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NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Group Chairman's Factual Report Digital Flight Data Recorder

(6 Pages)

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

November 9, 2000

Digital Flight Data Recorder

Group Chairman's Factual Report of Investigation

A. ACCIDENT

Location : Near Port Hueneme, California
Date : January 31, 2000
Aircraft : MD-83, N963AS
NTSB Number : DCA00MA023

B. GROUP

Erin M. Gormley, NTSB Group Chairman
Michael Bartron, Pratt and Whitney
Steven Fulton, Alaska Airlines
Pierre Huggins, Air Line Pilots Association
Eric West, Federal Aviation Administration
David Yingling, The Boeing Company

C. SUMMARY

On January 31, 2000, Alaska Airlines flight 261, a Boeing MD-83, N963AS, crashed approximately 2.69 miles north of Anacapa Island, California into the Pacific Ocean. The flight from Puerto Vallarta, Mexico to Seattle, Washington, with an intermediate stop in San Francisco, was operating under Title 14 Code of Federal Regulations Part 121.

The Digital Flight Data Recorder (DFDR), a Sundstrand model UFDR DXUN (S/N 9182), was recovered from the underwater wreckage and transported to the National Transportation Safety Board (NTSB) Vehicle Recorders Laboratory for readout and evaluation. A readout was successfully performed.

Exhibit 10-A contains the DFDR Factual Report, Exhibit 10-B contains the graphical plots of the DFDR data, and Exhibit 10-C contains the DFDR data in a tabular format.

D. DETAILS OF INVESTIGATION

1. Description of Data

The particular model flight recorder aboard the accident aircraft recorded aircraft data in a digital format on eight separate tracks (1-8) contained on ¼ inch mylar-based magnetic tape. The recording process consists of tape being drawn from one coplanar reel to another through a set of read/write heads and erase heads. The recording method is bi-directional with tracks 1, 3, 5, and 7 recorded in one direction and tracks 2, 4, 6, and 8 in the other direction.

The DFDR records 64 words of digital flight information, each word 12 bits in length, onto the tape every second. Each grouping of 64 words, each second, is called a subframe, four of which constitute a frame of data. Each subframe has a designated 12-bit synchronization (sync) word identifying it as subframe 1, 2, 3, or 4 within the frame. The sync words are the first words in each subframe. The data stream is "in sync" when successive sync words appear at 64-word intervals. Each data parameter (i.e. altitude, heading, airspeed) has a specifically assigned word and bit location within the subframe.

The last 25 hours of operational data are retained on the recording medium. The 25 hours of data are stored on 8 separate tracks of 3 hours and 8 minutes each. The recorder design allows the newest data to be recorded in place of the oldest data being erased. This particular model DFDR records data in one direction on a track and then switches tracks and direction when a transparent section of tape called a window passes by an optical end-of-tape sensor.

2. Examination and Readout

The DFDR was transported to the laboratory in a cooler of fresh water. The outside of the recorder was noticeably deformed and the faceplate was semi-detached. The Underwater Locating Beacon (ULB) and the bracket that secures the beacon to the faceplate were missing. The outer dustcover was removed to gain access to the crash-protected module which houses the magnetic tape recording medium. This protected casing was not damaged. The casing was opened and the tape was found intact. The tape was removed, cleaned, dried and mounted onto a reel.

The DFDR data were transcribed from the tape to hard disk for further analysis using the NTSB laboratory equipment. Alaska Airlines provided the DFDR data conversion documentation for N963AS. This documentation included parameter names, subframe and word slot locations, bit assignments, and conversion formulas specific to the aircraft's DFDR system. The conversion information included the formulas to convert from recorded binary values (0's

and 1's) to engineering units (feet, knots, degrees, etc.). The conversion is accomplished by an automated process which incorporates the NTSB laboratory computers and associated software.

A list of all parameters recorded on this aircraft can be found in Attachment I0A-6. During examination of the data, 2 parameters were identified as not returning expected engineering values. Upon further investigation, the parameters, angle of attack and left brake pressure, were determined to be inoperable for the entire 25 hours of data stored on the tape medium.

An additional discrepancy was noted with the data. Typically, each grouping of 64 words of flight information, each second, is called a subframe, four of which constitute a frame of data. During the last 49 seconds of DFDR recording, there is a consistent pattern of invalid data being registered every 4 seconds. This condition occurred 13 times thus affecting 13 seconds worth of data. In these 13 cases, all the odd numbered words (with the exception of word 1, the sync word) recorded invalid data. The cause of this anomaly was not specifically determined but it was acknowledged that the aircraft was not within its normal operating conditions at the time. For example, at the first recording of invalid data, the roll parameter recorded -152 degrees left wing down and the vertical acceleration parameter recorded –1.41 g's. The invalid data were replaced with red asterisks on the graphical plots and question marks on the tabular data.

3. Details of Readout

The DFDR data from the accident flight were verified for accuracy by examining additional data stored on the tape medium which were recorded during previous flight operations. All 25 hours of data were transcribed. This transcription was performed to review previous flight data for the aircraft, N963AS, especially pitch trim characteristics and autopilot usage. Only DFDR data relevant to the accident flight are contained in this report. Further information concerning previous data can be found in the Addendum to the Group Chairman's Aircraft Performance Study. All times in this report are Pacific Standard Time (PST). The DFDR data, recorded in relative seconds, were converted to PST as derived from the Socal TRACON GMT time. Further details concerning the time correlation can be found in the Group Chairman's Aircraft Performance Study.

