U.S. Department
of Transportation
Federal Aviation
Administration

800 Independence Ave., S.W.
Washington, D.C. 20591

MAY 28 1998

Dr. Bernard S. Loeb
Director of Aviation Safety
National Transportation
Safety Board
490 L'Enfant Plaza East, SW.
Washington, DC 20594-2000

Dear Dr. Loeb:

The Federal Aviation Administration, pursuant to Section 845.41(b) of the Rules of Practice in Transportation: Accident/Incident Hearings and Reports of the National Transportation Safety Board, submits the enclosed comments to the public record in response to the Petition for Reconsideration of the Direction Générale de l'Aviation Civile of the Republic of France, in the aircraft accident report involving Simmons Airlines, d.b.a. American Eagle Flight 4184, Avions de Transport Regional (ATR) Model 72-212, N401AM. The accident occurred at Roselawn, Indiana, on October 31, 1994.

Copies of this letter and the enclosure have been served on all other parties to the investigation, and proof of service is enclosed.

Sincerely,

Guy S. Gardner
Associate Administrator for
Regulation and Certification

Enclosure

cc: Members of the Board

United States of America
National Transportation Safety Board
Washington, DC 20594

In the Matter of the Investigation of the
In-Flight Icing Encounter and Loss of Control
Simmons Airlines, d.b.a. American Eagle
Flight 4184, Avions de Transport Regional (ATR)
Model 72-212, N401AM, Roselawn, Indiana
October 31, 1994

Docket No. AAR-96/001

Comments of the Federal Aviation Administration to the Petition for Reconsideration of the Direction Générale de l'Aviation Civile of the Republic of France

The Federal Aviation Administration (FAA), pursuant to Section 845.41(b) of the Board's Rules of Practice in Transportation Accident/Incident Hearings (49 CFR 845.41(a)), hereby submits comments to the public record related to the Petition for Reconsideration of the Direction Générale de l'Aviation Civile (DGAC) of the Republic of France in the subject accident. The comments of the Federal Aviation Administration (FAA) are organized in three general areas and correspond to issues one through four of the DGAC's Petition. The FAA has reviewed the DGAC's issue five and, while electing not to comment formally, does support a review of the human factors issue of crew performance in the events leading to the accident.

More specifically, the FAA submits the following comments:

1. The Report incorrectly analyzes the evidence from earlier ATR incidents and the FAA's response to certain icing recommendations issued by the Board in 1981, and erroneously finds that the Roselawn accident was foreseeable.

2. The Report does not correctly address the aircraft certification process in general and the role of bilateral airworthiness agreements in particular.

3. The roles, functions, and responsibilities of the Aircraft Evaluation Group (AEG) and the Transport Airplane Directorate are misrepresented.

1. THE ROSELAWN, INDIANA, ACCIDENT IS NOT DIRECTLY RELATED TO EARLIER ATR ICING INCIDENTS

Since 1986, when the ATR-42 entered service, the ATR fleet has accumulated approximately 4 million flight hours. During the time prior to the Roselawn accident, there were five serious roll anomalies related to in-flight icing on the ATR-42. The FAA believes that there is a pattern to these earlier incidents, but that pattern is unlike the Roselawn accident in several important ways. Most importantly, except for the Newark incident, these earlier incidents were all related to an aerodynamic stall of the wing at slow speeds and high angles-of-attack (AOA) during flight in severe icing conditions. The Newark incident also occurred in severe icing conditions, but it was accompanied by gusts/turbulence and occurred at a lower AOA than the other incidents.

Indeed, in each of the five pre-Roselawn incidents the roll was induced by a stall and not by an aileron hinge moment anomaly.[1] In each previous case the roll occurred prior to aileron movement. By contrast, at Roselawn, the aileron hinge moment anomaly caused the aileron to deflect completely to its extreme right wing down position before the roll, and the aileron deflection then caused the roll. In addition, in the pre-Roselawn incidents there were no reports by the flightcrews of high control wheel forces whereas in the Roselawn situation there was evidence, from control wheel movement, of higher than normal control wheel forces or inadequate or conflicting control input by the crew. Simply stated, the Roselawn accident was caused by a phenomenon different from the phenomena involved in the earlier incidents addressed by the Report, and one that generally was not well understood by the aviation industry. This new phenomenon relates to aileron hinge moment anomalies caused by supercooled large droplets (SLD) (defined as icing conditions consisting of water droplets larger than those contained in Appendix C of Part 25, and includes freezing drizzle and freezing rain).

In each of the earlier incidents discussed by the Board, except for Newark, the airplane stalled at or slightly lower than the AOA of the icing stall warning threshold due to the accumulation of icing having characteristics that were outside the certification standards and outside the design standards for the airplane. Airflow separation over the wings due to a classic trailing-edge-first stall progression predominated in each of the pre-Roselawn incidents. Also, freezing rain appears to have been present in most of the early incidents. However, study of the digital flight data recorders (DFDR) for the earlier incidents indicates effects of freezing rain that were totally unlike those observed at Roselawn.

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[1] The control phenomenon often referred to as "hinge moment anomaly" is more properly described as a shift in required pilot control force to maintain a desired aircraft attitude. Under the most severe conditions this shift results not in lesser but reversed control forces. Simply stated, a reversal of force means that if the control wheel were released, it would move away from the neutral position and require force to return it to the neutral position. The term "hinge moment anomaly" is often used synonymously with "hinge moment shift" and "hinge moment reversal." Hinge moment anomaly is not an increase in control wheel force, and in the case of the Roselawn accident, the control surfaces remained effective and the controls operated in the normal sense, that is, control input in the right wing down direction resulted in airplane roll to the right.

