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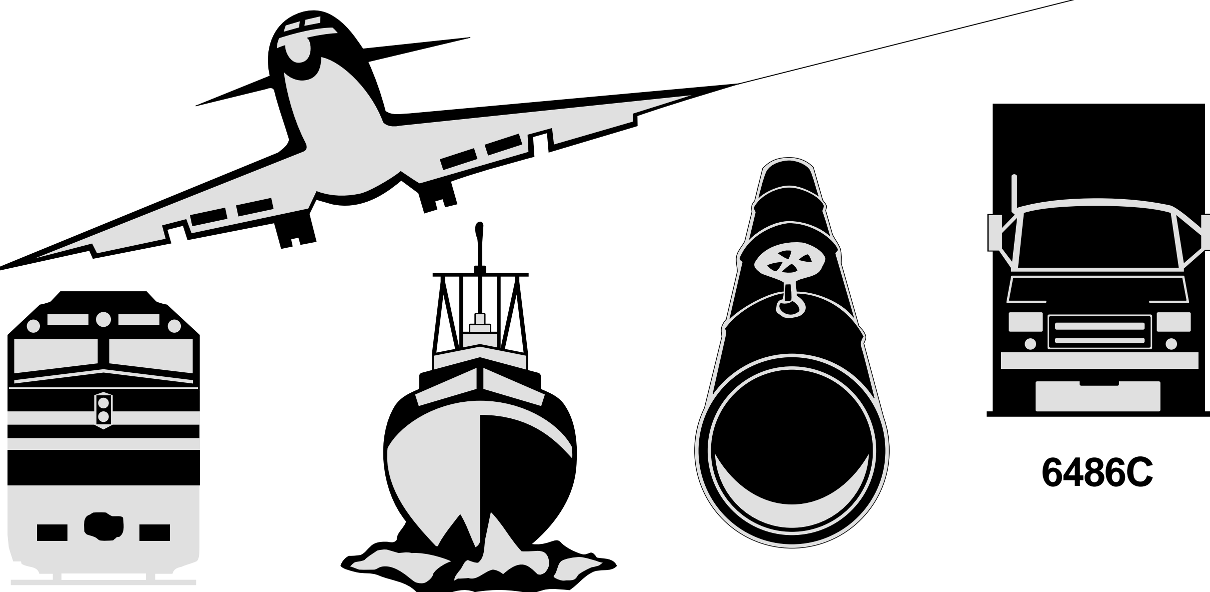
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

IN-FLIGHT ICING ENCOUNTER AND LOSS OF CONTROL
SIMMONS AIRLINES, d.b.a. AMERICAN EAGLE FLIGHT 4184
AVIONS de TRANSPORT REGIONAL (ATR)
MODEL 72-212, N4O1AM
ROSELAWN, INDIANA
OCTOBER 31, 1994

VOLUME I: SAFETY BOARD REPORT



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Abstract: Volume I of this report explains the crash of American Eagle flight 4184, an ATR 72 airplane, during a rapid descent after an uncommanded roll excursion. The safety issues discussed in the report focused on communicating hazardous weather information to flightcrews, Federal regulations on aircraft icing certification requirements, the monitoring of aircraft airworthiness, and flightcrew training for unusual events/attitudes. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration, the National Oceanic and Atmospheric Administration, and AMR Eagle. Volume II contains the comments of the Bureau Enquetes-Accidents on the Safety Board's draft of the accident report.

EXECUTIVE SUMMARY

On October 31, 1994, at 1559 Central Standard Time, an Avions de Transport Regional, model 72-212 (ATR 72), registration number N4O1AM, leased to and operated by Simmons Airlines, Incorporated, and doing business as American Eagle flight 4184, crashed during a rapid descent after an uncommanded roll excursion. The airplane was in a holding pattern and was descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. The airplane was destroyed by impact forces, and the captain, first officer, 2 flight attendants and 64 passengers received fatal injuries. Flight 4184 was a regularly scheduled passenger flight being conducted under 14 Code of Federal Regulations, Part 121; and an instrument flight rules flight plan had been filed.

The National Transportation Safety Board determines that the probable causes of this accident were the loss of control, attributed to a sudden and unexpected aileron hinge moment reversal that occurred after a ridge of ice accreted beyond the deice boots because: 1) ATR failed to completely disclose to operators, and incorporate in the ATR 72 airplane flight manual, flightcrew operating manual and flightcrew training programs, adequate information concerning previously known effects of freezing precipitation on the stability and control characteristics, autopilot and related operational procedures when the ATR 72 was operated in such conditions; 2) the French Directorate General for Civil Aviation's inadequate oversight of the ATR 42 and 72, and its failure to take the necessary corrective action to ensure continued airworthiness in icing conditions; and 3) the French Directorate General for Civil Aviation's failure to provide the Federal Aviation Administration with timely airworthiness information developed from previous ATR incidents and accidents in icing conditions, as specified under the Bilateral Airworthiness Agreement and Annex 8 of the International Civil Aviation Organization.

Contributing to the accident were: 1) the Federal Aviation Administration's failure to ensure that aircraft icing certification requirements, operational requirements for flight into icing conditions, and Federal Aviation Administration published aircraft icing information adequately accounted for the hazards that can result from flight in freezing rain and other icing conditions not specified in 14 Code

of Federal Regulations, Part 25, Appendix C; and 2) the Federal Aviation Administration's inadequate oversight of the ATR 42 and 72 to ensure continued airworthiness in icing conditions.

The safety issues in this report focused on communicating hazardous weather information to flightcrews, Federal regulations regarding aircraft icing and icing certification requirements, the monitoring of aircraft airworthiness, and flightcrew training for unusual events/attitudes.

Safety recommendations concerning these issues were addressed to the Federal Aviation Administration, the National Oceanic and Atmospheric Administration, and AMR Eagle. Also, as a result of this accident, on November 7, 1994, the Safety Board issued five safety recommendations to the Federal Aviation Administration regarding the flight characteristics and performance of ATR 42 and ATR 72 airplanes in icing conditions. In addition, on November 6, 1995, the Safety Board issued four safety recommendations to the Federal Aviation Administration concerning the Air Traffic Control System Command Center. In accordance with Annex 13 to the Convention on International Civil Aviation, the Bureau Enquetes-Accidents provided comments on the Safety Board's draft of the accident report that are contained in Volume II of this report.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was properly certified and qualified in accordance with applicable regulations to conduct the flight.

2. The Chicago air route traffic control center (ARTCC) sector controllers were properly certified and trained to perform their duties.

3. The ATR 72 was certificated, equipped, and maintained in accordance with Federal regulations and approved procedures.

4. There was no evidence of an aircraft structural or system failure that would have either been causal or contributing to the accident.

5. Flight 4184 encountered a mixture of rime and clear airframe icing in supercooled cloud and drizzle/rain drops. Some drops were estimated to be greater than 100 microns in diameter, and some were as large as 2,000 microns.

6. The forecasts produced by the National Weather Service (NWS) were substantially correct, and the actions of the forecasters at the National Aviation Weather Advisory Unit (NAWAU)

and the meteorologists at the Chicago ARTCC's Center Weather Service Unit (CWSU) were in accordance with NWS guidelines and procedures.

7. Safety would be enhanced if the hazardous inflight weather advisory service (HIWAS) information were presented more consistently and had included all of the information pertinent to the safety of flight, such as the altitudes of the icing conditions, the intensity and type of icing, and the location of the actual or expected icing conditions (e.g. in clouds and precipitation).

8. The flightcrew's actions would not have been significantly different even if they had received the available AIRMETs.

9. The flightcrew's actions were consistent with their training and knowledge.

10. PIREPs [pilot reports] of icing conditions, based on the current icing severity definitions, may often be misleading to pilots, especially to pilots in aircraft that may be more vulnerable to the effects of icing than other aircraft.

