Aviation Investigation Final Report

Location:	Wailuku, Hawaii	**Accident Number:**	WPR14LA251
Date & Time:	June 17, 2014, 13:30 Local	**Registration:**	N6094H
Aircraft:	Airbus AS 350 BA FX1	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	7 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Sightseeing		

Analysis

The commercial pilot of the helicopter was conducting the third local tour flight of the day when, about 10 minutes after departure, the main rotor speed (rpm) started to decrease and the low rotor warning alarm sounded. The pilot lowered the collective pitch control to increase rotor rpm, and the helicopter started to descend. He then raised the collective pitch control, and the main rotor rpm started to decrease again. The pilot entered an autorotation, and the helicopter landed hard in tall grass, resulting in substantial damage to the fuselage and tailboom.

A test run of the engine revealed that, when power was applied, the engine would not achieve a speed above about 78% Ng (engine gas generator speed). Fuel flow indications during the test run were between 125 and 140 pounds per hour (pph); the required value was 300 pph. A leak test of the pneumatic controls revealed that the fitting for the input line to the pneumatic pressure (Pc) filter housing was fractured. A second test run of the engine, following replacement of the Pc filter assembly, was successful. Thus, the fractured fitting rendered the control system incapable of modulating Pc pressure to the fuel control, which resulted in a loss of engine power.

Further examination of the fitting revealed fracture features consistent with fatigue and overload. The Pc filter requires continuous recurring inspections. The filter housing is hard-mounted to the side of the engine plenum and connected to the system via hard pneumatic lines with torqued fittings. Each time that the filter is inspected, the filter housing fittings are subjected to mechanical loosening and re-torqueing. It is likely that the repeated loosening and re-torqueing of the fitting during required maintenance and inspection contributed to the fitting's failure. Following the accident, the manufacturer issued a service bulletin regarding the service and inspection of Pc filter fittings.

Probable Cause and Findings

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

The failure of the engine's pneumatic fuel control line fitting, resulting in a loss of engine power. Contributing to the failure was the repeated loosening and re-torqueing of the fitting during required maintenance and inspection.

Findings

Aircraft	Pneumatic distribution system - Failure
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Personnel issues	Aircraft control - Pilot
Environmental issues	Rough terrain - Effect on operation

Factual Information

History of Flight

Enroute-change of cruise level	Loss of engine power (partial) (Defining event)
Autorotation	Hard landing

On June 17, 2014, about 1330 Hawaii standard time, an Airbus AS 350 BA helicopter, N6094H, sustained substantial damage during a hard landing following a loss of engine power and off-airport auto rotation. The helicopter was registered to and being operated by Sunshine Helicopters Inc., Puunene, Hawaii, as a visual flight rules (VFR) scenic tour flight under 14 Code of Federal Regulations (CFR) Part 135. Visual meteorological conditions prevailed; the pilot and the five passengers were not injured. The flight departed Kalului Airport (PHOG), Kalului, Hawaii, about 1300, and company flight following procedures were in effect.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) on June 26, a representative for Sunshine Helicopters said the pilot reported that he was 10 minutes out on his third flight of the day, when during cruise flight the main rotor speed (RPM) started to decrease and the low rotor warning alarm sounded. He lowered the collective pitch control to increase rotor RPM, and the helicopter started to descend. He raised the collective pitch control and the main rotor RPM started to decrease again; he entered an autorotation, and landed the helicopter.

The helicopter landed hard in tall grass, structurally damaging the fuselage and tailboom.

After recovery, the helicopter's engine (Model LTS101-600A-3A) was removed, and was shipped to the engine manufacturer's facility for further examination under the supervision of the NTSB.

On August 7, 2014, an examination of the engine was conducted.

The examination was conducted under the supervision of the NTSB IIC. In attendance were representatives of the FAA, the operator, and the engine manufacturer. The engine was received in secure packaging and remained unopened until commencing the examination.

ENGINE

Honeywell LTS101-600A-3A Serial # ADCC40239400315

Total Time Since New 8,917

Total Time Since Major Overhaul 547

Total Since Last Inspection (100 hour) 3

ENGINE CONDITION

The engine did not appear to have sustained any physical damage during the autorotation and hard landing. The decision was made to attempt to run the engine in a test cell prior to any disassembly. The engine was installed in an engine test cell and an exterior examination completed.

