Aviation Investigation Final Report

Location:	KAHULUI, Hawaii	**Accident Number:**	LAX00LA167
Date & Time:	April 21, 2000, 09:30 Local	**Registration:**	N6094H
Aircraft:	Eurocopter AS-350 BA	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	6 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Sightseeing		

Analysis

The pilot attempted a run on landing after a loss of engine power over rough terrain. The helicopter bounced back into the air after initial touchdown and came to a sudden stop after a skid caught in a ditch. The pilot saw the engine oil pressure light illuminate followed by an illuminated generator light and the sound of the low rotor rpm audio. He informed his passengers that he was making a precautionary landing and briefed them on emergency procedures. After entering autorotation, he unsuccessfully attempted to restart the engine. He continued to the preselected landing zone, and after clearing obstacles, landed in an open area. One passenger seated in the back recalled smelling fuel about 15 seconds prior to the low rpm audio warning. During the on-scene inspection of the fuel system, the T-fitting was partially attached to the ignition solenoid housing. It was further noted that the safety wire was not a field installation. Maintenance personnel indicated that they had not done fieldwork in this area, and the last overhaul was conducted at the manufacturer's facilities in June 1999. The engine was later examined at the manufacturer's facility. Prior to removal of the ignition solenoid valve, T-fitting, and start drain components, manufacturer representatives confirmed that the safety wire, a swedged unit, was installed at their facility during the last overhaul. A visual inspection of the T-fitting and ignition solenoid valve revealed that the threads of both units were covered in a black substance with metallic particles sticking to the threads. The O-ring on the T-fitting was flattened with material missing from it. A metallurgical examination of the ignition solenoid valve and T-fitting was conducted. The T-fitting is made from steel, and the ignition solenoid valve is made from an aluminum alloy. The O-ring is located in a recessed groove that provides sealing between the threaded portion of the ignition solenoid valve and T-fitting. An energy dispersive x-ray spectroscopy (EDS) test indicated that the black substance found on the threads of both components contained peaks of aluminum. It also revealed that the inside threaded portion of the ignition solenoid valve housing exhibited deterioration consistent with fretting. An examination of the chamfer area of the ignition solenoid housing was outside of the manufacturer's design specifications. The chamfer area is the recessed groove in the ignition solenoid housing and is designed to guide the O-ring into

position and prevent it from being pinched between the T-fitting and ignition solenoid valve once installed. The O-ring would not have seated properly during installation due to the chamfer area being outside of design specification limits. This would have prevented adequate clamping forces to be applied and may have allowed the lock nut to loosen. The engine was the placed in a test cell for an acceptance run. The engine started and ran for approximately 20 minutes while a range of acceptance tests were conducted. No discrepancies were noted with the engine run-up.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Failure of the manufacturer to ensure proper quality control of the ignition solenoid housing chamfer area, which allowed for insufficient clamping forces between the ignition solenoid housing and T-fitting, and the eventual separation of the T-fitting, loss of fuel, and loss of engine power.

Findings

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - MECH FAILURE/MALF
Phase of Operation: CRUISE

Findings
1. (C) FLUID,FUEL - STARVATION
2. (C) FUEL SYSTEM,SELECTOR/VALVE - FRETTED
3. (C) FUEL SYSTEM - IMPROPER - MANUFACTURER
4. (C) INADEQUATE QUALITY CONTROL - MANUFACTURER

Occurrence #2: HARD LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Findings
5. TERRAIN CONDITION - ROUGH/UNEVEN
6. TERRAIN CONDITION - MOUNTAINOUS/HILLY
7. TERRAIN CONDITION - HIGH VEGETATION
8. TERRAIN CONDITION - HIDDEN OBSTRUCTION(S)

Factual Information

On April 21, 2000, at 0930 hours Hawaiian standard time, an American Eurocopter AS-350 BA, N6094H, experienced a loss of engine power during cruise. The pilot made a hard landing in rough mountainous terrain in Iao Valley, 7 miles southwest of Kahului airport, Maui, Hawaii. The helicopter was operated by Sunshine Helicopters, Inc. as a nonscheduled, domestic, passenger, sightseeing flight under 14 CFR Part 135, and sustained substantial damage. The commercial instrument helicopter pilot, and five passengers were not injured. Visual meteorological conditions existed for the 30-minute tour of the west Maui Mountains. A company visual flight rules (VFR) flight plan had been filed. The flight originated at 0915, and was scheduled to terminate at the Kahului airport.

