Log 2546

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: March 6, 1995

In reply refer to: A-95-18 through -23

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On March 2, 1994, about 1759:46 eastern standard time (est), Continental Airlines flight 795 (COA flight 795), a McDonnell Douglas MD-82, registration N18835, sustained substantial damage when the captain rejected the takeoff from runway 13 at LaGuardia Airport, Flushing, New York. The airplane continued beyond the takeoff end of runway 13 and came to rest on the main gear wheels with the nose pitched downward, so that the fuselage was balanced on top of a dike. The underside of the nose lay on a tidal mud flat of Flushing Bay. There were 110 passengers, 2 flightcrew members and 4 flight attendants aboard the airplane. There were no fatalities, and no serious injuries were reported. There were 29 minor injuries to passengers, all of which were sustained during the evacuation, and 1 minor injury to a flightcrew member. There was no postcrash fire.[1]

The National Transportation Safety Board has determined that the probable causes of this accident were the failure of the flightcrew to comply with checklist procedures to turn on an operable pitot/static heat system, resulting in ice and/or snow blockage of the pitot tubes that produced erroneous airspeed indications, and the flightcrew's untimely response to anomalous airspeed indications with the consequent rejection of takeoff at an actual speed of 5 knots above V1.

[1]For more detailed information, read Aircraft Accident Report–"Runway Overrun Following Rejected Takeoff, Continental Airlines Flight 795, McDonnell Douglas MD-82, N18835, LaGuardia Airport, Flushing, New York, March 2, 1994" (NTSB/AAR-95/01)

In this accident, the Safety Board believes that the flightcrew deviated significantly from standard operating procedures. Specifically, the flightcrew delayed starting the second engine, which was contrary to a COA requirement to taxi on two engines during conditions that require the use of engine anti-ice. This deviation contributed to the flightcrew being rushed during final preparations for takeoff. They also failed to use the Delayed Engine Start Checklist, missed items on several other checklists, and did not call checklists complete.

Prior to taking the runway, the first officer conducted a visual inspection of the wing, and the captain conducted a rejected takeoff (RTO) briefing. The flightcrew appears to have initially conducted the takeoff in a proper manner. The first officer was controlling the airplane, and the captain was performing the duties of the nonflying pilot, such as setting the power, and monitoring engine instruments and airspeed.

The rejected takeoff was not initiated until 34 seconds after the start of the takeoff roll after the airplane had traveled nearly 3,600 feet. The normal time to achieve 60 knots would have been 14 seconds with about 600 feet of roll. The airspeed indicator's needle apparently was not moving for nearly 20 seconds before the takeoff was rejected. The Safety Board believes that if the captain had been monitoring the airspeed adequately, he would have noted and reacted to the discrepant airspeed indication sooner.

The Safety Board considered the possibility that this accident could have been prevented if the airplane had been equipped with a takeoff performance monitoring system or the flightcrew had been required to use takeoff performance monitoring procedures. Although the subject of takeoff performance monitoring techniques and equipment has been of repeated interest, the concept has not been adopted by the air carrier industry.

As a result of previous takeoff accidents and studies, the Safety Board has supported the development of a reliable takeoff acceleration monitoring system. The purpose of the system, as envisioned, is to detect subnormal acceleration, which could be caused by such factors as degraded engine performance, dragging wheel brakes, underinflated tires or runway contamination, early enough in the takeoff roll to initiate a rejected takeoff at a relatively low speed with sufficient runway remaining to bring the airplane to a safe stop. Several such systems have been developed and tested. However, the industry continues to believe that the complexity of design and the many variables involved in takeoff performance could

affect system reliability and lead to unnecessary RTOs with their associated risk. Most of the systems that have been developed to date are based on the measurement of the airplane's inertial acceleration and the comparison of these data with theoretical values for the existing conditions.

In this accident, the airplane accelerated normally during the takeoff roll, albeit the airspeed indication was reading erroneously. Thus, unless the performance monitoring system incorporated airspeed measurement in its alerting logic, it is questionable whether such a system would have been effective in preventing this accident. It is more likely that the flightcrew would have been confused by the abnormal airspeed indication regardless of the status of an on board takeoff performance monitoring system.

The Safety Board believes, however, that a more simple takeoff procedure, similar to that used by some military pilots, would have been effective in prompting an RTO before the airplane accelerated to a speed above V1. This procedure involves a crosscheck of elapsed time and airspeed or a crosscheck of distance traveled and airspeed, the latter being contingent upon the availability of runway distance remaining markers, which are not yet a requirement for airports used by air carrier airplanes. Basically, the flightcrew must use operational data to predetermine the theoretical airspeed that the airplane will reach within a given time or distance for the existing takeoff conditions. The nonflying pilot is then required to ascertain that the airplane has reached the target airspeed at the corresponding time or distance.

The Safety Board is encouraged by recent improvements by the aviation industry in RTO safety training that have been implemented by COA and other air carriers. However, the Board believes that RTO accident experience indicates a continuing need to provide flightcrews with a better means to verify acceleration during takeoff. Moreover, the Safety Board believes that this need could be met through procedural changes that incorporate currently available aircraft performance information.

