

Log 1512

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

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Forwarded to:
Honorable J. Lynn Helms
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)
A-82-79 through -89

On January 13, 1982, Air Florida Flight 90, a Boeing 737-222 (N62AF) struck the northbound span of the 14th Street Bridge which connects the District of Columbia with Arlington County, Virginia, and plunged into the ice-covered Potomac River just after taking off from the Washington National Airport. Seventy of the 74 passengers, 4 of the 5 crewmembers, and 4 persons in vehicles on the bridge were fatally injured. The weather conditions which had prevailed before and at the time of the accident consisted of subfreezing temperatures and almost steady moderate to heavy snowfall with obscured visibility. 1/

The facts developed during the Safety Board's investigation from witness accounts, surviving passenger observations, flight data recorder (FDR) parameters, and the cockpit voice recorder (CVR) provided indisputable evidence that the aircraft's performance was subnormal from the beginning of the takeoff roll. The aircraft accelerated more slowly and lifted off farther down the runway than normal B-737 departures. Although it reached its target liftoff speed and achieved a climb, the stall warning stickshaker activated almost immediately and the airspeed and rate of climb deteriorated. The aircraft experienced aerodynamic stall buffet before it began to descend at a steep angle, maintaining a nosehigh attitude until it struck the bridge.

The aircraft had been deiced before it taxied from the gate area; however, it was exposed to the continuing snowfall for about 50 minutes before the flight could take off. The delay was the result of a saturation of arriving and departing aircraft when the field reopened after being closed for a 90-minute snow removal operation. The CVR conversation between the captain and first officer showed that they were aware that some snow or ice had accumulated on the aircraft while waiting for takeoff.

The Safety Board's investigation and analysis of this accident were directed toward the effects of the weather and other environmental factors on the aircraft's performance; the pretakeoff events including deicing of the aircraft and air traffic control delays; the flightcrew's judgment and performance before and during the flight; and those factors which may have influenced the flightcrew's performance. The crash response and rescue efforts as well as Washington National Airport emergency facilities and their relation to the crash of Flight 90 were also examined.

1/ For more information read Aircraft Accident Report: "Air Florida, Inc., Boeing 737-222, N62AF, Collision with 14th Street Bridge, near Washington National Airport, Washington, D.C., January 13, 1982" (NTSB-AAR-82-8).

The National Transportation Safety Board determined that the probable cause of this accident was the flightcrew's failure to use engine anti-ice during ground operation and takeoff, their decision to takeoff with snow/ice on the airfoil surfaces of the aircraft, and the captain's failure to reject the takeoff during the early stage when his attention was called to anomalous engine instrument readings. Contributing to the accident were the prolonged ground delay between deicing and the receipt of ATC takeoff clearance during which the airplane was exposed to continual precipitation, the known inherent pitchup characteristics of the B-737 aircraft when the leading edge is contaminated with even small amounts of snow or ice, and the limited experience of the flightcrew in jet transport winter operations.

The Safety Board's investigation disclosed several circumstances either directly or indirectly related to the cause of the accident or the subsequent rescue efforts which warrant review or corrective actions by the Federal Aviation Administration (FAA). The areas addressed include maintenance, operations, aircraft flight characteristics and systems, air traffic control, and airport emergency response.

Maintenance.--The maintenance of Air Florida B-737 aircraft at the Washington National Airport is performed by American Airlines personnel under the provisions of a contract between Air Florida and American Airlines. The Safety Board's examination of the deicing procedures used for Flight 90 disclosed that there had been little communication between the carriers regarding these procedures and that the American Airlines maintenance personnel had only limited familiarity with the B-737 aircraft. Furthermore, the investigation disclosed that the Air Florida maintenance representative at Washington National Airport had received only limited orientation training upon his assignment to that position and that his duties and responsibilities were not well defined. The Safety Board concluded that there should have been more complete discussions between Air Florida and American regarding procedures to be applied during B-737 maintenance so that respective responsibilities were fully understood. This is particularly applicable since American did not operate B-737 aircraft. The Safety Board believes that the FAA should be more attentive to contract maintenance agreements between air carriers or with other contractors to assure that all personnel are adequately trained for the aircraft involved and fully aware of their individual responsibilities in the conduct of maintenance.

The aircraft was deiced by American Airlines personnel. The procedure used on the left side consisted of a single application of a heated ethylene glycol and water solution. No separate anti-icing overspray was applied. The right side was deiced using hot water before an anti-icing overspray of a heated ethylene glycol and water was applied. The procedures were not consistent with American Airlines own procedures for the existing ambient temperature and were thus deficient.

