NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

September 30, 1999

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID No.: DCA99MA060

A: ACCIDENT

Location:	Little Rock, Arkansas
Date:	June 1, 1999
Time:	2351 central daylight time (CDT)
Aircraft:	McDonnell Douglas MD-82, N215AA, American Airlines flight 1420

B: POWERPLANTS GROUP

Group Chairman:	Gordon J. Hookey National Transportation Safety Board Washington, D.C.
Member:	Steve Beheba Federal Aviation Administration Houston, Texas
Member:	Craig A. Barton American Airlines Tulsa, Oklahoma
Member:	Donald R. Stine, Sr. The Boeing Company Long Beach, California
Member:	Michael L. Young Pratt & Whitney East Hartford, Connecticut
Member:	Larry D. Birdwell Allied Pilots Association Fort Worth, Texas

C: SUMMARY

On June 1, 1999, at 2351 CDT, a McDonnell Douglas MD-82, N215AA, operated by American Airlines as flight 1420, came to rest off the end of runway 4R after landing at the Little Rock National Airport, Little Rock, Arkansas. The airplane landed on runway 4R, overran the runway and overrun area, went down an embankment and across a dirt road, and impacted several approach light support structures. The airplane was equipped with two Pratt & Whitney (P&W) JT8D-217C engines. The airplane was operating on an instrument flight rules flight plan under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Dallas-Fort Worth, Texas, to Little Rock.

The Powerplants Group commenced its examination of the airplane and engines on June 2, 1999. The two engines remained attached to the pylons, which remained attached to the fuselage. The engines did not have any evidence of any uncontainments, case ruptures, or precrash fires. The engines' low pressure rotors rotated freely and the fan blades had minor impact damage on the leading edges of the airfoils. The left engine's thrust reverser was partially deployed and the right engine's thrust reverser was completely stowed. The left engine's fuel control was in the reverse thrust range and the right engine's fuel control was in the forward thrust range. The engines, with the inlets and thrust reversers still in place, and the engine pressure ratio (EPR)[1] transmitters were removed from the airplane and shipped to American Airlines' Maintenance and Engineering Center (MEC), Tulsa, Oklahoma, for further examination and testing. The Powerplants Group completed its on-site activities on June 6, 1999.

The Powerplants Group reconvened at American Airlines' MEC on June 8, 1999. The two engines underwent a power assurance check and both were able to produce normal-rated takeoff thrust without exceeding any of the engine's operating limitations. The thrust reversers were checked and found to be able to cycle from the stowed to deployed and back to the stowed positions. The EPR transmitters were checked and found to function normally. The engines, thrust reversers, and EPR transmitters were not disassembled. The Powerplants Group completed its activities at American Airlines' MEC on June 9, 1999.

The digital flight data recorder (DFDR) data indicates that after the airplane landed, the thrust reversers were deployed and stowed twice, and then only the left engine's thrust reverser deployed at the end of the recording. The DFDR data for the airplane's previous landing at Dallas-Fort Worth shows that both thrust reversers deployed after the airplane touched down. In addition, the DFDR data indicates that both thrust reversers deployed when the airplane powered-back[2] from the gate when it departed for the flight to Little Rock.

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[1] EPR is a measurement of engine power output as a ratio of the total pressure of the gases in the exhaust pipe (P_{t7}) divided by the total pressure of the air entering the engine inlet (P_{t2}). EPR is equal to P_{t7}/P_{t2}.

[2] Power-back is a procedure used by American Airlines where an airplane uses reverse thrust to back away from the terminal instead of being pushed back by a tug.

D: DETAILS OF INVESTIGATION

1.0 Engine information

1.1 Engine history

The engines installed on N215AA were P&W JT8D-217C turbofan engines. American Airlines' records show the following operational history for the two engines:

	Engine No. 1 (left)	Engine No. 2 (right)
Serial number (SN)	718427	725712
Time since new	29,734 hours	25,131 hours
Cycles since new	15,711 cycles	13,216 cycles
Time since overhaul	11,216 hours	11,658 hours
Cycles since overhaul	5,189 cycles	5,421 cycles
Time since installation	5,256 hours	2,618 hours
Cycles since installation	2,447 cycles	1,229 cycles
Date of installation	September 7, 1997	July 30, 1998
Location of installation	LaGuardia	New Orleans

1.2 Engine description

The JT8D-217C engine is a dual-spool, medium-bypass, axial-flow, fully-ducted turbofan that features a single-stage fan, six-stage low pressure compressor (LPC), seven-stage HPC, nine-chamber can-annular combustor, single-stage high pressure turbine (HPT), three-stage low pressure turbine (LPT), and a mixer. The JT8D-217C turbofan engine has a normal takeoff thrust rating of 20,000 pounds and a maximum takeoff thrust rating of 20,850 pounds, both of which are flat-rated to 84°F.[3]

2.0 On-site examination of wreckage

2.1 Cockpit

The investigation team was informed that emergency response personnel entered the cockpit after the accident and changed the positions of some of the switches and levers before the positions were documented. The examination of the cockpit of the engine-related controls and indicators by the Powerplants Group revealed the following:

[3] Flat-rated to a specific temperature indicates the engine will be capable of attaining the rated thrust level up to the specified inlet temperature.

