



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 18, 2003

In reply refer to: A-03-22 through -36

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

On February 16, 2000, about 1951 Pacific standard time, Emery Worldwide Airlines, Inc., (Emery) flight 17, a McDonnell Douglas¹ DC-8-71F (DC-8), N8079U, crashed in an automobile salvage yard shortly after takeoff, while attempting to return to Sacramento Mather Airport (MHR), Rancho Cordova, California, for an emergency landing. Emery flight 17 was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 as a scheduled cargo flight from MHR to James M. Cox Dayton International Airport (DAY), Dayton, Ohio. The flight departed MHR about 1949, with two pilots and a flight engineer on board. The three flight crewmembers were killed, and the airplane was destroyed. Night visual meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan.²

The National Transportation Safety Board determined that the probable cause of the accident was a loss of pitch control resulting from the disconnection of the right elevator control tab. The disconnection was caused by the failure to properly secure and inspect the attachment bolt.

The Safety Board reviewed the accident airplane's maintenance history to determine when and where the improper installation of the attachment bolt may have occurred. On the basis of its review, the Safety Board concluded that the bolt attaching the accident airplane's right elevator control tab was improperly secured and inspected, either during the most recent D inspection by Tennessee Technical Services (TTS)³ or during subsequent maintenance by Emery; however, the Board was unable to determine when this improper securement and inspection occurred.

¹ Douglas Aircraft Company and McDonnell Aircraft Company merged in April 1967 and formed the McDonnell Douglas Company. The Boeing Company and McDonnell Douglas merged in August 1997 and operate under the Boeing name. Subsequent references to Boeing as the manufacturer reflect this merger.

² For more detailed information about this accident, see National Transportation Safety Board, *Loss of Pitch Control on Takeoff, Emery Worldwide Airlines, Flight 17, McDonnell Douglas DC-8-71F, N8079U, Rancho Cordova, California, February 16, 2000*, Aircraft Accident Report NTSB/AAR-03/02 (Washington, DC: NTSB, 2003).

³ Emery contracted with TTS to perform a variety of maintenance services.

Preflight Inspection

Emery's procedures required the flight engineer to examine the elevator control surfaces twice during his preflight inspections of the airplane—once with the elevator gust lock engaged and once with the gust lock disengaged. Although it was not possible to determine what position the control tabs were in during the flight engineer's preflight inspection of the airplane, if the right elevator control tab was disconnected when the preflight inspections were conducted, an asymmetry between the right and left control tabs would likely have existed.

Emery's aircraft operating manual (AOM) instructed pilots to check the elevator and tabs for "alignment and condition" and specified "with gust lock off, elevator should be up, control tabs up, and geared tabs down." Although this guidance is accurate, it should more strongly emphasize the importance of pilots ensuring that the right and left side elevators and tabs are deflected symmetrically during the preflight inspection. After the accident, Boeing emphasized flight control symmetry in its June 19, 2001, flight operations bulletin (FOB), which stated the following:

The proper functioning of the flight controls should be verified before every flight. If the exterior walk-around is made...with the gust lock released, the elevators and control tabs should be positioned toward UP (symmetrically), and the geared tabs DOWN (again symmetrically).

The Safety Board concludes that DC-8 operators' procedures and training should more clearly emphasize that DC-8 flight crewmembers need to verify symmetry between the right and left side elevators, control tabs, and geared tabs during the preflight inspection. Therefore, the Safety Board believes that the Federal Aviation Administration (FAA) should require all DC-8 operators to train DC-8 flight crewmembers to look for symmetry between the right and left side elevators, control tabs, and geared tabs during the preflight inspection, consistent with Boeing's June 2001 FOB guidance.

Elevator Checks/Use of the Elevator Position Indicator Gauge

Flight data recorder (FDR) and cockpit voice recorder (CVR) evidence indicates that the pilots attempted to verify elevator movement (presumably using the elevator position indicator [EPI])⁴ during the elevator taxi check. However, the EPI gauge would not have provided the pilots with an indication of a restricted control tab during this check (regardless of the range or direction of control column input).