According to the pilot's written statement to the Safety Board, approximately 20 minutes into the flight he informed the passengers that he was experiencing a loss of engine power and that he was going to make a precautionary landing. He stated that without prior indication of a problem, the engine oil pressure light illuminated followed by the generator light and the low rotor rpm audio warning. He lowered the collective to stop the low rotor rpm warning from sounding, to regain rpm, and to enter an autorotation, then made an attempt to restart the engine. He simultaneously briefed his passengers on emergency landing procedures. He noted that the N1 was at 10-12 percent and that the generator light was still not illuminated. He assumed the engine had restarted and "pulled a little collective" and "instantly noticed by 'sound' the rotor dropped a little." He knew he had experienced an engine failure and continued towards his preselected landing zone. In order to make the landing zone, the pilot had to clear several obstacles, then flare, and make a "run on landing." He flared the helicopter 2-3 times to clear obstacles, and then a final deceleration as he attempted the run-on landing. Approximately 10 feet short of the landing zone, he knew he was going to land hard and instructed his passengers to sit straight. After landing, the helicopter bounced 10 feet forward, coming to a sudden stop after a skid caught in a ditch.

Two passengers seated on the left side in the back, stated that about 15 seconds before the engine out low rpm audio sounded they smelled fuel fumes. One of the passengers started to feel sick and was about to tell the pilot when the warning sounded. None of the other passengers or the pilot recalled smelling fuel.

PERSONNEL INFORMATION

A Safety Board investigator reviewed the pilot's training records. The pilot held a commercial pilot certificate with ratings for rotorcraft and instrument helicopter. There were no restrictions noted. The pilot received his commercial certificate on October 19, 1993.

A review of the pilot's medical certificate revealed that he held a second-class medical issued

on October 8, 1999, with no limitations.

According to the pilot's training records he had a total time of 6,755.10 hours. In the last calendar quarter (January - March 2000), he had accrued 273.80 hours of total turbine time. Total time in the AS 350 for that same time period was 273.80 hours. In the month of April 2000, he had accrued 41.2 hours of flight time. The pilot's training records indicated that he completed an airman competency/proficiency check FAR 135.293, in an AS-350 BA on March 20, 2000. No discrepancies were noted during the check.

AIRCRAFT INFORMATION

The helicopter was inspected at the operator's facilities by a Federal Aviation Administration (FAA) inspector. During the inspection of the fuel system, the FAA inspector noted that a T-fitting had separated from the ignition solenoid valve housing. The inspector noted that the safety wire did not appear to be a field installation. Maintenance personnel from the operator indicated that they had not worked on this component since the last overhaul.

The inspector further noted that when he rotated the N1 section manually it turned freely.

The inspector also reviewed the helicopter airframe and engine logbooks, which showed a total airframe time as 10,066.3. The last annual inspection had been conducted on January 26, 2000. The last 100-hour inspection had been conducted on April 5, 2000.

On June 6, 1999, Turbomeca's Repair Station in Grand Prairie, Texas, overhauled the engine. Total engine time since new was 6,705.6 hours. Total engine time since overhaul was 525.1 hours.

TEST AND RESEARCH

On May 10, 2000, an engine examination took place at the Turbomeca overhaul facility in Grand Prairie, under the supervision of the Safety Board. Parties to the investigation in attendance at the examination were American Eurocopter, Sunshine Helicopter, Inc., and Turbomeca Engine Corporation.

EXTERNAL EXAMINATION

Technicians removed the ignition solenoid valve, T-fitting, and the start drain valve from the engine for inspection. The T-fitting remained attached to both the ignition solenoid valve and the start drain valve; however, it had separated from the ignition solenoid housing. Prior to removal of the unit, Turbomeca representatives confirmed that the safety wire, a swedged unit, had been installed at the Grand Prairie facility during the last overhaul.

ENGINE RUN

Prior to the engine run, the Fuel Control Unit (FCU) fuel screen and the oil filter were removed and inspected. The FCU fuel screen was free of debris. The oil filter appeared to have been recently installed. Carbon particles were found in the oil filter; however, the manufacturer considered this normal.

