NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Washington, DC

April 19, 2006

AIRCRAFT PERFORMANCE STUDY

Specialist's Report of Investigation
By Abdullah K. Kakar

DCA05RA093

A. ACCIDENT

Location: Near Machiques, Venezuela
Date: August 15, 2005
Time: 0700 Universal Time Coordinate (UTC)
Aircraft: MD-82, HK-4374X West Caribbean Airlines

B. GROUP

Chairman: Abdullah Kakar
Aerospace Engineer
NTSB, RE-60
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Members: Dennis Crider
National Resource Specialist
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David Yingling
Flight Safety and Design Office
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C. SUMMARY

On August 16, 2005, at about 07:00 UTC, a West Caribbean Airways MD-82 crashed near Machiques, Venezuela after the pilot reported engine problems. The 8 crewmembers and 152 passengers onboard were fatally injured and the airplane was destroyed. The airplane was being operated as a charter flight from Panama City, Panama, to Fort de France, Martinique

Data available pertaining to the accident included Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR), and radar data from Cerro Macco (CEM) and Riohacha (RIO) radar stations in Columbia.

This study used the available data to calculate the aircraft's pitch, angle of attack, and engine performance from the time when the flight was at cruise level of 33,000 feet to when the sound of the stick shaker was heard on the CVR. Issues that are relevant to this accident include flight close to stall regions and power requirements for cruise flight at the given altitude. Plots of various parameters such as, altitude, speeds, accelerations, and angles were presented to illustrate the findings.

D. RESULTS

The FDR data showed the flight cruising at about 33,000 feet on autopilot when the power was reduced by the auto throttle system at approximately 0648:00 UTC[1]. About 83 seconds later the speed began to decay from 270 knots and another 37 seconds later the stabilizer trim began to increase from 1 degree trailing edge up[2]. At 0652:24 the power, or engine pressure ration (EPR), was increased to about 1.97 for about 44 seconds then reduced to approximately 1.92, but the speed continued to decay and the stabilizer trim continued to move nose up. At 0657:10 the autopilot disconnected and the flight began to descend to flight level 31,000 feet. The altitude data showed the airplane continued to descend pass the target altitude and by about 0657:45 the speed had reduced to about 208 knots and the pitch trim had reached approximately 3.5 degrees trailing edge up. The airplane continued to lose altitude and ultimately crashed.

The study revealed that the power was reduced at 0648:00 and about 80 seconds later the airplane was not able to maintain both speed and altitude for the given power setting. Consequently the speed started to decay while the altitude was maintained by increasing pitch attitude of the airplane in the nose up direction. As the airplane decelerated while maintaining altitude, the required power to maintain airspeed further increased, and the airplane continually pitched up, ultimately reaching close to stall angle of attack.

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[1] All subsequent time references will be in UTC unless specified otherwise.

[2] Trailing edge up is recorded negative on the FDR, but to be more intuitive for purpose of this report the sign was reversed so a positive trailing edge up equates to airplane nose up.

E. DETAILS OF INVESTIGATION

1) Data Source

I. Aircraft Data

Relevant aerodynamic data for performance calculations were obtained from the aircraft manufacturer, Boeing. The load manifest indicated a take off weight of about 148,000 pounds and the Venezuelan authority had calculated a total fuel burn of approximately 6,000 pounds. For all calculations an aircraft weight of 142,000 pounds with a center of gravity at 14% was used. It was believed that the airplane weight could have possibly been greater then 142,000 pounds. Additional calculations at 148,000 pounds were conducted as well to ensure any uncertainty in weight of the airplane was accounted for. The flaps and slat positions were retracted for all calculations.

II. Radar Data

The radar data was used as a supplement for this study and was sent to the Board from the United States Air Force 84th Radar Evaluation Squadron (RADES) and included data from the CEM and RIO stations. Beacon code 0250 was assigned to HK-4374X for identification and tracking purposes.

CEM radar data, included in the appendix, was the primary source of radar data for this study because it provided an additional 22.2 seconds of data beyond the last return from the RIO station. The time range of data used was from 0641:02.7 to 0700:50.7. The sample rate of the data was inconsistent but it averaged about every 8.5 seconds. According to RADES the data was processed in Columbia and then routed to the US. The reason for the inconsistency in the sample rate was unknown. The data sets contained both the latitude/longitude and range/azimuth information. Plotting the latitude and longitude data showed the CEM track offset to the north of the RIO data. NTSB Air Traffic Control specialist determined that the CEM station coordinates used to convert the range and azimuth to latitude/longitude was incorrect. The correct coordinate of the CEM station was N09^{o} 53' 09" and W075^{o} 11' 31" at a total antenna elevation of 2,788 feet. Using a WGS-84 reference system the range and azimuth were used to recalculate the latitude and longitude with the updated station coordinates. The CEM track though was still shifted and resembled an offset observed when an incorrect magnetic variation is used. Considering the uncertainties of the other information about the CEM radar station, the magnetic variation was adjusted by about 1 deg west and the resulting track matched the RIO data. Figure 1 shows the latter segment of flight's adjusted ground track overlaid on a map. The radar files contained altitude data in increments of 100 feet implying an uncertainty of ±50 ft. The range and azimuth uncertainty of the CEM radar was unknown, but similar radars typically have uncertainties in range and azimuth of ±386 ft and 2 degrees respectively.

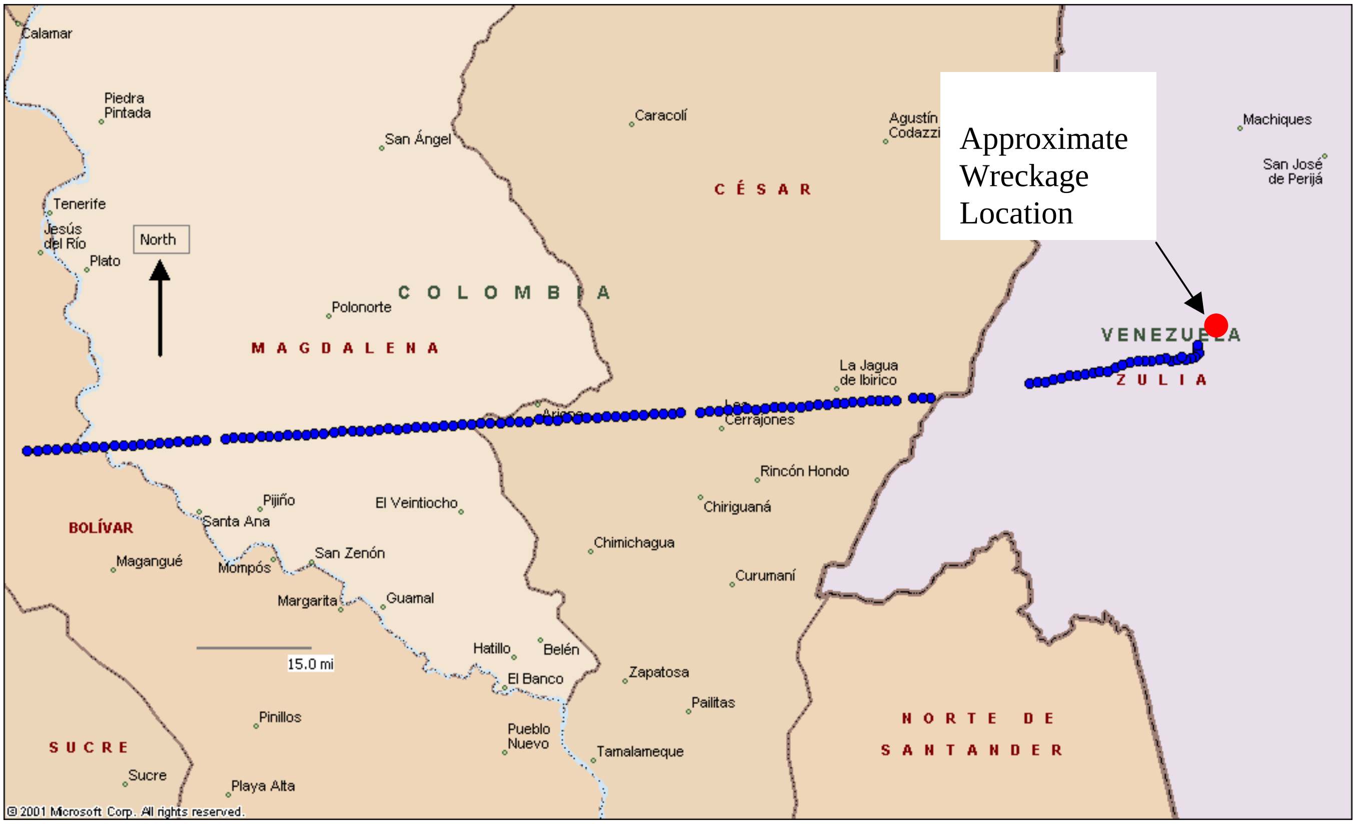

Figure 1. Adjusted Ground Track CEM Radar Data

III. FDR Data

The primary source of data for performance calculations was the FDR. Not all the data on the FDR were usable and some recorded parameters were very noisy. Details of the FDR read-out is explained in the Bureau D'Enquetes et D'Analyses (BEA) flight recorder read-out report. The relevant FDR data, pitch, roll, heading are shown in figure 2, vertical, lateral, and longitudinal accelerations in figure 3, speed, altitude, and Mach in figure 4, elevator position, pitch trim (stabilizer angle), and control column in figure 5, and EPR in figure 6. Note that the pitch and roll data were very noisy, and the elevator and control column data only showed negative angles. The magnetic heading was erroneous, indicating a constant northerly heading, although the radar shows the flight traveling in an easterly direction. The angle of attack was not a recorded parameter. According to Boeing performance estimates, engine 1 and engine 2 EPR[3] should have both been approximately 1.87-1.94 EPR[4] for Mach 0.76 to 0.65 and at a true air temperature range of about -11 to -19 degrees Celsius, respectively, for the given flight conditions[5]. However, the recorded EPR 1 data showed values that were too low and EPR 2 showed jumps in the data to as low as 1.2, neither of which seem reasonable. It

