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EXHIBIT NO. **13 E**

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

Group Chairman's Backdrive and Kinematic Study

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

December 15, 1994

Group Chairman's Backdrive and Kinematic Study

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 activity:

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

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

During the course of the investigation, two efforts were made to derive airplane control surface positions from the Flight Data Recorder data taken from USAir Flight 427. This study documents these efforts.

1. Backdrive of Boeing Simulator to Match FDR Data

A Boeing full motion engineering development simulator configured as a B-737-300 (using the Boeing document "Aerodynamic Data and Control System Description for the 737-300 Flight Simulator", document D6-37908, rev. C, January 30, 1992) was used to extract aerodynamic coefficients required to closely match FDR time data traces. Aircraft rates and accelerations were obtained by differentiating FDR data. The rates and accelerations were then used to determine the control surface position necessary to drive the simulator to recreate the FDR traces. The derived control input positions, rates, and angles were recorded and plotted. Plots of the best match to the FDR data are included in Exhibit 13G.

It is noted that the derived control positions are not necessarily indicative of the actual positions, since the resultant positions are a summation of all the aerodynamic coefficients.

2. Kinematic Study of the FDR Data

In a separate, independent study, USA427's FDR attitude data were differentiated to aerodynamic coefficients for the airplane's roll, pitch, and yaw axes. Additionally, an assumption was made that the FDR's pressure altitude and indicated airspeed data were uncorrected for position error. From that assumption, the aerodynamic coefficient associated to the aircraft's attitude (at that instant) without control surface deflection was subtracted from the total aerodynamic coefficient described by the FDR data. The resultant "delta-aerodynamic-coefficient" was then used to define control surface positions necessary to produce the equivalent aerodynamic coefficient. However, the "delta-aerodynamic-coefficient" was postulated as being equal to a control surface input, but not necessarily caused by control surface input. For example, in the case of the airplane's yaw axis, the resultant delta yaw moment coefficient was postulated to be the result of rudder surface deflection, and an equivalent rudder position defined by the delta-coefficient, but not caused by rudder surface deflection.

The results of the study are included in Exhibit 13G.

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Tom Jacky
Aerospace Engineer