



National Transportation Safety Board

Washington, D.C. 20594

September 13, 2002

Petitioners:

Pierre Graff, Le Directeur Général de L'Aviation Civile, and
Antoine Bouvier, Chief Executive Officer, Avions de Transport Régional

Aircraft Accident:

ATR 72-212, N401AM
Roselawn, Indiana
Notation 6486C,
Accident No. DCA-95-MA-001

RESPONSE TO PETITIONS FOR RECONSIDERATION

On July 9, 1996, the National Transportation Safety Board adopted its final report on the crash of an Avions de Transport Régional, model 72-212 (ATR 72), registration number N401AM, leased to and operated by Simmons Airlines, Incorporated (Simmons Airlines), and doing business as American Eagle flight 4184.¹ The crash occurred on October 31, 1994, near Roselawn, Indiana. By letter dated November 29, 1996, the French civil aviation authority, Le Directeur Général de L'Aviation Civile (DGAC), petitioned for reconsideration of the Safety Board's report. By letter dated May 28, 1998, the Federal Aviation Administration (FAA) submitted comments in support of the DGAC petition. By letter dated July 14, 1998, the Air Line Pilots Association (ALPA) submitted comments disagreeing with the DGAC petition and supporting the Board's report. By letter dated July 16, 1998, American Eagle also registered its disagreement with the DGAC's petition. By letter dated September 22, 1999, the manufacturer of the accident airplane, Avions de Transport Régional (ATR), filed a petition for reconsideration of the Board's report. The ATR petition raises many of the same issues discussed in the DGAC petition and expresses agreement with the positions taken by the DGAC and FAA.² By letter dated July 10, 2001, ALPA submitted comments disagreeing with the ATR petition and, again, supporting the Board's report.

¹ NTSB/AAR-96/01, *In-flight Icing Encounter and Loss of Control, Simmons Airlines dba American Eagle Flight 4184, Avions de Transport Regional (ATR) Model 72-212, N401AM, Roselawn, Indiana, October 31, 1994.*

² The Safety Board notes that, prior to the Board's consideration and adoption of the final report, the French accident investigation authority, Bureau Enquêtes-Accidents (BEA), filed comments on the Safety Board's draft final report that raised many of the same issues presented in the DGAC and ATR petitions; these comments were published as Volume II to the Safety Board's final report.

In accordance with 49 *Code of Federal Regulations* (CFR) Section 845.41, the Safety Board has reviewed all of these filings. On the basis of this review, the Safety Board grants the petitions in part and denies them in part.

Background Information

On October 31, 1994, at 1559 central standard time, an ATR 72 being operated by Simmons Airlines as flight 4184 crashed following an in-flight icing encounter that led to an uncommanded roll excursion and rapid descent. The airplane had been in a holding pattern at 10,000 feet with the flaps extended to 15° during the 24 minutes preceding the crash. The investigation revealed that, during this time, the airplane intermittently encountered freezing drizzle/freezing rain and accreted a ridge of ice aft of the deice boots in front of the ailerons, but that the crew was unaware of either circumstance. The crew had just retracted the flaps and was descending at 186 knots indicated airspeed (KIAS) to the flight's newly assigned altitude of 8,000 feet when, as the airplane's angle of attack was increasing through 5°, a rapid uncommanded aileron deflection caused the autopilot to disconnect and the airplane to roll sharply (77°) to the right. The crew's attempts to recover the airplane were unsuccessful; the airplane rolled two more times, at one point becoming inverted, before it impacted the terrain. The airplane was destroyed by impact forces, and the captain, first officer, 2 flight attendants, and 64 passengers were killed.

The Safety Board's final report on the accident contained the following 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 in-flight 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 [Airman's Meteorological Information].
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 warning 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 [angle of attack] 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 [Aircraft Flight Manual/Flight Crew Operating Manual] 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 the 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 instructors, 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.

The Safety Board determined that the probable cause of the accident was the following:

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.^[3]

³ The Board recognizes that the reference to the "International Civil Aviation Organization" should have been to the "Convention on International Civil Aviation."

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.

The petitioners do not disagree that the accident was precipitated by a sudden and unexpected aileron hinge moment reversal or shift⁴ that occurred after a ridge of ice accreted beyond the deice boots. However, they challenge much of the remainder of the Safety Board's probable cause statement, as well as many of the Board's other findings. They also take issue with many statements, both factual and analytical, from the text of the Board's report. ATR requests that the probable cause be modified to state that the accident occurred "following a prolonged operation of the aircraft in hazardous icing conditions well outside the certification envelope and for which no airplane is certified."

Discussion

The issues raised by the petitioners fall into the following three general areas:

1. The relevance of previously known information about aileron behavior and in-flight icing/roll events to the circumstances of the Roselawn accident – The petitioners assert that, contrary to the Safety Board's findings, prior to the Roselawn accident, ATR and the DGAC were not aware, nor could they have been aware, of the aileron hinge moment shift phenomenon that led to the Roselawn accident. The petitioners assert that information developed during certification of the ATR 42 and 72 and analysis of prior ATR 42 icing/roll incidents did not disclose the possibility of this phenomenon and, therefore, the actions taken in response to the prior icing incidents were appropriate.
2. The adequacy of the initial certification and monitoring of continued airworthiness of the ATR 42 and 72 under Annex 8 of the International Convention on Civil Aviation (Annex 8) and the Bilateral Airworthiness Agreement (BAA) – The petitioners assert that the following Safety Board findings are unsupported: that the FAA relied excessively on the DGAC during the initial certification of the ATR 42 and 72 (finding 30) and that the

⁴ Hinge moment is the tendency of a force to produce rotational movement about a hinge; in this case, it refers to the tendency of aerodynamic forces acting on an aileron surface to produce motion about the hinge axis of the surface. "Aileron hinge moment reversal" was used in the Safety Board's report to describe the phenomenon at issue because, in the Roselawn accident and in each of the previous incidents discussed in the report, the sign of the aileron hinge moment coefficient on the wing affected by flow separation changed from positive to negative (in other words, reversed) when it shifted from a stable trailing edge down moment to an unstable trailing edge up moment. For purposes of the Safety Board's report and this response to the petitions for reconsideration, the broader terms "aileron hinge moment modification" or "aileron hinge moment shift" could have been used in place of the term "aileron hinge moment reversal." However, it should be noted that uncommanded aileron deflections would not result from a hinge moment modification or shift unless the modification or shift also constituted a reversal. The conclusions in the Board's report and in this response would be the same regardless of which term is used to describe the phenomenon.

DGAC did not provide adequate information to the FAA about the continuing airworthiness of the ATR 42 and 72 (finding 29).

3. The role of crew performance in the Roselawn accident – The petitioners contend that the flight crew displayed poor cockpit discipline, resource management, and vigilance and that the Safety Board’s report failed to address the role that these deficiencies played in the accident.

1. Relevance of previously known information about ATR 42 and 72 aileron behavior and ATR 42 in-flight icing/roll events to the circumstances of the Roselawn accident

A) Development and certification of the ATR 42 and 72

Petitioners’ Arguments

The DGAC and ATR contend that no hinge moment activity comparable to what occurred at Roselawn was ever encountered during ATR 42 or 72 development or certification flight tests which, according to ATR, is contrary to page 176 of the Safety Board’s report, which states that “ATR had experienced aileron hinge moment reversals during the development of both the ATR 42 and 72.” The DGAC and ATR state in their petitions that uncommanded aileron activity that was noted at or near the stall regime during certification and development flight tests is a normal and expected hinge-moment characteristic of a nonhydraulic flight control system and is fully acceptable. Further, ATR asserts that the stall protection system (SPS) was not developed “for the sole reason of preventing alleged ‘hinge moment reversals,’” but was installed to address the potential of a deep stall. Although it was determined that no such potential existed, ATR states that the system was nonetheless “retained to provide a clear and distinctive stall identification.”

The petitioners also object to the Safety Board’s characterization of the vortex generators that were added to the ATR 42 in 1990 following the 1988 icing/roll event at Mosinee, Wisconsin,⁵ and that were incorporated into the design of the ATR 72 airplane. The Board’s report states the following on page 74:

During the ATR 72 development stages, efforts were made to achieve the needed roll and [angle of attack] performance by various means. Initial aileron configurations resulted in hinge moment reversals at [angles of attack] deemed to be too low by ATR. Vortex generators were then added to the upper wing surface of the ATR 72, in front of the ailerons, which delayed the aileron hinge moment reversal to 25 degrees vane [angle of attack]. The installation of the vortex generators, which proved effective in postponing the flow separation in the area of the ailerons and the resulting aileron hinge moment reversal, prompted ATR to develop similar aileron vortex generators for the ATR 42 as a product improvement.

⁵ This incident is discussed in more detail in the following section, “Previous ATR 42 icing/roll incidents.”

The report also states the following on page 80:

According to ATR statements provided to the Safety Board after the Roselawn accident, the vortex generators increased the [angle of attack] at which the airflow separation occurred and would provide an additional [angle of attack] margin of several degrees between the normal operating [angle of attack] and the aileron hinge moment reversal [angle of attack].

The DGAC and ATR contend that the vortex generators were not designed to correct the type of hinge moment shift that occurred at Roselawn; rather, they were intended to delay the onset of icing-related stalls and to improve the efficiency of the ailerons in the stall regime.

Finally, the petitioners point out that the Special Certification Review (SCR) team, which was convened after the Roselawn accident in response to a recommendation from the Safety Board,⁶ found that neither the ATR 42 nor the 72 exhibited “unsafe or atypical lateral control wheel force characteristics” during certification and although “minor uncommanded aileron activity was noted on several stalls . . . this activity was (and is) considered acceptable.” The SCR concluded that both airplanes were properly certificated in accordance with applicable regulations, practices, and procedures.⁷

Therefore, according to the petitioners, the development and certification history of the ATR 42 and 72 does not indicate that ATR or the DGAC was, or should have been, aware of the hinge moment phenomenon that occurred at Roselawn.

Safety Board’s Response

The information conveyed to Safety Board investigators by ATR engineers about the development of the lateral control system clearly indicates an awareness early in the history of the ATR 42 and 72 airplanes that they were subject to hinge moment shifts caused by airflow separation and an awareness that this phenomenon could be induced by asymmetrical ice buildups in front of the ailerons. Specifically, as recounted on page 74 of the Board’s report,

ATR engineers stated that the initial ATR 42 aileron system development included multiple balance/hinge moment-related configuration changes to achieve the desired roll efficiency, hinge moment characteristics, and roll trim characteristics. Several ATR 42 developmental aileron configurations produced aileron hinge moment reversals at low [angles of attack]. According to ATR engineers, the final ATR 42 design was a “compromise of acceptable roll rates

⁶ Safety Recommendation A-94-181, issued on November 7, 1994, asked the FAA to “[c]onduct 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.” Safety Recommendation A-94-181 was classified “Closed – Acceptable Action” on page 142 of the Safety Board’s report.

⁷ The SCR team included members from the FAA and DGAC and one individual from the National Aeronautics and Space Administration (NASA), but did not include any representatives from the other parties to the investigation.

and hinge moments,” and resulted in the aileron hinge moment reversals being delayed to about 25 degrees [angle of attack]. ATR indicated that the aileron hinge moment reversals were linked to aerodynamic stall. The susceptibility to hinge moment reversal from aerodynamic stall is a characteristic of aerodynamically balanced control surfaces at high [angles of attack], and the characteristics can vary among configurations.

According to ATR officials, the ATR 42 SPS was designed to provide a margin between “normal” aircraft operations and the higher [angles of attack] found to be associated with undesirable handling characteristics, including, but not limited to, aileron hinge moment reversals. SPS [angle of attack] thresholds were established for both a “clean” and “iced” airplane. The SPS threshold values for the airplane with ice contamination were established based upon the [angles of attack] at which undesirable handling characteristics, including aileron hinge moment reversals, occurred during the icing certification handling tests. This SPS design was carried forward during the development of the ATR 72.

Further, as stated on page 75 of the Board’s report,

The Safety Board reviewed graphical data from developmental test flights in which the aileron hinge moment reversals were encountered during flight test stall demonstrations. The graphs indicated that the aileron hinge moment reversal occurred at or above the current “clean” [free of contamination such as ice] airplane stick pusher activation [angle of attack]. The stall speeds noted on the graphs where the hinge moment reversals occurred were about 100 knots indicated airspeed (KIAS), and the flight test pilot indicated that the control forces required to counteract the uncommanded aileron deflections were “not excessive.” ATR engineers agreed in principle that airfoil contamination, such as icing, could tend to lower the [angle of attack] at which the aileron hinge moment reversal occurs, and that icing conditions beyond those specified for certification could lower the [angle of attack] at which the aileron hinge moment reversals occur to below the certified icing stall protection system (SPS) [angle of attack] thresholds.

