In-flight upset, McDonnell Douglas DC-10-10, May 21, 1998

Micro-summary: This McDonnell Douglas DC-10-10 experienced an in-flight upset climbing through FL290 in automatic flight.

Event Date: 1998-05-21 at 1305 PDT

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

Investigative Body's Web Site: http://www.ntsb.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!***

3. Reports may or may not represent reality. Many many non-scientific factors go into an investigation, including the magnitude of the event, the experience of the investigator, the political climate, relationship with the regulatory authority, technological and recovery capabilities, etc. It is recommended that the reader review all reports analytically. Even a "bad" report can be a very useful launching point for learning.

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National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: LAX98FA169	Aircraft Registration Number: N68043
Occurrence Date: 05/21/1998	Most Critical Injury: Serious
Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
LOS ANGELES	CA	90045	1305	PDT	

Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	Direction From Airport:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
McDonnell Douglas	DC-10-10	Airplane

Sightseeing Flight: No Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

On May 21,1998, at 1305 hours Pacific daylight time, Continental Airlines Flight 75, a McDonnell Douglas DC-10-10, N68043, experienced an upset while climbing through FL290. The airplane was not damaged. Three flight attendants and one passenger sustained serious injuries and there were 5 minor injuries to passengers. There were 285 passengers, 10 flight attendants, and 3 cockpit crew onboard. The aircraft was operated by Continental Airlines, Inc., under 14 CFR Part 121 of the Federal Aviation Regulations as a scheduled domestic passenger flight, which originated at 1234 from Los Angeles, California, en-route to Honolulu, Hawaii.

According to the captain's written statement, he was the flying pilot on this leg of the flight. The aircraft was climbing in smooth air about 500 feet per minute with the No. 1 autopilot engaged. The captain reported that the aircraft began a sudden and hard uncommanded 2g pull-up, with the control yoke moving rapidly aft. He stated that he immediately grabbed the control yoke, disengaged the autopilot, and leveled the aircraft. The captain reported that during this process the aircraft gained 1,200 feet in altitude and lost 30 knots of airspeed before he was able to disconnect the autopilot and regain control.

Statements from the cabin crew were reviewed and one passenger was interviewed by telephone. The three flight attendants that sustained serious injuries were in the aft galley preparing for the initial beverage and meal service. The seriously injured passenger was in the aft lavatory near door 4R at the time of the upset. Minor injuries were sustained by the passengers in the following seats: 45K, 44G, 44H, 17E and 29A.

The statements from the three flight attendants in the aft galley were consistent in describing the onset of the event as "being pulled to the floor by what felt like a strong pull of gravity." The force suddenly reversed and the three described being "thrown up into the ceiling." One of the flight attendants said that after his head hit the ceiling, the force continued until his entire back was against the overhead and he was looking down at the floor. Another force reversal followed and the three were "slammed down against the floor." The flight attendants said that a "roller coaster" type movement then occurred, which quickly damped into a steady state.

The passenger who was in the aft lavatory stated in a telephone interview that he was repeatedly bounced off the ceiling and floor during the event.

Two doctors and four paramedics who were traveling as passengers immediately went to the assistance of the injured personnel in the aft galley area.

Following recovery of the aircraft to a steady state condition, a flight attendant from the first class section went aft to assess the situation in the rear cabin. Moving aft past door 3L, he observed the doctors assisting the injured and glimpsed the aft galley area. He described the area as "torn apart," with overturned meal carts, food trays, drink cans, and other debris "everywhere."

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Narrative (Continued)

He reported that a passenger was lying half in and half out of the 4R lavatory door and went to that person's assistance. Following that, he proceeded to the cockpit to brief the captain on the situation.

Following recovery from the upset and the briefing from the cabin crew, the captain decided to return to Los Angeles. ATC was advised of the problem, and a clearance received for the return. During the flight back to Los Angeles fuel was dumped to achieve landing weight restrictions and an uneventful landing was made at 1355. Medical personnel met the flight as it arrived at the gate and the injured were taken to a local hospital.