[3] All future references to engine 1 EPR will be EPR 1 and engine 2 EPR will be EPR 2.
[4] Boeing provided the EPR data using their performance simulation program.
[5] The conditions used were: airplane weight of 142,000 pounds, altitude at 33,000 feet and anti-ice off. According to Boeing the difference between required EPR for anti-ice on and off is minimal.

was established that EPR 1 data and the lower range values of EPR 2 data were suspect and most likely not possible for the given flight conditions.[6]

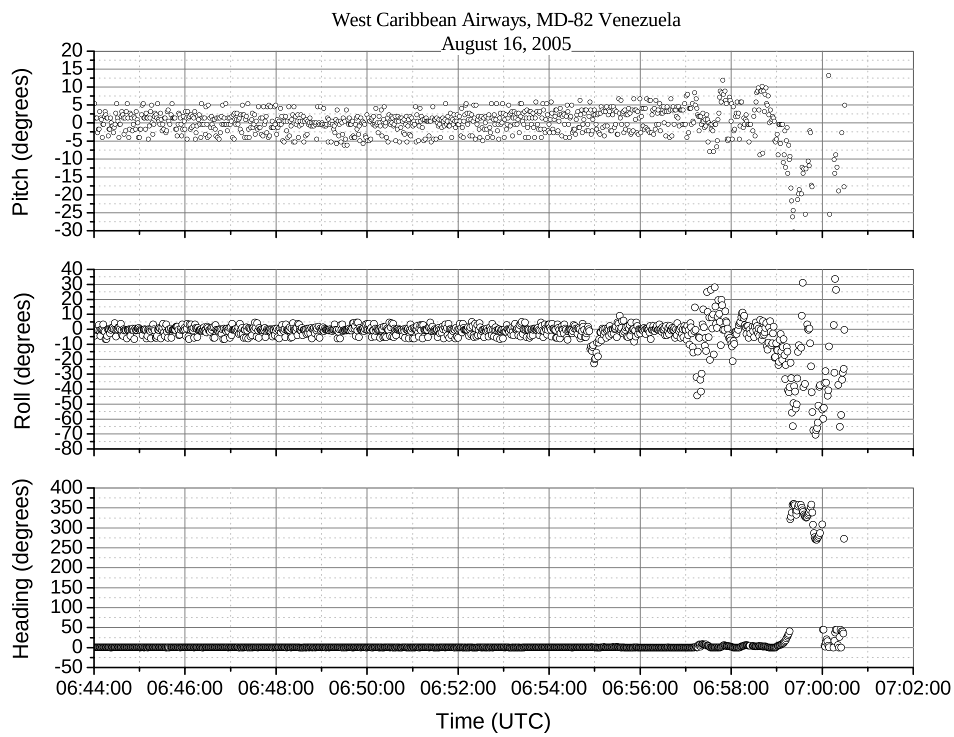

Figure 2. Raw FDR Data, Pitch, Roll, and Heading

[6] This was also validated by the Safety Board simulation discussed later in the report (see page 9, Simulation Results).

