



Aviation Investigation Final Report

Location:	San Antonio, Texas	Incident Number:	ENG171A005
Date & Time:	December 4, 2016, 14:53 Local	Registration:	N161SY
Aircraft:	Embraer ERJ170 200LR	Aircraft Damage:	Minor
Defining Event:	Landing gear collapse	Injuries:	1 Minor, 54 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

Based on the material laboratory examinations, the area around the failure point contained higher than allowable levels of retained austenite. The presence of too much retained austenite subsequently resulted in the formation of intergranular cracking. The intergranular cracking resulted in the formation of progressive cracking, which caused the separation and subsequent failure of the downlock spring. After the failure, the spring became lodged in the nose landing gear yoke, which prevented the nose gear from achieving a down and locked position. Without the NLG being fully down and locked, as the weight of the aircraft during landing was transferred to the nose and main landing gear, the NLG subsequently retracted back into the nose gear wheel.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be:

A failure of the nose landing gear down lock spring which precluded normal downlock operation of the nose landing gear. The spring failure was due to the presence of too much retained austenite which led to the formation of progressive cracking and subsequent failure of the spring.

Findings

Aircraft	Gear extension and retract sys - Failure
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Factual Information

History of Flight

Landing-landing roll	Landing gear collapse (Defining event)
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On December 04, 2016, about 1453 central daylight time, N161SY, an Embraer ERJ170 200L, operated by SkyWest Airlines, experienced an uncommanded retraction of the nose landing gear during rollout after landing on runway 4 at the San Antonio International Airport (KSAT), San Antonio, TX. The aircraft was originally scheduled to land at General Mariano Escobedo Int'l Airport (MMTY), Monterrey, Nuevo Leon, Mexico. However, after departure from the George Bush Intercontinental Airport (KIAH), Houston, Texas the crew heard a loud "thud/pop" just aft of the flight deck. Because no warnings or indications were displayed on the flight deck, the crew decided to proceed to MMTY. When the landing gear was extended on approach, the crew received warning indications regarding the landing gear position and a "LDG GEAR LEVER DISAGREE" message. The crew declared a missed approach, retracted the landing gear per the quick reference handbook (QRH) procedures, and elected to divert to KSAT. Upon entering US airspace, the crew declared an emergency and performed a flyby of the control tower to verify landing gear position. The tower confirmed that the gear appeared to be in the down position. After touchdown on runway 4, during the landing rollout the nose gear retracted, without command, as the aircraft slowed to a stop. The crew and passengers evacuated the aircraft from the aft cabin doors via the evacuation slides. The airplane sustained minor damage. The flight was conducted under the provisions of 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed and a Federal Aviation Administration (FAA) flight plan had been filed for the flight.

Pilot Information

Certificate:	Airline transport	Age:	38
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	5-point
Instrument Rating(s):	None	Second Pilot Present:	
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 1 With waivers/limitations	Last FAA Medical Exam:	May 1, 2016
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	
Flight Time:	2814 hours (Total, all aircraft), 685 hours (Pilot In Command, all aircraft), 189 hours (Last 90 days, all aircraft), 46 hours (Last 30 days, all aircraft), 11 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport; Flight instructor	Age:	
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	5-point
Instrument Rating(s):	None	Second Pilot Present:	
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	Toxicology Performed:	No
Medical Certification:	Class 1 Without waivers/limitations	Last FAA Medical Exam:	January 1, 2016
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	
Flight Time:	862 hours (Total, all aircraft), 132 hours (Last 90 days, all aircraft), 27 hours (Last 30 days, all aircraft), 11 hours (Last 24 hours, all aircraft)		

Cabin crew Information

Certificate:		Age:	
Airplane Rating(s):		Seat Occupied:	Unknown
Other Aircraft Rating(s):		Restraint Used:	4-point
Instrument Rating(s):		Second Pilot Present:	
Instructor Rating(s):		Toxicology Performed:	No
Medical Certification:		Last FAA Medical Exam:	
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:			

Cabin crew Information

Certificate:		Age:	
Airplane Rating(s):		Seat Occupied:	Unknown
Other Aircraft Rating(s):		Restraint Used:	4-point
Instrument Rating(s):		Second Pilot Present:	
Instructor Rating(s):		Toxicology Performed:	No
Medical Certification:		Last FAA Medical Exam:	
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	Embraer	Registration:	N161SY
Model/Series:	ERJ170 200LR 200LR	Aircraft Category:	Airplane
Year of Manufacture:	2016	Amateur Built:	
Airworthiness Certificate:	Transport	Serial Number:	17000569
Landing Gear Type:	Retractable - Tricycle	Seats:	80
Date/Type of Last Inspection:	November 29, 2016 Continuous airworthiness	Certified Max Gross Wt.:	85517 lbs
Time Since Last Inspection:		Engines:	2 Turbo fan
Airframe Total Time:	1307.3 Hrs at time of accident	Engine Manufacturer:	General Electric
ELT:	C126 installed, not activated	Engine Model/Series:	CF34-8E5
Registered Owner:	SKYWEST AIRLINES INC	Rated Power:	
Operator:	SKYWEST AIRLINES INC	Operating Certificate(s) Held:	Flag carrier (121)

