
In-flight upset, Boeing 747-236, G-BDXL, February 27, 2000

Micro-summary: This Boeing 747 encountered an in-flight upset during descent.

Event Date: 2000-02-27 at 2100 EST


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

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

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 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: NYC00LA085		Aircraft Registration Number: GBDXL	
		Occurrence Date: 02/27/2000		Most Critical Injury: Serious	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place PROVIDENCE		State RI	Zip Code 02901	Local Time 2100	Time Zone EST
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series 747-236		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:					
<p>On February 27, 2000, about 2100 Eastern Standard Time, a Boeing 747-236, G-BDXL, operated by British Airways, PLC., as flight 179, experienced an in-flight upset during a descent in the vicinity of Providence, Rhode Island. Three flight crewmembers, 14 flight attendants, and 354 passengers were not injured. One passenger received serious injuries, while 10 passengers and 1 flight attendant sustained minor injuries. Instrument meteorological conditions prevailed and an instrument flight rules flight plan had been filed for the flight that departed London-Heathrow Airport (LHR), England, United Kingdom, destined for the John F. Kennedy International Airport (JFK), Jamaica, New York. The scheduled international flight was conducted under 14 CFR Part 129.</p> <p>In an interview with a Federal Aviation Administration (FAA) Inspector, the flight crew reported that the fasten seat belt sign was "off," and the airplane's electrical system was configured for a Category III (CAT III) landing, when they began a descent from "flight level 350." At the same time, the flight engineer began to reconfigure the airplane's electrical system for a Category I (CAT I) landing, due to an improvement in landing visibility. When the flight engineer closed the "number one bus-tie-breaker," the airplane's pitch changed from 2-degrees nose-down, to about 5-degrees nose-up. The airplane was utilizing the "A" autopilot system, which remained engaged. The pilot disconnected the autopilot, leveled the airplane, re-engaged the autopilot, and then continued a normal descent. The airplane landed at JFK without further incident. Additionally, the pilot reported that the pitch-up was accompanied by numerous momentary instrument failures, and the effect was very similar to the electrical changeover that is experienced on the ground when the airplane's electrical system supply changes from ground power to aircraft power.</p> <p>Examination of the airplane's autopilot and electrical system performed by maintenance personnel at JFK did not reveal any discrepancies.</p> <p>The accident airplane was equipped with a Penny & Giles flight data recorder (FDR), and an optical quick access recorder (QOAR). The data from the recorders was downloaded by British Airways, and provided to the Safety Board. Examination of both the FDR and the QOAR information revealed an electrical discontinuity around the time of the event.</p> <p>According to British Airways, on the evening of February 29, the accident airplane was flown on a non-revenue flight back to LHR.</p> <p>During the flight to LHR, maintenance personnel were able to duplicate a "sudden pitch-up" while using the airplane's "B" autopilot system, and closing the "number two bus-tie-breaker." Additionally, the flight crew reported that the airplane "felt light in pitch."</p> <p>A subsequent inspection of the airplane revealed that the number 1 and 2, "elevator feel computer" pitot connections were capped. Review of the airplane's maintenance history revealed that the airplane underwent an "inter 2 check" at a British Airways maintenance facility between February 5</p>					
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and 23, 2000. According to a British Airways quality inspection report, during the time of the inter 2 check, the pitot connections to the elevator feel computer were disconnected by maintenance personnel in order to perform pitot static system checks "in-accordance-with (IAW) the [airplane] Maintenance Manual [Chapter] 34-11-00." A functional check of the feel computer was not performed before the airplane was returned to service.

Review of the Boeing basic 747 Maintenance Manual Chapter 34-11-00, Pitot-Static Adjustment/Test, revealed an "Elevator Feel Light Test" and the following note:

"The following test must be performed to ensure that auxiliary pitot systems No. 1 and 2, which were disconnected prior to system leakage test, are properly reconnected...."

