Aviation Investigation Final Report

Location:	El Paso, Texas	**Incident Number:**	DCA12IA113
Date & Time:	July 27, 2012, 14:14 Local	**Registration:**	N379SW
Aircraft:	Boeing 737-3H4	**Aircraft Damage:**	Minor
Defining Event:	Aircraft structural failure	**Injuries:**	76 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The aircraft experienced a structural failure of the nose landing gear (NLG) actuator retract beam when the landing gear was selected down during approach. The flight crew heard a loud noise during gear actuation, performed a go-around, and then returned to land uneventfully. Examination of the aircraft revealed a fracture across the horizontal leg of the actuator retract beam that propagated into the radius of the vertical leg. The fracture surface features were consistent with overstress failure with no sign of fatigue. The NLG hydraulic line to the actuator was found ruptured with abrasion damage aligned coincident with the NLG tire.

Disassembly of the actuator revealed the restrictor fitting was installed in the head end of the actuator and the union fitting was installed on the rod end cap although engineering documentation requires the restrictor fitting to be installed in the rod end cap and the union fitting to be installed in the head end. The union and restrictor are normally placed in the actuator prior to installing the actuator on the airplane.

Hydraulic fluid leaking from the actuator through the ruptured line allowed air to fill the actuator cavity on the head end of the actuator while hydraulic system pressure remained on the rod end. When the landing gear was selected down, air in the actuator allowed the actuator piston to move rapidly toward the head end. Due to the union rather than the restrictor being installed on the piston end, higher than normal hydraulic flow was permitted in the rod end of the actuator increasing the rate of piston movement. When the piston reached the end of range of motion, the resulting force was transferred to the NLG retract actuator beam.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: the rupture of the nose landing gear hydraulic line that resulted from abrasions due to contact with the nose landing gear tire. Contributing to the incident was the incorrect installation of union and restrictor

on the actuator.

Findings

Aircraft	Scheduled maint checks - Incorrect service/maintenance
Aircraft	Hoses and tubes - Incorrect use/operation
Aircraft	Hoses and tubes - Incorrect use/operation

Factual Information

History of Flight

Approach	Aircraft structural failure (Defining event)
Approach	Miscellaneous/other

HISTORY OF FLIGHT

On July 27, 2012, about 1400 mountain daylight time (MDT), Southwest Airlines flight 1871, a Boeing 737-3H4, N379SW, experienced a structural failure of the nose gear actuator retract beam when the landing gear was selected down during approach to El Paso International Airport (KELP), El Paso, Texas. There were no injuries to the 71 passengers and 5 crewmembers on board and the airplane sustained minor damage. The flight was operating under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121 on a regularly scheduled passenger flight from Las Vegas McCarran International Airport (KLAS), Las Vegas, Nevada to KELP. Visual meteorological conditions prevailed at the time of the incident.

The captain was the pilot flying and the first officer was the pilot monitoring.

At 1400:37, after receiving a clearance from Air Traffic Control (ATC) for a visual approach to runway 8R, the captain asked for "landing gear down".

At 1400:40, as the landing gear was extended; two loud snapping sounds were heard (later described by the captain as "a very loud bang." The captain and first officer discussed the sound and expressed concern regarding the condition of the nose gear.

At 1401:17, the first officer requested a fly-by from the tower and asked that the tower controller inspect the nose gear. The captain then briefed the fly-by and go-around procedure with the first officer. The crew conducted a fly-by at 500 feet above ground level.

At 1404:32, the tower controller advised the flight crew that the nose gear appeared normal and the crew entered a right traffic pattern for a visual approach to runway 8R.

The flight crew conducted a visual approach and landing on runway 8R, and then taxied to the gate uneventfully. During the post flight inspection, the flight crew discovered a puddle of hydraulic fluid under the nose gear and then found the A hydraulic system quantity reduced.

Further inspection by maintenance personnel revealed damage to a hydraulic hose and the nose gear actuator retract beam.

INJURIES TO PERSONS

There were no injuries to the 71 passengers and 5 crewmembers.

