Aviation Investigation Final Report

Location:	Webb, Idaho	**Accident Number:**	SEA03FA169
Date & Time:	August 13, 2003, 14:50 Local	**Registration:**	N57731
Aircraft:	Aerospatiale AS350D	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Serious
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The pilot had just maneuvered the helicopter for a water pickup for firefighting and was at an altitude of 100-150 feet above ground transitioning to forward flight (outside the height-velocity envelope) when the engine failed. He executed an autorotation to a hard landing as rotor speed bled off. Post accident examination of the engine revealed all the airfoils of the first stage turbine wheel were fractured/damaged and many of the fracture surfaces exhibited features indicative of fatigue progression. Fluorescent penetrant inspection revealed multiple cracks extending onto the rim faces and radial sectioning of several of the stage one turbine airfoils revealed intergranular cracks within the airfoils as well as cracks in the rim area consistent with exposure to temperature spikes and/or elevated operating temperatures. Examination of the second stage turbine nozzle assembly revealed evidence of both thermal distress and mechanical damage and the first stage blade track exhibited damage and deformation throughout its circumference. The diameter and run-out of both the first stage and second stage blade tracks revealed an out of round (warped) condition. Testing of the ToT gauge revealed an out of calibration condition between true input temperature and the temperature displayed on the gauge. The disparity increased as true temperature increased with the gauge reading on the low side (lower than true operating temperatures). Post accident examination revealed metal particulates bridging the contacts of the engine chip light plug. Testing of the warning system revealed a discontinuity within the airframe which prevented the chip light from operating.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: An over temperature condition within the gas generator turbine which led to first stage turbine blade fatigue as well as first stage blade track warping and consequent blade tip rub. The

fatigue and blade tip rub ultimately led to blade separation and failure of the engine. Contributing factors were the out of calibration condition of the turbine outlet temperature gauge and the non-operational engine CHIP warning light system. An additional factor was insufficient rotor RPM while conducting an autorotation.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: HOVER - OUT OF GROUND EFFECT

Findings
1. (C) TURBOSHAFT ENGINE,GAS GENERATOR TURBINE - OVERTEMPERATURE
2. (C) TURBINE ASSEMBLY,TURBINE BLADE - FATIGUE
3. (C) TURBINE ASSEMBLY,RING - WARPED
4. (F) ENGINE INSTRUMENTS,EGT/TOT GAGE - OUT OF CALIBRATION
5. (F) ANNUNCIATOR PANEL LIGHT(S) - NOT OPERATING

Occurrence #2: FORCED LANDING
Phase of Operation: DESCENT - EMERGENCY

Occurrence #3: HARD LANDING
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Findings
6. TERRAIN CONDITION - GROUND
7. (F) ROTOR RPM - INADEQUATE

Factual Information

HISTORY OF FLIGHT

On August 13, 2003, approximately 1450 Pacific daylight time, an Aerospatiale AS350D rotorcraft, N57731, registered to and operated by Silverhawk Aviation LLC, and being flown by a commercial pilot, sustained substantial damage during a loss of power and subsequent hard landing near Webb, Idaho. The pilot was seriously injured. Visual meteorological conditions existed and no flight plan had been filed. The flight, which was engaged in firefighting operations, was operated under 14 CFR 91, and had originated from a landing site near the accident.

The pilot reported that he had just acquired the first bucket of water from Mann Lake and was at an altitude of 100-150 feet above ground transitioning to forward flight (refer to Attachment HV-I) when he heard a loud "bang" followed by the ENGINE OUT light and warning horn. He then executed an autorotation to a hard landing in a clear area along the east side of the lake. Several witnesses reported seeing orange flames exiting from the engine's exhaust before the aircraft commenced its autorotation.

The pilot was interviewed following the accident by an inspector from the Federal Aviation Administration's (FAA) Spokane Flight Standards District Office (FSDO). He was asked if he had seen the engine chip light at any time during the flight and he reported that he had not.

PERSONNEL INFORMATION

The pilot possessed a commercial pilot certificate with a helicopter rating. He reported a total of 4,000 hours of flight experience (all in rotorcraft) and 100 hours in the AS350D rotorcraft (all pilot in command). His most recent biennial flight review was conducted in the AS350D on July 3, 2003. He held a Class II medical without limitations or waivers, which was issued February 5, 2003.

Additionally, according to records maintained by the FAA, the pilot held both a powerplant and airframe mechanic license issued May 13, 1993.

AIRCRAFT INFORMATION

According to the powerplant logs and records for N57731, the helicopter's Rolls Royce (Allison) 250-C30M turboshaft engine, serial number CAE897511, had undergone a 100-hour inspection on June 29, 2003, at a total aircraft time of 7103.9 hours (3061.7 hours Hobbs). The time since last major overhaul on the engine at that inspection was recorded as 2742.7 hours. The Hobbs meter read 3112.7 at the accident site. The airframe log showed an annual

inspection signed off on the same date and at the same total aircraft time. The airframe annual inspection was signed off by the pilot (refer to Attachment AF-I). The powerplant 100-hour inspection was signed off by a different FAA licensed A&P mechanic pilot (refer to Attachment EL-I).

Helicopter engine power check sheets for July 13, 15, 18, 20 and 21, as well as August 12, were reviewed. It was noted that as the checks were sequentially performed the torque output gradually increased while the (ToT) Turbine outlet Temperature decreased (refer to Attachment PC-I).

The mechanic was specifically asked if a Barfield test had been conducted on the helicopter's turbine temperature system at the June 29th 100-hour inspection and he reported that it was. He further reported that the results of the test were such that no corrective adjustment was required to the system.

