American Airlines®

February 6, 2003

Mr. Robert Benzon
Investigator In Charge
National Transportation Safety Board
AS-10
490 L'Enfant Plaza, SW
Washington, D.C. 20594-003

Re: American Airlines Flight 587
Accident at Belle Harbor, New York
November 12, 2001

Dear Mr. Benzon:

Attached please find two versions of a draft internal (May 1997) American Airlines memorandum from Captain Paul Railsback, Managing Director of Flight Operations Technical, to Captain Cecil D. Ewell, Chief Pilot and Vice President of Flight for American Airlines.

The two versions of these memoranda were only recently located as part of the discovery process in the Flight 587 litigation. The version of the Railsback memorandum that is attached as Exhibit 1 is dated May 27, 1997 and it was provided to us on January 30, 2003 by Captain Railsback from his personal files at home. We had not previously seen this or any other version of this memorandum. The version of the Railsback memorandum that is attached as Exhibit 2 is, according to Captain Railsback, an earlier version of the same memorandum. We received this version of the memorandum from Airbus' attorneys on January 31, 2003, but we do not know who provided Airbus with this version of the memorandum. We have reason to believe that Airbus' attorneys have been in possession of this document for several months at least, but they refused to produce this document for unknown reasons.

We are continuing to search for the final version of this memorandum, but we wanted to provide you with these drafts in the meantime. Captain Delvin Young, American's representative to the Operations Group, simultaneously will be providing a copy of these memoranda to Dave Ivey, Operations Group Chairman.

Sincerely yours,

Original Signed

Curt Lewis, P.E., CSP
Manager Systems Safety
Party Coordinator

Attachments

NYOFFICE 576932v1

DRAFT

May 27, 1997

To: C. D. Ewell

One of the key concepts articulated in AAMP training is that "at higher angles of attack, the rudder becomes the primary roll control" (see the attachments to this report). The program further states that aileron application in these situations is less desirable since it will create drag caused by spoiler deflection. In no uncertain terms pilots are told to use rudders as the primary means of roll control in unusual attitude recoveries involving windshear events and recovery from high angle-of-attack situations.

Consider the following facts:

- The use of *excessive* rudder at high angles-of-attack will cause a spin or a snap roll.

- The rolling moment caused by rudder input is generated by sideslip, which is slow to take effect, then rapidly becomes uncontrollable resulting in spin, snap roll or successive pilot induced oscillations. This is exacerbated by the inertia generated by the weight of wing mounted engines.

- Yaw dampers remain active at high angles-of-attack, or stall, with unpredictable and perhaps adverse consequences.

- Excessive yawing events will create gyroscopic effects and twisting moments on wing mounted engines, which may result in engine damage or even separation from the airplane.

- Jet transport airplane wings are designed so that ailerons are effective even at slow airspeeds and high angles-of-attack.

- Drag caused by spoiler activity during aileron input when returning to wings level or maintaining wings level is so small as to be inconsequential. In fact, drag caused by the sideslip effect yaw is much greater.

- John Cashman, Boeing Chief Test Pilot has stated to me that he "vehemently disagrees" with the AAMP high angle-of-attack theory..."no data supports Warren's assertions ". Tom Melody, McDonnell Douglas Chief Test Pilot also has expressed "serious concern and disagreement" with the rudder theories presented in AAMP.

- Much of the rudder theory and technique described in AAMP was "proven" in our simulators. Our simulators are training devices only, and not engineering simulators. They do not accurately represent the complex dynamics of flight in regimes that are not required for normal training events. A simulator is not an airplane.

In the context of the above points, consider the AA 903 accident: While the investigation is not complete, early analysis of the available information suggests that the rudder input played a significant role. The flight data recorder information became partially unreliable just after the onset of the event due to the g forces, but the crew statements, the available FDR readout and the observations of a deadheading check airman clearly point to the probability that at least one pilot induced snap roll occurred.

AA 903

AA 903 had descended to 16,000 feet to enter a holding pattern in an area of convective activity. The flight was experiencing only light chop. The crew stated that the autothrottles and autopilot were on and 210 knots was set in the speed window. As the airplane began a right turn to enter the holding pattern, for reasons unknown, the autothrottles did not advance and the speed decreased to about 190 knots (stall speed at current weight, 1g, is about 150 knots).