Only in the Newark incident, which involved freezing rain conditions resulting in a reported accretion of 3 inches of unclearable ice aft of the ice protection system, did the stall occur at an AOA less than stall warning. However, Newark is problematic to analyze because of the complications of the associated and recorded severe turbulence and/or wind gusts.

While the pre-Roselawn incidents were probably related to low-speed aerodynamic stall of the wing, FAA analysis of the Roselawn accident reveals an entirely different phenomenon. In the Roselawn accident, with the aircraft flying at holding airspeed with wing flaps down 15°, a ridge of ice, possibly (but not necessarily) asymmetrically distributed on the right and left wing, built up just aft of the ice protection boots and immediately ahead of the ailerons. Prior to experiencing control problems, the wing AOA was increased when the flaps were retracted while maintaining airspeed. At a particular AOA, the airflow over the ailerons was suddenly disrupted by the disturbed airflow from the ice ridge. This resulted in an imbalance in the aerodynamic forces on the right aileron to deflect its trailing edge up, which in turn resulted in a full deflection of both ailerons to the right-wing-down position. The aerodynamic airflow disruption was aggravated by the dynamics of the roll upset. The Roselawn accident aircraft was flying at a relatively high speed (approximately 188 knots), and it was in the en route portion of the flight (a holding pattern prior to the beginning of the approach). Each of the earlier incidents occurred after ice accreted with the flaps fully retracted at speeds much lower than V_{FE} and during the cruise or approach phase of the particular flights. Thus, in this respect also, the Roselawn accident was unrelated to the earlier incidents in this basic and fundamental way.

The significant differences between the Roselawn accident and the prior incidents are critical. The Report does not discuss the significance of these differences, and the importance of this fact is critical since it forms the basis for incorrect conclusions.

In the five pre-Roselawn roll upset incidents discussed in the Report (except for the Newark incident), the airplane stalled at a slightly lower AOA than the icing stall warning threshold. These incidents were characterized by increasing drag and increasing AOA over a period of several minutes before the upsets. More importantly, these incidents were characterized by wing rocking, indicative of wing stall.

It is particularly important to understand that airflow separation during the trailing-edge-first stall progression predominates in the pre-Roselawn incidents. There were, in all cases except for Newark, ample cues for the crews to observe decaying airplane characteristics and to take corrective measures. In all cases, increasing power to overcome increased drag would have prevented speed decay to the point of control difficulty and would have allowed the crews time to exit the icing condition. However, if selected to altitude hold or pitch attitude hold modes, the autopilot would have allowed increases in the AOA, adding further drag. In the first case, speed would decay at a constant altitude, ultimately causing the airplane to enter the stall region; and, in the second case, the airplane would descend and may also slow down.

Freezing rain also seems to predominate in the Mosinee and Newark incidents and appears likely in the other three pre-Roselawn encounters, as well. Since the flaps were not extended in any of the previous incidents, ice accretions on the leading edge with significant ice on the wing undersurface contributed to substantial drag increases. Studies recently completed by Aerospatiale have also shown that in the Roselawn accident configuration, spanwise changes to the stagnation point associated with flap extension would tend to produce ice formation on the deicing boots on the wing forward of the flaps, but aft of the deicing boots on the wing forward of the ailerons. This point is explained more fully in the "Roselawn Accident" section of this petition.

In the pre-Roselawn icing encounters, combinations of failure to activate ice protection systems, continued operation in very severe out-of-envelope icing conditions, and failure to recognize airspeed decay over several minutes were considered by the FAA to be preventable by anyone using normal airmanship skills.

Analysis of the earlier incidents, especially the one at Mosinee, clearly demonstrates that the effects of freezing rain produce a number of effects on the aircraft that are totally unlike the Roselawn situation. Drag increases associated with only several minutes of flight in the freezing rain conditions of the pre-Roselawn encounters are comparable to the drag that would be experienced after nearly 40 minutes of flight within Appendix C icing conditions without the operation of the deicing boots. Thus, the effects of freezing rain tended to occur more rapidly and were accompanied by clear and substantial performance decrements. Further, and again in the case of Mosinee, lateral lift asymmetry (wing heaviness), sensed as a substantial reduction in control effectiveness was observed. Neither of these factors--substantial drag increase prior to the accident or reduced control effectiveness--were observed in the DFDR data from the Roselawn accident.

Mosinee, Wisconsin, December 22, 1988, ATR-42, Airplane Serial Number (S/N) 91

Regarding the Mosinee incident, the FAA has no disagreement with the Board's finding of probable cause as stated in its accident brief adopted June 25, 1990, that this incident was stall induced by the accretion of moderate to severe clear ice. However, the FAA disagrees that the Mosinee incident is otherwise related to the Roselawn accident. Specifically, the ATR-42 aircraft at Mosinee was being flown in freezing rain with the ice protection system turned off until after the roll upset. Significant in the event sequence is the fact that the airplane rolled 28° before the ailerons deflected. The crew then rapidly applied aileron deflection counter to the roll and the airplane responded. However, the crew perceived the response to be abnormal. The Captain's written statement correlated with the DFDR analysis: "My control effectiveness had been reduced to the point of almost no input [response] for control movement on my part." The First Officer's written statement described the handling characteristics in roll: "The aircraft would not respond to control input . . . the aircraft was still very unstable." This clearly shows that the incident was related to wing lift or stall asymmetry since in the Roselawn accident the airplane's DFDR data showed that the accident airplane responded to aileron deflection in a normal way. Moreover, at Roselawn, the ailerons deflected to the stop prior to the airplane rolling. Thus, Mosinee and Roselawn were fundamentally different aerodynamic events.

