



Aviation Investigation Final Report

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|--------------------------------|--|-------------------------|-------------|
| Location: | Galliano, Louisiana | Accident Number: | CEN16LA401 |
| Date & Time: | April 7, 2016, | Registration: | N639NA |
| Aircraft: | AGUSTAWESTLAND PHILADELPHIA AW139 | Aircraft Damage: | Substantial |
| Defining Event: | Part(s) separation from AC | Injuries: | 9 None |
| Flight Conducted Under: | Part 91: General aviation - Other work use | | |

Analysis

During a business flight over the Gulf of Mexico, the crew felt a slight vibration of the tail rotor with no other anomalies noted and landed the helicopter uneventfully at their planned destination. A postflight inspection revealed that one of the tail rotor blade erosion shield extensions, also known as a lightning strip (LS), was missing and that only its side tabs remained attached to the blade. One of the main rotor blade tips sustained substantial damage when the LS separated from the tail rotor blade and impacted the bottom of the main rotor blade.

Metallurgical analysis of the fractured LS revealed microcavities in the metal, which resulted in a fatigue fracture. The helicopter manufacturer concluded that the microcavities were a direct result of the electroplating manufacturing process. Finite element modeling (FEM) of an exemplar LS revealed that the maximum stress values expected during flight were considerably lower than the fatigue limit specified for the electroplated nickel material. The microcavity observed on the accident LS could not be replicated by the FEM model, but the presence of a microcavity could adversely influence the in-flight stresses and reduce the overall strength of the LS. Additional flight testing with strain gauges did not reveal any load condition that would lead to similar LS failures that were experienced during the accident flight. It is likely the LS separated in flight due to a fatigue fracture that was the result of increased stress in the presence of a material flaw that had existed since its manufacture.

The helicopter manufacturer, in response to multiple reports of similar LS failures, changed the material specification from electroplated nickel to a higher strength steel. The steel LS will be installed on all newly built helicopters, and an optional service bulletin will be issued to operators to provide the steel LS upon request.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The fatigue failure of a tail rotor blade erosion shield extension, which resulted in in-flight damage to a main rotor blade.

Findings

| | |
|------------------------------|--------------------------------------|
| Aircraft | (general) - Fatigue/wear/corrosion |
| Organizational issues | Equipment manufacture - Manufacturer |

Factual Information

History of Flight

| Enroute | Part(s) separation from AC (Defining event) |
|---------|---|
|---------|---|

HISTORY OF FLIGHT

On April 7, 2016, at an unknown time, an AgustaWestland AW139 helicopter, N639NA, sustained damage to a main rotor blade during a flight over the Gulf of Mexico. The pilot, co-pilot, and 7 passengers were not injured, and the helicopter sustained substantial damage. The helicopter was registered to and operated by Chevron USA Inc., under the provisions of Title 14 *Code of Federal Regulations* Part 91 as business flight. Visual meteorological conditions prevailed for the flight and a company visual flight rules (VFR) flight plan had been filed. The flight originated at 0600 from South Lafourche Leonard Miller Jr. Airport, (GOA), Galliano, Louisiana, with an en route stop at an oil rig in the Gulf of Mexico and terminated at GOA about 1135.

On May 9, 2018, the Chevron aviation department reported the accident to the NTSB and stated that during the flight the crew felt a slight vibration of the tail rotor. After landing at GAO during a post flight inspection, one of the tail rotor blade (TRB) erosion shield extensions (figure 1) commonly known as a lightning strip (LS) was missing and only its side tabs remained attached to the blade. Additionally, a main rotor blade (MRB) tip was damaged.

