National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation Log 2105C

Date: November 3, 1988

In reply refer to: A-88-145 and -146

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On November 15, 1987, Continental Airlines, Inc., flight 1713, a McDonnell Douglas DC-9-14, N626TX, was operating as a regularly scheduled, passenger-carrying flight between Denver, Colorado, and Boise, Idaho. The airplane was cleared to take off following a delay of approximately 27 minutes after deicing. The takeoff roll was uneventful, but following a rapid rotation, the airplane crashed off the right side of runway 35 left. Both pilots, 1 flight attendant, and 25 passengers sustained fatal injuries. Two flight attendants and 52 passengers survived.[1]

The Safety Board is concerned that Continental's background check of the first officer did not reveal he had been discharged by a previous employer because of an inability to pass a flying check ride. Contrary to fact, the background check characterized the first officer's work as "very good" and went on to state that he left that company on his own accord. The Board believes that had Continental been aware of the first officer's employment background it would have had the option of not hiring him in the first place or of emphasizing areas in his DC-9 training where he had previously demonstrated weakness. Therefore, the Board believes that Continental should implement procedures to conduct substantive background checks of pilot applications which include verification of personal flight records and examination of training, performance, and disciplinary records of previous employers and Federal Aviation Administration safety and enforcement records.

The Safety Board believes that ice contamination that formed on flight 1713 during the 27 minutes it waited to depart Denver was sufficient to raise the stall speed of the airplane and compromise its stability and the pilot's ability to maintain control. At the Safety Board's public hearing on the accident, a representative from McDonnell Douglas stated that small amounts of upper wing ice may severely degrade the lifting capability of the wing and lead to loss of roll and pitch control on DC-9-10 series airplanes. He concluded that the DC-9-10 series and other airplanes, with and without leading edge slats, would be affected to varying degrees by small

[1]For more detailed information, read Aircraft Accident Report--*Continental Airlines, Inc., Flight 1713 McDonnell Douglas DC-9-14, N626TX, Stapleton International Airport, Denver, Colorado, November 15, 1987* (NTSB/AAR-88/09)

amounts of upper wing ice contamination. For example, granular ice of only 0.030 inch (similar to the roughness of 30-40 grit sandpaper) would degrade the maximum lifting capability of the DC-9 wing by about 20 percent. For a given increase in angle of attack, an ice-contaminated wing would have a lesser increase of lift than would an ice-free wing. The stall speed would increase and the stall angle of attack would decrease, possibly to the point that the stall warning indicator (receiving its signals from angle of attack sensors, not airspeed sensors) would not activate before stall. Indeed, in the case of flight 1713, no stick shaker was heard on the cockpit voice recorder (CVR) tape, although the airplane was in the stall regime before impact. In addition, if less-than-normal lift is available during the takeoff pitch rotation, the airplane may not be able to leave the ground either when expected or in a stable manner. In any case, the stall safety margin is significantly reduced.

Ice contamination also may produce roll oscillations and unexpected pitch-up tendencies during flight. Ice accumulations usually are not uniform and result in nonuniform lift degradations on the wings, horizontal tail, and, to a small degree, the fuselage. For example, a small section of ice on an otherwise contaminant-free wing or a small section of rougher ice on a contaminated wing may be the first area on the wing to stall or produce less-than-normal lift. This uneven lift may result in the onset of roll, followed by pilot-initiated counter aileron and spoiler deflections which can quickly set up roll oscillations. On swept-wing airplanes, contaminated outboard wing areas also can produce unexpected pitch-up tendencies because the outboard wing areas are usually behind the center of gravity of the airplane. When the wingtips stall, the inboard parts of the wings (ahead of the center of gravity) produce proportionally more lift and the nose pitches up. However, the greater-than-normal pitch rate on flight 1713 was present during initial rotation (when the wings were unloaded) indicating that the high pitch rate was pilot-induced. Ice-induced pitch rates, on the other hand, result from loaded wings that just reach the localized stall angle of attack. The Safety Board is not aware of any service history or pilot reports describing DC-9-10 series ice-induced pitch-up tendencies.

The small amount of ice on the wings of the airplane contributed to significant controllability problems on flight 1713. Safety Board calculations show that a stall could have occurred on the accident airplane at 165 knots calibrated airspeed with 1.4 Gs on the airframe if there had been about a 20 percent reduction in maximum lifting capability. Flight 1713's maximum airspeed of about 165 knots was recorded on the flight data recorder simultaneously with 1.4 Gs. At almost exactly the same time, an exclamation from a crewmember was recorded on the CVR. A 20-percent reduction in lift would have resulted from 0.03 inch of ice, which the Safety Board believes is at least the amount that could have accumulated in 27 minutes. Therefore, the Safety Board concludes that the accident was precipitated by the captain's failure to return for a second deicing after the extensive delay before takeoff because the upper wing surface contamination that existed was sufficient to cause the loss of control during the takeoff attempt.

Although the captain was an experienced pilot with apparently better-than-average flying skills, he was relatively inexperienced as a captain on air carrier turbojet airplanes, and he had very little total flying time in the DC-9. He was not seasoned in either the supervision or judgment of first officers, nor was he familiar with the unique characteristics of the DC-9-10 series airplane in icing conditions. Although he was taught about DC-9 cold weather operations during his ground training and simulator sessions, he had never actually encountered ground icing conditions in a DC-9 before the accident. Also, he did not understand the intent of the company procedures concerning taxi from the gate through the deice pad and on

to the runup pad. His failure to contact ground control for clearance to taxi to the deice pad precipitated a series of events that caused a portion of the 27-minute delay between deicing and takeoff.

Company procedures also required the captain to inspect the airplane if the takeoff is delayed for more than 20 minutes after deicing. The captain did not examine the wings or cause the wings to be examined even after 27 minutes had elapsed. Although there was no intercockpit discussion of this requirement, a comment about increasing engine power momentarily for engine anti-ice capability indicated that he was aware of the elapsed time since engine start and was aware of the need to increase engine power periodically to improve engine anti-icing airflow during icing conditions on the ground. Unfortunately, he appears to have linked icing conditions on the ground with optimum engine operation rather than optimum airfoil effectiveness. It is possible that the captain thought that since they were ready to take off approximately 20 minutes after deicing, a return to the deicing pad for more deicing was not necessary, in spite of the unanticipated additional delay of about 7 minutes.

Therefore, as a result of its investigation, the National Transportation Safety Board recommends that Continental Airlines, Inc.:

> Implement procedures to conduct substantive background checks of pilot applicants which include verification of personal flight records and examination of training, performance, and disciplinary records of previous employers and Federal Aviation Administration safety and enforcement records. (Class II, Priority Action) (A-88-145)
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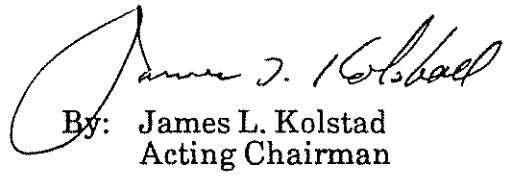
> Implement company procedures to monitor ground movements of aircraft at Denver Stapleton International Airport during periods of adverse weather when deicing operations are underway, and meter the release of company airplanes from the deicing facility to eliminate excessive delays following deicing. (Class II, Priority Action) (A-88-146)

Also, as a result of its investigation, the Safety Board issued Safety Recommendations A-88-134 through 142 to the Federal Aviation Administration, A-88-143 to the National Fire Protection Association, and A-88-144 to the American Association of Airport Executives and the Airport Operators Council International.

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.



By: James L. Kolstad
Acting Chairman