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## Uncommanded roll, McDonnell Douglas DC-9-15, July 12, 1997

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**Micro-summary:** This McDonnell Douglas DC-9-15 encountered an uncommanded right roll while on approach.

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**Event Date:** 1997-07-12 at 1735 EDT


**Investigative Body:** National Transportation Safety Board (NTSB), USA


**Investigative Body's Web Site:** <http://www.nts.gov/>

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  2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***
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		NTSB ID: CHI97IA212		Aircraft Registration Number: N9138	
		Occurrence Date: 07/12/1997		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place MEMPHIS		State TN	Zip Code 38101	Local Time 1735	Time Zone EDT
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer McDonnell Douglas		Model/Series DC-9-15		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
History of Flight					
<p>On July 12, 1997, at 1735 eastern daylight time, a McDonnell Douglas DC-9-15, N9348, operated by Northwest Airlines, experienced an uncommanded right roll while on final approach into Memphis International Airport, Memphis, Tennessee. The airline transport pilot landed the airplane without incident. Neither the pilot, co-pilot, two flight attendants, or the 71 passengers were injured. The passengers were deplaned normally. The 14 CFR Part 121, Flight 944, had departed Indianapolis International Airport, Indiana, and was scheduled to land at Memphis International Airport. Northwest Airlines removed the airplane from service to investigate the incident. Visual meteorological conditions prevailed at the time and an instrument flight plan had been filed.</p> <p>The pilot reported that at 150 feet AGL, the aircraft performed an uncommanded roll to the right requiring maximum left aileron control input to correct. The pilot reported that the uncommanded roll repeated itself three times between 150 to 50 feet AGL.</p>					
Personnel Information					
<p>The airline operator reported that the Captain held an Airline Transport Rating and had 8,531 total hours of flight time in the DC-9-15.</p> <p>The airline operator reported that the Copilot held an Airline Transport Rating and had 1,178 total hours of flight time in the DC-9-15.</p>					
Aircraft Information					
<p>The airplane was a McDonald Douglas DC-9-15, serial number 45797, fuselage number 127, equipped with two Pratt &amp; Whitney (P&amp;W) model JT8D-7B engines. It was manufactured on June 26, 1967, and had 64,560 total airframe hours.</p> <p>On May 28, 1997, a structural crack was detected at St Louis, Missouri (STL), and the airplane was ferried to Minneapolis, Minnesota (MSP), for repair. While at MSP, further inspection revealed additional right wing cracks and corrosion. The airplane was then ferried to Triad International Maintenance Corporation (TIMCO), a Federal Aviation Administration (FAA) certified Class IV Repair Station located at Piedmont Triad International Airport (GSO), Greensboro, North Carolina, for repair and other scheduled maintenance. The airplane arrived at TIMCO on June 4, 1997.</p> <p>Part of the scheduled maintenance accomplished by TIMCO included removing and replacing the upper and lower spar caps and fuel tank refurbishment. Spar cap replacement required that the entire lateral control system be removed from the aft spar, including all cables, pulley brackets and associated actuators, and control surfaces. In order to facilitate other maintenance (FOM), Job</p>					
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## Narrative (Continued)

Card 28009 required TIMCO to disconnect spoiler control cables 17B and 18B, and later re-connect and rig per NWA 90-2000-1-9000 control cable procedures. Since spoiler cables were not considered primary flight control cables, they were not designated by NWA as Required Inspection Items (RII). After scheduled maintenance was completed, N9348 was released for service by TIMCO on July 1, 1997.

The airplane was positioned by a ferry flight to DTW, and then began passenger service on the same day. N9348 flew 52 flights before the first incident. During that period there were no discrepancies noted concerning flight control problems.

On July 9, 1997, at about 0015, the first reported uncommanded roll incident occurred while landing on runway 18R at MEM. The flight had departed Detroit Metro Wayne County Airport (DTW), Detroit, Michigan. The uncommanded roll, "right wing dips excessively with no known wind and no aircraft ahead, seems to occur during ground effect," prompted the flightcrew to initiate a go-around maneuver. On the next approach, a less severe uncommanded roll was experienced, and the airplane was landed successfully.