	Engine No. 1	Engine No. 2
Power levers	$2\frac{7}{16}$ inches	$3\frac{3}{16}$ inches
	(distance from rear stop to back of levers)	
Fuel shutoff levers	On (knob broken off)	On
Thrust reverser handle position	Stowed (knob broken off)	Stowed
Fire handles	End broken off	Handle vertical
EPR	Bug: 1.65 Needle: <0.8 Digits: 1.085 (red bar in window)	Bug: 1.7 Needle: 1.0 Digits: 1.04 (red bar in window)
N1 rpm[4]	0	0
N2 rpm[5]	0	0
Exhaust gas temperature (EGT)(°Celsius)	0	0
Fuel flow (pounds per hour)	0	0
Fuel used (pounds)	3,861	3,859
Fuel temperature (°C)	-70	-70
Fuel heat	Off	Off
Oil pressure (pounds per square inch)	-2	-1
Oil temperature (°C)	18	19
Oil quantity (quarts)	17	8
Anti-ice	On	Off
Generator	On	On
Constant speed drive	Guard closed & wired.	Guard closed & wired.
Start valve	Off	Off (Guard open)
Ignition	Off	

[4] N1 rpm is the fan and low pressure rotor speed.
[5] N2 rpm is the high pressure rotor speed.

2.2 No. 1 (left) engine, SN 718427

2.2.1 Exterior

The No. 1 engine remained attached to the pylon that was still attached to the fuselage. The No. 1 engine's cowling did not have any penetration or fire damage. The center of the lower forward cowl door, just aft of the forward flange, had an impact mark that did not penetrate the door. The external drain masts at the bottom of the cowling were in place.

The No. 1 engine's pylon did not appear to be damaged except for the trailing edge that was buckled.

After the upper and lower cowl doors were removed from the No. 1 engine, the examination of the engine showed that there was no fire damage, case penetration, or other damage to the engine's external cases and ducts.

2.2.2 Inlet

The inlet ring did not have any dents and the inlet duct's interior surface did not have any damage.

The inlet bullet did not have any damage.

The inlet guide vane (IGV) case was intact and the IGVs were undamaged. The P_{t2} and T_{t2} probes[6] did not have any damage. There were pieces of aircraft insulation and burned paper laying in the bottom of the inlet around the IGVs and fan blades.

The fan front case acoustic liner had numerous dents and holes around the circumference as noted below:

[6] Gas turbine engine convention is to number the aerodynamic engine stations with station 1 being at the front of the engine's inlet duct, and then progressively higher numbers along the gas path to the exhaust nozzle. Generally, the number is accompanied by a prefix P (pressure) or T (temperature). On the JT8D engine, station 2 is the engine's inlet case.

Location[7]	Distance from "C" flange[8]	Damage
12:00	½ inch	⅜ inch-circumferential cut
1:00	½	½ inch-circumferential cut
2:00	3	½ inch-diameter hole
3:00	1 ¾	¼ inch-diameter hole
3:30	1 ¼	¼ inch-axial cut
3:30	2 ½	1 inch- circumferential x ¾-inch axial dent
4:00	1 ¾	⅛ inch-diameter dent
4:00	3 ¾	⅛ inch-diameter dent
5:00	4	¾ inch-circumferential x ¼ inch-axial hole
6:30	1 ¼	¾ inch-circumferential x ½ inch-axial dent
7:00	3	¼ inch-diameter hole
8:00	adjacent	1 ¼ inch-circumferential x ½-inch axial piece of skin missing with small tab of skin raised up
8:00	1	1 ¼ inch-circumferential cut
9:00	1 ¼	¼ inch-diameter dent
10:00	2 ¼	¼ inch-diameter hole
10:30	½	¼ inch-diameter dent
11:00	1 ½	½ inch-circumferential cut
11:30	¾	1 inch-long piece of acoustic skin imbedded in the skin

2.2.3 Fan

The fan could be rotated freely by hand. The LPT rotated concurrently with the fan.