CVR evidence indicates that the pilots also attempted to verify the elevator's proper operation during the 80-knot elevator check by checking the EPI indication in accordance with Emery's procedures and practices. The flight crew appeared satisfied with the results of the 80-knot elevator check and continued the takeoff roll. However, because the aerodynamic forces

⁴ The DC-8 EPI is a 1-inch diameter circular cockpit gauge with a pointer needle and index markings for UP, DN (down), and NEUT (neutral) positions to indicate the position of the elevators. When the EPI is properly calibrated, the up index mark should correspond to the maximum trailing edge up (TEU) elevator surface position of 27° and the down index mark should correspond to the maximum trailing edge down (TED) elevator surface position of 16.5° TED. A narrow white band adjacent to the NEUT index mark indicates an elevator surface position between 0° and 5° TEU.

acting on the elevator and control tabs would have been significant as the airplane accelerated during the takeoff roll, the abnormal control tab condition would have prevented the elevator from moving to its full trailing edge down (TED) position. Therefore, under the circumstances of this accident, the EPI needle would not have moved below the neutral mark during the 80-knot elevator check, thus providing an indication that the elevator was not fully operational.

Emery's AOM regarding the use of the EPI during the 80-knot elevator check instructed pilots to apply "full forward" control column pressure, then "release slightly forward of neutral...confirm nose DN response...look for EPI to respond to yoke movement." Although the AOM did not explicitly describe the expected EPI indications during the 80-knot elevator check, Emery's AOM guidance for the ground taxi check stated that, with the control columns full forward, the EPI needle "should now point between [neutral] mark and the [down] mark." On an airplane with a properly functioning elevator, a similar indication would be expected during the 80-knot elevator check. AOM guidance to this effect might have been helpful to the pilots because when the accident airplane's EPI needle did not move below the neutral mark, they might have been alerted to the elevator's abnormal operation.

Review of other DC-8 operator's procedures indicated that Emery's guidance regarding EPI usage was among the most thorough in the industry. The AOMs of five of the other six DC-8 operators surveyed⁵ did not mention using the EPI during the 80-knot elevator check.⁶ Postaccident interviews with Emery personnel and FDR data indicate that Emery's pilots used the EPI but only to confirm elevator response in the proper direction. Observation of EPI needle movement below the neutral mark during the 80-knot elevator check would provide a more quantitative determination that the elevator was functioning properly.

The Safety Board found that there is no standardization of EPI guidance and EPI use across DC-8 operators. The 80-knot elevator check provides flight crews with their last chance to detect abnormal elevator performance (which could result from foreign object damage, fractured geared tab arms, mechanical failure [as with the accident flight], and/or damage to components that might have occurred since the earlier elevator checks) before the airplane lifts off the runway. However, the procedures and practices currently in use appear to make minimal use of the EPI's potential as a go/no-go tool during the 80-knot check, resulting in pilots continuing a takeoff with a potentially unsafe elevator condition.

The Safety Board concludes that DC-8 operators, including Emery, do not use the EPI to confirm elevator movement indications above and below the neutral range during the 80-knot elevator check and, thus, do not take full advantage of the EPI's capabilities to provide pilots with an indication of an abnormal elevator condition. Therefore, the Safety Board believes that the FAA should require the development of DC-8 80-knot elevator check procedures that will ensure that pilots are clearly made aware of whether the elevator is functioning properly before the airplane lifts off, then require all DC-8 operators to incorporate these procedures into their training and normal operations. The procedures should contain specific guidance regarding an

⁵ In addition to Emery, there are six other DC-8 operators: Air Transport International, Arrow Air, United Air Lines, Airborne Express, DHL, and United Parcel Service.

⁶ The airworthiness directive (AD) that required DC-8 operators to install the EPI (AD 78-01-15) did not require operators to use the EPI during 80-knot elevator checks.

expected range of EPI needle movement (including EPI needle movement well below the neutral mark with forward control column movement) and specific criteria for aborting a takeoff as a result of an inadequate elevator movement indication.

The Safety Board's review also indicated that there is no ongoing calibration requirement for the EPI gauge/system. Although the Board could not determine the calibration of the accident EPI, it notes that the EPI installed on a test airplane⁷ was not accurately calibrated when the ground tests were performed. The Safety Board concludes that the EPI needs to be periodically calibrated to ensure that it provides the most accurate information possible to the pilots. Therefore, the Safety Board believes that the FAA should require all DC-8 operators to incorporate periodic EPI calibration inspections into their maintenance programs to ensure that the EPI indications observed by pilots accurately represent the condition of the elevator.

Finally, the Board noted that the small (1-inch diameter) EPI gauge was installed in a location on the accident airplane (the lower left side of the first officer's instrument panel) that was not ideally visible for either pilot. The Safety Board concludes that the EPI gauge should be readily visible to both pilots. Therefore, the Safety Board believes that the FAA should require DC-8 EPIs to be located and sized so that they are visible and usable for both the captain and first officer.