The flightcrew previously had flown 6 other flight segments with the airplane, and did not report any flight control discrepancies. The airplane remained on the ground for 6 hours and 32 minutes, before its next flight.

Corrective actions taken by NWA maintenance at MEM were: "Checked flaps with protractor and checked control surfaces per MM Chapter 27 (flight controls); Troubleshoot flight spoilers, ground speed spoiler brakes, flaps, and flap vanes; No loose or floating problems were noted; Airplane needs further troubleshooting."

After these maintenance actions, N9348 was released for service.

The airplane departed MEM at 0700 on July 9, 1997 for DTW, with a different flightcrew. No flight control discrepancies were noted. At DTW, the flightcrew changed again, and N9348 flew 2 more segments, ending up in Minneapolis-St Paul International Airport (MSP), Minneapolis, Minnesota. No flight control discrepancies were noted. The flightcrew changed again, and N9348 departed for Cedar Rapids Municipal Airport (CID), Cedar Rapids, Iowa.

At 1715, on July 9, 1997, after flying four flight segments since the first occurrence, the second reported uncommanded roll incident occurred. The "airplane abruptly rolled right, full left control wheel input was required to stop the right roll, aircraft then rolled sharply left, this sequence occurred several times," while the airplane was on an approach to runway 9 at CID. The airplane landed successfully, and remained on the ground for 15 hours and 50 minutes before its next flight.

Following this incident, NWA maintenance at CID found the right inboard spoiler cables extremely loose, and re-rigged the cables per MM 27-60-1. The airplane was released for service.

After being released for service, the airplane flew 16 more flight segments before departing Indianapolis International Airport (IND), Indianapolis, Indiana, and arriving at MEM on July 12, 1997. There were no discrepancies noted concerning flight control problems during those 16 flights.

At 1730, on July 12, 1997, at MEM, the third reported uncommanded roll incident occurred. The pilot indicated the, "airplane abruptly rolled right, full left aileron was required to maintain control." The airplane remained on the ground for over 4 days before its next flight. Corrective actions taken by NWA maintenance at MEM that involved flight controls were:

1. Looked at right elevator and found the Right Elevator Damper bad. Removed and replaced the Right Elevator Damper per MM 27-30-5 (Elevator Dampers).

2. Checked cable runs on right and left wings for aileron and spoilers. Cables checked

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normal, no crossed cables or turn-barrel interference.

3. Left and Right Mixers looked normal. 4. At NWA Maintenance Control request, replaced right hand (RH) inboard (IB) and RH outboard (OB) Spoiler Actuators per MM 27-61-2.
5. Found RH OB spoiler cables under-tensioned. Re-tensioned per MM 27-61-0. Spoiler rig and operational checks within limits per MM 27-61-0.
6. Left IB Flap Actuator leaking. Replaced IB Flap Actuator per MM 27-52-2. Functional Check is good.
7. Performed Hydraulic Decay ITCAN (inspect, test, and correct as necessary) per MM 29-10-0, and found left hand (LH) OB Spoiler Actuator bypassing severely. Replaced the Spoiler Actuator per MM 27-61-2.
8. At NWA Maintenance Control request, replaced Rudder Power Pack per CITEX 09-2722-1-9801.
9. During rudder check, found Hydraulic Shut-Off Valve bypassing. Replaced Rudder Power Shut-Off Valve per MM 27-20-9. Leak Check and Function Check are good.
10. RH Flap Moveable Vane Track Cable rubbing at top. The bolt and swivel appear to be worn. Removed and replaced IB Bus Cable End Fitting. No help. After flap valve adjustments were made, ample clearance was achieved.
11. At NWA Maintenance Control request, removed the Stability Augmentation Computer and installed a serviceable unit per MM 22-11-1.
12. LH and RH Flap Moveable Vanes are out of limits. Adjusted and tested vanes per MM 27-51-2.
13. RH Flap Moveable Vane Track has flat spot. Flat spot is within limits of MM 27-50-1. Wear is normal and no action is required.
14. Spoiler Deployed Light does not come on until 45 degrees of control wheel travel to right. Checked spoiler extend function per MM 27-61-1. Indicator illuminated before 10 degrees of spoiler deflection.
15. Found cable run 17B caught between cable guards at pulley for 18B and riding on lower side of pulley for 18B. Freed cable. Checked routing and rig checked/throw checked good per MM 27-61-0.

