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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

Group Chairman's Simulator Study III

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Washington, D.C.

December 15, 1994

Group Chairman's Simulator Study III

A. ACCIDENT DCA-94-MA-076

Location: Aliquippa, Pennsylvania
Date : September 8, 1994
Time : 1904 Eastern Daylight Time
Aircraft: Boeing 737-300, N513AU

B. GROUP IDENTIFICATION

The Aircraft Performance Group met at the airplane manufacturer's facility in Seattle, Washington on November 3, 1994. The following group members participated in the investigation:

Chairman: Thomas R. Jacky, NTSB
Member : Bob McCullough, USAir
Member : Steven E. O'Neal, FAA
Member : Keakini Kaulia, ALPA
Member : James Kerrigan, Boeing

Additionally, the following persons participated in this phase of the investigative effort:

Marty Ingham, Boeing
Jim Wilborn, Boeing
Mike Carriker, Boeing
Paul Sturpe, USAir
Dan Vicroy, NASA

C. SUMMARY

On September 8, 1994 at 1904 Eastern Daylight Time, USAir Flight 427, a Boeing 737-3B7, N513AU, crashed while maneuvering to land at Pittsburgh International Airport, Pittsburgh, Pennsylvania. The airplane was being operated on an instrument flight rules (IFR) flight plan under the provisions of Title 14, code of Federal Regulation (CFR), Part 121, on a regularly scheduled flight from Chicago O'Hare International Airport, Chicago, Illinois, to Pittsburgh. The airplane was destroyed by impact forces and fire near Aliquippa, Pennsylvania. All 132 persons on board the airplane were fatally injured.

D. DETAILS OF INVESTIGATION

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The group met at Seattle, Washington to review simulator data provided by Boeing and to further examine possible wake vortex encounter participation in the accident sequence. The Rankine potential vortex model developed by Boeing was used to represent the wake from the Delta Airlines B-727. The B-737 distributed lift model, was adjusted to include wake encounter effects to the vertical and horizontal tails. Forty-four simulator runs were attempted on November 2, 1994, using the Boeing Multipurpose Engineering Cab (MCAB) Simulator with the Aerodynamic Data and Control System Description for the 737-300 Simulator (Document D6-37908, rev C).

The model of Delta Airlines Flight 1083's wake vortex core diameter was 4 feet. Span distance between the vortex cores was 85 feet. The vortex circulation (or Γ) value used was 1500 ft^2/sec. A vortex "flight path angle" of 0.0° was used. To generate roll angles and rates similar to USA427 FDR's, the left vortex's circulation was dropped to zero, and the right vortex's circulation kept at Γ=1500 ft^2/sec.

The pilot participants first flew the simulator's distributed lift and tail effects model through a series of maneuvers. The pilots agreed that the models were accurate. The auto-pilot was used to make a 140° to 100° heading turn, with the yaw damper on and off. The same turn was attempted using control wheel steering (CWS). In another series of runs, the auto-throttles were manipulated in order to note throttle movement and rate. Finally, a series of runs were made by flying the aircraft into the wake vortex, followed by a 3°/sec rudder pedal input. A listing of the simulator runs is included in Attachment 1. The resultant data plots from the simulator runs were not included in this report; however, each party to the investigation received a complete set of simulator run data plots.

[redacted]

Tom Jacky
Aerospace Engineer

Attachments

1. Simulator Run and Scenario Log

ATTACHMENT 1

Simulator Run and Scenario Log

SUMMARY OF BOEING ENGINEERING FLIGHT SIMULATOR RUNS FOR USAIR FLIGHT 427 INVESTIGATION AIRCRAFT PERFORMANCE GROUP NOVEMBER 2, 1994

RUN #	SCENARIO SUMMARY
1	Heading change from 140° to 100°, Auto-Throttles on, Yaw Damper (Y/D) on, a/c @ 190 KIAS
2	Same scenario as no. 1, except Yaw Damper *off*
3	Control Wheel Steering (CWS) turn from 140° to 100°, Y/D on
4	Repeat of scenario no. 3
5	Basic airplane, pull column back to stickshaker
6	Repeat of scenario no. 5
7	Distributed lift model off, Horizontal tail model on, repeat no. 5
8	Distributed lift model off, Horizontal tail model off, check free response of airplane from column pitch-ups - pitch doublets
9	Repeat scenario 8, with distributed lift model on, horizontal tail model on - pitch doublets
10	Distributed lift model off, horizontal tail model off, Y/D off, rudder doublets - check of dutch roll
11	Repeat scenario no. 10
12	Repeat scenario no. 10, distributed lift model on, horizontal tail model off, vertical tail model on
13	Distributed lift model on, vertical tail model off, auto-pilot off, auto-throttle off, Y/D off; center of RH wake vortex (r = 2 ft., Γ = 1500 ft^2/sec.)
14	Repeat scenario no. 13, but Y/D on
15	Repeat scenario no. 13, Y/D off, vertical tail model on
16	Repeat scenario no. 13, Y/D on, vertical tail model on
101	Check of auto-throttle rates - ABORT
102	Repeat scenario 101, increase IAS
103	Repeat scenario 101, increase IAS
104	Repeat scenario 101, decrease IAS
105	Check of auto-throttle rates, increase IAS then decrease IAS
106	Repeat scenario 105 - ABORT
107	Check of auto-throttle - dial speed up and then dial speed down
108	Distributed lift model on, horizontal tail model off, vertical tail model on, attempted wake vortex intercept - missed intercept attempt
109	Repeat scenario 108
110	Left wake Γ = 0, right wake Γ = 1500 ft^2/sec., auto-pilot on; attempted intercept from left of wake
111	ABORT

RUN #	SCENARIO SUMMARY
112	Enter rudder into scenario
113	ABORT
114	ABORT
115	ABORT
116	Retry entry of rudder input
117	Repeat scenario 116, attempt pilot recovery @ roll = 40°
118	ABORT
119	Repeat scenario 116, attempt pilot recovery @ roll = 60°
120	Repeat scenario 119
121	Repeat scenario 120, input 3°/sec rudder pedal rate
122	Repeat scenario 121, pull column back then roll airplane
123	Repeat scenario 122, input rudder little sooner
124	Repeat scenario 122, let auto-pilot recover
125	Repeat scenario 124, roll into then rudder @ 90° roll
126	Attempt wake intercept w/ only tail entrance into wake
127	Start with aircraft underneath right wake vortex
128	Repeat scenario 127