WRECKAGE AND IMPACT INFORMATION

The aircraft crashed in an open, grassy field along the east edge of Lake Mann, approximately two nautical miles north northwest of Webb, Idaho. The accident site coordinates were estimated to be 46 degrees 22.45 minutes north latitude and 116 degrees 50.85 minutes west longitude. The elevation of the accident site was approximately 1,840 feet (MSL) above mean sea level (refer to CHARTS I & II and photographs 1 through 3).

An initial ground scar was observed with the external water bucket and attached connecting rod noted lying nearby. The rotorcraft was observed at the opposite end of the ground scar having rotated approximately 90 degrees from the axis of the ground scar. Both skids were collapsed, the tail rotor was broken off at the 90-degree gearbox and the ventral fin had broken off (refer to photographs 1 through 3).

The FAA inspector examined the aircraft at the accident site. During this examination metal particulates were observed within the oil filter and bridging the contacts of the engine chip light plug (refer to photographs 4 and 5). Additionally, the FAA inspector applied battery power to the helicopter's electrical system and then tested the chip detection system's continuity by grounding/shorting one of the chip detector plugs (gear box chip plug). He was unable to achieve a chip light illumination on the helicopter's annunciator panel.

The aircraft was subsequently moved to the facilities of Gustin Aviation, Lewistown, Idaho, where the FAA inspector supervised a cursory examination of the engine. During this examination it was determined that there was an N1/N2 lockup and metal particles were found on the chip plugs and in the oil.

TESTS AND RESEARCH

Both light bulbs for the engine chip light warning system within the annunciator panel were tested by removing the entire annunciator panel and then applying power to the panel. Both bulbs were found to be operational and the "press to test" function was functional. Additionally, a continuity check of the circuitry for the chip light detection system between the chip detectors on the engine continuing on up to the cannon plug joining the engine to the airframe section of the chip light system was performed. No discontinuity was found.

The engine ToT gauge was removed and tested at the facilities of Air Tech, Boeing Field, Seattle, Washington. The test results showed a disparity between true input temperature and the temperature displayed on the ToT gauge. Input temperatures at or below 200 degrees centigrade resulted in slightly lower indicator readings. Input temperatures from 400 degrees centigrade and above resulted in an increasing disparity in the opposite direction with a maximum error at an input temperature of 1000 degrees Centigrade showing a reading of 930 degrees Centigrade (refer to Chart T-I and Graphic Image I).

The Rolls Royce (formerly Allison) 250-C30M turboshaft engine, serial number CAE 897511, was removed from the airframe and shipped to Rolls Royce, Indianapolis, Indiana, where a disassembly, examination and metallurgical examination was conducted under the oversight of the Safety Board between September 15 through 19, 2003.

The examination revealed that all the airfoils of the first stage turbine wheel were fractured/damaged and many of the fracture surfaces exhibited features indicative of fatigue progression. Fluorescent penetrant inspection revealed multiple cracks extending onto the rim faces. Radial sectioning of several of the stage one turbine airfoils revealed intergranular cracks within the airfoils as well as cracks in the rim area.

Examination of the second stage turbine nozzle assembly revealed evidence of both thermal distress and mechanical damage. The first stage blade track exhibited damage throughout its circumference. The second stage blade track was cracked. Dimensional examination of the nozzle assembly revealed that it was deformed. The diameter and run-out of both the first stage and second stage blade tracks was measured (refer to Table II and Figures 33 and 34 of attached Metallurgical Investigation Report). Examination of four sectioning areas revealed that in two cases the casting wall thickness of the first stage blade track was found to be below the minimum thickness allowed in the overhaul manual (refer to Table III of attached Metallurgical Investigation Report and attachment OM-I). Further examination of the first stage blade track revealed transferred material consistent with the metal type of the first stage turbine wheel airfoils (refer to attached Metallurgical Investigation Report).

Pilot Information

Certificate:	Commercial	**Age:**	39,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	February 5, 2003
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	July 3, 2003
Flight Time:	4000 hours (Total, all aircraft), 100 hours (Total, this make and model), 3800 hours (Pilot In Command, all aircraft), 100 hours (Last 90 days, all aircraft), 45 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Aerospatiale	**Registration:**	N57731
Model/Series:	AS350D	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1434
Landing Gear Type:	Skid	**Seats:**	6
Date/Type of Last Inspection:	June 29, 2003 100 hour	**Certified Max Gross Wt.:**	4190 lbs
Time Since Last Inspection:	51 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	7154.9 Hrs at time of accident	**Engine Manufacturer:**	Rolls-Royce (Allison)
ELT:	Installed	**Engine Model/Series:**	250-C30M
Registered Owner:	Silverhawk Aviation LLC	**Rated Power:**	650 Horsepower
Operator:		**Operating Certificate(s) Held:**	
Operator Does Business As:		**Operator Designator Code:**	X5HL

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	LWS,1438 ft msl	**Distance from Accident Site:**	8 Nautical Miles
Observation Time:	14:56 Local	**Direction from Accident Site:**	253°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	8 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.01 inches Hg	**Temperature/Dew Point:**	32°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Craigmont, ID (S89)	**Type of Flight Plan Filed:**	Company VFR
Destination:		**Type of Clearance:**	None
Departure Time:	14:30 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious	**Latitude, Longitude:**	46.374168,-116.846664

Administrative Information

Investigator In Charge (IIC):	McCreary, Steven
Additional Participating Persons:	Donnie D Ware; FAA FSDO; Spokane, WA John Swift; Rolls-Royce; Indianapolis, IN
Original Publish Date:	September 1, 2004
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=57703