ACCIDENT

Aircraft Type and Registration:	Schweizer 269C, G-OGOB
No & Type of Engines:	1 Lycoming HIO-360-D1A piston engine
Year of Manufacture:	1987
Date & Time (UTC):	4 September 2005 at 1200 hrs
Location:	Putts Corner, Honiton, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1
Nature of Damage:	Significant damage to the cockpit, main rotors and tail boom
Commander's Licence:	Private Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	273 hours (of which 120 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	AAIB Field investigation

Synopsis

The pilot and a passenger were returning to Dunkeswell after a short pleasure flight when, at approximately six nautical miles from the airfield and at a height of 650 ft, the pilot became aware that the helicopter would not climb in response to collective inputs. After clearing an approaching ridge line the pilot elected to carry out a precautionary landing in a large field ahead, with the intention of investigating the problem on the ground. During the deceleration and descent into the field, the rate of descent increased rapidly, causing the helicopter to land heavily and roll over. The passenger sustained injuries in the roll-over and was assisted from the wreckage by the pilot. One safety recommendation has been made as a result of this investigation.

History of the flight

The pilot planned to take a passenger on a short flight from Dunkeswell Airfield to the Sidmouth area. The intended duration of the flight was 30 minutes, however, the helicopter had sufficient fuel for three hours flying and, hence, was flying at a relatively high weight. During the pre-flight magneto checks, the engine speed drop on both magnetos was excessive, being 150 rpm and 175 rpm (maximum 125 rpm) on the left and right magnetos respectively. Also, the engine ran roughly when using only the right magneto. The pilot attributed this to oil fouling of the ignition plugs during enforced prolonged running at idle power prior to the flight whilst parachuting operations were concluded over the airfield. The engine was then run at 3,000 rpm, for approximately one minute, to clear the plugs. A subsequent magneto check resulted in a drop of 125 rpm on each magneto.

The flight to Sidmouth was uneventful but, during the return, when some six nm from Dunkeswell and at a height of 650 ft, the pilot became aware that the helicopter would not climb in response to collective inputs. He confirmed that the collective friction lock was free and slowed the helicopter to 60 kt, whilst attempting to climb using both the collective and cyclic controls. Some height was gained using cyclic inputs, but use of the collective failed to produce a positive rate of climb. The helicopter's height had decreased to 500 ft and, due to an approaching ridge line, the pilot elected to find a suitable area to carry out a precautionary landing. After clearing the ridge at a height of 400 ft, the pilot prepared to land, in to wind, in a large field ahead.

However, due to a line of telegraph wires in the helicopter's flight path, the pilot turned to land in a westerly direction. At the time of the accident the reported wind conditions were 120º/15 kt giving him a tailwind component for the landing. As the pilot considered that there was now a risk of colliding with the far boundary hedge if he landed with significant forward speed, he attempted to slow the aircraft and land using the power available. Initially the descent appeared normal, with the rotor speed 'in the green'; however, as the descent progressed, the helicopter 'twitched' left and right and the descent rate increased rapidly. The pilot's attempts to slow the rate of descent, by raising the collective lever, were ineffective and the helicopter landed heavily and rolled onto its left side. The engine continued to run until the main rotor blades struck the ground. The pilot made his exit unaided and then assisted his injured passenger from the wreckage.

The helicopter suffered significant damage to the left side of the cockpit structure, the tail boom and the rotor blades. It was reported by both the pilot and the local fire service that fuel was seen leaking from the fuel tank vent system. There was no fire.

Description of the helicopter

The Schweizer 269C is a two/three seat helicopter powered by a Lycoming HIO-360-D1A engine fuel injected piston engine. This helicopter was configured with twin fuel tanks, one on either side of the main rotor mask, each holding 18.8 US gallons of fuel. The fuel tank breather system on G-OGOB had been modified by the installation of Schweizer Helicopter fuel vent modification kit, SA 269K-101-1, in accordance with UK CAA Additional Airworthiness Directive 002-02-2000 Rev 1, Figure 1. This modification links both fuel tank vents to a valve assembly and was designed to meet the requirements of Federal Aviation Regulation (FAR) 27.975 (b), which states:

> *'The venting system must be designed to minimise spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operation, or a survivable impact'.*

Aircraft Performance

The Schweizer 269C has a maximum takeoff weight of 930 kg, an empty weight of 499 kg and a maximum rate of climb at sea level of 750 fpm. The helicopter is fitted with a collective correlator, which increases the engine power as the collective lever is raised (to overcome the increased drag of the rotor blades as their pitch angle increases) to a level which maintains the desired rotor speed.