FUEL SYSTEM DESCRIPTION ENGINE MODEL LTS101-600A-3A

The fuel system consists of an airframe-mounted fuel filter, an engine control system, a fuel manifold with integral flow divider and associated lines. A pressure-operated drain valve at the bottom of the combustor housing drains fuel from the combustor when the engine is shut down. The engine control system consists of a gas generator fuel control (which includes fuel pump), an ambient temperature compensator, a PT governor and, if incorporated, a starting assist fuel system. The fuel system on engine LTS101-600A-3A includes components of the mechanical overspeed protection system and the power turbine retention system. Fuel flow control of the fuel system is controlled through pneumatic pressure (Pc) as generated by the compressor discharge and routed to the various control systems. The PC filter/housing is used to filter the pneumatic compressor discharge air prior to entering the engine control system.

EXAMINATION SUMMARY

8/7/2014:

The engine (LTS101-600A-3A) was removed from the standard shipping container and prepared for installation into the test cell.

The initial test to be performed was the power turbine governor check per the manufacturer's test instruction TI-8114.

Initially the engine was hard to start, but eventually was successfully started.

The engine was brought up to ground idle and stabilized appropriately.

The engine was advanced to flight idle and stabilized appropriately.

The power lever input to the engine was advanced above flight idle but the engine would not achieve a speed above approximately 78% NG. Fuel flow was approximately 125-140 pph.

The test requires 300 pph in order to successfully complete the test. The engine appeared to be sluggish and slow to respond to power lever inputs.

During the testing, vibration in the axial direction was measured on the forward flange of the compressor housing. The measurement exceeded the allowable limit of 0.7 in/sec. A maximum value of approximately 1.3 in/sec was observed with the test cell measurement equipment in the axial direction.

After shutting down the engine, a leak test of the pneumatic controls was initiated.

While removing the input line to the Pc filter housing (the filter and housing are located on the side of the compressor plenum housing) the fitting was found broken. This fitting sends compressor discharge air to the pneumatic system which is used for control of the engine by the various controls components.

A decision was made to replace the Pc filter assembly with a known good one and re-run the previous test.

A re-run of the engine, following the same PT governor check test, was successful with a 300 pph fuel flow achieved. The engine response was appropriately reactive to power lever angle changes and settings.

8/8/2014:

The fracture surface of the broken Pc filter housing inlet fitting was examined at Honeywell's materials analysis lab using a scanning electron microscope (SEM). Evidence of course fatigue striations were identified.

Additional vibration recording equipment was attached to the accident engine and a subsequent test run (with the known good Pc filter assembly) was performed. Vibration data was captured and recorded for future analysis.

The engine was removed from the test cell and sealed back into the approved shipping container.

PCD FILTER HOUSING EXAMINATION

In an effort to identify the failure mode of the lower fitting into the PC filter housing, the failed fracture surface was analyzed. SEM (Scanning Electron Microscope) documentation of the submitted failed parts was completed. SEM images and Energy Dispersive X-ray analyses (EDX) were captured of the fracture surface and material of the part. The following findings and conclusions were made:

• The tube separation at one end of the PC filter housing was a result of a high-strain fatigue fracture mode.

• The fatigue appeared to initiate from multiple locations around the OD of the tube. No defects or anomalies were observed on the fracture surface.

• The fatigue was observed around most of the fracture surface. The final separation exhibited fracture features indicative of fatigue/overload mixed fracture modes.

• Damage was noted on the hexagonal end of the housing where tooling is used to tighten the fittings.

Fuel is delivered through an airframe-mounted fuel filter to the pump section of the fuel control. The pump, driven by gearing from the gas generator spool, delivers fuel to the metering section of the fuel control. During engine start, metered fuel flow from the fuel control is initially directed to primary orifices of the fuel nozzles by the flow divider. Combustion is initiated by the igniter plug, and as the gas generator speed (Ng) and fuel pressure increases, the flow divider begins to direct fuel through secondary orifices of fuel nozzles. When the gas generator reaches 48 to 52 percent Ng, ignition and starter are manually de-energized. The PT governor is the principal controlling unit in a steady state

power range between the flight detent and maximum power. Maximum power and ground idle are controlled by the gas generator fuel control. Maximum and minimum fuel flows are limited by stops within the fuel control.

ADDITIONAL INFORMATION

Note: the pneumatic filter involved in the accident requires continuous recurring inspections as described below. The filter housing which failed is hard mounted to the side of the engine plenum, and connected to the system via hard pneumatic lines with torqued fittings. Each time that the filter is inspected, the filter housing fittings are subjected to mechanical loosening and re-torqueing.