The event airplane, an Embraer ERJ 170-200 LR, registration N161SY, serial number 17000569, was manufactured and delivered to the operator in 2016 and had accumulated 1,310 hours and 740 cycles. The NLG downlock springs were installed during manufacture and had accumulated the same time and cycles as the airframe.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KSAT	Distance from Accident Site:	
Observation Time:	18:51 Local	Direction from Accident Site:	
Lowest Cloud Condition:		Visibility	10 miles
Lowest Ceiling:	Overcast / 1300 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	10 knots /	Turbulence Type Forecast/Actual:	/ None
Wind Direction:	20°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.79 inches Hg	Temperature/Dew Point:	
Precipitation and Obscuration:			
Departure Point:	HOUSTON, TX (IAH)	Type of Flight Plan Filed:	IFR
Destination:	(MMTY)	Type of Clearance:	IFR
Departure Time:	11:53 Local	Type of Airspace:	Class B;Class D

Airport Information

Airport:	SAN ANTONIO INTL SAT	Runway Surface Type:	Concrete
Airport Elevation:	809 ft msl	Runway Surface Condition:	Wet
Runway Used:	04	IFR Approach:	None
Runway Length/Width:	8505 ft / 150 ft	VFR Approach/Landing:	Unknown

Wreckage and Impact Information

Crew Injuries:	4 None	Aircraft Damage:	Minor
Passenger Injuries:	1 Minor, 50 None	Aircraft Fire:	None
Ground Injuries:		Aircraft Explosion:	None
Total Injuries:	1 Minor, 54 None	Latitude, Longitude:	29.531389,-98.46833

Injuries to Persons

One minor injury was reported by a passenger which occurred during the evacuation of the aircraft.

Damage to Aircraft

Scraping damage was reported to the lower fuselage skin, forward of the nose landing gear bay and the nose landing gear doors. Minor scraping to the underside of the right-hand engine nacelle was also reported. During the aircraft recovery, a failed downlock spring was found lodged in a lightening hole in the nose landing gear yoke, which obstructed the downlock operation for the nose landing gear.

Flight recorders

The aircraft was equipped with two combination Cockpit Voice Flight Data Recorders (CVFDR) which

recorder identical sets of voice and parametric data. One CVFDR was sent to the NTSB Vehicle Recorders laboratory in Washington, DC for examination. The CVFDR recorded relevant data for landing gear and hydraulic system for the incident flight, and several previous flights. Due to the successful download of the stored data the other CVFDR was not downloaded for the investigation. The Flight Data Recorder Specialist's Factual Report can be found in the public docket for this incident.

Tests and Research

The NLG downlock springs were removed and shipped to the NTSB Materials laboratory in Washington, DC. The right NLG downlock spring was received intact. The left NLG downlock spring was received in two separate pieces. The NLG downlock spring separated in the ninth coil from the lower end due to progressive crack formation. No evidence of overstress was observed.

During a visual inspection, external surfaces of the downlock spring wire had small openings, which resulted in surface roughness measurements that were above the allowable limit set by Embraer. Cross-sections prepared through multiple downlock spring coils along the length of the spring showed intergranular cracking at the openings. The openings and cracking were associated with white etching microstructure of the wire that was consistent with retained austenite, while the base material of the coils had microstructure consistent with martensite, as specified. The amount of retained austenite in a circumferential surface layer of the downlock spring coils was above the allowable limit specified by Embraer per AMS 5678.

Two spring pieces (an end segment and a ring segment) were documented using radiographic images. The computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components. The results of the CT imaging were inconclusive in locating crack location in the spring segments.

The manufacturer provided information to the NTSB regarding additional NLG and MLG downlock springs that failed during operations. The spring from this incident was the only one which resulted in an uncommanded gear retraction on landing. Manufacturing records for the incident spring were reviewed and compared with other events. The manufacturer identified a suspect batch of raw material for the springs, common to multiple events and springs with higher than allowable amounts of retained austenite. The aircraft manufacturer performed multiple quality audits throughout the supply chain for the spring manufacturing process and shared the results with the investigative team.

Additional Information

On March 1st, 2017, Embraer released a retrofit letter, in conjunction with service bulletins for the E170/175 and E190/195 fleet. The letter addressed an inspection and possible replacement of the NLG

downlock springs manufactured from certain material batches.

Administrative Information

Investigator In Charge (IIC): Bauer, Michael

Additional Participating Persons:

Original Publish Date: November 15, 2018

Last Revision Date:

Investigation Class: [Class](#)

Note: The NTSB did not travel to the scene of this incident.

Investigation Docket: <https://data.nts.gov/Docket?ProjectID=94460>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).