The stall situation which Mosinee represents is thoroughly and accurately covered in the ATR Flight Crew Operating Manual. Moreover, according to the DFDR, normal aileron activity was observed after the stall. The ailerons deflected after the autopilot disconnected, but control inputs were promptly made by the crew in less than 1 second. The crew applied control wheel input opposite the roll and added engine power to recover the airplane to a wings-level attitude. The flight data recorder evidence does not suggest that aileron hinge moment anomaly caused the roll but rather post-stall rolloff followed by normal post-stall activity of the ailerons. Moreover, uncommanded control forces were not at issue in the Mosinee incident.

Airframe de-icing was not selected on prior to the roll upset.

Indian Ocean, April 17, 1991, ATR-42, S/N 208

The Air Mauritius incident over the Indian Ocean was similar to the Mosinee incident in that there was no demonstration of aileron hinge moment anomaly.

During cruise at 16,000 feet and a static air temperature of -3° C, the speed of the Air Mauritius flight decreased from 190 knots calibrated airspeed (KCAS) to 165 KCAS at a constant RPM and presumed constant power setting and coincided with flight through clouds. Two diverging rolls of approximately 5° and 12° right wing down were controlled by the autopilot. The autopilot then disconnected and the airplane rolled to 40° right wing down. Aileron inputs of 5° to 8° against the roll combined with simultaneous reduction of AOA from 10.8° to 5.4° recovered the airplane to a wings level attitude. Propeller RPM was at 77 percent and engine torque at 71 percent at the start of the incident. Engine torque was increased to 77 percent during the roll to 40°; then it was increased to 93 percent during the recovery in the 32-second incident. At recovery, speed increased to 175 knots coincident with a loss of altitude of 900 feet.

What is important to note with regard to this incident is that the airplane stalled while on autopilot after experiencing dramatic increases in drag caused by airframe ice accretion. Dramatic changes in both increase and decrease in total drag were associated with cloud penetration. Simulations later showed that the control wheel forces were less than the limit defined in FAR § 25.143.

Since the aileron movements were against the rolls, this incident was unlike Roselawn.

Airframe de-icing was not selected on prior to the roll upset.

Brecon, South Wales, United Kingdom, August 11, 1991, ATR-42, S/N 161

The Board staff has asserted that the roll upset that occurred over Brecon, United Kingdom, was similar to the Roselawn accident.[2] The Board also asserts that it has not observed other airplane roll upsets with the same characteristics as the ATR. The FAA does not agree. The FAA has examined the Brecon incident and has concluded that it is not similar to the Roselawn accident. There is no indication of aileron hinge moment anomaly associated with the Brecon incident; rather, it appears to be a conventional stall that occurred at AOA lower than the stall protection system stick pusher threshold. The reduced stall AOA was caused by severe ice, which again was outside the limits of the airplane certification standards.

In the Brecon incident, the airplane encountered a conventional stall while at cruise at flight level 180 with the autopilot engaged, airframe de-icing selected "on," and propeller RPM at 77 percent (in lieu of a setting not below 86 percent specified for flight in icing conditions). At a constant power setting of 67 percent, airspeed decreased uniformly from 180 to 145 knots calibrated airspeed at a rate of 8 knots per minute. The corresponding AOA necessary to maintain altitude increased from 3° to 10° varying to 13°. The autopilot disconnected at an AOA that suggested self-disconnect at stall warning. The ailerons were used in a conventional way opposite the roll. There is some evidence of aileron buffet, but no evidence of hinge moment anomaly, as seen in the Roselawn accident where the roll resulted from the aileron self-deflection.

The Brecon incident is characterized by four diverging rolls to a maximum bank angle of 48° left wing down, then 50° right wing down. Aileron deflection was always against the roll; that is, in the direction to recover the airplane, which is exactly opposite of the Roselawn accident. At the 50° right wing down roll position, the AOA was dramatically reduced in a rapid pitch-down maneuver to zero g. After that, the airplane was promptly stabilized in roll with a few minor overcorrections. Shortly afterward, the flightcrew reported to air traffic control very heavy icing conditions at flight level 180. Thus, Brecon and Roselawn are not at all alike.

It is useful to compare the Brecon incident with an incident that occurred on another airplane in the same weather system. On the same day, August 11, 1991, in the same general weather system, 50 miles to the east, a British Aerospace Ltd., Advanced Turboprop (ATP) experienced a roll upset during climb. The airplane lost approximately 3,500 feet in the recovery. There was also a pattern of diverging, then converging, roll oscillations. At the extreme, the ATP airplane rolled from approximately 20° right wing down to 68° left wing down. The incident started at an AOA of approximately 5° below the normal stall angle and stall warning threshold. The pilot reported that he manually disconnected the autopilot after the incident started and, during the recovery, the airplane was slow to respond to roll control inputs.

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[2] p. 130, lines 15 - ff., Sunshine Meeting transcript.

The ATP elevator and the ailerons showed signs of buffet. Normal acceleration oscillated during the incident from 0.7 to 1.5 g. Propeller vibrations were also reported. With the exception of the fact that the ATP (at Cowly) was in a climb, compared with the constant altitude cruise of the ATR at Brecon, both flight data recorder traces show very similar time histories. It is also noteworthy that roll anomalies in severe icing conditions have occurred on other airplanes in addition to the ATR and the ATP where it has been determined that speed management by the crew was inadequate.

The FAA's conclusion is that the Brecon incident was caused by fundamentally different factors than the Roselawn accident, based on completely different flight data time histories. To the extent that the Report equates the Roselawn accident with the Brecon incident, the FAA believes that there was a misunderstanding of the significance of the aerodynamics of the two events.