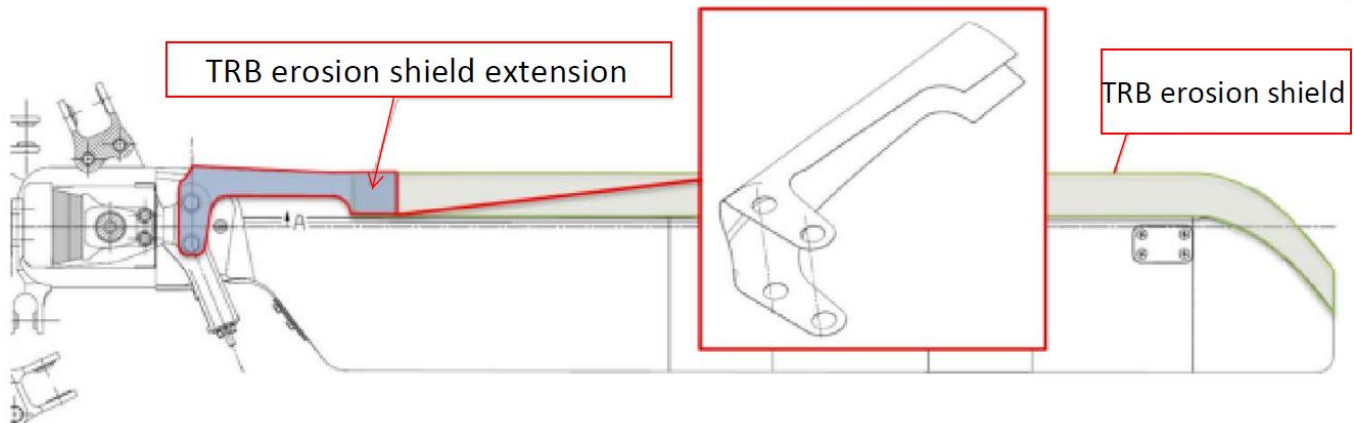


Figure 1 – TRB erosion shield extension diagram with notations (Courtesy of Leonardo)

PERSONNEL INFORMATION

AIRCRAFT INFORMATION

The separated LS was identified as part number (p/n) 3G6410L00152 that was manufactured in electroplated nickel.

Chevron reported that as a normal maintenance practice, an LS would be installed as a brand new part or as an "on-condition" item that had been installed at the discretion of the company maintenance personnel after the component was inspected and determined to be in airworthy condition.

Chevron reported that the associated tail rotor blade (TRB) was received new from Leonardo on May 22, 2015, without an LS installed. An LS was subsequently installed by Chevron with no serial number tracking requirement.

On January 30, 2016, the white TRB was removed and replaced due to wear on the main erosion shield from contact with the LS. The same LS was reinstalled on the replacement white TRB.

From February 26, 2016, to April 6, 2016 the helicopter accumulated 129.1 flight hours with the new TRB installed. During that time, 34 daily serviceability checklist inspections were completed and no discrepancies applicable to the LS on the white TRB (or any other TRB) were noted.

METEOROLOGICAL INFORMATION

WRECKAGE AND IMPACT INFORMATION

A Chevron post flight inspection of the helicopter revealed that the LS on the white TRB was fractured and most of the component was missing. Only the side tabs, where the tail rotor damper bracket bushings pass through, remained attached (figure 2).



Figure 2 – Damaged Tail Rotor Erosion Shield Extension (Courtesy of Chevron)

The inspection also found damage to one of the main rotor blades; the blue MRB tip sustained damage mostly on the under side of the blade (figure 3). No additional damage was observed on the remainder of the helicopter.

