Wheel separation on takeoff, Boeing 737-222, April 7, 1995

Micro-summary: **This Boeing 737-222 lost a wheel on takeoff.**

Event Date: **1995-04-07 at 1710 CDT**

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

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

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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: CHI95IA119	Aircraft Registration Number: N9090U
Occurrence Date: 04/07/1995	Most Critical Injury: None
Occurrence Type: Incident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
CHICAGO	IL	60666	1710	CDT	

Airport Proximity: On Airport	Distance From Landing Facility: 0	Direction From Airport: 0

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
BOEING	737-222	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 THE FLIGHT

On April 8, 1995, at 1710 central daylight time(cdt), a Boeing 737-222, N9040U, aircraft number 9640, operated under 14 CFR Part 121 as United Airlines (UAL) flight #536 to Atlanta, Georgia, experienced a left outboard (#1 main) wheel separation on takeoff from runway 09L at Chicago O'Hare International Airport (ORD). The left inboard wheel was unaffected and remained installed. The airplane returned to ORD and landed on runway 32L without incident at 1846 cdt after circling to burn fuel. The 111 passengers and 5 crewmembers were uninjured, and deplaned via the stairs. The wheel damaged two fences and several rental cars in parking lots located on the airport.

Detailed laboratory inspection revealed a failure of the outboard wheel bearing. Indications of grease migration outboard, out of the bearing cavity, was evident. The recovered bearing components exhibited mechanical deformation and heat distress. This damage precluded a definite determination of the initiating failure. The December 5, 1995, engineering report by the Timken Company on "The Investigation of Landing Gear Parts, Aircraft #9640" states that a likely cause of the bearing failure was inadequate lubrication.

The Timken report was written at the request of the National Transportation Safety Board, and parties to the investigation were the NTSB, Timken, UAL, Allied Landing Systems (ALS), and Boeing Aircraft Company. All parties were present at the Timken facility during the physical inspection, and all have made comments which are incorporated in or appended to the Timken report.

Boeing comments state "...no definitive cause was established, but the hardware condition was consistent with a failure stemming from inadequate lubrication."

Twenty five of twenty seven rollars were recovered. No fragments of the two unrecovered rollers were apparent (Reference paragraph #3, page 6, under "General Discussion" of Timken report 12/5/95). The bearing cage was destroyed during the failure. Timken stated "there was no evidence for there having been one or more cracked rollers, and that the damage in the failed bearing was not consitent with such a condition."

HISTORY OF THE FAILED BEARING

A review of maintenance records on the wheel assembly indicated that the #1 main wheel had been installed on February 1, 1995, at 55,443 aircraft cycles. A brake change was performed on February 25, 1995, at 55,573 cycles. The wheel loss occurred at 55,792 cycles.

This is a total of 219 cycles since the brake change, and 349 cycles since installation. It could not be determined if the bearing was repacked with grease during the brake change.

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

Narrative (Continued)

The outboard bearing cup exhibited date code "ZD" which indicates a manufacturing date of February 1993 (approximately 26 months). Timken (the bearing manufacturer) stated this age is not exceptional.

BEARING LIFE EXPECTANCY

Bearings are installed with wheel assemblies after buildup, and remain installed until the wheel is removed and disassembled. This normally occurs as a result of tire removal due to tread wear or tire damage. There is no high cycle limit placed on tires or wheel assemblies. Removals are "on condition" based on tire tread.

Timken stated that "...with rare exceptions, rolling contact fatigue is not a condition observed as a life limitation of aircraft wheel bearings."

Boeing indicated a worldwide 737-200 fleet average of 200 cycles between tire changes (which would require repacking or installation of a new bearing).

UAL provided a sample of 19 737-200 tire changes. The high life tire in the sample was removed at 326 landing cycles. The average (mean) tire life was 259 cycles, with a standard deviation of 39.9 cycles. The failed bearing remained installed to 349 cycles.

LUBRICATION PROCEDURES

At initial installation, the wheel assembly has a freshly grease packed new or re-used and inspected bearing. During a brake change, if the wheel assembly is reinstalled, the bearing may not be repacked if it visually appears to have grease.

UAL Maintenance Procedures for 737-200 Wheel and Tire Assembly - Removal / Installation, 32-41-01, paragraph 2. D (4), states "Install outer bearing (packed with GRE4500-8A)." The procedures for Main Gear Wheel Brake - Removal / Installation, 32-43-01, paragraph 7. J. states, "Install main gear wheel (Ref. 32-41-01/201)."