All of the fan blades were in place and intact. The fan blades' midspan shrouds were not locked up. Several of the fan blades had damage to the leading edge as follows:

[7] All references to direction or position as referenced to the clock will be as viewed from the rear, looking forward, unless otherwise specified.
[8] Gas turbine engine convention is to identify case flanges alphabetically from the front of the engine going rearward. On the JT8D-200 engine, the fan front case rear flange is "C" flange. Refer to Appendix 2 for a cross section of the JT8D-200 engine that identifies the case flanges.

No.[9]	Distance from tip[10]	Damage
1	2 ¾ inches	¼ inch-dent
6	¼	Straw wrapped around leading edge
13	2 ¼	¼ inch-wide x ⅛ inch-deep nick
17	4	¼ inch-wide dent
20	1 ½	¼ inch-wide dent
	4 ½	⅜ inch-wide dent
22	⅝	1 1⁄16 inch-nick
26	1 ⅜	⅛ inch-wide dent
	8	¼ inch x ⅛ inch-deep nick
	9 ⅝	⅛ inch-wide x ⅛ inch-deep nick
27	at tip	Insulation wrapped around leading edge
30	¼	¼ inch-wide x ⅛ inch-deep nick
32	7 ½	¼ inch-wide x ¼ inch-deep nick

The 1st stage compressor stator vanes were all in place and did not have any impact damage on the leading edges.

2.2.4 Turbine/exhaust

The 4th stage turbine blades were all in place and intact. The blades' airfoils did not have any metal spatter.

All of the mixer's pedestal feet were in place in the end caps.

2.2.5 Thrust reverser

The No. 1 engine's thrust reverser upper and lower doors were not in the stowed position. The center of the upper door's leading and trailing edges were raised up about 2 ½-inches above the adjacent cowling and tailpipe, respectively. The center of the lower door's leading edge was about 10 ½-inches below the adjacent cowling and straw was entrapped between the left side of the lower door's leading edge and the cowling. The lower door was displaced laterally to the left so the outboard side of the door was directly against the left side of the tailpipe and the inboard side was about 6-inches away from the right side of the tailpipe. The thrust reverser was pushed inward from 2:00 to 4:00 o'clock. There was a 12-inch by 12-inch section of the tailpipe that was pulled out at 4:00 o'clock that remained attached to the inboard thrust reverser actuating assembly. The lower door's inner skin surface was covered with mud and straw.

[9] Blade No. 1 was selected arbitrarily for identification purposes and the other blades were numbered in a clockwise pattern as viewed from the rear.

[10] For reference purposes, the fan blade's midspan shroud is located 5 ⅜ inches from the blade tip.

The thrust reverser interlock/feedback mechanism was found rotated to a mid-range position between the stowed and deployed positions.

2.2.6 Fuel control

The No. 1 engine's fuel control throttle lever arm was in the reverse thrust range. The throttle lever arm was rotated so the alignment hole was approximately ⅛-inch forward from the idle power rig pin hole.

2.3 No. 2 (right) engine SN 725712

2.3.1 Exterior

The No. 2 engine remained attached to the pylon that was still attached to the fuselage. The No. 2 engine's cowling did not have any penetrations or in-flight fire damage. The inlet cowl's exterior surface from the inlet ring back to the leading edge of the pylon from 7:30 to 2:00 o'clock that was adjacent to the burned fuselage was burned. The external drain masts at the bottom of the cowling were still in place.

The No. 2 engine's pylon did not have any apparent damage.

After the upper and lower cowl doors were removed from the No. 2 engine, the examination of the engine showed that there was no fire damage, case penetration, or other damage to the engine's external cases and ducts.

2.3.2 Inlet

The inlet ring's leading edge did not have any dents. The inlet ring just aft of the leading edge from 8:30 to 10:00 o'clock was burned away to expose the internal baffle. The inlet duct's interior surface did not have any damage.

The inlet bullet did not have any damage.

The IGV case was intact and the IGVs were undamaged. The P_{t2} and T_{t2} probes did not have any damage. There were pieces of aircraft insulation, straw, burned paper, and melted metal in the bottom of the inlet case around the IGVs and fan blades. The IGV inner duct fairing was coated with mud.

The fan front case acoustic liner had several dents and holes around the circumference as follows:

Location	Distance from "C" flange	Damage
3:15	4 inches	½ inch-circumferential cut
4:00	4	¾ inch-circumferential x ½ inch-axial hole
8:30	5	¼ inch-diameter dent

2.3.3 Fan

The fan could be rotated freely by hand. The LPT rotated concurrently with the fan.

