
Partially extended left main gear landing, Boeing 737-300, April 30, 1996

Micro-summary: This Boeing 737-300 executed a landing with a partially extended left main landing gear, following several unsuccessful methods to extend it.


Event Date: 1996-04-30 at 1436 PDT


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

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

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		NTSB ID: LAX96IA184		Aircraft Registration Number: N331SW	
		Occurrence Date: 04/30/1996		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place ONTARIO		State CA	Zip Code 91761	Local Time 1436	Time Zone PDT
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series 737-300-3H4		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>HISTORY OF FLIGHT</p> <p>On April 30, 1996, at 1436 hours Pacific daylight time, Southwest Flight 1767, a Boeing 737-300-3H4, N331SW, with 127 passengers and crew of 5 was en route to Burbank, California, from Las Vegas, Nevada. During the initial approach into Burbank, the landing gear was extended, at which time an unusual noise was heard by the captain and an unsafe gear light was observed. The aircraft discontinued the approach and maneuvered in the general area of Burbank. After performing normal emergency gear extension procedures without success, and consulting with Southwest maintenance personnel, the decision was made to divert to Ontario, California. A flyby, a bounce and go landing, and a low "G" maneuver was performed at Ontario without success. Subsequently, the aircraft landed on runway 26R with a partially extended left main landing gear. The 127 passengers and 5 crew were evacuated via chutes and there were no injuries.</p> <p>AIRCRAFT INFORMATION</p> <p>The aircraft was maintained under an FAA approved continuous airworthiness program. The last "C" check (C2 and 3C2) was conducted on April 16, 1996. At the time of the incident, the aircraft accumulated a total of 26,697.45 flight hours with 27,340 cycles. The time since the C2 and 3C2 checks was 129.50 hours with 117 cycles. The left landing gear was overhauled by BF Goodrich Aerospace, Miami, Florida, on June 29, 1995, and installed on the aircraft on July 1, 1995. The left landing gear accumulated 2,890 hours and 2,681 cycles since the overhaul at the time of the incident.</p> <p>WRECKAGE AND IMPACT INFORMATION</p> <p>On-scene examination revealed that the damage was confined to the left engine nacelle, with minor damage to the engine and to the left flap fairings.</p> <p>EXAMINATION OF THE LEFT LANDING GEAR</p> <p>Examination of the left landing gear oleo strut revealed that it had over extended prior to gear retraction into the wheel well. The inboard tire was observed to be partially above the blade seal in the wheel well. The tire had minimal tread wear. The torque links were at maximum extension and were parallel with the oleo piston (inner cylinder). The chrome portion of the inner cylinder was measured at 16 inches of exposed chrome. Scoring was observed on the forward side of the piston, with strut oil covering both main gear wheel assemblies and trailing from the left wheel well aft to the tail cone. The strut was removed from the aircraft and flown to Boeing Aircraft in Seattle, Washington, for disassembly and examination.</p> <p>TESTS AND RESEARCH</p>					
FACTUAL REPORT - AVIATION					
					Page 1

 <p>National Transportation Safety Board FACTUAL REPORT AVIATION</p>	NTSB ID: LAX96IA184
	Occurrence Date: 04/30/1996
	Occurrence Type: Incident

Narrative (Continued)

On May 3, 1996, the shock strut was examined at Boeing under the supervision of the NTSB with BF Goodrich, Boeing, and the FAA ACO present. Prior to disassembly, the shock strut was taken to the Boeing Flight Technology/Physics Department and x-rayed (Industrial Computed Tomography). The x-ray revealed that the upper bearing carriers (p/n 69-65396-1) became dislodged. The upper bearing carriers provides the outstop/extension for the inner cylinder during strut extension. As a result of these displaced parts, complete compression of the strut was not possible.

After removal of the piston/inner cylinder from the outer cylinder, fragments of the upper bearing outer shell were spilled out. The aluminum, nickel, and bronze bearing shell provides the wear surface between the aluminum upper bearing carrier and the inside diameter of the outer cylinder (p/n 65-61740). After the inner cylinder (p/n 65-46116) was completely removed, the aluminum bearing carriers were recovered.

Examination revealed that the absence of the outer bearing half shell resulted in approximately 0.15 inches of bearing carrier wear due to the bearing carrier abrading against the outer cylinder's inside diameter. According to Boeing engineers, the resultant radial wear/clearance allowed the bearing carriers to override the lip retainers on the inner cylinder, thereby eliminating the normal strut extension stop.