The crew realized that the airspeed had slowed and believing that they were in a microburst, executed a takeoff and landing microburst escape procedure despite the fact that the altitude was 16,000 feet. The FO added full power, pulled the nose up to twenty degrees pitch and attempted to roll the airplane to wings level with full inputs of left aileron and left rudder. The crew stated that the airplane then violently rolled to the left about to eighty degrees bank. They responded with aileron and rudder in the opposite direction and they think the airplane then violently rolled to the right to about eighty degrees bank (this is not confirmed by FDR data). They continued to hold the pitch at twenty degrees nose up and eventually regained control after a large altitude loss.

Probable cause

The crew believes that they encountered a convective weather phenomena, either a microburst or descending vertical airmass, which upset the airplane and caused the altitude loss. However the airplane immediately following reported no turbulence or convective activity in the same area. Even though microbursts are transient in nature, the extreme airplane bank activity is not consistent with either a microburst or downdraft, unless in the middle of a thunderstorm.

The microburst escape procedure...which specifies twenty degrees nose up...is intended to be used in the takeoff and landing phase of flight (e. g. Delta 191). The correct procedure for their situation...approach to stall, which is taught in simulator training during every recurrent training cycle...is to add power, lower the nose, roll the wings level, recover airspeed and return to assigned altitude. The extreme bank angles occurred because of excessive rudder inputs which caused the airplane to snap roll at least once and possibly more. The behavior of the airplane, the altitude loss and the engine damage to the acoustic lining is exactly consistent with the previous points regarding rudder input at high angle of attack.

I submit that the violent nature and altitude loss of the AA 903 accident was not caused by turbulence, but was a pilot induced snap roll caused by excessive rudder inputs while the airplane was at high angle-of-attack.

Furthermore, we are presently conducting high angle of attack training and demonstrations in simulators which do not accurately replicate the behavior of the airplane and are very likely to provide a false sense of confidence and knowledge to our pilots.

I strongly recommend that we take immediate corrective action to change our training programs and advise our flight crews of the correct nature and danger of rudder input at high angle-of-attack.

P. W. Railsback

Aerodynamic Definitions

Dihedral Effect (3)

The effectiveness of the rudder as a roll control will increase with increasing angle of attack. At the higher angles of attack, THE <u>RUDDER</u> becomes the primary roll control.

Notes

Aerodynamic Definitions

Dihedral Effect (3)

The effectiveness of the rudder as a roll control will increase with increasing AOA. At the higher angles of attack, THE RUDDER becomes the most effective roll control.

Smooth application of coordinated rudder will improve roll response significantly at higher AOA.

Notes

Windshear / Microburst

- Avoidance
- Buy Insurance
- Recognition (Wind Arrow↗)
- Initial Response (A/P - A/T - S/B)
  - 15° Deck Angle or FD Commands
- Pilot-Not-Flying Responsibilities
- High AOA Maneuvering = RUDDER
- Respect Stick Shaker (Phugoid)
- Autopilot Limitations

Notes

Pilot Response to Wake Turbulence

- Rolling moment on aircraft with shorter wing spans can be dramatic.
- Resulting attitude may be nose low with more than 90° of bank.
- Apply the appropriate unusual attitude recovery procedure.
  - Do not apply any back pressure on yoke at more than 90° of bank. ROLL FIRST - THEN PULL.
  - High AOA maneuvering = RUDDER.
  - Corner speed - high lift devices extended.

Notes

AA587
130211

Stall Warning on Takeoff or After Takeoff

- Takeoff Considerations
  - Runway Length
  - Takeoff Roll Distance
  - Acceleration Rate
  - Elevator Feel at Rotation
  - Airspeed above V1
- After Takcoff
  - High AOA Maneuvering - 'RUDDER

Notes

Ground Proximity Warning System

- Mode 2 "Terrain - Terrain" Response

Autopilot / Autothrottles	Disconnect
Throttles	Full Forward
Pitch	Rotate to 20° or Greater (3°/sec)
Speed Brakes	Retracted

  - Wings level pull if IMC
  - Pilot-Not-Flying responsibilities
  - Respect stick shaker - Phugoid
  - High AOA Maneuvering - RUDDER
  - Continue climb to MEA if IMC?