PERSONNEL INFORMATION

The captain holds an airline transport pilot certificate with a type rating in the DC-10. According to records supplied by Continental Airlines, his total flight time was 17,000 hours, with 9,000 in the DC-10, 6,000 of which were accrued as pilot-in-command. His most recent simulator proficiency check was completed on April 5, 1998.

The first officer holds an airline transport pilot certificate with an airplane multiengine land rating. According to records supplied by Continental Airlines, his total flight time was 5,000 hours, with 364 in the DC-10. His most recent simulator proficiency check was completed on May 8, 1997.

AIRCRAFT INFORMATION

The aircraft, a McDonnell Douglas DC-10-10, serial number 46902, was manufactured in 1972, and the airframe had accrued a total time in service of 84,423 hours and 29,977 cycles.

A review of the aircraft's maintenance records for the year preceding the accident revealed that the autopilot system had been written up as a discrepant system over 50 times for uncommanded disconnects, uncommanded pitch-ups, and failures to engage. One item in the discrepancy log dated 12 November 1992 states "A/C [aircraft] has a long history of pitch oscillations, both autopilots." A complete list of the preceding year's discrepancies related to the autopilot are appended to this report.

The maintenance records disclosed that the first officer's control wheel sensor unit had accrued 29,402 hours since new and installation in the aircraft.

Further investigation revealed that this aircraft was involved in a similar accident on November 7, 1986, when it experienced an uncommanded pitch excursion in cruise flight with the No. 1 autopilot engaged. In the accident, one flight attendant sustained a fractured ankle. The Safety Board determined that the probable cause of that accident was the erratic electrical signal output from the first officer's control wheel sensor.

McDonnell Douglas issued Service Bulletin 22-115 on April 14, 1987, which was applicable to DC-10 series 10, 15, 30, and 40 aircraft and with an affectivity that included this aircraft. The service bulletin noted that the reason for issuance was that, "Six operators have reported seven instances of abrupt pitch and/or roll motion with the aircraft in autopilot cruise flight mode." The bulletin further attributed the condition to "an intermittent open circuit in the autopilot control wheel steering sensor strain gage network resulting in an erroneous input to the autopilot." The details of the bulletin called for the modification of the pitch and roll computers so that they would automatically disengage the autopilot when an electrical signal greater than +/-3.5 volts was detected from the control wheel sensor unit. Review of the records and comparison of the pitch computer part number disclosed compliance with Service Bulletin 22-115.

FLIGHT RECORDER INFORMATION

National Transportation Safety Board

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Narrative (Continued)

The aircraft was equipped with a Sundstrand Digital Flight Data Recorder (DFDR), serial number 8597, which was removed from the aircraft and sent to the Safety Board's Vehicle Recorders Laboratory for readout and evaluation. A complete report of the DFDR readout is appended to this report.

Review of the data revealed that as the aircraft passed through 29,200 feet, four pitch cycles were recorded between sub frame reference numbers (elapsed seconds) 1905 and 1915, and were accompanied by vertical, longitudinal, and lateral accelerations. The first pitch cycle generated vertical accelerations between 1.84 and -0.12 g's. The initial uncommanded nose pitch-up was preceded by a left inboard elevator (controlled by the autopilot) movement from -1.88 degrees to +2.79 degrees from 1904 to 1905 and resulted in a nose pitch change from 2.24 degrees to 4.02 degrees. During this time, the right outboard elevator remained constant at -1.48 degrees. The first nose down pitch change consisted of about 4 degrees, and occurred in just over 1 second with the movement of the right outboard elevator to -6.43 degrees. The second cycle's vertical accelerations were between 1.62 and 0.37 g's, again accompanied by movement of the right outboard elevator between -6.43 and +1.97 degrees. The remaining two cycles varied between 1.21 and 0.80 g's, with corresponding movements of the right outboard elevator, before the aircraft returned to a steady state condition.

