Department of Transport and Communications

Bureau of Air Safety Investigation

ACCIDENT INVESTIGATION REPORT
B/921/1036

Aerospatiale AS355F1 VH-NJL
Kelmscott WA
8 May 1992

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ISBN 0 642 19297 9 May 1993

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SYNOPSIS

Aerospatiale AS355F1 helicopter VH-NJL was to land on a sports oval as part of a police public relations display for school children. It approached from the north-east and entered a steep descent from about 22 m above ground level. The descent rate was reported to be higher than normal. This high descent rate continued until ground impact. The helicopter bounced and completed two anti-clockwise rotations before coming to rest. A small fire, which began in the engine bay, grew to completely destroy the helicopter.

1. FACTUAL INFORMATION

1.1 Background

The helicopter was owned by the Western Australia Police Department. However, because the department had no experience in operating rotary winged aircraft, it contracted a local helicopter operator to provide pilots and be responsible for the maintenance of the aircraft.

1.2 History of the flight

After a normal engine start, the pilot raised the collective pitch control lever to check engine power response. However, the Number 1 engine torque indication did not increase in parallel with the Number 2 engine torque indication. The pilot trimmed the Number 1 engine but the split in torque indications was still present when the collective pitch was increased. The pilot again trimmed the Number 1 engine and this time the torque readings for both engines responded normally. He then departed on the flight.

The helicopter was to land on a sports oval as part of a police public relations display for school children. The oval was partly bordered by tall trees. Witnesses reported that the helicopter made a fast approach from the east and flared positively before descending rapidly and almost vertically from about 22 m above ground level. (There was no pause between the flare and the initiation of the descent.) The initial ground impact was on the rear of the right skid and tail boom/tail rotor. The tail rotor assembly separated from the helicopter and the fuselage pitched forward before completing two rapid anticlockwise rotations, during which the tail boom separated from the fuselage, and the main rotor blades struck the ground. The helicopter came to rest facing its original approach direction.

The pilot reported that, during the final descent to ground impact, there was a split between the engine torque gauge indications. He could not quantify the split but thought that there had been a power loss on the Number 1 engine. Neither the pilot nor any of the other occupants recalled hearing the rotor low-RPM warning horn sound at any stage during the flight. However, the horn had operated normally during the pre-flight checks.

1.3 Injuries to persons

The pilot and crewman received minor injuries, and the two passengers serious injuries, as a result of the accident.

1.4 Damage to aircraft

During the impact sequence, substantial damage occurred to the tail boom and to the main and tail rotor systems. A small fire, which began in the engine bay, could not be controlled by hand-held extinguishers and soon spread to destroy the helicopter.

1.5 Personnel information

The pilot in command held a current Commercial Pilot Licence (Helicopter) and was endorsed on the AS355F1 helicopter. He completed his last proficiency check on the type in November 1991. His total flying experience at the time of the accident was 5,264 h, of which 3,463 were on rotary winged aircraft. His experience on AS355F1 helicopters was 315 h.

1.6 Aircraft information

The helicopter was manufactured by Aerospatiale in 1981 and was an AS355F1 Twin Star carrying Serial Number 5039. It had accumulated 2,033 flying hours since new.

The weight of the helicopter at the time of the accident was calculated as about 2,170 kg and the centre of gravity was within limits. The maximum take-off and landing weight for the helicopter was 2,400 kg.

1.7 Meteorological information

The weather was fine at the time of the accident with a clear sky, a light south-easterly breeze, and a temperature of about 20°C.

1.8 Wreckage examination

Photographs of the accident sequence showed a crease on the underside of the tail boom, indicating that the initial impact had bent and weakened the tail boom.

Fire damage precluded a complete examination of the wreckage. However, both engines were disassembled and examined. No fault was found in either which might have prevented normal operation. Further, no fault was found in the fuel control unit and governor from the Number 1 engine (the corresponding accessories to the Number 2 engine were destroyed by the fire). The

rigging of the engines individually, and as a pair, could not be checked. This was precluded by fire damage to the engine trimming control systems, including the trim linkage tree and the actuating cable between the engine trim actuator and the power turbine governor for the Number 1 engine. While the flight control system was also largely destroyed by fire, there was no indication that any failure in this system had contributed to the accident.

1.9 Medical and pathological information

There was no evidence that the pilot had any medical or psychological condition which might have contributed to the accident.

1.10 Survival aspects

During the impact sequence, the two rear-seat passengers were thrown partially outside the cabin but were restrained by lap seat belts which caught around their lower legs and ankles. The rescue of all occupants was quickly and efficiently accomplished by police officers at the site before the fire took hold of the helicopter.

