National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 4, 2006

In reply refer to: A-06-42
Reiterate A-03-52

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

On November 28, 2004, a Canadair, Ltd., CL-600-2A12, operated by Air Castle Corporation doing business as Global Aviation Glo-Air flight 73, crashed into the ground during attempted takeoff in snowing conditions at Montrose Regional Airport (MTJ), Montrose, Colorado. Before the accident flight, the airplane had arrived at MTJ from Van Nuys, California. The airplane remained parked at MTJ for about 45 minutes while wet snow fell in subfreezing temperatures, and the airplane was not deiced before takeoff. The captain, the flight attendant, and one passenger were killed; the first officer and two passengers received serious injuries; and the airplane was destroyed by impact forces and a postcrash fire. The on-demand charter flight was operated under the provisions of 14 *Code of Federal Regulations* (CFR) Part 135.

The National Transportation Safety Board determined that the probable cause of this accident was "the flight crew's failure to ensure that the airplane's wings were free of ice or snow contamination that accumulated while the airplane was on the ground, which resulted in an attempted takeoff with upper wing contamination that induced the subsequent stall and collision with the ground. A factor contributing to the accident was the pilots' lack of experience flying during winter weather conditions." Numerous issues related to the pilots' failure to recognize the seriousness of winter weather hazards, as well as their inadequate crew resource management (CRM), were discussed in the report. Of particular concern to the Safety Board is that a qualified 14 CFR Part 135 captain and first officer, both of whom received winter weather operations training in accordance with the company's Federal Aviation Administration (FAA)-approved winter operations procedures, could fail to understand the insidious nature of upper wing surface contamination and its threat to the safety of the flight. Further, proper CRM could have helped the crew identify the risks associated with winter weather operations.

Ground-Icing Hazards Training

Air Castle's winter operations program was approved under 14 CFR Part 121 standards, and the company provided instruction regarding winter operations to the captain and the first officer during their initial company training within the previous 7 months and 3 months, respectively, before the accident. The training addressed the types and characteristics of deicing/anti-icing fluids; the use of holdover times when using deicing/anti-icing fluids;

deicing/anti-icing procedures, including inspection and check procedures and responsibilities; surface contamination, critical area identification, and knowledge of how the adherence of frost, ice, or snow adversely affects performance and flight characteristics; cold weather preflight inspection procedures; and techniques for recognizing contamination.

Moreover, the captain was an experienced airline transport pilot with about 12,400 total flight hours, which included 10,900 hours as pilot-in-command, 5,600 hours in turbine-powered airplanes, and 900 hours in Canadair CL-600-series airplanes. The first officer also held an airline transport pilot certificate. Yet neither the captain nor the first officer had any significant experience flying in winter weather conditions and likely gained the knowledge they had about such conditions during training only. Although the airplane's cockpit voice recorder captured that the captain and the first officer agreed that the airplane's wings appeared "clear," witness accounts of their preflight examination of the airplane (during which neither crewmember requested deicing services or appeared to check the airplane's wings) and of the apparently visible upper wing surface contamination, show that the captain and the first officer either failed to recognize the presence of the contamination or did not appreciate the potential consequences of such contamination. In either case, their lack of vigilance during the snowing conditions clearly shows that their training was not effective in conveying that even a small amount of frost or ice accumulation could result in a significant degradation of airplane performance.

The accident flight crew was not alone in failing to fully recognize the hazard that winter precipitation presents. There appears to be a continued lack of understanding among members of the pilot community as to the insidious nature of even small amounts of ice and snow accumulation. Shortly after this accident, for example, newspapers reported that a pilot, who was also the "president of…a worldwide charter aircraft referral service, said the Challenger's engines were so powerful that it could have taken off even with icy wings. 'The extra weight of ice and snow shouldn't have made a difference, it should have been able to bully its way through,' he said."[1]

The belief indicated in these statements—that ice and snow adherence affects only the weight of the airplane and that some airplanes' engines can compensate for the additional weight—demonstrates a fundamental misunderstanding of the aerodynamic penalties of upper wing surface contamination and highlights the misconceptions still present among some pilots regarding the hazardous aerodynamic effect of small amounts of upper wing ice. Concerned about these misconceptions, the Safety Board issued a document, titled "Alert to Pilots: Wing Upper Surface Ice Accumulation," on December 19, 2004, followed by an aircraft icing safety alert, which emphasized to pilots that small, almost visually imperceptible amounts of ice accumulation on the upper surface of a wing can cause the same aerodynamic penalties as much larger (and more visible) ice accumulations.