During the overhaul/repair process when an inner cylinder is reinstalled into the outer cylinder, a technician must hold the two bearing carriers and the two bearing half shells in position as the inner cylinder is installed through the wipers and seals into the outer cylinder. The process is accomplished vertically with the use of a hoist and a sling when at a repair facility and removed from the aircraft.

According to the June 29, 1995, records, overhaul of the bearing outer half shells (p/n 69-65397-1) were reused after a visual inspection. The bearing carriers inner shells (p/n 69-65396-1) were replaced with new parts.

According to the aircraft maintenance log, from April 23, 1996, to the date of the incident, there were no indications of prior problems with the landing gear. There were two standard tire pressure checks during this period.

According to a Boeing dimensional inspection that was performed on the main landing gear shock strut inner cylinder, it was found out of tolerance in the area of impact damage. The outer cylinder wear was visibly apparent. The Boeing report states that the wear occurred in an area where the inner cylinder contacted the outer cylinder, with the bearing out of place. The results of the Boeing report concluded that the parts examined in the EQA Laboratory were made per drawing, and did not contribute to the cause of the incident.

The shock strut fluid recovered from the incident gear was analyzed using Fourier Transform Infrared Spectroscopy (FTIR), and Microprobe and X-Ray Fluorescence Spectroscopy (XRF). The fluid was metallic in color due to the suspension of fine metal particles. The laboratory concluded that the shock strut fluid generally met the shock strut/operators specification and did not contribute to the incident.

SERVICE DIFFICULTY REPORT HISTORY

A review of the SDR data base revealed a similar incident occurred in Atlanta, Georgia, on March 20, 1990. The right landing gear overextended prior to gear retraction into the wheel well. The SDR stated that the upper bearing retainer was found out of position inside the strut. There was no additional information available.

Another incident occurred in England on October 7, 1994, with British Midland Airlines. In this

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID: LAX96IA184

Occurrence Date: 04/30/1996

Occurrence Type: Incident

Narrative (Continued)

case, both main gears were overhauled by BF Goodrich, U.K., and reinstalled on the aircraft. While the aircraft was on the jacks and the strut extension was being measured, it was discovered that the proper oleo extension could not be obtained on the left main gear strut. The fully extended strut should be 15.5 inches at 250 psi. The actual measurement was 13.5 inches at 250 psi. During disassembly to determine the cause, it was discovered that a bearing half shell (p/n 69-65397-1) (1.945 inches in width), was found out of position and obstructing the strut from its full extension. It was jammed between the spacer (p/n 65-46158-4), and the upper bearing retaining flange of the inner cylinder (p/n 65-46116-51).

Subsequently, after the British Midland incident, BF Goodrich revised their overhaul manual by adding a boxed alert as step 11(a), which states: "carefully check packing bore to verify shell half #28 are properly seated on upper bearing." After the Ontario incident, BF Goodrich created a tool (BFG 96-001) similar to a ring compressor, to keep the bearing half shells in position during the insertion of the inner cylinder into the outer cylinder instead of the direct use of the technicians hands.

According to BF Goodrich records, during the overhaul of the left landing gear at Miami, the bearing carriers were replaced with new parts. The bearing half shells were visually and dimensionally examined then reused as a matched set. During the assembly and testing of the strut, which requires two technicians, measurements are taken of the fully compressed and the fully extended lengths.

According to the Southwest Airlines main landing gear installation sign off sheet, there are no required measurements taken of the fully extended or the fully compressed strut lengths during installation. After the aircraft is lowered from the jacks, the strut extensions are adjusted to a predetermined setting.

BF GOODRICH AEROSPACE

The Landing Gear Services Division of BF Goodrich is an FAA approved repair station. They specialize in the overhaul of landing gear systems for most of the large aircraft manufacturers.

PERSONNEL INFORMATION

During the assembly of the incident landing gear there were three BF Goodrich production employees involved. One had an FAA repairman certificate (FAR part 65, subpart E).

During the high and low pressure testing, there were five BF Goodrich employees involved and all were FAA certificated. One was also involved in the assembly and two were inspectors.

The experience levels of the certificated employees ranged between 10 to 15 years of aviation maintenance experience. They all had training records documenting their training experience on particular models of aircraft landing gears.

INSPECTION ORGANIZATION

According to BF Goodrich, "Inspectors are industry experienced personnel that perform condition inspections on in-coming material and review documentation and condition of components completing the overhaul process. Only inspectors with certified mechanic status can final inspect and issue a release-to-service document."