Furthermore, the investigation disclosed that American Airlines maintenance personnel had replaced the delivery nozzle on the Trump D40D deicing vehicle used to apply the mixture of the deicing fluid (ethylene glycol) solution and water to the aircraft. Whereas the original nozzle on the vehicle was modified and calibrated to be compatible with the mixture and delivery rate of the vehicle, the replacement was a less expensive, commercially available part which was not modified or calibrated for the application. Consequently, the deicing fluid/water mixture which was actually dispersed by the vehicle did not correspond with the mixture selected by the operator and resulted in a less

concentrated ethylene glycol solution than intended. The Safety Board believes that such actions indicate that operators and maintenance personnel fail to appreciate that properly maintained ground support equipment may be critical to flight operations and that insufficient attention is given to this aspect of maintenance by carrier and FAA surveillance personnel. However, the absence of adequate research data concerning the effectiveness of specific deicing/anti-icing procedures combined with the extended exposure to continual precipitation before takeoff precluded the Safety Board's determining that the deicing/anti-icing procedures used on Flight 90 was a causal factor in the accident.

Operations.--The investigation of this accident revealed that the flightcrew began the takeoff roll with a known accumulation of snow or ice on the wings. The Safety Board is concerned that although all of the flight training received and advisory material provided during a pilot's career stress the importance of "clean" wings for takeoff and although the FAA regulations prohibit takeoff when frost, snow, or ice is adhering to the wings or control surfaces, some pilots apparently do not fully understand or appreciate the extent to which even a small amount of contaminant can degrade an aircraft's aerodynamic performance. The Safety Board's accident investigations show that pilots might be influenced by such factors as anticipated further delays, observations of other departing aircraft, and even personal encounters with airframe icing during cruise flight which can lead them to believe that some wing contamination can be tolerated. Therefore, the Safety Board believes that air carrier training programs should be reviewed to assure that the effects of airfoil contamination on stall characteristics, longitudinal stability, acceleration, and climb capability are adequately covered. Furthermore, the relationship between angle of attack and airspeed should be stressed as it affects those functions which are activated by the angle of attack vane, such as stall warning systems and autothrottle speed command systems (ATSC). Although not related to this accident, the Board is concerned that some pilots may believe that the angle of attack limits of ATSC systems will provide a safe stall margin regardless of the effects of airfoil contamination.

A most significant factor in this accident was the failure of the flightcrew to use engine anti-ice during ground operation and takeoff. As a result, the engine inlet pressure P_t probe became blocked with ice, causing a significant error in the engine pressure ratio (EPR) instrumentation. Consequently, the takeoff was attempted with too low thrust.

The Safety Board notes that a B-737 flightcrew's attention is directed to engine anti-ice on the after-start checklist but that this item does not appear on the taxi and takeoff checklist. Although it may not be pertinent to the conditions existing on January 13, 1982, the Safety Board can conceive of situations involving lengthy ground delays wherein significant changes in ambient conditions will occur between the conduct of the after-start checklist and the initiation of takeoff. These changes may require a reassessment of the use of engine anti-ice. The Safety Board can only speculate whether a pretakeoff checklist entry for engine anti-ice would have prompted the flightcrew to turn it on for takeoff. Had the crew turned it on at that time, the accident probably would have been averted. In assessing the significance of the taxi and takeoff checklist in this accident, the Safety Board also considered its expectations of an experienced professional flightcrew. The Safety Board believes that a flightcrew preparing for takeoff in conditions as they existed on January 13, 1982, should routinely check all items related to safe operations in subfreezing weather, such as pitot heat and engine anti-ice, regardless of whether such items appeared on a checklist. While the Safety Board, therefore, did not include the omission of anti-ice from the taxi and takeoff checklist as a factor in the cause of this accident, the Board believes that the checklists of all transport

category aircraft could profitably be reviewed again to determine if they include all items pertinent to safety.

Because of the false EPR indications resulting from the blocked Pt₂ probe, the flightcrew attempted the takeoff with subnormal thrust. Consequently, the aircraft's acceleration rate during the takeoff roll was subnormal. The Safety Board believes that had the flightcrew been alerted to the subnormal acceleration, they may have rejected the takeoff safely. The subject of acceleration takeoff monitors was extensively discussed in the Safety Board's special hearing on May 3, 1982. It was evident that takeoff monitor systems for installation in air carrier aircraft are technically feasible but that problems remain to be solved before they will gain FAA and industry acceptance. The Safety Board believes, however, that runway distance to go markers and corresponding operational procedures would provide an invaluable aid to flightcrews until more sophisticated systems are implemented. The Safety Board, therefore, believes that the FAA should reassess its position regarding the installation of these markers and reiterates its 1972 Safety Recommendation A-72-3: "Require the installation of runway distance markers at all airports where air carrier aircraft are authorized to operate."