## Tests and Research

The flight spoiler system consists of four spoiler panels, four actuators, two pressure reducer valves, two pressure switches, the speedbrake control lever, portions of the left and right lateral control mixers, and connecting cable systems, and mechanical linkages.

The spoiler panels supplement the flight control surfaces during flight and during the landing roll. There are two spoiler panels on the upper surface of the trailing edge of each wing, forward of the ailerons. The spoiler mechanical system is a hydraulically actuated system that controls the movement of the spoiler panels to supplement the ailerons in lateral control of the airplane. The system also acts as a speedbrake.

There are two lateral control mixers, one located in each main gear wheel well. The mixers allow the spoiler system to be operated by the speedbrake control lever, by the aileron control wheels, or by both simultaneously. The mixer brackets also serve as common attachment points for cable

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pulleys and drums of the spoiler system, aileron control system, aileron trim control system, and the flap followup system.

Spoiler panel float, due to loss of hydraulic pressure, is prevented by a cam attached to a torsion bar and positioned against rollers on the actuator aft hinge pin. The cam exerts a force against the hinge point so that the drive linkage from the actuator to the spoiler panel is locked in an over-center position, when the panel is retracted.

The cable rigging is described as follows:

Cable run 17B movement is commanded to open the control valve to raise spoiler panel from inputs by the Speed Brake Handle and Aileron Control Wheel (movement past 8 (+/-3) degrees from neutral) through the Aileron/Spoiler Mixer Assembly. When Douglas Aircraft Company (DAC) drawing 7910334 and MM 27-60-0 are used as a visual reference, the drawings show 17B cable to be routed forward of both pulleys, and that both cables 17B and 18B are parallel, not crossed.

NWA's Maintenance found 17B cable to be routed underneath the second pulley and the third pulley guard pin, and was sharing the pulley groove with cable 18B. The two cables were also crossed just inboard of the three outboard pulleys. A detailed assessment that was written by NWA Senior Systems Engineer stated:

- A. There did not appear to be any damage to the pulley by the misrouted cable.
- B. There was no physical damage to the cable guide, other than a slight burnishing of the guide where the cable was riding across the top of it.
- C. A split fairlead inboard of the inboard pulley had one half of the fairlead missing. It did not appear that the misrouted cable caused the half of the fairlead to be pulled out of its hole. There was no apparent damage to the remaining half.
- D. There was no apparent damage to the cable 17B itself.

The NWA Engineering and Boeing (DACO) Engineering Assessment concluded that the primary cause of the incident was intermittent binding of cable run 17B which prevented the spoiler from returning to the full down and locked position. The DACO reported that this action caused deployment of the RH OB spoiler, and subsequently an uncommanded right roll.

A summary of the DACO assessment concluded that the binding cable prevented the spoiler from returning to the full overcenter/locked down position, as normally commanded by a neutral control wheel input. The two cables (17B and 18B), acting opposite to each other within the same pulley groove, caused an intermittent binding between the cables and subsequent false control commands to the spoiler actuator. The binding, between the cables at the point of contact, caused one side of cable run to have a higher tension. This action caused the opposite cable to become slack, leading to a false control input to the spoiler actuator, which was intermittently powered slightly beyond the anti-float, over-center, down and locked position.

The DACO also reported that the 50-degree flap setting on approach created a high pressure area underneath the spoiler, causing it (partially commanded up and pass the over-center position) to float intermittently. It should be noted that the spoiler over-center mechanism is designed to prevent this action, when the spoiler is commanded down.

DACO reported further that common knowledge of aircraft rigging would dictate that cables transversing in opposite directions should not share the same pulley, nor should two cables be retained underneath a single guard pin and sharing the same pulley. (See Maintenance Records Group Chairman's Factual Report)

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## Additional Information


The NWA Flight Operations Manual was revised. The revision required that a Captain have direct communication with the Director of Flight Safety or the Chief Pilot whenever a flight control malfunction occurred.