All of the fan blades were in place and intact. The fan blades' midspan shrouds were not locked up. The fan blades had a light coating of mud from the blade root platform outward to the underside of the midspan shrouds. There were several fan blades that had damage to the leading edge of the airfoils as follows:

No.	Distance from tip	Damage
6	3 ¼ inches	⅛ inch-deep nick
11	2 ¾	¼ inch-deep nick
20	5 ¼	⅛ inch-deep nick

The 1st stage compressor stator vanes were all in place and did not have any impact damage on the leading edges.

2.3.4 Turbine/exhaust

The 4th stage turbine blades were all in place and intact. The blades' airfoils did not have any metal spatter.

All of the mixer's pedestal feet were in place in the end caps.

2.3.5 Thrust reverser

The No. 2 engine's thrust reverser was in the stowed position. The thrust reverser did not have any apparent damage.

The thrust reverser interlock/feedback mechanism was in the thrust reverser stowed position.

2.3.6 Fuel control

The No. 2 engine's fuel control was in the forward thrust range. The throttle lever arm was found rotated so the alignment hole was approximately $\frac{3}{16}$ inch-rearward from the idle power rig pin hole.

3.0 Engine, thrust reverser, and EPR transmitter testing

After the engines were removed from the airplane at Little Rock, the engines, with the thrust reversers still attached, were transported via truck to American Airlines' MEC, Tulsa, Oklahoma, for testing. In addition, the EPR transmitters were removed from the tailcone area of the fuselage and also sent to American's MEC for testing.

3.1 Engines

The No. 1 and 2 engines underwent a power assurance check during individual runs in Test Cell No. 1 at American Airlines' MEC. The engines were prepared for the check by installing a test bellmouth and tailpipe assembly onto the front and rear of the engines, respectively.[11] In addition, the test cell throttle system was rigged to permit the engines' fuel controls to go into the reverse thrust range.

Before the engines were mounted in the test cell, the 1.5, 6th, and 7th stage compressor blades, and fuel nozzles and combustion chambers were inspected with a fiberoptic borescope, which was hooked up to a small color monitor that could be viewed by the Powerplants Group. The No. 1 engine was inspected by Mr. S. J. Gifford, American Airlines Powerplant/Quality Assurance Inspector. The No. 1 engine's 1.5 and 6th stage compressor blades were not damaged, and there were three 7th stage compressor blades that had nicks on the leading edge near the blade tip. The combustion chambers were still in place on the fuel nozzles. The No. 2 engine was inspected by Mr. W. E. Christman, American Airlines Powerplants/Quality Assurance Inspector. The No. 2 engine's 1.5, 6th and 7th stage compressor blades were not damaged and the combustion chambers were still in place on the fuel nozzles, but the front side of the fuel nozzles and the combustion chamber domes were coated with dried mud.

After the engines were mounted in the test cell but before they were started, the engines were water washed with warm, fresh water to flush out any debris or contaminants that may have been in the gaspath. Because of the dried mud that was observed on the No. 2 engine's fuel nozzles and combustion chambers, that engine was borescope inspected a second time to see how much, if any, of the mud remained on the fuel nozzles and combustion chambers. The second borescope inspection revealed that most of the mud had been washed from

[11] Although the JT8D-217C engines can be operated in the test cell with the MD-80 airplane's inlet and thrust reverser installed, the engines cannot be operated in reverse thrust in the test cell because of exhaust gas recirculation. Because of the damage to the No. 1 engine's thrust reverser and No. 2 engine's inlet that necessitated the installation of the test tailpipe and bellmouth, respectively, on those engines to accomplish the test, it was decided to install the test tailpipe and bellmouth on both engines to establish similar test conditions for both engines.

the backs of the fuel nozzles and the combustion chamber domes. Because some mud still remained on the fuel nozzles and combustion chambers, the No. 2 engine was water washed a second time before the engine was started.

The No. 1 engine was started without any problems and the performance was checked at ground idle, flight idle,[12] reverse thrust up to about 1.29 EPR, and normal takeoff thrust. During the check, the engine did not surge and no operating limitations were exceeded. The No. 1 engine attained a JT8D-217C corrected normal takeoff thrust[13] of 20,098 pounds with the EPR: 1.94, N1: 7,698 rpm, N2: 11,766 rpm, EGT: 1,058°F, inlet vibration: 1.03 mils,[14] and rear mount vibration: 1.53 mils.[15,16] The test cell operators for No. 1 engine's power assurance check were Messrs. J. D. Blackford and W. Rosa. For further details, refer to Appendix 3.

