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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

SYSTEMS GROUP CHAIRMAN'S FACTUAL REPORT

American Airlines flight 1420
Little Rock, Arkansas
June 1, 1999

DCA99MA060

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

November 5, 1999

Systems Group Chairman's Factual Report

A. ACCIDENT DCA99MA060

Location: Little Rock, Arkansas

Date: June 1, 1999

Time: 2351 Central Daylight Time (CDT)

Airplane: American Airlines Flight 1420, N215AA
McDonnell Douglas DC-9-82 (MD-82)

B. Systems Group

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C. SUMMARY

On June 1, 1999, at 2351 Central Daylight Time (CDT), a McDonnell Douglas DC-9-82 (MD-82), N215AA, operated by American Airlines as flight 1420, regularly scheduled passenger service from Dallas, Texas, overran the end of runway 4R and collided with the runway 22L approach lighting system at the Little Rock National Airport, in Little Rock, Arkansas. The captain and 10 passengers sustained fatal injuries; the remaining 134 passengers and crewmembers sustained various injuries. Shortly before the accident, the weather conditions at the airport were reported as: wind from 180 degrees at 9 knots, visibility 7 miles with thunderstorms, few clouds at 7,000 feet in cumulonimbus clouds, ceiling broken at 10,000 feet; temperature 77 degrees F, dew point 73 degrees F; altimeter, 29.86 Hg; Remarks - ASOS observation - thunderstorm began at 23 minutes after the hour, frequent lightning in clouds, and cloud-to-cloud, located from the west through the northwest; thunderstorms west through northwest moving northeast. The airplane was being operated in accordance with 14 CFR 121, and an instrument flight rules (IFR) flight plan had been filed.

The Systems group met at the accident site from June 1 to 8, 1999. The following components were subsequently tested and/or examined by the Systems group: the Auto Spoiler Switching Unit and the Ground Spoiler Control Box at the American Airlines facility in Tulsa, Oklahoma, on July 1, 1999; the cockpit throttle quadrant at the Safety Board's materials laboratory on July 15, 1999; the Antiskid Control Box at the Hydro-Aire facility in Burbank, California, on August 3, 1999; and the Auto Spoiler Actuator at the Telair International facility in Oxnard, California, on August 6, 1999.

D. DETAILS OF THE INVESTIGATION

1.0 FLIGHT CONTROLS

There were no pre-impact discrepancies found in the aileron, elevator, or rudder flight control systems. The control cables were severed or severely stretched and suffered severe burn damage at approximately fuselage station 788 (the center fuselage section was displaced about 15 feet from the aft fuselage section). No pre-impact failures were noted in the control cables forward of the fuselage break.

The cockpit horizontal stabilizer position indicator was found at 4° airplane nose up (ANU). The actual position of the horizontal stabilizer was measured to be 7.0 inches from

leading edge to the neutral reference (golden rivet). This corresponds to approximately 4.9° ANU stabilizer position.

The left and right wing slats were found in their extended position. Both slat control cylinders were found extended and a puncture/tear was found at wing station 72 on the right wing leading edge upper nose skin (this area would be protected by the slat when retracted).

Inspection of the right inboard flap track revealed crushing damage on the upper roller guide 4.8 inches aft of the 40° placard and outward deformation on the upper flange of the track 13.2 inches aft of the placard. The damage corresponded to the distance from the upper and center rollers to the scribe line on the flap roller structure and is consistent with a 40° flap position. There were no significant witness marks on the left inboard flap track.

1.1 MD-82 Spoiler System Description

The MD-82 has two outboard flight spoilers and one inboard ground spoiler on each wing. Hydraulic power for the inboard spoiler actuators is supplied by the left hydraulic system through the left spoiler bypass valves (SBV) and a pressure reducer valve (1,500 psi). Similarly, the outboard spoiler actuators are supplied by the right hydraulic system through the right SBV and a pressure reducer valve. The ground spoiler actuators are powered by both hydraulic systems through the SBVs but not the pressure reducer valves (see Appendix B for schematic).