Newark, New Jersey, March 4, 1993, ATR-42 S/N 259

During descent for final approach with flaps at the 0° position, RPM at 77 percent, and engine torque at 30 percent, the airplane—in turbulence ranging overall from 0.8 to 1.4g—experienced a 1.32 g spike as the AOA reached 7°. The autopilot disconnected as the airplane rolled to 14° right wing down. The ailerons then deflected to 9° right wing down until the crew responded in approximately ½ second to input full (to the stop) left wing down aileron. This is exactly opposite the situation that existed at Roselawn where the aileron self-deflected to the right wing down stop, thus causing the aircraft to roll. The Newark airplane then continued to roll 52° right wing down and under control of the crew to 10° left wing down. The airplane then experienced two more roll excursions to the right to 28° and then left to 27°. After the second roll, the pilot increased engine power (torque) to 96 percent. The airplane experienced a minor roll to 21° right wing down at an AOA of 9.6° as the vertical acceleration reached 1.4 g. Considering all of those facts, it appears that possible ice accretion asymmetry associated with the crew report of 3 inches of ice beyond the aft limit of the boots combined with turbulence was responsible for the roll upset at an AOA prior to stall protection system (SPS) activation. Moreover, a stall prior to actuation of the SPS, induced by turbulence with a reported 3 inches of unbroken ice beyond the limits of the ice protection system, resulted in post-stall roll excursions.

The Newark incident is somewhat different from the other incidents because of the complication of the rapid and dramatic changes in the load factor induced by gusts and/or turbulence. This combination of factors complicates the issue and makes it more difficult to assess and categorize. However, and notwithstanding the complicating factors, one thing is very clear, and that is that the Newark incident is different from the Roselawn accident in a very important way. In the Newark incident, the pilots were able to hold full aileron opposite the roll and recover the airplane to a wings-level attitude. At no time at Roselawn did the crew input left aileron to the limit of aileron deflection.

In this Newark incident, ice accretion is of special interest. It was alleged by the crew that there were 3 inches of ice covering the entire span of the wing. This extraordinary amount of alleged ice was approximately four times the height of the ice ridge which nearly replicated the Roselawn time history and twice the height of the ice shape tested by ATR during certification. Nevertheless, in neither of those cases was the resulting effect on the ailerons the same as was experienced at Roselawn. Further, the pilot of the Newark airplane reported control wheel force characteristics that were not at all similar to those apparent at Roselawn.

Here, too, FAA's conclusion is that this incident was very different from Roselawn. While it may be true that the Newark incident is difficult to assess and categorize, it clearly differed from the Roselawn situation in that the roll preceded the aileron movement.

Burlington, Massachusetts, January 28, 1994, ATR-42, S/N 153

The Burlington incident was also unlike the Roselawn accident. At Burlington, during cruise at an altitude of 16,000 feet with the autopilot engaged, speed decreased at a constant rate from 158 KCAS to 143 KCAS in 47 seconds. As the AOA increased from 7.6° to 11.5°, the autopilot self-disconnected at the stall warning. The vertical load factor showed a sudden decrease, referred to as a "g-break," defining a sudden loss of lift at the stall. The airplane rolled 10° to the left prior to autopilot disconnect with the autopilot applying aileron against the roll at the time of disconnect. Roll continued to a maximum angle of 54° left wing down as the AOA increased to 12.4°. At stall warning autopilot self-disconnect, the ailerons deflected 10° left wing down until the crew took control rapidly, applying 13° right wing down aileron and simultaneously reducing AOA to 7.4°. Propeller RPM was at 86 percent and engine torque at 64 percent, and both remained nearly constant during the incident and recovery. Airframe de-icing had been selected on prior to the upset incident.

Unlike Roselawn, this incident was a stall identified by a g-break, followed by aileron deflection until the crew responded within approximately ½ second and then applied nearly full opposite aileron to arrest the roll and regain control of the airplane. From g-break to wings level took 11 seconds, associated with an altitude loss of 900 feet. The altitude loss followed nose-down pitch input associated with stall recovery. There was no roll overshoot.

The stall occurred as the autopilot maintained altitude by increasing AOA as the airspeed decreased. No additional engine power was added to compensate for decreasing airspeed caused by increased drag as a result of ice accumulation.

The differences between the Burlington incident and the Roselawn accident are not arguable. The situations are clearly unlike each other, and the fact that the Report equates them is further evidence of a misunderstanding of the significance of the aerodynamics of both events.

The Roselawn Accident, October 31, 1994, ATR-72, S/N 401

An important factor in the Roselawn accident, and one which the Report does not portray properly, is that the complex atmospheric icing conditions at the accident site contained a large amount of drizzle-size droplets in the near-freezing range and perhaps few droplets that were even larger. This unusual drizzle icing condition, combined with the increased exposure of the upper surface of the outer wing at the decreased AOA with the flaps extended to 15°, was essential to rapid formation of a high ridge of ice forward of the ailerons. The formation of this ridge involved proper use of the deicing boots by the flightcrew that periodically cleaned the leading edge but not the ice accretion aft of the active portion of the boots, thus forming a sharp step-like surface irregularity. This irregularity caused the ice accumulation at that position to grow in height and allowed the ridge to maintain a sharp, irregular edge, which proved essential for the airflow disturbance. While the ice ridge may have been slightly spanwise asymmetric, gross asymmetry (i.e., ice on one wing but not the other) was not necessary for the Roselawn upset. This fact was shown by actual flight tests by Aerospatiale that duplicated the Roselawn upset with ice shapes on both wings forward of the ailerons.

A sharp-edged, irregular ridge of ice of limited chordwise extent with elements over 3/4-inch in height aft of the deicing boots at 8 to 9 percent wing chord caused airflow separation over a limited chordwise region aft of the ridge as the AOA exceeded approximately 6°. This region of separated airflow did not extend aft to the trailing edge of the wing but became reattached. However, the resulting unsteady aerodynamic disturbance was sufficient to alter indirectly the pressure over the aileron.

