NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorders Division
Washington, D.C.

March 27, 2003

Specialist's Factual Report of Investigation
Digital Flight Data Recorder

NTSB Number:
DCA03MA022

A. EVENT

Location:	Charlotte, North Carolina
Date:	January 8, 2003
Aircraft:	Beech 1900D, N233YV
Operator:	Air Midwest, Inc.

B. GROUP

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C. SUMMARY

On January 8, 2003, Air Midwest flight 5481 (d.b.a. US Airways Express), a Beech 1900, N233YV, crashed shortly after takeoff from Charlotte-Douglas International Airport (CLT), Charlotte, North Carolina after a distress call was made by the Captain. The flight was a scheduled passenger flight to Greenville-

Spartanburg, South Carolina. The airplane was destroyed due to impact forces and a post-crash fire.

D. DETAILS OF INVESTIGATION

The digital flight data recorder (DFDR) was retrieved by NTSB investigators from the wreckage site on the afternoon of the accident, January 8, 2003, and transported to NTSB headquarters in Washington, DC. The recorder was examined in the Vehicle Recorders Laboratory and the following information was noted:

Recorder Manufacturer/Model:	**L3 Fairchild Model F-1000**
Recorder Serial Number:	**01110**

General Recorder Description

This model F-1000 DFDR records airplane flight information in a digital format using solid-state Flash Memory as the recording medium. The DFDR was configured to record 64 12-bit words of digital information every second. Each grouping of 64 words (each second) is called a subframe and 4 subframes comprise a frame. Each subframe has a unique 12-bit synchronization (sync) word identifying it as either subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The data stream is "in sync" when successive sync words appear at proper 64-word intervals. Each data parameter (e.g. altitude, heading, airspeed) has a specifically assigned word number.

Accident Recorder Examination and Readout

The exterior of the recorder from the accident airplane exhibited damage which was a result of the impact forces and post-crash fire. This damage to the recorder did not allow the data to be extracted in the normal manner. The recorder was cut open and, internally, the crash-protected memory encasement was found to be in good condition. The solid-state memory module was extracted from the encasement and a new connector was attached. The module was then inserted into a surrogate F-1000 DFDR and the data were downloaded and decompressed using the recorder manufacturer's software. There was a total of about 95 hours of recorded data on the DFDR. Photographs of the DFDR can be found in Attachment I.

The DFDR data were then transferred to NTSB internal software programs. Information regarding the flight recorder system and the documentation to convert the raw, binary data into engineering units were obtained from Air Midwest (the operator), Raytheon Aircraft Company (the aircraft manufacturer), and Downey Corporation (the STC holder for Beech 1900 DFDR expanded parameters). Once the data were transcribed, the accident flight was located as the last recorded data on the DFDR. The last 3.08 seconds of data output by the

system were determined to be invalid data. According to the DFDR manufacturer, if the recorded data ends in the middle of a frame, padded data are inserted to complete the frame (up to 4 seconds) during the decompression process. These data were ignored and do not appear in this report.

Recorded Parameter Examination

The flight data recorder system on this Beech 1900D Airliner, as delivered by the manufacturer, was designed to record 18 parameters. A 1997 FAA regulatory rule change concerning flight recorders mandated additional recording requirements. In 2001, N233YV was upgraded to record 4 additional parameters using the Downey Corporation's Supplemental Type Certificate (STC). A list of all recorded parameters on this aircraft can be found in Attachment II.

The recorded flight data were reviewed for accuracy and some inconsistencies were noted. The flight recorder system on this aircraft utilized a pneumatic F-1000 DFDR. This system gets altitude and airspeed information from pitot-static inputs that are fed directly into the front of the recorder. The altitude data recorded is pressure altitude, which is the altitude as measured at standard atmospheric conditions. Therefore, a barometric pressure adjustment must be applied to obtain MSL altitude. Using the barometric pressure recorded by the tower during the time of the accident, 29.76 inHg, there is a 149 foot difference between pressure altitude and MSL altitude[1]. When the correction was applied to the pressure altitude recorded before takeoff, the value obtained was 65 feet lower than that of the runway elevation which is 746 feet MSL. Thus, an offset of 65 feet was applied to the recorded altitude data values. The plotted and tabular altitude data included in this report reflect that offset. Additionally, the last recorded altitude point does not correlate with the elevation of the accident site presumably due to the unusual attitudes the aircraft experienced during the final segment of recorded data. It should also be noted that the minimum recording range for the airspeed parameter is 30 knots. While the data often reads 30 knots on the ground and during taxi, this could indicate airspeeds anywhere between 0-30 knots.