DAMAGE TO AIRPLANE

The lower T chord of the actuator retract beam was fractured across the horizontal leg of the T chord and into the radius of the vertical leg about 16 inches aft of the nose wheel forward bulkhead.

The nose gear actuator retract beam was comprised of 4 individual web bays each separated by a vertical web stiffener. The bays were numbered 1 thru 4 beginning with the aft most bay. The aft most bay, bay 1, was undamaged. Bay 2 was buckled along a 45-degree angle forward and down from the aft upper fastener. Bay 3 was also buckled along a 45-degree angle forward and down from the aft upper fastener. The vertical stiffener was cracked vertically along the radius at the lower fastener.

A gap of about 3/8 of an inch was also present between the lower portion of the stiffener and the web. The entire lower edge of the web in Bay 4 was displaced outboard to the left consistent with the lower T chord displacement with no other obvious signs of damage. The lower T chord was displaced outboard and to the left by as much as 2 inches at STA 243.7 in the area of the lower T chord fracture.

All the examined fracture surfaces exhibited features consistent with overstress failures with no evidence of fatigue.

The nose landing gear (NLG) retract actuator hydraulic line was ruptured about 8.5 inches from the forward end of the hose (the end connected to the airplane.) In the area of the rupture, 3.18 inches of black outer spiral wrap was missing. Abrasion marks were also evident on the corrosion resistant steel (CRES) braid on the outboard side, facing away from the actuator beam, also aligned with the axis of the hose. Individual CRES strands were broken with the free ends abraded down to "chisel points" in numerous locations. The Teflon inner liner was ruptured in the area of the damaged CRES braid.

PERSONNEL INFORMATION

The captain, age 47, held a valid FAA Airline Transport Pilot (ATP) certificate with a B737 type rating and a current FAA first-class medical certificate with a limitation requiring him to possess glasses to correct for near vision. The captain reported approximately 15,110 hours total time including about 7,500 hours pilot-in-command and 9,960 hours on the B-737.

The first officer, age 36, held a valid FAA ATP certificate with type ratings for ATR-42, ATR-72, EMB-135, EMB-145, and B737, and a current FAA first-class medical certificate with no limitations. The first officer reported 9,500 hours total time at the time of the incident.

AIRCRAFT INFORMATION

The incident airplane, manufacturer serial number 26586, is a Boeing B737-3H4 equipped with two CFM International CFM56-3B2 turbofan engines. Records indicate the airplane was delivered in 1994.

The airplane had logged about 59,939 hours total time on the airframe and 49,780 cycles as of the day of the incident, and the most recent inspection was conducted on November 5, 2011, as part of the operator's continuous airworthiness maintenance program.

METEOROLOGICAL INFORMATION

The aviation routine weather report (METAR) recorded at 1951 at ELP, indicated wind from 110 degrees at 16 knots gusting to 23 knots, visibility 10 statute miles, few clouds at 5,500 feet, scattered clouds at 10,000 feet, broken cloud layers at 15,000 feet and 25,000 feet, temperature 29 degrees Celsius, dewpoint temperature 16 degrees Celsius, altimeter setting 30.09 inches mercury.

AIRPORT INFORMATION

El Paso International Airport is located 4 miles northeast of El Paso, TX at an elevation of 3,962 feet above mean sea level. The airport has six runways. The landing runway, runway 8R, is grooved asphalt 150 feet wide and 9,028 feet long with a runway end elevation of 3,927 feet above mean sea level. The runway is served by a 4-light precision approach path indicator with a 3-degree glideslope on the left side of the runway and runway end identifier lights.

FLIGHT RECORDERS

The cockpit voice recorder (CVR), an Allied Signal Model 6022, serial number 2319, was removed from the airplane and downloaded at the NTSB Vehicle Recorder Laboratory. The cockpit voice recorder contained 2 hours, 5 minutes of recording on two sets of audio data files; a 2-channel recording containing the last 2 hours of recorded data and a 4-channel file containing the last 30 minutes of recorded data. The audio quality of the channels containing information from the captain's and first officer's audio panels, and the audio quality of the channel containing information from the cockpit area microphone was characterized as good. The recording included events from the flight beginning with the departure climb out prior to reaching 10,000 feet and ending when the CVR was deactivated about 40 minutes after landing. Timing on the CVR summary was established by correlating CVR elapsed time to common events on the Flight Data Recorder (FDR) and adjusting to local MDT.