The aircraft icing safety alert has proven to be one of the most popular informational items on the Safety Board's Web site (the alert has received nearly 600 hits per month since it was posted), demonstrating that today's media and training aids provide an opportunity to go beyond just teaching about icing in a manual. Improved training to better educate pilots about

[1] D. Kelly, "Pilot of Ebersol Jet Didn't Order Wings De-Iced," *Los Angeles Times*, December 1, 2004: A26. The article was also posted and reprinted by other news sources.

icing hazards must continue to be explored, and demonstrating to flight crews what contamination "looks like and feels like"[2] would be an even more effective means of ensuring that pilots really understand the insidious nature of ice and snow accumulation. For example, high-resolution photographs, videos, interactive animations, and other training materials have been developed by the National Aeronautics and Space Administration, some of which can be accessed over the Internet. Moreover, Bombardier Aerospace and other airplane manufacturers have developed DVD-based training programs regarding ground-icing hazards that are disseminated to the operators of the respective aircraft.

The Safety Board considers these types of visual materials capable of accurately depicting the small amounts of upper wing surface contamination that can be detrimental to flight. Such depictions are important tools in assisting pilots in recognizing that even almost-imperceptible amounts of ground ice on an upper wing surface can be deadly. The value of these visual materials would be improved if they were supplemented with tactile training aids that simulate the size, texture, and other characteristics of the minute levels of contamination that can prevent an airplane from achieving lift. Such tactile simulations of hazardous ice contamination, which can be as sparse as the equivalent of a grain of salt per square centimeter over the upper surface of a wing, would enhance pilots' understanding of these hazards and allow them to practice tactile techniques to detect the hazards during actual operations. Therefore, the Safety Board believes that the FAA should develop visual and tactile training aids to accurately depict small amounts of upper wing surface contamination and require all commercial airplane operators to incorporate these training aids into their initial and recurrent training.

Crew Resource Management Training

Although the accident flight crew had no winter weather operating experience, Federal regulations and company procedures were available to the crew that could have guided any professional flight crew on how to properly address the winter weather challenges and achieve a safe takeoff in the conditions that existed. The accident flight crew, however, failed to follow these procedures. The Safety Board is concerned that the captain failed to provide a complete takeoff briefing that would have coordinated the crew's recognition of winter weather hazards affecting the flight and focused and coordinated the crew's actions to address these hazards. The Safety Board is also concerned that the captain's decision-making with regard to airplane performance limitations, as well as the first officer's failure to challenge the captain's decisions, were in direct conflict with company procedures, Federal regulations, and airplane performance limitations.

[2] On March 18, 1993, the Safety Board issued Safety Recommendation A-93-21, recommending that the FAA require that flight crew and appropriate ground personnel responsible for the inspection of transport-category airplanes for wing contamination receive specific, periodic training that will "illustrate what contamination looks like and feels like on a wing." In response, the FAA developed Advisory Circular (AC) AC-120-60 (the current revision of which is AC-120-60B), and the Board classified the recommendation "Closed—Acceptable Action" on May 20, 1994.

For example, according to Air Castle procedures, a takeoff briefing should iterate, among other things, the type of takeoff to be performed, the engine bleed air system configuration, and runway contamination. Also, according to Air Castle procedures and the requirements of 14 CFR 135.227, a pretakeoff contamination check must be completed within 5 minutes before takeoff any time the conditions are such that contamination might reasonably be expected to adhere to the airplane. About 16 minutes before takeoff, the captain and the first officer agreed that the airplane's wings appeared "clear," but they did not comply with the company and FAA requirements regarding a pretakeoff contamination check.

The flight crew also failed to recognize that the presence of runway contamination, such as slush or snow, would affect the airplane's performance limitations and would increase the runway takeoff distance required.[3] Both Air Castle procedures and the airplane's FAA-approved airplane flight manual (AFM) required that, when runway contamination was present, flight crews must consult the performance planning tables that were specific to contaminated runway operations. The captain and the first officer failed to do so and instead consulted the performance planning tables for the dry runway condition.[4] Although the investigation determined that the flight crew's failure to use the performance planning tables for contaminated runways was not related to the probable cause of the accident, this failure does serve to further illustrate the CRM shortcomings of this crew.

Also, in direct conflict with the procedures outlined in the AFM, the captain and the first officer improperly manipulated the airplane's takeoff configuration to take off from a runway that, if the airplane had been properly configured, would not have been long enough to meet the runway takeoff length requirements. For example, the captain had initially planned to take off from a 10,000-foot runway based on the first officer's calculations that the airplane would need 8,000 feet of runway for takeoff with the engine bleed air systems on; according to the airplane's AFM, this configuration was appropriate for the runway and weather conditions. However, after the captain learned that a snowplow would be operating on that runway for an undetermined amount of time, he told the first officer that the other runway was immediately adjacent to the ramp where the airplane was parked (the taxi distance to the 10,000-foot runway was about 1 mile). When the first officer told the captain that the adjacent runway's length was only 7,500 feet, the captain asked the first officer to determine the runway length requirements for the airplane with the bleed air systems off.

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[3] For operational planning purposes, takeoff runway length is the greater of either the distance required to accelerate to V_1 and then come to a full stop or the distance required to accelerate to V_1 and then continue acceleration with an engine failed, rotate, and climb to a height of 35 feet above the runway surface. According to 14 CFR Part 1, V_1 is generally defined as the maximum speed in the takeoff at which, in the event of an aborted takeoff, the pilot must take the first action to stop the airplane within the accelerate-stop distance.