The flight spoilers are controlled by the aileron control system by either control wheel in the cockpit, or by the speedbrake control lever on the forward pedestal (see Appendix B for schematic). When operated by the control wheels to supplement lateral control, the system extends the flight spoilers on one wing to a maximum of 60° from the faired position. When extended via the speedbrake lever, all flight spoilers are extended symmetrically to a maximum of 35° in flight and 60° on the ground. The flight spoilers are mechanically held down by a torsion bar that is spring loaded to the retract position when not extended.

The ground spoiler control valves are dual signal input systems. In order to extend, the valves require a mechanical input from the speedbrake control lever and an electrical signal from the proximity switch electronic unit through several relays (see Appendix B for schematic). The ground spoilers are automatically extended to about 60° only during landing (or a rejected takeoff) and are locked down by hydraulic power and an overcenter holddown link during all other phases of flight.

Operation of the ground and flight spoilers during landing (or a rejected takeoff) may be manual or automatic. Automatic extension of the flight and ground spoilers is through the autospoiler system that mechanically moves the speedbrake control lever full aft. The system consists of the speedbrake control lever, ground spoiler actuator, autospoiler switching unit, wheel spin-up transducers via the ground spoiler control box, and nose oleo switches (see Appendix B for diagram).

The pilot "arms" the autospoiler system for landing by raising the speedbrake control lever up to the ARM position, thereby fully revealing the red ARM indicator stripe. This positions the roller on the speedbrake lever in front of the autospoiler crank arm. When the ground spoiler actuator is commanded to drive to the extend position, the crank arm pushes the speedbrake lever fully aft, extending all the spoilers. It is important to note that the actuator always drives the crank arm from the retract to extend position during every landing. Spoiler deployment depends solely on whether or not the speedbrake control lever has been armed (see Appendix B for diagram).

The autospoiler actuator is electrically controlled by the autospoiler switching unit (ASU). During landing, the ASU triggers spoiler deployment with main wheel spin-up, via the wheel spin-up transducers, or with nose gear touchdown, via the nose oleo switches (see Appendix B for schematic).

If a failure is detected in the autospoiler system, the ASU monitors will illuminate the amber "AUTOSPOILER DO NOT USE" annunciator light. This light will illuminate if the actuator fails to change state within 10 seconds when commanded, if there is an internal short to ground in the spoiler control relay circuit or the ground spoiler control box circuit, or if only one takeoff or land relay channel is energized. In addition, the ground spoiler gear interlock relay will illuminate the annunciator if there is a difference between the two weight-on-wheel sensors and the landing gear handle.

1.2 N215AA Spoiler System

The left flight spoilers were found retracted and could not be lifted. The left ground spoiler panel was fractured inboard of the actuator attachment— the spoiler actuator is hinged to the rear spar and the left wing had separated from the center wing section just inboard of the actuator. The ground spoiler actuator had heat and fire damage and the intact portion of the panel was free to move (see Appendix A for photograph).

The right flight spoilers were found retracted and could not be lifted. The right ground spoiler panel was found fractured just outboard of its actuator hinge. The inboard section of the panel remained attached to the actuator hinge and could not be lifted. Inspection of the mechanical overcenter link found that it was latched (see Appendix A for photograph). The overcenter link was manually unlatched using a screwdriver, subsequently, the spoiler could be lifted and lowered by hand.

The cockpit center pedestal had considerable displacement and deformation in the left downward direction. The cockpit spoiler control handle was found in the full aft position. About half of the red autospoiler ARM indicator was visible and the handle guide (nub located in the center of the ARM indicator) was resting on the pedestal surface (see Appendix A for photograph). The spoiler handle could not be pulled up or pushed down. The handle could be moved forward about an inch, however, the left throttle would also move, and vise versa.