It was demonstrated that the 17B cable could be pulled down and positioned into the lower 18B roller slot by pulling down on the cable with a finger and positioning it in the pulley slot. Minimal force was required and no disassembly of parts or cable guides was necessary.

Research of the DAC historical data base revealed no previous occurrences of cable misrouting in this specific area.

The airplane was returned to service and departed MEM on July 16, 1997, at 2252 on a ferry/test flight to ATL. As of June 26, 1998, the NWA Flight Safety Department stated that no further flight control roll problems had been noted.

Parties to the investigation included the Federal Aviation Administration, Northwest Airlines, TIMCO, and the Airline Pilot's Association.

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<b>Landing Facility/Approach Information</b>					
Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
MEMPHIS INTERNATIONAL	MEM	400 Ft. MSL	18	9319	150
Runway Surface Type: Asphalt					
Runway Surface Condition: Dry					
Type Instrument Approach:					
VFR Approach/Landing: Precautionary Landing					
<b>Aircraft Information</b>					
Aircraft Manufacturer		Model/Series		Serial Number	
McDonnell Douglas		DC-9-15		45787	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 83	Certified Max Gross Wt.	90700 LBS	Number of Engines: 2	
Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:		
Turbo Jet	P&W	JT8D	12000 LBS		
- Aircraft Inspection Information					
Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time		
Continuous Airworthiness	08/1996	5092 Hours	64560 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? Yes	ELT Operated? No	ELT Aided in Locating Accident Site?			
<b>Owner/Operator Information</b>					
Registered Aircraft Owner		Street Address			
NORTHWEST AIRLINES		5101 NORTHWEST DR.			
		City	State	Zip Code	
		ST. PAUL	MN	55111	
Operator of Aircraft		Street Address			
Same as Reg'd Aircraft Owner		Same as Reg'd Aircraft Owner			
		City	State	Zip Code	
Operator Does Business As:			Operator Designator Code:		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Flag Carrier/Domestic					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Non-scheduled; Domestic; Passenger Only					

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**First Pilot Information**

Name On File	City On File	State On File	Date of Birth On File	Age 45
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number: On File
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Certificate(s): Airline Transport

Airplane Rating(s): Multi-engine Land

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): None

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Unknown	Date of Last Medical Exam: 06/1997
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time	8531	8531								
Pilot In Command(PIC)										
Instructor										
Last 90 Days		171								
Last 30 Days										
Last 24 Hours		5								

Seatbelt Used? Yes	Shoulder Harness Used? Yes	Toxicology Performed? No	Second Pilot? Yes
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**Flight Plan/Itinerary**

Type of Flight Plan Filed: IFR

Departure Point INDIANAPOLIS	State IN	Airport Identifier IND	Departure Time 1635	Time Zone CDT
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Destination Same as Accident/Incident Location	State	Airport Identifier MEM	
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Type of Clearance: IFR


Type of Airspace: Class B

**Weather Information**

Source of Briefing: TV/Radio Weather

Method of Briefing:




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<b>Weather Information</b>					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
MEM	1700	CDT	400 Ft. MSL	0 NM	0 Deg. Mag.
Sky/Lowest Cloud Condition: Unknown			0 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: Broken		25000 Ft. AGL		Visibility: 12 SM	Altimeter: 30.00 "Hg
Temperature: 32 °C	Dew Point: °C	Wind Direction: 270		Density Altitude: Ft.	
Wind Speed: 15	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0 SM	Intensity of Precipitation: Unknown			
Restrictions to Visibility: None					
Type of Precipitation: None					

<b>Accident Information</b>		
Aircraft Damage: None	Aircraft Fire: None	Aircraft Explosion: None

Classification: U.S. Registered/U.S. Soil					
<b>- Injury Summary Matrix</b>	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants				2	2
Other Crew					
Passengers				71	71
- TOTAL ABOARD -				75	75
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	75	75

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Administrative Information

Investigator-In-Charge (IIC)  
JIM SILLIMAN

Additional Persons Participating in This Accident/Incident Investigation:

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