



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

LOG A-2560

Date: November 14, 1995

In reply refer to: A-95-107 through -109

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 27, 1995, about 1730 eastern daylight time, an Airbus A320-211, N331NW, operated by Northwest Airlines as flight 352, experienced what the pilot reported as an uncommanded roll of 30° while on final approach to runway 18 at Washington National Airport. The flightcrew executed a missed approach and subsequent successful landing. Visual meteorological conditions prevailed at the time. The winds were reported from 220° at 17 knots, gusting to 25 knots. No injuries were reported, and the airplane was not damaged. Flight 352 was being conducted under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121 as a domestic, scheduled passenger service flight from Minneapolis, Minnesota, to Washington, D.C. The National Transportation Safety Board is investigating the incident with the assistance of the Federal Aviation Administration (FAA), and Northwest Airlines. An Accredited Representative from the French Bureau Enquetes-Accidents (BEA), assisted by Airbus Industrie personnel, is also participating.

Data from the flight data recorder (FDR) indicate that on the first landing approach, the airplane's roll attitude was initially stable, and the flaps were deflected to the 20° position (referred to as the CONF 3 position). The approach required the captain to align with the runway approximately 150 feet above ground level (agl). FDR data indicate that, after performing the final turn to align with the runway, the captain began to make a series of approximately 12 large, rapid, cyclic deflections of his sidestick controller. Most of the deflections were from stop to stop in approximately 1 second intervals. The airplane responded to these control movements with bank angles of up to 15° left and right. The FDR data show that the aileron deflections and roll response of the airplane were consistent with the sidestick controller movements. There was no evidence of an uncommanded roll.

Rapid, cyclic control inputs such as these are typical of a phenomenon termed pilot-induced oscillation (PIO). 'Aerodynamics for Naval Aviators' states that: "The pilot-induced oscillation is most likely under certain circumstances. Most obvious is the case of the pilot unfamiliar with the "feel" of the airplane and likely to overcontrol or have excessive response lag." FDR data indicate that the magnitude of the pilot sidestick deflections was too great to

maintain roll attitude. The Safety Board believes that the roll experienced by flight 352 is consistent with PIO and was not the result of any uncommanded roll.

The Safety Board learned that this was not the first incident in which an A320 flightcrew experienced a lateral PIO during a landing attempt with flaps in CONF 3. Airbus was aware of approximately 10 similar incidents occurring on other A320s.

Airbus first addressed this problem in Temporary Revision (TR) No. 192 to the A320 Flight Crew Operating Manual entitled, "Flaps Setting for Landing in Turbulence or Suspected Windshear," dated April 1993. This revision stated:

- There have now been a small number of cases where pilots making approaches in CONF 3 in gusty turbulent conditions have experienced lateral control difficulties. The reasons for this are currently under investigation by the relevant design office. There have been no similar incidents reported in CONF full [35° deflection].
- Pending the outcome of the proper investigation of this phenomenon, Airbus Industrie has decided to recommend that CONF full should be used whenever possible when [landing] conditions are likely to be turbulent.

Although TR No. 192 was received by the three U.S. A320 operators, the Safety Board learned that the information was interpreted and handled in different ways by each operator. For example, Northwest Airlines made no changes to its A320 Flight Handbook, while America West summarized the information in the "Adverse Weather" section of its cockpit operations manual.

TR No. 192 had been reviewed by the Direction Generale De L'Aviation Civile (DGAC) of France in 1993. It had determined that no regulatory action was required. The investigation revealed that the FAA did not perform a review to determine if regulatory action was required. Also, since the TR was considered to be advisory in nature, the FAA was not required to perform surveillance on the manner in which U.S. operators incorporated and disseminated this information to their flightcrews.

