

ACCIDENT

Aircraft Type and Registration:	Eurocopter AS350B3e Squirrel, G-ECUK
No & Type of Engines:	1 Turbomeca Arriel 2D turboshaft engine
Year of Manufacture:	2012 (Serial no: 7491)
Date & Time (UTC):	19 June 2013 at 1840 hrs
Location:	Private helicopter landing site near Oxford
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (serious) Passengers - None
Nature of Damage:	Substantial damage to airframe, rotor blades and dynamic components
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	224 hours (of which 8 were on type) Last 90 days - 10 hours Last 28 days - 8 hours
Information Source:	Field Investigation

Synopsis

The pilot lost yaw control of the helicopter as it approached the final stage of a decelerating transition to a hover. Examination of the helicopter established that hydraulic fluid leaked from two unions securing hydraulic pipes to the tail rotor hydraulic servo. The leak depleted the hydraulic contents to the extent that a loss of system pressure occurred.

History of the flight

The helicopter, with the pilot and his son on board, was in the late stages of an approach to a private helicopter landing site when the accident occurred. The weather conditions were fine, with good visibility and calm wind.

The pilot reported that he carried out a detailed Check A of the aircraft before flight, which revealed no abnormalities. In particular, there were no signs of fluid on the helicopter skins or on the hangar floor. The early stages of the flight were uneventful and the pilot returned to the same landing site after about 20 minutes. He flew an approach to an open grass field adjacent to the landing pad, crossing electricity cables at the field boundary at about 30 ft and 40 kt. In the latter stages of the approach at about 15 ft and 20 kt, the pilot increased collective pitch a little and began a slight flare. At about the same time he made a left pedal input to make a track correction. As he did so, he experienced what he described as a slight jolt, followed by an immediate and violent yaw to the left.

The pilot believed that he instinctively applied more collective pitch in order to avoid ground contact, and the left yaw rate increased, causing him to believe that a tail rotor malfunction had occurred. He reported trying to control the yaw with pedal input, but without effect. He therefore reduced collective and the yaw rate reduced, but by this time he felt the “control forces were extreme”. The helicopter made two or three more complete rotations before contacting the ground. The right skid collapsed, causing the main rotor blades to strike the ground. The pilot secured the aircraft, and both occupants vacated through their respective side doors. The pilot was subsequently found to have suffered three broken vertebra.

The pilot reported that his full attention was directed at controlling the sudden and unexpected yaw, particularly as the helicopter was at such a low height. He initially stated that, because of the difficulty controlling the helicopter, he could not recall whether there had been any cockpit warning lights or sounds before it struck the ground. After later consideration, he was certain there had been none.

Pilot information

The pilot had previously flown Hughes 369 and Enstrom 480 helicopters. He commenced flying training for an AS350B3e type rating on the 8 May 2013 and passed a Licence Skills Test on 30 May 2013, all training being conducted on G-ECUK. The accident flight was the pilot's first in the helicopter since that date.

Aircraft examination

An initial examination of the helicopter was carried out at the accident site by a field service representative of Eurocopter UK. The examination confirmed that the helicopter had suffered significant damage to the airframe, rotor blades and dynamic components. During the examination, evidence of a hydraulic leak at the base of the tail boom was observed. Further examination confirmed that hydraulic fluid had been leaking from two unions which secured hydraulic pipes to the tail rotor hydraulic servo and load compensator. Both unions could be easily rotated on their threads using finger pressure. After righting the helicopter the level of hydraulic fluid remaining in the tank was found to be approximately 130 ml above the hydraulic fluid supply pipe.

AS350B3e Squirrel hydraulic system

The AS350B3e Squirrel is fitted with a hydraulic system to provide assistance to the pilot's control inputs. The system consists of three main rotor servo actuators, a tail rotor servo actuator, a hydraulic fluid tank and a mechanically driven hydraulic pump. Loss of system pressure is indicated to the pilot by a warning chime and a HYD caption on the Caution and Warning Panel (CWP).

The hydraulic tank has a useable fluid capacity of three litres. In the event of a loss of hydraulic system pressure the AS350B3e is fitted with load compensators (accumulators) on the main rotor servo actuators which provide hydraulic assistance for a short time after the loss of pressure. This variant of the AS350 was not originally fitted with a load compensator on the tail rotor servo actuator; tail rotor or yaw control assistance was provided by additional chin weights fitted to the tail rotor blades.