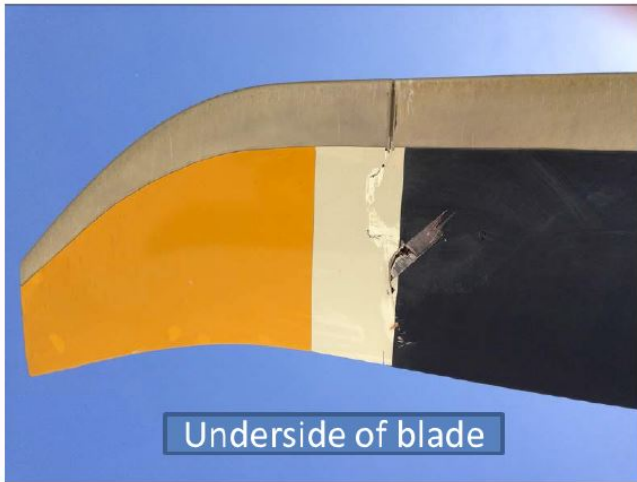


Figure 3 – Damaged Main Rotor Blade (Courtesy of Chevron)

TESTS AND RESEARCH

Failure Analysis

Leonardo, the current AW139 helicopter manufacturer, performed a failure analysis on the remaining portion of the LS, using a scanning electron microscope (SEM), which revealed the presence of microcavity spots or porosity on the surface of the fractured section. Leonardo concluded that the microcavities were a direct result of the electroplating manufacturing process. In figure 4, the area circled in yellow is the microcavity, the red dashes indicate the crack initiation, and the blue arrows indicate the direction of the fatigue crack propagation.