11. The aviation community's general understanding of the phrase "icing in precipitation," which is used by the NWS and is often contained in in-flight weather advisories, does not typically specify types of precipitation. The provision of a definition in aviation publications, such as the Aeronautical Information Manual (AIM) or Part 1 of the Federal Aviation Regulations, would make pilots and dispatchers more aware of the types of precipitation and icing conditions that are implied by this phrase.

12. Continued development of equipment and computer programs to measure and monitor the atmosphere could permit forecasters to produce real-time warnings that define specific locations of potentially hazardous atmospheric icing conditions (including freezing drizzle and freezing rain) and short range forecasts ("nowcasts") that identify icing conditions for a specific geographic area with a valid time of 2 hours or less.

13. The 14 Code of Federal Regulations (CFR) Part 25, Appendix C, envelope is limited and does not include conditions of freezing drizzle or freezing rain; thus, the current process by which aircraft are certified using the Appendix C icing envelope is inadequate and does not require manufacturers to sufficiently demonstrate the airplane's capabilities in all the possible icing conditions that can, and do, occur in nature.

14. No airplane should be authorized or certified for flight into icing conditions more severe than

those to which the airplane was subjected in certification testing, unless the manufacturer can otherwise demonstrate the safety of flight in such conditions.

15. If the FAA had acted more positively upon the Safety Board's aircraft icing recommendations issued in 1981, this accident may not have occurred.

16. ATR 42 and 72 ice-induced aileron hinge moment reversals, autopilot disconnects, and rapid, uncommanded rolls could occur if the airplanes are operated in near freezing temperatures and water droplet median volume diameter (MVDs) typical of freezing drizzle.

17. At the initiation of the aileron hinge moment reversal affecting flight 4184, the 60 pounds of force on the control wheel required to maintain a wings-level-attitude were within the standards set forth by the Federal Aviation Regulations. However, rapid, uncommanded rolls and the sudden onset of 60 pounds of control wheel force without any waning to the pilot, or training for such unusual events, would most likely preclude a flightcrew from making a timely recovery.

18. ATR is considering design changes to the lateral control system for current and future ATR airplanes that will reduce the susceptibility to flow separation-induced aileron hinge moment reversals. Such design changes could minimize the reliance on the changes to flight operations and pilot training that have already been mandated.

19. The French Directorate General for Civil Aviation (DGAC) and the Federal Aviation Administration (FAA) failed to require the manufacturer to provide documentation of known undesirable post-SPS [stall protection system] flight characteristics, which contributed to their failure to identify and correct, or otherwise properly address, the abnormal aileron behavior early in the history of the ATR icing incidents.

20. The addition of a test procedure, similar to the "zero G" flight test maneuver (pushover) designed to identify ice-induced elevator hinge moment reversals, could determine the susceptibility of an aircraft to aileron hinge moment reversals in both the clean and iced-wing conditions and could help prevent accidents such as the one involving flight 4184.

21. Prior to the Roselawn accident, ATR recognized the reason for the aileron behavior in the previous incidents and determined that ice accumulation behind the deice boots, at an AOA sufficient to cause an airflow separation, would cause the ailerons to become unstable. Therefore, ATR had sufficient basis to modify the airplane and/or provide operators and pilots with adequate, detailed information regarding this phenomenon.

22. The 1989 icing simulation package developed by ATR for the training simulators did not provide training for pilots to recognize the onset of an aileron hinge moment reversal or to execute the appropriate recovery techniques.

23. ATR's proposed post-Mosinee AFM/FCOM changes, even if adopted by the DGAC and the FAA, would not have provided flightcrews with sufficient information to identify or recover from the type of event that occurred at Roselawn, and the actions taken by ATR following the Mosinee incident were insufficient.

24. The 1992 ATR *All Weather Operations* brochure was misleading and minimized the known catastrophic potential of ATR operations in freezing rain.

25. ATR failed to disseminate adequate warnings and guidance to operators about the adverse characteristics of, and techniques to recover from, ice-induced aileron hinge moment reversal events; and ATR failed to develop additional airplane modifications, which led directly to this accident.

26. The DGAC failed to require ATR to take additional corrective actions, such as performing additional icing tests, issuing more specific warnings regarding the aileron hinge moment reversal phenomenon, developing additional airplane modifications, and providing specific guidance on the recovery from a hinge moment reversal, which led directly to this accident.

27. The FAA's failure, following the 1994 Continental Express incident at Burlington, Massachusetts, to require that additional actions be taken to alert operators and pilots to the specific icing-related problems affecting the ATRs, and to require action by the manufacturer to remedy the airplane's propensity for aileron hinge moment reversals in certain icing conditions, contributed to this accident.

28. The FAA Aircraft Evaluation Group (AEG) did not receive in a timely manner, from all sources, pertinent documentation (such as the ATR analyses) regarding the previous ATR icing incidents/accidents that could have been used to monitor the continued airworthiness of the airplane.

29. The ability of the FAA's AEG to monitor, on a real-time basis, the continued airworthiness of the ATR airplanes was hampered by the inadequately defined lines of communication, the inadequate means for the AEG to retrieve pertinent airworthiness information, and the DGAC's failure to provide the FAA with critical airworthiness information, because of the

DGAC's apparent belief that the information was not required to be provided under the terms of the Bilateral Airworthiness Agreement (BAA). These deficiencies also raise concerns about the scope and effectiveness of the BAA.

30. The FAA's limited involvement in the ATR 42 certification does not appear to have resulted in an improperly certificated airplane (ATR 42/72). However, the FAA's excessive reliance on a foreign airworthiness authority may result in tacit approval of the certification of a foreign-manufactured airplane without sufficient oversight and is not in the best interest of safety.

31. The nearby air traffic control facilities were aware that light icing conditions were forecast for the area of the LUCIT intersection. Nonetheless, the release of flight 4184 from Indianapolis was proper because there were viable options for pilots who chose to avoid holding in icing conditions.

32. Under the circumstances on the day of accident, the controllers acted appropriately in the management of traffic flow into O'Hare International Airport (ORD), which necessitated the holding of flight 4184 in the BOONE sector.

33. The air traffic control (ATC) traffic management coordinator failed to report flight 4184 to the air traffic control system command center (ATCSCC) as an arrival delay, and he failed to alert the ATCSCC that flight 4184 had been holding for more than 15 minutes. However, this lack of information did not affect the operation of the flight and did not contribute to the accident.

34. Because there were no PIREPs [pilot reports] provided to the Boone sector controller by other pilots, and because the crew of flight 4184 did not provide a PIREP of icing conditions at the LUCIT intersection, it was reasonable for the controller to conclude that there were no significant weather events in that area and that the crew of flight 4184 was not experiencing any problems that would have warranted precautionary action by the controller.

35. Because the DGAC did not require ATR, and ATR did not provide to the operators of its airplanes, information that specifically alerted flightcrews to the fact that encounters with freezing rain could result in sudden autopilot disconnects, aileron hinge moment reversals, and rapid roll excursions, or guidance on how to cope with these events, the crew of flight 4184 had no reason to expect that the icing conditions they were encountering would cause the sudden onset of an aileron hinge moment reversal, autopilot disconnect, and loss of aileron control.

36. Neither the flight attendant's presence in the cockpit nor the flightcrew's conversations with her contributed to the accident. However, a sterile cockpit environment would probably have reduced flightcrew distractions and could have promoted an appropriate level of flightcrew awareness for the conditions in which the airplane was being operated.

37. The flightcrew's failure to increase the propeller RPM to 86 percent and activate the Level III ice protection system in response to the 1533:56 caution alert chime was not a factor in the accident.

38. Had ice accumulated on the wing leading edges so as to burden the ice protection system, or if the crew had been able to observe the ridge of ice building behind the deice boots or otherwise been provided a means of determining that an unsafe condition was developing from holding in those icing conditions, it is probable that the crew would have exited the conditions.

39. The captain's departure from the cockpit to use the rest room while the airplane was in the holding pattern was neither prohibited by Federal regulations nor inconsistent with Simmons Airlines/AMR Eagle policies and procedures and did not contribute to the accident.