The No. 2 engine was started without any problems and the performance was checked at ground idle, flight idle, reverse thrust up to about 1.36 EPR, and normal takeoff thrust. During the check, the engine did not surge and no operating limitations were exceeded. The No. 2 engine attained a JT8D-217C corrected normal takeoff thrust of 20,096 pounds with the EPR: 1.94, N1: 7,666 rpm, N2: 11,959 rpm, EGT: 1,061°F, inlet vibration: 0.70 mils, and rear mount vibration: 1.62 mils. The test cell operators for No. 2 engine's power assurance check were Messrs. J. D. Blackford and W. Rosa. For further details, refer to Appendix 4.

The engines were not disassembled.

3.2 Thrust reversers

The No. 1 engine's thrust reverser upper door appeared to be undamaged. The lower door was bent and buckled. The left side of the lower door was flush against the exhaust duct and the right side of the lower door was about 10-inches from the exhaust duct. The inside of the lower door was covered with dried mud. The outboard lower drive link was bowed outward along the full length of the link and outboard idle link was bent near the end of the link. The inboard upper and lower idler links were bent in the middle and the upper link was cracked at the bend. The inboard actuator support assembly was pulled out of the tailpipe attachment area and bent down and towards the right.

The No. 2 engine's thrust reverser did not have any apparent damage.

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[12] Flight idle is the lowest engine speed allowable in flight. Flight idle is slightly higher than ground idle to provide greater surge margin and quicker response time at power up.

[13] Corrected thrust is the actual measured thrust of the engine that has been corrected to account for the effects of temperature, pressure, and airflow losses within the test cell.

[14] For the JT8D engine, vibration, or rotor unbalance, is measured in mils, which is the radial displacement of the inlet or turbine case in thousandths of an inch. One mil of vibration is equal to 0.001 inch displacement of the case as measured with an accelerometer.

[15] The JT8D-200 Engine Manual Section 72-00-00 Testing-06 shows the JT8D-217C operating limits are: N1: 8,350 rpm, N2: 12,550 rpm, EGT: 1,094°F, inlet vibration: 3 mils, and rear mount vibration: 3 mils.

[16] The readings for N1 rpm, N2 rpm, and EGT are observed readings rather than corrected for the effects of temperature.

The No. 1 and 2 engine thrust reversers were individually hooked up to a hydraulic pressure cart to cycle the doors from the stowed to deployed positions. The No. 1 engine's thrust reverser could be cycled, but not to the completely stowed or completely deployed positions. When the No. 1 engine thrust reverser was initially cycled, the inboard links became jammed against a piece of tailpipe that was bent. After the piece of tailpipe that was impeding the inboard links was bent inwards away from the links, the No. 1 engine thrust reverser could be cycled from a nearly stowed to nearly deployed position. When the No. 1 engine thrust reverser was in the deployed position, the upper and lower doors touched at the right side, but a 4-inch wide gap remained between the upper and lower door corners on the left side. There was no leakage from any of the No. 1 engine's thrust reverser hydraulic tubing or connections.

The No. 2 engine's thrust reverser could be cycled from the completely stowed to completely deployed positions.

The operation of each of the thrust reverser's deployed switch and two stowed switches were checked using a Fluke Model 77 multimeter, SN 303043, which was tagged as being due for calibration on March 16, 2001. When the thrust reverser is moved to the deployed position or away from the stowed positions that closes the switch, the multimeter would show that the circuit was completed that would result in the thrust reverser or reverser unlocked lights, respectively, illuminating in the cockpit. The switches on the No. 1 and 2 engines' thrust reversers worked correctly. Because of the deformation of the No. 1 engine's thrust reverser that prevented the doors from going to the completely stowed or deployed positions and precluded normal contact with the switches, the switches had to be closed by inserting pieces of shim stock between the switch and the reverser assembly.

The No. 1 engine's thrust reverser fuel control interlock cable rigging could not be checked because of the deformation to the thrust reverser assembly. For the No. 2 engine's thrust reverser fuel control interlock cable rigging check, the rig pins could be inserted into the alignment holes.

The thrust reversers were not disassembled.