Elevator Design Issues

Civil Aviation Regulations (CAR) 4b.320 amendment 4b-3, under which the DC-8 was certificated, stated that "Tab control systems shall be such that disconnection or failure of any element...cannot jeopardize the safety of flight." According to Boeing's submission on this accident, the company and the FAA considered the possibility of a failure of the crank fitting/pushrod attachment during the development and certification of the DC-8; however, subsequent control tab and pushrod end movements, such as those that likely occurred on the accident airplane, and the resultant jam/restricted movement of the control tab were not considered. The submission further stated that Boeing has "begun developing an enhanced design of the control tab pushrod that will prevent the pushrod from dropping or otherwise moving in front of the control tab crank should the bolt migrate out of the connecting joint. The front end of the pushrod is also being reviewed for consequences should it become disconnected."

Boeing also conducted a postaccident review of more than 180 additional attachment points on the DC-8 elevator, aileron, and rudder flight control systems to identify other potentially vulnerable attachments. In a letter to the Safety Board dated May 14, 2003, Boeing stated that its review showed that a disconnection at any of these other attachment points would

⁷ Using an Emery DC-8-71F that was equipped and had been operated similarly to the accident airplane, the Safety Board conducted tests to document the deflections of the test airplane's elevator, control columns, and control tabs (with the right elevator control tab disconnected from its pushrod) while the elevators were moved to duplicate a range of travel consistent with that recorded by the FDR from the accident airplane. The Board also conducted tests to determine the test airplane's EPI indication during elevator checks before taxi, during taxi, and at 80 knots during a simulated takeoff roll to identify what a flight crew might see at various elevator deflections under normal conditions.

result in “minor or no degradation” in the associated system’s operation. Further, Boeing stated that its survey of flight control attachment points on other tab-driven airplanes (including the DC-9, MD-80/90, and 717)⁸ indicated that the DC-8 elevator control tab was the “only tab surface that can pose a loss-of-control disconnect concern.”

The Safety Board concludes that the circumstances of the Emery flight 17 accident show that the current DC-8 design does not preclude a catastrophic result from a disconnection or failure of the existing control tab crank fitting to pushrod attachment. Therefore, the Safety Board believes that the FAA should require Boeing to redesign DC-8 elevator control tab installations and require all DC-8 operators to then retrofit all DC-8 airplanes with these installations such that pilots are able to safely operate the airplane if the control tab becomes disconnected from the pushrod.

Current Federal regulations (14 CFR Section 25.607) require manufacturers of transport-category airplanes to incorporate two separate locking devices at every removable bolt (or other fastener) if the loss of the bolt could result in reduction in pitch, yaw, or roll control capability. The use of dual-locking devices at critical flight control attachments was intended as additional protection against a catastrophic result from disconnection of a flight control. However, airplanes certificated under CAR 4b were not required to incorporate dual-locking devices. The Safety Board concludes that there may be airplanes that were certificated to CAR 4b standards other than the DC-8 on which the disconnection of a critical flight control could have catastrophic results. Therefore, the Safety Board believes that the FAA should evaluate airplanes other than the DC-8 certificated to CAR 4b standards to evaluate whether disconnection or failure of critical flight control systems could have catastrophic results and, if so, require that they also be redesigned and retrofitted and/or equipped with dual-locking devices to preclude such catastrophic results.

Elevator Geared Tab Crank Arm Fractures

During this investigation, the Safety Board reviewed the history of fractured DC-8 geared tab crank arms, which, though not a factor in this accident, have been involved in other elevator jam events over the years. Although AD 78-01-15 required DC-8 operators to modify the clearances for the geared tab crank arms, DC-8 elevator system jams caused by fractured aluminum geared tab crank arms are still occurring. The Board notes that AD 78-01-15 does not require operators to replace the existing aluminum crank arms with forged stainless steel crank arms, as suggested by Douglas in Service Bulletin (SB) 27-262. The SB stated that “replacing the existing aluminum geared tab crank assemblies with forged stainless steel crank assemblies and improving the crank assembly clearance will minimize the possibility of crank failure.”