At low AOA, this airflow separation located immediately aft of the ice ridge may have reattached, but flow separation at the trailing edge of the wing advanced progressively forward as AOA increased. At a certain AOA greater than the onset of the initial separation but much less than the wing stall angle, the trailing edge separation reached the aileron hinge line and the difference in pressure above and below the aileron was sufficient to cause the right aileron to deflect upward and the left aileron to deflect downward, thus promoting a right roll. In this case, due to very good aerodynamic balance of the ailerons, the left aileron contributed little if any restoring force to the right aileron, and the roll continued. Also, due to the right roll rate, the AOA seen by the right aileron was greater than the AOA of the left aileron, promoting greater flow separation over the right aileron and less separation over the left aileron, increasing the right aileron trailing edge up hinge moment, and decreasing the contribution of the left aileron to decrease the deflection of the right aileron. This was a low AOA phenomenon, further placing Roselawn apart from the other icing incidents.

Proper use of the ice protection system by the flightcrew removed ice from the leading edge of the wing and minimized the drag buildup caused by ice on the wing leading edge. Selection of flaps at 15° during the hold not only contributed to the development of a damaging ice ridge aft of the active portion of the boots on the upper surface of the wing, but also prevented drag-inducing ice from forming on the lower surface of the wing.

Thus, the drag increase observed in other SLD incidents was not evident in the Roselawn accident until the flow separated aft of the ice ridge and over the ailerons at approximately 6° AOA.

Because flaps were extended during the ice-accretion phase, there was a difference in the stagnation points of the wing forward of the flap compared to the wing forward of the aileron. Recent analysis by Aerospatiale has shown that at the Roselawn conditions, the stagnation point forward of the ailerons would reside somewhat higher (further aft) than forward of the flaps. Thus, the ice that formed on the outer wing formed aft of the boots while the ice that formed forward of the flaps formed on the boots and was subsequently removed by deicing boot operation. This partial span ice ridge on the upper surface of the wing (together with the lack of ice on the lower surface of the wing) produced a minimal drag increase less than approximately 10%, according to Aerospatiale. The artificial ice shape that was generated as a result of the tanker testing that reproduced the flight profile of the Roselawn accident matched the Roselawn drag increase.

During the holding pattern turn prior to the Roselawn roll upset, with the autopilot engaged in altitude and heading hold mode, the DFDR data indicated that the ailerons were deflected in a left-roll direction. The autopilot self-disconnected and the airplane rolled rapidly due to the uncommanded aileron deflection. All of this happened at an AOA much lower than the advanced icing stall warning (stick shaker) or icing stall identification (stick pusher) threshold. It occurred within a very narrow AOA range such that the first substantial indication of impending upset was the rapid deflection of the ailerons to the right wing down stop, which was followed by a roll.

Extensive flight and wind tunnel testing conducted by the manufacturer after the accident revealed a distinctive characteristic about the mechanism that caused the roll upset. At approximately 6° AOA, normally-attached airflow just aft of the "Roselawn" ice ridge became detached from the wing and then reattached further aft along the chord. The location of the reattachment was erratic and sensitive to small changes in AOA, which induced an erratic change in pressure on the upper surface of the aileron. The rapidly changing pressure over the aileron tended to deflect the aileron up or down and required a substantial and opposite fluctuating control wheel force to hold it steady or set it to the desired position. This erratic behavior was observed in the AOA range between 6° and 10°. After exceeding 10°, erratic changes in control wheel forces suddenly decreased by approximately 75 percent and did not subsequently increase even though the AOA increased to 15°. Significantly, during post-accident flight testing with the Roselawn ice shapes, the airplane stick pusher actuated before the wing stall angle was reached. Thus, the FAA does not consider what occurred at Roselawn as the same kind of an event as the pre-Roselawn occurrences but simply at a lower AOA; rather, the FAA considers Roselawn to be totally different in kind due to the unique characteristics of airflow separation.

Airflow separation which moves towards the leading edge or the trailing edge of the wing are important and distinctly separate mechanisms, each of which may cause aileron and roll anomalies but of different magnitudes. Most importantly, each is responsive to different corrective measures. For the icing incidents prior to Roselawn, separation occurred at the trailing edge first, and the corrective measures effective for these conditions included delaying the onset of separation over the wing by installation of wing-mounted vortex generators (VG) and reducing the SPS thresholds during flight in icing conditions. These VG's were not effective in helping to prevent the Roselawn upset since they are located at 30 percent chord, and were immersed in the ice-ridge-caused airflow separation. Roselawn corrective measures necessitated the prevention of a ridge of ice greater than the critical height from forming forward of the aileron by increasing the chordwise extent of the active portion of the pneumatic boots on the upper surface. This significant difference in the appropriate corrective measures is itself the best evidence of the fundamental differences between the Roselawn accident and the prior incidents, and it is one that the Report does not acknowledge.

The inescapable facts are that the fundamental aerodynamics of Roselawn, the tactile cues presented to the crew, and the design corrective measures were different at Roselawn than in any of the preceding incidents.

The FAA Did Not Ignore Icing-Related Recommendations Issued In 1981, And In Any Case The NTSB Has Misjudged Their Significance To The Roselawn Accident

The Report asserts that if the FAA had complied with the Board's 1981 recommendations regarding freezing rain and mixed-phase icing conditions (supercooled liquid water and ice crystals), the Roselawn accident may not have occurred. While the FAA has not incorporated freezing rain or mixed conditions into its icing requirements, in the case of the ATR, the airplane, during post-certification flight testing by Aerospatiale, was tested in freezing rain conditions, and no control response similar to that at Roselawn was observed. What the FAA, and the entire aviation community, found is that effects of freezing drizzle appear to be far more adverse than freezing rain with respect to the formation of a ridge and the ability to generate large, rapidly changing and reversing control wheel forces. In the case of the ATR accident at Roselawn, where the airplane accreted ice with the flaps extended, the resulting ice ridge on the upper surface was not accompanied by a substantial increase in drag. Moreover, it has also recently been documented that, in certain other conditions and configurations not related to Roselawn, freezing drizzle can also be far more adverse in drag than freezing rain or mixed conditions. Thus, freezing drizzle, not freezing rain or mixed conditions, appears to be the most severe condition, which is counterintuitive to the usual cause/effect relationships associating severity with size and amount.