In forward flight, and at normal operating weights, the optimum climb performance for this helicopter is achieved at approximately 50 kt; at higher weights the

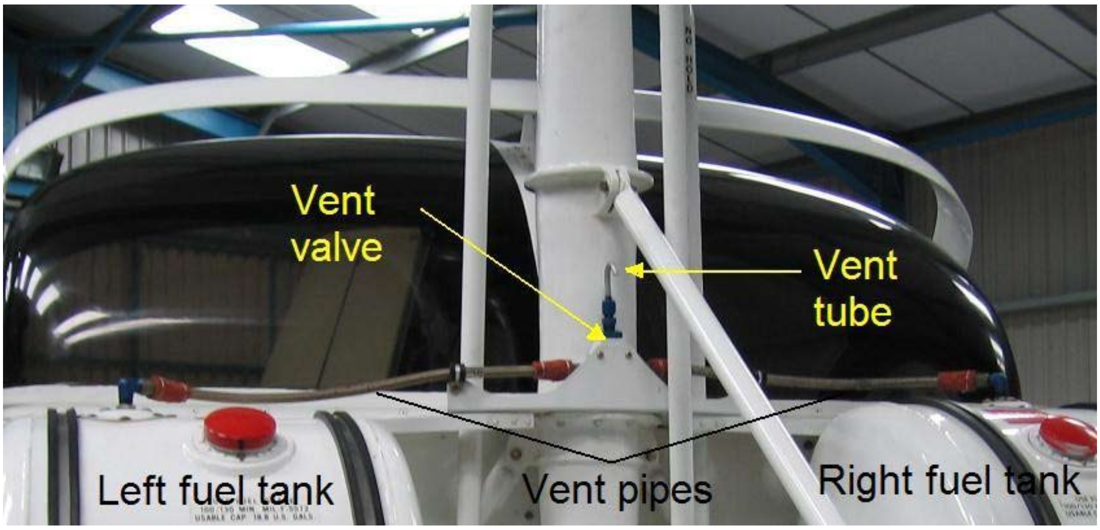

Figure 1
Location of fuel tanks vent

airspeed must be reduced to approximately 40 kt to achieve a similar rate of climb. The climb performance of G-OGOB was such that it reduced with increasing airspeed. It was reported by several Chief Flying Instructors who instruct on the type that, between 60 kt and 70 kt, dependant on its weight, the 269C has a restricted rate of climb in response to collective inputs.

Examination

General

After recovery to its hangar at Dunkeswell, the helicopter was examined by the engineer who usually carried out its routine maintenance. He reported that the engine showed no evidence of a significant failure and that the spark plugs were all free from oil fouling, were of a similar colour and visually appeared in good condition. The fuel filter was found to be free from contamination. A more detailed examination of the engine and its related fuel and airframe systems, also failed to reveal any faults which could explain the helicopter's reported loss of performance.

A further examination of the helicopter was carried out by the AAIB which confirmed that the engine had not suffered from any catastrophic failure. In addition, there was no evidence of any failures or disconnections within either the helicopter's flight controls or transmission system. The main rotor gearbox and fuel tank vent system were removed from the helicopter for further examination.

The main rotor gearbox was disassembled and inspected for any evidence of pre-existing damage or damage caused by the accident. The pinion and ring gears were found to be in good condition, with no evidence of adverse wear or cracking to the gear teeth. The pinion gear shaft was intact, and there was no damage to the drive belt or tail rotor drive splines.

Fuel tank vent system examination

On the Schweizer 269, the fuel tank vent connections are positioned on the upper left surface of each tank, Figure 1. In the event of a roll over, and depending on the fuel state of the helicopter, the possibility exists that fuel may flow from the higher tank to the lower tank.

The orientation of the connections means that the risk of a fuel tank becoming 'overfilled' is greater if the helicopter should roll onto its left side rather than its right. As fuel was reportedly seen leaking from the vent system after the accident, the fuel tank vent system was removed from the aircraft and taken to the AAIB for detailed examination and testing.

Vent system tests

The first series of tests allowed free fluid flow from a one gallon unsealed header tank through the vent system, whilst rotating the system to simulate the roll over, see Figure 2. This resulted in a few drops of fluid being released from the vent tube before the vent valve closed at approximately a 91º roll angle.