Stainless steel is stronger than aluminum and the Safety Board is not aware of any fractures of stainless steel DC-8 geared tab crank arms that have occurred in normal operation. In fact, although both elevator geared tab aluminum crank arms on the accident airplane (the inboard crank arms) fractured as a result of the impact forces, the elevator geared tab stainless steel crank arms were twisted but not fractured. Therefore, the Safety Board concludes that replacement of the DC-8 aluminum elevator geared tab crank arms on DC-8 airplanes with

⁸ Boeing’s evaluation of the flight controls on the 707 was ongoing at the time of the letter.

stainless steel elevator geared tab crank arms would likely eliminate the possibility of a jam resulting from fractured geared tab crank arms. Therefore, the Safety Board believes that the FAA should require all DC-8 operators to replace all DC-8 aluminum elevator geared tab crank arms on their DC-8 airplanes with stainless steel elevator geared tab crank arms.

Emery's DC-8 Maintenance Documents and Guidance

Required Inspection Items

The Safety Board notes that Emery's work cards for installation of the right elevator tabs (work card 3502D) and right elevator assembly (work card 3504D) contained specific instructions for verification of proper "installation and security" and that an inspector stamp/signoff was required for these steps. However, Emery's work card 3504D contained another step after the inspector verification of installation and security—"rig [right-hand] elevator [assembly] per DC-8 MM [maintenance manual] chapter 27." Although an inspector stamp/signoff was required for this task and the MM cited inspection of elevator "mechanism rods secure and safetied," there was no discrete work card step requiring an inspector to re-verify the security of attachments after the rigging work was completed. Thus, it is possible that a once-properly secured bolt, which was inspected and signed off during the installation inspection, could be returned to service after the postinstallation rigging process without a properly secured bolt or subsequent inspection.

The Safety Board notes that 14 CFR 121.369[b][2] requires operators to designate "items of maintenance...that must be inspected...including at least those that could result in a failure, malfunction, or defect endangering the safe operation of the airplane, if not performed properly." Although the instructions and steps contained on Emery's DC-8 work card 3504D were consistent with industry standards that have been in use for decades, the Board is concerned that the lack of specificity regarding a postrigging inspection could result in a hazardous condition. As demonstrated in this accident, if a missing securing device at a critical attachment goes undetected, it can have catastrophic consequences. Although the Board did not determine whether the lack of specific information on Emery's work cards was directly related to the improper securement of the bolt in this case, the addition of discrete inspection items, specifically identifying the attachments/fittings to be inspected, could only help ensure the security of this critical flight control⁹ attachment. (The Board is aware of one carrier that included in its maintenance documents a specific "safety check" work card, requiring inspection of all previously installed/assembled/inspected components.)

The Safety Board concludes that DC-8 elevator rigging procedures should be fully addressed in a separate work card that specifically lists required inspection items, including verifying the security of elevator control tab attachments after the rigging is completed. Therefore, the Safety Board believes that the FAA should require all DC-8 operators to create or revise DC-8 work cards to ensure they specifically include a postrigging inspection of the elevator assembly, including verifying the security of elevator control tab attachments.

⁹ The DC-8 elevator control tab is a critical flight control because certain failures of this flight control can be catastrophic.

Because carriers customarily base their maintenance programs on the manufacturer's recommendations, Emery's DC-8 work card 3504D was most likely based on a generic work card originally prepared by the manufacturer as part of an overall recommended DC-8 maintenance program. Therefore, the Safety Board is concerned that other DC-8 work cards based on that set of generic work cards may contain a similar level of detail, or lack thereof. The Safety Board concludes that all DC-8 work cards related to critical flight controls should identify required inspection items as discrete tasks with individual inspection signoff requirements. Therefore, the Safety Board believes that the FAA should require all DC-8 operators to review their work cards related to critical flight controls, and revise them as necessary to ensure that appropriate tasks are identified as discrete tasks with individual inspection signoff requirements.

Emery's B-2 Inspection

The B-2 inspection conducted by Emery between the November 1999 D inspection and the accident included instructions for maintenance personnel to "visually inspect elevators and tabs for general condition, corrosion, leakage, and security of attachment." However, when the control tab fairing is installed, it prevents any visual examination of the control tab crank fitting to pushrod attachment or the inboard hinge fitting, making it impossible to inspect either attachment point for "security of attachment," as called for by the B-2 inspection work card.

During postaccident interviews, Emery maintenance personnel stated that they did not remove the control tab fairing or inspect the crank fitting/pushrod attachment during the B-2 inspection. In public hearing testimony, witnesses from Emery indicated that its B-2 inspection was intended to be a general visual inspection, to be accomplished without removing access or inspection panels or fairings. However, witnesses from TTS stated that, although not specifically listed as a step, removal of the control tab fairing was necessary to satisfactorily perform the tasks described in Emery's B-2 work card. Further, the Safety Board's survey of several other DC-8 operators revealed inconsistent interpretation and application of the work card task regarding the inspection of the elevator and control tab for security of attachment.