Notes

AAMP Simulator Training

- High AOA Maneuvering Demonstration
  - Apply climb power
  - Maintain 15° to 30° deck angle
  - Respect the stick shaker (Fly in the PLI)
  - Now roll alternately left and right to 40° of bank - MAINTAIN HIGH AOA
    - ▲ First, use only ailerons and spoilers
      - Note: Sluggish roll response - Developing sink rate
    - ▲ Second, use only rudder - (smoothly)
      - Note: Improved roll response - Developing climb rate
    - ▲ Third, practice combination (both aileron & rudder)
      - Note: Optimum roll response

Notes

AAMP Simulator Training

- Sim profiles designed to develop & reinforce specific flying skills.
  - High AOA maneuvering demo - NOT full stalls
  - Unusual attitudes - nose high & nose low
  - Microburst - demanding level
  - Engine failure - low altitude & low energy
  - GPWS - mode 2 'Terrain' profile
  - High altitude upset - fleet specific
- Integrated into each fleet Transition & Recurrent Training Syllabus.

Notes

FLIGHT DEPARTMENT DEBRIEF/REPLY RECORD: DE-IDENTIFIED

DATE: 12-May-97
EMP#: 52075
FLT#: 903 / 12-May-97 / BOS-MIA

DTN: 97006566
BASE: MIA
A/C#: 070 TYPE: 300
REPLY REQUESTED: Y

PROCESSING DATA

DBF RECVD: 13-May-97 [1 Days] CODE: IRTUZZZZ-A (B) at: MIA
PROCESSED: 13-May-97 [0 Days] TO: 135/ V (A) by: 166501
REPLY RCV: [Days] FROM: / Res:
FORWARDED: [Days] via: Result: NA Mag:

SUMMARY

SEVERE TURBULANCE

DEBRIEF DETAIL

Z TIME- 1830Z FREQ/ALTITUDE- 124.85/16000
ATC FACILITY- MIA APPROACH
LOCATION- HEATT INTERSECTION
AT 16000 FT WE WERE CLEARED TO HOLD AT HEAT INTERSECTION AS DEPICTED. WE OBSERVED ON RADAR THAT A CELL EXISTED AT OR JUST SOUTH OF HEATT. WE REQUESTED PERMISSION TO HOLD 10 MILES NORTH OF HEATT WHICH APPEARED TO BE CLEAR OF WTHR ANOTHER AA AIRCRAFT REQUESTED THE SAME CLEARENCE. AS WE APPROACHED OUR NEW HOLDING POINT WE NOTICED THE AIRSPEED OF 210 KTS (AUTO PILOT AND AUTO THROTTLES WE NOTICED OUR AIRSPEED DROPPING FROM OUR SELECTED SPEED. WE IMMEDIATELY ADVANCED THE THROTTLES.2 TO 3 SECONDS LATER WE FELT TURBULANCE BUILDING FOLLOWED BY SHARP CHANGES IN PITCH AND ROLL. AS THIS TRANSPIRED WE APPLIED MAX (FIRE WALL) POWER AND CONTROLLED ROLL WITH RUDDER AND FLEW APPROX 20 DEGREES NOSE UP STILL LOSING APPROX 4000 FEET BY THE EXIT POINT. THE EVENT LASTED APROX. 15-20 SECS

NO ELECTRONIC REPLY DETAIL

END

REQUIRED REPORT

To: C. D. Ewell

I have grave concerns about some flawed aerodynamic theory and flying techniques that have been presented in AAMP. Furthermore, I believe that these concerns are validated by the recent AA 903 accident. Let me explain:

One of the key concepts articulated in AAMP training is that "at higher angles of attack, the rudder becomes the primary roll control". The program further states that aileron application in these situations is undesirable since it will create drag caused by spoiler deflection. In no uncertain terms pilots are told to use rudders as the primary means of roll control in unusual attitude recoveries involving windshear events and recovery from high angle-of-attack situations.

This is not only wrong, it is exceptionally dangerous. Consider the following facts:

- The use of excessive rudder at high angles-of-attack will cause a spin or a snap roll.