A second series of tests were conducted by closing the outlet pipe before the system was rolled to simulate the 'overfilling' of the lower fuel tank. In this condition, at roll angles greater than 45º, fluid flowed from the vent tube at a rate of 0.5 litres per minute until the system was rotated to 95º, when the flow ceased by the action of the valve closing. This series of tests was repeated after sealing the header tank, to simulate an airtight system. The maximum flow rate from the vent tube was reduced to 0.3 litres per minute, with the valve closing at 91º on the majority of occasions. During three of these tests, the valve failed to close completely, and could be clearly heard 'shuttling' in the valve body, with pressure pulses felt within the system. In this condition, a very rapid dripping flow of five drips per second was released from

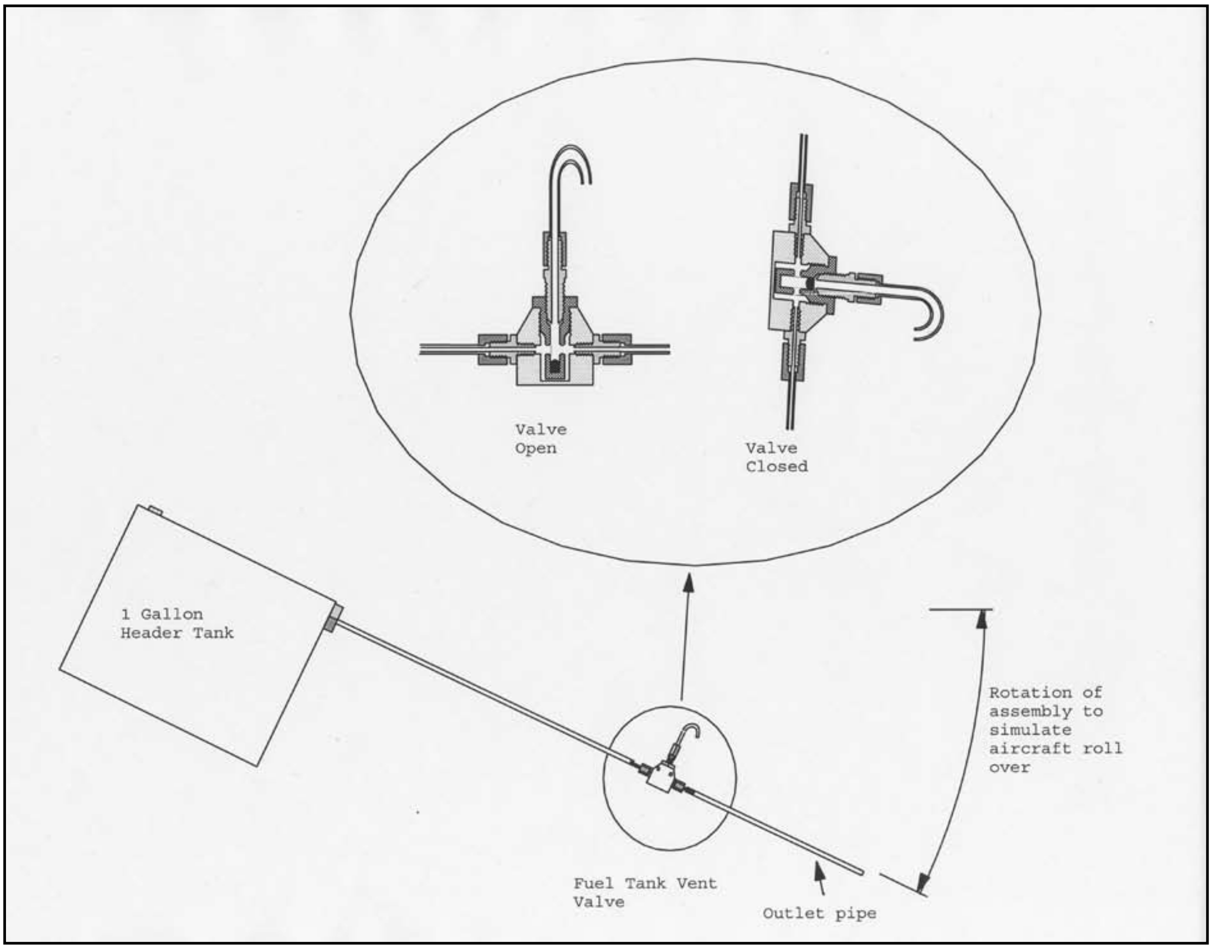

Figure 2

the vent tube for approximately 45 seconds, or until the roll angle had been increased to 99º.