British Airways utilized a customized version of the 747 Maintenance Manual, which was provided by Boeing. Review of the maintenance manual chapter 34-11-00, Pitot-Static Adjustment/Test revealed that the customized section did not contain the requirement for an elevator feel light test. The section did specify that a "leak check" be performed after the pitot-static lines are reconnected. A representative from Boeing stated that if the pitot-static connections to the elevator feel computer were left disconnected and capped, then a "leak check" would not identify an unconnected elevator feel computer, provided that the caps were pressure tight.

The Boeing representative also stated that Boeing intends to publish a revised customized 747 Maintenance Manual for British Airways, which will include an elevator feel light test in Chapter 34-11-00. Additionally, Boeing will revise the customized maintenance manuals for four other 747 operators.

Boeing provided information on the effect of disconnected pitot-static lines on the elevator feel computer.

According to Boeing, the elevator control system required artificial feel forces that were provided by a combination of mechanical and hydraulic springs contained in the feel unit. The feel computer programs hydraulic pressure to the feel unit actuators as a function of pitot pressure and stabilizer position. With the lines disconnected, the feel computer would react as if the airspeed is low and thus the feel unit forces would be less than expected. The autopilot reacts against artificial feel forces to regulate the deflection of the elevator surface. If the artificial feel forces were low, the autopilot command would cause greater than normal elevator deflection, resulting in a larger upset of the airplane than would normally be encountered.

Boeing calculated that the normal autopilot elevator authority for the flight conditions at the time of the accident should have been about 4 degrees. The estimated actual elevator deflection during the accident sequence was 6.87 degrees nose up, and 6.97 degrees nose down.

British Airways reported they were able to duplicate the pitch-up during two test flights, using two other 747-200 airplanes; however, the magnitude of the elevator movement experienced during the test flights remained within the autopilot elevator authority.

Subsequently, British Airways instituted the following modified bus-tie-breaker (BTB) re-engagement procedure:

"In flight, when it is necessary to CLOSE a BTB, the autopilot must be disconnected prior to selecting CLOSE on the BTB. The autopilot may be reselected once normal conditions are confirmed. In addition, when closing the BTB, possible short term flight instrument failures may occur."

The Boeing Operations Manual for the airplane, stated:

"When the No. 1 and No. 2 Bus Tie OPEN lights illuminate due to triple channel operation, reclose

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BTBs during accomplishment of the AFTER LANDING PROCEDURE or when in stabilized flight."

The Boeing Flight Crew Training Manual for the airplane, Automatic Flight, Go-Around section included the note:

"The automatic bus isolation system will reclose the DC isolation relays when any A/P [autopilot] disengages, however, bus tie breakers 1 and 2 will not reclose automatically. The bus tie breakers do not have auto-paralleling circuits and when placed to CLOSE will connect the bus regardless of phase relationship. Closing of the bus tie breakers during certain out of phase conditions may cause a voltage fluctuation. While these voltage fluctuations are within system tolerance, momentary airplane instrumentation instability could occur...."


At the time of the accident, British Airways operated 16 Boeing 747-200 airplanes that were modified by a supplemental type certificate to allow for a modified flight management computer (FMC) interface with the autopilot. The modification incorporated a Honeywell FMC, and a Honeywell data adapter unit. The modified British Airways 747-200 airplanes had been in use since 1984. According to Boeing and Honeywell, there were no other known 747-200 aircraft that were modified to this configuration.


British Airways reported they were in the process of "retiring" their 747-200 airplanes and expect to have all of their 747-200 airplanes out of service by April of 2002. The airplanes are being sold to a leasing company that intends to utilize the airplanes as freighters.

Thirty two operators of "classic 747" aircraft were surveyed with regards to the procedures their flight crews used when they reconfigured from a CAT III approach to a CAT I approach. They were also asked to report any uncommanded aircraft motions as a result of electrical system reconfigurations. Twenty-one operators responded to the survey.