40. Although the Simmons Airlines/AMR Eagle policy does require flightcrews to provide a PIREP of icing conditions, and it would have been prudent for the crew of flight 4184 to provide such a report, their failure to do so did not contribute to the accident.

41. Although the crew of flight 4184 received an aural traffic alert and collision avoidance system (TCAS) alert shortly before the roll excursion, this alert was not perceived by the crew as a conflict, and the proximity of the two airplanes to one another did not contribute to the accident.

42. Both pilots saw the ground, realized their close proximity and high descent rate, and made a nose-up elevator input that, combined with the high airspeed (about 115 KIAS over the certified maximum operating airspeed) resulted in excessive wing loading and structural failure of the outboard sections of the wings.

43. Although both crew members of flight 4184 were certified flight insructors, this was probably the first time they had experienced such unexpected and excessive roll and pitch attitudes in the ATR 72. If the operators had been required to conduct unusual attitude training, the knowledge from this training might have assisted the flightcrew in its recovery efforts and might have prompted the captain to provide useful information to the first officer to facilitate a timely recovery of the airplane.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the loss of control, attributed to a sudden and unexpected aileron hinge moment reversal that occurred after a ridge of ice accreted beyond the deice boots because: 1) ATR failed to completely disclose to operators, and incorporate in the ATR 72 airplane flight manual, flightcrew operating manual and flightcrew training programs, adequate information concerning previously known effects of freezing precipitation on the stability and control characteristics, autopilot and related operational procedures when the ATR 72 was operated in such conditions; 2) the French Directorate General for Civil Aviation's (DGAC's) inadequate oversight of the ATR 42 and 72, and its failure to take the necessary corrective action to ensure continued airworthiness in icing conditions; and 3) the DGAC's failure to provide the FAA with timely airworthiness information developed from previous ATR incidents and accidents in icing conditions, as specified under the Bilateral Airworthiness Agreement and Annex 8 of the International Civil Aviation Organization.

Contributing to the accident were: 1) the Federal Aviation Administration's (FAA's) failure to ensure that aircraft icing certification requirements, operational requirements for flight into icing conditions, and FAA published aircraft icing information adequately accounted for the hazards that can result from flight in freezing rain and other icing conditions not specified in 14 Code of Federal Regulations (CFR) Part *25,* Appendix C; and 2) the FAA's inadequate oversight of the ATR 42 and 72 to ensure continued airworthiness in icing conditions.

4. RECOMMENDATIONS

As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

—to the Federal Aviation Administration:

Direct principal operations inspectors (POIs) to ensure that all 14 Code of Federal Regulations (CFR) Part 121 air carriers require their dispatchers to provide all pertinent information, including airman's meteorological information (AIRMETs) and Center Weather Advisories (CWAs), to flightcrews for preflight and inflight planning purposes. (Class II, Priority Action) (A-96-48)

Require that Hazardous In-flight Weather Advisory Service (HIWAS) broadcasts consistently include all pertinent information contained in weather reports and forecasts, including in-flight weather advisories, airman's meteorological information (AIRMETs), significant meteorological information (SIGMETs), and Center Weather Advisories (CWA's). (Class II, Priority Action) (A-96-49)

Encourage principal operations inspectors (POIs) and operators to reemphasize to pilots that Hazardous In-flight Weather Advisory Service (HIWAS) is a source of timely weather information and should be used whenever they are operating in or near areas of potentially hazardous weather conditions. (Class II, Priority Action) (A-96-50)

Revise the existing aircraft icing intensity reporting criteria (as defined in the Aeronautical Information Manual (AIM) and other Federal Aviation Administration (FAA) literature) by including nomenclature that is related to specific types of aircraft, and that is in logical agreement with existing Federal Aviation Regulations (FARs). (Class II, Priority Action) (A-96-51)

Publish the definition of the phrase "icing in precipitation" in the appropriate aeronautical publications, emphasizing that the condition may exist both near the ground and at altitude. (Class II, Priority Action) (A-96-52)

Continue to sponsor the development of methods to produce weather forecasts that both define specific locations of atmospheric icing conditions (including freezing drizzle and freezing rain) and produce short-range forecasts ("nowcasts") that identify icing conditions for a specific geographic area with a valid time of 2 hours or less. (Class II, Priority Action) (A-96-53)

Revise the icing criteria published in 14 Code of Federal Regulations (CFR), Parts 23 and 25, in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution, and temperature, and recent developments in both the design and use of aircraft. Also, expand the Appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions, as necessary. (Class II, Priority Action) (A-96-54) (Supersedes A-81-116 and -118)

Revise the Federal Aviation Regulations (FARs) icing certification requirements and advisory material to specify the numerical methods to be used in determining median volumetric diameter (MVD) and liquid water content (LWC) during certification tests. (Class II, Priority Action) (A-96-55)

Revise the icing certification testing regulation to ensure that airplanes are properly tested for all conditions in which they are authorized to operate, or are otherwise shown to be capable of safe flight into such conditions. If safe operations cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flightcrews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification. (Class II, Priority Action) (A-96-56)

Require all aircraft manufacturers to provide, as part of the certification criteria, information to the FAA and operators about any known undesirable characteristics of flight beyond the protected (stall system and related shaker/pusher) flight regime. (Class II, Priority Action) (A-96-57)

Develop an icing certification test procedure similar to the tailplane icing pushover test to determine the susceptibility of airplanes to aileron hinge moment reversals in the clean and iced-wing conditions. Revise 14 CFR Parts 23 and 25 icing certification requirements to include such a test. (Class II, Priority Action) (A-96-58)

Encourage ATR to test the newly developed lateral control system design changes and upon verification of the improved or corrected hinge moment reversal/uncommanded aileron deflection problem, require these design changes on all new and existing ATR airplanes. (Class-Il, Priority Action) (A-96-59)

Revise 14 CFR Parts 91.527 and 135.227 to ensure that the regulations are compatible with the published definition of severe icing, and to eliminate the implied authorization of flight into severe icing conditions for aircraft certified for flight in such conditions. (Class II, Priority Action) (A-96-60)

Require all principal operations inspectors (POIs) of 14 CFR Part 121 and 135 operators to ensure that training programs include information about all icing conditions, including flight into freezing drizzle/freezing rain conditions. (Class II, Priority Action) (A-96-61)

Develop an organizational structure and a communications system that will enable the Aircraft Evaluation Group (AEG) to obtain and record all domestic and foreign aircraft and parts/systems manufacturers' reports and analyses concerning incidents and accidents involving aircraft types operated in the United States, and ensure that the information is collected in a timely manner for effective AEG monitoring of the continued airworthiness of aircraft. (Class II, Priority Action) (A-96-62)

Review and revise, as necessary, the manner in which the FAA monitors a foreign airworthiness authority's compliance with U.S.
type certification requirements under the Bilateral Airworthiness Agreement (BAA). (Class II, Priority Action) (A-96-63)

Establish policies and procedures to ensure that all pertinent information is received, including the manufacturer's analysis of incidents, accidents or other airworthiness issues, from the exporting country's airworthiness authority so that the FAA can monitor and ensure the continued airworthiness

of airplanes certified under the Bilateral Airworthiness Agreement (BAA). (Class II, Priority Action) (A-96-64)

Evaluate the need to require a sterile cockpit environment for airplanes holding in such weather conditions as icing and convective activity, regardless of altitude. (Class II, Priority Action) (A-96-65)

Amend the Federal Aviation Regulations to require operators to provide standardized training that adequately addresses the recovery from unusual events, including extreme flight attitudes in large, transport category airplanes. (Class II, Priority Action) (A-96-66)

Revise FAA Order 8400.10, Chapter 7, Section 2, paragraph 1423 (Operational Requirements - Flightcrews) to specify that Center Weather Advisories (CWAs) be included and considered in the flightcrew's preflight planning process. (Class II, Priority Action) (A-96-67)

Revise FAA Order 7110.65, "Air Traffic Control," Chapter 2, "General Control," Section 6, "Weather Information," paragraph 2-6-3, "PIREP" Information, to include freezing drizzle and freezing rain. Additionally, these conditions should be clearly defined in the Pilot/Controller Glossary. (Class U, Priority Action) (A-96-68)