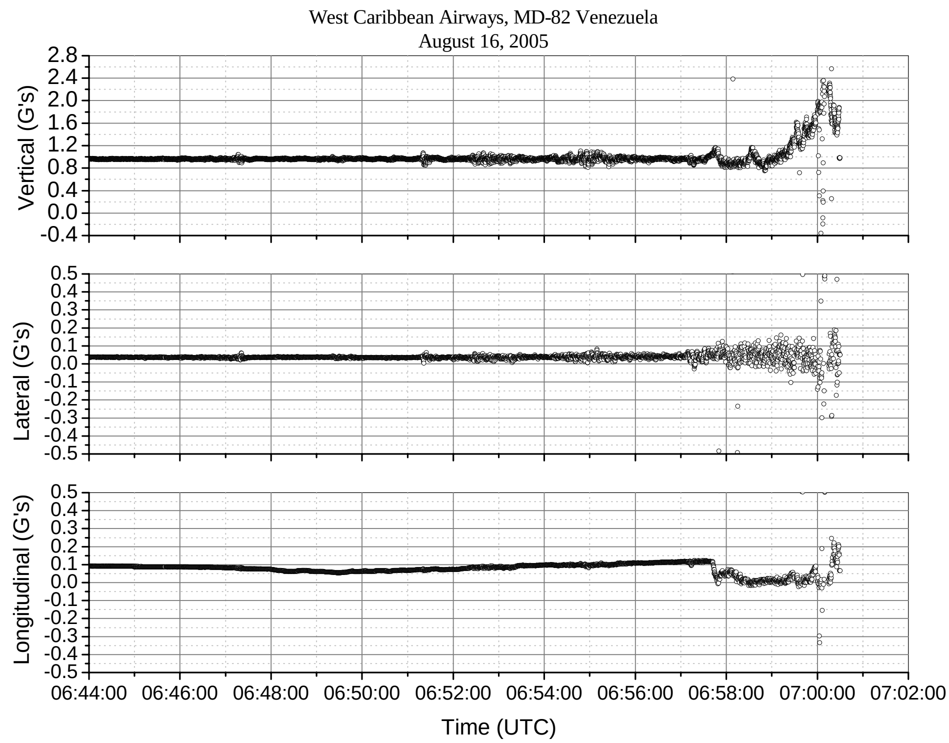

Figure 3. Raw FDR Data, Vertical, Lateral, and Longitudinal Acceleration

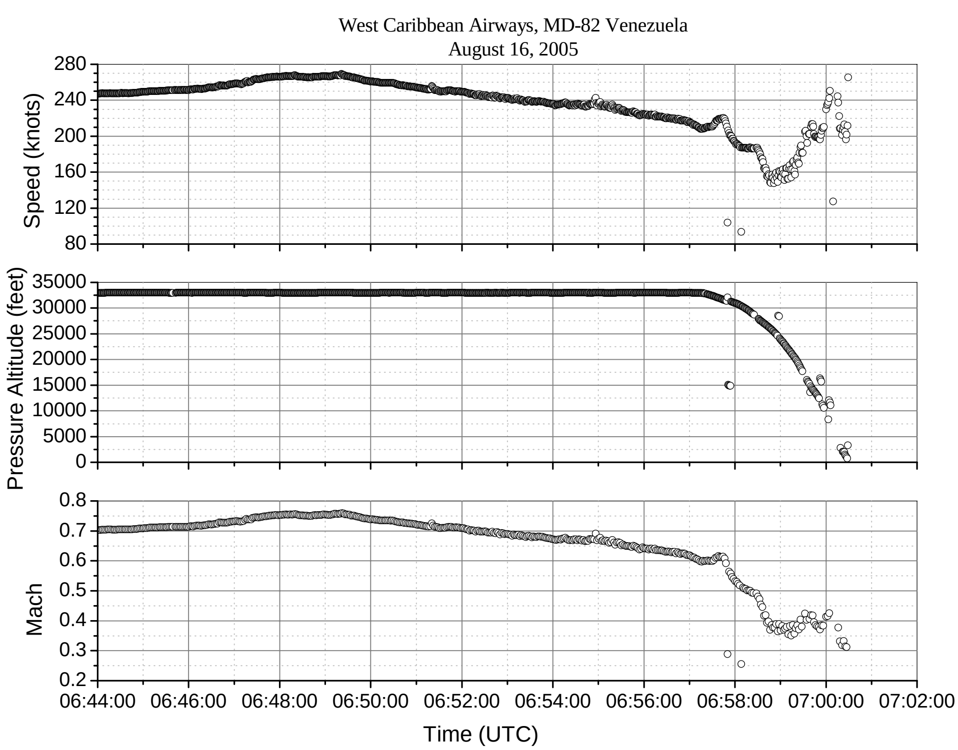

Figure 4. Raw FDR Data, Speed, Altitude, and Mach

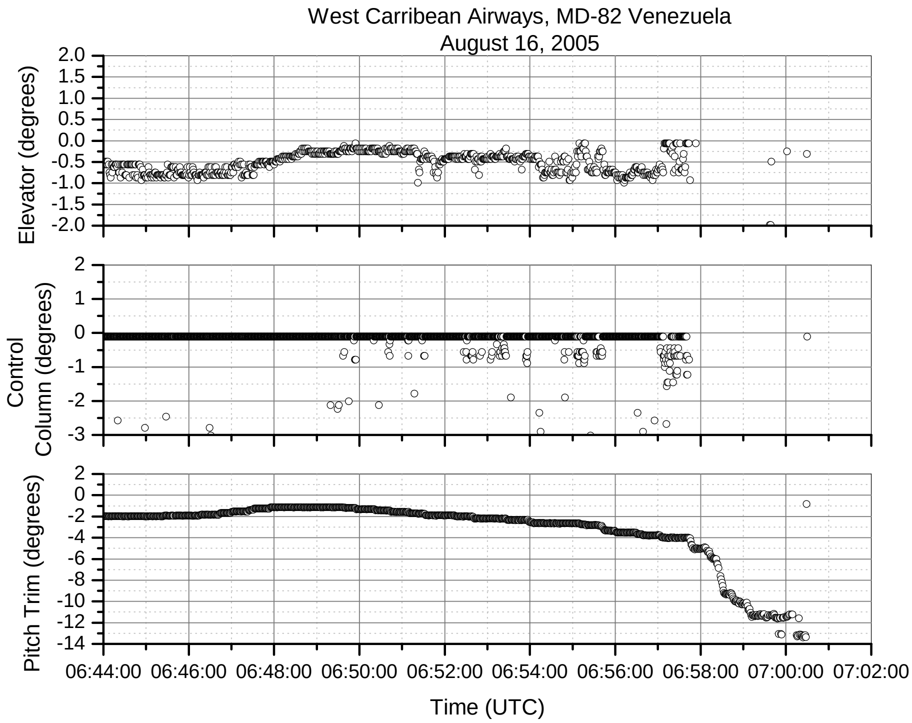

Figure 5. Raw FDR Data, Elevator, Control Column, and Pitch Trim

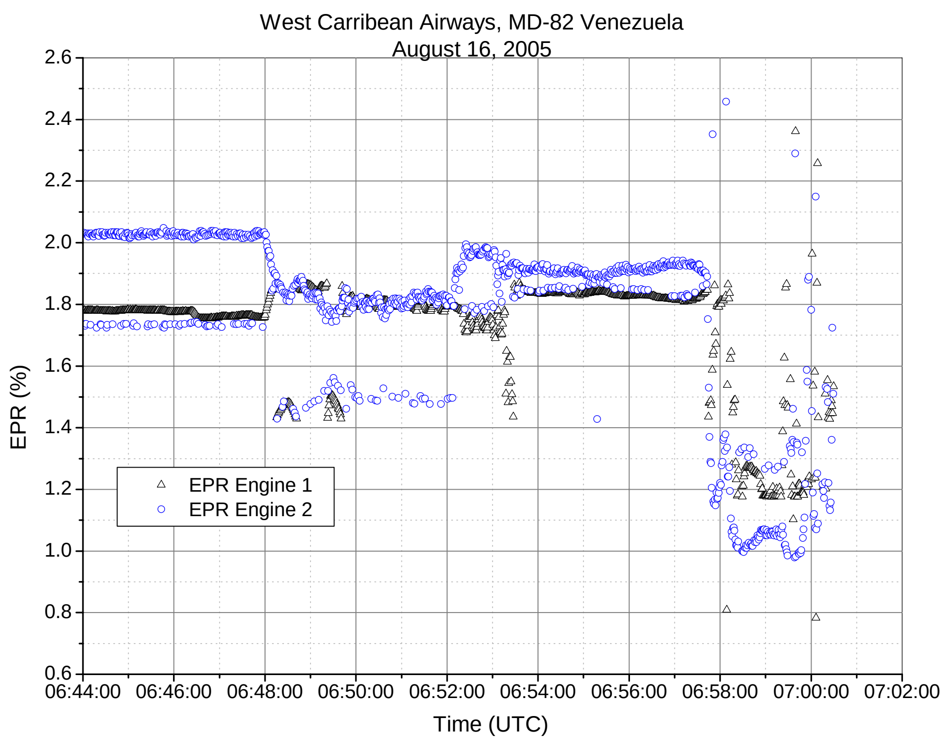

Figure 6. Raw FDR Data, Engine 1 and Engine 2 EPR

2) Time Correlation of Data Sources

BEA conducted the time correlation of FDR time to UTC hh:mm:ss format. According to BEA 11177.625 FDR seconds was equivalent to around 0657:08 UTC which is the correlation used in this report.

3) Simulation

I. Simulation Calculations

The objective of a simulation is to recreate the aircraft's motions and the inputs that resulted in those motions. If critical information on the FDR is not available then a simulation can be performed to obtain the parameters of interest. The simulation results are then matched with the available FDR data for validity. The quality of the simulation depends on the precision of the match and if the FDR parameters used for the match are questionable then so will the results of the simulation. Information about the airplane such as aerodynamic data, engine data, airplane geometry, and airplane configuration are some of the data needed for the simulation. The simulator will then 'drive' or 'fly the airplane' and calculate the aircraft motion required to match the available FDR data. However, the simulation is limited to regimes when the airplane is normally operated and where validated data is available. At extreme flight conditions such as at high angle of attack and beyond stall the simulation is not valid.

For the Venezuela MD-82 investigation the critical parameters, pitch, angle of attack, roll and EPR as discussed in the FDR subsection were not readily usable or available to conduct a complete performance study. Given the available data, the Safety Board conducted simulations using the desktop simulator at the Board, to derive these key parameters. Once the key parameters were determined a better understanding of the performance of the accident airplane was possible. Also, per NTSB's request Boeing performed simulation to determine the required power levels for the given flight conditions.

The simulation consisted of two sections. The first section covered from cruise flight condition to when the airplane approached the buffet angle of attack[7]. The second section started from buffet angle of attack to when the airplane stick shaker was heard on the CVR. The reason for splitting the simulation in two sections will be clarified later in the report.

The accident flight was flown by autopilot for the period of interest so the methodology used for the simulation was similar to how an autopilot is designed to control an airplane. This method includes controlling speed by adjusting the power and controlling altitude by adjusting the pitch angle.

[7] According to Boeing, the MD-82 experiences an aerodynamic buffet prior to the natural aerodynamic stall.

The input data for the simulation included FDR recorded altitude, speed, pitch trim, and heading. The heading data was invalid for the flight so the radar data was used to derive heading information and used in the simulation (figure 7). The simulation was based on data available for the engine model JT8D-219 rather than JT8D-217A and per Boeing, the EPR to thrust relationship between the two models are nearly identical. The simulation required pitch data to control altitude but the FDR recorded pitch data was very noisy. An alternative source for pitch information would have been the elevator data, but that was unusable (as discussed in the FDR subsection). The FDR stabilizer trim was then used as the main source of data to derive the pitch.

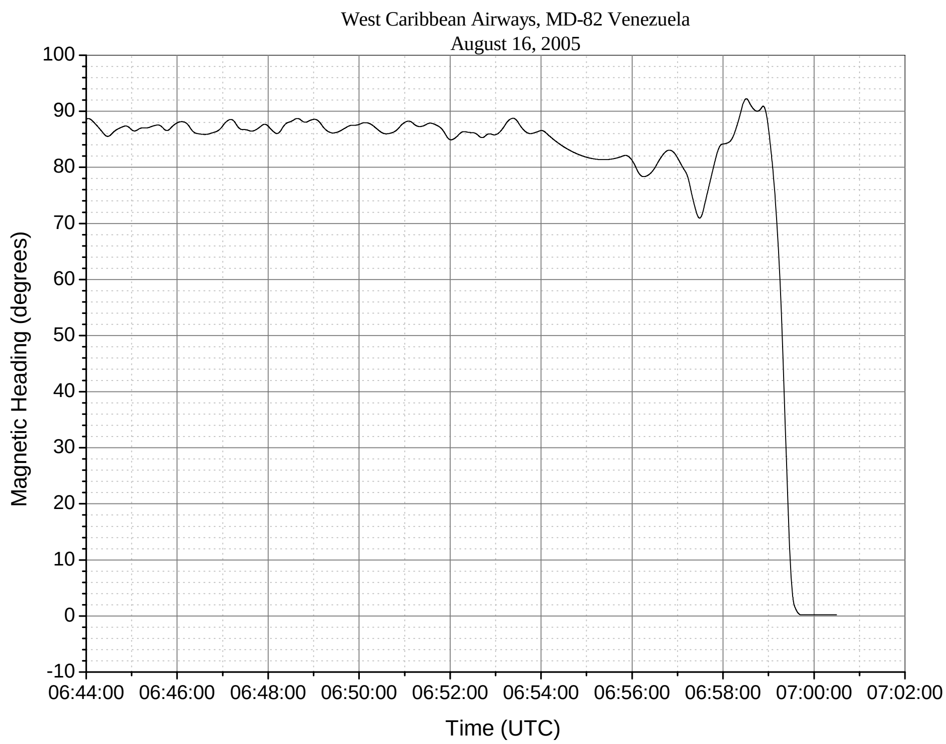

Figure 7. Radar Derived Magnetic Heading

II. Simulation Results

Matching the FDR altitude and speed profiles, shown in figure 8 resulted in the simulation EPR trace in figure 9. Aerodynamic stall occurs at around 9 degrees angle of attack, and the simulation match degrades after about 0657:45, as the aerodynamic model is not validated for stalled flight. Note that the calculated EPR follows the upper range of FDR EPR 2 data and confirms that EPR 1 and the lower range of EPR 2 data were not plausible. Consequently the FDR EPR 2 lower range data was removed and only the upper range was retained, displayed in figure 10 as EPR 2 clean. The calculated thrust per engine based on the clean EPR 2 data is shown in figure 11.