On July 15, 1999, an examination of the cockpit center pedestal was performed at the Safety Board's materials laboratory, with NTSB, Boeing, and American Airlines personnel in attendance. No significant marks were found on the spoiler control handle or handle slot. The autospoiler crank arm was found in a position that corresponds to spoilers extended. The left throttle spoiler auto-retract cam was measured to be 1.75 inches from the idle stop. There was no evidence of preexisting failures of any center pedestal switch or control.

The autospoiler actuator was removed from the cockpit center pedestal and examined at the manufacturer, Telair International, in Oxnard, CA, on August 6, 1999, with NTSB, Boeing, and American Airlines personnel in attendance. The actuator had sustained impact damage and the filter/rectifier (FR) box had separated from the motor housing and was retained to the motor/gearbox units only by the electrical wiring. The actuator passed all functional test points except when positioned to mid-stroke with a weight attached to the arm. Irrespective of the anomalies found, the group concluded that the autospoiler actuator was capable of functioning within its operational parameters. The teardown report is included as Appendix C.

On July 1, 1999, functional tests of the autospoiler switching unit, P/N 5935212-501H, S/N 0737, and ground spoiler control box, P/N 42-091-3, S/N 1993A, were performed at the American Airlines Maintenance Facility in Tulsa, OK, with FAA, Boeing, and American Airlines personnel in attendance. Both boxes passed all functional tests described in the applicable Component Maintenance Manuals. The functional test report is included as Appendix D.

The two ground control nose oleo switches (P/N H14-1000)—which trigger ground spoiler deployment in the event of failure of the wheel spin-up transducers—were tested on July 10, 1999, at the Safety Board's materials laboratory. Both switches operated smoothly and electrical continuity was verified in both the air and ground (nose gear compressed) switch positions.

After the wreckage was moved to a storage hanger the group examined the left and right spoiler bypass valves (SBV) located in each of the main gear wheel wells. The right spoiler bypass valve was found in the ON position. Subsequent to the removal of the left main landing gear (LMLG) from the left wheel well area, the left SBV was found in an intermediate position and the handle was broken off. Examination of the Digital Flight Data Recorder (DFDR) data showed a full right roll input, which included full deployment of the right inboard flight spoiler, just prior to impact (see the FDR Group Chairman Factual Report).

2.0 WHEELS/TIRES/BRAKES

The tread depth measurements of the MLG Michelin tires were recorded by members of the Aircraft Performance Group (see Aircraft Performance Group Chairman Factual Report).

2.1 Right Main Landing Gear Assembly

The right main landing gear (MLG) was found separated from the rear spar and resting aft of the right inboard wing with both complete wheel/tire/brake assemblies. The inboard (No. 3) tire was found deflated and the outboard (No. 4) tire was found pressurized. The No. 4 integral pressure gage read about 190 PSI and was confirmed by a calibrated pressure gage to be 195 PSI (unloaded). Both tires had large cuts and lacerations on both the tread surface and sidewalls (see Appendix A for photographs). There was no evidence of flat spotting on either tire and they appeared less than 50% worn.

Both wheel "C" flange and balance weight attachments showed impact damage and all tie bolts and nuts were intact. The wheels were free to rotate and there was no obvious damage or overheat to the brake assemblies. The No. 3 brake had approximately 0.75 inch of wear pin remaining and the No. 4 brake had about 1.0 inch of wear pin remaining.

2.2 Left Main Landing Gear Assembly

The left main landing gear was lodged into the center wing structure and wheel well, and the wheel axle was oriented 90° clockwise (view looking inboard) from its normal position. The group examined the left MLG after the wreckage was moved to a hanger on June 6, 1999, and the gear was dislodged from the wheel well structure (see Appendix A for photographs).

Both the outboard (No. 1) and inboard (No. 2) tire were found deflated and showed deformation from side loads and impact damage. Both tires had large cuts and lacerations on both the tread surface and sidewalls and there was no evidence of flat spotting on either tire.