3.3 EPR transmitters

The left and right EPR transmitters, part number LG80E1, SN F1203 and E1473, respectively, were checked in the Electrical and Pneumatic shop at American Airlines' MEC by Messrs. F. Goran, Jr. and M. Chavis, respectively. The EPR transmitters provide three channels of data to the cockpit instrumentation, thrust rate computer, and DFDR. The EPR transmitters were checked for internal leakage, scale errors, repeatability, mechanical stops, and hysteresis as outlined in the test procedures in the Honeywell Component Maintenance Manual LG80E Engine Pressure Ratio Computer Task 77-13-01 (Appendix 5). The checks were accomplished by hooking up the EPR transmitter's inlet (P_{t2}) and exhaust (P_{t7}) ports to a Ruska DDR-1000 direct reading gage's static and differential pressure ports, respectively, and reading the electronic output data on an angle position indicator. The direct reading gage, SN 201176, had a tag indicating the next calibration was due on July 5, 1999, and the angle position indicator, SN

303113, had a tag indicating the next calibration was due on April 23, 2000. The results of the checks of the left and right EPR transmitters were documented on two hand-scribed worksheets, Appendix 6 and 7.

The EPR transmitters were not disassembled.

3.3.1 Leak check

The leak check is accomplished by applying pressure to the P_{t2} and P_{t7} ports, and after five minutes time, noting the pressure drop.

	Left	Right	Limits
P_{t2} pressure drop	0.018 in. Hg	0.017 in. Hg	0.25 in. Hg
P_{t7} pressure drop	0.17	0.09	0.25

No hesitant operation was noted.

3.3.2 Scale error check

The scale error check is accomplished by applying various pressures to the P_{t2} and P_{t7} ports as specified by the test procedures and reading the output angle on the angle position indicator. The applied P_{t2} and P_{t7} pressures displaces an internal plate that is in the EPR transmitter. A cam follower within the EPR transmitter moves to recenter the plate. The position of the cam follower provides an angular signal that is displayed on the angle position indicator. The scale error check is accomplished with EPR transmitters setting upright, rotated left and right 45° at several of the test points (position check), and after being vibrated by spinning the square-shaped wood handle of a slotted screwdriver on the EPR transmitter case.

Left engine EPR transmitter

Test point	Pre-vibration check Channel 1	Pre-vibration check Channel 2	Pre-vibration check Channel 3	Post-vibration check Channel 1	Post-vibration check Channel 2	Post-vibration check Channel 3	Limits
1	332.24°	332.31°	332.21	332.36°	332.43	332.34°	331.50°±3.80
2	9.63	9.67	9.79	9.63	9.67	9.81	9.50±1.90
3	48.25	48.25	48.4	48.17	48.17	48.32	47.50±1.90
4	123.50	123.45	123.53	123.62	123.59	123.67	123.50±1.90
5	160.79	160.90	160.77	160.81	160.93	160.79	161.50±1.90
6	9.98	9.99	10.15	9.52	9.58	9.73	9.50±1.90
7	85.74	85.67	85.87	85.60	85.62	85.82	85.50±1.90
8	121.76	121.73	121.81	121.84	121.80	121.90	123.50±1.90
9	47.92	47.86	47.99	47.66	47.65	47.80	47.50±1.90
10	162.00	162.10	161.98	161.85	161.97	161.85	161.50±1.90
Position check							
45° left	161.95	162.11	161.99				
45° right	161.76	161.90	161.79				
11	9.92	9.95	10.07	9.79	9.87	10.00	9.50±0.95
12	124.17	124.13	124.23	124.12	124.13	124.23	123.50±0.95
13	241.58	241.82	241.38	241.39	241.59	241.16	236.50±4.75
14	332.00	332.04	331.97	331.94	331.99	331.91	331.50±3.80
15	47.72	47.72	47.88	47.67	47.72	47.86	47.50±0.95
16	214.58	214.89		214.30	214.61	214.17	208.00±4.75
17	294.39	294.61	294.40	294.35	294.45	294.24	293.50±3.80
Position check							
45° left	294.34	294.46	294.25				
45° right	294.20	294.31	294.10				
18	9.70	9.73	9.88	9.62	9.66	9.88	9.50±0.95
19	123.96	123.95	124.06	123.95	123.94	124.05	123.50±0.95
Position check							
45° left	123.95	123.95	124.05				
45° right	123.92	123.94	124.05				
20	275.31	275.44	275.11	275.08	275.21	274.95	274.50±4.75
21	124.13	124.12	124.19	124.05	124.06	124.19	123.50±1.90