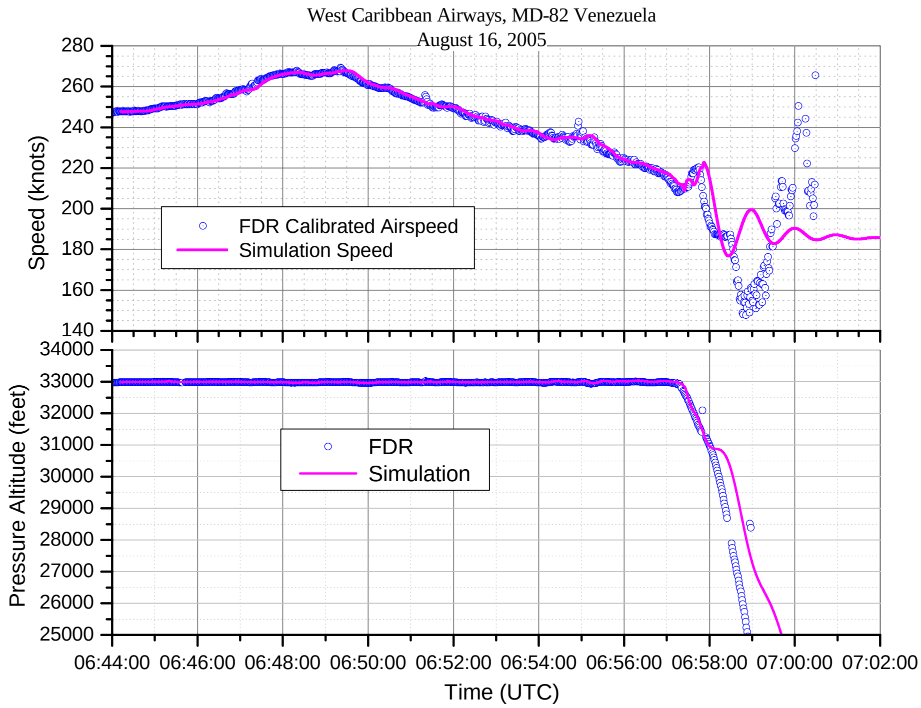

Figure 8. Section 1 Simulation Speed and Altitude Match of FDR data

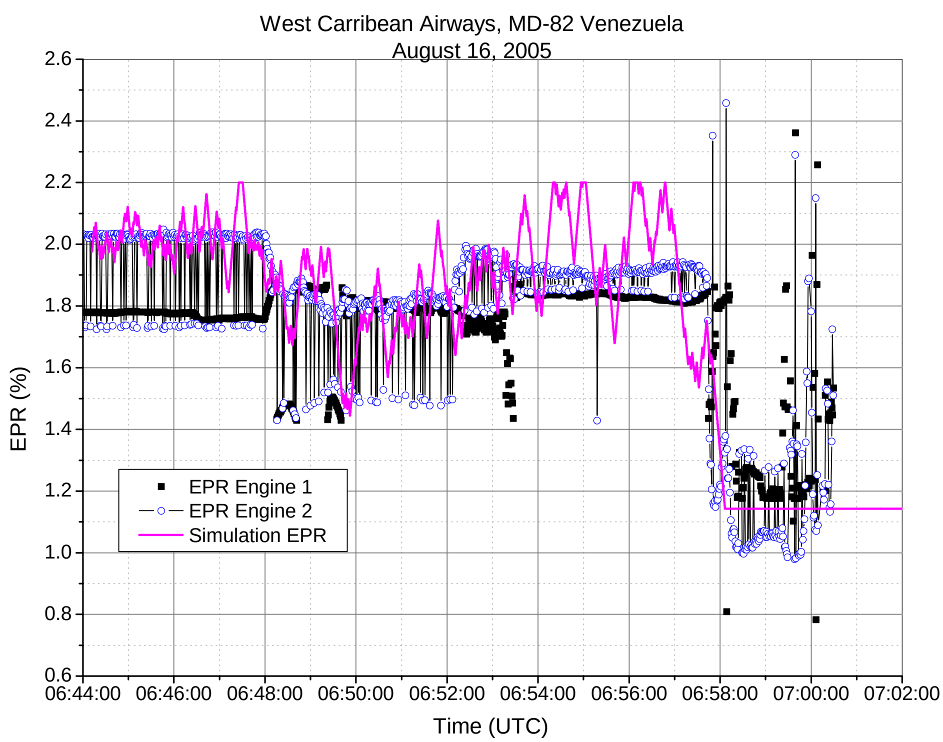

Figure 9. Raw FDR data and Simulation derived EPR

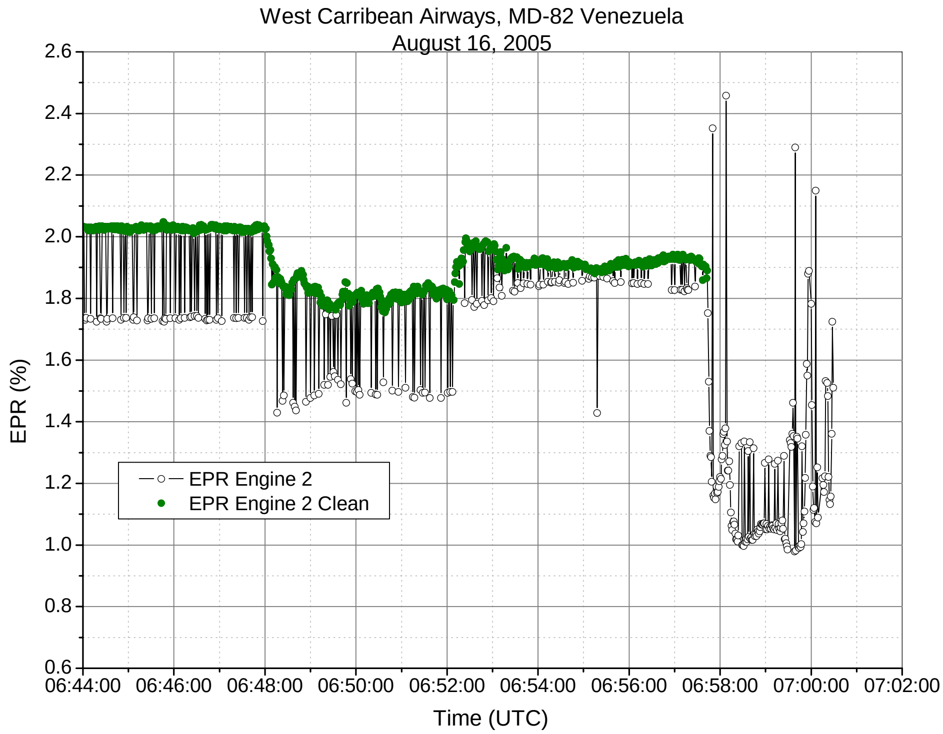

Figure 10. FDR EPR 2 and EPR 2 Clean

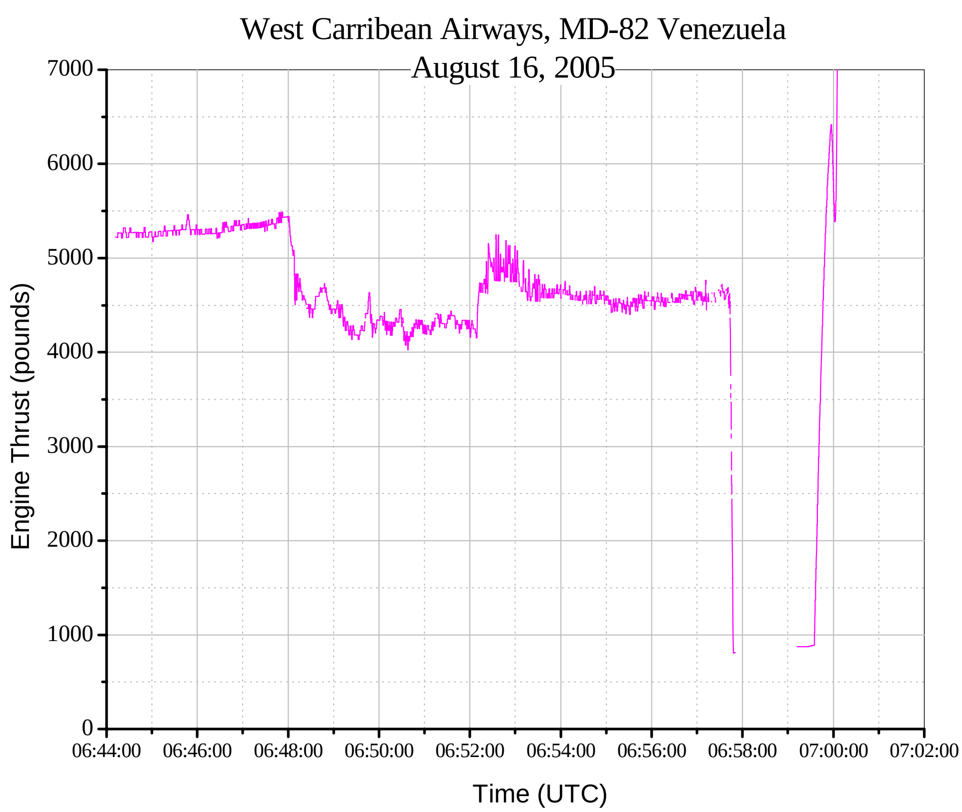

Figure 11. Section 1 Simulation Calculated Thrust per Engine

The calculated column position is plotted in figure 12 and shows that prior to about 0657:00 there is very little activity, which is consistent with a trimmed flight condition. Figure 13 depicts the calculated pitch angle and angle of attack. The plot shows the angle of attack increasing to buffet angle of 6.4 degrees at Mach 0.61 around 0657:13. The region just after the angle reaches the Mach buffet was aerodynamically uncharacteristic and did not match the airplane performance because of the extreme fluctuations in the pitch angle. However, this region was critical to understand because it provided information about the flight's stall characteristics.

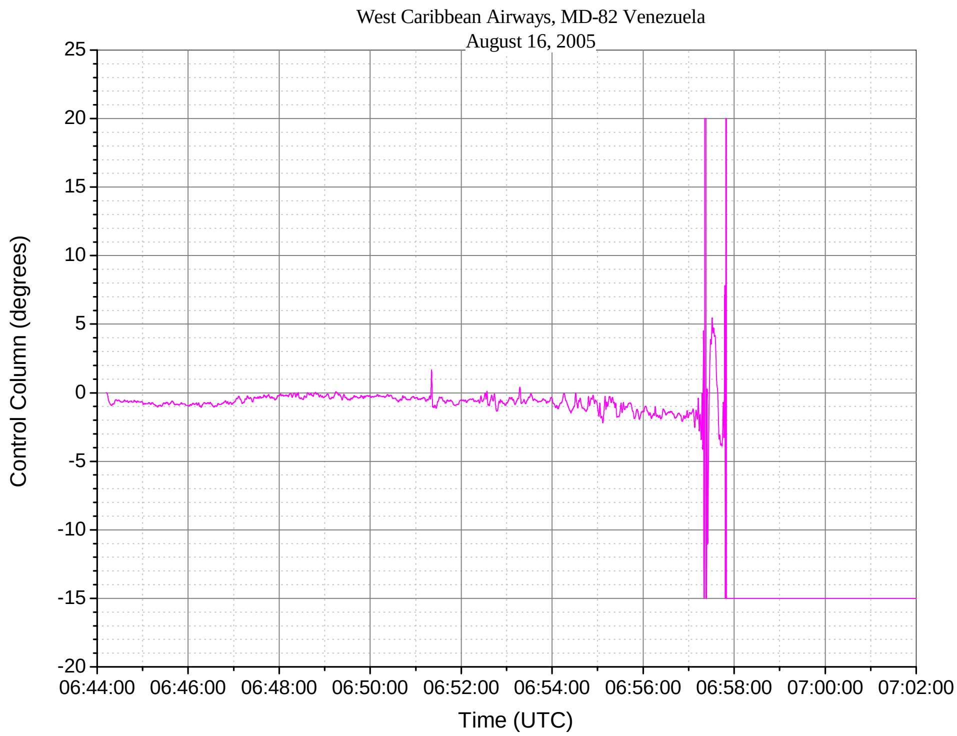

Figure 12. Section 1 Simulation Derived Control Column Position

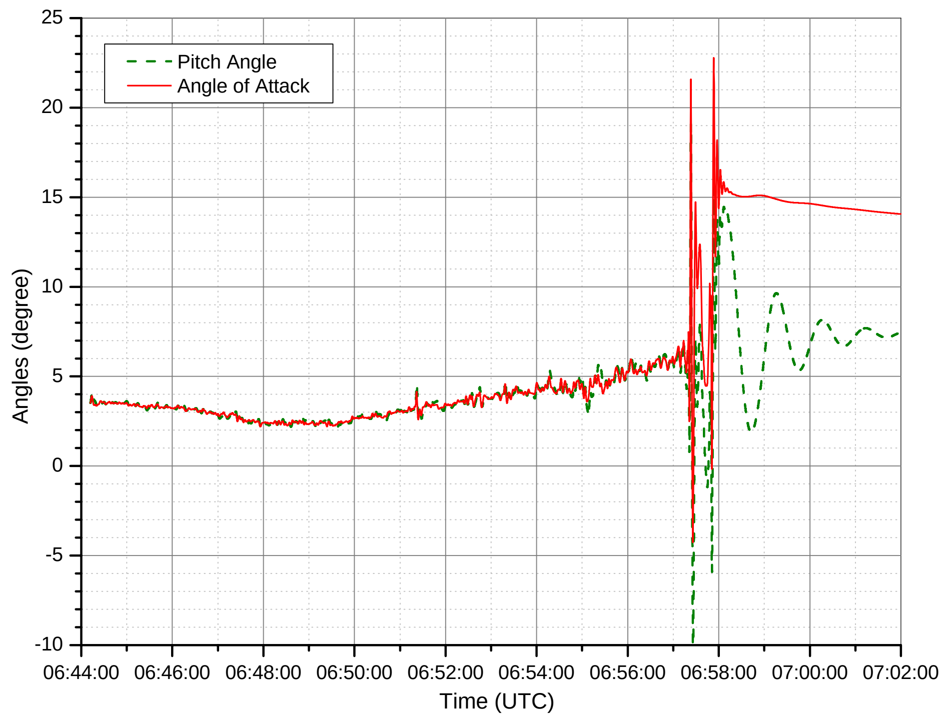

Figure 13. Section 1 Simulation Derived Pitch Angle and Angle of Attack

To gain more insight into the region beyond buffet angle a different approach to the simulation was pursued. The second section of the simulation consisted of using the elevator to drive the simulation to match the FDR vertical acceleration. Recall that the FDR elevator data was unusable as explained in the FDR section of the report (see figure 5), so the elevator data was derived to match the simulation to the FDR data. The elevator data was initially set to 0 degrees deflection angle and then was adjusted as needed to achieve a match of the simulated vertical acceleration with the recorded parameter. Additionally, the drag was increased starting at 06:57:02 to achieve the match of the altitude profile. The simulation duration was from 0655:50 to when the stick shaker sound was heard on the CVR at 0657:45. Result of the match is shown in figure 14 along with the required elevator input. The pitch and angle of attack are plotted in figure 15 and shows the angle of attack continues to increase and trend towards the stall angle of 9 degrees (stall angle data was obtained from Boeing manuals). The times when the stick shaker was heard on the CVR and when the autopilot was disengaged are denoted on the plot. Note that the simulation is restricted to only the period before the stall due to the limitations mentioned earlier in the report. Figure 16 shows part two of the simulation's speed and altitude match with FDR data. There were uncertainties about the exact weight of the airplane as mentioned earlier in the report. To check the affects of the weight an additional simulation run was performed with an airplane weight of 148,000 pounds. The results showed the stall angle increased by approximately 0.5 degrees.