The DFDR first begins recording accident flight data about 13:32. The flight sensing parameter switches from ground to air during 13:37, indicating takeoff, and a pitch trim setting of –7 degrees is recorded. At 13:40:12, at a recorded altitude of 6,196 feet, the autopilot parameter changes from off to engaged. During 13:42, the VHF 2 parameter registers 2 microphone keys. The autopilot parameter value switches from engaged to off at 13:53:12, at a

recorded altitude of 28,557 feet and a recorded pitch trim position of 0.4 degrees. The aircraft continues to climb and levels off about 31,000 feet. The VHF 2 parameter registers significant activity starting during 15:21 and continuing through 16:13:08. At 15:47:00, the autopilot parameter changes from off to engaged. At 15:49:57, the autopilot parameter value changes to off for a period of 19 seconds and then it again registers engaged.

During 16:09:16, while at a recorded altitude of 31,050 feet and an airspeed of 301 knots, the pitch trim, pitch, and elevator parameters begin to deviate significantly from their recent values and the autopilot parameter switches from engaged to off. Vertical acceleration values begin to vary and within 5 seconds show a minimum value of 0.432 g's while the pitch trim parameter records 2.5 degrees. At this point, the recorded pressure altitude values begin to decrease, the recorded airspeed values start to increase, and the engine EPR values start to decrease. At 16:09:44, the spoiler parameters show activation as the pitch parameter records a minimum value of –8.4 degrees, the altitude parameter records 29,205 feet, and the airspeed parameter records 325 knots. The altitude parameter continues to decrease until reaching a value of about 23,500 feet at 16:10:35.

At 16:18:01, the slat position parameters show the beginning of a transition to the mid position and at 16:18:09, the flap parameter registers the beginning of flap extension to 11 degrees. At 16:18:31, the flaps begin to retract from 11 degrees and are fully retracted at 16:18:37, at which time the slats are transitioning to retract.

Around 16:19:34, at a recorded altitude of about 17,900 feet, the flaps start to extend, the longitudinal acceleration values are decreasing and there is a slight increase in the vertical acceleration values. During 16:19:37, as the flaps are extending, the slats begin to transition to the mid position. There is a significant increase in vertical acceleration values and a significant decrease in both lateral acceleration values and pitch attitude during this time. The elevator parameter begins to register invalid data at 16:19:36. During 16:19:39, the vertical acceleration reaches a minimum of –3 g's, the pitch trim shows a value of 2 degrees, the roll parameter is –7 degrees left wing down, and the pitch parameter records -60 degrees nose down. Within the next 3 seconds, the roll parameter decreases to –109 degrees and the pitch parameter records a maximum nose down attitude of –70 degrees. The pitch, roll and acceleration parameters continue to fluctuate for the remainder of the data as the recorded altitude decreases. The last valid altitude recorded is 1,727 feet at 16:20:53. The end of valid recorded DFDR data occurs about 16:20:56. At this time, the recorded airspeed is 215 knots, the pitch attitude is –45 degrees, the roll attitude registers 117 right wing down, and the vertical acceleration parameter records –1.05 g's.

Beginning at 16:20:07, until the end of the recording, there is consistent invalid data being registered every four seconds. These data are denoted with red asterisks on the graphical plots and question marks on the tabular data.

Erin M. Gormley
Aerospace Engineer
Vehicle Recorders Division

List of Attachments:

Attachment 10A-6: Parameter Listing

Attachment 10A-6 Digital Flight Data Recorder Parameter List
MD83 Alaska Airlines N963AS

Aileron Position (left)
Air/Ground Sensing
Angle of Attack**
Autopilot (engaged,in use)
Autopilot Modes(armed,pitch,roll,throttle)
Brake Pressure (left**,right)
Cabin Pressure Warning
Computed Airspeed
EGT (engines: left,right)
Elevator Position (left,right)
EPR (engine: left)
EPR (engine: right)
Event Marker
Fire Warning (engines: left, right)
Flap Position (left)
Fuel Flow (engines: left, right)
Glideslope Deviation (1,2)
Glideslope Warning
Hydraulic System (press. low: left,right)
Hydraulic System (temp. high: left,right)
Landing Gear (rgt main: up,down)
Lateral Acceleration
Localizer Deviation (1,2)
Longitudinal Acceleration
Mach Number
Magnetic Heading
Marker Beacons (middle,outer,inner)
Master Warning
Max Allow Airspeed
N1 (engines: left, right)
N2 (engines: left, right)
Pitch Attitude
Pitch Trim Position
Pressure Altitude (coarse,fine)
Radio Altitude (coarse,fine)
Roll Attitude
Rudder Pedal Position
Rudder Position
Slat Disagree
Slat Positions (LA/LB,RA/RB)
Slat Retract
Spoilers (left outboard,right inboard)
Stick Pusher
Terrain Warning
Thrust Rev (engine:left unlock,reverse)
Thrust Rev (engine:right unlock,reverse)
Total Air Temperature
Vertical Acceleration
VHF Keying (I,2)
Windshear

**parameters determined to be invalid