Right engine EPR transmitter

Test point	Pre-vibration check Channel 1	2	3	Post-vibration check Channel 1	2	3	Limits
1	331.9°	331.7°	331.4°	332.0°	331.9°	331.5°	331.50°±3.80
2	10.4	10.2	9.9	10.5	10.3	10.0	9.50±1.90
3	47.9	47.7	47.7	48.1	47.9	47.9	47.50±1.90
4	124.1	124.2	124.3	124.6	124.7	124.8	123.50±1.90
5	163.2	163.2	159.2	163.5	163.5	163.6	161.50±1.90
6	7.1	6.9	6.6	6.7	6.5	6.3	9.50±1.90
7	84.7	84.7	84.8	85.5	85.3	85.4	85.50±1.90
8	122.0	122.2	122.3	122.4	122.5	122.6	123.50±1.90
9	48.0	47.8	47.8	47.8	47.6	47.6	47.50±1.90
10	161.1	161.2	161.3	161.8	161.8	161.9	161.50±1.90
11	10.2	10.0	9.7	10.0	9.8	9.5	9.50±1.90
12	122.1	122.2	122.4	122.5	122.6	122.7	123.50±0.95
13	237.7	237.5	237.8	237.6	237.4	237.7	236.50±4.75
14	331.4	331.3	330.9	331.6	331.5	331.1	331.50±3.80
15	46.82	46.7	46.6	47.0	46.8	46.8	47.50±0.95
16	207.7	207.6	208.1	209.2	209.1	209.6	208.00±4.75
17	294.2	294.0	293.8	294.0	293.9	293.6	293.50±3.80
18	10.0	9.8	9.5	10.1	9.9	9.6	9.50±0.95
19	122.8	122.9	123.0	122.9	123.0	123.1	123.50±0.95
20	275.8	275.6	275.5	275.5	275.3	275.2	274.50±4.75
21	123.1	123.3	123.4	123.2	123.3	123.4	123.50±1.90

The position check was not accomplished on the right engine's EPR transmitter.

3.3.3 Mechanical stop check

The EPR transmitters have an upper and lower limit mechanical stop installed. The mechanical stops are checked by applying pressure to the P_{t2} and P_{t7} ports in accordance with the test procedures, and then bleeding off the P_{t7} pressure to a specified level. For the upper limit stop, 28.0 in. Hg absolute is applied to the P_{t2} and P_{t7} ports, and then the P_{t7} pressure is reduced to 19.60 in. Hg absolute. For the lower limit stop, 28.0 in. Hg absolute is applied to the P_{t2} and P_{t7} ports, and then P_{t7} pressure is increased to 73.90 in. Hg absolute. The mechanical stop position is read off of the angle position indicator.

	Left	Right	Limits
Upper limit	200.22°	199.7°	198.4 - 201.9°
Lower limit	180.43	179.2	167.2 - 182.4

3.3.4 Hysteresis check

The hysteresis check shows the repeatability of the EPR transmitter at a set point when the angle is increasing and decreasing. Two checks were made with P_{t2} and P_{t7} set at 7 and 9.4 in. Hg, respectively, and 7 and 16.8 in. Hg, respectively.

Test points		Left angle		Right angle		
P_{t2}	P_{t7}	increasing	decreasing	increasing	decreasing	Limit
7 in. Hg	9.4 in. Hg	300.95°	302.21°	300.4°	300.3	0.95°
7	16.8	143.63	143.83	146.25	146.3	0.95

4.0 DFDR data

The DFDR provided data for the No. 1 and 2 engines' EPR, N1 rpm, EGT, and thrust reverser position[17] for the airplane's landing at Little Rock, prior landing at Dallas-Fort Worth, and the airplane's departure from the gate at Dallas-Fort Worth was reviewed.

For the landing at Little Rock, the DFDR data commenced at 11:49:50 pm CDT[18] as the airplane was descending on final approach with the No. 1 and 2 engines' EPR at 1.36 and 1.40, respectively, N1 rpm at 69 and 74 percent,[19] respectively, EGT at 414 and 407°C, respectively, and both thrust reversers stowed. The data shows that at 11:50:00, the No. 1 and 2 engines' EPR increased to a maximum of 1.52 and 1.50, respectively, at 11:50:04. The No. 1 and 2 engines' EPR decreased to 1.33 at 11:50:08, and then increased to 1.39 and 1.40, respectively, at 11:50:11. At 11:50:16, the engines' EPR decreased to about 1.10 until after the airplane touched down, which occurred at 11:50:20. The DFDR data shows that at 11:50:22, the thrust reversers were unlocked,[20] and at 11:50:24, the thrust reversers were deployed. After the reversers were deployed, the No. 1 and 2 engines' EPR increased to a maximum of 1.89 and 1.67, respectively, at 11:50:26. The DFDR data shows that at 11:50:27, the reversers went from the deployed to the unlocked position, and at 11:50:28, the No. 1 and 2 engines' EPR decreased to 1.24 and 1.13, respectively. At 11:50:29, the thrust reversers went to the deployed position, and the No. 1 and 2 engines' EPR increased to 1.51 and 1.23, respectively, at 11:50:30. The No. 1 and 2 engines' EPR decreased to 1.30 and 1.27, respectively, at 11:30:32, but increased to 1.98

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[17] The DFDR recorded EPR and EGT once every second, and recorded N1 rpm and thrust reverser position once every other second.