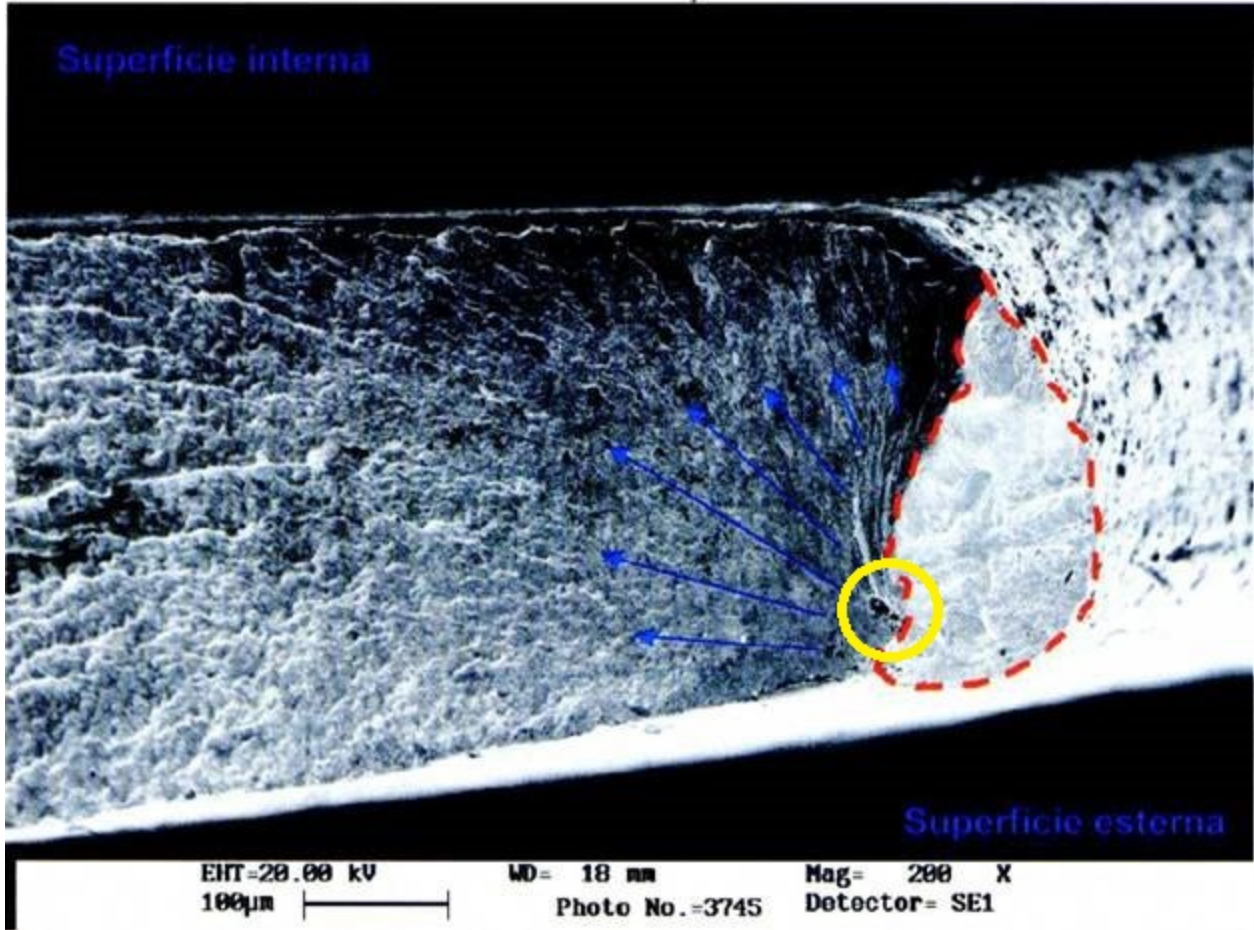


Figure 4 – SEM image of the fatigue propagation from a micro-cavity, yellow circle (Courtesy of Leonardo)

Figure 5 shows a wide view of the fracture surface with the crack origination circled in red.

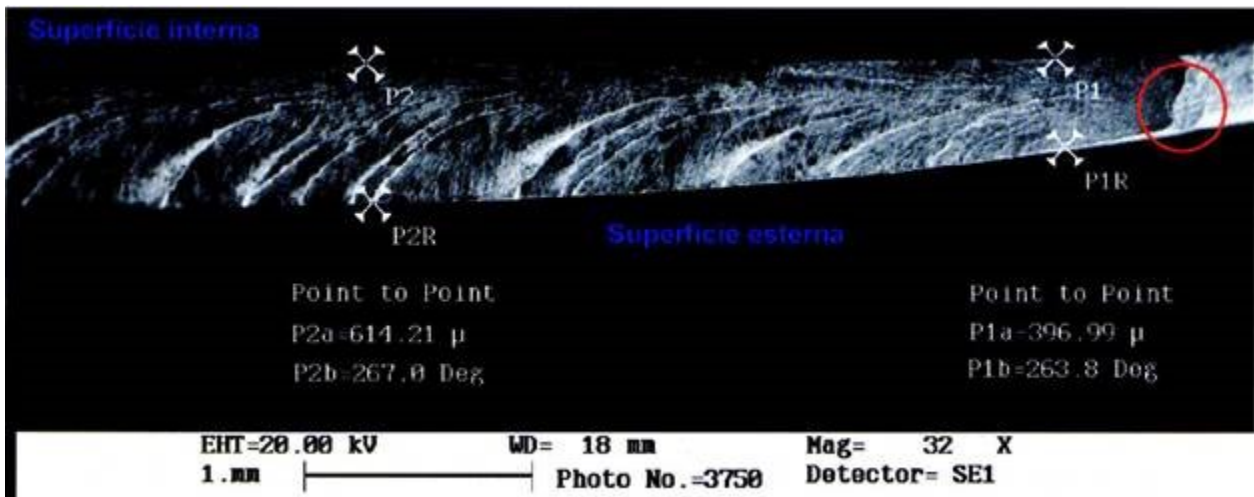


Figure 5 – SEM image, wide view of fracture surface (Courtesy of Leonardo)

Static Testing

Finite element modeling (FEM) of an exemplar LS was completed to determine the expected inflight stress values, to include the influence of the centrifugal force and the bending moment due to the deformation of the TRB under beam bending loads. The simulation showed that the maximum stress values in the crack initiation area were considerably lower than the fatigue limit specified for the electroplated nickel material. Of note, the FEM model considered the geometric and fitting stress concentrations without the presence of a material flaw (such as a microcavity). Although the microcavity observed on the accident LS could not be replicated by the FEM model, Leonardo concluded that the presence of a microcavity could adversely influence the in-flight stresses and reduce the overall strength of the LS.