Conduct or sponsor research and development of on-board aircraft ice protection and detection systems that will detect and alert flightcrews when the airplane is encountering freezing drizzle and freezing rain and accreting resultant ice. (Class II, Priority Action) (A-96-69)

—to the National Oceanic and Atmospheric Administration:

Develop methods to produce weather forecasts that both define specific locations of atmospheric icing conditions (including freezing drizzle and freezing rain), and that produce short range forecasts ("nowcasts") that identify icing conditions for a specific geographic area with a valid time of 2 hours or less. Ensure the timely dissemination of all significant findings to the aviation community in an appropriate manner. (Class II, Priority Action) (A-96-70)

—to AMR Eagle:

Require dispatchers to include in the flight release airman's meteorological information (AIRMETs) and center weather advisories (CWAs) that are pertinent to the route of flight so that flightcrews can consider this information in their preflight and in-flight decisions. (Class II, Priority Action) (A-96-71)

Encourage captains to observe a "sterile cockpit" environment when an airplane is holding, regardless of altitude, in meteorological conditions such as convective areas or icing conditions, that have the potential to demand significant attention of a flightcrew (Class II, Priority Action) (A-96-72)

Conduct a procedural audit to eliminate existing conflicts in guidance and procedures between the Aircraft Flight Manuals, Flight Operations Manuals, and other published material. (Class II, Priority Action) (A-96-73)

Also as a result of this accident, the Safety Board issued the following safety recommendations to the FAA on November 7, 1994:

Conduct a special certification review of the ATR 42 and ATR 72 airplanes, including flight tests and/or wind tunnel tests, to determine the aileron hinge moment characteristics of the airplanes operating with different airspeeds and configurations during ice accumulation and with varying angles of attack following ice accretion. As a result of the review, require modifications as necessary to assure satisfactory flying qualities and control system stability in icing conditions. (Class II, Priority Action) (A-94-181)

Prohibit the intentional operation of ATR 42 and ATR 72 airplane in known or reported icing conditions until the effect of upper wing surface ice on the flying qualities and aileron hinge moment characteristics are examined further as recommended in A-94-181 and it is determined that the airplane exhibits satisfactory flight characteristics. (Class I, Urgent Action) (A-94- 182)

Issue a general notice to ATC personnel to provide expedited service to ATR 42 and ATR 72 pilots who request route, altitude, or airspeed deviations to avoid icing conditions. Waive the 175 knot holding speed restriction for ATR 42 and ATR 72 airplanes pending acceptable outcome of the special certification effort. (Class I, Urgent Action) (A-94-l 83)

Provide guidance and direction to pilots of ATR 42 and ATR 72 airplanes in the event of inadvertent encounter with icing conditions by the following actions: (1) define optimum airplane configuration and speed information; (2) prohibit the use of autopilot; (3) require the monitoring of lateral control forces; (4) and define a positive procedure for reducing angle of attack. (Class I, Urgent Action) (A-94-1 84)

Caution pilots of ATR 42 and ATR 72 airplanes that rapid descents at low altitude or during landing approaches or other deviations from prescribed operating procedures are not an acceptable means of minimizing exposure to icing conditions. (Class I, Urgent Action) (A-94-1 85)

In addition, the Safety Board issued the following safety recommendations to the FAA on November 6, 1995:

Require the Air Traffic Control System Command Center to retain all flow control-related facility documents for 15 days, regardless of title, name, or form number, for reconstruction purposes. (Class II, Priority Action) (A-95-103)

Develop a list of documents to be completed by the Air Traffic Control System Command Center personnel in the event of an incident or accident. (Class II, Priority Action) (A-95-1 04)

Revise Order 8020.11, "Aircraft Accident and Incident Notification, Investigation and Reporting," to include the Air Traffic Control System Command Center (DCC) facility. Ensure that the DCC facility is assigned specific requirements to be included in an accident/incident package. (Class II, Priority Action) (A-95-105)

Revise FAA Order 7210.3, "Facility Operation and Administration," Chapter 3, "Facility Equipment," Section 4, "Recorders," paragraph 3-41, "Assignment of Recorder Channels," to include the Air Traffic Control System Command Center facility, listing the recorded positions and their priority. (Class II, Priority Action) (A-95-106)

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July 9, 1996

PB96-910402
NTSB/AAR-96/02
DCA95MA001

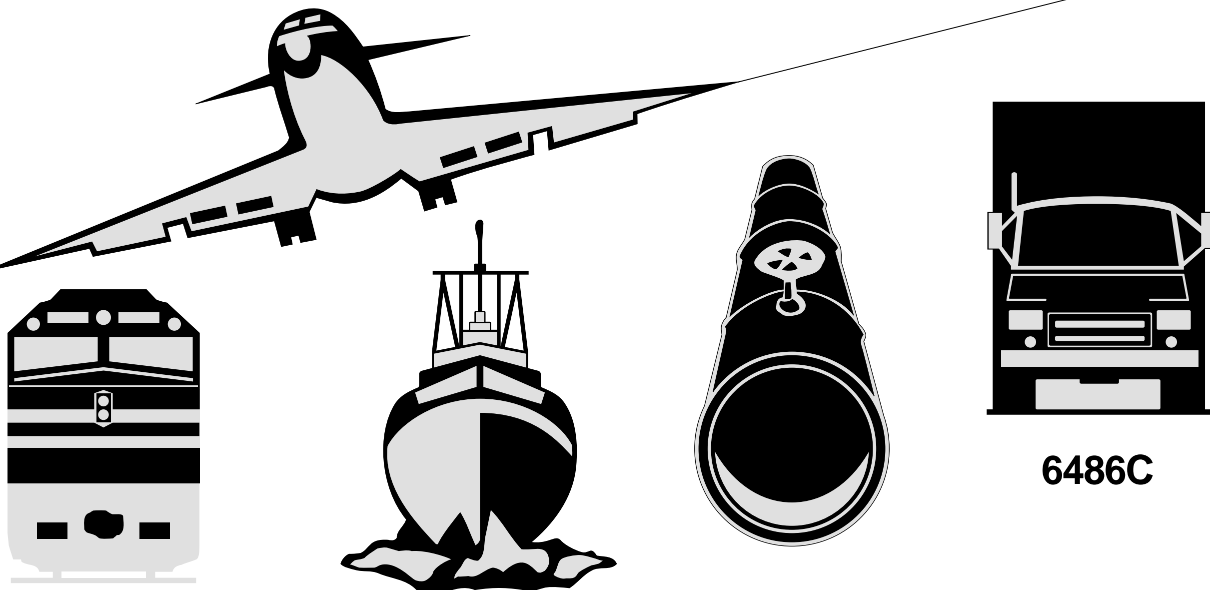
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

IN-FLIGHT ICING ENCOUNTER AND LOSS OF CONTROL SIMMONS AIRLINES, d.b.a. AMERICAN EAGLE FLIGHT 4184 AVIONS de TRANSPORT REGIONAL (ATR) MODEL 72-212, N4O1AM ROSELAWN, INDIANA OCTOBER 31, 1994

VOLUME II: RESPONSE OF BUREAU ENQUETES-ACCIDENTS TO SAFETY BOARD'S DRAFT REPORT



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Abstract: Volume II contains the comments of the Bureau Enquetes-Accidents on the Safety Board’s draft of the accident report. The comments are provided in accordance with Annex 13 to the Convention on International Civil Aviation. Volume I of this report explains the crash of American Eagle flight 4184, an ATR 72 airplane during a rapid descent after an uncommanded roll excursion. The safety issues discussed in the report focused on communicating hazardous weather information to flightcrews, Federal regulations on aircraft icing and icing certification requirements, the monitoring of aircraft airworthiness, and flightcrew training for unusual events/attitudes. Safety recommendations concerning these issues were addressed to the Federal Aviation Administration, the National Oceanic and Atmospheric Administration, and AMR Eagle.