PERSONNEL TRAINING

Personnel are trained through the process of on-the-job training, while working with an experienced technician. Oversight and documentation (form BFG-086) is provided by the crew lead man and the

National Transportation Safety Board

FACTUAL REPORT

AVIATION

SAFETY BOARD

NTSB ID: LAX96IA184

Occurrence Date: 04/30/1996

Occurrence Type: Incident

Narrative (Continued)


work center supervisor.


FAA OVERSIGHT

The FAA principal maintenance inspector (PMI) is located at the FAA Flight Standards District Office in Miami, Florida.

GENERAL OVERHAUL MANUAL

The FAA approved overhaul data used is from the original equipment manufacturer unless otherwise specified by the particular operator. In this incident, the overhaul manual was provided by Boeing Aircraft Company, with BF Goodrich safety inclusions.

 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: LAX961A184				
		Occurrence Date: 04/30/1996				
		Occurrence Type: Incident				
Landing Facility/Approach Information						
Airport Name ONTARIO INTERNATIONAL		Airport ID: KONT	Airport Elevation 925 Ft. MSL	Runway Used 26R	Runway Length 12200	Runway Width 150
Runway Surface Type: Concrete						
Runway Surface Condition: Dry						
Type Instrument Approach: ILS-complete						
VFR Approach/Landing: Precautionary Landing						
Aircraft Information						
Aircraft Manufacturer Boeing		Model/Series 737-300-3H4		Serial Number 23695		
Airworthiness Certificate(s): Transport						
Landing Gear Type: Retractable - Tricycle						
Homebuilt Aircraft? No		Number of Seats: 145		Certified Max Gross Wt. 130000 LBS	Number of Engines: 2	
Engine Type: Turbo Fan		Engine Manufacturer: GE		Model/Series: CFM-56	Rated Power: 20000 LBS	
- Aircraft Inspection Information						
Type of Last Inspection Continuous Airworthiness		Date of Last Inspection 04/1996	Time Since Last Inspection 129 Hours		Airframe Total Time 26697 Hours	
- Emergency Locator Transmitter (ELT) Information						
ELT Installed?		ELT Operated?		ELT Aided in Locating Accident Site?		
Owner/Operator Information						
Registered Aircraft Owner SOUTHWEST AIRLINES, INC.		Street Address 2833 SHORECREST DRIVE				
		City DALLAS		State TX	Zip Code 75235	
Operator of Aircraft Same as Reg'd Aircraft Owner		Street Address P.O. BOX 36611				
		City DALLAS		State TX	Zip Code 75235	
Operator Does Business As:				Operator Designator Code: SWAA		
- 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						

 <p>National Transportation Safety Board FACTUAL REPORT AVIATION</p>	NTSB ID: LAX96IA184
	Occurrence Date: 04/30/1996
	Occurrence Type: Incident

First Pilot Information

Name On File	City On File	State On File	Date of Birth On File	Age 42
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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; 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?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 01/1996
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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	12500	5600	3500	8000	3000	1200	200			
Pilot In Command(PIC)	8000	2400	3300	4500	3000	1200	200			
Instructor	1500		1200	200	400	600				
Last 90 Days	240	240		240		6				
Last 30 Days	80	80		80		6				
Last 24 Hours	5	5		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 LAS VEGAS	State NV	Airport Identifier LAS	Departure Time 1500	Time Zone PST
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Destination BURBANK	State CA	Airport Identifier BUR	
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Type of Clearance: IFR

Type of Airspace: Class C

Weather Information

Source of Briefing: Company

Method of Briefing:

 <p>National Transportation Safety Board FACTUAL REPORT AVIATION</p>	NTSB ID: LAX96IA184	
	Occurrence Date: 04/30/1996	
	Occurrence Type: Incident	

Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
ONT	1550	PDT	925 Ft. MSL	0 NM	0 Deg. Mag.
Sky/Lowest Cloud Condition: Clear			0 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: None		0 Ft. AGL	Visibility: 30	SM	Altimeter: "Hg
Temperature: 32 °C	Dew Point: °C	Wind Direction: 230		Density Altitude: Ft.	
Wind Speed: 10	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					

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				3	3
Other Crew					
Passengers				127	127
- TOTAL ABOARD -				132	132
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	132	132

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National Transportation Safety Board

FACTUAL REPORT

AVIATION



NTSB ID: LAX96IA184

Occurrence Date: 04/30/1996

Occurrence Type: Incident

Administrative Information

Investigator-In-Charge (IIC)

GEORGE E. PETTERSON

Additional Persons Participating in This Accident/Incident Investigation:

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