In its petition, ATR objects to these paragraphs in the Safety Board’s report as “misleading.” However, ATR does not deny that the information reported in those paragraphs was conveyed to investigators by ATR officials and engineers. All of the information contained in the above quotations from pages 74-5 of the Board’s report was presented to the Airplane Performance Group by ATR representatives at a November 15, 1994, meeting. The Airplane Performance Group Chairman documented this information after attending that presentation. Consistent with the Board’s standard procedure, a draft of the Airplane Performance Group Chairman’s report⁸ was provided to all the parties, including ATR, for comment before it was entered into the public docket. In its comments on this draft report, ATR did not object to any of the information cited in the paragraph above.

⁸ The final version of this report, titled *ATR-42/72 Lateral Control System Development History Factual Report*, dated February 9, 1995, is included the Safety Board’s public docket on this accident.

ALPA, in its comments on the DGAC petition, describes the November 15, 1994, meeting (at which representatives from ALPA were also present) and confirms that the

[g]roup was informed by ATR engineers that hinge moment related design changes were required during the design and development history of the ATR control system (Reference NTSB Exhibit 13C, ATR-42/72 Lateral Control System Development History Factual Report). An intermediate design resulted in an aileron hinge moment reversal. This phenomenon was similar to that believed to have caused the [flight] 4184 accident. The original flight test data indicated that at [angles of attack] above 12-14°, the force required to maintain a given aileron position (hinge moment) actually begins to decrease rapidly. For these reasons, a Stall Protection System (SPS) and vortex generators were installed on each model aircraft to provide a suitable margin between aircraft operations and the anomaly.

In its comments on the ATR petition, ALPA asserts that the development of, and changes to, the ATR 42 and 72 aileron system indicate that “hinge moment effects were identified, discussed and acted upon during design. Although the potential severity of this anomaly may never have been envisaged, it was known and dealt with.”

An awareness that hinge moment shifts caused by airflow separation could be induced by asymmetrical ice buildups in front of the ailerons is also evident in a March 21, 1989, letter from the DGAC to the FAA following the 1988 icing/roll event at Mosinee, Wisconsin. According to ATR’s analysis of the event (which ATR had provided to the DGAC), that event involved asymmetrical ice buildup resulting in a hinge moment shift followed by uncommanded aileron deflections.⁹ Following the Mosinee event, the FAA issued a notice of proposed rulemaking (NPRM) proposing to mandate the installation of vortex generators on all ATR 42 airplanes.¹⁰ In the DGAC’s March 21, 1989, letter,¹¹ which it submitted in response to the FAA’s proposal, the DGAC stated the following:

it has been shown that the [Mosinee] incident most probably occurred as a consequence of asymmetrical ice buildups on the wing in front of the ailerons, after a prolonged flight in freezing rain.

The ATR constructor has very recently been led to investigate, as part of the development of the ATR 72 project, several options for its roll control. Among these configurations, the installation of vortex generators on the upper

⁹ As previously noted, a hinge moment shift that results in an uncommanded aileron deflection is a hinge moment reversal.

¹⁰The FAA’s NPRM stated that “installation of vortex generators on the upper surface of the...ATR 42 airplane wing significantly improves the effectiveness of the ailerons, which reduces the severity of the roll upset that can occur with asymmetric ice accumulations resulting from icing conditions such as freezing rain. ... The FAA has determined that long term continued operational safety will be better assured by design changes to remove the source of the problem rather than by repetitive inspections or special operating procedures.” See 54 Federal Register 300059, 300060 (July 18, 1989).

¹¹ This letter is included as Appendix I to the BEA’s comments on the Safety Board’s draft final report, which was published as Volume II of the Board’s final report.

wing surface forward of the ailerons has proved to be efficient in correcting the local airflow disturbances coming from ice buildups on the leading edge. This improvement should also be worthwhile in the cases of asymmetric ice buildups or deposits.

Thus, the development and installation of vortex generators in response to Mosinee (which ATR and DGAC knew involved a hinge moment shift and uncommanded aileron deflection after asymmetric ice buildup) indicates that the vortex generators were intended, at least in part, to address this phenomenon.

The DGAC and ATR acknowledge in their petitions that the SPS and vortex generators were installed on ATR airplanes to help pilots avoid stalls and stall-related control difficulties. If, as the DGAC and ATR contend, uncommanded aileron deflections are a normal and expected part of the stall regime, then avoidance of, or delaying the onset of, stall and related lateral control difficulties will naturally prevent or delay the onset of the resulting uncommanded aileron deflections. This was confirmed by testimony from ATR's Chief Engineer at the Safety Board's public hearing. In response to questioning about the SPS thresholds, he indicated that the setting of those thresholds was aimed at eliminating both basic wing stalls within the certification envelope and what he referred to as "the separate phenomena ... [of] uncommanded aileron deflection[s]." It does not follow, however, that these activities indicate an awareness of the potential for hinge moment shifts at angles of attack well below stall thresholds like the event at Roselawn. To this extent, the petitioners are correct – the developmental history of certification does not indicate an awareness of the special case of Roselawn. The pertinent point is only that the general phenomenon was understood and the special sensitivity of the ATR 42 and ATR 72 flight control arrangements is part of the backdrop against which subsequent consideration of ATR icing events occurred.

Finally, the Safety Board notes that the SCR's findings confirmed that minor, uncommanded aileron activity was noted, albeit in the stall regime near the stick pusher angle of attack, during certification flights of the ATR airplanes with ice shapes representative of those that could develop in Appendix C conditions. The fact that the DGAC and the FAA deemed this aileron activity to be acceptable and certified the airplane pursuant to all applicable regulations does not detract from the Safety Board's point that ATR and the DGAC were alerted to the airplane's propensity for hinge moment shifts and uncommanded aileron deflections, especially with ice accretions, during the development and certification of the ATR airplanes. Further, it should also be noted that the SCR only evaluated whether the ATR airplanes met the icing certification criteria described in the Appendix C envelope. It did not evaluate whether the certification process adequately addressed the airplane's performance and handling qualities in conditions outside the Appendix C icing envelope. However, as further discussed in the next section, the airplane's performance and handling in conditions outside the Appendix C icing envelope became an issue early in the service life of the ATR 42, prior to certification of the ATR 72. As will be discussed, a series of icing/roll upsets beginning in 1988 indicated that the ATR 42 was having continued problems in those conditions.

B) Previous ATR 42 icing/roll incidents

Petitioners' Arguments

The petitioners assert that the previous ATR 42 icing/roll incidents discussed in the Safety Board's report were not precursors to the Roselawn accident and that ATR and the DGAC responded properly to each of them. The incidents discussed in the Board's report are AMR Eagle/Simmons Airlines at Mosinee, Wisconsin (December 22, 1988); Air Mauritius over the Indian Ocean (April 17, 1991); Ryan Air over Ireland (August 11, 1991); Continental Express at Newark, New Jersey (March 4, 1993), and Continental Express at Burlington, Massachusetts (January 28, 1994).

The petitioners assert that these previous incidents involved a different sequence of events than the Roselawn accident scenario, pointing to the fact that the SCR concluded that these prior events provided no evidence that the ATR 72 had any problems with any icing conditions for which it was certified. They maintain that, in each of the previous cases, an asymmetric wing stall, not an uncommanded aileron deflection, was the initiating event and, therefore, the "primary cause" of the roll excursions. The DGAC and ATR reiterate their position that the post-stall aileron deflections that occurred during these incidents are normal and expected, and that they occur on all airplanes with unpowered ailerons. According to ATR's petition, "the prior ATR 42 incidents were conventional stall events which occurred at or about the angle of attack where stalls normally occur in such conditions." ATR maintains that the previous incidents "did not involve a roll departure caused by an aileron hinge moment shift, which in turn caused an uncommanded aileron deflection, as was the case in the Roselawn accident." (Emphasis in original.)

In addition, the DGAC and ATR assert that the circumstances leading up to the previous roll excursions were fundamentally different from those that led up to Roselawn. Specifically, the petitioners note that, in contrast to Roselawn, the prior events occurred at flaps 0° (and the ice had accreted at flaps 0°) and did not involve prolonged holding in severe icing conditions using flaps 15°, as did the Roselawn accident. Further, the petitioners assert that, with the exception of the incident at Newark, the rolls were induced at high angles of attack that were at or close to the stall warning threshold for severe icing conditions after prolonged performance degradations that should have signaled that an ice-induced stall was imminent. Regarding the Newark incident, the petitioners acknowledge that the roll occurred at a low angle of attack (7°) that was well below the stall warning threshold. However, they assert that severe turbulence¹² could have caused the aileron deflections and resulting rolls that occurred during that incident.

¹² Even though weather reports indicated "severe turbulence" in the Newark area around the time of the incident, the Safety Board does not agree with the petitioners that the incident airplane was encountering severe turbulence during the incident. The FAA defines severe turbulence as turbulence that causes large, abrupt changes in altitude and/or attitude, and usually causes large variations in indicated airspeed. The FDR data from the Newark incident shows that the abrupt changes in aircraft attitude and roll excursions were predominantly caused by the aileron deflections, contrary to what would be expected if they had been caused by turbulence. Further, the FDR data shows changes in G forces of only $\pm .2$ Gs, which is much less than would be expected in severe turbulence. In addition, FDR data shows that the uncommanded aileron deflections occurred repeatedly at about the same angle of

The petitioners also argue that the actions taken in response to each of the previous incidents were appropriate and sufficient. In support, they reiterate their position that the previous incidents provided no warning of the phenomenon that later occurred at Roselawn. In particular, ATR objects to statements in the Board's report indicating that the 1989 icing simulation package and the December 1992 All Weather Operations brochure were inadequate in that they did not bring to pilots' attention that icing encounters could lead to "rapid and uncommanded aileron and control wheel deflections to near their full travel limits with high unstable control wheel forces."¹³ ATR argues that these characteristics were not present during any of the previous incidents and, therefore, ATR could not have been expected to warn pilots about them.

The DGAC asserts, as does the FAA in its comments on the DGAC petition, that the difference between the problem that led to the previous incidents and the problem that led to the Roselawn accident is illustrated by the fact that they were addressed by different airplane design changes. They point out that the corrective action taken in response to the earlier incidents (i.e., installation of vortex generators and reduction of the SPS thresholds for flight in icing conditions) would not have been effective corrective actions for the Roselawn accident.¹⁴ The DGAC also claims that, contrary to the position taken in the Safety Board's report, the corrective action that would have prevented the Roselawn accident (which, according to the DGAC, is extension of the deice boots) would not have effectively prevented the earlier incidents. ATR does not make either of these arguments.

Safety Board's Response

To the extent that the petitioners are asserting that one or more of the prior incidents did not involve uncommanded aileron deflections, they are incorrect. Although, in each of the prior ATR 42 incidents cited in the Safety Board's report, ice accretion led to asymmetric lift loss, it is also a fact that in each incident, ice-induced flow separation also caused aileron hinge moment shifts that resulted in uncommanded aileron deflections. These uncommanded aileron deflections are evident from the FDR plots from the incidents, each of which shows aileron deflections in a direction opposite the direction needed to promote a recovery from the roll and coincident with exceeding a particular angle of attack¹⁵ (both of which indicate that the deflections were not pilot induced).¹⁶ Further, the FDR data shows that the ailerons deflected at a high rate, in some cases

attack, which strongly suggests that the phenomenon was being triggered by that angle of attack and was not caused solely by turbulence.

¹³ This phrase, or similar ones, appears on pages 80, 178, and in two places on page 179 of the report.

¹⁴ The FAA explained in its comments that the localized airflow separation in the area of the ailerons would have prevented the vortex generators from functioning as intended.

¹⁵ The triggering angles of attack in the prior incidents ranged from 7° (in the Newark incident) to 12.5° (in the Mosinee incident).

¹⁶ These characteristics are less pronounced in the Air Mauritius data than in the data from the other four incidents, most likely because the pilots took over manual control of the airplane (in response to a speed decrease) prior to the autopilot disconnect, which would have masked the uncommanded aileron deflections to some extent. However, it is evident from the FDR data that the pilots in the Air Mauritius incident had difficulty maintaining roll control coincident with exceeding a particular angle of attack near the stall warning threshold, and that angle of attack remained consistent throughout the event.

exceeding the deflection rate capability of a pilot or any airplane system. (See enclosed FDR plots.)

The prior ATR 42 incidents were similar to Roselawn in that they most likely involved operations in icing conditions outside of the certification envelope, ice accretions aft of the deice boots in front of the ailerons,¹⁷ and resulting airflow separation and pressure distribution changes that caused aileron hinge moment shifts and uncommanded aileron movements. Admittedly, the uncommanded aileron deflections occurred after some level of wing stall in each of the prior events. Whether the onset of these traditional icing stall characteristics would have, or should have, diverted the attention of the regulators and the manufacturer away from the significance of the aileron movements is open to some question. Whether the uncommanded aileron movements occurred, persistently and repeatedly at angles of attack below stick pusher threshold, is not.¹⁸ In each of the prior incidents, the uncommanded aileron deflections were the predominant cause of the roll excursions and severely limited the pilots' ability to maintain control. Even if an asymmetric wing stall or lift loss initiated the roll, analysis of the FDR data shows that the magnitude, or severity, of the roll upset was exacerbated by the uncommanded aileron activity.