INTRODUCTION

The BEA appreciates the invitation extended to it by the NTSB, as required by Annex 13 to the Convention on International Civil Aviation, to comment on the draft accident investigation Final Report. This will serve as the BEA’s comments on that draft Final Report. We understand that the Board, as required by Section 6.9 of Annex 13, will either amend the draft Final Report to include the substance of these comments, or append these comments to the Final Report.

However the BEA wishes to express its disappointment about its absolute non participation to the investigation phase related to analysis, findings, causes and safety recommendations, despite the initial commitment from the NTSB and despite its repeated efforts to provide the NTSB investigators with relevant views and documentation. This presently leads to a major disagreement between two Investigative Authorities on facts, analysis and on the accident causes, and, moreover, to the risk that the safety recommendations will not be properly taken into account by all the parties of the aviation community worldwide, because they will be based on an arguable report.

EXECUTIVE SUMMARY

General

The BEA strongly disagrees with substantial portions of the Factual, and with the Analysis, Conclusions, and Probable Cause sections of the report. In the BEA’s view, except for the Recommendations section, the present report is incomplete, inaccurate, and unbalanced. It appears to have been influenced by an a priori belief on the probable cause of this accident The BEA strongly believes that today one-sided approach is detrimental to the cause of international aviation safety.

The Factual section selectively reports the facts of this accident. Some relevant facts are omitted and

some other which are included are simply not accurate or their presentation is misleading. The BEA regrets it, since it had already advised the NTSB of a number of significant omissions, inaccuracies, and misrepresentations through his three sets of comments to the earlier drafts of this section. and since it was agreed that many of these errors would be rectified.

The Analysis and Conclusions sections are hampered by the incomplete and inaccurate Factual section. Many of the issues which are discussed are addressed in an incorrect or incomplete manner. Those sections also regrettably omit any discussion of several highly relevant issues for safety and for the understanding of this accident and fail to address a true combination of factors which has caused it. They clearly are unconsistent [sic] with the safety recommendations which follow.

Given the facts of this accident, the current Probable Cause statement, which ignores critical causal factors, is unbalanced, not correct, and detrimental to the public concern for safety.

Accordingly, the BEA considers that the report requires substantial reworking. Acknowledging the necessity, for achieving true aviation safety to take into consideration all relevant aspects of the aviation system, outside any national consideration or any a priori sharing of blame or liability, it has expended significant efforts to prepare in these comments such a substantial reworking of all or part of the quoted sections, to assist the NTSB in making the necessary revision and facilitate the inclusion of the comments.

Probable Cause Statement

This accident was caused by a combination of factors, as reflected in the following BEA-proposed Probable Cause Statement:

The Probable Cause of this accident is the loss of control of the aircraft by the flight crew, caused by the accretion of a ridge of ice aft of the de-icing boots, upstream of the ailerons, due to a prolonged operation of Flight 4184 in a freezing drizzle environment, well beyond the aircraft's certification envelope, close to VFE, and utilizing a 15 degree flap holding configuration not provided for by the Aircraft Operating Manuals, which led to a sudden roll upset following an unexpected Aileron Hinge Moment Reversal when the crew retracted the flaps during the descent.

The contributing factors to this highly unusual chain of events are:

1 The failure of the flight crew to comply with basic procedures, to exercise proper situational awareness, cockpit resource management, and sterile cockpit procedures, in a known icing environment, which prevented them from exiting these conditions prior to the ice-induced roll

event, and their lack of appropriate control inputs to recover the aircraft when the event occurred;

2. The insufficient recognition, by Airworthiness Authorities and the aviation industry worldwide, of freezing drizzle characteristics and their potential effect on aircraft performance and controllability;

3. The failure of Western Airworthiness Authorities to ensure that aircraft icing certification conditions adequately account for the hazards that can result from flight in conditions outside 14 CFR Part 25, Appendix C, and to adequately account for such hazards in their published aircraft icing information;

4. The lack of anticipation by the Manufacturer as well as by Airworthiness and Investigative Authorities in Europe and in the USA, prior to the post accident Edwards AFB testing program, that the ice-induced Aileron Hinge moment reversal phenomenon could occur;

5. The ATC's improper release, control, and monitoring of Flight 4184.

Associated Findings and Analysis

The NTSB's record in this investigation clearly shows that this flight crew had entered icing conditions, and yet failed to comply with mandatory requirements pertaining to such conditions contained in the applicable flight manuals, Federal Aviation Regulations, and explicit company policies, which, if followed, would have prevented this accident.

The situation was greatly exacerbated by the lack of proper situational awareness, cockpit resource management, and sterile cockpit procedures, which resulted in their failure to exit the known icing conditions prior to the ice-induced roll event and their subsequent surprise and lack of appropriate control inputs to recover the aircraft when the event occurred.

In the BEA's view, the operation of any airplane with unpowered flight controls in this fashion and environment, would severely jeopardize the safety of the flight. Accordingly, the BEA believes that these factors must be the focal point of the analysis, findings, and probable cause statement in this accident report. This is particularly true in light of the other more recent accidents involving cockpit failures by flight crews, which led to the FAA's pending in-depth review of a flight crew training program.

Thus, the BEA strenuously disagrees with the current Analysis, Findings, and Probable Cause Statement sections, which ignore, or address in a very shallow fashion, very important issues in this

accident, and only addresses in an excessive mode the aircraft and the manufacturer's and Airworthiness Authorities' responses to certain prior incidents. This excessive approach is simply [not] supported by the NTSB's own record of investigation.

Report Causal Factor No.1:

ATR failed to completely disclose to operators and incorporate in the ATR-72 AFM and FCOM and training programs, adequate information concerning previously known effects of freezing drizzle and freezing rain conditions on the stability and control characteristics, autopilot and related operational procedures when the ATR-72 is operated in such conditions.

Comment:

This probable cause finding (and the associated analyses and findings) is not supported by the record of investigation and is wrong.

ATR disseminated to its operators extensive information and warnings reminding them that prolonged exposure to freezing rain conditions is to be avoided. ATR also provided operators and flight crews with additional information designed to facilitate the recognition and avoidance of such conditions, which exceed the certification limits of all turboprop aircraft. ATR very specifically advised operators that such conditions could effect roll control forces leading to an autopilot disconnect and a resulting roll to a large bank angle until the crew took over the controls. ATR described appropriate recovery procedures and introduced them into ATR training programs. ATR also modified simulator packages for icing operations to simulate such roll departures.

In fact, the investigative record clearly shows that American Eagle/Simmons passed on to its flight crews these ATR warnings that, in icing conditions outside those specified in 14 CFR Part 25, Appendix C, the ATR 42/72 aircraft performance and controllability may be affected in such a way that autopilot self-disconnect and subsequent roll excursions could occur; that roll efficiency would nevertheless be maintained; and that recovery could be readily achieved by making firm aileron inputs to counter the roll excursions, and by applying basic stall recovery techniques.

In addition to stating that ATR did not provide operators with the above-referenced information, the report also states that an "aileron hinge moment reversal" mechanism was disclosed in the icing related incidents it reviews, and criticizes ATR for failing to issue warnings to specifically describe such an event. These "facts" are wrong and this assertion is untrue.

The basis for this assertion is the claim that an "aileron hinge moment reversal" was involved in the incidents of Mosinee, Ryanair, Air Mauritius, Burlington, and Newark and was therefore known to

ATR.

On the contrary, the DFDR data from Mosinee, Ryanair, Air Mauritius and Burlington incidents confirm that they were all stall departures following ice accumulations which resulted from flight crew failures to follow the basic procedures for operation in icing conditions by failing to select aiframe de-icing, to maintain minimum airspeeds or proper propeller speed settings.

No "aileron hinge moment reversal" was involved in Ryanair or Air Mauritius. The momentary modification of the aileron hinge moment in Mosinee and in Burlington which occurred after the asymmetrical stall commenced had no direct effect on these incidents. Both the NTSB and ATR determined that the Newark incident involved severe turbulence. From a review of the Newark DFDR data after Roselawn, because of the high level of turbulence, it cannot be determined whether or not any aileron hinge moment modification was involved in the incident.

