



National Transportation Safety Board Aviation Accident Final Report

Location:	Escalon, CA	Accident Number:	WPR10LA126
Date & Time:	02/02/2010, 1400 PST	Registration:	N9286U
Aircraft:	ARROW FALCON EXPORTERS INC OH-58A	Aircraft Damage:	Substantial
Defining Event:	Powerplant sys/comp malf/fail	Injuries:	1 Serious
Flight Conducted Under:	Part 91: General Aviation - Positioning		

Analysis

The pilot had reported to his mechanic prior to the accident flight that the helicopter was not producing full power, was vibrating heavily, and that the DC generator caution light had illuminated. He also reported that his work load was heavy, and that he would continue onwards to return the helicopter to its home base. Shortly after takeoff the engine lost power, the pilot performed a forced landing, and the helicopter collided with terrain. Examination of the engine revealed that a stainless steel pneumatic fuel-to-governor control line had failed at its fitting. Witness marks on the line revealed that it had been rubbing against an adjacent oil line. Additionally, the pneumatic line had been bent during installation such that its surface was in contact with the connector ferrule. Analysis of the line's fracture surface revealed indications of high cycle fatigue. The fuel controller was replaced about 26 flight hours prior to the accident; replacement of the controller would have required the removal and installation of the failed line. The engine manufacturer provided installation guidance in multiple publications, and specifically cautioned against improper installations of engine lines. Examination of the DC starter-generator revealed that it had experienced a partial mechanical failure, which was likely the reason the pilot felt a vibration and observed a dc generator caution light. During the investigation the failed line was replaced, and the engine was successfully run in a test cell throughout its power range.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A loss of engine power during cruise flight due to the fatigue failure of the pneumatic fuel-to-governor control line. Also causal was the inadequate installation of the pneumatic line by maintenance personnel, and the pilot's decision to continue flight with a known discrepancy.

Findings

Aircraft	Maintenance/inspections - Incorrect service/maintenance (Cause) Engine fuel and control - Fatigue/wear/corrosion (Cause)
Personnel issues	Decision making/judgment - Pilot (Cause)

Factual Information

HISTORY OF FLIGHT

On February 2, 2010, about 1400 Pacific standard time, an Arrow Falcon Exporters, OH-58A helicopter, N9286U, landed hard in an orchard shortly after takeoff near Escalon, California. Cavanagh Flying Service was operating the helicopter under the provisions of Title 14 Code of Federal Regulations Part 91 as a positioning flight. The commercial pilot sustained serious injuries; the helicopter sustained substantial damage. The local flight departed from an orchard near Escalon. Visual meteorological conditions prevailed, and no flight plan had been filed.

The pilot left two voicemail messages for his mechanic about 30 minutes prior to the accident. In the messages he relayed that the helicopter was vibrating heavily, "did not have a whole lot of power," and that the dc generator caution light was illuminated. He further stated that he was experiencing, "big maintenance problems." He went on to comment that his work load was heavy, and he would attempt to fly the helicopter home.

According to a family member of the pilot, while fueling the helicopter prior to the accident flight, the pilot reported that the helicopter was vibrating. The pilot then proceeded to takeoff in the helicopter, and a short time later reported over the radio that the generator light was illuminated. Shortly thereafter, the pilot relayed the message, "I'm going down."

In a written statement, the pilot reported that shortly after departure, at an altitude of about 200 feet above ground level, the engine lost power. He performed a forced landing and the helicopter landed hard, sustaining substantial damage to the entire fuselage structure.

HELICOPTER INFORMATION

The helicopter, serial number 69-16198, was equipped with a Rolls-Royce/Allison T63-A-720 gas turbine engine, serial number 405588. In February 1997 it received a restricted class airworthiness certificate under the agricultural and pest control category.

A review of the helicopter's logbooks revealed that during the last annual inspection dated December 7, 2009, the helicopter amassed a total airframe time of 7,549.3 flight hours, with a corresponding Hobbs hour meter time of 3,602.7. The corresponding entry for the annual inspection in the engine logbook indicated, "Eng TT 1,776.3."