In the Safety Board's view, ice accretion in operations outside of the icing certification envelope was a recognizable issue, and thus the SCR's conclusion that the prior events (which were described in the SCR report as "unacceptable control anomalies") provided no indication that the ATR airplanes had any "problems with any icing conditions for which it was certificated" has little relevance to the issue at hand: the obligations of the regulators and the manufacturer for continued safe operation of the ATR turboprop aircraft.

In this regard, the Safety Board notes ATR's request that the probable cause statement be revised to indicate that the aileron hinge moment shift occurred "following a prolonged operation of the aircraft in hazardous icing conditions well outside the certification envelope and for which no airplane is certified." The Board agrees that operation outside of the icing certification envelope is an important part of the accident scenario and will revise the probable cause statement, consistent with conclusion 5 and other statements in the report, to include language similar to that requested by ATR. Specifically, the first sentence of the probable cause statement will be revised to read as follows (new language is shown in italics):

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 *while*

¹⁷ For example, ATR's analyses of the Mosinee and Newark incidents refer to ice accretions aft of the deice boots. Further, in postaccident testing, aileron activity similar to what was observed at Roselawn and in the five prior incidents occurred when the airplane was flown with a simulated ice ridge aft of the deice boots in front of the ailerons.

¹⁸ In the prior incidents, the lift loss and aileron hinge moment shift occurred at attack angles between 7° and 12.5°; stick pusher protection occurs at 15.3°. Although the Safety Board recognizes that the SPS thresholds were designed only to protect against Appendix C icing conditions and not the severe icing conditions likely encountered in the prior incidents, for the SPS to be effective, stalls and the associated hinge moment shifts should not occur until after the angle of attack at which the stick pusher is designed to activate has been exceeded. As discussed previously, the SPS thresholds were developed to protect against both stalls and uncommanded aileron deflections. These incidents, in which uncommanded deflections occurred prior to the SPS threshold levels, were an indication that ATR 42 airplanes were being flown in icing conditions outside those defined in Appendix C, and that the SPS was not providing adequate protection against stalls and uncommanded aileron deflections in those conditions.

the airplane was in a holding pattern during which it intermittently encountered supercooled cloud and drizzle/rain drops, the size and water content of which exceeded those described in the icing certification envelope. The airplane was susceptible to this loss of control, and the crew was unable to recover.

Notwithstanding operations in weather outside of certificated standards, and regardless of whether conventional stalls or turbulence were involved in some of the previous icing events, the continued occurrence of roll departures aggravated by uncommanded aileron deflections following flow separation during icing encounters prior to stick pusher activation should have indicated to ATR and its regulators that the corrective actions taken after earlier incidents (including installation of the vortex generators and publication of the All Weather Operations brochure) were inadequate to prevent similar events from occurring. ATR and the DGAC should have conducted further research and developed more effective means of preventing such incidents.

Specifically, these incidents might have prompted additional research, evaluation, analysis, and testing to learn more about the potential range of icing conditions and accretion characteristics that could cause this phenomenon and the ramifications of such icing encounters under other conditions (e.g., at different airspeeds, different flap settings, in holding patterns, etc.). In addition, ATR and the DGAC might have worked on identifying and disseminating (via publications that flight crews are required to read, such as the AFM and other manuals) information about reliable visual cues or other means for recognizing icing conditions outside the Appendix C envelope. ATR and the DGAC might also have developed improved simulator training that accurately modeled all aspects of the events, including the uncommanded aileron deflections that could occur in such conditions. Additional research might well have resulted in the development of airplane modifications such as extended deicing boots. All of this was done after the Roselawn accident.

In sum, the Safety Board continues to believe that it would have been prudent for ATR to examine more thoroughly the combinations of icing conditions and airplane configurations that produced the performance, stability, and control characteristics exhibited in the prior incidents and the possible repercussions of aileron hinge moment shifts.¹⁹ Likewise, it seems clear that there was more than adequate data available to have spurred the DGAC to require such additional work, and to have prompted FAA to assert that its French counterpart take a more active role in pursuing answers to the questions raised.

However, the Safety Board also recognizes that some of its findings (such as findings 21, 25, and 26) could be interpreted as indicating that the Board believed ATR and the DGAC were aware, prior to the Roselawn accident, that a rapid uncommanded full deflection of the ailerons could result from the precise circumstances leading up to that accident (e.g., operating at flaps 15° at a relatively high speed and low angle of attack). The Safety Board wishes to clarify, by way of this response, that such an interpretation is unwarranted. The accident and its antecedents permit only the judgment that data were available to ATR, the DGAC, and FAA that might have

¹⁹ In its comments on the DGAC petition, ALPA expresses a similar position. ALPA states that “the prior incidents and accidents provided clear evidence to the DGAC and [ATR] that the ATR 42/72 aircraft exhibited aircraft performance and handling quality problems in icing conditions. This evidence should have indicated to DGAC, ATR and the FAA that further testing must be conducted to determine the extent of such problems and preclude the potential for future similar events.”

prompted additional research that would in turn have led them to better understand and address the dangers that could result from severe icing encounters. Inferences beyond that are too speculative, and are unnecessary to the Board's purposes. Therefore, the Safety Board will revise its findings and the probable cause statement as detailed at the conclusion of this response.

2. Adequacy of initial aircraft certification and continuing airworthiness under Annex 8 and the Bilateral Airworthiness Agreement

The DGAC, ATR, and the FAA each challenge the Safety Board's findings regarding initial certification of the ATR 42 and 72 airplanes and the monitoring of their continued airworthiness, stating that the Safety Board misunderstood the requirements of the bilateral agreement between France and the United States.

A) Initial Certification

Petitioners' Arguments

The DGAC and ATR disagree with finding 30 of the Safety Board's report, which characterizes FAA's reliance on the DGAC during the initial certification of the ATR 42 and 72 as "excessive" and states that such reliance "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." They state that Annex 8 and the BAA adequately ensure the safety of imported aircraft and again point out that the SCR found that the ATR 42 and 72 were properly certified and complied with all certification requirements. The DGAC asserts that "there is no statistical or historical evidence to suggest that the safety of these airplanes or their level of compliance with the Federal Aviation Safety Regulations is any different than those ... certified directly by the FAA."

In its comments on the DGAC petition, the FAA provides a detailed description of how the bilateral certification process is designed to work. The FAA indicates that most technical evaluations, inspections, and certifications are properly conducted by the exporting country's civil airworthiness authority (in this case the DGAC), and that the importing country (in this case the United States) is justified in relying on the exporting country's expertise in making its findings of regulatory compliance. The FAA explains that this high degree of confidence is placed on the exporting country's technical competence and regulatory capability only after the United States has completed an assessment to determine that the country has a satisfactory civil aircraft certification system.

As the Safety Board understands the FAA's position, the FAA believes that its level of involvement in the bilateral certification process is appropriate, but that the Board erroneously characterized the process in its report, making it appear that the FAA's level of involvement was even more limited than it actually was. The Board's report states the following on page 185:

The Safety Board is concerned about the FAA's limited involvement during the initial certification of the ATR 42 and 72. For example, there were several meetings in which only one person from the FAA reviewed vast amounts of certification documentation and had to resolve problems from many technical

disciplines. Further, because FAA personnel were either unavailable, or budget constraints restricted travel, issues involving noncompliance or other concerns were resolved only through “issue papers.”

According to the FAA, the agency’s technical review of certification data took place before the meetings described above. The FAA states that the meetings that were attended by only one FAA employee were entirely administrative and did not involve any technical review. Further, the FAA states that the use of issue papers to resolve open issues is a normal part of all certifications, both domestic and foreign, and should not be viewed as “a crutch used to compensate for any shortcoming in FAA certification procedures.” The FAA points out, however, that because the ATR was a foreign certification, it was DGAC, rather than the FAA, that made the final findings of compliance to close out issue papers.

Finally, the FAA takes issue with the Safety Board’s statements on page 186 of the report regarding flight testing:

According to testimony provided by the FAA ATR certification team leader, the FAA does not flight test the aircraft; rather, it conducts “evaluation” flights for the purpose of “familiarity with the airplane ... and [to] determine suitability for use in airline service.” The FAA conducted about 10 hours of evaluation flights on the ATR; however, none of these flights duplicated any tests required for certification, and none were conducted in icing conditions.

The FAA emphasizes that the purpose of its evaluation flights is not to duplicate any of the certification testing and states that its evaluation flights are preceded by an in-depth review of the foreign manufacturer’s flight test data. The FAA states that, although it sometimes flight-tests foreign-certificated airplanes, this was not deemed necessary for the ATR 42 or 72.

Safety Board Response

The Safety Board did not find that the certification of the ATR 42 or 72 did not comply with the BAA or any other applicable requirements or agreements. Nor did the Board find, or mean to suggest that, because these airplanes were certificated pursuant to the BAA rather than directly by the FAA, they are any less safe than U.S.-certified airplanes. The Board’s description of the bilateral certification process was based on hearing testimony and other information provided by the FAA in connection with this accident investigation. However, to the extent that the Board’s description of the bilateral certification process in general or the initial certification of the ATR 42 and 72 was incomplete, the Board takes note of the FAA’s expanded description of how the process is intended to work and what took place in the case of the ATR certifications. In particular, the Board appreciates the FAA’s clarification regarding the purely administrative purpose of the meetings at which the FAA was represented by only one employee and its assurance that the agency’s technical review of certification data occurred prior to those meetings.

Nonetheless, the Safety Board remains concerned about the apparently limited nature of the FAA’s involvement. The Board questions whether a technical review that takes place so far from the manufacturer’s facility, engineers, and design experts would be as thorough and

probing as one that takes place with those experts present or readily available to answer questions and provide explanations. Similarly, although the Board agrees that issue papers can be an appropriate and effective means of addressing and resolving open issues or other differences, that process would also be more thorough if the manufacturer's subject matter experts were present or readily available to fully explore and resolve those issues with the FAA certification staff.

Increased FAA involvement during the initial certification of the ATR 42 and 72 airplanes would not likely have resulted in any changes to the airplanes' designs as they related to icing. However, increased involvement would likely have resulted in the FAA being better informed about the developmental histories of the airplanes. Consequently, the FAA would have been in a position to better understand and address continuing airworthiness issues, such as the icing/roll issues that developed in connection with the series of incidents, previously discussed, that preceded the Roselawn accident.

The gist of the Safety Board's findings with regard to the initial certification of the ATR 42 and 72 was, and still is, that a process that permits an aircraft to be certified for use in the United States with such limited participation by the FAA is not appropriate. Neither the DGAC, ATR, nor the FAA has persuaded the Safety Board to change its position on this point.

B) Continuing Airworthiness

Petitioners' Arguments

The petitioners assert that the DGAC complied with all requirements pertaining to continuing airworthiness of the ATR 42 and 72. In particular, the DGAC claims that, contrary to the Safety Board's probable cause statement, the DGAC did not "fail 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." Although the DGAC does not deny that it did not provide the FAA with ATR's analyses of each of the previous icing/roll events, the DGAC states that under Annex 8, the only information it was required to report to the FAA was that pertaining to mandatory corrective actions and that, other than the Mosinee incident (for which ATR's analysis was provided to the FAA), none of the previous incidents fell into this category.

In addition, the FAA states that the Safety Board's report misconstrued the continuing airworthiness responsibilities of the FAA's Aircraft Evaluation Group (AEG). The FAA contends that the Safety Board was incorrect in concluding (in finding 29) that the AEG's ability

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 ... BAA.

The FAA states that the responsibility for monitoring continued airworthiness does not rest solely with the AEG but, rather, rests primarily with a different office of the FAA known as the Aircraft Certification Service. Further, the FAA points out that, with regard to foreign-manufactured aircraft, the foreign airworthiness authority is primarily responsible for the continued airworthiness of its products and that the FAA generally relies on the foreign authority to review and take appropriate action on information forwarded by foreign manufacturers. The FAA also indicates that, as part of its efforts to improve its system for monitoring continued airworthiness, it has created a new international branch, which includes a database to track foreign airworthiness matters.