The incorrect assertion of prior knowledge is all the more surprising [in] that the NTSB was the primary investigation authority for the Mosinee incident, with full access to the facts and data involved. It had full access to the BEA's report, which incorporated ATR's own analysis[,] and was involved with the FAA in several meetings with the BEA, the DCAC and ATR[.] The NTSB's level of participation and knowledge of the Mosinee incident was at least as great as any other entity investigating the incident. The NTSB had absolutely no recommendations or suggestions for any other corrective action, warnings, or any other response to the incident.

This assertion is also surprising because the NTSB not only received the full and open cooperation of the manufacturer, but also encouraged and participated in the manufacturer's extensive efforts after the Roselawn accident that led to the initial discovery of the ice-induced "aileron hinge moment reversal" phenomenon.

The NTSB knows of the extensive wind tunnel testing, high speed taxi tests, flight testing, and considerable efforts spent by the manufacturer after Roselawn for the first-ever USAF tanker freezing drizzle/rain testing program for civil or military aircraft at Edwards AFB. The NTSB knows from its own involvement in the testing that the phenomenon of an "ice-induced aileron hinge moment reversal" and its associated flow separation behind the boots at low Angle of Attack was discovered for the very first time as a result of this exhaustive post-Roselawn investigation

The BEA also wonders about the differences which a previously disseminated information on the phenomenon of an "ice-induced aileron hinge moment reversal[,]" had it been identified, would have brought to the crew's behaviour[.] The warnings which were provided to all operators, and which in turn were provided by Simmons to its flight crews, identified that the weather environment of concern

could affect roll control forces leading to an autopilot disconnect and a resulting roll to a large bank angle until the flight controls were taken over by the crew. The fact that such a change in aileron control forces might or might not be caused by an "aileron hinge moment reversal" is not a piece of information which would have added to the warning provided to the flight crews.

What is most disturbing about the report's position on this point is that it obscures the safety concern disclosed in this accident that this flight crew was so oblivious to the icing conditions they encountered that they ignored the multiple warnings, instructions, and regulations they already had received regarding proper operations in such conditions. To suggest that a more specific warning about an "aileron hinge moment reversal" phenomenon would have had any impact on this flight crew is not supportable by the NTSB's record of investigation.

Report Causal Factor No.2:

The French DGAC's inadequate oversight of the ATR-42 and ATR-72 and necessary corrective action to assure continued airworthiness in icing conditions.

Comment:

The BEA strongly disagrees with this erroneous probable cause finding (and the associated analyses and findings). The DGAC has consistently fulfilled its obligations as the primary certification Authority for the ATR-42 and ATR72 aircraft. The joint FAA/DGAC Special Certification Review Report confirmed that the ATR 42 and 72 were properly certified in full accordance with both US and European certification standards, that the DGAC acted correctly and properly in its certifications of the different ATR model aircraft, and that the DGAC and FAA properly applied the Bilateral Airworthiness Agreement ("BAA") between the U.S. and France in their certifications of the aircraft.

Despite this, the report's findings state that ATR airplanes have a unique susceptibility to ice-induced aileron hinge moment reversals. This is not accurate. The concern about ice-induced aileron hinge moment reversals caused by freezing drizzle droplets applies to all aircraft with unpowered controls. This is amply evidenced by (I) the Post-Roselawn review of other turboprop icing related events, which has disclosed similar characteristics for those airplanes, and (II) the FAA's recently proposed Airworthiness Directives relating to restrictions on operations in icing conditions, which result from the FAA's post-Roselawn accident investigation of how ice accretion resulting from freezing drizzle impacts on different models of aircraft. These proposed AD's apply to virtually every model of turboprop aircraft in the world.

The suggestion that the DGAC provided inadequate oversight and inadequate corrective action with respect to the ATR aircraft also, is not supported by the NTSB's investigative record regarding prior

ATR icing incidents. The investigative record demonstrates that the DGAC was actively involved in investigating the ATR previous icing events, considered whether these events warranted any corrective actions, and required that the manufacturer take decisive corrective action whenever this was appropriate.

This probable cause finding, and the associated analyses and findings, to the effect that the DGAC failed to require the manufacturer to take additional corrective actions and that this "led directly to this accident" appears to be based on the erroneous assumption that the DGAC had identified, from earlier ATR icing incidents, the "ice induced aileron hinge moment reversal" which was involved in the Roselawn accident.

Neither the DGAC nor the NTSB, FAA, BEA, or ATR identified, from their investigation of these earlier incidents, the "aileron hinge moment reversal" phenomenon which was involved in the Roselawn accident. This phenomenon was not identified until after the Roselawn accident. Thus, the BEA entirely disagrees with the statement that the DGAC's failure to require ATR to take additional corrective action "led directly to this accident."

Report Causal Factor No.3:

The French DGAC's failure to provide the FAA with timely airworthiness information developed from previous ATR incidents and accidents in icing conditions, as specified under the BAA and ICAO Annex 8.

Comments:

This probable cause finding (and the associated analyses and findings) appears to be based on a misunderstanding of the BAA and ICAO Annex 8, is not supported by the record of investigation, and is wrong.

The pertinent sections of the BAA (section 6) and of Annex 8 (Section 4.2.2), require the Exporting State to provide to other airworthiness authorities information obtained during the investigation of major incidents or accidents only where those incidents or accidents "raise technical questions regarding the airworthiness of [the aircraft]" or otherwise identify information which is "necessary for the continuing airworthiness of the aircraft and for the safe operation of the aircraft."

There is no factual basis whatever in the NTSB's record of investigation to support the suggestion that the DGAC failed to provide the FAA on a timely basis with critical airworthiness information developed from previous ATR icing events. Prior to the Roselawn accident there had never been an ATR 72 accident of any type, nor had there been any ATR-72 icing incidents involving roll control

issues.

With regard to the ATR-42 icing related incidents which were reviewed by the NTSB and occurred prior to the Roselawn accident, the facts demonstrate that the DGAC fully complied with its obligations under the BAA and Annex 8. In the one incident which did disclose an airworthiness issue (Mosinee — S/N 91), the DGAC worked closely with the FAA to identify corrective actions, passing on adequate information to the FAA and other Airworthiness Authorities. In the other incidents, no investigative Authority including the BEA and the NTSB determined that any aircraft airworthiness or safe operation issue was involved.

To the extent that the report is suggesting that the DGAC failed to disclose to the FAA information indicating that the ATR was susceptible to an aileron hinge moment reversal of the type which caused the Roselawn accident, this suggestion simply ignores the fact that none of the parties which had investigated any of the prior incidents, including the NTSB, had identified this phenomenon before the Roselawn accident.

RECOMMENDATIONS

The BEA notes with interest the disparity between the broad scope of the recommendations which the NTSB makes as a result of this accident and the selective focus of the NTSB's statements of its findings and proposed Probable Cause of this accident. The BEA generally does not disagree with the NTSB recommendations, but suggests several changes. To supplement its proposed revisions to the current recommendations, the BEA suggests the addition of recommendations to ensure that (1) flight crews "report icing conditions to ATC/FSS," as required by the Airman's Information Manual; (2) air traffic controllers solicit PIREPS regarding "icing of light degree or greater," as required by FAA Order 7110.65, Air Traffic Control; (3) NTSB and FAA provide on a timely basis all pertinent information from their accident and incident investigations respectively to the Investigative and Airworthiness Authorities of the country of certification and manufacture of the aircraft involved; and (4) FAA take all necessary steps to recall to the Airlines and Flight crews, the rules and procedures regarding cockpit discipline, cockpit resource management and situational awareness, which were missing in this accident.

CONCLUSION

The BEA firmly believes that if the draft Final Report is reworked as suggested here, then the long-term legacy of the Roselawn accident and its investigation will be the development of critically important safety lessons with regard to not only the dangers posed by freezing drizzle and the need to modify icing certification and operational standards, but the other important issues discussed herein

as well. Such safety lessons will benefit the entire aviation industry worldwide.