An entry in the engine logbook revealed that the fuel control unit was replaced on December 27, 2009, at a Hobbs hour meter time of 3,610.4.

The most recent logbook entry was for a 25-hour inspection, dated January 31, 2010, at a Hobbs hour meter time of 3,633.6. The Hobbs hour meter at the accident site indicated 3,636.6 hours.

TESTS AND RESEARCH

External Engine Exam

The engine was removed from the helicopter in the presence of the NTSB investigator-in-charge, and representatives from Rolls-Royce and Bell Helicopters. The engine compartment was largely intact and the engine appeared to have sustained minimal impact damage. Inward facing indentations were observed on the outer combustion case adjacent to the fuel igniter; additionally, the fuel nozzle/igniter boss appeared canted approximately 10 degrees from its

normal plane.

Rotation of the N1 rotor by hand revealed it to be free and continuous from the compressor through to the starter generator. Additionally, rotation of the N2 rotor revealed it to be continuous from the 4th stage turbine through to the freewheeling unit output shaft. No indication of foreign object damage was noted at the compressor inlet and first stage wheel.

Examination of the engine fuel control unit (FCU) revealed that the pneumatic control line, part number 6870035, which connects the power turbine governor to the FCU, had fractured at the FCU connector. The line was noted displaced about 1/4-inch laterally from its fitting.

Pneumatic Control and Oil Sump Accessory Lines

Examination of the pneumatic control line revealed that it had fractured 0.42 inches from the end of the tube, adjacent to the end of the ferrule. A rub mark measuring about 0.125 inches in diameter was noted on the line adjacent to an oil sump accessory housing line, part number 6853464AL. The oil line displayed a corresponding rub mark. The pneumatic line was visually compared to an exemplar tube and appeared to be bent outwards in two planes.

Both lines were further examined by the Rolls-Royce metallurgical department. The examination revealed that the outer surfaces of the pneumatic line displayed several circumferential score marks adjacent to the fracture surface at the shoulder of the ferrule. The fracture face was examined utilizing a scanning electron microscope (SEM). Crack signatures were observed to progress radially at the tube wall in the area of the scoring, and progress circumferentially around the tube. Rolls-Royce stated that the fracture features were indicative of high cycle fatigue. A cross-section of the flared tube end revealed the existence of two additional cracks originating on the outer wall, which had not propagated through to the inner surface of the tube. According to Rolls-Royce, the pneumatic line was of an appropriate stainless steel type, and met the wall thickness and diameter dimensions specified in the engineering drawings.

Rolls-Royce produced an examination report, which was reviewed by the Safety Board Office of Research and Engineering, Materials Laboratory Division. The report is included in the public docket for this accident.

Engine Test

The engine was relocated to a Rolls-Royce service facility for further examination.

The damaged pneumatic and oil scavenge lines, and the impact damaged outer combustion case, were replaced with slave units in preparation for an engine test run. During their replacement it was noted that the fuel nozzle/igniter had sustained fretting damage in the area adjacent to the combustion liner. Additionally, a 2-inch-long section of the double lip flange at the base of the combustion liner was missing. The missing section was not located within the engine.

The engine was then installed in a Rolls-Royce engine test cell. The engine was started, and checked throughout its power range for about 1 hour; no anomalies were noted.

DC Starter-Generator

The starter-generator was removed from the engine for examination. A data plate on the side of

the unit indicated that it was manufactured by Lear Siegler, Inc., model number of 23032-022, with a manufacture date of June 6, 1980.

Visual examination of the starter-generator revealed that the main bearing shield had become separated from the bearing, exposing the inner bearing race at the splined shaft. The shield was free on the shaft and appeared distorted. Both the race and shield exhibited a blue tint. Rotation of the starter-generator by hand resulted in a grinding sound emanating from within the unit. Additionally, about 1 millimeter of lateral play was noted in the splined shaft at the area of the main bearing.