The investigation revealed that Northwest Airlines personnel were not aware of the known susceptibility for PIO nor of the manufacturer's recommendation to avoid landings in CONF 3 in gusty, turbulent conditions. Consequently, this information was not disseminated to flightcrews. The Safety Board concludes that information on the PIO susceptibility was not effectively disseminated from the manufacturer to the different airworthiness authorities and to operators and flightcrews. The Safety Board is concerned that other useful and perhaps critical information of a similar nature is not being effectively communicated. In accordance with the standards of ICAO Annex 8, Part II, paragraph 4, "Continuing airworthiness of the aircraft," the Safety Board believes that the FAA, in conjunction with the French DGAC, should develop procedures to ensure proper dissemination of such information.

The A320 flight control system features fly-by-wire technology, meaning that inputs from the flightcrew are made electronically rather than mechanically. The airplane is equipped with two sidestick controllers in the cockpit, which replace the conventional control columns. Lateral inputs made to the sidestick controllers are electronically sensed by the Elevator Aileron Computers (ELACs).

Software in the ELAC computers determines the roll response of the airplane based on a variety of inputs, including flap position. The airplane's response to sidestick inputs in the lateral axis is distinctly different in flaps CONF 3 and CONF FULL. According to Airbus engineering personnel, the flight control laws were designed to optimize takeoff handling characteristics rather than landing handling characteristics, with CONF 3 selected.

The Safety Board learned that Airbus has developed a flight control software modification to minimize the susceptibility for PIO in CONF 3. A new version of ELAC software known as the L69J Standard contains changes that alter the way the airplane responds to lateral sidestick inputs in CONF 3. These changes make the airplane less sensitive to lateral sidestick inputs and therefore less prone to PIO. The new software, which also contains other unrelated modifications, is addressed in Airbus Service Bulletin (SB) No. A320-27-1082, dated April 25, 1995.

The opening paragraph in Airbus SB No. A320-27-1082 is entitled "Reason/Description /Operational Consequences." The paragraph describes seven unrelated changes incorporated in the L69J Standard software. The paragraph does not mention the known susceptibility to PIO in flaps CONF 3 landings, nor does it mention the changes to airplane handling qualities incorporated in the software. Airbus engineering personnel stated that they believed it was not necessary to inform operators of these changes. To date, the DGAC and FAA have not made compliance with this SB mandatory.

On conventionally controlled airplanes, changes in flying characteristics are only possible with major structural or flight control system modifications. However, with the advent of fly-by-wire technology, flying qualities can now be altered via flight control computer software. The Safety Board is concerned that without an appropriate description of all corresponding changes to airplane flying qualities, operators will be unaware of the ramifications of new flight control computer software. The Safety Board believes that the FAA should require Airbus to revise SB A320-27-1082 to include an appropriate description of all changes to airplane flying qualities that are affected by the software.

In addition, the Safety Board believes that repeated instances of lateral PIO during landing attempts pose a significant safety risk. The L69J Standard software update, if incorporated, will reduce this risk. Northwest Airlines has upgraded its entire A320 fleet with the new software on a voluntary basis, while the other two current U.S. operators have upgraded about half of their fleets to date. The Safety Board believes that the FAA should take action to ensure that all current and future U.S.-operated A320s are modified with the new software to reduce the risk of

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

Require that Airbus Industrie revise the opening paragraph of Airbus Service Bulletin No. A320-27-1082 to include a description of all flight control changes included in the L69J ELAC software revision. (Class II, Priority Action) (A-95-107)

To reduce the potential for pilot-induced oscillation during CONF 3 landings, issue an airworthiness directive to make compliance with revised Airbus Service Bulletin No. A320-27-1082 mandatory. (Class II, Priority Action) (A-95-108)

In conjunction with the French Direction Generale De L'Aviation Civile, establish policy and procedures to assure effective dissemination of all essential information regarding airworthiness problems and corrective actions in accordance with ICAO Annex 8, Part II, paragraph 4. (Class III, Longer Term Action) (A-95-109)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT and GOGLIA concurred in these recommendations.

By:


Jim Hall
Chairman