3.1. BEA FINDINGS

The BEA strongly believes that the following Findings are mandated by the facts of this accident. These Findings are fully supported by the previously cited factual references and analysis of the accident.

1. This accident occurred as a result of a prolonged operation of the aircraft in freezing drizzle/rain conditions well beyond the certification envelope for all aircraft.

2. Airworthiness Authorities and the aviation industry worldwide did not sufficiently recognize, prior to the Flight 4184 accident, freezing drizzle characteristics and their potential effect on aircraft performance and controllability.

3. Despite investigation of prior incidents involving icing conditions outside 14 CFR Part 25, Appendix C, by the NTSB, BEA, ATR, FAA and DGAC these parties did not anticipate the mechanism of the ice-induced aileron hinge moment reversal that was involved in this accident and that was not discovered until the post-accident Edwards AFB testing program.

4. ATR properly analyzed and took appropriate and adequate measures in response to such prior icing related incidents.

5. The DGAC acted correctly and properly in its certifications of the different ATR model aircraft as the primary certification authority, and the FAA properly applied the Bilateral Airworthiness Agreement in its certifications of the aircraft.

6. The DGAC provided appropriate oversight of the continued airworthiness of the ATR-42 and ATR-72 aircraft and took all appropriate actions to assure the continued airworthiness of the aircraft in response to such prior icing related incidents.

7. The DGAC provided the FAA on a timely basis with all relevant airworthiness or safety of operation information developed from previous ATR icing incidents, including those in freezing rain, in full compliance with the BAA and ICAO Annex 8.

8. The FAA Indianapolis Ground Controller released Fight 4184 from a 42-minute ground hold despite having been informed by the Traffic Management Coordinator that conditions were such that the flight would likely be required to hold in the air before reaching its destination.

The release of Flight 4184 under these conditions was contrary to the policy established in FAA Order 7110.65, *Air Traffic Control,* to reduce congestion in the air traffic system and to limit the duration of airborne holding.

9. American Eagle/Simmons' policy precluded the distribution of AIRMET *Zulu Update 3 for icing and freezing level* in the Flight Release for Flight 4184. This AIRMET was applicable to Flight 4184's route of flight from Indianapolis to Chicago, and stated that "light occasional moderate rime icing in cloud and in precipitation" could be expected. This AIRMET also provided information regarding the freezing level along Flight 4184's route of flight.

10. AMR Eagle/Simmons was adequately warned by ATR prior to the accident about the dangers of operating in freezing precipitation and understood the need to avoid such conditions.

11. AMR Eagle/Simmons, in turn, warned its flight crews prior to the accident about the dangers of operating in icing conditions, including freezing precipitation, and instructed its flight crews to avoid such conditions.

12. The flight crew of Flight 4184 had been expressly warned about the dangers of freezing precipitation and the necessity of crew vigilance.

13. Flight 4184's flight crew knew they were operating in icing conditions.

14. Proper monitoring of the outside air temperature, clouds, precipitation, and the ice accumulating on the aircraft by the crew of Flight 4184 would have informed them that they might be operating in a freezing precipitation environment.

15. Despite these warnings and instructions, and having entered known icing conditions, the flight crew of Flight 4184 had absolutely no discussions regarding: the nature and extent of the icing conditions they were encountering; the outside meteorological conditions; the need to request a clearance to an alternative altitude or route to remain clear of the known icing conditions; the operation of the aircraft's de-icing and anti-icing equipment.

16. Flight 4184's flight crew had ample opportunity to ask the ATC for a clearance to exit the icing conditions.

17. AMR Eagle/Simmons' company policies require that flight crews stay out of icing conditions when possible.

18. After the Mosinee incidents, ATR proposed to the FAA, through the DGAC, a revision to the ATR-42 FCOM and AFM which contained information on the effects of freezing rain conditions on aircraft stability and control characteristics and on the autopilot and set forth related operational procedures to be used when an aircraft inadvertently encounters such prohibited conditions. This proposal was not accepted by the FAA.

19. ATR provided Simmons and other operators with the identical information, applied to both the ATR-42 and ATR-72 aircraft, concerning the effects of freezing rain (understood by Simmons to include "freezing precipitation" in the AOM).

20. ATR provided specific warnings to Simmons and other operators, for their pilots, about the adverse characteristics of freezing rain and about roll events which could occur in such conditions and gave specific guidance for recovery from such events and, in addition, developed aircraft modifications seeking to reduce the possibility of such events occurring.

21. Simmons company policy had already provided ample instructions to the Flight Crews regarding the icing threat and the basic rules of behaviour to face such a situation.

22. The failure of Flight 4184's flight crew to follow these company policies and manual provisions and exit the known icing conditions led directly to this accident.

23. Despite the lack of anticipation by the NTSB, BEA, ATR, FAA and DGAC, prior to the accident, of the mechanism of the ice-induced aileron hinge moment reversal, Simmons/AMR Eagle and its flight crews had been warned that, under icing conditions outside those specified in 14 CFR Part 25, Appendix C the ATR 42/72 aircraft performance and controllability might be affected in such a way that auto-pilot self-disconnect and subsequent roll excursions could occur; that roll efficiency would nevertheless be maintained; that recovery could be achieved by making firm aileron inputs to counter the roll excursions and by applying basic stall recovery techniques. These were appropriate and adequate instructions to flight crews based on what was known from prior incidents.

24. ATR adopted appropriate and adequate changes to its flight crew training program and simulator data training package based on what was known from prior icing incidents.

25. Chicago ARTCC controllers were aware that light to moderate icing conditions were forecast for the area of LUCIT intersection at the time Flight 4184 was released from its ground hold.

26. Chicago ARTCC controllers had received PIREPs reporting icing conditions on the day of the

accident and had been specifically briefed by their supervisor at the beginning of their shift that they must be aware of icing conditions and because "Icing Kills."

27. Chicago ARTCC controllers were aware that the weather conditions were deteriorating throughout the Chicago area before and during the time Flight 4184 was enroute from Indianapolis to Chicago. Therefore they could not have ignored the specific weather conditions at the LUCIT holding pattern, at Flight Level 100.

28. If the Controller at Chicago ARTCC had received an icing PIREP from Flight 4184, immediate precautionary communication would have been made by ATC with the crew regarding exiting the icing area.

29. Flight 4184 was the only aircraft holding at LUCIT intersection, and multiple altitudes were available for diversion from the known icing conditions.

30. AMR Eagle/Simmons' company policy, Federal Aviation Regulations, and the Airman's Information Manual require that flight crews provide ATC with a PIREP of known icing conditions. However the crew of Flight 4184 did not to provide such a report of their known icing conditions.

31. Had the crew of Flight 4184 provided to ATC the mandatory PIREP of their known icing conditions, ATC would have provided them with a diversionary clearance so that they could have immediately exited the icing conditions. The flight crew's failure to provide a PIREP of their known icing conditions contributed to this accident.

32. FAA Order 71 10.65J, *Air Traffic Control,* requires ATC controllers to solicit PIREPS of "icing of light degree or greater" when such conditions exist or are forecast to exist in their area of jurisdiction. ATC did not solicit an icing PIREP from Flight 4184, that contributed to this accident.

33. ARTCC failed to report to the Air Traffic Control System Command Center (ATCSCC) and the Traffic Management Coordinator of the excessive holding time experienced by Flight 4184 as required.

34. The Sterile Cockpit Rule (as imposed by FAR 121.542 and Simmons/AMR Eagle's Flight Manual) requires the captain to impose the rule during any phase of a particular flight as deemed necessary. This rule should have been applied by the Captain of Flight 4184.

35. Flight 4184's holding in known icing conditions at 10,000 feet, in instrument conditions, awaiting momentary clearance to descend below 10,000 feet to commence an instrument approach into one of the world's busiest airports constituted a "critical phase of flight" within the meaning and intent of FAR Section 121.542.