NTSB Recommendation A-81-116 is particularly relevant here; it states:

> Review the icing criteria published in 14 CFR [Code of Federal Regulations] [part] 25 in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution, and temperature, and

recent developments in both the design and use of aircraft; and expand certification criteria to include freezing rain and mixed water droplet/ice crystal conditions, as necessary.

The environmental conditions described in the recommendation, for all intents and purposes, were examined for the ATR, and those conditions were found not to pose a problem for the aircraft. Because the facts of the Roselawn accident are not consistent with the assumptions in the recommendation, the FAA does not believe that adherence with the recommendation would have prevented the Roselawn accident.

Based on all of the available evidence, the Administrator believes that, prior to the ATR accident at Roselawn, ATR airplanes had been tested in freezing rain conditions and that the adverse effects of the freezing rain appeared to be conventional drag increase and lift loss/reduction in stall angle. When compared to the known history of the ATR and other airplanes in service, the hazard due to freezing rain appears to be stall at an AOA less than SPS activation while flying on autopilot accompanied by predictable rolloff followed by—but not caused by—aileron activity.

It is important to stress that the hazard which existed at Roselawn was caused by water droplets in the freezing drizzle size range that are not associated with a drag increase and that were not addressed by its 1981 recommendations. Indeed, it appears that the Board, like the FAA, the DGAC, and ATR, learned about the particular dangers of freezing drizzle only after the Roselawn accident. At Roselawn, drizzle-size droplets combined with configuration-related factors generated a ridge of ice—an ice accretion with a blunt forward surface, a sharp edge, and limited chordwise extent—located close to the leading edge. This aerodynamically disruptive ridge of ice was responsible for the dramatic change in hinge moment at a low AOA that occurred at Roselawn.

2. THE REPORT MISCONSTRUES THE CERTIFICATION PROCESS FOR FOREIGN MANUFACTURED AIRCRAFT

On pages 184-186, the Report states:

> The Bilateral Airworthiness Agreement between U.S. and France eliminates a significant amount of duplication in the overall certification of an aircraft. This method of certification relies significantly upon the airworthiness authority of the exporting country to review manufacturer data and ensure adherence to the U.S. type certification procedures and requirements. It is generally an appropriate process if the FAA is involved in monitoring the certification by a foreign airworthiness authority. However, it appears that the FAA has implemented the process with extremely limited "hands-on" involvement in the development, construction and flight testing of the aircraft. . . . The Safety Board concludes that 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, such

excessive reliance on a foreign airworthiness authority could result in improper certification of an aircraft. Therefore, the Safety Board believes that the FAA should review and revise, as necessary, the manner in which it monitors a foreign airworthiness authority's compliance with U.S. type certification requirements under the Bilateral Airworthiness Agreement (BAA).

It is clear from the above-quoted text that the Board misunderstands the reciprocal certification procedures that exist under Bilateral Airworthiness Agreements (BAA) in general, and, in particular, under the BAA between the United States and France. As explained below, the Board also misunderstands the role the Direction Générale de l'Aviation Civile (DGAC) had in the original certification of the Aerospatiale ATR-42 and ATR-72.

A BAA is a technical agreement concerning the performance of airworthiness certification functions. It is based on, among other things, a high degree of confidence in the exporting country's technical competence and regulatory capability for performing airworthiness certification functions within the scope of the particular agreement. The United States. has developed and implemented BAA's with 27 other countries. Each agreement varies considerably in scope, but all of them provide in effect that, "the importing State shall give the same validity to the certification (made by the competent aeronautical authority of the exporting State) as if the certification had been made by its (the importing country's) own competent aeronautical authority in accordance with its own applicable laws, regulations, and requirements." Para. 2a BAA, 24 UST 2142, 2143 Sept. 26, 1973.

Before a BAA can be adopted, the FAA performs an in-depth technical assessment of the exporting State's civil aircraft certification system. This includes an assessment of the foreign airworthiness authority's technical competence, capabilities, regulatory authority and efficacy, as well as the foreign industry's overall state-of-the-art in design and manufacturing capability for the scope of the agreement sought. This process typically takes several years to complete.

If the FAA's technical assessment is satisfactory, the FAA notifies the U.S. Department of State (DoS). The DoS then works on the draft of the scope, substance, and text of the BAA, usually working with the civil airworthiness authority of the other State. Once a draft BAA is completed, the text is transmitted by the DoS to its counterpart of the other country for review, comment, and negotiation. The DoS concludes the BAA process through an exchange of diplomatic notes with the other State.

One condition that is common to all 27 of these agreements is that the importing State may prescribe additional technical conditions, "which the importing State finds necessary to ensure that the product meets a level of safety equivalent to that provided by its applicable laws, regulations, and requirements which would be effective for a similar product produced in the importing State." Para. 4, BAA 24 UST 2142, 2143 Sept. 26, 1973. Thus, the FAA works through these agreements to make findings, as required by 49 USC § 44704, that the import product meets U.S. or equivalent standards based on a certifying statement to that effect from the civil airworthiness authority of the exporting State.

