Aviation Investigation Final Report

Location:	Los Angeles, California	**Incident Number:**	ENG09IA014
Date & Time:	September 8, 2009, 11:54 Local	**Registration:**	N670SW
Aircraft:	Boeing 737	**Aircraft Damage:**	Minor
Defining Event:	Aircraft structural failure	**Injuries:**	142 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

During landing, the inboard axle of the right main landing gear separated from the airplane. The crew taxied the airplane off the runway and the passengers and crew deplaned with no injuries. Examination of the axle revealed an area of fatigue cracking emanating from the brake mounting bolt hole at the 12:00 position. The fatigue crack likely initiated in an area where there was scoring and fretting damage to the Sermetal coating. In-service examination of brake mounting bolt torque indicated that over time, the brake mounting bolts may loosen allowing the bolts to spin in the holes.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The failure of the right main landing gear inboard axle due to fatigue cracking as a result of fretting damage in one of the brake mounting bolt holes.

Findings

Aircraft	Main gear strut/axle/truck - Fatigue/wear/corrosion

Factual Information

History of Flight

Landing-landing roll	Aircraft structural failure (Defining event)

HISTORY OF FLIGHT

On September 8, 2009, approximately 1154 Pacific Daylight Time (PDT), Southwest Airlines (SWA) Flight 341, a Boeing 737-3G7, N670SW, experienced a failure of the inboard axle on the right main landing gear (RMLG) during landing on runway 24R at Los Angeles International Airport (LAX). The pilot, first officer, 3 flight attendants, 1 jumpseater, and 136 passengers were not injured. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan was filed for the 14 Code of Federal Regulations (CFR) Part 121 scheduled domestic passenger flight. The flight originated at McCarran International Airport, Las Vegas, Nevada, about 1055 PDT.

According to the captain, he felt the aircraft swerve during the landing rollout and stopped the airplane on the taxiway. A flight attendant called the cockpit and reported that a deadheading SWA pilot reported that he observed a tire depart the airplane. The RMLG inboard wheel and brake assembly separated from the aircraft and was recovered on the north side of the runway near the 4,000 feet remaining marker. The airplane was taxied off the runway to taxiway Y where the passengers were deplaned by airstairs onto waiting buses.

PERSONNEL INFORMATION

Captain

The 46-year-old captain held private, flight instructor, commercial and airline transport pilot certificates with type ratings for B737 and SA227 airplanes and a first class medical certificate. His most recent medical certificate was issued on June 29, 2009, with no limitations and his most recent flight review was performed on May 16, 2009. He had accrued 230, 77, and 4 flight hours in the last 90 days, 30 days, and 24 hours, respectively.

First Officer

The 39-year-old first officer held private, flight instructor, commercial and airline transport pilot certificates with a type ratings for B737, LR-JET, DA-20, and A320 (SIC only) airplanes and a first class medical certificate. His most recent medical certificate was issued on March 6, 2009, with no limitations and his most recent flight review was performed on March 2, 2009. He had accrued 197, 53, and 4 flight hours in the last 90 days, 30 days, and 24 hours, respectively.

AIRCRAFT INFORMATION

The Boeing 737-3G7 airplane, N670SW, was last inspected during a scheduled A-check on September 7, 2009. According to SWA maintenance records, the RMLG was installed on the airplane on November 8, 2003. The RMLG was most recently overhauled in October 2003 and the inner cylinder had accrued 48,856 hours and 36,016 cycles since new and 18,200 hours and 14,182 cycles since overhaul at the time of the incident. The RMLG inner cylinder should be overhauled every 10 years or 21,000 cycles and has a life limit of 75,000 cycles according to Boeing. The RMLG inboard brake was last replaced on June 27, 2009 and the RMLG inboard wheel was last replaced on August 9, 2009.

METEOROLOGICAL INFORMATION

The KLAX METAR reported the following weather at 1153; wind from 270 degrees at 10 knots, visibility 10 miles, few clouds at 9000 feet, temperature 23 degrees Celsius, dew point 16 degrees Celsius, and an altimeter of 29.87 inches of Mercury.