Flight Testing

A flight test was performed to evaluate the load conditions of the LS during flight. Strain measurement instrumentation was installed on a Leonardo helicopter to monitor and record the load conditions. Test results did not reveal any particular load condition that could lead to similar LS failures experienced during the accident flight.

ADDITIONAL INFORMATION

Related Events

Leonardo identified 6 additional events involving the same LS part number and the three scenarios are listed below. Of note, all three scenarios resulted in an uneventful landing.

- LS crack identified during scheduled inspections (3 events)
- LS fractured and separated in flight (2 events)
- LS fractured and separated inflight, which resulted in damage to MRB tip (2 events, including the accident flight)

Corrective Actions

In response to the reports of similar LS failures, Leonardo changed the specification from electroplated nickel to a higher strength steel. As of July 31, 2017, for all newly built helicopters, the TRB installation drawing was updated to prescribe the installation of a steel LS, p/n 3G6410A03053, (figure 6). Additionally, Leonardo will issue an optional service bulletin to provide the steel LS upon customer request.

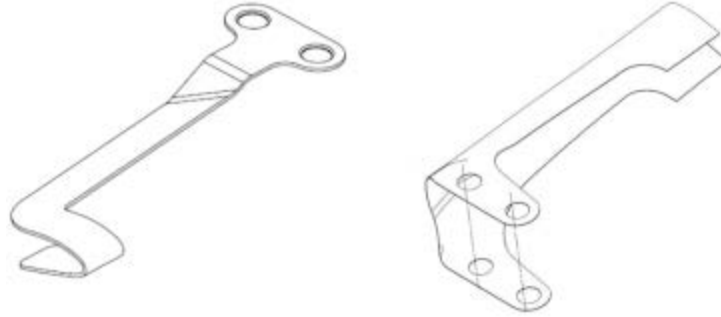


Figure 6 – Diagram of the updated steel LS (left) and electroplated nickel LS (right)

Pilot Information

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|----------------------------------|--|--|-------------------|
| Certificate: | Airline transport | Age: | 52, Male |
| Airplane Rating(s): | None | Seat Occupied: | Right |
| Other Aircraft Rating(s): | Helicopter | Restraint Used: | 4-point |
| Instrument Rating(s): | Helicopter | Second Pilot Present: | Yes |
| Instructor Rating(s): | Helicopter | Toxicology Performed: | No |
| Medical Certification: | Class 1 Without waivers/limitations | Last FAA Medical Exam: | February 19, 2016 |
| Occupational Pilot: | Yes | Last Flight Review or Equivalent: | October 31, 2015 |
| Flight Time: | 14500 hours (Total, all aircraft), 1250 hours (Total, this make and model), 12000 hours (Pilot In Command, all aircraft), 125 hours (Last 90 days, all aircraft), 35 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft) | | |

Co-pilot Information

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|----------------------------------|--|--|------------------|
| Certificate: | Airline transport | Age: | 35, Male |
| Airplane Rating(s): | Single-engine land | Seat Occupied: | Left |
| Other Aircraft Rating(s): | Helicopter | Restraint Used: | 4-point |
| Instrument Rating(s): | | Second Pilot Present: | Yes |
| Instructor Rating(s): | Helicopter; Instrument helicopter | Toxicology Performed: | No |
| Medical Certification: | Class 1 Without waivers/limitations | Last FAA Medical Exam: | March 20, 2016 |
| Occupational Pilot: | Yes | Last Flight Review or Equivalent: | October 31, 2015 |
| Flight Time: | 5792 hours (Total, all aircraft), 1813 hours (Total, this make and model), 2866 hours (Pilot In Command, all aircraft), 114 hours (Last 90 days, all aircraft), 32 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft) | | |