- The rolling moment caused by rudder input is generated by sideslip, which is slow to take effect, then rapidly becomes uncontrollable resulting in spin, snap roll or pilot induced oscillation.

- Yaw dampers remain active at high angles of attack or stall with unpredictable and perhaps adverse consequences.

- Excessive yawing events will create twisting moments to wing mounted engines, which may result in engine damage or even separation from the airplane

- Jet transport airplane wings are designed so that ailerons are effective even at slow airspeeds and high angles-of-attack.

- Drag caused by spoiler activity during aileron input when returning to wings level or maintaining wings level is so small as to be inconsequential. In fact, drag caused by yaw is probably much greater.

- John Cashman, Boeing Chief Test Pilot says that he "vehemently disagrees" with the aggressive use of rudder at high angle-of-attack..."it is extremely dangerous and unpredictable". Tom Melody, McDonnell Douglas Chief Test Pilot also has expressed "serious concern and disagreement" about the rudder theories presented in AAMP.

- Much of the rudder theory and technique described in AAMP was "proven" in our simulators. Our simulators are training devices only, and not engineering simulators. They do not accurately represent flight regimes that are not required for normal training events. A simulator is not an airplane.

In the context of the above points, consider the AA 903 accident: The flight data recorder information became partially unreliable just after the onset of the event due to the g forces, but the crew statements, the available FDR readout and a statement by a deadheading check airman paint a pretty clear picture.

The Setup

AA 903 was descending to 16,000 feet to enter a holding pattern in an area of convective activity, although they were experiencing only light chop. The crew stated that the autothrottles and autopilot were on and 210 knots was set in the speed window. As the airplane entered a right holding pattern turn, for reasons unknown, the autothrottles did not advance and the speed decreased to about 190 knots (stall speed at their weight, 1g, is about 150 k).

The Event

The crew realized that the airspeed had slowed and believing that they were in a microburst, executed an escape procedure in spite of the fact that the altitude was 16,000 feet. The FO added full power, pulled the nose up to twenty degrees pitch and attempted to roll the airplane to wings level with full inputs of left aileron and rudder. At this point the flight data recorder information becomes unreliable because the forces on the airplane caused the tape to separate from the head. The crew stated that the airplane violently rolled to the left about eighty degrees bank. They responded with aileron and rudder in the opposite direction and the airplane then violently rolled to the right to about eighty degrees bank. They continued to hold the pitch at twenty degrees nose up and eventually regained control after a large altitude loss.

Probable cause

The crew believes that they encountered a convective meterological phenomena, either a microburst or descending vertical airmass, which upset the airplane and caused the altitude loss. However the airplane immediately following reported no significant turbulence or convective activity in the that same area. Even though microbursts are transient in nature, the extreme airplane bank activity is not consistent with either a microburst or downdraft.

The microburst escape procedure specifying twenty degrees nose up is intended to be used in the takeoff and landing phase of flight (e. g. Delta 191). The correct procedure for their situation...approach to stall, which is taught in simulator training during every recurrent training cycle...is to add power, lower the nose, roll the wings level, recover airspeed and return to assign altitude. The radical bank angles occurred because of excessive rudder inputs which caused the airplane to snap roll in both directions. The behavior of the airplane, the altitude loss and the engine damage is exactly consistent with the previous points regarding rudder input at high angle of attack.

I submit that the violent nature of the event was not caused by turbulence, but by excessive rudder inputs by the crew, which is exactly what they were taught by AAMP. I further believe that American Airlines is at grave risk of a catastrophic upset because AAMP is teaching aerodynamic theory and technique regarding high angle of attack flying that is wrong, dangerous, and directly contrary to the stated opinion of both Boeing and McDonnell Douglas.

I also want to point out that since we are selling or giving this program to other airlines we will be held legally accountable if an accident occurs which can in any way be linked to AAMP, particularly since Boeing and McDonnell Douglas have both expressed disagreement with the high angle of attack theory being advocated.

Furthermore, we are presently conducting high angle of attack training in simulators which do not accurately replicate the behavior of the airplane and are very likely to provide a false sense of confidence to our pilots. This is negative training at its worst.

I suggest that American Airlines take immediate corrective action to change our training programs and advise our flight crews of the correct nature and danger of rudder inputs at high angle of attack.

P. W. Railsback