A new ignition solenoid valve, T-fitting, and start drain valve were installed on the engine. The engine was placed in a test cell for an engine acceptance test run. The engine started and ran for approximately 20 minutes while a range of acceptance tests were conducted. The engine ran at 97 percent N1 through high and low rpm/torque ranges with no deviations. The throttle was advanced to maximum N1 with no discrepancies noted. During this operation it was also noted that the bleed air valve opened and closed within the normal range.

A fuel leak was introduced into the system and the engine ran at 97 percent N1. A variety of tests were conducted until the engine quit. Another engine run with the fuel leak was conducted with the bleed air valve manually opened. When that element was introduced, the engine flamed out immediately.

INTERNAL EXAMINATION

The T-fitting was removed from the ignition solenoid valve. The T-fitting was covered with a black substance and metallic shavings were stuck to the threads. The threads of the unit inside the valve were also covered with a black substance. Metallic shavings were also found inside the valve. The O-ring, which was seated between the T-fitting and the ignition solenoid valve, was flattened and had material missing from it. The unit was sent to the Safety Board's metallurgical laboratory in Washington, D.C., for further examination.

METALLURGICAL EXAMINATION

The metallurgist indicated that the T-fitting was made of steel, which is then threaded into the ignition solenoid valve housing that is made of an aluminum alloy. An O-ring is placed in the groove that allows sealing between the threaded portions of the T-fitting and ignition solenoid valve housing.

Energy dispersive x-ray spectroscopy (EDS) was conducted on the black substance found on the T-fitting threads and inside the ignition solenoid aluminum alloy housing. The EDS spectra in those areas had peaks of aluminum. However, no aluminum peaks were observed on the T-fitting away from the threaded ends where there was no black substance observed. The threads inside the aluminum alloy housing exhibited deterioration that was consistent with fretting.

The metallurgist stated that the O-ring was flattened and that material was missing. This damage extended approximately 135 degrees in circumference. On one side of the center circumferential plane of the O-ring a corresponding impression was observed on the opposite side that would be consistent with a pinched O-ring.

The resulting examination by the Safety Board metallurgist of the chamfer area revealed that the chamfer area was outside the manufacturer's design specifications. The chamfer is between the outer surface and the recessed area in the aluminum alloy housing. It is designed to guide the O-ring into position and to prevent it from being pinched between the T-fitting and ignition solenoid valve as it is being installed. Insufficient clamping forces due to flattening of the O-ring may have allowed the lock nut to loosen.

Pilot Information

Certificate:	Commercial	**Age:**	38,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	October 18, 1999
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	6811 hours (Total, all aircraft), 4551 hours (Total, this make and model), 6811 hours (Pilot In Command, all aircraft), 295 hours (Last 90 days, all aircraft), 90 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N6094H
Model/Series:	AS-350 BA AS-350 BA	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2694
Landing Gear Type:	Skid	**Seats:**	7
Date/Type of Last Inspection:	April 5, 2000 100 hour	**Certified Max Gross Wt.:**	4630 lbs
Time Since Last Inspection:	52 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	10066 Hrs	**Engine Manufacturer:**	Turbomeca
ELT:	Installed, not activated	**Engine Model/Series:**	ARRIEL 1B
Registered Owner:	SUNSHINE HELICOPTERS, INC.	**Rated Power:**	600 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	SSHA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	OGG ,54 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	09:54 Local	**Direction from Accident Site:**	210°
Lowest Cloud Condition:	Scattered / 4700 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	20 knots / 16 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	50°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	26°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	, HI (OGG)	**Type of Flight Plan Filed:**	Company VFR
Destination:		**Type of Clearance:**	VFR
Departure Time:	09:07 Local	**Type of Airspace:**	Class C

Airport Information

Airport:	KAHULUI AIRPORT OGG	**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	5 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	6 None	**Latitude, Longitude:**	20.759479,-156.450469(est)

Administrative Information

Investigator In Charge (IIC):	Cornejo, Tealeye
Additional Participating Persons:	DARCY REED; HONOLULU , HI ARCHIE WHITTEN; GRAND PRAIRIE , TX KEN ARNOLD; GRAND PRAIRIE , TX RAY WEISER; GRAND ISLAND , NY
Original Publish Date:	July 17, 2001
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=49022