Safety Board Response

Requirements of Annex 8

The petitioners are correct that neither Annex 8 nor the BAA specifically requires the DGAC to provide the FAA with information developed as a result of incidents that do not result in mandatory corrective actions. Annex 8 provides that the “State of Manufacture of an aircraft shall transmit any generally applicable information which it has found necessary for the continuing airworthiness of the aircraft and for the safe operation of the aircraft.” The scope of the information required to be transmitted is further defined in Annex 8 as including “mandatory requirements for modification, replacement parts or inspection of aircraft and amendment of operating limitations and procedures. Among such information is that issued by Contracting States in the form of airworthiness directives.” Further, as stated on page 151 of the Board’s report, the BAA defines information required to be exchanged among parties as including “all mandatory airworthiness modifications and special inspections which they determine are necessary in respect of imported or exported products to which this agreement applies.”²⁰

As the Safety Board recognized on page 88 of its report, “the BAA does not specifically require the DGAC or any other airworthiness authority to provide the FAA with the manufacturer’s incident/accident analyses.” Therefore, the Board will amend the probable cause by deleting the phrase, “as specified under the Bilateral Airworthiness Agreement and Annex 8 of the International Civil Aviation Organization,” from the end of the first paragraph.

FAA Monitoring of Continuing Airworthiness

However, the Safety Board believes, as stated on page 187 of its report, that the lack of a requirement for the exchange of information, as described in the previous section, raises concerns about the scope and effectiveness of the BAA. This concern was reflected in Safety Recommendation A-96-64, which recommended that the FAA “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 it “can monitor and ensure the continued airworthiness of airplanes certified under the BAA.” In followup correspondence on Safety Recommendation A-96-64, the FAA

²⁰ The BAA also required the exporting State to “assist the aeronautical authorities of the importing State in analyzing those major incidents occurring on products to which this agreement applies and which are such as would raise technical questions regarding the airworthiness of such products.”

indicated that reviewing all available airworthiness information “would require the FAA to review thousands of service reports that are already collected and reviewed by the State of Design,” and stated that it did not have the resources to implement the approach recommended by the Safety Board.

In a November 30, 1999, letter to the FAA, the Safety Board classified Safety Recommendation A-96-64 “Closed – Unacceptable Action,” stating its continued belief that

the FAA needs to independently track foreign incidents/accidents, receive foreign manufacturer analyses of their incidents/accidents, and audit the exporting authority’s decisions regarding findings of unsafe conditions. The exporting country would remain responsible for collecting the information and conducting its own final analysis to determine whether an unsafe condition exists but, in the end, would provide sufficient material to the FAA for its review and concurrence. In this manner, the FAA could monitor and ensure the continued airworthiness of airplanes certified under the BAA.

The FAA should expend the necessary manpower and resources to institute a system whereby the FAA receives pertinent reports, including analysis reports, from manufacturers, operators, maintainers, and governments. Under the current system, the Safety Board believes that the FAA misses significant, potentially critical safety information, has no method to conduct a meaningful trend analysis, and is forced to rely on the exporting authority to ensure continued airworthiness.

In connection with its investigation of the Roselawn accident, Safety Board investigators requested all ATR 42 and 72 incident and accident reports from a variety of sources, including ATR, FAA, AMR Eagle (Simmons Airlines’ parent company), ALPA, and NASA. The Board found that the FAA had little of the pertinent information in ATR’s possession that was eventually instrumental in identifying, and developing an interim solution for, the problem of the airplane’s aileron instability in certain icing conditions. However, AMR Eagle had a great deal of relevant information. As a result, the Board issued Safety Recommendation A-96-62, asking the FAA

to develop an organizational structure and a communications system that will enable the [AEG] to obtain and record all domestic and foreign aircraft and parts/systems manufacturer’s 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.

Although the Safety Board received information during its investigation of the Roselawn accident indicating that the AEG was responsible for monitoring fleet service history and that it participated in continuing airworthiness activities along with the FAA’s certification offices,²¹ it is possible that its findings and recommendations on this point might have been more appropriately directed to a different office within the FAA or to the agency as a whole, rather than to the AEG in particular. However, the Board does not regard this as a significant issue

²¹ This information is described in section 1.18.2 of the Safety Board’s report.

requiring any change to the report. As the Board stated in its August 20, 1997, response letter to the FAA regarding this recommendation,

[r]egardless of the organizational structure and responsibilities of the respective FAA organizations, during the investigation of the Roselawn accident, the Safety Board determined that there were deficiencies in the FAA's monitoring and communication of in-service fleet history for continuing airworthiness evaluations.

Because the FAA took no action to ensure that it would receive foreign manufacturers' analyses related to safety issues resulting from incidents or accidents, on January 7, 1999, Safety Recommendation A-96-62 was classified "Closed – Unacceptable Action."

Thus, since the adoption of its report, and at least until January 7, 1999, the Safety Board has continued to express its concern that, regardless of the precise organizational structure and division of responsibilities within the FAA, the FAA did not have an adequate means for learning about pertinent airworthiness information affecting foreign-manufactured airplanes. It seems clear from both the text of the Safety Board's report and subsequent correspondence on these issues that, although the FAA and the Board may have disagreed on the need for change, the Board correctly understood the scope of the DGAC and FAA obligations for continuing airworthiness under the applicable bilateral agreements.²² It also seems clear that, until 1999 and perhaps later, regardless of which office within the agency is responsible for continuing airworthiness activities, those activities did not include receipt of foreign manufacturers' reports and analyses like those that addressed the previous ATR 42 icing/roll incidents.

Accordingly, other than modifying the probable cause statement to delete the phrase "as specified under the Bilateral Airworthiness Agreement and Annex 8," the Safety Board finds no basis in the petitions for modifying its report with regard to continuing airworthiness.

3. Role of crew performance

Petitioners' Arguments

The petitioners assert that the Safety Board did not adequately address the role that crew performance played in the accident. The DGAC asserts that the crew

did not exercise proper workload management, cockpit/crew resource management techniques, crew discipline, situational awareness/crew vigilance, and compliance with applicable company policies and procedures.

In particular, the DGAC contends that, as a result of these errors, the crew was unaware of the severe icing conditions they were operating in and was unprepared to respond effectively to the upset when it occurred. The DGAC believes that the captain should not have left the cockpit when he did, stating that he thereby deprived himself of any opportunity to monitor the icing

²² Since the Roselawn report was issued, the FAA has begun entering into Bilateral Aviation Safety Agreements in place of BAAs.

conditions during this time and request a clearance to deviate from them. According to the DGAC, the captain's question upon returning to the cockpit ("Are we out of the hold?") indicates a lack of situational awareness. The DGAC also asserts that the crew's failure to respond to a traffic collision avoidance system (TCAS) advisory and anti-ice advisory system (AAS) chime also indicated a lack of situational awareness.

The DGAC also asserts that the crew's extensive nonpertinent conversations indicated a lack of professionalism and detracted from the crew's ability to exercise vigilance. In this respect, both petitioners object to the Safety Board's finding that "[n]either the flight attendant's presence in the cockpit nor the flightcrew's conversations with her contributed to the accident" and assert that this finding is inconsistent with the Board's recommendation that the FAA evaluate the need to require a sterile cockpit environment whenever a crew is holding in icing conditions. The DGAC also contends that the crew's preoccupation with the aircraft communications addressing and reporting system (ACARS) and the music that was being broadcast over the frequency in the first officer's headseat were additional distractions that contributed to the crew's lack of vigilance. Finally, the DGAC asserts that the crew's efforts to recover the airplane after the upset were inappropriate and uncoordinated.

In its comments on these issues, ALPA indicates that the DGAC's positions are premised on an erroneous presumption that the ice accretion leading to the accident could have been recognized by the crew, and that the crew's casual behavior distracted them from their duties and caused them to incorrectly analyze the ice accretion. According to ALPA, the ice accretion observed by the crew was probably not unusual or indicative of a serious problem. ALPA noted that the evidence indicated that the rate of ice accretion was slow, and that the ice ridge behind the deicing boots was not likely detectable by the crew. ALPA also stated that the comment, "I'm showing some ice now," which was made 7 minutes after the crew activated the Level III ice protection system, indicated that the pilot had been looking for signs of ice accretion. According to ALPA, the crew members had no reason to believe that their normal methods of evaluating ice accretion would not be adequate, and they did not have the proper cues or guidance to know that they were operating in an adverse icing environment.

Regarding the DGAC's contention that the crew lost situational awareness, ALPA states that, in light of the fact that it was the first officer and not the captain who had received the ATC instruction to hold, it was normal and appropriate, and did not indicate a lack of situational awareness, for the captain to inquire, upon his return to the cockpit, whether they were still holding. ALPA also points out that the TCAS traffic advisory did not require any response or action.

Safety Board Response

Flight 4184 remained in a holding pattern for 39 minutes, as instructed by air traffic control. During that time, the airplane did not experience any significant performance degradations and, although the pilots recognized that they were experiencing some icing, their only comments about the icing were "I'm showing some ice now" (about 9 minutes before the initial upset) and "we still got ice" (about 2 minutes before the initial upset). Further, the pilots' activation of the Level III deicing system (including the deice boots) at 1513, at the beginning of

the descent to the holding pattern altitude (10,000 feet), their deactivation of the system at 1523, and their re-activation at 1541 (7 minutes before the comment “I’m showing some ice now”) indicates that the crew was monitoring the cues for icing and responding appropriately. The routine nature of these comments and actions also suggests that the crew was not alarmed by the conditions and believed that the airplane’s deicing system was handling it adequately. The Safety Board agrees with ALPA that the crew had no reason to believe that the aircraft anti-icing and deicing systems were performing inadequately, or that their normal methods for evaluating ice accretion were insufficient to detect potentially dangerous icing.

The SCR report, which the DGAC and ATR rely on heavily as support for many of their other points, confirms that the supercooled drizzle drop (SCDD) phenomenon may be difficult to detect and may occur more frequently than previously believed. The SCR acknowledges that “there are limited means for the pilot to determine when the airplane has entered conditions more severe than those specified in the present certification requirements.” At the time of the Roselawn accident, ATR’s All Weather Operations brochure stated that freezing rain could be predicted by listening to SIGMET [significant meteorological information] messages and monitoring the outside air temperature for the presence of temperature inversions, and could be recognized by the presence of heavy rain in “conditions propitious to freezing rain formation.” The brochure noted that these conditions would “lead to clear ice building on [the] aircraft,” and further described this ice accretion as being “transparent and consequently more difficult to detect but gives an unusual shiny aspect to the covered areas” and “adher[ing] to most of the surfaces of the aircraft.” None of these cues were observed during the post-Roselawn icing tanker testing. The Roselawn pilots did not receive any SIGMETs, PIREPS, or ATC reports that indicated the existence of freezing precipitation along their route of flight,²³ nor were they trained to look for side window icing²⁴ or other cues that might more reliably indicate they were operating in freezing rain or drizzle.

Although postaccident tanker testing showed that the location of the ice ridge that accreted during the hold was due primarily to the extension of flaps, the crew cannot be faulted for holding with flaps 15°. Neither the ATR 72 airplane flight manual, which was approved by the DGAC, nor the FAA addressed the use of flaps in icing conditions. Holding with flaps 15° would provide a more desirable margin for stall protection than the flaps 0° configuration. Similarly, ATR’s 1992 All Weather Operations brochure did not recommend against flap extension in icing conditions,²⁵ and neither it nor any other publication indicated any danger in extending the flaps or subsequently retracting them in icing conditions.

²³ There were AIRMETs (Airman’s Meteorological Information) in effect for the route of flight that indicated light, occasional, moderate rime icing “in cloud and in precipitation.” However, these AIRMETs were not provided to the crew in their flight release package. Although the AIRMETs would have been available to the crew prior to their departure and in-flight on the Hazardous In Flight Weather Advisory Service (HIWAS) frequency, no evidence indicated whether the flight crew accessed the AIRMETs through either of these means.

²⁴ The icing tanker testing confirmed that side window icing is a visual cue that the airplane is operating in freezing drizzle or freezing rain. The flightcrews involved in the Ryan Air and Newark incidents reported seeing icing on the side windows.

²⁵ In fact, the brochure indicated that, “should the aircraft enter ... a freezing rain zone,” pilots should, among other things, “[e]xtend flaps as close as possible to respective VFE [the maximum permissible speed with flaps extended].”

Further, the Safety Board continues to believe that, for several reasons, it was not inappropriate for the captain to choose to leave the cockpit temporarily at 1549:44 to use the lavatory. The flight was in a holding pattern during which the pilots had a relatively low workload, and the captain would have known that they would be facing a high workload period as soon as the flight was cleared to exit the hold and descend. Up to that time, the flight had been uneventful; the pilots therefore had no reason to believe that the first officer required the captain's assistance. The captain was gone for about 5 minutes, less than the time required to complete a circuit in the holding pattern (about 8 minutes). Further, nothing significant occurred during his absence from the cockpit, and the first officer's workload was relatively undemanding during that time (requiring primarily that he monitor ATC communications and observe the autopilot as it flew the airplane in the holding pattern). The upset occurred several minutes after the captain's return when both pilots were present in the cockpit. The Safety Board found no evidence that the outcome of the accident flight would have been any different if the captain had not left the cockpit when he did.