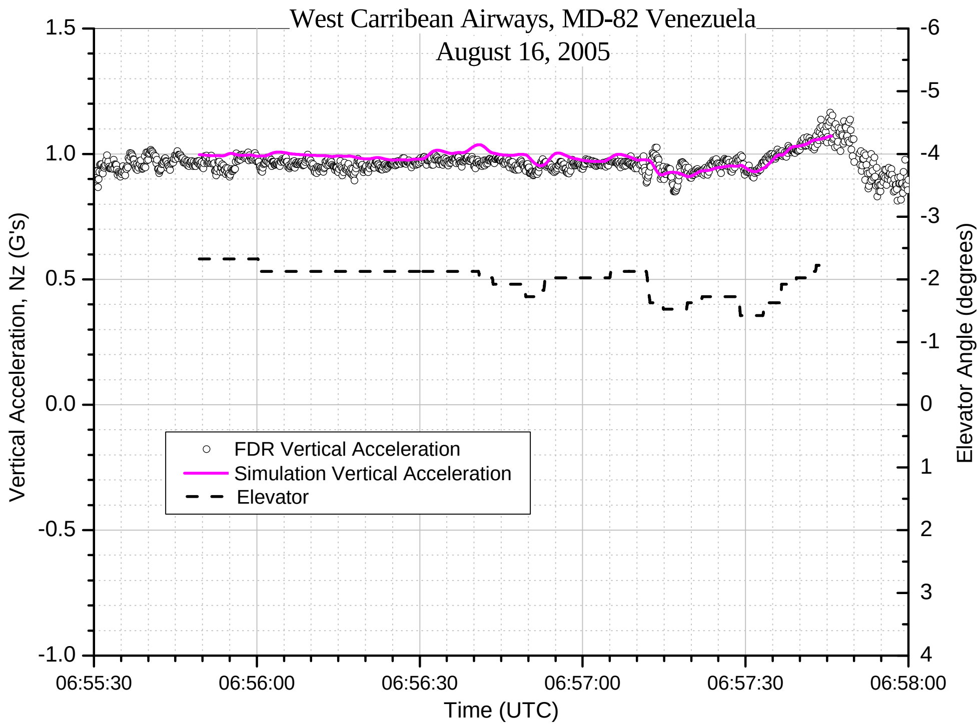

Figure 14. Section 2 Simulation Match of FDR Vertical Acceleration and Elevator Input

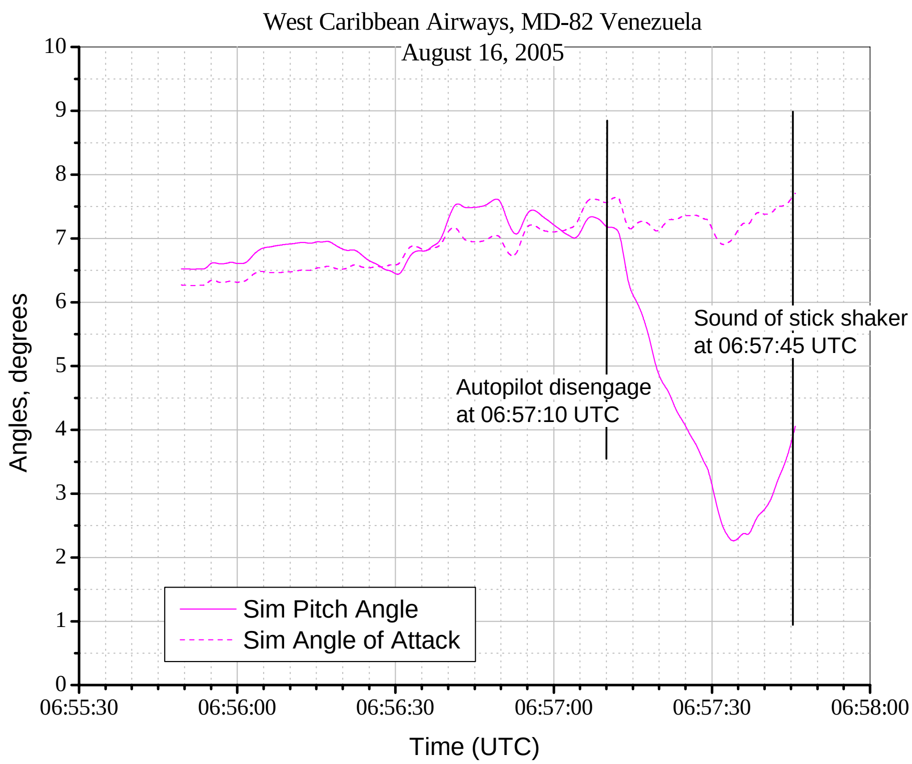

Figure 15. Section 2 Simulation Derived Angle of Attack and Pitch Angle

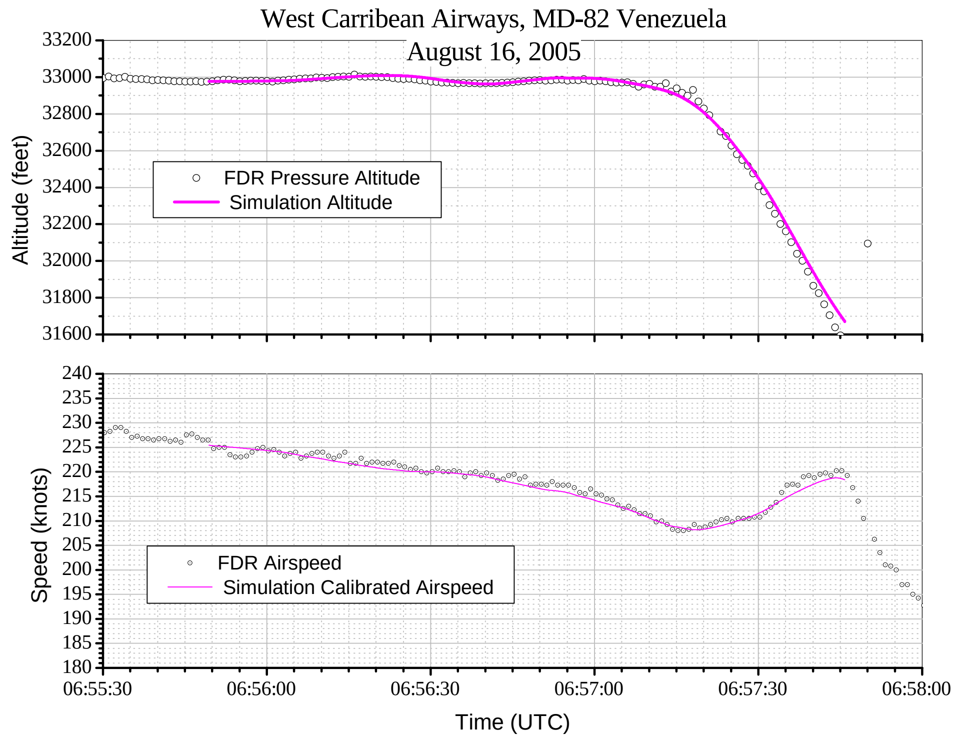

Figure 16. Section 2 Simulation Speed and Altitude Match of FDR Data

4. Flight Behind the Power Curve

An airplane is behind the power curve, when at a given flight condition, the airplane slows to below the minimum drag speed. Further decrease below the minimum drag speed requires greater thrust to maintain altitude. This condition of flight is typically referred to as 'flying behind the power curve' or 'backside of the thrust curve'.

Per the Board's request Boeing performed simulation at trim conditions for various speeds to determine the required power and EPR. The simulation was based on aircraft flight test performance data and used the following conditions: altitude at 33,000 feet, airplane weight of 142,000 pounds, anti ice off, clean airplane configuration. Figure 17 illustrates the power required for a given Mach number and shows that minimum drag occurs at about Mach 0.73. As the Mach number continues to decrease below this critical number, more thrust is required to maintain altitude.