Emery's interpretation of its B-2 work card was consistent with Boeing's position that the manufacturer's recommended program work cards "do not call for the removal of the inboard control tab fairing during the B [inspections]. The inboard control tab fairing is not removed until the [heavy maintenance inspection equivalent to Emery's C- and D-inspections]...Therefore, the Emery B-2 inspection work card...would be...an inspection to be accomplished without removing access or inspection panels, fairings, or the like." (Emery performed C inspections about every 2 years and D inspections about every 12 years.)

The Safety Board notes that several air carrier operators have tried to clarify the intended scope of maintenance tasks by including in work cards an enumeration of the actions that are necessary for the proper accomplishment of the associated work task. Although this additional detail on work cards is not required by the FAA, its inclusion should result in more consistent accomplishment of maintenance tasks. The Safety Board concludes that all air carrier operators should provide maintenance personnel with more detailed information regarding the steps or actions that are necessary to satisfactorily accomplish a maintenance task. Therefore, the Safety Board believes that the FAA should require all 14 CFR Part 121 air carrier operators to revise

their task documents and/or work cards to describe explicitly the process to be followed in accomplishing maintenance tasks.

DC-8 MM Information

The information regarding the control tab installation that was in Emery's DC-8 MM and illustrated parts catalog (IPC) in use at the time of this accident did not specify that a cotter pin was required. However, the Safety Board has no evidence that the lack of specific reference to, or depiction of, a cotter pin at this attachment in the DC-8 MM and/or IPC was a factor in this accident. In fact, that information had been used for years with no other known instance of an incorrectly safetied bolt separating. Boeing subsequently improved the related information in its DC-8 MM, revising it to explicitly state that a cotter pin is needed to secure the elevator control tab crank fitting to pushrod attachment. The five primary U.S. operators (that is, those who operate multiple DC-8s) have all adopted this revision in their MMs.

Boeing did not issue a similar revision to the DC-8 IPC because it was not intended to be used as a reference for installation and/or assembly of components; rather, Boeing intended that mechanics use its installation drawings for installation and assembly tasks. However, the Safety Board notes that Emery did not list the manufacturer's installation drawings as a reference to be used in Emery's maintenance program, and Emery did not provide TTS with Boeing's DC-8 installation drawings. In the absence of installation drawings, it is possible that a mechanic would use the IPC as a reference for installation and/or assembly of components. Because the IPC is not required to be updated, the information contained in that document might be incomplete or might not accurately reflect an airplane's configuration. The Safety Board concludes that the use of outdated, incomplete, or otherwise unsuitable reference materials by maintenance personnel during the installation and/or assembly of airplane components can occur and is a potentially unsafe practice. Therefore, the Safety Board believes that the FAA should require all air carrier operators to either: 1) provide all pertinent maintenance personnel with the manufacturer's current installation drawings for pertinent airplanes, update those installation drawings as needed, and require use of those drawings during installation and/or assembly of that airplane's components; or 2) list the IPC on that operator's operation specifications, provide maintenance personnel with up-to-date IPCs for reference, continue to update those IPCs as needed, and require maintenance personnel to use the pertinent updated IPCs during installation and/or assembly of an airplane's components.

FDR-Related Issues

The Safety Board's examination of the data from the accident airplane's FDR (a Loral Fairchild F-800 model) revealed an anomaly with the recorded elevator position data, which complicated this investigation and delayed the Safety Board's recognition of the significance of the elevator movement during the accident sequence. Observing abnormalities in the recorded elevator data, the Board reviewed the data more thoroughly and determined that the elevator's neutral position was not accurately identified during the original correlation. Specifically, the Board noted that an 11° trailing edge up (TEU) adjustment to the elevator conversion value resulted in an elevator position of 0° when the gust lock was engaged.

In compliance with Federal regulations, the accident airplane's FDR was upgraded to record additional parameters (including elevator position) during its most recent heavy

maintenance inspection in November 1999. The accident airplane was the first of Emery's DC-8 fleet to be so upgraded, and a full correlation of the data recorded by the FDR to the actual elevator positions was performed and documented. Given that the total range of elevator travel from the documented data from the accident airplane's original correlation was similar to the elevator's normal operating range and that the recorded travel above and below neutral (when corrected) was consistent with its design, it is apparent that the entire range of elevator travel, including the elevator neutral position, was not accurately identified during the original correlation.