As a result of in-service experience, Eurocopter published a Service Bulletin (SB), AS350-01.00.66, to remove the additional tail rotor blade chin weights and fit a load compensator to the tail rotor servo actuator.

Maintenance history

At three flying hours from new, the helicopter was modified in accordance with SB AS350-01.00.66. The modification was completed by a team dispatched from the helicopter manufacturer in France. At the time of the accident the helicopter had accumulated approximately 15 flying hours. No further work, other than routine inspections, had been carried out on the helicopter prior to the accident.

Detailed examination

After recovery of the helicopter, a detailed examination was carried out by specialists from the helicopter manufacturer under the supervision of the AAIB.

Examination of the tail rotor control circuits confirmed that there was no evidence of a pre-impact restriction and that all of the circuits were correctly connected and rigged. After tightening of the load compensator/tail rotor servo hydraulic unions the tail rotor hydraulic system was tested and found to operate normally. Pressure decay checks confirmed that both the hydraulic low pressure warning chime and the HYD caption operated within the required tolerances. Function tests of the hydraulic switch on the collective and the accumulator test function showed that they operated normally.

A number of additional tests were carried out in order to determine the potential rate of leakage from the hydraulic system as a result of the loose load compensator unions. When the unions were correctly torqued, then 'backed off' by one turn, a leak rate of approximately one litre per hour was measured. The maximum leak rate achieved was approximately six litres per hour which occurred when the union connecting the hydraulic pressure supply line was loosened. The leak rates achieved during the tests therefore indicated that, if the hydraulic system was full, it could lose all pressure within 30 minutes of the unions becoming loose. With the hydraulic leak from the loose unions, a change in attitude of the helicopter in flight, such as during the landing flare, could result in the exposure of the hydraulic supply pipe and loss of system pressure before all the useable fluid had been lost.

The manufacturer carried out a review of the aircraft maintenance task cards associated with the mounting of the load compensator and associated unions. This identified that the task cards allowed the possibility of orienting load compensator and hydraulic unions in a way which would place the unions under load. This could result in the unions becoming loose in operation leading to a hydraulic fluid leak.

The manufacturer confirmed that no other events of hydraulic unions becoming loose in operation had been reported to them.

Analysis

Prior to the accident, no evidence of a hydraulic fluid leak had been observed by either the pilot or maintenance personnel, so it is reasonable to assume that the unions became loose at some point during the accident flight. When hydraulic system pressure was lost, the loose unions would have allowed the pressure within the tail rotor load compensator to dissipate. This would have resulted in an immediate loss of assistance to the yaw controls and an increase in the force required by the pilot to maintain directional control. The presence of fluid within the hydraulic system would have prevented the loss of pressure in the main rotor load compensators, allowing hydraulic assistance of the main rotor controls to be maintained for a period.

Detailed testing established that full control of the tail rotor remained available albeit without hydraulic assistance. The higher control loads associated with an immediate and unexpected loss of hydraulic power to the tail rotor servo probably led the pilot to believe that tail rotor control had failed.

Both the warning systems designed to alert the pilot to a loss of hydraulic pressure were found to operate normally. As the hydraulic system pressure dropped, the warnings would be expected to activate. The pilot was fully occupied in controlling the helicopter at a critical moment close to the ground, so may not have perceived the warnings.

No other such events have been identified on the AS350B fleet which indicates that the unions, if correctly torqued, are unlikely to become loose. The only maintenance which was carried out on the tail rotor servo actuator was as a result of the incorporation of the Eurocopter SB AS350-01.00.66. It is therefore probable that, while carrying out this SB, the load compensator and hydraulic unions were orientated in such a way as to apply a load to the unions. This resulted in the unions becoming loose, causing a loss of hydraulic fluid and ultimately system pressure.

Safety action taken by the manufacturer

As a result of this accident the manufacturer has introduced a number of changes to the work cards used during the incorporation of SB AS350-01.00.66 and maintenance to the tail rotor load compensator to ensure that the load compensator and hydraulic unions are oriented in such a manner as to minimise the loading on the unions.

In addition, the manufacture has carried out an inspection of all other affected helicopters to ensure that the hydraulic unions are correctly orientated. No abnormalities were found during these inspections.