The Safety Board investigator asked UAL maintenance personnel to clarify these procedures. Line maintenance supervisors from UAL San Francisco Engineering stated that personnel may interpret this to mean that if the outer bearing was removed from the wheel, or a new one installed, that the bearing would be repacked with grease. If the wheel was removed as an assembly for a brake change, and then reinstalled as an assembly, the bearing would not necessarily be repacked.

Interviews with three FAA airworthiness inspectors, two of whom had B-737 experience, indicated that during a brake change where a wheel was removed and reinstalled, they would expect a mechanic to visually inspect the wheel. They stated that if grease was visually present, they would not expect a mechanic to repack the bearing.

TYPE OF LUBRICANT

UAL repair shop working documents specify Aeroshell-5 as an approved lubricant by Allied Landing Systems in CMM 32-40-01. Aeroshell-5 was confirmed by lab testing to be the grease in use.

Timken stated that they and ALS have recommended Aeroshell-22 as a superior grease for aircraft wheel applications, but that Aeroshell-5 has shown acceptable performance.

No discrepancy with the use of Aeroshell-5 was noted.

RETENTION OF LUBRICANT

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

Narrative (Continued)

UAL Maintenance Procedures for 737-200 Wheel and Tire Assembly - Removal / Installation, 32-41-01, paragraph 2. D (4), states "Outer seal (adjacent to axle nut) no longer required." This refers to a grease dam, part number 2602576, depicted on Allied Landing System drawing 2601571-1. This grease dam is designed to retain lubricant within the bearing cavity, and is optional as per ALS.

The failed wheel assembly exhibited radial streaks of grease which had migrated out of the bearing cavity.

Boeing stated that the majority of 737-200 airplanes in service worldwide operate without the optional grease dam installed.

AGE OF LUBRICANT

The UAL procedures in place specify for a brake change to refer to the wheel removal/installation procedures. These procedures refer to the installation of a packed bearing. Statements by various FAA inspectors, and UAL, indicate that if grease was visually present, a bearing may or may not actually be repacked with fresh grease by a mechanic on the line. The wheel may be reinstalled with the original grease. The failed wheel bearing had grease which was either 219, or 349 cycles old.

Allied Landing Systems and Timken indicate that after approximately 150 cycles, lubricant degradation begins to accelerate in aircraft wheel bearings.

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
O'HARE INT'L AIRPORT	ORD	650 Ft. MSL	9L	7967	150

Runway Surface Type: Asphalt

Runway Surface Condition: Dry

Type Instrument Approach: ILS-complete; Visual

VFR Approach/Landing: Precautionary Landing; Straight-in

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
BOEING	737-222	19078

Airworthiness Certificate(s): Normal; Transport

Landing Gear Type: Retractable - Tricycle

Homebuilt Aircraft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	117	117000 LBS	2

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Jet	P&W	JT8D-7B	14000 LBS

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
Continuous Airworthiness	11/1994	794 Hours	51274 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?	ELT Operated?	ELT Aided in Locating Accident Site?

Owner/Operator Information

Registered Aircraft Owner	Street Address		
UNITED AIR LINES, INC.	O'HARE INTERNATIONAL AIRPORT		
	City: CHICAGO	State: IL	Zip Code: 60666

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: UNITED AIR LINES

Operator Designator Code: UALA

- 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: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	38

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

Certificate(s): Airline Transport; Flight Instructor

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

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: 12/1994

- 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	5564	3368								
Pilot In Command(PIC)		3368								
Instructor										
Last 90 Days			153							
Last 30 Days			30							
Last 24 Hours										

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? | 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			1710	CDT

Destination	State	Airport Identifier	
ATLANTA	GA	ATL	

Type of Clearance: IFR

Type of Airspace: Class B

Weather Information

Source of Briefing: Company; Commercial Weather Service

Method of Briefing:

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
ORD	1652	CDT	650 Ft. MSL	0 NM	0 Deg. Mag.

Sky/Lowest Cloud Condition: Unknown 0 Ft. AGL

Condition of Light: Day

Lowest Ceiling: Overcast 1500 Ft. AGL

Visibility: 4 SM

Altimeter: 29.00 "Hg

Temperature: 6 °C

Dew Point: 3 °C

Wind Direction: 40

Density Altitude: Ft.

Wind Speed: 16

Gusts:

Weather Condtions at Accident Site: Visual Conditions

Visibility (RVR): 0 Ft.

Visibility (RVV) 0 SM

Intensity of Precipitation: Unknown

Restrictions to Visibility: Haze

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				111	111
- TOTAL ABOARD -				116	116
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	116	116

National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI95IA119

Occurrence Date: 04/07/1995

Occurrence Type: Incident

Administrative Information

Investigator-In-Charge (IIC)

MATTHEW L. THOMAS

Additional Persons Participating in This Accident/Incident Investigation:

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