Fortunately, the Board was able to adjust the conversion for use in this investigation; however, the Board's identification of the incorrect elevator conversion delayed a thorough evaluation of the elevator's behavior during the accident and previous flights. This problem could have been identified and corrected at the time of the upgrade if L2 Consulting Services, Inc. (the company that performed the correlation after the upgrade) or Emery had verified that the accident airplane's original correlation reflected the elevator's actual (design) range of travel during the correlation or after the correlation was completed.

The subsequent readout and evaluation of three other Emery DC-8 FDRs (two of which were installed at different times on the Emery DC-8 used in postaccident tests) also indicated problems with the elevator data conversions. According to documentation the Safety Board received from Emery and L2 Consulting Services, Inc., the accident airplane's FDR system was the only FDR system on which a complete correlation of recorded FDR data to actual elevator position was accomplished. The other two airplanes examined were only subjected to a verification test during which the elevator was moved to its neutral, full up, and full down positions,¹⁰ then the measured values from the accident airplane's correlation were applied. Unfortunately, the elevator position correlation for the accident airplane, which was used by Emery for the remainder of its upgraded DC-8 fleet, was incorrect. The Federal Aviation Regulations (FARs) (specifically, Section 121.343[j]) permit the use of a single correlation for airplanes of the same type if they have the same FDR and sensors, presumably because full correlations on similar equipment would be expected to be similar. However, the Board observed significant differences in the conversions required for Emery's DC-8s. The correlation problems observed during this investigation raise concerns about the use of a single correlation for a fleet of airplanes.

The Safety Board's discovery of a shift in the control column range of travel between the time of the original correlation and the accident provides further evidence of inconsistencies with the FDR-to-actual position correlations. Although the shift in control column range of travel did not result in a change to the control column conversion, the Board is concerned about the cause of the shift, which was not determined.

The Safety Board has found that FDR correlation inconsistencies occur more frequently on airplanes manufactured on or before August 18, 2000, that have been retrofitted to record additional parameters (in compliance with Federal regulations). Consequently, the use of a single correlation document for an existing fleet, while permitted by regulation, may be more

¹⁰ These elevator movements were not physically measured; rather, the erroneous correlations from the accident airplane were applied to data obtained from the other two airplanes.

problematic when applied to older airplanes that have been retrofitted to record additional FDR parameters. These difficulties have often resulted in more difficult and time-consuming investigations.¹¹

Because older airplanes with retrofitted FDRs are not required to record as many parameters as newly manufactured airplanes,¹² the loss of data from just one parameter on an older retrofitted airplane can significantly hamper and slow progress in an investigation. Although investigators are often able to estimate the values for the lost or invalid data using data from other parameters and sources of information, this reconstruction of the data takes time and can delay the identification of potentially critical safety issues (and can potentially lead to incorrect conclusions regarding the recorded data). When more recorded data is available during an investigation, it is more likely that investigators will be able to identify critical safety issues early in the investigation and not spend a significant amount of investigative time compensating for lost or unreliable FDR data.

The Safety Board concludes that the use of a single airplane's FDR parameter correlation for all airplanes of the same type is inadequate to ensure accurate correlations for older airplanes that have been retrofitted to record additional FDR parameters. Therefore, the Safety Board believes that the FAA should require operators of airplanes manufactured before August 18, 2000, that have been retrofitted with additional FDR parameters in compliance with Federal requirements and for which an operator maintains a common correlation document for that airplane type to conduct a full correlation of all such airplanes' FDR parameters at the airplanes' next required FDR maintenance inspection to verify accurate FDR system documentation and sensor function.

Additionally, the Safety Board's examination of the transcribed FDR data revealed that the FDR erroneously switched to the first track every time electrical power to the FDR stopped. Thus, the FDR did not record data throughout the length of its 25-hour loop tape (and would not have, unless the FDR was powered nonstop during that 25 hours). Further, because of the track-switching anomaly, the Safety Board had only the most recent 8 hours 11 minutes of elevator data to examine instead of the required 25 hours of recent data. (The remaining data recorded by the FDR was from unidentified previous flights, some of which occurred at least 3 months prior to the accident [before the FDR was upgraded to 17 parameters].) The process of viewing all 25 hours of data recorded on the FDR's six tracks, identifying the locations of track switching, and identifying the data that corresponded to the airplane's most recent operations was time consuming.