Aircraft Flight Characteristics and System Modifications.--Since 1970, operators of B-737 aircraft have reported a number of aircraft pitchup or rolloff incidents immediately after takeoff in weather conditions conducive to the formation of ice or frost on the wing leading edges. The Safety Board is aware of 22 such reports. Some of the incidents required abnormal forward force on the control column augmented with trim changes to recover. As a result of these incidents, The Boeing Co. has issued three Operations Manual Bulletins addressing precautions and procedures to minimize the potential for an accident. Additionally, The Boeing Co. conducted a special flight test program to quantify the aerodynamic effects of contaminated leading edge slats on the B-737 aircraft. Flight tests determined that the stall speeds at takeoff flap settings could be increased by 8 to 10 knots and that the stalls were characterized by pitchup, yaw, and rolloff.

The evidence indicates that Flight 90 did experience a pitchup upon rotation for takeoff which was not or could not be immediately corrected by the crew. The aircraft consequently became airborne in a high pitch attitude, which when combined with low thrust and high drag, inhibited the aircraft's acceleration to a safe airspeed. The Safety Board could not determine whether the aircraft's aerodynamic design makes the B-737 more sensitive than other aircraft to pitching or rolling moments when the wing is contaminated or whether more frequent operation of these aircraft in environmental conditions conducive to snow or ice accretion during ground operations, coupled with the near to the ground wing placement, accounts for the higher number of reported B-737 pitchup/rolloff incidents. Regardless, the Safety Board agrees with the United Kingdom Civil Aviation Authority (CAA) that flightcrew advisories and precautions are not sufficiently positive to prevent incidents, particularly under conditions in which the crew may not be able to detect even small amounts of contaminant on the leading edge. The CAA began contemplating the requirement for operational procedures which would provide added airspeed margins as early as May 1981. On January 5, 1982, it issued Airworthiness Directive 010-01-82 requiring that, under conditions where visible moisture existed and the outside air temperature was less than 5° C, 2 knots must be added to the airspeed schedule for the B-737 standard airplane during takeoff with flaps in the 1 and 2 positions and 5 knots must be added to the B-737-200 advanced airplane under the same circumstances. The CAA proposed an amendment to AD 010-01-82 on February 15, 1982, to add an additional 5 knots to the speed schedule when using a takeoff flap setting of 5 in any B-737 and further that a flap setting greater than 5 would be required when taking off from a runway contaminated with water, snow, or ice.

Moreover, the Safety Board is aware that as a result of the CAA-contemplated actions, The Boeing Co. has been considering and evaluating modifications to the B-737 wing thermal anti-ice system to permit the use of that system during ground operations to prevent the formation of ice on the wing leading edge devices. Such usage would alleviate the need for the additional takeoff speed margin and the associated takeoff weight penalty which might be required at certain airports.

The Safety Board believes that measures such as those imposed by the CAA in its AD 010-01-82, or alternative measures such as the engineering modifications to the B-737 wing thermal anti-ice system and the appropriate procedures to ensure clean leading edges should be implemented before the next winter season to prevent more pitchup or rolloff occurrences.

Air Traffic Control (ATC).--To minimize the potential for further snow or ice accumulation following the deicing of aircraft, takeoff clearance must be issued without excessive delay. Unfortunately, the type of weather conducive to icing is also most apt to produce ATC delays. On the day of the accident, both arriving and departing traffic at Washington National Airport were backlogged because the airport had been closed for snow removal. Since the inability of the airport to handle large numbers of aircraft without difficulty is recognized, the Safety Board believes that the FAA should have anticipated the situation and used all available means to prevent airport and ATC saturation. The Safety Board believes that, by effective use of the Central Flow Control Facility (CFCF), the FAA could have limited the traffic flow and reduced the takeoff delays.

The Safety Board believes that the CFCF should be capable of adjusting rapidly to changing weather conditions to enable the system to hold traffic at the departure airports. The failure to do so resulted in a flow of arrival traffic immediately after the airport reopened which saturated the airport. The Safety Board concluded that the FAA's CFCF did not anticipate the developing situation and take action to prevent it. The Safety Board believes that its failure to act may have been the result of inadequate communications between facilities--either in the lack of timeliness of essential information or through providing inaccurate information. The Safety Board thus believes that the FAA should review ATC coordination practices and modify them as necessary to require that facilities provide CFCF with current and accurate information and that CFCF act on that information in a positive manner to minimize airport saturation and extensive traffic delays.

