APPENDIX C

Autospoiler Actuator Teardown Report

NATIONAL TRANSPORTATION SAFETY BOARD
SOUTHWEST REGIONAL OFFICE

NOTES ON COMPONENT EXAMINATION
AUGUST 6, 1999
AUTO SPOILER ACTUATOR
AA1420 LITTLE ROCK, AR

LOCATION: Telair International
1950 Williams Drive
Oxnard, CA 93030

ATTENDANCE:

NTSB	Jeff Rich, Senior Air Safety Investigator, SWR
Telair	Nick Gillichbauer, Product Support Manager Richard Nash, Customer Support Engineer Carl Pettit, Product Engineering R. Thomas Meyers, QA Manager
American	Tammy Smart, Flight Safety Investigator
Boeing	Hank Don, Electrical Systems Engineer

EXAMINATION DETAILS:

1.0 Unit History

Prior to the examination, a discussion of component history was performed. The unit serial number was found to be 1569 **B**, instead of the originally believed 15698. The 'B' designation identifies the version of the unit. According to Telair factory records, the unit was manufactured February 26, 1981, as a basic model (no suffix) and delivered new to McDonnell Douglas. Internal evidence (discussed later) shows the unit was re-worked in the field to the 'B' configuration, most likely in response to Telair SB 104-T100-27-02 (SB's 1 & 2 are attached), which was dated June 1, 1987. The re-work generally met workmanship and component conformance standards. The addition of the 'B' suffix was rather crude and not at all how the factory would have done it.

Teleair has no record that the unit was ever returned to the factory for overhaul or repair.

The only history AA has on the part is it's installation in the accident aircraft on July 17, 1997; according to their records [by this serial number 1569B] it has accumulated 5,745 hours and 2,667 cycles since new and installation. AA was tasked with going back into their records under the serial nos. 1569 and 1569A to see if the unit has been in the AA system before it shows up on the accident ship.

Historical analysis reports covering both AA and all operators were obtained from Telair which show teardown findings and historical problem areas for the unit. The reports, which are appended to these notes, only cover units returned to the factory for repair or overhaul.

2.0 External Findings

The unit was removed from the shipping container and documented with photographs in an as received condition. The actuator arm was found in the full clockwise stroke position, which according to Teleair engineering drawings, corresponds to spoilers fully extended. This was confirmed by Boeing with reference to the aircraft Flight and Accessory Control Rigging Instruction drawing, 7930980.

A small dent was observed on the connector side corner of the filter/rectifier (FR) box cover. The box cover was separated from the motor housing and retained to the motor/gearbox units only by the electrical wiring. On the connector side of the FR box, the attachment screws were pulled through the holes, with the still safetied screws retained in threaded holes in the motor. The screw holes on the opposite side of the box cover were intact and the screws were missing; visual examination of the threaded screw holes in the motor housing revealed damage to some threads. The electrical connector mounting plate was loose and partially separated from the FR housing cover.

The motor brake assembly was viewed through ventilation openings in the magnet housing at the rear of the motor. The air gap between the Electromagnet Plate and the Coil Plate appeared excessive. The gap was measured at 0.032-inches. The allowable gap is 0.005 to 0.010.

The Boeing mounting hardware and actuator arm were removed from the unit in preparation for functional testing.

3.0 Dielectric Test

The unit was subjected to a standard dielectric test at 750v in accordance with a new unit acceptance test. Intermittent leakage was observed. The short was subsequently identified in the wiring between the FR box and the motor/gearbox components. The FR box cover was moved until the short disappeared, and the cover secured with rubber bands.

4.0 Functional Test

The unit was mounted in a test fixture and subjected to a standard Telair new unit acceptance test procedure, which mirrors the procedure specified on page 701 and 702 of the overhaul manual. The torque wrenches used to measure the specified torque values at appropriate test points were calibrated on August 6, 1999. Except for the test points specifying a different value, the test voltage was 116v at 400 cps. The test sheets with the recorded values for each point are attached to these notes.

The unit passed all test points except for 8(b)(4). In this test point, the actuator is positioned to mid-stroke with a 17.5-pound weight mounted on a 4-inch arm. At an input power of 100v at 400 cps, the actuator must move against this load. The unit did not move in either the clockwise or counter-clockwise directions.