In addition, the Safety Board disagrees for several reasons with the DGAC's contention that the crew lacked situational awareness. First, as indicated by ALPA, the captain's question upon returning to the cockpit ("Are we out of the hold?") was normal and logical and does not indicate a lack of situational awareness. Second, as the Board stated on page 195 of its report, the TCAS alert was advisory only and did not require any verbal acknowledgement or response from the crew.²⁶ Third, the crew reacted properly to the caution alert chime at 1541:07 by activating the Level III ice protection system and increasing propeller rpm to 86 percent. Although the crew did not activate the ice protection system after an earlier chime at 1533:56, as noted on page 190 of the Safety Board's report, this chime could have been activated by an aircraft system other than the AAS. However, assuming the chime was activated by the AAS, the Board concluded that the delay in activating the Level III ice protection system and increasing the propeller rpm to 86 percent at that time was not a factor in the accident because the increased rpm would only have prevented the formation of ice in the propeller slipstream area and would not have affected ice formation or airflow further outboard on the wings in front of the ailerons.

The Safety Board does acknowledge that the atmosphere among the crewmembers was relaxed and that the captain may have engaged in excessive nonpertinent conversation during the flight. However, contrary to the DGAC's contention that

[by] edit[ing] the CVR transcript to delete these 'non-pertinent' conversations²⁷
... the NTSB deprived itself of an important and unique opportunity to analyze and comment upon human factors issues related to flightcrew/cabin crew interaction and male/female crew interaction, and how such interactions can interfere with flightcrew vigilance and flightcrew performance,

²⁶ Because of the proximity of other airplanes, TCAS advisory alerts are often generated by airplanes in a holding pattern.

²⁷ The Safety Board continues to believe that the conversations designated as "nonpertinent" were nonpertinent to the accident scenario. However, the Board notes that all conversations recorded on the CVR during the last 15 minutes of the flight (beginning at 1542:41 until the time of impact) were transcribed. Further, all the parties, including DGAC and ATR, heard and had an opportunity to comment on, the entire unedited CVR recording.

the Safety Board did analyze and comment on the crew's interactions. The Board recognized on page 193 of its report that this conversation, the presence of broadcast music on the ADF frequency,²⁸ and the captain's departure from the cockpit for about 5 minutes (to use the lavatory) were "potentially distracting," but that "both pilots appeared to be attentive to flight-related duties both immediately before, as well as during the roll upset" and that neither the flight attendant's presence in the cockpit nor the flight crew's conversations with her contributed to the accident.

Nonetheless, the Safety Board went on to state that a "a sterile cockpit environment would probably have reduced flight crew distractions and could have promoted an appropriate level of flight crew awareness for the conditions in which the airplane was being operated." The Board recommended that Simmons "encourage its captains to observe a sterile cockpit environment when an airplane is holding, regardless of altitude, in meteorological conditions such as convective areas and icing conditions that have the potential to demand significant attention by a flightcrew." The Board also recommended that the FAA "[e]valuate the need to require a sterile cockpit environment for airplanes holding in such weather conditions as icing and convective activity, regardless of altitude."²⁹ Despite these admonitions in its earlier report, the Board understands that its finding number 36 may have appeared to condone or approve of the nonpertinent activity, and this was not the Board's intention. Hence, we will revise that finding.

With regard to the issue of recoverability, the ATR petition objects to the statement on page 117 of the Safety Board's report that "the chief test pilot for ATR testified that the type of roll anomaly the flight crew experienced would not have been recoverable by the average line pilot." ATR states that this misrepresents what the chief test pilot said and points out that postaccident testing confirmed that the upset was recoverable. According to ATR, Safety Board staff agreed at the October 12-13, 1995, technical review meeting to either delete this language from the draft report or to quote directly from the hearing transcript. In a November 22, 1996, letter to the Safety Board, the chief test pilot who testified, Mr. Gilbert Defer, also objected to this representation of his testimony as erroneous. In a response dated January 21, 1997, the Safety Board's Director of Aviation Safety acknowledged that this testimony "was not stated as factually as it could have been" in the Board's report. However, the response noted that other evidence indicated that the airplane would not have been recoverable by an average line pilot. The response cited the pilots' lack of unusual attitude training and the lack of other information that could have better prepared them to recover from such an event, and indicated that the Safety Board's conclusions about airplane controllability were reached in the context of this and other information.

Because pilots at the time of the Roselawn accident were not informed about the possibility of ice-induced aileron hinge moment shifts and effects of the resulting uncommanded aileron deflections, the Safety Board continues to believe that the upset would not have been recoverable by the average line pilot. The Board recognizes that Mr. Defer's testimony is

²⁸ It should be noted that this music ended about 12 minutes before the upset.

²⁹ In response, the FAA revised advisory circular (AC) 120-51B, Crew Resource Management, Appendix 3, Appropriate Training Topics, recommending that crew resource management training identify conditions in which additional vigilance is required (e.g., holding in icing or near convective activity). The AC specifically recommended that the training should emphasize the need for maximum situational awareness and the appropriateness of sterile cockpit discipline, regardless of altitude. Safety Recommendation A-96-95 was classified "Closed—Acceptable Action."

subject to interpretation,³⁰ but the Board's conclusions regarding controllability are supported by other evidence discussed in the report without reference to his testimony. Therefore, the Safety Board will delete the sentence characterizing Mr. Defer's testimony from page 117 of the report, but will not otherwise modify its discussion of the role of the crew in the accident.

Summary

On the basis of its review and consideration of the DGAC's and ATR's petitions for reconsideration and the FAA's and ALPA's comments, the Safety Board grants the petitions in the following respects:

- Findings 21, 23, 24, 25, 26, 35, and 36 (and the corresponding text on pages 177, 178, 179, 179-80, 181, 193, and 194, respectively) are revised as follows:³¹
 21. ~~Prior to~~ *Before* the Roselawn accident, ~~ATR recognized the reason for the aileron behavior in the previous incidents and determined demonstrated~~ that ice accumulation behind the deice boots, at an [angle of attack] sufficient to cause an airflow separation, would cause the ailerons to become unstable. Therefore, *it would have been prudent for ATR to examine the combinations of icing conditions and airplane configurations that could produce the performance, stability, and control characteristics (including aileron hinge moment shifts) exhibited in the prior incidents, and the possible repercussions of such aileron hinge moment shifts had sufficient basis to modify the airplane and/or provide operators and pilots with adequate, detailed information regarding this phenomenon.*
 23. ATR's proposed post-Mosinee AFM/FCOM changes, ~~even if which were not~~ *not* 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~~ *did not adequately communicate* the ~~known~~ catastrophic potential of ATR operations in freezing rain.

³⁰ Pages 1079-80 of the public hearing transcript reflect the following exchange:

MR. PEREIRA: How long after the initial upset based on your experience with this phenomena do you think a recovery becomes difficult after which --

THE WITNESS: I believe it is again difficult to answer any precise time, you know. It's -- the only thing I can tell you is that when I flew those things which is based on the best representation of the shapes which themselves were derived from the best expectation that we had from the weather specialist, we found that kind of result. And I cannot and I do not want to take any advantage of that work to go into judging what the crew did. I believe they did what they could.

MR. PEREIRA: Do you feel that the average line pilot can recover from this type of event?

THE WITNESS: It is the same answer, Sir. It's -- if you want me to tell you that such a phenomena that we did not know is viable then I go to the answer and the answer is, no. And had we known it before, of course, we would have done something.

³¹ New text is in italics.

25. ~~Information provided by ATR failed to disseminate adequate warnings and guidance to operators after the late 1980s and early 1990s about ice-related incidents did not give 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. ~~Prior to the Roselawn accident, the DGAC failed to require ATR to examine the combinations of icing conditions and airplane configurations that could produce the performance, stability, and control characteristics (including aileron hinge moment shifts) exhibited in the prior incidents, and the possible repercussions of such aileron hinge moment shifts; take additional corrective actions, such as performing additional icing tests, issuing to issue more specific warnings regarding the aileron hinge moment reversal phenomenon; developing additional airplane modifications, and providing to provide specific guidance on the recovery from a hinge moment reversal, which led directly to this accident.~~
35. ~~Because the DGAC did not require ATR, and ATR did not to 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 a more appropriate level of flightcrew awareness for the conditions in which the airplane was being operated.~~
- The probable cause is amended as follows:

The National Transportation Safety Board determines that the probable ~~causes~~ *cause* of this accident ~~were~~ *was* 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; while the airplane was in a holding~~

pattern during which it intermittently encountered supercooled cloud and drizzle/rain drops, the size and water content of which exceeded those described in the icing certification envelope. The airplane was susceptible to this loss of control, and the crew was unable to recover.

*Contributing to the accident were 1) ~~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; 2) ~~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) ~~3)~~ 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 conditions not specified in 14 Code of Federal Regulations (CFR) Part 25, Appendices C, and 2) ~~4)~~ the FAA's inadequate oversight of the ATR 42 and 72 to ensure continued airworthiness in icing conditions; and 5) *ATR's inadequate response to the continued occurrence of ATR 42 icing/roll upsets which, in conjunction with information learned about aileron control difficulties during the certification and development of the ATR 42 and 72, should have prompted additional research, and the creation of updated airplane flight manuals, flightcrew operating manuals and training programs related to operation of the ATR 42 and 72 in such icing conditions.**

- The following paragraph is removed from page 75:

~~Hydraulically powered flight controls can overcome high control forces resulting from normal in-flight control surface hinge moments. If properly designed, they can also prevent control surface anomalies from being transmitted back through the control system and into the cockpit. According to ATR engineers, hydraulically powered ailerons were discussed during the preliminary design of the ATR 42. It was determined that adequate lateral control characteristics could be obtained without the additional weight and complexity of a hydraulic system. Hydraulic aileron control was again discussed informally among ATR engineers after an incident involving a Simmons Airlines ATR 42 in Mosinee, Wisconsin, in December 1988. ATR management has since stated that hydraulically powered ailerons have never been "officially" considered for either the ATR 42 or 72.~~

- The following sentence is removed from page 117:

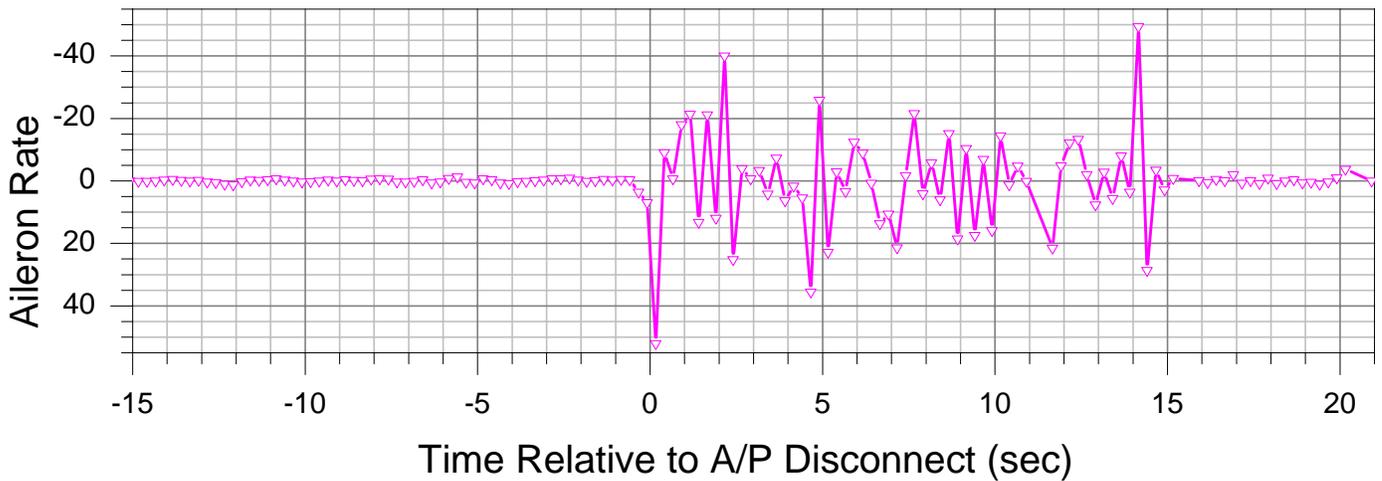
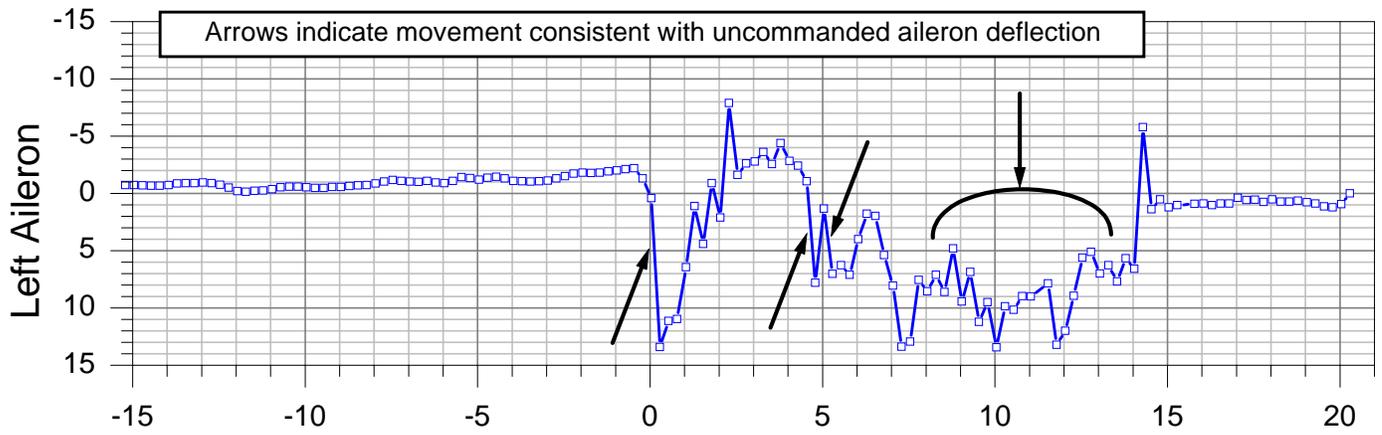
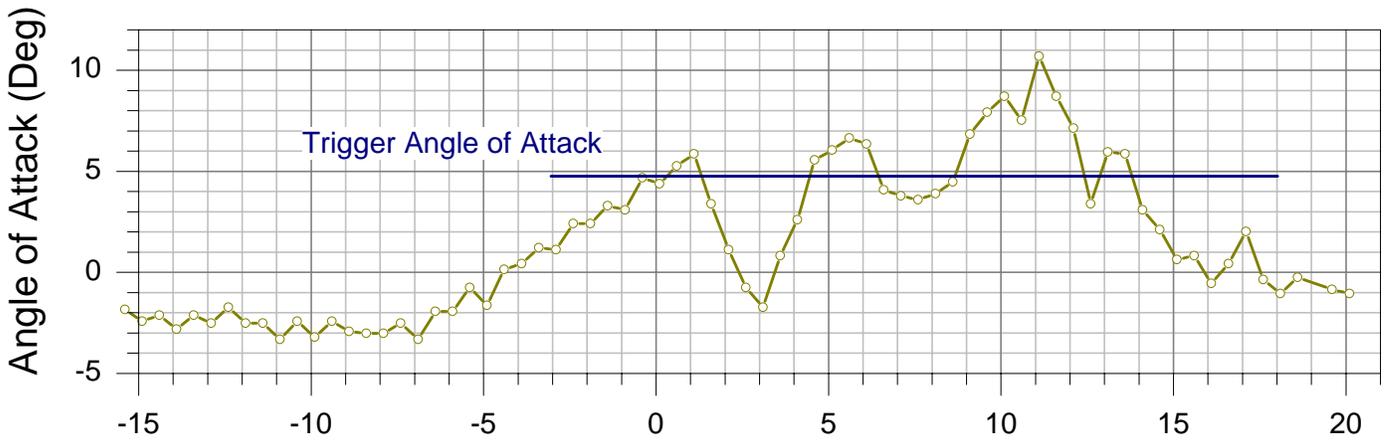
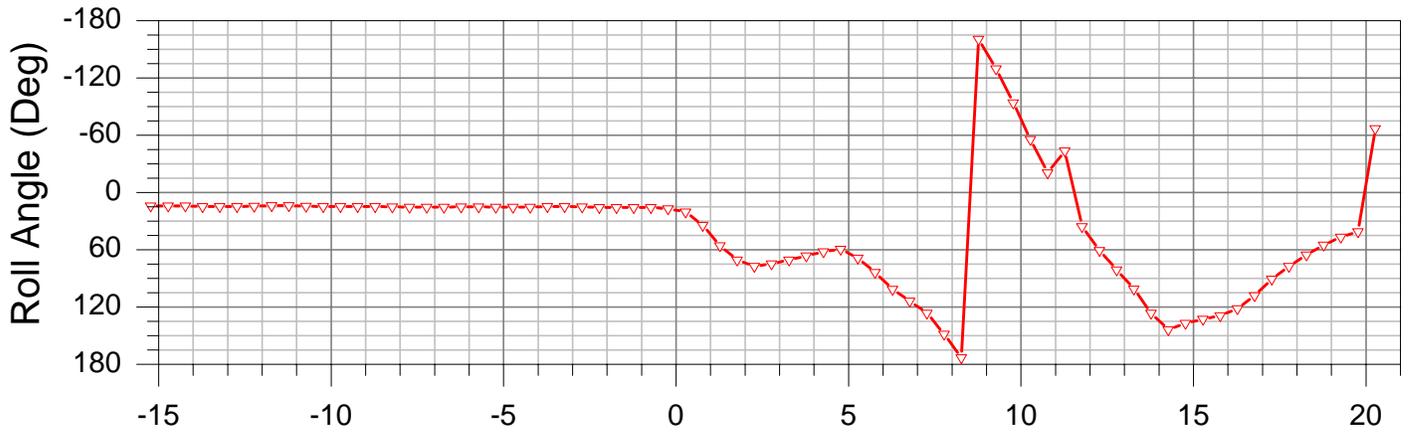
~~Also, with respect to Flight 4184, the chief test pilot for ATR testified that the type of roll anomaly the flight crew experienced would not have been recoverable by the average line pilot.~~

In all other respects, the petitions are denied.

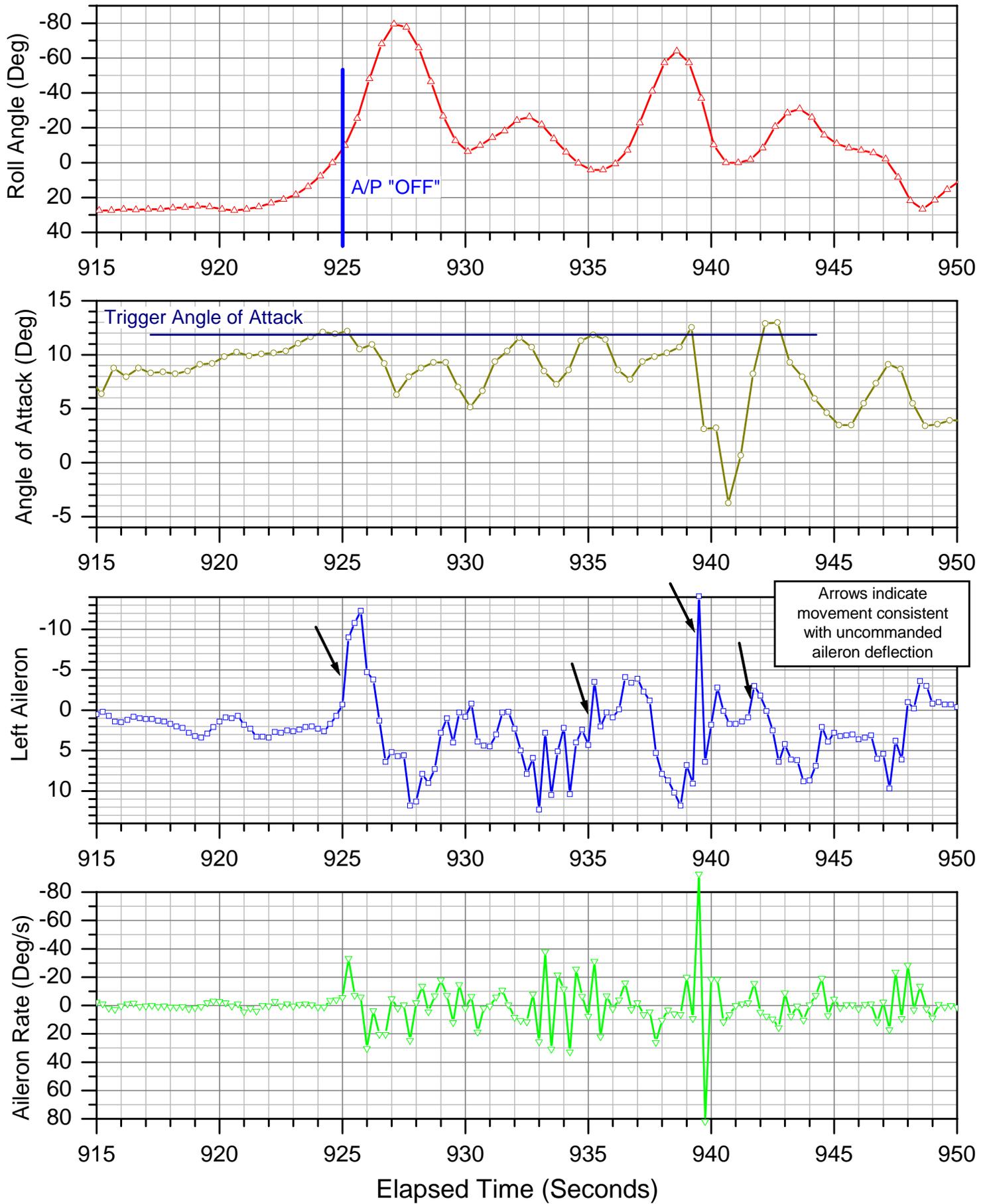
Chairman BLAKEY, Vice Chairman CARMODY, and Members HAMMERSCHMIDT, BLACK, and GOGLIA concurred in this petition for reconsideration.