The facts established during the accident investigation also indicated that the separation between an arrival aircraft, Eastern Flight 1451, a B-727, and the departing Air Florida B-737 was less than that required by criteria set forth in FAA's Air Traffic Control Handbook 7110.65C. ATC communications and radar data confirmed that Eastern 1451 touched down on runway 36 before Air Florida Flight 90 became airborne. The ATC Handbook specifically required the controller, under IFR conditions, to separate a departing aircraft from an arriving aircraft on final approach by a minimum of 2 miles if separation will increase to a minimum of 3 miles within 1 minute after takeoff. The criteria are intended to assure that safe separation is maintained between aircraft if the arrival aircraft executes a missed approach. The Safety Board is particularly concerned that both the local controller on duty at the time of the accident and the Washington National Airport Tower Chief stated at the Board's public hearing after this accident that the FAA's ATC handbook criteria are widely interpreted to allow for the "accordion effect" of landing deceleration and takeoff acceleration. The Safety Board notes that the ATC training manuals and controller tests clearly indicate that no such allowance is intended.

Although the Safety Board did not believe that there was sufficient evidence to determine that the ATC handling of Flight 90 was a causal factor, the Safety Board concluded that the local controller's overeagerness to expedite the traffic flow to relieve the departure backlog resulted in actions that were contrary to established procedures and jeopardized safety. The Board believes, therefore, that the separation criteria for this situation should be emphasized to avoid misinterpretation by controllers.

The Safety Board also believes that the compromise of ATC separation criteria as it occurred during the departure of Flight 90 was an operational error. However, the situation was not identified as such by appropriate FAA personnel. The Safety Board is concerned because operational error data are compiled and used to monitor the safety of the ATC system. According to the FAA data, the number of operational errors reported has lessened since the air traffic controllers strike on August 3, 1981. The Safety Board is concerned that the failure to identify the separation compromise between Eastern 1451 and Flight 90 as an operational error, in conjunction with the overall reduction in the number of such error reports, might be indicative of a trend within ATC to disregard operational error reports, thus degrading their significance as a measure of ATC system safety. The Board believes that FAA should evaluate the criteria and current practices of ATC facilities to ensure that all compromises to the separation criteria are reported and investigated.

Airport Emergency Response.—The airport fire department was notified of the accident about 3 minutes after it occurred. Two minutes later, the Washington Metropolitan Area Communications Circuit of the Defense Civil Preparedness Agency was notified and it in turn alerted all circuits to an aircraft emergency. The notification included Arlington fire and police departments, U.S. Park Police, the District of Columbia fire and police departments, and the Fairfax and Alexandria, Virginia, fire departments. All departments responded; however, none were properly equipped to perform a rescue operation in the ice-covered river. The Washington National Airport airboat was available for rescue efforts, but it had never been tested for performance on ice. It was launched at 1620, but experienced directional control difficulties and did not reach the rescue scene in time to be used to rescue the survivors. The District of Columbia fire boat and harbor police boats were unable to break the ice in order to reach the scene in time to be effective.

The U.S. Park Police helicopter did reach the scene promptly and although not equipped nor required to be equipped for water rescue operations, it predominated in the rescue effort. As soon as Eagle 1, a jet-powered Bell Jet Ranger helicopter arrived on the scene, the pilot hovered the craft near the survivors while his crewman dropped make-shift rescue aids -- ropes with loops and life rings -- to survivors in the water. The survivors were dragged to the shore clinging to these make-shift aids. To rescue one survivor, the crewman stood on the helicopter's skid and pulled the survivor from the water. Another survivor was rescued when a bystander disregarded his personal safety and jumped into the frigid water to swim and aid her to the shore.

While recognizing the contribution of certain individuals in rescuing the survivors of this accident, the Safety Board is extremely concerned about the readiness of the various emergency response organizations for this emergency. Undoubtedly, had there been a large number of persons surviving the impact forces, many would have drowned in the icy water before they could be rescued. The Safety Board has continually supported and advocated disaster planning and reciprocal agreements between airports and their surrounding communities. The Washington National Airport plan was tested during a simulated ditching exercise as recently as July 1981 in which the surrounding communities

participated. The exercise may have effectively pointed out some equipment problems. Also, apparently, little thought had been given to a situation during conditions as they existed on January 13, 1982. The accident demonstrated the need for special equipment capable of being launched rapidly and of performing on ice. The Safety Board further notes that there are no specific requirements for the type of equipment necessary to accomplish rescue from waters surrounding any air carrier airports. In fact, Washington National had more equipment than was required by applicable regulations. However, the guidance provided in Advisory Circular 150 15210-13 goes beyond regulatory requirements and suggests that the emergency plans, facilities, and equipment at airports include capability for water rescue for conditions which might be encountered.