The Type Certification Process Under A Bilateral Airworthiness Agreement

A type certificate is issued for an aircraft, aircraft engine, or propeller manufactured in a foreign country in accordance with the requirements of 14 CFR § 21.29. This regulation provides that a type certificate may be issued for a product that is manufactured in a foreign country with which the United States has an agreement for the acceptance of these products for export and import and that is to be imported into the United States if the country in which the product was manufactured certifies that the product has been examined, tested, and found to meet U.S.-certification requirements. When issuing a type certificate under 14 CFR § 21.29, the FAA follows the procedures listed in Advisory Circular 21-23. These procedures state, in part, "the FAA's findings of compliance for products to be imported are based, for the most part, on technical evaluations, inspections, and certifications made for the FAA by the ECAA [Exporting Country's Civil Airworthiness Authority] of the country of the applicant. For all BAA type certification programs, the exporting country assumes the role of the 'certificating authority,' and the importing country assumes the role of the 'validating authority'."

In the role of the validating authority, the FAA routinely exercises its right to examine any data it chooses at any time during a type certification program. The FAA exercises this right in order to assure that compliance with the U.S. certification basis has been demonstrated. In considering the most appropriate level of its involvement, the FAA will pay particular attention to its familiarity with, and the extent of, its recent interaction with the exporting authority, any novel or unique features of the proposed design, and whether special conditions or exemptions are applicable. Generally, the FAA focuses on areas that are controversial, covered by new regulations, or have been found to cause certification or service problems on other programs.

The Roles Of FAA Personnel And "Issue Papers" In The Certification Process

On page 185, the Report states:

> 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."

These statements are erroneous. The Report is incorrect in its assertion that a lone FAA employee was compelled to review "vast amounts" of assorted technical information on a transport airplane project without assistance of other FAA technical specialists who are experts in their respective disciplines. According to the testimony of the FAA Special Certification Review Team leader at the Board's public hearing in Indianapolis on March 3, 1995, one FAA employee has attended the final type board meetings of some recent certification programs. (Hearing transcript, p. 1496). However, the business conducted at these final type board meetings is entirely administrative, as all of the technical certification review by the FAA has already taken place. The purpose of these meetings is to ensure that the compliance checklist is complete and that all open administrative issues are closed, so that the type certificate can be issued.

The Report also demonstrates a misunderstanding of the role played by FAA issue papers in a certification program. The Board believes that issue papers are used to compensate for a perceived lack of FAA involvement. In fact, issue papers are a normal part of all certification programs, both domestic and foreign, and they play a vital role in transferring certification requirements, policy, procedures, lessons learned, and other valuable information to the applicant and foreign authority. Issue papers make clear any concerns the FAA may have about a particular certification subject, and both the foreign authority and the applicant have an opportunity to share in the resolution of the issue. Issue papers are an important and integral part of thorough domestic and foreign airplane type approval programs, and are not a crutch used to compensate for any shortcoming in FAA certification procedures.

Contrary to the suggestion made in the Report, an airplane cannot be certificated with any open issues. During the discussion of the various issues, the FAA, the applicant, and the foreign authority may not be in accord concerning the solution path. When all parties are in agreement concerning the solution path, the issue is considered closed. The last step in all issues resolved by issue papers is that a finding of compliance is made by the certificating authority on FAA's behalf in accordance with the solution path.

As a further clarification, issue papers evolve through several "stages" during their development. In Stages 1 and 2, the FAA identifies the need for the issue paper and drafts the issue paper listing the "statement of issue" and the "FAA position." The initial issue paper is then reviewed by both the manufacturer and, if a BAA program, the foreign authority. The manufacturer and the foreign authority are expected to provide their positions and any supporting documentation (Stage 3). Occasionally, lengthy discussions are held at this stage until the FAA is satisfied that both the authority and the manufacturer understand the issue and agree upon a satisfactory means of compliance.

When technical agreement is reached, the issue paper is revised to include the positions and supporting data of all parties. A final review of the issue paper is then made by the FAA at which time a "conclusion" is added and the issue paper is finally closed (Stage 4). For a BAA program, the FAA would then expect the foreign authority to make compliance findings on behalf of the FAA in accordance with the understandings and instructions contained in the relevant issue paper.

Issue papers are a vital tool the FAA uses to help fulfill its responsibility as the validating authority and to assure that the certificating authority has all the information and understanding necessary to apply pertinent FAA regulations and policy positions in all situations. Once the FAA is assured that the issue is understood and that the means of compliance will be acceptable, it is a normal part of the BAA process to allow the certificating authority to make those findings of compliance on behalf of the FAA. If the FAA made its own findings of compliance, this would involve a duplication of effort and would violate at least the spirit of the BAA. Such duplication would detract from the FAA's safety effort by greatly increasing the workload of certification personnel, thus denying the ability to apply resources in depth where needed.

Under the BAA, the FAA retains control over the certification program while multiplying the effectiveness of its employees. The BAA accomplishes an important safety function in foreign certification programs much as the Designated Engineering Representative system and the Delegated Option Authority system function in domestic certification.

It should be noted that during the original certification program for the ATR-42 the FAA prepared 98 issue papers. For the ATR-72, which was a derivative of the already-certified ATR-42, the FAA prepared 19 issue papers. This large number of issue papers clearly shows that the Board's assertion of a "hands-off" approach to the certification of these airplanes by the FAA is erroneous.

Relevant to the icing certification of the ATR-72, Aerospatiale, through the DGAC, proposed an additional requirement for the ATR-72 icing certification, namely special condition (SC) B6. SC B6 added certain requirements over and above those required by the FAA. These additional technical conditions were addressed in an issue paper. The outcome of the issue was that SC B6 was found to be acceptable to the FAA.

FAA Flight Testing Of Foreign-Manufactured Airplanes

On page 186, the Report states:

> Included in the certification process is the FAA review of test data acquired from flight tests. 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.