The Safety Board has previously observed track-switching anomalies with other F800 model FDRs. The F800 manufacturer, Loral Fairchild,¹³ identified several potential causes of track-switching anomalies and issued three field service bulletins (FSBs) to correct them. Two

¹¹ The Safety Board has issued many related safety recommendations to the FAA to remedy these difficulties throughout the years and has included improvements in on-board recording devices on its list of most wanted safety improvements since 1997.

¹² Airplanes manufactured on or before August 18, 2000, are required to be upgraded as necessary to record 17 parameters (as with the accident airplane) or 34 parameters, while newly manufactured airplanes are required to record 57 or 88 parameters (depending on the date of manufacture).

¹³ Loral Fairchild is now L3 Communications.

of the three FSBs¹⁴ appear to address a condition like that of the accident FDR (serial number 04018, part number 17M303-282). However, according to Emery's records, none of the components of the accident FDR were subject to modifications per any of the FSBs regarding track switching.

The Safety Board considered two possible explanations for the accident airplane's track-switching anomaly: 1) the accident FDR's track-switching condition was a previously unidentified condition for which no remedy had been developed, and therefore none of the FSBs applied, or 2) one or more of the existing FSBs were applicable to the accident FDR, but Emery's paperwork did not reflect installation of the relevant components (whether accomplished or not). Regarding the second scenario, although the FSB's targeted replacement of one or more specific components on a board in the FDR and such component revisions should be marked on the boards, a mechanic could easily remove one board and replace it with another without documenting the components on the replacement board if slight differences exist. Thus, it is possible that one or more of the FSBs designed to address track switching applied to the accident airplane's FDR but this was not indicated in Emery's documentation for that FDR. (The condition of the recorder prevented the Board from physically verifying the components installed on the accident FDR.)

The Safety Board concludes that Loral Fairchild Model F-800 FDRs with unaddressed or unidentified track-switching anomalies may currently be in operation. Therefore, the Safety Board believes that the FAA should require all operators of airplanes equipped with Loral Fairchild Model F-800 FDRs to comply with Loral Fairchild FSBs digital flight recorder (DFR) 011 and DFR 027 for recorders with applicable part numbers and installed component numbers. Further, the Safety Board believes that the FAA should require overhaul facilities that service Loral Fairchild Model F-800 FDRs to monitor those recorders to determine whether abnormal track switching is occurring and to report any such findings to the FAA and the manufacturer.

Drug and Alcohol Testing of Ground Personnel

The FARs require that all employees who perform a "safety-sensitive" function be tested for drugs or alcohol if their performance could have contributed to or could "not be completely discounted as a contributing factor to the accident." Drug testing and alcohol testing are required to be accomplished as soon as possible but no later than 32 and 2 hours after the accident, respectively. However, the ground personnel at MHR who were involved with the accident airplane (including cargo handlers, load planners, and ramp supervisors) were not required to submit to drug or alcohol testing promptly after the accident, in part because the applicable regulations (specifically 14 CFR Part 121, Appendixes I and J) do not define their duties as "safety-sensitive."

Although not required, voluntary drug tests were eventually conducted on eight cargo handlers, a load planner, and the ramp supervisor involved with the accident flight. Samples were taken from the 10 tested employees between 1 and 6 days after the accident; 2 of the 10 employees tested positive for drugs and were subsequently relieved of their duties.

¹⁴ Loral Fairchild FSBs Digital Flight Recorder (DFR) 011 and DFR 027.

Although it was determined that the performance of cargo-handling personnel was not a factor in this accident, improper loading of the airplane's cargo and/or a cargo shift during takeoff have been involved in previous accidents and were considered possibilities during the early stages of this investigation. As evidenced by the history of cargo-related accidents, the way cargo-handling personnel conduct their duties (whether those duties involve the loading of cargo in cargo compartments; the loading/packing of the containers, pallets, and other items for placement within the cargo compartments; or planning the placement of the load) can have a significant effect on the safety of a flight. This potential effect is no less serious than several of the functions that are currently defined as safety-sensitive by the FARs, including aircraft dispatcher duties, ground security coordinator duties, aviation screening duties, and aircraft maintenance or preventive maintenance duties.

