
Flight control vibration, Boeing 737-448, May 8, 2002

Micro-summary: Flight control vibration resulted in a diversion of this Boeing 737-448.

Event Date: 2002-05-08 at 1600 EDT

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

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

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		NTSB ID: MIA02IA094		Aircraft Registration Number: EI-BXI	
		Occurrence Date: 05/08/2002		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place Miami	State FL	Zip Code 33159	Local Time 1600	Time Zone EDT	
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series B737-448		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 On May 8, 2002, about 1600, eastern daylight time, a Boeing 737-448, Irish registration EI-BXI, registered to Aer Lingus PLC, Dublin, Ireland, and operated by Ryan International Airlines, as a Title 14 CFR Part 121 international passenger flight for Apple Vacations, had a continuous severe vibration in the flight controls while en route to Chicago O'Hare International Airport, and diverted to Miami, Florida. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The airline transport-rated pilot, first officer, 4 flight attendants, and 154 passengers were not injured, and the aircraft received minor damage. The flight originated from Montego Bay, Jamaica, the same day, about 1535. The pilot stated that the aircraft had been performing normally, except for a slight vibration during the flight to Montego Bay, Jamaica. He said he was not concerned, and the landing had been normal. He further stated that after takeoff from Montego Bay, Jamaica, en route to Chicago, Illinois, the aircraft started vibrating "ten times as bad", and he made the decision to divert and land at Miami, Florida. He said the vibration had continued, until "flaps five" was added and then the vibration stopped. He then executed an uneventful landing with emergency vehicles standing by, taxied to the gate, and deplaned. The NTSB received notification of this incident from an official with Ryan International Airlines, after the airplane had been at Miami International Airport, Miami, Florida, and most of the repairs had been performed. The official stated that an approximate 24-inch section of the right elevator trim tab had been missing from the aircraft. Upon receiving notification the NTSB responded to Miami International Airport, and observed that repairs had been performed and that remaining affected parts which included the damaged right elevator tab, control rods, and tab hinge clevis fitting had been removed and shipped to Boeing Aircraft Company, Seattle, Washington, and the elevator had been shipped to Aero Fabricator, Dallas, Texas, for examination. In addition, flight data recorder data had already been downloaded, and sent to Boeing Aircraft Company, and the airplane was being readied to be returned to service. On October 22, 2002, the NTSB conducted a detailed examination of the parts pertaining to the damaged/missing right hand elevator trim tab at Boeing Materials Laboratory, Seattle, Washington. The pieces examined included the remaining portion of the right hand elevator tab, the inboard control rod on the right elevator tab, a portion of the outboard control rod on right elevator tab, the forward portion of the outboard control rod on right hand elevator tab, and the number one elevator tab hinge fitting on the right elevator tab. The portion of the right hand elevator tab showed signs that there was a fracture inboard of the inboard end of the No. 2 hinge fitting. The fracture ran approximately perpendicular to the span of the tab, along the cord of the tab. On the bottom of the tab, the skin was torn away from the tab					
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outboard. A debonding was noted on the upper surface between the leading edge of the spar cap, and the spar, starting from the No. 2 hinge fitting and extending outboard. To crack appeared to follow the leading-edge connection to the tab spar. In addition, two areas of tab repair were noted, one was located between the No. 2 and the No. 3 hinge, and the other was located at the outboard end of the tab. After inspection the tab x-rayed to determine the presence of moisture in the tab and none was noted. In addition, the tab was examined using Thorough Transmission Ultrasound (TTU), to determine in areas of composite delamination or debonding. The inspection indicated that delamination/debonding had occurred in the area of the fracture continuing outboard for about 4 inches. The inspection also noted debonding along the bottom line between the spar cap, and the spar leading edge, extending outboard from the No. 2 hinge fitting. In addition, the elevator tab was subjected to a manual calls tactical ultrasound inspection. The inspection verified the area of debonding/delamination in the area, the fracture and a crack from the No. 2 hinge fitting.

Examination of the inboard elevator control rod from the right hand elevator tab revealed that the rod was fractured at the aft fitting. The rod end jam nut was found at the end of the rod, and visual inspection of the rod revealed several rub marks along the rod. The forward end appeared undamaged. Examination of the fractured surface of the rod was accomplished using a scanning electron microscope, which revealed fatigue that had initiated at the six and 12 o'clock positions of the rod. The portion of the outboard control rod on the right hand elevator tab showed that this portion of the elevator tab was approximately 12 1/8 inches long, and it exhibited fractures at both ends of the rod. The fracture surfaces showed signs of damage due to repeated contact, such that no assessment of the fracture type was possible. Examination of the forward portion of the outboard control rod on the right hand elevator tab had about a 5 1/2-inch long piece that was fractured at the aft end, and the damage precluded any assessment as to the nature of the fracture.