This paragraph indicates that the Board misunderstood the nature of the evaluation flights. As stated at the Board's public hearing in Indianapolis on March 3, 1995, the purpose of the flights is not to duplicate any of the certification testing, which is conducted under the

BAA,[3] but rather as a means of familiarization for the FAA flight test pilot on the certification team. (Hearing transcript, pp. 1502-3). Such familiarization is necessary for the FAA test pilot to fulfill his/her duties during the life of the airplane, including analyzing service difficulties, evaluating modifications that impact flying qualities, etc. FAA evaluation flights are preceded by an in-depth FAA review of flight test data prepared by the manufacturer for the foreign authority. If unacceptable items are found during the FAA evaluation flight or if items are found to have been conducted in a manner unacceptable to the FAA during earlier flight testing, these items would be more thoroughly investigated and would have to be corrected with FAA test pilot involvement prior to certification. Notwithstanding these possible complications, a well planned and thorough flight evaluation campaign can be, and has been, accomplished in as little as 10 hours of flight time.

The FAA does reserve the right to flight test airplanes if, in its judgment, such flight testing is warranted. During two recent foreign certification programs (Fokker 50 and Fokker 100), the FAA conducted certification flight tests that did, in fact, duplicate earlier testing by the civil airworthiness authority of the exporting State. These tests included stall speeds, stall characteristics, minimum control speed, climb performance, static and maneuvering stability, lateral-directional static stability, and engine operating characteristics. There are other examples of FAA flight test programs that duplicated earlier certification testing by the civil airworthiness authority of the exporting State. As stated before, the FAA exercises its judgment in each situation, and requests any data (or conducts any test) that it finds is warranted in a particular situation. No such requests were made in the cases of the ATR-42 or -72 because no such requests were warranted or necessary.

3. THE REPORT MISCONSTRUES THE ROLE, FUNCTION, AND RESPONSIBILITY OF THE AIRCRAFT EVALUATION GROUP (AEG) AND THAT OF THE TRANSPORT AIRPLANE DIRECTORATE

On page 184, the Report states:

> "The Safety Board concludes that the lack of defined lines of communication and adequate means to retrieve pertinent airworthiness information prevented the AEG from effectively monitoring the continued airworthiness of aircraft."

This statement is incorrect, and it also demonstrates a misunderstanding of the role, function, and responsibility of the AEG. Responsibility for monitoring the continued airworthiness of type-certificated aircraft does not rest solely with the AEG. The Aircraft Certification Service's highest priority is the continued airworthiness of the current airline fleet, and the Aircraft Certification Service and the Flight Standards Service (the parent organization of the AEG) cooperate fully in this important function. The Aircraft

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[3] Flight testing of both models was handled under the normal and customary procedures of the BAA.

Certification Service has the prime responsibility for monitoring the continued airworthiness of the airline fleet.

Within the United States, the FAA relies on the formal data collection system known as the Service Difficulty Reporting System for the majority of adverse in-service reports on U.S.-manufactured airplanes. Airplane operators, under the supervision of their respective Principal Maintenance Inspectors (PMI), are required to submit written reports of equipment failures and other in-service problems to the FAA database in Oklahoma City. Specialists in that office collect the information and make it available to anyone in the FAA through local computer access. In addition, that office performs trend analysis and reports adverse trends to FAA engineering offices on a periodic basis. Offices within the Aircraft Certification Service have direct computer access to this information.

FAR § 21.3 contains a list of failures, malfunctions, and defects that are required to be reported directly to the FAA. In addition, many PMI's contact their AEG directly with information about failures and malfunctions that have been observed. Additionally, because of warranty and other economic considerations, operators routinely contact the manufacturer immediately following most adverse service problems; most manufacturers in turn contact the FAA certification office directly to pass along this safety information. Thus, there are numerous ways in which information regarding service difficulties that occur within the United States is forwarded to the FAA.

The provisions of International Civil Aviation Organization Annex 8 clearly designate the exporting country's civil aviation authority (ECAA) as the primary party responsible for the continued airworthiness of products designed and manufactured in the exporting country. The BAA's by which the FAA accepts imported products reinforce this principle. The BAA between the United States and France, for example, requires each party to keep the other "fully informed of all mandatory airworthiness modifications and inspections which they determine as necessary" concerning imported or exported products.

The FAA requests airworthiness information from foreign certification authorities, including France, when appropriate. However, in most instances, the FAA relies on the ECAA to review and take appropriate action on the airworthiness information provided by the ECAA's manufacturers. The FAA normally accepts the corrective actions taken by the ECAA in the issuance of its own mandatory corrective actions but is under no obligation to do so. The decision as to the final action to be taken lies solely with the FAA. As in the FAA type certification of imported products, the FAA's continued airworthiness programs for imported products rely largely on the ECAA to make the technical determinations (with the FAA reviewing such determinations) and--just as importantly--monitoring the system that makes those determinations.

Over the last several years, the Aircraft Certification Service has made improvements in its system to monitor the continued airworthiness of the airline fleet. Following a review of the FAA by the Office of Inspector General in 1994 (Report Number E5-FA-4-009, Responsiveness to Suspected Aircraft Maintenance and Design Problems), the FAA has instituted positive improvements to its continued airworthiness review process. The Los Angeles Aircraft Certification Office (ACO), which is responsible for certification matters related to airplanes built by the former McDonnell Douglas Corporation, and the Seattle ACO, which is responsible for certification matters related to Boeing airplanes, have instituted formalized continued airworthiness procedures. In addition, the Standardization Branch within the Transport Airplane Directorate has more than doubled its staff in the last 2 years, and a new International Branch has been formed in order to improve FAA's timely response to continued airworthiness matters on foreign-manufactured airplanes. Further, a new database has been instituted in the International Branch to track more closely foreign airworthiness matters and to ensure that complementary FAA airworthiness directives are issued as soon as possible.

It is the FAA's view that these issues are extremely relevant to a complete understanding of the accident and its causes and should be addressed by the Board as part of the effort to consider the Petition for Reconsideration that has been submitted by the DGAC of the Republic of France.

Respectfully Submitted,

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