Manufacturers of turbojet airplanes routinely develop acceleration data as a function of time during the certification process. These data could be reformatted to provide elapsed time values to target speeds, and made available as part of the airplane's performance data for use by flightcrews to verify acceleration during takeoff. Accordingly, the Safety Board believes that the Federal Aviation Administration (FAA) should require the manufacturers of transport category

airplanes to publish and distribute to operators of these airplanes specific elapsed times to target speeds, under normal acceleration, over the range of authorized operational conditions. Moreover, the FAA should require that the use of this information be incorporated as part of the takeoff performance data available to air carrier flightcrews. Finally, the FAA should require that this takeoff performance data be incorporated into all air carrier RTO training programs.

The pitot tubes of the MD-80 have a small hole behind the inlet that serves as a drain for water entering the inlet. If the inlet becomes clogged, and the drain hole remains open, the pressure sensed by the pitot system will equalize with the ambient static pressure so that the airspeed indication will return to zero.

Total air temperature data recorded on the flight data recorder (FDR) indicated that the airplane's ram air temperature probe heating was not initiated after the airplane's air/ground system switched from "ground" to "air," when the nose landing gear collapsed at the end of the runway. This information confirms that the pitot heat was not selected "on" by the flightcrew.

Extensive postaccident systems testing of the airplane found that the pitot/static (air data) heating and related airspeed indication systems were capable of fully functioning, if they were activated.

A buildup of snow and/or ice in the pitot/static system tubes and ports resulted in erroneous airspeed readings for the captain's and first officer's airspeed indicators during the takeoff/abort sequence. The captain observed that both his and the first officer's airspeed indicators showed similar readings, and the FDR data recorded from the first officer's airspeed indicator confirmed this observation. Because the captain's and first officer's systems are completely independent of each other (different pitot tubes), it is evident that the inlets to both pitot tubes closed at about the same time, an occurrence consistent with the buildup of ice at the inlets. Also, ambient conditions were conducive to the pitot inlet icing.

The Safety Board believes that the activation of pitot/static and other air data heating systems should be automatic and should not require flightcrew actions. There have been many accidents because of frozen pitot/static systems over the years in various model airplanes, including transport category airplanes. The reasons for these accidents have always involved the lack of proper flightcrew actions. Many modern airplanes have automatic systems to activate the pitot/static heating systems. The Safety Board believes that current technology could be used

to install such automatic systems on transport category airplanes to remove the possibility of flightcrew errors. Similarly, 14 Code of Federal Regulations Part 25.1323 (e) should be amended to require such systems on newly certificated airplanes.

The investigation of this accident was hampered by the lack of cockpit voice recorder (CVR) information covering the time that the flightcrew would have been expected to perform the "Before Pushback/Before Start" checklist. Investigators had no documented evidence concerning how or if the flightcrew performed the "Before Pushback/Before Start" checklist, and they had to rely entirely on the flightcrew's recollection.

The FDR and CVR information, in conjunction with other physical evidence and extensive postaccident testing, has proved conclusively that the pitot/static heat system was serviceable but that it was not turned "on" prior to the start of the takeoff roll. However, there was no recorded evidence as to why the pitot/static heat was not selected.

Over the years, the Safety Board has investigated several accidents and incidents in which vital CVR information has been written over and lost because of the 30 minute recording limitation. The Safety Board has recognized the advantages of an extended duration CVR in certain accidents and especially in incidents. However, until recently, the costs and technical difficulties precluded the feasibility of such recorders.

The availability of low cost, high density memory devices has made it possible for flight recorder manufacturers to offer 2 hour solid state CVRs (SSCVRs) that cost only 10 to 15 percent more than comparable 30 minute SSCVRs. Thus, 2 hour CVRs are now technically and economically feasible.

The international community has also recognized the need for 2 hour CVRs. The International Civil Aviation Organization (ICAO) and the European Joint Aviation Authorities (JAA) have both taken positions favoring 2 hour CVRs. In April 1992, the JAA issued a draft revision to require the forward fit of 2 hour CVRs. The draft is scheduled to be adopted in March of 1995. ICAO Annex 6 Part 1 recommends a 2 hour CVR for airplanes over 5,700 kilograms with an individual certificate of airworthiness issued after January 1, 1990.

Accordingly, the Safety Board believes that after December 31, 1995, all newly manufactured airplanes, and all airplanes brought into compliance with operating rules

that require a CVR, should be required to have a 2 hour CVR. In addition, 30 minute CVRs that have reached the end of their service life should be replaced with 2 hour CVRs.

The investigation revealed some disturbing information concerning the emergency evacuation following the accident. For example, the flightcrew failed to shut down the engines before the captain issued instructions to evacuate. His instructions were perceived by flight attendants and passengers as ambiguous and confusing.

The flightcrew performed the shutdown procedures when they were told to do so by a firefighter who had entered the cabin at the L-1 exit. During the shutdown procedure, the crew turned off the emergency lighting system, preventing the cabin emergency lights and the floor proximity lights from illuminating when the engines were shut down.