5.0 Teardown Inspection

Disassembly of the unit was performed in order to identify and resolve the noted electrical and mechanical discrepancies. Photographs documenting the procedure are appended to these notes.

5.1 Gearbox

The gearbox cover was removed. No abnormal operating signature was observed on the gears or slip clutch. Only 2 of 6 of the lock tabs on the tab washer were bent over the clutch nut. The limit switch hammers were noted to be of original style and material had been ground away in accordance with the instructions contained in Telair SB 104-T100-27-02. The ground surfaces were uneven in the transverse

plane. The insulator covers on the solder terminals of the limit switches were not the material used by Telair during manufacture, but considered equivalent.

The gearbox housing was removed from the motor unit, with the switch wire bundles preserved by disconnection from the switch terminals.

5.2 Electrical

The motor was separated from the FR box and separate dielectric tests using the standards in 3.0 were conducted on each component. The motor passed this test with no leakage. The FR box failed the test with leakage that exceeded the pre-set safety cut-out on the test stand. Examination of the wire bundles by pulling them out of the FR box revealed a area of scraped insulation on the gray wire which goes from terminal J in the filter/rectifier box to the counter-clockwise (CCW) limit switch (see the attached photo's and the wiring diagram on page 2 of the overhaul manual). The scrapped insulation exposed bare conductor, with the scrapped portion of the insulation bent upwards about 70 degrees. With the gray wire out of the FR box, the unit passed the dielectric test.

On the underside of the FR box, 1 of 2 white wires connected between terminal A and the motor field coils was found broken at the FR box solder terminal. A view of the broken wire strands under optical magnification to 100x revealed no necking of the wire strands and the strands were bent about 90 degrees. According to engineering personnel at Telair, if the wire had been broken before the functional tests, the unit would not have worked. See wiring schematic on the appended Telair drawing 1040101.

The insulating material used on terminals A, B, C & D of the FR box were not the material used by Telair during manufacture, but considered equivalent.

The solder joints were inspected and found to meet industry standards.

5.3 Motor

The motor was tested separately. It was found to pull it's design load of 4 inch-ounces at 100v 400 cps without brake release. Stall torque was noted to be 20 inch-ounces clockwise and 28 inch-ounces in the counter-clockwise direction (minimum specification is 26). The motor runs at load in both directions at voltages from 72 to 115, and stalls at voltages below 72.

As noted in section 2.0, the motor brake had an excessive air gap between the electromagnet and coil plates. The brake unit functioned electrically, however, the electromagnet plate would not mechanically pull back from the brake disk assembly. When moved by hand to near the coil plate, the electromagnet plate would engage and release the brake.

The brake unit was disassembled. The brake pad on the side of the brake disk nearest the electromagnet plate was worn down to 0.016-inches, while the opposite side measured 0.025-inches; acceptable limits are between 0.025 and 0.030 of brake pad remaining.

A circular groove matching the dimensions and location of the brake pad was found worn into the face of the electromagnet plate to a depth of 0.017-inches. The center area inside of the groove was worn 0.002-inches below the plate surface. A new electromagnet plate was pulled from stock for comparison to the one removed from the unit. The new plate had a flat uniform surface without a groove.

Group Consensus

Irrespective of the electrical and mechanical anomalies found, the unit was capable of functioning within operational perimeters assuming that proper line voltage was supplied.

The broken white wire between the FR and motor occurred after the functional tests during disassembly operations.

No consensus was reached regarding the timing of the damage to the gray wire between the FR unit and the CCW limit switch. The FR box was not cut open to look for evidence of arcing.

According to Telair, the motor brake is designed to limit over coast of the motor and prevent the possible mechanical backdrive of the actuator. As evidenced by the fact that the motor pulled design load without brake release, the brake was not providing any significant drag to the unit. Therefore the unit had no over-travel protection beyond the actuator physical limit stops, and could be back driven mechanically.

The unit was overhauled in the field sometime after June of 1987. The unit's operating and maintenance history are unknown for the period between manufacture in 1981 and installation on the accident aircraft in 1997.

[redacted]
Jeff Rich
Senior Air Safety Investigator