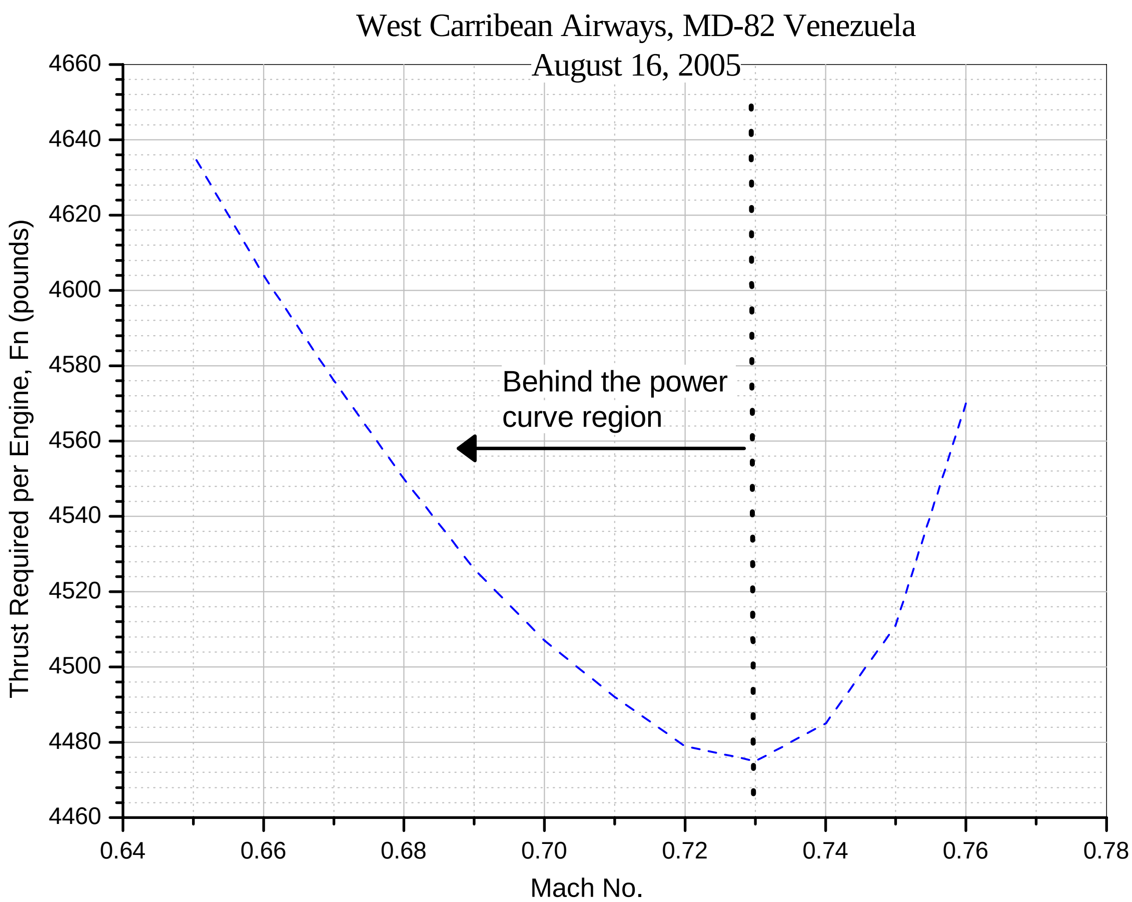

Figure 17. Power Curve, Boeing Performance Simulation Data

Figure 18 shows the FDR EPR 2 clean, the Mach number, Boeing EPR required and auto throttle EPR limit[8] plotted versus time. The Boeing EPR data was first translated to a time domain. The plot shows at about 0648:00 the reduction in EPR from about 2.03 at Mach 0.75 towards approximately 1.86 EPR, denoted as point A on the plot. According to Boeing's EPR and Auto Throttle System Modes report, it is believed that at this time both engine and airfoil ice protection system was turned on. The EPR then drops below the required level and the auto throttle cruise EPR limit (with anti-ice on). The Mach number subsequently starts to decrease about 80 seconds later. The Mach continues to decrease to about 0.70 when an increase in EPR to about 1.95 – 2.0 is recorded, denoted by point B. The EPR then is again reduced to approximately 1.90 as the Mach number continually decreases and the EPR required continues to increase, point C. Boeing EPR required data was not available for less than Mach 0.65 because of the software limitations close to the buffet angle.

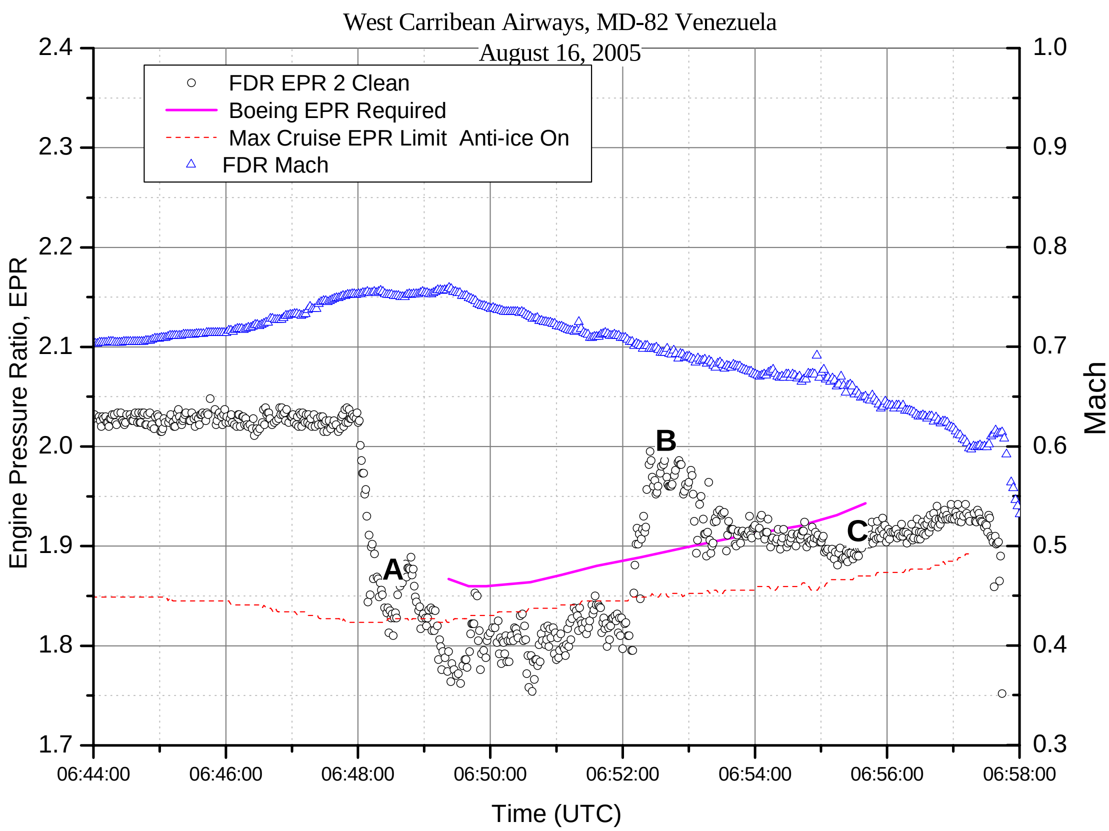

Figure 18. FDR EPR 2 Clean, Mach No., and Boeing Simulation EPR and Auto Throttle System EPR Limit (JT8D-217A Engines, weight of 142,000 pounds)

Note that once the airplane is on the backside of the power curve at about 0649:00, additional power will not recover the airplane from this condition although that is the natural reaction for recovery by the crew. Increasing the speed is the only method

[8] Details can be found in Boeing's report on EPR and Auto Throttle Modes.

to recover, and that is accomplished by pitching the airplane nose down and reducing altitude.

Figure 19 is a plot of the thrust and Mach number versus time. It includes the thrust calculated by the NTSB (same plot as figure 11) and the Boeing required thrust using the aerodynamic performance program and the stability and control simulation program. Note that the stability and control data is not buffet limited so it includes data to Mach 0.6.

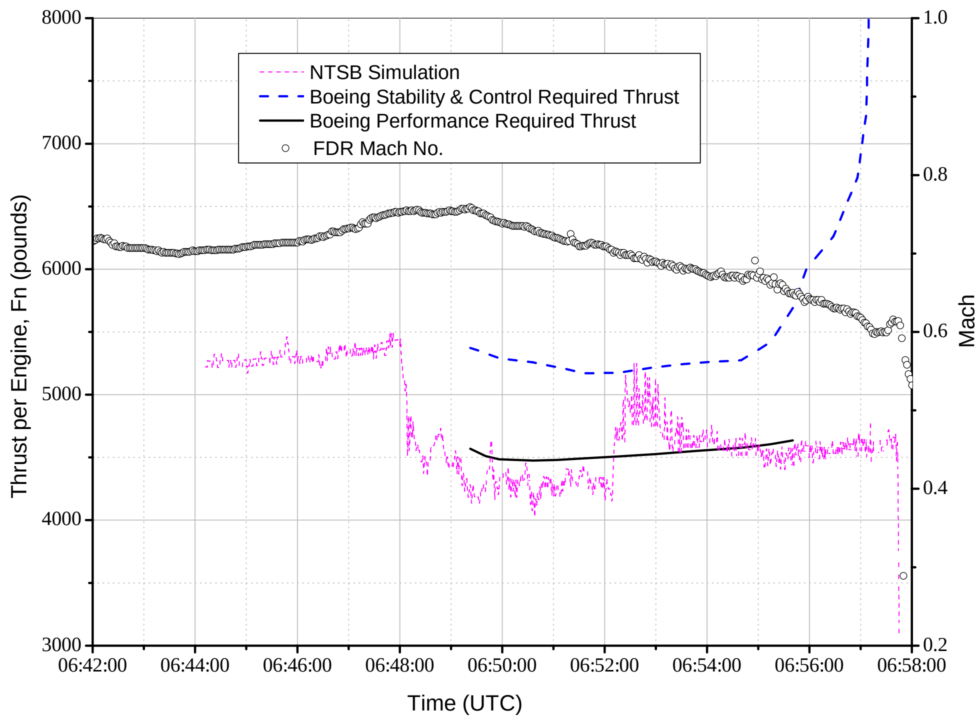

Figure 19. Boeing Thrust Required Data and NTSB Simulation

F. CONCLUSION

The flight was cruising on autopilot at about 33,000 feet at Mach 0.76 when the power was adjusted by the auto throttle system. About 83 seconds later the speed started to decay and another 37 seconds later the airplane stabilizer trim showed a nose up pitch. About 10 minutes after the initial power adjustment occurred, the speed had decayed to 208 knots (Mach 0.6) and the simulation showed the airplane angle of attack was at about 8 degrees and trending up. The simulation also revealed that about 80 seconds after the initial power adjustment the airplane was not able to maintain both the speed and the altitude for the given power, and consequently the speed started to degrade as the altitude was maintained. As the speed continued to decrease the need for power further increased and the angle of attack was increased to maintain altitude, subsequently reaching the stick shaker activation angle of attack and close to the aerodynamic stall angle.