[18] The DFDR data was correlated to local time through the cockpit voice recorder and air traffic control communication tapes.

[19] 100 percent N1 is equal to 8,220 rpm.

[20] The unlocked position of the thrust reverser refers to any intermediate position of the thrust reverser doors between fully stowed or fully deployed.

and 1.64, respectively, at 11:50:34, and then decreased to 1.16 and 1.19, respectively, at 11:50:36, at which time the thrust reversers went from the deployed to the unlocked position. At 11:50:39, the thrust reversers went from the unlocked to the deployed position. At 11:50:41, the No. 2 engine thrust reverser went from the deployed to the stowed position. For the remainder of the recording, which terminated at 11:50:47, the No. 1 engine reverser was in the deployed position, the No. 2 engine reverser was in the stowed position, and the engines' EPR were at about 1.08 and 1.04, respectively. For further details on the DFDR data for the airplane's landing at Little Rock, refer to Appendix 8 or the Flight Data Recorder Group Chairman's Factual Report.

For the airplane's previous landing at Dallas-Fort Worth, the DFDR data commences at 6:58:15 pm CDT with the airplane on final approach and both of the thrust reversers stowed. The DFDR data shows the airplane landed at 6:58:20. At 6:58:26, the reversers went from the stowed to the unlocked position, and at 6:58:27, the reversers went to deployed position. The reversers remained in the deployed position until 6:58:42, and at 6:58:44, the reversers were in the stowed position. For further details on the DFDR data for the airplane's previous landing at Dallas-Fort Worth, refer to Appendix 9 or the Flight Data Recorder Group Chairman's Factual Report.

The DFDR data shows that when the airplane departed the gate at Dallas-Fort Worth, the thrust reversers were used to power back. At 10:40:38 pm CDT, the thrust reversers went from the stowed to unlocked position, and at 10:40:40, the thrust reversers went to the deployed position. The No. 1 and 2 engines' EPR increased to about 1.22, until 10:41:16 when the EPR decreased to about 1.10 and the thrust reversers went from the deployed to the unlocked position. At 10:41:18, the thrust reversers went to the stowed position and at 10:41:20, the No. 1 and 2 engines' EPR increased to 1.15 and 1.14, respectively, and then decreased to 1.11 at 10:41:23. For further details on the DFDR data for the airplane's departure from the gate at Dallas-Fort Worth for the flight to Little Rock, refer to Appendix 10.

5.0 Engine maintenance writeups

American Airlines provided the list of engine maintenance requests, or writeups, made by the pilots about the airplane's No. 1 and 2 engines and the resulting maintenance action for the last 31 days before the accident.

5.1 No. 1 engine maintenance writeups for the last 31 days before the accident

Date	Item/maintenance action
5/5/99	Oil quantity indicator replaced. Oil quantity normal.
5/22/99	Fuel heat light malfunction that was repaired.

5.2 No. 2 engine maintenance writeups for the last 31 days before the accident

Date	Item/maintenance action
5/15/99	Right throttle binding last third of movement toward idle in both fore and aft movement. Checked and found no binding. Lubed precautionary.
5/18/99	Throttle binding/hunting with autothrottle. Checked and repaired.
5/19/99	Engine throttle right side only binding at cruise. Checked okay, lubed cables.
5/22/99	Serviced engine oil. Excess drained, no leaks.

[original signed]

Gordon J. Hookey
Powerplants Group Chairman

APPENDIX

1. Photographs

2. JT8D-200 engine cross section showing the alphabetic identification of the case flanges

3. JT8D-217C SN 718427 test cell performance data sheet

4. JT8D-217C SN 725712 test cell performance data sheet

5. Honeywell Component Maintenance Manual LG80E Engine Pressure Ratio Computer Task 77-13-01

6. Left EPR transmitter PN LG80E1 SN F1203 check worksheet

7. Right EPR transmitter PN LG80E1 SN E1473 check worksheet

8. DFDR graph and tabular data for the airplane's landing at Little Rock, Arkansas

9. DFDR graph and tabular data for the airplane's previous landing at Dallas-Fort Worth, Texas.

10. DFDR graph and tabular data for the airplane's departure from the gate at Dallas-Fort Worth, Texas for the flight to Little Rock, Arkansas.