Enclosures

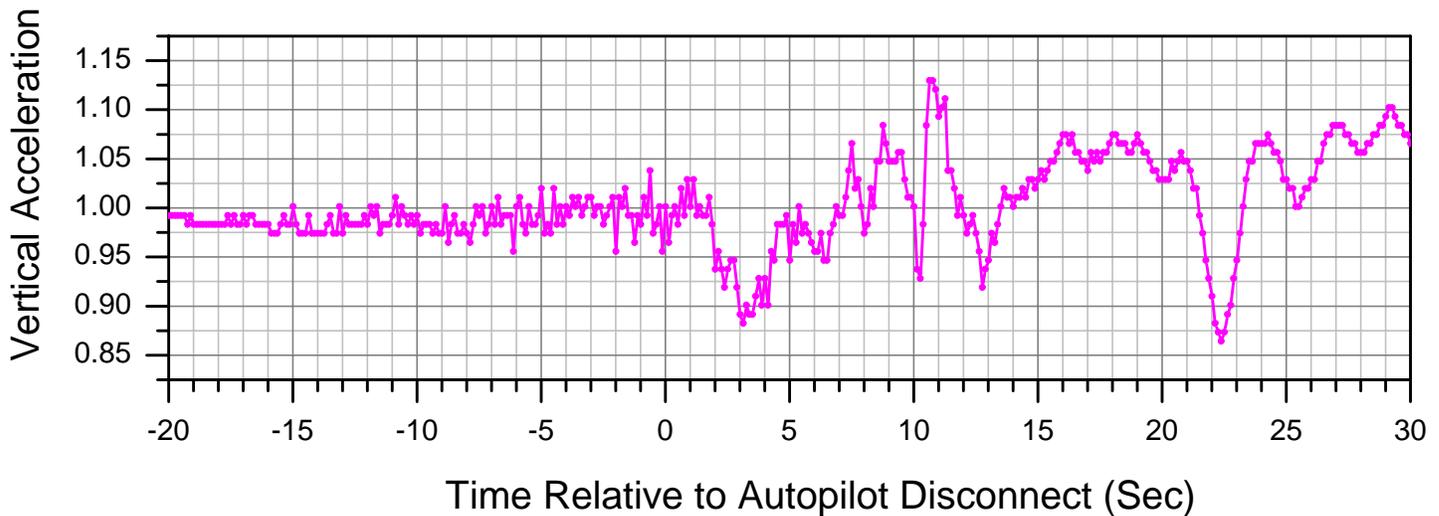
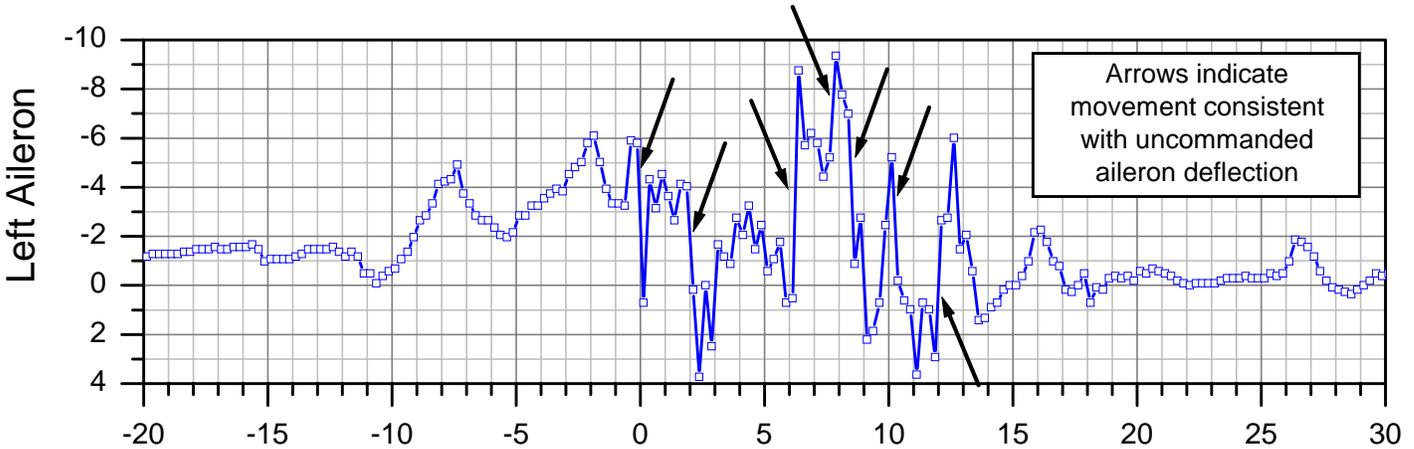
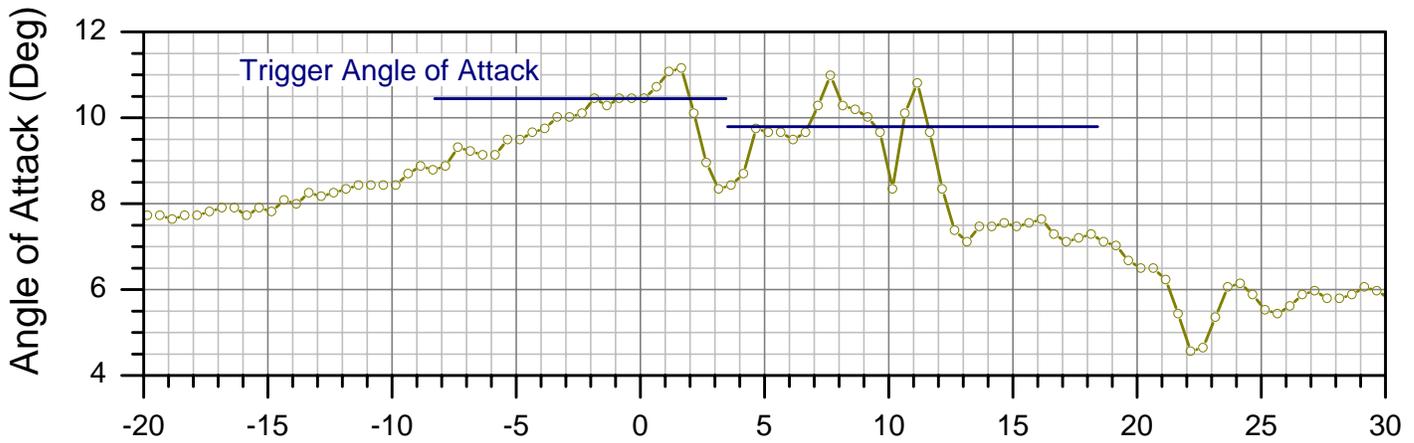
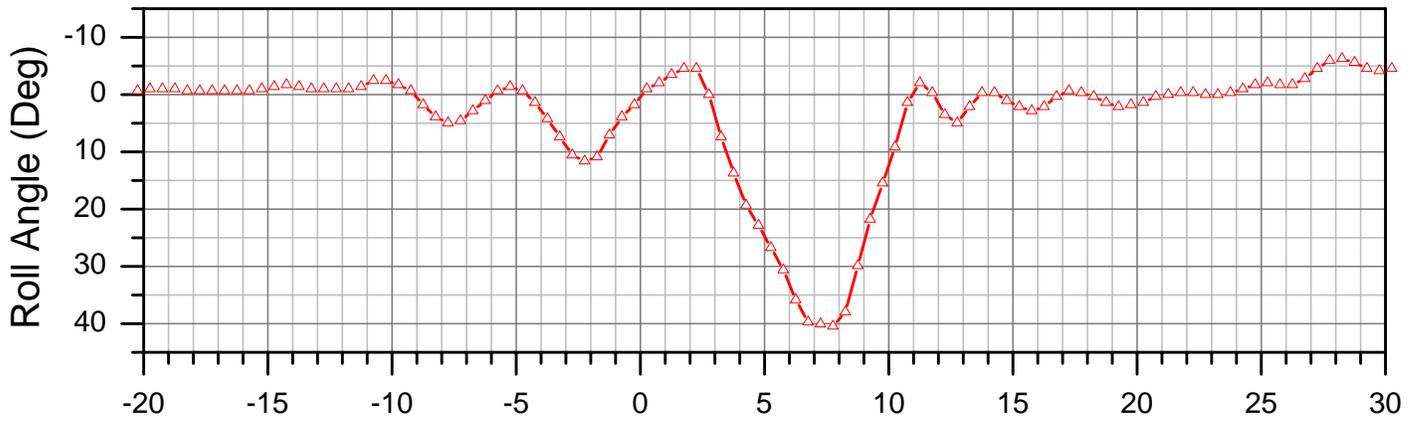
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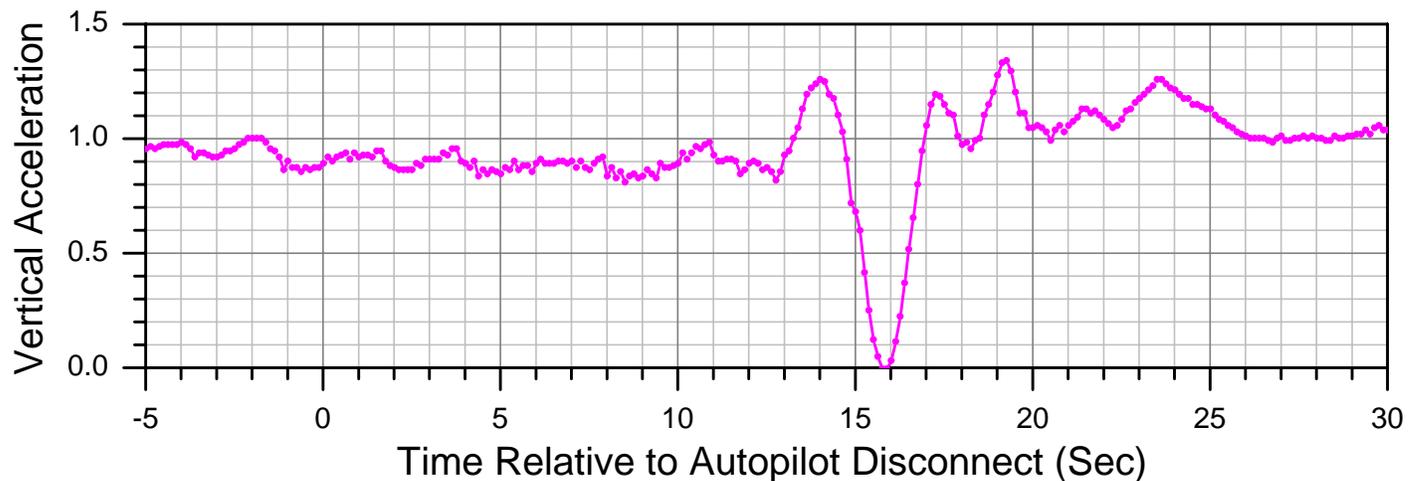
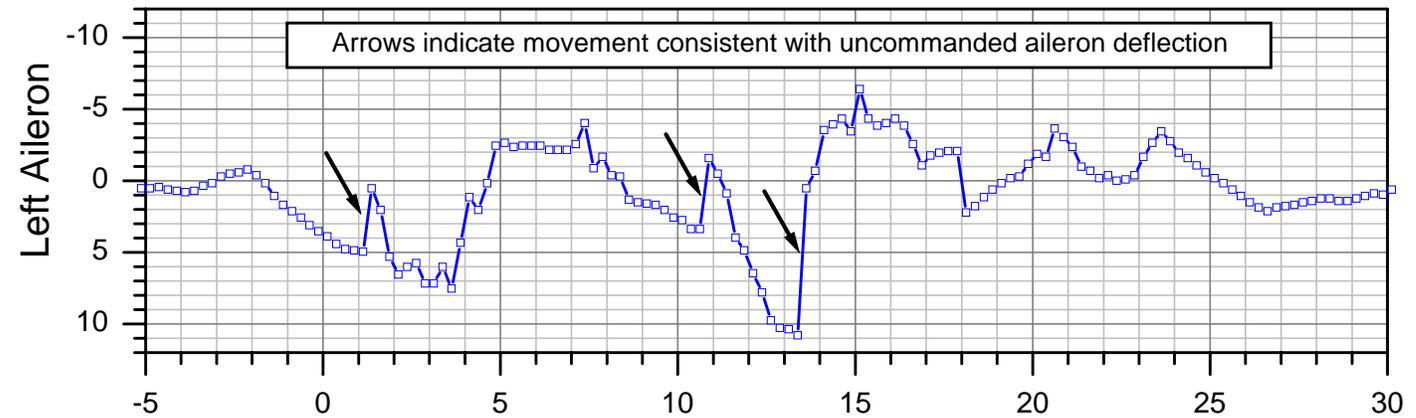
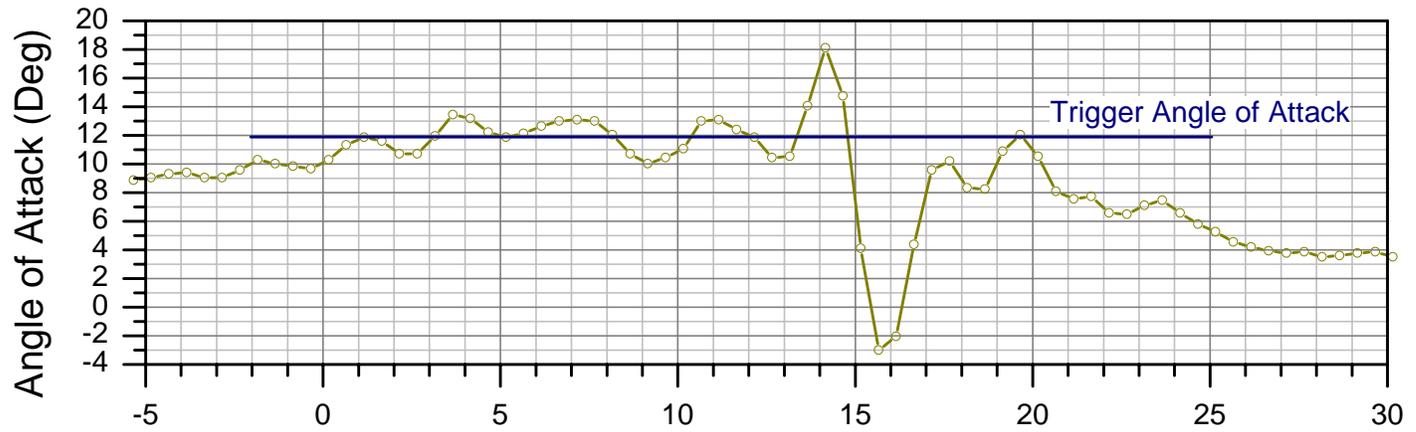
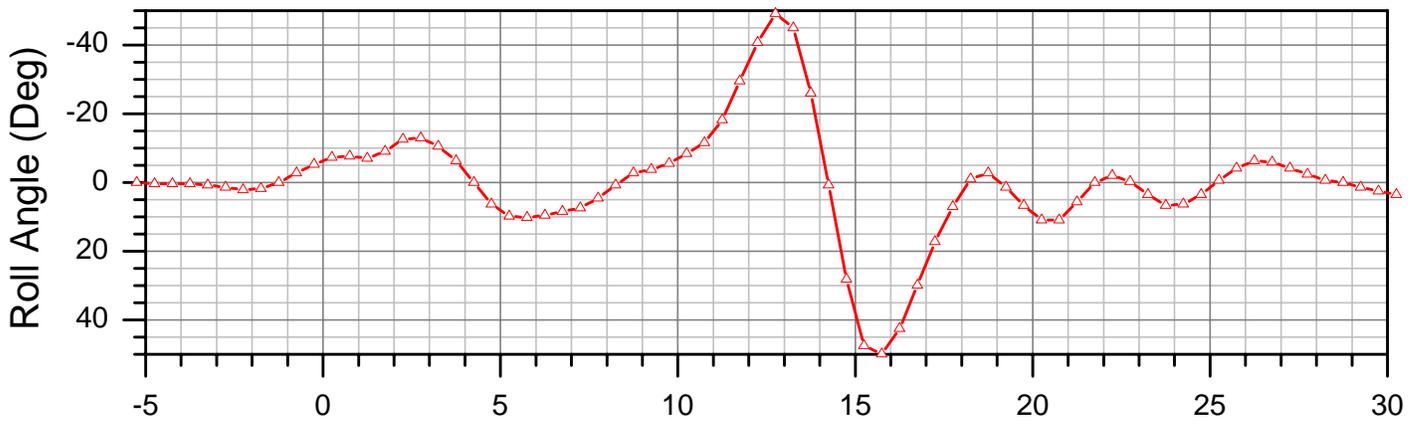