Aircraft and Owner/Operator Information

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|--------------------------------------|---|---|--------------------------|
| Aircraft Make: | AGUSTAWESTLAND PHILADELPHIA | Registration: | N639NA |
| Model/Series: | AW139 | Aircraft Category: | Helicopter |
| Year of Manufacture: | 2013 | Amateur Built: | |
| Airworthiness Certificate: | Transport | Serial Number: | 41326 |
| Landing Gear Type: | Tricycle; Emergency float | Seats: | 14 |
| Date/Type of Last Inspection: | April 6, 2016 Continuous airworthiness | Certified Max Gross Wt.: | 14991 lbs |
| Time Since Last Inspection: | | Engines: | 2 Turbo shaft |
| Airframe Total Time: | 2497.8 Hrs at time of accident | Engine Manufacturer: | P&W CANADA |
| ELT: | C126 installed, not activated | Engine Model/Series: | PT6C-67C |
| Registered Owner: | CHEVRON USA INC | Rated Power: | 1531 Horsepower |
| Operator: | CHEVRON USA INC | Operating Certificate(s) Held: | On-demand air taxi (135) |
| Operator Does Business As: | | Operator Designator Code: | AC2A |

Meteorological Information and Flight Plan

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|---|----------------------------------|---|-------------------|
| Conditions at Accident Site: | Visual (VMC) | Condition of Light: | Day |
| Observation Facility, Elevation: | KXPY,99 ft msl | Distance from Accident Site: | 19 Nautical Miles |
| Observation Time: | 09:15 Local | Direction from Accident Site: | 170° |
| Lowest Cloud Condition: | | Visibility | 10 miles |
| Lowest Ceiling: | | Visibility (RVR): | |
| Wind Speed/Gusts: | 7 knots / None | Turbulence Type Forecast/Actual: | / |
| Wind Direction: | 340° | Turbulence Severity Forecast/Actual: | / |
| Altimeter Setting: | 30.03 inches Hg | Temperature/Dew Point: | 22°C / 12°C |
| Precipitation and Obscuration: | No Obscuration; No Precipitation | | |
| Departure Point: | GALLIANO, LA (GAO) | Type of Flight Plan Filed: | Company VFR |
| Destination: | Galliano, LA (GAO) | Type of Clearance: | None |
| Departure Time: | 06:00 Local | Type of Airspace: | Class E;Class G |

Airport Information

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|-----------------------------|---------------------------------------|----------------------------------|---------|
| Airport: | SOUTH LAFOURCHE LEONARD MILLER GAO | Runway Surface Type: | |
| Airport Elevation: | 0 ft msl | Runway Surface Condition: | Unknown |
| Runway Used: | | IFR Approach: | None |
| Runway Length/Width: | | VFR Approach/Landing: | None |

Wreckage and Impact Information

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|----------------------------|--------|-----------------------------|---------------------------|
| Crew Injuries: | 2 None | Aircraft Damage: | Substantial |
| Passenger Injuries: | 7 None | Aircraft Fire: | None |
| Ground Injuries: | N/A | Aircraft Explosion: | None |
| Total Injuries: | 9 None | Latitude, Longitude: | 29.438055,-90.262496(est) |

Administrative Information

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|--|---|
| Investigator In Charge (IIC): | Lindberg, Joshua |
| Additional Participating Persons: | Harold Aycock; Federal Aviation Administration; Jackson, MS Mikael Amura; Italian Safety Investigation Authority, ANSV Giorgio Dossena; Leonardo Helicopters Chris Lemieux; Leonardo Helicopters |
| Original Publish Date: | June 25, 2019 |
| Last Revision Date: | |
| Investigation Class: | Class |
| Note: | The NTSB did not travel to the scene of this accident. |
| Investigation Docket: | https://data.nts.gov/Docket?ProjectID=97230 |

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