TEST AND RESEARCH

The RMLG Inner Cylinder Assembly (P/N 65-46116-46, S/N 4P2790) was removed from the aircraft and sent to The Boeing Company. The teardown and examination of the inner cylinder was accomplished under the supervision of the NTSB. The inboard axle exhibited a fracture that emanated from the bolt hole at the 12:00 position in the brake mounting flange. The fracture exhibited surface features consistent with fatigue propagation for approximately 3.5 inches. The remainder of the fracture exhibited surface features consistent with ductile separation. The area where the bolt hole inner diameter intersected the chamfer on the outboard face of the flange exhibited scoring and fretting damage to the Sermetal coating and microscopic inspection indicated this was the likely area of fatigue crack initiation. A metallographic cross section of the crack initiation point was prepared and the microstructure examination revealed the presence of base metal heat damage in the area of scoring damage. Away from this area the axle material was consistent with the specification and drawing requirements.

At the request of the NTSB, SWA gathered data on the in-service brake mounting bolt breakaway torque on 13 brake assemblies that required brake replacement due to wear. The breakaway torque on the RMLG outboard brake from the incident airplane was also measured. The brake mounting bolts are to be installed with a final torque of 125-135 foot-pounds per the Aircraft Maintenance Manual, chapter 32-41-41. The in-service mounting bolt torque values on the 14 brake assemblies measured averaged 104 foot-pounds with a minimum measured torque of 35 foot-pounds and a maximum of 175 foot-pounds. The minimum and maximum torque values were recorded on different brakes. Eight of the 14 brakes measured had average torque values greater than 100 foot-pounds but only 3 brakes had average torque values greater than 125 foot-pounds. Six of the 14 brakes had 5 or more brake mounting bolts with

torque values less than 100 foot-pounds and these six brakes all had average torque values less than 100 foot-pounds. There is no requirement or guidance to check the bolt torque after installation.

ADDITIONAL INFORMATION

Federal Aviation Administration Airworthiness Directive (AD) 2000-05-13 mandates that a one-time magnetic particle inspection or a one-time high frequency eddy current inspection of the MLG axle flange be performed to detect cracking and a detailed visual inspection of the bolt holes be performed to detect corrosion or fretting. The AD was performed on the incident RMLG on February 17, 2001.

Examination of the Flight Data Recorder data indicated the landing was essentially normal with no abnormal control inputs or accelerations recorded.

Pilot Information

Certificate:	Airline transport; Commercial; Flight instructor; Private	**Age:**	46,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	June 29, 2009
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 16, 2009
Flight Time:	19642 hours (Total, all aircraft), 13274 hours (Total, this make and model), 12406 hours (Pilot In Command, all aircraft), 230 hours (Last 90 days, all aircraft), 77 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Commercial; Flight instructor; Private	**Age:**	39,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	March 6, 2009
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 2, 2009
Flight Time:	7640 hours (Total, all aircraft), 1313 hours (Total, this make and model), 2800 hours (Pilot In Command, all aircraft), 197 hours (Last 90 days, all aircraft), 53 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N670SW
Model/Series:	737 3G7	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	23794
Landing Gear Type:	Retractable - Tricycle	**Seats:**	145
Date/Type of Last Inspection:	September 7, 2009 Continuous airworthiness	**Certified Max Gross Wt.:**	139500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	69060 Hrs at time of accident	**Engine Manufacturer:**	CFM
ELT:	Not installed	**Engine Model/Series:**	56 Series
Registered Owner:	Polaris Leasing International, Inc.	**Rated Power:**	
Operator:	Southwest Airlines, Co.	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	SWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KLAX,125 ft msl	**Distance from Accident Site:**	
Observation Time:	11:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Few / 900 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	270°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	23°C / 16°C
Precipitation and Obscuration:			
Departure Point:	Las Vegas, NV (KLAS)	**Type of Flight Plan Filed:**	IFR
Destination:	Los Angeles, CA (KLAX)	**Type of Clearance:**	IFR
Departure Time:	10:55 Local	**Type of Airspace:**	

Airport Information

Airport:	Los Angeles International KLAX	**Runway Surface Type:**	Concrete
Airport Elevation:	125 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	24R	**IFR Approach:**	Unknown
Runway Length/Width:	8925 ft / 150 ft	**VFR Approach/Landing:**	Unknown

Wreckage and Impact Information

Crew Injuries:	6 None	**Aircraft Damage:**	Minor
Passenger Injuries:	136 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	142 None	**Latitude, Longitude:**	33.942501,-118.407218

Administrative Information

Investigator In Charge (IIC):	Crookshanks, Clinton
Additional Participating Persons:	Eric West; FAA; Washington, DC Richard Anderson; Boeing; Seattle, WA Jeff Grenier; Southwest Airlines; Dallas, TX
Original Publish Date:	January 7, 2011
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=74683