During the review of data, two parameters were found not to be yielding expected values. The parameter engine torque left did not show any activity during the accident flight. Upon further examination, it was established that this parameter was intermittently active in other parts of the recorded data but was not operating at any time during the accident flight. This parameter was deemed inoperable and is not included in this report. It was also determined that lateral acceleration was not yielding expected values. Further work is currently underway to determine the validity of this parameter's outputted values. Therefore, lateral acceleration will not be included in this factual but may be presented in subsequent reports.

[1] Table II of the National Bureau of Standards Report No. 538, "Altitude-Pressure Tables Based on the United States Standard Atmosphere", was used to determine this value.

The pitch control position parameter records values in degrees from a sensor attached to the control column. Though the sensor is not physically attached to the elevator, in a typical flight control rigging the values recorded should reflect degrees of travel of the elevator. The operating range of the elevator is -14 degrees to +20 degrees[2]. It was noted that the limits of the recorded pitch control position data did not fall within that range since values of beyond -14 degrees were recorded. The effects of an abnormal flight control configuration on the recorded data must be considered. Hence, supplementary recorded data from the accident aircraft and similar Beech 1900D Airliners are being examined to determine the validity of the recorded values for this parameter. This information will be produced in subsequent reports.

DFDR Timing

The DFDR data are presented in Local Time (hh:mm:ss) which is Eastern Standard Time. The data were time-correlated with the cockpit voice recorder (CVR) using the microphone keying parameter. For further information on the time correlation, see the Group Chairman's Aircraft Performance Study.

Accident Data Description

The DFDR powered up for the accident flight just before 08:25 with the right engine running. The prop RPM left parameter began increasing soon after 08:30 to match the right engine setting. Beginning at 08:35:16, a control check of the ailerons and elevators was performed. During this check, the pitch control position parameter recorded data points of -16.5 degrees to +15 degrees. Around 08:46:21, while the aircraft was on a magnetic heading of 186 degrees and the pitch trim was set at +2.2 degrees, the prop RPM data for the engines began to increase followed by an increase in engine torque. A little less than 30 seconds later, as the airspeed increased over 102 knots, the first movement was recorded in the pitch control position parameter. This parameter value increased from -16.4 to -9.5 degrees and the pitch attitude of the aircraft began to increase. After 08:46:53, the pitch trim started moving aircraft nose down and reached -5.2 degrees at 08:47:03. At this point, the pitch was +20 degrees, the pressure altitude was 990 feet, and the airspeed was 139 knots. After takeoff, the pitch control position parameter had returned to -16.4 degrees at 08:46:57 and remained there for about one second. It then continually decreased and stayed around -17.2 degrees.

At 08:47:13, a maximum pitch attitude of +54 degrees was recorded. At 08:47:16, the comm1 keying parameter switched from off to on indicating a radio transmission. Several seconds later, between 08:47:17 and 08:47:19, the data

[2] The movement in parameter values associated with a climbing, right turn shall be considered positive for this report.

shows that a maximum left roll of -127 degrees, a maximum pressure altitude of 2090 feet and a minimum airspeed of 31 knots were all captured. As the aircraft's attitude decreased through 0 degrees of pitch, the pitch control position value moved aft reaching +18.8 degrees. At 08:47:26, a maximum right roll of +68 degrees was recorded along with a maximum vertical acceleration of +1.9 g's. The final recorded pitch was -47 degrees, roll was +66 degrees and pitch control position was +19 degrees. The last valid recorded data occurred just after 08:47:28.

Plotted Data

Graphical plots of the recorded data can be found in Attachment III. All valid parameters recorded on this DFDR were plotted and are shown on either plot format a or b. The plots illustrate data for the accident flight in timeframes of 22 minutes (plot1a_22min, plot1b_22min) and 80 seconds (plot2a_80sec, plot2b_80sec). The tabular data associated with the plotted files are presented in electronic format as a comma delimited file, DCA03MA022_DFDRTabular.csv, in Attachment IV.

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Attachments
Attachment I: DFDR Photographs
Attachment II: DFDR Recorded Parameter Listing
Attachment III: DFDR Plotted Data
Attachment IV: DFDR Associated Tabular Data (electronic only)