The No. 1 hinge fitting on the right hand elevator tab was examined, and it revealed an indentation between the two attachment lugs on the bottom edge of the fitting, slightly offset to the outboard side of the fitting. The outboard lug was fractured, while the inboard lug was not fractured, and when examined with a scanning electron microscope, indicated that a ductile failure had occurred. Observation of the lower fracture service indicated the presence of postfracture damage to the fracture surface, which precluded a determination as to the failure mode.

The left elevator tab was also removed by Ryan airlines and shipped to Boeing for examination, and the examination the presence of two small 5/16 inch debond had occurred to the upper surface between the leading edge of the spar cap and the spar, starting at the inboard edge of the spar cap, outboard of the number two hinge fitting, and emanating in the chordwise direction.

On May 20-22, 2002, an examination of the elevator was performed at Aero Fabricators, Dallas, Texas. Fasteners were removed to gain access to inner surfaces of the skin panels, spars, and ribs.

In addition the tab control rod inner faring and elevator, rear spar reinforcing angle were disassembled from the elevator rear spar to enable further examination.

The elevator skin panels, spars and ribs are made of graphite epoxy composite fabric and tape materials. The internal and external tab rod and mast fittings are made of fiberglass epoxy composite materials, and the hinge and actuator fittings are made of aluminum alloys. The examination included external surfaces and fittings. During examination, the external surfaces of upper and lower skin panels the half edge of the lower skin panel at the inboard tab hinge location was notched in the aft edge and there a was damage at the aft edge of the upper skin panel at the corresponding location. The inboard end between a closure rib on the upper and lower honeycomb were soft to external pressure. 5the aft edge of the lower skin outer plies were delaminated in several places between stations. There were indications of a possible repair or delamination in the outboard bay of the upper panel at locations aft of the front spar. A rubbing abrasion was noted in areas of the aft face of the upper and lower skin panels and elevator rear spar. The upper and lower skin panels and internal surfaces had minimal damage in this damage was at stations in

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between closure ribs, areas of the inner skin and core. There were no signs of distress in the fasteners attaching the panels to the front and rear spars ribs or at the trailing edge. It was no damage the front spar assembly or balance weight support details except for some signs of abrasion on the spar web, upper and lower stiffening angles, located on aft face of the spar web. Damage are spar included impact damage in the spar web and spar reinforcing angle flange centered on the tab control rod's and damage at the inboard tab hinge location. To rear spar reinforcing angle and impact damage in the upper surface of the free flange centered on the tab control rods with a crack located under the outboard rod centerline. The elevator tab control rod inner fairing had severe abrasion damage and cracking in the angle attaching the rear spar and in and around the forward cutout for the control rods. The elevator external control rod mast fitting fairing had severe abrasion damage cracking and a small portion missing from the aft edge. Nondestructive inspections (NDI) were also made of selected areas of the graphite epoxy composite front and rear spars, and the skin panels, and no hidden damage was identified by the NDI inspections.

The flight data recorder data had been downloaded in Miami, and the data sent to Boeing Company in advance of the NTSB being notified. The flight data recorder data was reviewed and a large quantity of the data had "dropouts", which made the information unusable.

According to the NTSB Structures Group Chairman, although requested, the NTSB did not receive pertinent maintenance records from Ryan International Airlines, or from Aer Lingus PLC, related to the elevator "freeplay" check, as required by Boeing Service Bulletin 737-55A1070R1.

TESTS AND RESEARCH

Boeing advised operators through the use of an "All-Operator Message", to stress the importance of SB 737-55A1070 R1 inspections. It advised operators about the sensitivity of the elevator tab system to improper maintenance. In addition, a telegraphic Flight Operation Technical Bulletin was released on July 16, 2002 to and was intended to increase operational awareness about elevator tab related vibration and appropriate flight crew response. Service Bulletin 737-27A1266, was released on September 18, 2003, which requires a one-time detail visual inspection of elevator tab control rod jam nuts, as well as requiring that the torque be checked and tamper-proof putty be applied.

In addition, Boeing is presently working to complete Service Bulletins (SB) 737-55A1070, Rev 2, 737-55A1085, 737-55A1078.