ADDITIONAL INFORMATION

Rolls-Royce released a Customer Service Letter A-1166, MAINTENANCE WARNING – EXTERNAL LINES dated November 15, 1990, and revised February 5, 2007. The letter reiterated the need to adherence to operation and maintenance manual procedures regarding proper alignment, clamping, and torquing of engine tubing during installation. In part, the letter stated that failures in external tube lines can be caused by, "Bent tubes which induce misalignment at the flare and result in cracked flares or fretting of the tube at the end of the ferrule...Tube to fitting misalignment caused by poorly aligned fittings, which result in cracked flares or fretting of the tube at the end of the ferrule."

The Rolls-Royce Operation and Maintenance Manual 73-20-02 applicable to the accident engine described the fuel control removal and installation procedures in the section – Bendix Gas Producer Fuel Control – Maintenance Practices. The section states:

"WARNING: FAILURE TO PROPERLY INSTALL, ALIGN AND TIGHTEN FUEL, OIL, AND AIR FITTINGS AND TUBES COULD RESULT IN AN ENGINE FAILURE."

According to the Rolls-Royce representative, a leak in the pneumatic control line could result in a reduction in engine power, with a complete failure of the line likely causing an engine power loss to sub-idle conditions.

History of Flight

Prior to flight	Aircraft maintenance event
Enroute	Powerplant sys/comp malf/fail (Defining event) Loss of engine power (partial)
Emergency descent	Collision with terr/obj (non-CFIT)

Pilot Information

Certificate:	Commercial	Age:	68, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land; Single-engine Sea	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With Waivers/Limitations	Last Medical Exam:	01/06/2010
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	10/08/2008
Flight Time:	12928 hours (Total, all aircraft), 3010 hours (Total, this make and model), 30 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	ARROW FALCON EXPORTERS INC	Registration:	N9286U
Model/Series:	OH-58A	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Restricted	Serial Number:	69-16198
Landing Gear Type:	Skid	Seats:	4
Date/Type of Last Inspection:	12/07/2009, Continuous Airworthiness	Certified Max Gross Wt.:	3000 lbs
Time Since Last Inspection:	3 Hours	Engines:	1 Turbo Shaft
Airframe Total Time:	7580 Hours	Engine Manufacturer:	Rolls-Royce
ELT:	Not installed	Engine Model/Series:	T63-A-720
Registered Owner:	On file	Rated Power:	420 hp
Operator:	On file	Air Carrier Operating Certificate:	
Operator Does Business As:	Cavanagh Flying Service	Operator Designator Code:	VFEG

Meteorological Information and Flight Plan

Observation Facility, Elevation:	KMOD, 97 ft msl	Observation Time:	1353 PST
Distance from Accident Site:	9 Nautical Miles	Condition of Light:	Day
Direction from Accident Site:	190°	Conditions at Accident Site:	Visual Conditions
Lowest Cloud Condition:		Temperature/Dew Point:	12° C / 8° C
Lowest Ceiling:	Broken / 1300 ft agl	Visibility	4 Miles
Wind Speed/Gusts, Direction:	4 knots, 10°	Visibility (RVR):	
Altimeter Setting:	29.83 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	Haze; No Precipitation		
Departure Point:	Escalon, CA	Type of Flight Plan Filed:	None
Destination:	Modesto, CA	Type of Clearance:	None
Departure Time:	1355 PST	Type of Airspace:	

Wreckage and Impact Information

Crew Injuries:	1 Serious	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Serious		

Administrative Information

Investigator In Charge (IIC):	Elliott Simpson	Adopted Date:	10/21/2010
Additional Participating Persons:	Timothy L Jarrard; Federal Aviation Administration FSDO; Oakland, CA Jon Michael; Rolls-Royce; Indianapolis, IN David C Dosker; Bell Helicopter Textron Inc.; Fort Worth, TX		
Publish Date:	10/21/2010		
Investigation Docket:	http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=75333		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.