The wheels were free to rotate and there was no evidence of overheat damage to the brake assemblies. The No. 1 brake had approximately 1.0 inch of wear pin remaining and one of its hydraulic system inlet lines was detached due to shock strut piston rotation. In addition, a brake piston housing was fractured at one piston dome (the bushing and piston were found in the debris field). The No.2 brake had about 11/16 inch of wear pin remaining and both hydraulic system lines were attached.

2.3 Nose Landing Gear Assembly

The nose landing gear (NLG) strut and wheel assembly was found protruding from beneath the right-hand fuselage belly. Both tires were found deflated and both inboard wheel halves were cracked from one tie bolt to the adjacent tie bolt hole. The nose wheel steering cylinders were found in the debris field with the pistons extended approximately equal amounts left and right.

2.4 Antiskid Control Box

On August 3, 1999, a functional test of the antiskid control box, P/N 42-807, S/N 259C, was performed at the manufacturer, Hydro-Aire, in Burbank, CA, with NTSB, Boeing, and American Airlines personnel in attendance. The control box passed all functional tests described in the Crane Hydro-Aire TP42-807 Test Procedure. The test memo is included as Appendix E.

2.5 Brake Accumulators

The wheel brake hydraulic accumulators were inspected after the wreckage was moved to the storage hangar. The left and right accumulator pressure gages read about 600 and 800 psi, respectively (see Appendix B for schematic).

2.6 Runway Markings

A runway diagram was created by the Aircraft Performance Group (see Aircraft Performance Group Chairman Factual Report). No fluid markings or aircraft components were found on the runway surface prior to impact.

3.0 GROUND TESTS

In order to understand the spoiler system operation, the group requested ground tests to be completed at American Airlines Maintenance and Engineering facility in Tulsa, Oklahoma, on a similar MD-82 airplane (test airplane).

3.1 Roll Spoiler Deflection

The FDR data recorded a right roll input with the right inboard roll spoiler extending to approximately 60° after landing (see the FDR Group Chairman Factual Report). The test airplane was initially configured with all spoilers retracted. The right flight spoiler deflected to approximately 60° with a full right roll control wheel deflection.

3.2 Ground Spoiler Auto Retract

The MD-82 is configured with a spoiler auto retract mechanism that will retract the ground and flight spoilers if the left throttle is advanced above idle. The test airplane was initially configured with all spoilers extended. All spoilers retracted when the left throttle was advanced approximately 1 3/8" to 2" from the idle stop to aft edge of the throttle. The right throttle did not auto retract the ground spoilers —and is not designed to.

3.3 Auto Spoiler /Auto Stow Check

The group learned that American Airlines had received several inquiries in the past from line pilots about possible autospoiler problems after landing. The inquiries stated that the

spoilers extended and then immediately retracted after main wheel touchdown. It was subsequently determined that the spoilers immediately retracted due to the throttles being above idle at touchdown (see Ground Spoiler Auto Retract test). In order to verify this scenario, the test airplane was configured in the following sequence:

1. Circuit Breakers L and K 33 (Ground Control Relays)- Pulled
2. Hydraulics - Auxiliary System with PTU open.
3. Auto Spoilers - Armed
4. Left Throttle - Greater than 2" above Idle.

When the L and K 33 CBs were pushed in, the spoiler handle moved to the full aft extended position and retracted immediately. The spoiler panels lagged slightly behind the handle and did not reach full extension prior to retraction. The time for the spoiler panels to cycle was approximately less than 1 second.

Examination of the DFDR data showed no movement of either the left outboard or right inboard flight spoiler at airplane touchdown during the accident flight (see the FDR Group Chairman Factual Report). The flight spoiler positions are recorded at two samples per second.

4.0 COCKPIT DOCUMENTATION

Documentation of all cockpit readings and switch positions was performed by members of the systems group during the on-scene investigation and are included in Appendix F. The creditability of all the switch positions is in question because the rescue personnel stated that they "turned many switches off" on the night of the accident. Additionally, they stepped on the center pedestal when removing the first officer for medical treatment (see the Airports Group Chairman's Factual Report).

Joseph M. Sedor
Systems Group Chairman

12/3/99