During the event, a 3-knot airspeed loss and a 242-foot altitude gain were recorded.

TESTS AND RESEARCH

Following the aircraft's return to Los Angeles it was taken out of service for detailed examination of the autopilot system.

All wiring related to the No. 1 autopilot was checked and found serviceable. Bite checks of the related autopilot computers were satisfactory. The cannon plugs on the left inboard and right outboard elevator actuators/transducers were changed due to corrosion.

Postaccident test of the control wheel sensor units revealed that the first officers showed an out of tolerance and drifting null signal. The control wheel sensor units were then removed from both the captain's and first officer's control wheels for further testing. Spares from stock were used as replacements for the removed sensor units. The units removed from the aircraft were taken to the manufacturer's facility in Leonia, New Jersey, for detailed diagnostic tests.

The following components were then removed for further testing and were replaced with serviceable units from spares stock: pitch computer, air data computer, autopilot control panel, and the power control units for both the left inboard and right outboard elevators. These components bench tested satisfactorily. At the conclusion of ground diagnostic checks of the autopilot and the elevator control rigging, the aircraft was test flown. During the test flight, the No. 1 autopilot would not engage under certain circumstances. The aircraft was returned to Los Angeles and further diagnostic tests revealed a failed control wheel sensor unit in the first officer's wheel. This second unit was replaced with another from stores and the test flight was repeated, with satisfactory results. The aircraft was then returned to service.

The control wheel sensor unit used strain gages to provide electrical signals to the autopilot systems and has a pitch channel for each autopilot, P1 for autopilot No. 1 and P2 for autopilot No. 2. The accident first officer's control wheel sensor was hooked up to a power supply. As in the postaccident tests, the null signal for P1 was found to be out of tolerance and drifting, while the signal for P2 was within tolerance and stable. After about 3 minutes, P1's null signal became noisy and jumped to values of up to 4 volts several times. Many spikes were observed at values under 3.5 volts (See AIRCRAFT INFORMATION section above concerning SB22-115; 3.5 volts is the trigger value to disengage the autopilot). The unit was then subjected to environmental extremes

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Narrative (Continued)

of heat and cold, with no change observed in unit behavior. Subsequent examination of the pitch strain gages by optical magnification found a foreign black-gray metallic-like substance bridging the terminal lug ends of one of the strain gages for P1. The control wheel sensor was then transported to the Safety Board's Materials Laboratory for further examination and classification of the contaminant.

The Materials Laboratory conducted stereo microscope and scanning electron microscope (SEM) examinations of the strain gage from the first officer's control wheel sensor unit. In addition, energy dispersive x-ray analysis (EDS) was performed on the deposit. Similar examinations were conducted on the captain's control wheel sensor unit and the second failed unit removed from the accident aircraft during the autopilot diagnostic tests. The complete Materials Laboratory report is appended to this report.

According to the report, optical and SEM examinations of the first officer's accident control wheel sensor P1 strain gage revealed that the foreign contaminant was bridging the gap between terminal lugs 1 and 2, and also between lugs 5 and 6. The contaminants were found beneath a sealing layer applied at the factory. EDS analysis revealed peaks of silver, chloride, sulfur, iron, oxygen, and carbon from the highest peak to the lowest peak respectively.

Spectral EDS analysis of the solder produced peaks for lead, tin silver, iron, chlorine, silicon and aluminum, from the highest peak to the lowest peak respectively, a composition that is not consistent with the silver-gold solder material specified by the manufacturer.

An EDS analysis was also conducted on a cross section of a wire between the terminal lug and tab. The center of the wire produced peaks for silver and gold. The outside diameter of the wire produced peaks for gold. The manufacturer's specification calls for the wire to be gold-plated platinum.

Contaminant deposits consistent with those found on the accident control wheel sensor were also found on the strain gages from the other control wheel sensor units submitted for examination.