A final series of tests were conducted, with the header tank sealed, at angles of roll small enough to prevent the vent valve closing. These showed that fluid flowed from the vent tube at an initial rate of 0.3 litres per minute, decreasing to a slow drip after 2 minutes, as hydrostatic equilibrium was reached in the header tank; the total fluid volume released was 0.53 litres.

Analysis

Prior to the accident, there were no reported signs of the engine running roughly, high vibration or unusual parameters, and no evidence to suggest that the engine had suffered from a major internal failure. No evidence was found to indicate that the fuel injection or ignition systems were defective, or that any restriction existed in the engine's fuel supply. Also, given that the helicopter was fitted with a fuel injection system and the absence of any reported rough running, it is considered unlikely that engine intake icing was a casual factor in this accident. In addition, examination of the helicopter's flight controls and transmission system revealed no evidence of any pre-existing defects which could have produced the symptoms of low power described by the pilot. In summary, no technical defects were discovered which could have been causal factors in this accident.

Calculations using the weight of the helicopter's occupants and the estimated fuel remaining at the time of the accident, show that the helicopter was operating at a weight of approximately 780 kg. At this weight, it is possible that the helicopter could have had a reduced climb performance at airspeeds over 60 kt.

It was considered possible that, during the descent into the field, the combination of the tailwind component and descent rate resulted in the helicopter descending into the downwash produced by its main rotor blades. This 'vortex ring state' results in a significant reduction of lift from the main rotor blades, the effect of which is a marked increase in the rate of descent, increased vibration, and general difficulties with control. If a helicopter remains in this state, any attempt to slow the rate of descent using collective pitch inputs would be ineffective and the descent would rapidly become uncontrollable. Although the pilot was reasonable certain that the rotor speed did not reduce during the descent to the field, the symptoms described could also be associated with a reduction of the speed of the rotor.

Although the testing carried out on the fuel vent system indicated that, at roll angles greater than 91º, the fuel tank vent valve regularly prevented the external release of fuel, they also showed that it was possible, in certain conditions, for the fuel vent valve to 'shuttle' which allowed the release of fuel at roll angles greater than 91º. The fuel system was tested using a small header tank of different rigidity to the helicopter fuel tanks and, as such, the duration of any valve 'shuttling', and the rate of fuel release on the helicopter, may differ from the test results.

The test also indicated that in the event of the helicopter rolling over to an angle of less than 91º there is the possibility, particularly with large quantities onboard, of fuel escaping from the vent tube if the lower fuel tank becomes full. Due to the arrangement of the fuel vent system this is more likely if the helicopter rolls onto its left side. The volume of fuel released in such a situation is dependant on how 'air tight' each fuel tank is, but the tests showed that, in this condition, a minimum of approximately 0.5 litres could be released. However, if hydrostatic equilibrium cannot be achieved in the higher of the two fuel tank, ie, air is able to enter the tank as fuel drains away, fuel could escape through the vent tube at a rate of 0.5 litres per minute,. The position of the fuel tanks and vent system on the airframe, in relation to the engine and exhaust manifold mean that any such fuel leakage from this area would provide a significant fire hazard, thus negating the reason for fitting the vent system modification in the first place.

Safety Recommendation

Tests have shown that despite the introduction of Schweizer Aircraft Corporation modification SA269K-101-1 significant quantities of fuel could escape from the fuel tank vent system in the event of the helicopter rolling over to less than 91º, which could provide a potential fire hazard. In some conditions it was demonstrated that the fuel may continue to flow from the vent system at roll angles up to 99º for a short time. The following safety recommendation is therefore made.

Safety Recommendation 2006-064

It is recommended that the Federal Aviation Administration require the Schweizer Aircraft Corporation to review modification SA269K-101-1, relating to the fuel tank vent system on the Schweizer 269 helicopter, to further reduce the possibility of fuel escaping from the fuel tank vent system in the event of the helicopter rolling over.

Conclusions

No technical defects were identified which could have explained the apparent loss of engine power. However, the possibility remains that an unidentified transient defect in the fuel or ignition systems may have prevented the engine from producing adequate power. The helicopter was operating at a weight which may have been sufficient to reduce its rate of climb from response to collective inputs, at high airspeeds.

In an attempt to avoid obstacles in the landing field, the pilot may have inadvertently entered a ‘vortex ring state’ or allowed the rotor speed to droop, resulting in an uncontrollable descent and subsequent hard landing and roll over.