Therefore, the Safety Board concludes that the current regulatory definition of safety-sensitive functions is too narrow for the issue of postaccident testing because it does not include cargo handlers, load planners, and ramp supervisors, all of whom have a demonstrated potential to affect the safety of a flight. Therefore, the Safety Board believes that the FAA should modify the list of safety-sensitive functions described in 14 CFR Part 121, Appendixes I and J, to include all personnel with direct access to the airplane and a direct role in the handling of the flight, including cargo handlers, load planners, and ramp supervisors.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require all DC-8 operators to train DC-8 flight crewmembers to look for symmetry between the right and left side elevators, control tabs, and geared tabs during the preflight inspection, consistent with Boeing's June 2001 flight operations bulletin guidance. (A-03-22)

Require the development of DC-8 80-knot elevator check procedures that will ensure that pilots are clearly made aware of whether the elevator is functioning properly before the airplane lifts off, then require all DC-8 operators to incorporate these procedures into their training and normal operations. The procedures should contain specific guidance regarding an expected range of elevator position indicator (EPI) needle movement (including EPI needle movement well below the neutral mark with forward control column movement) and specific criteria for aborting a takeoff as a result of an inadequate elevator movement indication. (A-03-23)

Require all DC-8 operators to incorporate periodic elevator position indicator (EPI) calibration inspections into their maintenance programs to ensure that the EPI indications observed by pilots accurately represent the condition of the elevator. (A-03-24)

Require DC-8 elevator position indicators to be located and sized so that they are visible and usable for both the captain and first officer. (A-03-25)

Require Boeing to redesign DC-8 elevator control tab installations and require all DC-8 operators to then retrofit all DC-8 airplanes with these installations such that pilots are able to safely operate the airplane if the control tab becomes disconnected from the pushrod. (A-03-26)

Evaluate airplanes other than the DC-8 certificated to Civil Aviation Regulations 4b standards to evaluate whether disconnection or failure of critical flight control systems could have catastrophic results and, if so, require that they also be redesigned and retrofitted and/or equipped with dual-locking devices to preclude such catastrophic results. (A-03-27)

Require all DC-8 operators to replace all DC-8 aluminum elevator geared tab crank arms on their DC-8 airplanes with stainless steel elevator geared tab crank arms. (A-03-28)

Require all DC-8 operators to create or revise DC-8 work cards to ensure they specifically include a postrigging inspection of the elevator assembly, including verifying the security of elevator control tab attachments. (A-03-29)

Require all DC-8 operators to review their work cards related to critical flight controls, and revise them as necessary to ensure that appropriate tasks are identified as discrete tasks with individual inspection signoff requirements. (A-03-30)

Require all 14 CFR Part 121 air carrier operators to revise their task documents and/or work cards to describe explicitly the process to be followed in accomplishing maintenance tasks. (A-03-31)

Require all air carrier operators to either: 1) provide all pertinent maintenance personnel with the manufacturer's current installation drawings for pertinent airplanes, update those installation drawings as needed, and require use of those drawings during installation and/or assembly of that airplane's components; or 2) list the IPC on that operator's operation specifications, provide maintenance personnel with up-to-date IPCs for reference, continue to update those IPCs as needed, and require maintenance personnel to use the pertinent updated IPCs during installation and/or assembly of an airplane's components. (A-03-32)

Require operators of airplanes manufactured before August 18, 2000, that have been retrofitted with additional flight data recorder (FDR) parameters in compliance with Federal requirements and for which an operator maintains a common correlation document for that airplane type to conduct a full correlation of all such airplanes' FDR parameters at the airplanes' next required FDR maintenance inspection to verify accurate FDR system documentation and sensor function. (A-03-33)

Require all operators of airplanes equipped with Loral Fairchild Model F-800 flight data recorders to comply with Loral Fairchild Field Service Bulletins digital flight recorder (DFR) 011 and DFR 027 for recorders with applicable part numbers and installed component numbers. (A-03-34)

Require overhaul facilities that service Loral Fairchild Model F-800 flight data recorders to monitor those recorders to determine whether abnormal track switching is occurring and to report any such findings to the Federal Aviation Administration and the manufacturer. (A-03-35)

Modify the list of safety-sensitive functions described in 14 *Code of Federal Regulations* Part 121, Appendixes I and J, to include all personnel with direct access to the airplane and a direct role in the handling of the flight, including cargo handlers, load planners, and ramp supervisors. (A-03-36)

Chairman ENGLEMAN, Vice Chairman ROSENKER, and Members CARMODY, GOGLIA, and HEALING concurred in these recommendations.

Original Signed

By: Ellen G. Engleman
Chairman