The Safety Board does not believe that the Washington National Airport's planning and equipment was totally consistent with the guidance provided in the Advisory Circular. The Safety Board is concerned about the lack of adequate equipment and the apparent lack of planning to meet an emergency of this magnitude, especially at an airport with the high traffic density of Washington National.

As a result of the investigation of the accident involving Air Florida Flight 90, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue a Maintenance Alert Bulletin to require Principal Maintenance Inspectors to emphasize to air carrier maintenance departments that proper maintenance of ground support equipment may be critical to flight operations and the importance of adhering to maintenance practices recommended by the manufacturers of such equipment. (Class II, Priority Followup) (A-82-79)

Issue a Maintenance Alert Bulletin to require Principal Maintenance Inspectors to review contract agreements between an air carrier operating into a facility at which another air carrier or maintenance contractor is providing maintenance services to assure that the responsibilities of both parties and key personnel are clearly defined and that the contractor providing the maintenance is thoroughly familiar with the maintenance of the type of aircraft involved. (Class II, Priority Followup) (A-82-80)

Issue an Operations Alert Bulletin to require Principal Operations Inspectors to require that air carrier training programs adequately cover the effects of aircraft leading edge contamination on aerodynamic performance, particularly as it affects the relationship between airspeed and angle of attack and those functions whose activation is dependent on the angle of attack, such as stall warning systems and autothrottle speed command systems. (Class II, Priority Followup) (A-82-81)

Require revision of the B-737 Approved Flight Manual to add "anti-ice" to the normal taxi and takeoff checklist. Review the checklists for all air carrier aircraft to ensure that all action items required for a successful takeoff are included on the appropriate checklist. Special consideration should be given to items whose functions may be affected by environmental conditions subject to change during ground delay periods. (Class II, Priority Followup) (A-82-82)

Issue an Airworthiness Directive to implement the necessary airplane modifications and/or changes in operational procedures for B-737 aircraft takeoff operations during weather or runway conditions conducive to the formation of leading edge frost, snow, or ice contamination to require either: (1) that the leading edge is free of frozen contaminant through the pretakeoff use of a ground-operable wing thermal anti-ice system, or (2) an increased stall airspeed margin at liftoff which will provide adequate pitch and roll control to counter the effects of undetected leading edge contaminants by modification of takeoff flaps configuration and/or increased takeoff airspeed schedules. (Class II, Priority Followup) (A-82-83)

Amend Air Traffic Control coordination procedures and practices to require that terminal and en route facilities provide the Central Flow Control Facility (CFCF) with current and accurate information regarding congestion and that CFCF act on that information in a positive manner to minimize airport saturation and extensive traffic delays. Review implementation of prescribed gate-hold procedures and require their use wherever possible. (Class II, Priority Followup) (A-82-84)

Issue a General Notice to terminal area Air Traffic Control facilities to emphasize to controllers that the separation criteria set forth in FAA Air Traffic Control Handbook 7110.65C which require a minimum of 2 miles separation do not permit deviation based upon the anticipated acceleration differences between landing and departing traffic. (Class II, Priority Followup) (A-82-85)

Evaluate the criteria and current practices of Air Traffic Control facilities regarding the declaration and reporting of operational errors to ensure that all such errors are reported and are investigated. (Class II, Priority Followup) (A-82-86)

Provide for essential equipment and increased personnel training to improve the water rescue capabilities at the Washington National Airport in all anticipated weather conditions, and provide necessary funding for surrounding communities and jurisdictions which will be called on to support the airport's rescue response. (Class II, Priority Followup) (A-82-87)

Survey all certificated airports having approach and departure flightpaths over water and evaluate the adequacy of their water rescue plans, facilities, and equipment according to the guidance contained in Advisory Circular 150/5210-13 and make recommendations for improvement as necessary to appropriate airport authorities. (Class II, Priority Followup) (A-82-88)

Amend 14 CFR 139.55 to require adequate water rescue capabilities at airports having approach and departure flightpaths over water which are compatible with the range of weather conditions which can be expected. (Class II, Priority Followup) (A-82-89)

BURNETT, Chairman, GOLDMAN, Vice Chairman, McADAMS, BURSLEY, and ENGEN, Members, concurred in these recommendations.

A handwritten signature in black ink that reads "Jim Burnett". The signature is written in a cursive style with a long, sweeping horizontal line extending to the right from the end of the name.

By: Jim Burnett
Chairman