The FDR, an Allied Signal Model 6022, serial number 0832, was removed from the airplane and downloaded at the NTSB Vehicle Recorder Laboratory. The recorder arrived in good condition and contained approximately 27.2 hours of data which was extracted normally. The event flight was the last flight of the recording and its duration was approximately 1 hour and 37 minutes. Correlation of the FDR data to event local time, MDT, was established using the recorded GMT (Greenwich Mean Time) parameter.

TESTS AND RESEARCH

SYSTEMS

The NLG hydraulic hose, transfer cylinder, retract actuator and hydraulic modular package assemblies were removed from the airplane for examination.

Visual examination of the hydraulic hose revealed a rupture of the hose located 8.5 inches from the "A" end of the hose (the end attached to the airplane, opposite the end attached to the actuator) and approximately 3.18 inches of the black outer spiral wrap was missing in this area. The ends of the spiral wrap showed abrasion aligned with the axis of the hose on the outboard side away from the actuator beam and an arc shape was evident. Abrasion marks were also found on the corrosion resistant steel (CRES) braid with individual strands of the CRES broken and some ends worn down and some strands bent over facing forward. The Teflon inner liner was ruptured in the area of the damaged CRES and black debris were found in and around the damaged CRES braids.

A visual examination of the transfer cylinder indicated no signs of damage or defects except that a tab on the identification tag was broken. Leakage and operational tests were conducted in accordance with the Component Maintenance Manual (CMM) and no faults were found.

A visual examination and a digital radiography inspection of the retract actuator was conducted with no anomalies noted. A functional test of the actuator was conducted in accordance with the CMM. The actuator appeared to operate normally during 5 complete extend and retract cycles with snubbing apparent at both ends of the stroke and no leaks noted.

Additional leak testing was accomplished by extending the actuator as it would be in the gear retracted position and removing hydraulic pressure. When the gear extend hose fitting was removed to simulate a ruptured hydraulic hose, leakage started as a drip and progressed to a steady stream.

Disassembly of the actuator revealed the restrictor fitting was installed in the head end of the actuator and the union fitting was installed on the rod end cap. The engineering drawing, the CMM, and the Illustrated Parts Catalogue require the restrictor fitting to be installed in the rod end cap and the union fitting to be installed in the head end.

The hydraulic modular package assembly was visually examined with no defects noted. The assembly was functionally tested in accordance with the CMM with no faults found during the ten elements of the test procedure.

NLG Functional Demonstration

A nose landing gear functional demonstration was conducted using a similarly equipped 737-300 airplane. A visual inspection of the hydraulic hose, the retract actuator, and connections conducted prior to the demonstration indicated no signs of abrasion on the hose and that the union and restrictor were installed per engineering drawing requirements.

The nose landing gear was extended and retracted three times while measurements and video were taken to assess the movement and positioning of the NLG hydraulic hose. The closest proximity of the hose to the NLG tire was 0.5" and the clearance varied by plus or minus .35" during cycling. The hose could be manually moved into a position in contact with the NLG tire when retracted. The hydraulic hose end attached the actuator was removed from the NLG actuator and then was reinstalled with a twist in the flexible hose sufficient to cause contact with the tire.

MAINTENANCE RECORDS

A review of maintenance records indicated the Retract Actuator Support Beam Assembly was the original component installed on the aircraft and had not been changed previously.

The union and restrictor were normally replaced as part of the scheduled NLG retract actuator overhaul. Actuators were removed from the aircraft and shipped to another location for overhaul and were returned without the union and restrictor. SWA maintenance placed the union and restrictor on the actuator prior to installing the actuator on the airplane. Review of records indicated an overhauled NLG retract actuator was installed on the airplane August 18, 2006.