ADDITIONAL INFORMATION

The following person(s) not listed on page 5 of this report were participants in the investigation:

Mr. Russell Bjornsen Boeing/McDonnell Douglas Long Beach, CA 90846

National Transportation Safety Board

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NTSB ID: LAX98FA169

Occurrence Date: 05/21/1998

Occurrence Type: Accident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
		Ft. MSL	0		

Runway Surface Type:

Runway Surface Condition:

Type Instrument Approach: NONE

VFR Approach/Landing: None

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
McDonnell Douglas	DC-10-10	46902

Airworthiness Certificate(s): Transport

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	302	430000 LBS	3

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Fan	GE	CF6-6D	39300 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	04/1998	270 Hours	18887 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?	ELT Operated?	ELT Aided in Locating Accident Site?
Yes	No	

Owner/Operator Information

Registered Aircraft Owner	Street Address	City	State	Zip Code
FIRST SECURITY BANK	79 MAIN STREET	SALT LAKE CITY	UT	84111

Operator of Aircraft	Street Address	City	State	Zip Code
CONTINENTAL AIRLINES	2929 ALAN PARKWAY	HOUSTON	TX	77019

Operator Does Business As:

Operator Designator Code: CALA

- 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: Scheduled; Domestic; Passenger Only

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: LAX98FA169

Occurrence Date: 05/21/1998

Occurrence Type: Accident

First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	55

Sex: M | Seat Occupied: Left | Principal Profession: Civilian Pilot | Certificate Number: On File

Certificate(s): Airline Transport; Commercial

Airplane Rating(s): Multi-engine Land; Single-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?

Medical Cert.: Class 1 | Medical Cert. Status: Valid Medical--no waivers/lim. | Date of Last Medical Exam: 04/1998

- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	17000	9000								
Pilot In Command(PIC)	10000	6000								
Instructor										
Last 90 Days	79	79								
Last 30 Days	37	37								
Last 24 Hours	2	2								

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? Yes

Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point	State	Airport Identifier	Departure Time	Time Zone
Same as Accident/Incident Location		LAX	1234	PDT

Destination	State	Airport Identifier
HONOLULU	HI	HON

Type of Clearance: IFR

Type of Airspace: Class A

Weather Information

Source of Briefing: Company

Method of Briefing:

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: LAX98FA169

Occurrence Date: 05/21/1998

Occurrence Type: Accident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
LAX	1150	PDT	134 Ft. MSL	150 NM	90 Deg. Mag.

Sky/Lowest Cloud Condition: Clear 0 Ft. AGL

Condition of Light: Day

Lowest Ceiling: None 0 Ft. AGL

Visibility: 10 SM

Altimeter: 30.00 "Hg

Temperature: 19 °C

Dew Point: 13 °C

Wind Direction: 260

Density Altitude: Ft.

Wind Speed: 12

Gusts:

Weather Condtions 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

Accident Information

Aircraft Damage: None

Aircraft Fire: None

Aircraft Explosion None

Classification: U.S. Registered/U.S. Soil

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer				1	1
Cabin Attendants		3		7	10
Other Crew					
Passengers		1	5	279	285
- TOTAL ABOARD -		4	5	289	298
Other Ground	0	0	0		0
- GRAND TOTAL -	0	4	5	289	298

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AVIATION

NTSB ID: LAX98FA169

Occurrence Date: 05/21/1998

Occurrence Type: Accident

Administrative Information

Investigator-In-Charge (IIC)

R. G. MUCHO

Additional Persons Participating in This Accident/Incident Investigation:

EVAN WOOD
WP-LAX-FSDO
LOS ANGELES, CA 90045

EUGENE A CARROLL
CONTINENTAL AIRLINES
HOUSTON, TX 77032

BRIAN WOZNIAK
INT'L ASSOC OF MACHINISTS
NEWARK, NJ 07114

C. FARLEY
ALLIED SIGNAL
SYLMAR, CA 91342