEMAN CONNERS, HEALING and HERSMAN concurred in these safety recommendations.

By: Mark V. Rosenker
Acting Chairman