The flight attendants did not demonstrate assertiveness prior to and during the evacuation. For example, the cockpit was never queried on the extent of the situation before the captain ordered the evacuation some 55 seconds after the airplane came to rest. Moreover, the flight attendants did not climb onto passenger seats and shout commands to direct passengers to useable exits to maximize the egress process known as "flow control." While these procedures are contained in the COA flight attendant emergency procedures manual, they are not practiced during recurrent training sessions. Therefore, it is not surprising that they were not followed during this evacuation.

The Safety Board's special investigation of flight attendant training programs at 12 air carriers examined the ability of flight attendants to perform appropriately during in-flight emergencies and during postaccident emergency evacuations.[2] Several flaws, inconsistencies, and shortcomings were found with both initial and recurrent FAA-approved training programs that affect flight attendant behavior during emergency situations, some of which were found in this accident.

The Safety Board's special investigation resulted in 13 safety recommendations to the FAA which addressed such diverse topics as: the lack of guidance given to principal operations inspectors regarding flight attendant training

[2]See "Special Investigation Report, Flight Attendant Training and Performance During Emergency Situations," NTSB/SIR-92/02, June 9, 1992.

programs; the ability of flight attendants to retain information about the emergency equipment and procedures for the several airplanes in which they must be qualified; the fidelity of training devices; the need for cockpit and cabincrews to train together to develop the skills to communicate and coordinate effectively during emergency situations; and the need for realistic and interactive scenarios to practice emergency procedures.

In that special investigation, the Safety Board found:

> Emergency situations typically require quick, assertive, and decisive action with little time for analysis of the situation. For most flight attendants, the only opportunity to practice skills needed in an emergency is during initial and recurrent training. These skills are perishable, and continuing and effective training is essential for maintaining them.

Safety Recommendation A-92-74 asked the FAA to require an evacuation and/or wet ditching drill group exercise during recurrent training. The Safety Board believed that exercises having participation by both cockpit and cabincrews would be especially beneficial for crewmembers who operate airplanes with two-person cockpit crews.

The FAA did not agree that the Federal Aviation Regulations need to be amended because it believes that current training is adequate. Nonetheless, it requested that the Aviation Regulation Advisory Committee (ARAC), Subcommittee on Training and Qualifications, examine the possibility of improving training. The Safety Board classified the FAA's response to this safety recommendation "Open--Acceptable Alternate Response" on June 8, 1993. No further correspondence has been received from the FAA on this recommendation.

Safety Recommendation A-92-77 asked the FAA to require that flight attendants receive crew resource management (CRM) training that includes group exercises to improve flightcrew and cabincrew coordination and communication.

The FAA agreed with the intent of the recommendation and asked the ARAC's Subcommittee on Training and Qualifications to develop an advisory circular on CRM that includes flight attendants. The Safety Board classified the FAA's response to this safety recommendation "Open--Acceptable Response" on

June 8, 1993. No further correspondence has been received from the FAA on this recommendation.

Nevertheless, the Board is aware that on December 8, 1994, the FAA issued a Notice of Proposed Rulemaking (NPRM) that proposes to revise the training and qualification requirements for certain air carriers and commercial operators. If this NPRM becomes a final rule, these operators will be required to provide approved CRM training not only to flight crewmembers but to their flight attendants, as well as to aircraft dispatchers.

Therefore, as a result of its investigation of this accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require manufacturers of airplanes operated by air carriers to publish and distribute to operators specific elapsed times to target speeds (given normal acceleration, the times to given airspeeds). (Class II, Priority) (A-95-18)
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> Require that the elapsed times to target speeds be incorporated as part of the takeoff performance data available to air carrier flightcrews. (Class II, Priority) (A-95-19)
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> Require that air carrier rejected takeoff training include elapsed time to target speed takeoff performance data. (Class II, Priority) (A-95-20)
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> Require the modification of transport category airplanes to incorporate the automatic activation of air data sensor heating systems without flightcrew action. (Class II, Priority) (A-95-21)
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> Amend the requirements of Part 25.1323 (e) to require that, for newly certificated airplanes, anti-ice protection for the air data sensor heating systems is provided automatically (without flightcrew action) following engine start. (Class II, Priority Action) (A-95-22)
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> Require, after December 31, 1995, that all newly manufactured cockpit voice recorders intended for use on airplanes have a

minimum recording duration of 2 hours. (Class II, Priority Action) (A-95-23)

Also, the Safety Board issued Safety Recommendation A-95-24 to Continental Airlines, Inc.

In addition, as a result of its investigation of this accident, the National Transportation Safety Board reiterates Safety Recommendations A-92-74 and A-92-77 to the Federal Aviation Administration:

A-92-74
Amend 14 CFR Part 121.417 to require an evacuation and/or wet ditching drill group exercise during recurrent training. Ensure that all reasonable attempts are made to conduct joint flightcrew/flight attendant drills, especially for crewmembers operating on airplanes with two-person cockpit crews.

A-92-77
Require that flight attendants receive Crew Resource Management training that includes group exercises in order to improve crewmember coordination and communication.

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in these recommendations.

By: Jim Hall
Chairman