1.11 Additional information

1.11.1 Engine rigging

Another company pilot had, on two occasions, experienced a lack of response from the Number 1 engine after start, similar to that which occurred prior to the accident flight. On each occasion, the problem had been overcome by operating the engine trim through its full range. All company pilots reported that every major engine power change during flight required the engines to be retrimmed. Torque gauge splits of up to 15% were not uncommon.

The maintenance records for the helicopter contained no record of any maintenance having been conducted on the engine trim system since the operator had taken delivery of the helicopter. All company pilots flying the helicopter received their on-type endorsement on VH-NJL and reported that they accepted the rigging as a normal aircraft handling characteristic. Pilots stated that they had verbally advised maintenance staff of the problem. However, the relevant engineers had since obtained employment outside Australia and could not be interviewed about this matter.

Tests on another AS355F1 helicopter showed none of the engine torque rigging problems reported in relation to VH-NJL. Advice obtained indicated that the rigging was difficult to adjust properly and that a particular procedure had to be followed during setting-up. With the system correctly rigged, the torque split between the engines during normal operations would not normally be more than about 3%.

1.11.2 The approach and landing sequence

The pilot reported that, based on some smoke he observed in the distance, he assessed there to be no wind at the landing site. He flew the approach towards the west and described a normal approach angle and speed, terminating in a hover at about 6 m above ground level. The pilot thought that the helicopter then experienced an engine power loss and a heavy landing had resulted. He said that apart from applying full collective pitch in an attempt to control the descent rate as the helicopter neared the ground, he did not make any other control input.

Witnesses reported that the helicopter, while on a westerly heading, performed a positive flare and immediately entered an almost vertical descent from about 22 m above ground level. They also reported that the fuselage was randomly ‘rocking’ from side to side during the descent. This information was supported by a series of photographs taken during the accident sequence

by a professional photographer. Witnesses also indicated that the helicopter was descending at a higher than normal rate compared to other helicopters they had observed. Photographs of the post-crash fire indicated that a light east to south-east breeze (i.e. a tailwind with respect to the helicopter) was blowing at the time of the accident. The effect of the tailwind would have been to steepen the descent angle of the helicopter and to reduce its forward speed with respect to the local airmass.

A condition called 'power settling' or 'vortex ring state', and which is inherent in all helicopters, involves unstable airflow through the rotor disc caused by the helicopter settling in its own downwash. Characteristics of the vortex ring state include a rapid increase in the rate of descent, random rolling and pitching, a decrease in cyclic effectiveness, and random yawing off heading. Flight conditions which contribute to the condition include a vertical or near vertical descent of at least 300 ft/min (the critical rate varies depending on helicopter type and flight conditions), utilisation of between 20% and 100% of available engine power, and near-zero horizontal velocity. An attempt to reduce the rate of descent by increasing collective pitch and engine power can aggravate the condition and produce an even higher rate of descent. Recovery from vortex ring state can be accomplished by lowering collective pitch and/or increasing airspeed. However, substantial height loss is usually involved.

1.11.3 Check-and-training procedures

The company operations manual required monthly check-and-training exercises to be conducted for each company pilot. It was established that the pilot of VH-NJL had completed only one check-and-training flight (in November 1991) between his initial endorsement on the helicopter in August 1990 and the date of the accident.

2. ANALYSIS

The helicopter was in a steep descent at high-weight, low-forward speed, and under the influence of a light tailwind. Additionally, witnesses described its descent rate as high compared to other helicopters they had observed, and there was photographic and witness evidence of random rocking of the fuselage during the descent. It is probable, therefore, that the helicopter had entered a vortex ring state. By increasing the collective pitch, the pilot was exacerbating the situation.

A further possibility is that there was insufficient power available (the pilot reported seeing a split in the torque gauges) to arrest the rate of descent as the helicopter neared the ground. Had this occurred, however, the rotor low RPM warning should have sounded. That no warning was heard indicates that rotor RPM was maintained throughout the descent and that neither engine suffered a significant power loss.

The geography of the landing area left other approach avenues open to the pilot than that which he flew. These would have permitted a more conventional and safe approach with regard to both approach angle and wind direction.

3. CONCLUSIONS

3.1 Findings

1. The pilot was appropriately licensed to undertake the flight.
2. The aircraft's weight and centre of gravity were within limits.
3. The helicopter performed a high-speed downwind approach, followed by a positive flare and an immediate entry into a steep descent.
4. The helicopter probably entered a vortex ring state during the descent.
5. The checking and training of pilots was not in accordance with the Company Operations Manual requirements.

3.2 Factors

1. The pilot flew a steep final approach to the landing area.
2. The approach was flown with a light tailwind component.
3. The helicopter probably entered a vortex ring state during the final approach.

4. SAFETY ACTIONS

In the early stages of the investigation it became apparent that there were anomalies in the check-and-training procedures of the operator. These anomalies were brought to the attention of the appropriate Civil Aviation Authority flying operations inspector.

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