Abdullah Kakar
Aerospace Engineer

Appendix

Cerro Macco (CEM)
Radar Data
August 15, 2005

0641:02.7 to 0700:50.7 UTC

CEM Radar Data

Time (UTC)	Range (Nautical Miles)	Azimuth (Degrees)	Altitude Mode C (Feet)
06:41:02.7	31.3750000	145.195000	31100.0000
06:41:11.5	32.0000000	143.525000	31100.0000
06:41:20.1	32.5000000	141.855000	31100.0000
06:41:28.7	33.2500000	140.273000	31300.0000
06:41:37.7	33.8750000	138.691000	31400.0000
06:41:46.2	34.5000000	137.197000	31500.0000
06:41:55.0	35.1250000	135.791000	31500.0000
06:42:03.5	35.8750000	134.473000	31500.0000
06:42:12.3	36.6250000	133.154000	31500.0000
06:42:20.9	37.3750000	131.924000	31800.0000
06:42:29.8	38.1250000	130.781000	32000.0000
06:42:38.5	38.8750000	129.639000	32000.0000
06:42:46.9	39.6250000	128.584000	32200.0000
06:42:55.9	40.3750000	127.529000	32300.0000
06:43:04.6	41.1250000	126.562000	32300.0000
06:43:12.8	42.0000000	125.596000	32200.0000
06:43:21.4	42.7500000	124.629000	32300.0000
06:43:30.4	43.6250000	123.662000	32400.0000
06:43:39.0	44.3750000	122.783000	32500.0000
06:43:47.9	45.2500000	121.992000	32500.0000
06:44:05.2	47.0000000	120.410000	32700.0000
06:44:14.1	47.7500000	119.707000	32700.0000
06:44:22.2	48.6250000	119.092000	32800.0000
06:44:31.2	49.5000000	118.389000	32900.0000
06:44:39.6	50.3750000	117.686000	32900.0000
06:44:48.6	51.2500000	117.158000	33000.0000
06:44:57.9	52.1250000	116.543000	33000.0000
06:45:06.3	53.0000000	115.928000	33000.0000
06:45:15.2	54.0000000	115.400000	33000.0000
06:45:23.6	54.8750000	114.873000	33000.0000
06:45:31.7	55.7500000	114.346000	33000.0000
06:45:41.0	56.6250000	113.818000	33000.0000
06:45:50.0	57.6250000	113.291000	33000.0000
06:45:57.6	58.5000000	112.764000	33000.0000
06:46:06.2	59.5000000	112.324000	33000.0000
06:46:15.6	60.3750000	111.885000	33000.0000
06:46:24.4	61.3750000	111.445000	33000.0000
06:46:32.5	62.2500000	111.006000	33000.0000
06:46:41.3	63.2500000	110.566000	33000.0000
06:46:49.8	64.2500000	110.215000	33000.0000

Time (UTC)	**Range** (Nautical Miles)	**Azimuth** (Degrees)	**Altitude Mode C** (Feet)
06:46:58.7	65.1250000	109.775000	33000.0000
06:47:07.7	66.1250000	109.424000	33000.0000
06:47:16.8	67.1250000	109.072000	33000.0000
06:47:24.9	68.1250000	108.721000	33000.0000
06:47:33.4	69.0000000	108.369000	33000.0000
06:47:42.1	70.0000000	108.018000	33000.0000
06:47:51.1	71.0000000	107.666000	33000.0000
06:47:59.3	72.0000000	107.314000	33000.0000
06:48:08.2	73.0000000	106.963000	33000.0000
06:48:16.7	74.0000000	106.699000	33000.0000
06:48:25.4	75.1250000	106.436000	33000.0000
06:48:34.7	76.1250000	106.084000	33000.0000
06:48:42.6	77.1250000	105.820000	33000.0000
06:48:51.8	78.1250000	105.557000	33000.0000
06:48:59.5	79.1250000	105.205000	33000.0000
06:49:08.6	80.2500000	105.029000	33000.0000
06:49:17.1	81.2500000	104.766000	33000.0000
06:49:25.8	82.2500000	104.414000	33000.0000
06:49:34.5	83.3750000	104.238000	33000.0000
06:49:42.9	84.3750000	103.975000	33000.0000
06:49:51.5	85.5000000	103.799000	33000.0000
06:50:00.5	86.5000000	103.535000	33000.0000
06:50:09.0	87.5000000	103.359000	33000.0000
06:50:17.9	88.6250000	103.184000	33000.0000
06:50:26.1	89.6250000	102.920000	33000.0000
06:50:35.1	90.6250000	102.744000	33000.0000
06:50:44.1	91.7500000	102.480000	33000.0000
06:50:52.8	92.7500000	102.305000	33000.0000
06:51:00.8	93.7500000	102.129000	33000.0000
06:51:10.1	94.7500000	101.953000	33000.0000
06:51:27.0	96.8750000	101.602000	33000.0000
06:51:35.4	97.8750000	101.426000	33000.0000
06:51:44.4	98.8750000	101.250000	33000.0000
06:51:52.8	99.8750000	101.074000	33000.0000
06:52:01.7	100.875000	100.898000	33000.0000
06:52:10.6	102.000000	100.723000	33000.0000
06:52:19.2	103.000000	100.635000	33000.0000
06:52:28.1	104.000000	100.459000	33000.0000
06:52:36.4	105.000000	100.283000	33000.0000
06:52:45.1	106.000000	100.195000	33000.0000
06:52:53.4	107.000000	100.020000	33000.0000
06:53:02.2	108.000000	99.9320000	33000.0000

Time (UTC)	**Range** (Nautical Miles)	**Azimuth** (Degrees)	**Altitude Mode C** (Feet)
06:53:10.9	108.875000	99.7560000	33000.0000
06:53:19.6	109.875000	99.5800000	33000.0000
06:53:28.2	110.875000	99.4920000	33000.0000
06:53:37.0	111.875000	99.3160000	33000.0000
06:53:45.7	112.875000	99.2290000	33000.0000
06:53:54.5	113.750000	99.0530000	33000.0000
06:54:02.7	114.750000	98.9650000	33000.0000
06:54:12.0	115.750000	98.7890000	33000.0000
06:54:21.5	116.625000	98.7010000	33000.0000
06:54:30.7	117.625000	98.6130000	33000.0000
06:54:37.9	118.625000	98.5250000	33000.0000
06:54:55.1	120.500000	98.2620000	33000.0000
06:55:06.2	121.500000	98.1740000	33000.0000
06:55:13.9	122.375000	98.0860000	33000.0000
06:56:56.6	133.500000	96.5920000	33000.0000
06:57:05.1	134.375000	96.5040000	33000.0000
06:57:13.7	135.250000	96.4160000	33000.0000
06:57:22.7	136.125000	96.2400000	33000.0000
06:57:32.1	137.000000	96.1520000	33000.0000
06:57:39.9	137.875000	95.9770000	33000.0000
06:57:48.6	138.750000	95.8890000	33000.0000
06:57:58.1	139.625000	95.8010000	33000.0000
06:58:08.4	140.500000	95.7130000	33000.0000
06:58:18.3	141.250000	95.6250000	33000.0000
06:58:24.4	142.125000	95.5370000	32900.0000
06:58:33.0	143.000000	95.3610000	32700.0000
06:58:42.7	143.750000	95.1860000	32300.0000
06:58:49.3	144.625000	95.0100000	31900.0000
06:58:58.9	145.500000	94.9220000	31400.0000
06:59:06.9	146.250000	94.9220000	31100.0000
06:59:15.6	147.000000	94.8340000	30600.0000
06:59:24.4	147.750000	94.7460000	29800.0000
06:59:32.6	148.500000	94.6580000	28800.0000
06:59:41.5	149.250000	94.7460000	27700.0000
06:59:50.2	149.875000	94.6580000	26700.0000
06:59:59.6	150.375000	94.5700000	25600.0000
07:00:09.0	150.875000	94.6580000	24200.0000
07:00:15.9	151.375000	94.5700000	22600.0000
07:00:24.6	151.875000	94.4820000	20900.0000
07:00:34.0	152.125000	94.3070000	18900.0000
07:00:42.1	152.000000	94.1310000	16400.0000
07:00:50.7	152.000000	93.9550000	14300.0000