NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594
April 30, 1997

SYSTEMS GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION ADDENDUM
Additional Chip Shear Testing

A. ACCIDENT DCA-94-MA-076

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

B. SYSTEMS GROUP

Chairman:	Greg Phillips National Transportation Safety Board Washington, DC
Member:	Captain John Cox Air Line Pilots Association-USAir Coraopolis, PA
Member:	Ken Frey Federal Aviation Administration Aircraft Certification Office Seattle, WA
Member:	Olney Anthony IAMAW-USAir Pittsburgh, PA
Member:	Richard Kullberg Boeing Commercial Airplane Group Seattle, WA
Member:	Thomas C. Nicastro USAir Pittsburgh, PA

Member: Tom Conway
Parker Bertea
Ogden, UT

Member: Steve Weik
Parker Bertea
Irvine, CA

C. SUMMARY

On September 8, 1994, at 1904 Eastern Daylight time, USAir flight 427, a Boeing 737-3B7 (B-737-300), 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, Illinois, to Pittsburgh. The airplane was destroyed by impact forces and fire near Aliquippa, Pennsylvania. All 132 persons on board were fatally injured.

D. DETAILS OF THE INVESTIGATION

The systems group, performed six tests at the Boeing Equipment Quality Analysis (EQA) Laboratory in Everett, Washington, on February 18, 1997, to examine the chip shear effects of different materials inserted into flow passages between the secondary slide and control valve housing of the Boeing 737 main rudder power control unit (PCU) servo control valve. During earlier chip shear testing of the servo valve primary spool by the systems group (January 10-12, 1995), it was determined that the only material that could not be sheared with the 44 pound (axial) maximum test load was 52100 steel.

As a result of these findings, the systems group decided to explore the chip shear effects of varying sizes of the 52100 material. Chips of 52100 were manufactured for the tests from a minimum size of .013 x .011 to a maximum size of .014 x .042. The nominal metering window size in the servo valve housing is .015 x .045 inches.

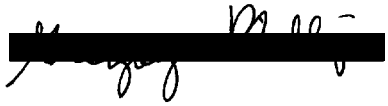
During the January 1995 tests, a pneumatic load cylinder was used to drive the primary spool while the secondary spool was held. The chips were inserted into the metering window through machined openings and the chip shear forces were measured and recorded.

The February 1997 tests were conducted by applying an hand-operated (screw thread) axial load to the secondary spool and inserting chips into machined openings in the servo valve housing (see figures 1 and 2 in attachment). The chips were then sheared between the secondary spool and the servo valve housing. The testing was designed to measure and record the forces required to shear varying thickness' of 52100 (MIL-S-7420, Hardness Rc 59.9), and one specimen each of 7075-T73 aluminum and Al-Ni-Br. Six tests were conducted.

Parker Bertea provided all materials for the tests with the exception of the x-y plotter which was provided by Boeing. A test fixture was used to hold the servo valve body. The test fixture schematic is shown in Figure 6 of attachment 1. A force transducer was connected to an x-y plotter to record force vs. displacement. Photos taken of the surfaces where the chips were sheared can be found in attachment 1.

The following table summarizes the results of the testing:

Test	Material	Size (in)	Position	Shear force (lbs)
1	7075-T73	.014 x .031	A	17.5
2	Al-Ni-Br	.013 x .030	A	25
3	52100	.014 x .016	A	53
4	52100	.014 x .0255	B	88
5	52100	.014 x .042	C	140
6	52100	.013 x .011	D	23



Gregory Phillips
Systems Group Chairman
National Transportation Safety Board

Attachment
Test Data and Photos