There was no required maintenance program for the NLG retract hydraulic hose. The hose would be replaced on condition (i.e., if it was noted as damaged or leaking.)

There were no records recovered indicating the NLG retract hydraulic hose had been previously replaced. Records indicate that during prior maintenance activity on October 30, 2008, the retract hydraulic hose was removed and reinstalled as part of a SWA aircraft change order.

ORGANIZATIONAL AND MANAGEMENT INFORMATION

Southwest Airlines is owned and operated by Southwest Airlines Co. who also owned Air Tran Airways. On September 26, 2010, the company entered into a merger agreement for the company's acquisition of AirTran Holdings, Inc. and closed the acquisition on May 2, 2011.

Southwest Airlines is based in Dallas, Texas and started service in June 1971 with three Boeing B-737 aircraft serving three Texas cities: Dallas, Houston, and San Antonio. As of December 31, 2011, Southwest Airlines operated flights to 72 destinations in 37 states and AirTran Airways operated flights to 68 destinations in the United States, Puerto Rico, Mexico, Jamaica, the Bahamas, Aruba, Dominican Republic, and Bermuda. As of December 31, 2011, the combined fleet consisted of 698 airplanes including 610 Boeing B-737's and 88 B-717's.

During 2012, the company initiated a fleet modernization program and introduced the Boeing 737-800 into the fleet.

The incident aircraft is owned by Southwest Airlines Co. and operated by Southwest Airlines for common carrier passenger operations.

ADDITIONAL INFORMATION

Following this event, Southwest Airlines developed a special inspection procedure to inspect the NLG retract actuator hydraulic hose for damage and to inspect the union and restrictor for proper installation.

Following this event, Boeing issued a publication to operators recommending examination of the actuator hydraulic hose for chafe damage, and examination of the union and restrictor for correct installation. Additionally, Boeing amended the CMM to enhance guidance regarding installation of the union and restrictor.

Pilot Information

Certificate:	Airline transport; Private	**Age:**	47,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Airship	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	March 15, 2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	September 9, 2011
Flight Time:	(Estimated) 15110 hours (Total, all aircraft), 9960 hours (Total, this make and model)		

Co-pilot Information

Certificate:	Airline transport; Private	**Age:**	36,Female
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	5-point
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:**	January 17, 2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 23, 2012
Flight Time:	(Estimated) 9500 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N379SW
Model/Series:	737-3H4	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	26586
Landing Gear Type:	Retractable - Tricycle	**Seats:**	145
Date/Type of Last Inspection:	November 5, 2011 Continuous airworthiness	**Certified Max Gross Wt.:**	138500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	59940 Hrs at time of accident	**Engine Manufacturer:**	CFM INTL.
ELT:	Not installed	**Engine Model/Series:**	CFM56 SERIES
Registered Owner:	SOUTHWEST AIRLINES CO	**Rated Power:**	2200 Horsepower
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:	KELP,3962 ft msl	**Distance from Accident Site:**	13 Nautical Miles
Observation Time:	13:51 Local	**Direction from Accident Site:**	90°
Lowest Cloud Condition:	Few / 5500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 15000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	16 knots / 23 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	110°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.09 inches Hg	**Temperature/Dew Point:**	29°C / 16°C
Precipitation and Obscuration:			
Departure Point:	Las Vegas, NV (KLAS)	**Type of Flight Plan Filed:**	IFR
Destination:	El Paso, TX (KELP)	**Type of Clearance:**	IFR
Departure Time:	11:41 Local	**Type of Airspace:**	

Airport Information

Airport:	El Paso International Airport KELP	**Runway Surface Type:**	Asphalt
Airport Elevation:	3962 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	08R	**IFR Approach:**	Visual
Runway Length/Width:	9028 ft / 150 ft	**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	5 None	**Aircraft Damage:**	Minor
Passenger Injuries:	71 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	76 None	**Latitude, Longitude:**	31.807222,-106.376388(est)

Administrative Information

Investigator In Charge (IIC):	Helson, David
Additional Participating Persons:	Dave Keenan; Federal Aviation Administration
Original Publish Date:	August 20, 2019
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=84479