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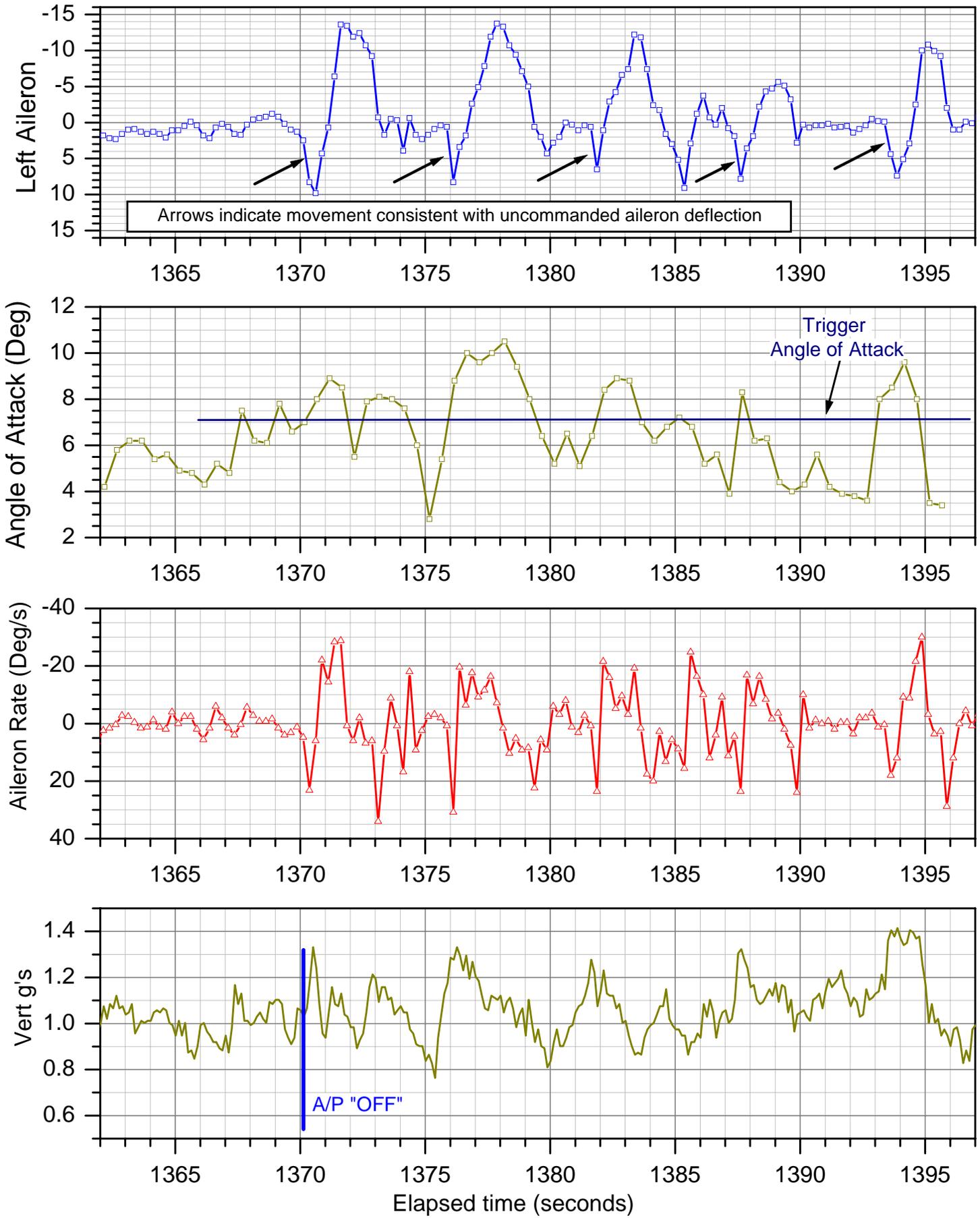
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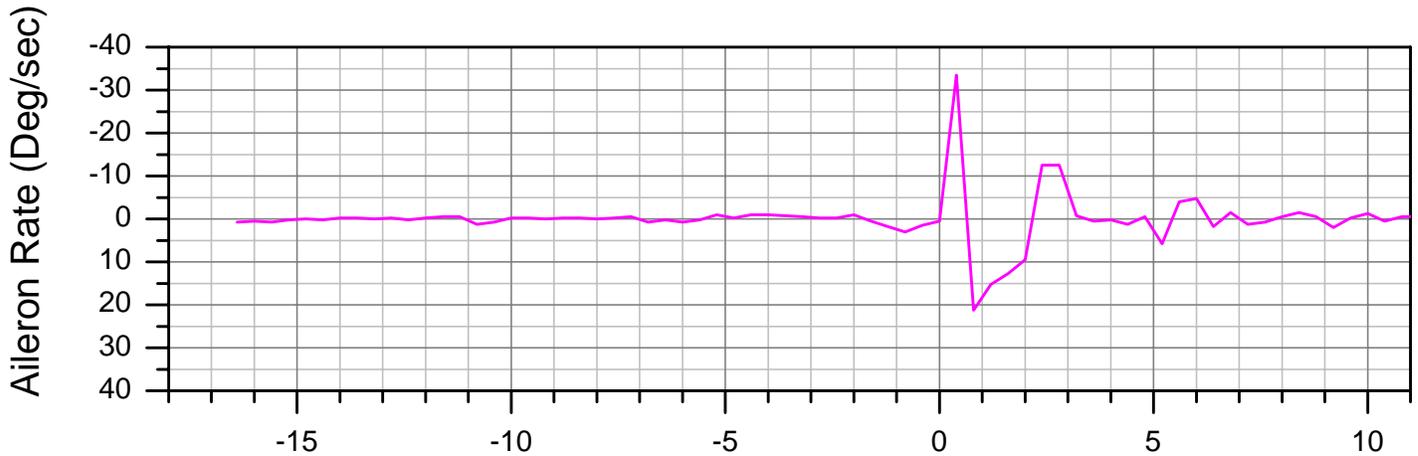
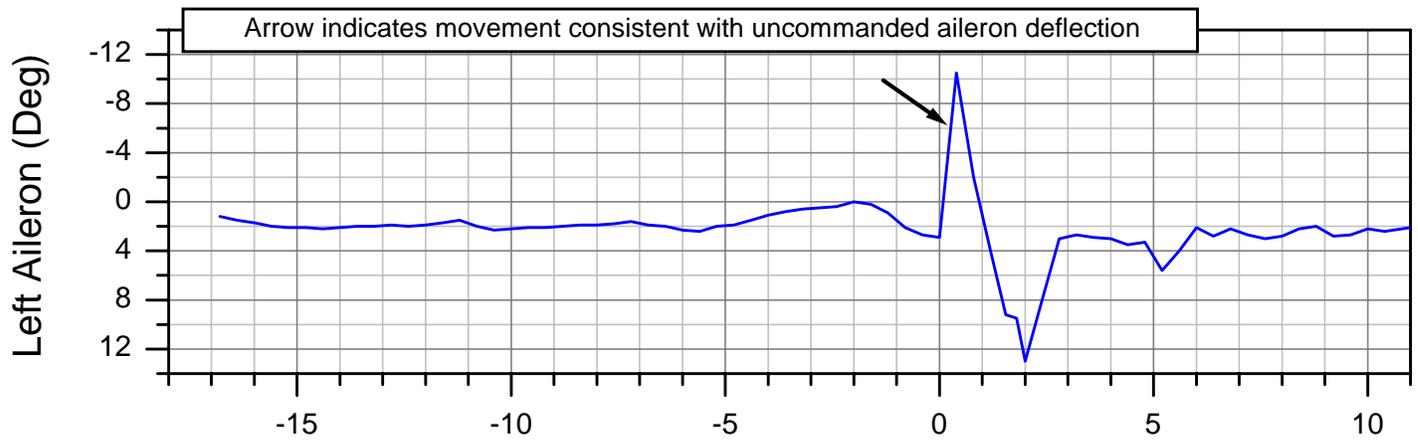
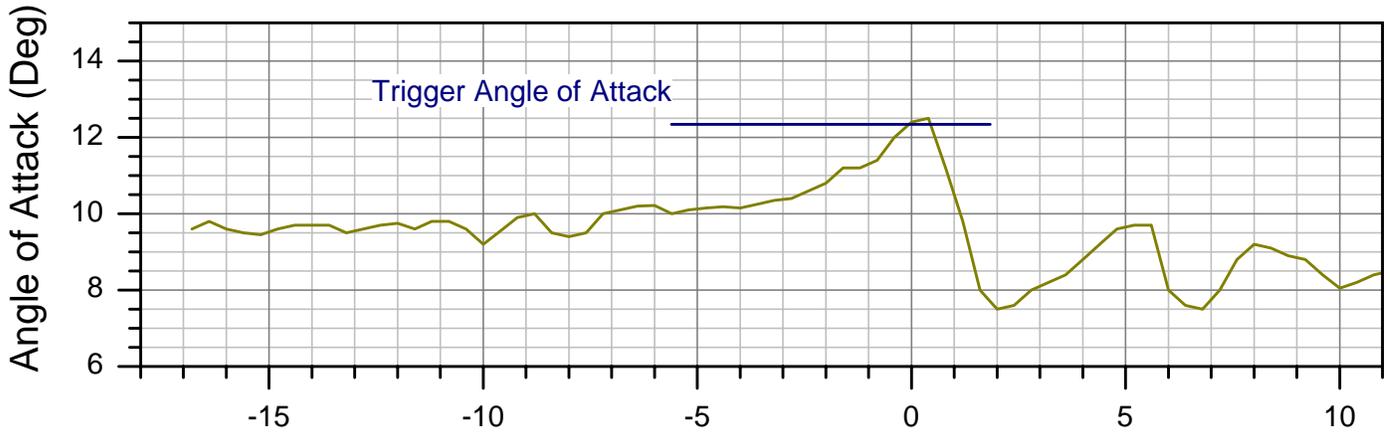
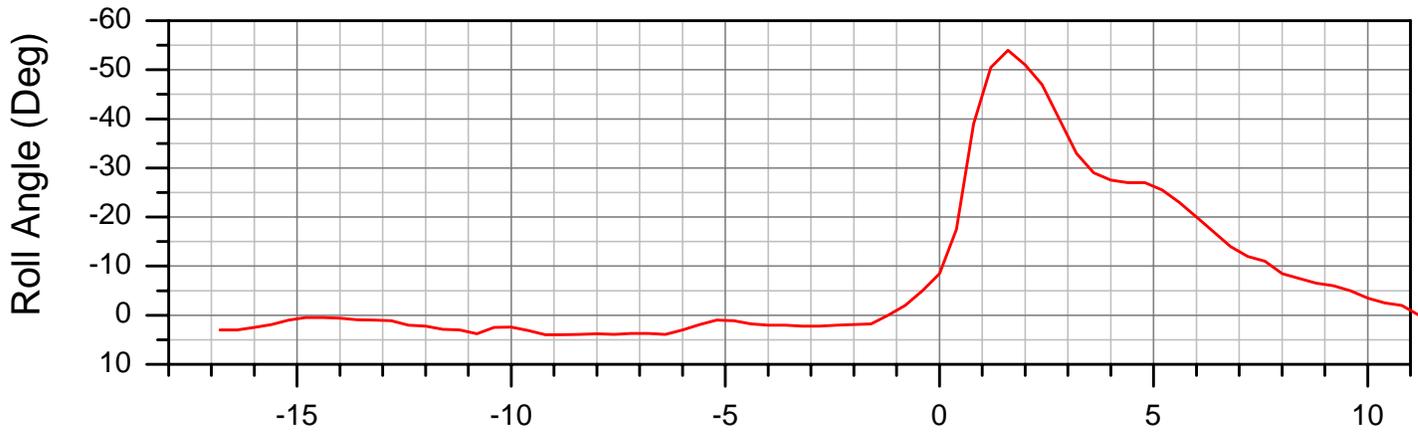
Ryan Air FDR Data



Newark FDR Data



Burlington FDR Data



Time Relative to Autopilot Disconnect (Sec)