Of the twenty one operators which responded, 6 operators reported they performed CAT III approaches, of which, 4 operators stated they waited until after landing to reconfigure the BTBs and 2 operators published procedures for closing the BTBs after a missed approach. None of the respondents reported uncommanded aircraft motion as a result of BTB manipulation.

The source of the pitch-up command to the autopilot, which was experienced during the accident and test flights, was not determined; however, when the autopilot system was properly configured, the pitch-up characteristics were not objectionable and within expected values.

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Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation Ft. MSL	Runway Used 0	Runway Length	Runway Width
Runway Surface Type:					
Runway Surface Condition:					
Type Instrument Approach:					
VFR Approach/Landing:					
Aircraft Information					
Aircraft Manufacturer Boeing		Model/Series 747-236		Serial Number 22305	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 394	Certified Max Gross Wt.	820000 LBS	Number of Engines: 4	
Engine Type: Turbo Fan	Engine Manufacturer: Rolls-Royce	Model/Series: RB211-524D4	Rated Power: 52810 LBS		
- Aircraft Inspection Information					
Type of Last Inspection Continuous Airworthiness	Date of Last Inspection 02/2000	Time Since Last Inspection 59 Hours	Airframe Total Time 648 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? No	ELT Operated?	ELT Aided in Locating Accident Site?			
Owner/Operator Information					
Registered Aircraft Owner BRITISH AIRWAYS, PLC.		Street Address P.O. BOX 365			
		City HARMONDSWORTH	State OF	Zip Code	
Operator of Aircraft Same as Reg'd Aircraft Owner		Street Address Same as Reg'd Aircraft Owner			
		City	State	Zip Code	
Operator Does Business As:			Operator Designator Code:		
- Type of U.S. Certificate(s) Held: None					
Air Carrier Operating Certificate(s):					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 129: Foreign					
Type of Flight Operation Conducted: Scheduled; International; Passenger/Cargo					
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First Pilot Information

Name On File	City	State On File	Date of Birth	Age 47
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number:
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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): Airplane Multi-engine; Instrument Airplane

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--w/ waivers/lim.	Date of Last Medical Exam: 09/1999
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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	13200									
Pilot In Command(PIC)	4600	2670								
Instructor		800								
Last 90 Days		94								
Last 30 Days		56								
Last 24 Hours										

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 LONDON	State OF	Airport Identifier LHR	Departure Time 1830	Time Zone GMT
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Destination JAMAICA	State NY	Airport Identifier JFK	
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Type of Clearance: IFR

Type of Airspace: Class A

Weather Information

Source of Briefing: Company

Method of Briefing:

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Weather Information


WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
	0000		0 Ft. MSL	0 NM	0 Deg. Mag.
Sky/Lowest Cloud Condition: Unknown			0 Ft. AGL	Condition of Light: Night/Dark	
Lowest Ceiling: Unknown			0 Ft. AGL	Visibility: 0 SM	Altimeter: "Hg
Temperature: °C	Dew Point: °C	Wind Direction:		Density Altitude: Ft.	
Wind Speed:	Gusts:	Weather Conditions at Accident Site: Instrument Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0 SM	Intensity of Precipitation: Unknown			
Restrictions to Visibility:					
Type of Precipitation:					

Accident Information

Aircraft Damage: None	Aircraft Fire: None	Aircraft Explosion: None
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Classification: Foreign 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			1	14	15
Other Crew					
Passengers		1	10	354	365
- TOTAL ABOARD -		1	11	371	383
Other Ground	0	0	0		0
- GRAND TOTAL -	0	1	11	371	383

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Administrative Information

Investigator-In-Charge (IIC)
LUKE SCHIADA

Additional Persons Participating in This Accident/Incident Investigation:

MIKE CARTELLI
FAA FSDO
GARDEN CITY, NY

SIMON LIE
BOEING
SEATTLE, WA

MARTIN BUZZARD
BRITISH AIRWAYS
LONDON, UK

GREG NIECIECKI
HONEYWELL
PHOENIX, AZ