36. The flight crew of Flight 4184 demonstrated a lack of involvement in primary duties and failed to exercise proper situational awareness as well as proper Cockpit Resource Management. This directly contributed to the accident.

37. The Captain's lack of assertiveness and complete failure to integrate himself into the required flight activities left the entire operation of the aircraft to the First Officer.

38. AMR Eagle/Simmons' ATR42/72 Airplane Operating Manual (AOM) provides only for holding with the aircraft configured in the flap zero degree configuration. Flight 4184's flight crew's unauthorized use of the flap 15 configuration while holding at 175 knots in icing conditions created the critical ice ridge beyond the de-icing boots which ultimately led to the roll upset, and thereby directly contributed to the accident.

39. Post-accident flight tests at Edwards Air Force Base and in France confirmed that Flight 4184 was recoverable after the initial roll upset.

3.2. PROBABLE CAUSE

This accident was caused by a combination of factors, as reflected in the following BEA-proposed Probable Cause Statement :

The Probable Cause of this accident is the loss of control of the aircraft by the flight crew, caused by the accretion of a ridge of ice aft of the de-icing boots, upstream of the ailerons, due to a prolonged operation of Flight 4184 in a freezing drizzle environment, well beyond the aircraft's certification envelope, close to VFE, and utilizing a 15 degree flap holding configuration not provided for by the Aircraft Operating Manuals, which led to a sudden roll upset following an unexpected Aileron Hinge Moment Reversal when the crew retracted the flaps during the descent.

The contributing factors to this highly unusual chain of events are:

1. The failure of the flight crew to comply with basic procedures, to exercise proper situational awareness, cockpit resource management, and sterile cockpit procedures, in a known icing environment, which prevented them from exiting these conditions prior to the ice-induced roll

event, and their lack of appropriate control inputs to recover the aircraft when the event occurred;

2. The insufficient recognition, by Airworthiness Authorities and the aviation industry worldwide, of freezing drizzle characteristics and their potential effect on aircraft performance and controllability;

3. The failure of Western Airworthiness Authorities to ensure that aircraft icing certification conditions adequately account for the hazards that can result from flight in conditions outside 14 CFR Part 25, Appendix C, and to adequately account for such hazards in their published aircraft icing information;

4. The lack of anticipation by the Manufacturer as well as by Airworthiness and Investigative Authorities in Europe and in the USA, prior to the post accident Edwards AFB testing program, that the ice-induced Aileron Hinge moment reversal phenomenon could occur;

5. The ATC's improper release, control, and monitoring of Flight 4184.

4. [DETAILED] RECOMMENDATIONS

The BEA notes with interest the disparity between the broad scope of the recommendations which the NTSB makes as a result of this accident and the selective focus of the NTSB's statements of its findings and proposed Probable Cause of this accident. Except as noted below, the BEA agrees with the NTSB recommendations.

4.1. FLIGHT CREW PERFORMANCE — STERILE COCKPIT

It is significant that the Report recommends that the FAA evaluate the need to make observance of the sterile cockpit rule mandatory for air carriers when their aircraft are holding in icing conditions regardless of altitude (4.2.8), and recommends that AMR Eagle "encourage" its captains to observe a sterile cockpit environment in icing conditions. These recommendations are in sharp contrast with the Report's incorrect "findings" that the gross distractions of this flight crew and the Captain's departure from the cockpit in <u>known</u> icing conditions "did not contribute to this accident." The BEA suggests that the NTSB recommend that the FAA take steps to emphasize that the sterile cockpit rule applies to <u>all</u> critical phases of flight, and that a critical phase of flight includes all operations in known icing conditions, regardless of altitude. This recommendation is consistent with the FAA's rationale behind the sterile cockpit rule.

4.2. PRE-FLGHT AND IN-FLIGHT WEATHER INFORMATION

The report's nine recommendations regarding pre-flight and in flight weather information (4.11 -4.16, 4.3, 4.2, and 4.3) seek to assure that pilots are provided, obtain, and consider all pertinent weather information both for in-flight and pre-flight planning purposes, and that further steps be taken to improve the quality of the information. The BEA agrees with these recommendations, but finds it surprising that the report makes no mention in its findings of the failure of the Company to provide the flight crew of Flight 4184 with AIRMET information which specifically forecasted icing conditions along their route of flight, and the complete absence in the CVR transcript of any effort by the flight crew to update their weather information while enroute and during their hold.

4.3. PIREPS

The BEA suggests that the NTSB recommend that the FAA and American Eagle/Simmons take steps to enforce the Airman's Information Manual (AIM) requirement that flight crews "report icing conditions to ATC/FSS." The BEA also suggests that the NTSB recommend that the FAA take steps to enforce FAA Order 7110.65, Air Traffic Control, which requires that ATC solicit PIREPS regarding "icing of light degree or greater." The failure of the flight crew to provide a PIREP to ATC, and the failure of ATC to solicit a PIREP from the flight crew, and the critical effects of these failures in contributing to this accident are ignored by the report in its findings and recommendations. It is insufficient to simply suggest, as does report Recommendations 4.31, that the definition of PIREP information should be amended.

4.4. AIRCRAFT CERTIFICATION — FREEZING DRIZZLE/RAIN

The report's five recommendations regarding aircraft certification (4.17 - 4.21) properly call for more accurate determination of the parameters affecting ice accretion. However, if the recommendation to expand the icing certification envelope to include freezing drizzle/freezing rain conditions as necessary is meant to imply that the NTSB believes aircraft should now be certified for operations in these dangerous conditions where the risks to aircraft are still relatively unknown, instead of focusing on improved detecting and avoidance of these conditions, the interests of aviation safety are not being served. Regarding the report's recommendation for certification test programs and certification criteria[,] these issues are addressed in Recommendation 3 of the Special Certification Review Report of the FAA and DGAC. The BEA therefore suggestions that this recommendation be adopted by the NTSB to replace the current recommendation on this subject.

4.5. CERTIFICATION AND CONTINUING AIRWORTHINESS UNDER

THE BAA

The BEA believes that with respect to the report's three recommendations to the FAA regarding certification and monitoring of continued airworthiness of aircraft operating in the U.S. (4.25 to 4.27), the NTSB recognizes that the concern is not with the BAA itself, but instead with the procedures being used for the mutual exchange of significant incident, accident, and other airworthiness information pursuant to either the BAA or other formal or informal agreements between the FAA and DGAC. The BEA suggests that the report recommend that the NTSB and the FAA take steps to assure that all pertinent information from accident and incident investigations conducted by the NTSB or FAA involving a foreign manufactured aircraft, including all facts and analyses of incidents and accidents and other airworthiness information, is provided on a timely basis to the exporting country's airworthiness authority so that it can monitor and insure the continued airworthiness of aircraft certified by it as the primary certification authority.

4.6. ATR

The recommendation the report makes to ATR is written so as to imply that there is a "hinge moment reversal problem" with the aircraft that has not been resolved. The BEA disagrees with this implication The actions taken as a result of the post-accident investigation and test program, including those addressed to flight crews and the modifications of the boots, addressed and resolved the issue. The BEA also does not believe that this issue is unique to ATR. Rather, it applies to all turboprop aircraft, as evidenced by the recent FAA proposed Airworthiness Directives on this subject, which apply to virtually every model of turboprop aircraft in the world. The BEA encourages the further work being done by ATR to consider redundant safety measures to protect against inadvertent encounters with icing conditions beyond Appendix C certification standards.

4.7. AMR EAGLE

Based on the lack of cockpit discipline the the BEA suggest that the report recommends that the FAA and AMR Eagle take all necessary steps to prevent the recurrence of such conduct. In the this regard, AMR Eagle's operating and training procedures should be fully reviewed and corrected if necessary, so as to address such conduct.

The BEA agrees with the report recommendation that the FAA require air carriers to provide standardized the training that adequately addresses recovery from unusual events and unusual attitudes it *(*4.29*)*. Based upon this accident, the BEA supports the report recommendation that AMR Eagle takes steps to immediately institute a training program to address these issues with flight crews.