Pneumatic Control System Filter (Pc)

Pc filter servicing will be accomplished at each 150 hour periodic inspection. Service interval may be adapted to a specific operating environment.

A. Pc filter servicing will be accomplished at each 150 hour periodic inspection or service interval may be adapted to a specific operating environment.

B. Service Pc filter by any one of the following steps:

(1) Remove and replace Pc filter element.

(2) Remove, clean and reinstall Pc filter element.

(3) Perform Pc filter differential pressure check.

C. Establish Pc filter service interval as follows:

(2) Perform Pc filter differential pressure check at each 150 hour periodic inspection.

(a) If the Pc filter does not require cleaning or replacement after five 150 hour periodic inspections (700 engine operating hours since step (1)), 600 engine operating hours may be established as the Pc filter service interval and the performance of the Pc filter differential pressure check may be discontinued.

(b) If the PC filter requires cleaning or replacement prior to the fourth 150 hour periodic inspection, the total number of engine operating hours since step (1) minus 150 engine operating hours may be established as the Pc filter service interval and the performance of the Pc filter differential pressure check may be discontinued.

Following the examination, the manufacturer took the following steps;

1. On December 8, 2015, the manufacturer released a category 1 safety service bulletin (LT 101-73-10-0278) to the field affecting all LTS101 engines removing specific versions of the Pc Filter with minimal wall thickness at the inlet fitting making them more susceptible to over stress during removal and installation of the attachment fittings if not properly torqued or supported. (Note: there are 3 versions of the Pc filter in the field.)

2. In addition, this same service bulletin provided instructions to perform PC filter fitting crack inspections; provided torqueing instructions for the PC filter pneumatic tubing B nuts requiring the use of a backup wrench on the attachment fittings while torqueing the B nut; Perform a pneumatic leak check of the pneumatic control system.

3. New Pc filter assemblies are being made available to the field with an increased wall thickness at the fitting attachment point to provide a higher margin of safety in the event the inlet fitting is over torqued or is not properly supported during torqueing. An update to the service bulletin from December of 2015 is about to be released alerting the field to the new PC filter assemblies that are available.

   The manufacturer felt that with the use of proper torqueing values and proper torqueing techniques as defined in the engine maintenance manual, an issue like this should not occur. However, in order to add an additional significant safety margin to the assembly in the event that the proper torque or technique is not used, the manufacturer also increased the part's strength with a thicker wall thickness at the fitting inlet.

Pilot Information

Certificate:	Commercial	**Age:**	45,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	3-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	August 27, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 1, 2013
Flight Time:	4200 hours (Total, all aircraft), 868 hours (Total, this make and model), 4000 hours (Pilot In Command, all aircraft), 205 hours (Last 90 days, all aircraft), 61 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus	**Registration:**	N6094H
Model/Series:	AS 350 BA FX1 BA	**Aircraft Category:**	Helicopter
Year of Manufacture:	1993	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2694
Landing Gear Type:	High skid	**Seats:**	7
Date/Type of Last Inspection:	June 16, 2014 100 hour	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:	3 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	15269 Hrs at time of accident	**Engine Manufacturer:**	Honeywell
ELT:		**Engine Model/Series:**	LTS 101-600A-
Registered Owner:	SUNSHINE HELICOPTERS INC	**Rated Power:**	486 Horsepower
Operator:	SUNSHINE HELICOPTERS INC	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Sunshine Helicopters	**Operator Designator Code:**	SSHA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	OGG	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	09:54 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	20 miles
Lowest Ceiling:	Broken / 3500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	18 knots / 31 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	45°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.02 inches Hg	**Temperature/Dew Point:**	28°C / 3°C
Precipitation and Obscuration:			
Departure Point:	KAHULUI, HI (OGG)	**Type of Flight Plan Filed:**	Company VFR
Destination:	KAHULUI, HI (OGG)	**Type of Clearance:**	VFR
Departure Time:	13:00 Local	**Type of Airspace:**	Class D

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	6 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	7 None	**Latitude, Longitude:**	20.898611,-156.430557

Administrative Information

Investigator In Charge (IIC):	Lewis, Lawrence
Additional Participating Persons:	Edward Valdez; FAA FSDO ; Honolulu, HI Jay Eller; Honeywell Aerospace; Phoenix, AZ
Original Publish Date:	March 23, 2017
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=89477