According to an investigator with Boeing Flight Safety, SB 737-55A1070, Rev 2 is due to be released in the second quarter of 2005, concurrently with SB 737-55A1085, and will specify repeat inspection of elevator tab control mechanism. In conjunction with SB 737-55A1085, it will negate the need to perform unclamped tab hinge freeplay inspections. In addition, an appendix with a list of potential causes of freeplay will be added to help with troubleshooting, as well as add elevator tab mast fitting inspections, requiring them every 1,500 flight cycles/2,000 flight hours perform a detail visual inspection and "wiggle check" of the mast fitting lugs. In addition, a note will be added in the airplane maintenance manual requiring a one-time inspection of the mast fitting within 10 days of elevator tab mast fitting bolt removal/ installation

SB 737-55A1085 is due to be released in the second quarter of 2005, concurrently with SB 737-55A1070 Rev 2. They will require that inspection putty on clamped hinge bolt heads to detect bolt rotation, and if rotation is detected, will require hinge bushings and bolts be replaced with new parts.

SB 737-55A1078 is due to be released second quarter of 2005, and will be applicable to 737-100/-200 airplanes with elevators that have aluminum rear spars, and will require updated inspection intervals for elevator rear spar, to inspect for cracking, corrosion and/or delamination, with intervals and inspection requirements being based on the elevator rear spar configuration.

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Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation Ft. MSL	Runway Used NA	Runway Length	Runway Width
Runway Surface Type: Unknown					
Runway Surface Condition: Unknown					
Type Instrument Approach: Unknown					
VFR Approach/Landing: Precautionary Landing					
Aircraft Information					
Aircraft Manufacturer Boeing		Model/Series B737-448		Serial Number 25052	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 178	Certified Max Gross Wt.	150000 LBS	Number of Engines: 2	
Engine Type: Turbo Fan	Engine Manufacturer: CFM International	Model/Series: CFM563B-2	Rated Power: 22500 LBS		
- Aircraft Inspection Information					
Type of Last Inspection Continuous Airworthiness	Date of Last Inspection 12/2001	Time Since Last Inspection 787 Hours	Airframe Total Time 26400 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? No	ELT Operated? No	ELT Aided in Locating Accident Site? No			
Owner/Operator Information					
Registered Aircraft Owner Aer Lingus		Street Address Dublin Airport			
		City Dublin	State	Zip Code	
Operator of Aircraft RYAN AIR INC		Street Address 266 North Main			
		City Wichita	State KS	Zip Code 67202	
Operator Does Business As: Ryan International Airlines			Operator Designator Code: RYNA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Supplemental					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Scheduled; International; Passenger Only					
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First Pilot Information					
Name		City		State	Date of Birth
On File		On File		On File	On File
					Age
					29
Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot		Certificate Number: On File	
Certificate(s): Airline Transport; Flight Instructor; Commercial					
Airplane Rating(s): Multi-engine Land; Single-engine Land					
Rotorcraft/Glider/LTA: None					
Instrument Rating(s): Airplane					
Instructor Rating(s): Airplane Multi-engine; Airplane Single-engine; Instrument Airplane					
Type Rating/Endorsement for Accident/Incident Aircraft? Yes				Current Biennial Flight Review? 05/2002	
Medical Cert.: Class 1		Medical Cert. Status: Valid Medical--no waivers/lim.		Date of Last Medical Exam: 10/2001	
- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night
Total Time	3916	660		2365	
Pilot In Command(PIC)	2900	456			
Instructor					
Last 90 Days	199	199		199	
Last 30 Days	70	70		70	
Last 24 Hours	6	6		6	
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
Montego Bay			MKJS	1435	AST
Destination		State	Airport Identifier		
Chicago			ORD		
Type of Clearance: IFR					
Type of Airspace: Class A					
Weather Information					
Source of Briefing: Unknown					
Method of Briefing: Unknown					

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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
MIA	1656	EDT	8 Ft. MSL	NM	Deg. Mag.
Sky/Lowest Cloud Condition: Scattered			4200 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: None			Ft. AGL	Visibility: 10 SM	Altimeter: 30.06 "Hg
Temperature: 28 °C		Dew Point: 19 °C	Wind Direction: 80		Density Altitude: Ft.
Wind Speed: 12		Gusts:	Weather Conditions at Accident Site: Visual Conditions		
Visibility (RVR): Ft.		Visibility (RVV) SM	Intensity of Precipitation:		
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information					
Aircraft Damage: Minor		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						
Cabin Attendants				4	4	
Other Crew						
Passengers				154	154	
- TOTAL ABOARD -				160	160	
Other Ground						
- GRAND TOTAL -				160	160	

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Administrative Information

Investigator-In-Charge (IIC)

John W. Lovell

Additional Persons Participating in This Accident/Incident Investigation:

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