[4] Because the captain and the first officer failed to recognize that the presence of runway contamination, such as slush or snow, increased the runway takeoff length required and failed to consult the applicable performance planning table, the required runway lengths they discussed incorrectly referenced the dry runway takeoff performance planning tables. The supplements for contaminated runway operations showed that the airplane's actual required takeoff runway length, which, by definition, must include the stopping distance in the event of an aborted takeoff, was more than 11,000 feet for the airplane in the proper engine bleed air system configuration as outlined in the AFM for the prevailing weather conditions.

The captain and the first officer then began a series of calculations based on the new configuration, with each subsequent calculation resulting in a shorter takeoff runway length requirement. They eventually concluded that, with no engine bleed air systems in use (which, according to the AFM, was not an appropriate configuration for the runway and weather conditions), the runway length required was 7,200 feet. When the captain asked the first officer if he agreed that they could use the 7,500-foot runway, the first officer stated, "these number [sic] are always conservative anyway."

Even after these planning discussions, the captain again requested to change the airplane's configuration to include the use of engine cowl anti-ice (which was an engine bleed air system and would thus increase the runway takeoff length required), and, within seconds, he and the first officer initiated the airplane's takeoff procedures with no performance planning discussions regarding this change.

The Safety Board notes that, although the captain's decision-making showed deficiencies regarding airplane performance limitations, company procedures, and Federal regulations, the first officer's failure to challenge the captain's decisions is also of concern. As second-in-command, the first officer could have provided critical independent evaluation and monitoring of the captain's actions.

The Safety Board's investigation revealed that Air Castle did not have, and was not required to have, a formal CRM-specific training program. The only CRM training provided to its flight crewmembers was included as a topic within their initial, transition, upgrade, recurrent, or qualification training and during airplane-specific training conducted by outside vendors. The FAA currently requires formal CRM training programs for only Part 121 operators, although most scheduled Part 135 operators voluntarily provide CRM training that meets the Part 121 standards. The formal CRM training programs, which last several days, include a review of accidents and a presentation of skills and techniques for effective crew coordination, resource allocation, and error management. Formal CRM training augments technical training and enhances pilots' performance in the cockpit. The Board notes that, in the case of the captain, formal CRM training might have assisted him with directing crew attention to the hazards posed by the weather, reinforced his awareness of the importance of complying with company procedures, and promoted more effective crew coordination. In the case of the first officer, who was recently hired, formal CRM training might have reinforced the company's support for challenging a captain's actions.

Since 1980, the Safety Board has issued numerous recommendations to the FAA regarding improved CRM training requirements for Part 135 operators, and the Board notes that the FAA has taken some positive action in response to initial recommendations. The Board's most recent recommendation on this subject is Safety Recommendation A-03-52, which was issued on December 2, 2003, as a result of the investigation of the October 25, 2002, accident involving a Raytheon (Beechcraft) King Air A100, which crashed near Eveleth, Minnesota. Safety Recommendation A-03-52 asked the FAA to do the following:

> Require that 14 *Code of Federal Regulations* (CFR) Part 135 on-demand charter operators that conduct dual-pilot operations establish and implement a Federal

Aviation Administration-approved crew resource management training program for their flight crews in accordance with 14 CFR Part 121, subparts N and O.

The FAA responded on April 12, 2004, that an aviation rulemaking committee was revising and improving Part 135, including requiring CRM training, and that the rulemaking committee had a 2-year charter with a notice of proposed rulemaking (NPRM) targeted for fiscal year 2005. The Safety Board was encouraged by the FAA's response and, in January 2005, classified Safety Recommendation A-03-52 "Open—Acceptable Response," pending the completion of the revisions to Part 135. At that time, the Board noted that the NPRM was only the first step in the rulemaking process and encouraged the FAA to expedite the process wherever possible. The Board is disappointed that the NPRM has still not been issued.

The FAA's action on this issue is overdue, and this fatal accident emphasizes again the need for timely action in response to Safety Recommendation A-03-52. Specifically, this accident occurred about 1 year after the recommendation was issued and more than 7 months after the FAA stated that the NPRM was in progress. Thus, the Board has reclassified Safety Recommendation A-03-52 "Open—Unacceptable Response." The Safety Board believes the captain's and first officer's actions demonstrate the critical and immediate need for improved CRM training for all Part 135 operators; therefore, the Safety Board reiterates Safety Recommendation A-03-52.

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

Develop visual and tactile training aids to accurately depict small amounts of upper wing surface contamination and require all commercial airplane operators to incorporate these training aids into their initial and recurrent training. (A-06-42)

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

Require that 14 *Code of Federal Regulations* (CFR) Part 135 on-demand charter operators that conduct dual-pilot operations establish and implement a Federal Aviation Administration-approved crew resource management training program for their flight crews in accordance with 14 CFR Part 121, subparts N and O. (A-03-52)

Acting Chairman ROSENKER and Members HERSMAN and HIGGINS concurred with this recommendation.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman