Eurocopter AS355N Ecureuil II, G-OROM

AAIB Bulletin No: 9/98 Ref: EW/C98/1/5 Category: 2.2

Aircraft Type and Registration:	Eurocopter AS355N Ecureuil II, G-OROM
No & Type of Engines:	2 Turbomeca Arrius 1A turboshaft engines
Year of Manufacture:	1996
Date & Time (UTC):	28 January 1998 at 1852 hrs
Location:	1 nm west of Souldern, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - Fatal - Passengers - N/A
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Private Pilot's Licence (with Night Rating)
Commander's Age:	50 years
Commander's Flying Experience:	721 hours (of which 126 were on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

History of the Flight

The pilot had planned to fly from his house near Bicester to Oxford Kidlington airfield to carry out some pre-arranged consolidation flying training with the chief pilot/instructor of the helicopter's maintenance organisation. At approximately 1530 hrs on the day of the accident he asked his estate manager to prepare the helicopter for flight, to increase its fuel load from 70% to 80% for the forthcoming 'day into night' training session, and to position the helicopter on the helipad ready for take off. The manager refuelled the helicopter and manoeuvred it clear of its purpose built hangar, onto the helipad. With these preparations complete the estate manager walked back towards the house passing the pilot who was on his way to the helicopter. No one saw the pilot prepare for

departure, but he was seen after take off, as the helicopter hovered for a short while, before setting off for Kidlington where he arrived at 1610 hrs.

The instructor met the pilot and briefed him, for approximately 30 minutes, on single engine failures occurring during 'clear area' and 'helipad' take offs and 'day and night' landings using only one engine. The training was to take place using an illuminated 'T' with a glide slope indicator set at 3° to 4° placed on the grass in 'Area 1' within the airfield boundary to the west of Kidlington's main Runway 02/20. The instructor stated that at that time the weather was misty with an in flight visibility of 2 to 3 miles at 1,000 feet. The outside air temperature (OAT) was +1°C, the sky was clear and there was no sign of fog.

After the briefing both pilots carried out an external inspection of the helicopter before boarding. The pilot sat on the right with the instructor on the left. They took off at 1650 hrs and carried out approximately 20 minutes of flying in daylight conditions. The instructor reported that the pilot was initially tense but soon settled down to produce a very competent and confident performance. The pilot continued with his consolidation training flying for 1 hour 20 minutes at night until landing at 1836 hrs.

After the training both pilots discussed the session and were satisfied that the training had gone well. The pilot had planned to arrange further continuation training on another day, practising different emergencies. The helicopter was then 'hover-taxyed' across the runway and landed close to the maintenance hangar where the instructor, having secured his seat belt, got out and waved the pilot farewell. In response the pilot flashed the landing light and departed for the short flight back to his landing site. The instructor reported that the helicopter was fully serviceable and the fuel state was approximately 37%. Fuel consumption is approximately 30% per hour with a minimum recommended landing fuel of 10%. The Secondary Surveillance Radar (SSR) transponder was set to '7000 and standby' and the GPS (Global Positioning System) was selected 'ON'.

Radio transmissions, recorded from the Oxford tower frequency, showed that at 1838:30 hrs the pilot requested clearance to 'TAXI FOR LOW LEVEL DEPARTURE TO THE NORTHEAST FOR SOULDERN WITH ONE ON BOARD'. The tower confirmed the clearance and passed the surface wind as calm. The pilot was cleared to lift at 1839:30 hrs and his last recorded transmission of 'OSCAR MIKE WE'LL QSY EN ROUTE THANKS A LOT GOODNIGHT' was recorded at 1841:30 hrs.

The National Air Traffic Services (NATS) radar at Clee Hill, 5 miles east of Ludlow, recorded the helicopter's progress as it departed Oxford (Kidlington). The first radar return was recorded at 1840:44.4 hrs to the east of Tackley, 4.5 km north north-east of Oxford (Kidlington). The helicopter had adopted a track of approximately 300° before it turned onto a track of 020° direct for the pilot's landing site. It passed just to the east of Steeple Aston; 1 km to the west of the disused airfield at Upper Heyford; over the village of Somerton and then, as it reached the M40 motorway,

1 km short of its destination, it turned onto a more northerly track. The last radar return, timed at 1845:42.45 hrs, positioned the helicopter approximately 1 km to the north-west of the pilot's landing site with the helicopter entering a right turn. The radar recording also showed that for the majority of the flight the helicopter maintained a ground speed of 105 kt, reducing to between 80 and 69 kt during the final right turn. No Secondary Surveillance Radar mode 'C' (encoded height information) was recorded.

It was not possible to determine exactly the progress of the helicopter for the minutes following the last radar return except that a witness, driving northwards through the village and close to the pilot's house, saw the lights of a helicopter at an estimated height of 200 to 250 feet above trees by the pilot's house. Some 'ear witnesses' heard the noise from the helicopter's rotor blades 'die down completely - the noise that they were familiar with hearing when the pilot was landing.' A couple in residence close to the pilot's helipad also heard the helicopter land and 'stay with the engine running on the ground' before they 'heard it fly off as though going out again'.

The helicopter's flight after this subsequent take off was seen by motorists travelling north and south bound on the M40 motorway, some 1,000 metres west of the helipad. Generally, the witnesses describe the helicopter's flight as being from the east to the west over the motorway at high speed descending at a steep angle from a height estimated to be between 100 to 300 feet. The helicopter was then seen to impact with the ground to the west of the motorway.

A passenger in a car travelling south on M40 first saw the navigation and landing lights of the helicopter to his left travelling towards the motorway at a range of 1 to 2 miles at a height he estimated to be 1,000 feet. The light from the landing light outshone the navigation lights and appeared surrounded by a halo caused by the misty conditions. The visibility at ground level on the motorway was described as good.

As the helicopter continued towards the motorway it lost height. Distracted in conversation with his driver, the witness looked again to see the helicopter travelling at right angles to the motorway at an estimated height of 300 feet. The landing light was now pointing towards the ground at an angle of 45° but the helicopter appeared to be in a descent of about 30°. The helicopter then appeared to accelerate rapidly with wisps of mist visible in the landing light beam before it disappeared from view behind a hill. When he had been driven clear of the hill the witness could see several fires on the ground.

Accident site

The accident site was in a field of young crop which formed part of Souldern Grounds Farm. The field was located approximately 900 metres to the south west of the helicopter landing pad at Souldern Manor and 250 metres feet to the south west of the M40 motorway. The accident site was

about 30 feet below the height of the helicopter landing pad. The general area to the south and west of the accident site consisted of agricultural land with isolated farm houses and buildings. To the south and east there was an unlit high ridge. An unlit railway viaduct crossed land which descended to the west of the site.

The initial impact with the ground was made by the main rotor blades and the forward sections of both skids. The lower forward fuselage contacted the ground immediately following the initial impact. The depth and severity of the main rotor blade ground strike marks, together with the associated earth throw, was consistent with the rotor blades rotating at about their normal operating speed and with high energy. Evidence from the initial impact marks indicated that the helicopter was flying on a straight track with the right-hand skid slightly lower than the left, with its nose pitched down by about 23°, on a heading of 236° magnetic and descending with a forward speed in the region of 100 kt. Due to the high vertical and forward speed of the helicopter at the initial impact, the fuselage structure was severely disrupted. The disrupted fuselage of the helicopter bounced following the initial impact and, upon it's second impact, fuel from the ruptured fuel tank ignited. The resulting fireball travelled with the main body of the wreckage which came to rest within the substantial hedge that formed the southern boundary of the accident field. The fire continued to burn until extinguished by the emergency services. Areas of fuel stained grass were evident three days after the accident indicating that there had been a large quantity of fuel aboard the helicopter at the time of the accident.

Examination of wreckage

A complete detailed examination of the helicopter wreckage was not possible because many areas had been consumed by the post impact fire. Only a very small amount of the flying control systems were recovered and examination of these items did not show any evidence of a pre-impact disconnection or restriction. The three autopilot flying control bias trim actuators were recovered and all were found in their neutral positions. The three main rotor hydraulic actuators were examined and their impact positions measured. There was no evidence of a mechanical failure or actuator runaway. The actuator extensions were reproduced on another helicopter of the same type which gave a collective control position of nearly full up and a cyclic control position of slightly right and forward of neutral. The position of the tail rotor control could not be determined. Microscopic examination of the intact light bulbs that were recovered and identified, gave indications consistent with a flight at night. The Caution Advisory Panel was recovered with all of its light bulbs intact. Examination indicated that at the time of impact none of the helicopter's systems warning or caution captions were illuminated. This indicated, amongst other things, that there had been no engine or gearbox fires, that the helicopter's electrical, hydraulic and fuel systems were functioning, that both engines were running, and that both engine's Digital Control Units were functioning. The autopilot mode indicator panel was recovered with all but two of the light bulbs intact. Examination showed that none of these bulbs were illuminated at impact, indicating that none of the autopilot modes were engaged and that a flying control trim runaway had not occurred.

Both engines were taken to the engine manufacturer's facility in France for a detailed examination. A strip examination of the engines revealed positive evidence that, at impact, they were rotating at a high speed and that combustion was occurring consistent with normal engine operation. The internal condition of both engines was found to be very good, consistent with the low number of hours that they had operated since new.

Meteorological conditions

An aftercast for 1851 hrs on 28 January 1998 obtained from the Meteorological Office, Bracknell, showed that the synoptic situation was a ridge of high pressure established over England and Wales with light and variable winds. The weather was fine but local mist patches were probably beginning to develop. Visibility was around 3,000 metres generally, locally 1,200 to 1,500 metres with no low cloud but with a scattered cloud base at 25,000 feet. At the surface the wind was 030°/03 kt with a temperature of -1°C and a dew point of -3°C. At 2,000 feet the wind was variable 5 kt or less with a temperature of -0°C and a dew point of -1°C.

The observer in the police helicopter that attended the accident stated that visibility in the area was at least 8 km above some light mist patches but the horizon was indistinct. The area was also very dark due to the lack of ground lights and high cloud cover was obscuring any light that may have been cast by the moon or starlight.

A driver travelling southbound on the M40 motorway, 30 minutes after the accident, reported that ,as he approached the junction 4 km south of the accident site, he was surprised at 'how dark it appeared'. He was used to seeing the lights associated with the service area at the junction and the associated street lights as he reached the warning signs for the junction exit, but that night they only became visible at very short range. A further witness to the accident, travelling southbound on the motorway, stated that there was light mist over the motorway to the extent that the helicopter itself was not visible, only its lights.

Pilot's experience

The pilot had obtained his Private Pilot's Licence (Helicopters) (PPL(H)) on 19 June 1993 with a type rating on the Eurocopter AS 350B. A normal condition stated "not permitted to fly helicopters out of sight of ground or water or by sole reference to instruments". The licence was amended on 9 May 1997 to include a type rating on the Eurocopter AS 355F and AS 355N. A night rating was issued on 22 November 1993. The licence included a valid Class III medical certificate issued on 29 May 1997 with the condition that the holder was to wear correcting spectacles with a second pair available.

Although the pilot's log book showed that he had flown at night seven times throughout 1997, and once in 1998, he had only carried out one take off at night from his helipad before the accident.

Terrain warning

The helicopter was fitted with an Automatic Voice Alert Device (AVAD) which was interfaced with the Radar Altimeter (RADALT) and the intercommunications system to give audio warnings at 100 feet and at a pre-set height using the RADALT bug. When the helicopter descends through the RADALT bugged height, which in this case was set to 110 feet, a 'CHECK HEIGHT' message is heard. A 'ONE HUNDRED FEET' message is also heard when the helicopter height is at or passes through 100 feet. The 'ONE HUNDRED FEET' and 'CHECK HEIGHT' messages have the same priority therefore a 'CHECK HEIGHT' warning in progress will delay the 'ONE HUNDRED FEET' warning. This can result in the 'ONE HUNDRED FEET' warning being heard at heights significantly below one hundred feet.

The helipad

The helicopter was parked in a purpose built hangar on the estate close to the main residence. The hangar, set into an embankment, was constructed so that it was partially lower than local ground level. The helipad, which extended from the hangar doors towards the west occupied a partially sunken area bounded to the north and south by grass banks and to the west by gently up-sloping ground. Situated just to the south of the hangar on the ground, level with the hangar roof, was a wind sock. Mounted on the top of the wind sock pole was a white strobe light and positioned at the base were a pair of approach slope indicators with one indicator aligned for approaches from the south set at 8.5° and the other for approaches from the west, set to 9.5°. At the time of the accident the south facing approach slope indicator was unserviceable.

The helipad was capable of being illuminated by flood lights. One light was mounted above the hangar door, pointing down onto the pad and two were positioned at ground level on the southern side, adjacent to the helipad, pointing to illuminate the concrete. These lights, which were very bright, were capable of shining directly into the cockpit with the helicopter parked on the helipad facing west.

Approaches to the pad were normally made from the west, passing over the nearby motorway and departures were normally flown to the west. Power lines, running north / south, situated several hundred metres to the west of the pad had been buried underground for several hundred metres of their length to facilitate obstruction free approaches and departures.

The lights associated with the installation, described above, could be activated by a radio transmission from a helicopter prior to landing. The farmer and owner of the land upon which the helicopter crashed stated that the hangar lights and the strobe light on top of the wind sock mast were illuminated at the time of the accident.

Post accident test flight

As part of the investigation a helicopter of a similar type was flown at night along the radar track of the accident helicopter. From the position of the last radar return a circling approach was flown to the helipad. The helicopter then remained on the ground, rotors running, for approximately 30 seconds before taking off on a heading of 240° over flying the accident site. The time of flight from the last radar return position until the over flight of the accident site coincided with the timing of the accident. A flight test to determine the time taken for the helicopter to descend 200 feet starting at a speed of 40 kt and descending at an angle of 22° nose down was also flown. It was found that the steep descent took 6 seconds and the speed increased to 80 kt.

Discussion

The pilot was properly licensed on the type of helicopter being flown and experienced to a level sufficient to carry out the VFR night flight from Oxford to his private landing site. He held a night rating and had just completed some night continuation training to a standard, assessed by his instructor, as competent. The helicopter was fully serviceable prior to its departure from Oxford, the pilot made no comment on the radio to the contrary and wreckage examination suggested that, as far as could be determined, the helicopter was serviceable at impact.

Radar evidence showed that the pilot did not make a direct approach to his helipad from the west but instead flew to the north of the site turning to the right to make a landing from the north. An eye witness in the village and close to the pilot's house confirmed that the helicopter approached over trees to the north of the helipad. After landing the helicopter remained on the ground briefly, with the rotors running, before taking off and departing to the west. The intended purpose of this flight is not known. It is possible that the pilot may have decided to carry out a further take off, approach and landing to conclude his night training session.

Whilst parked on the helipad, facing to the west and preparing to depart, the pilot's eyes would have been subjected to the very bright light emanating from the helipad flood lights. With gently rising

ground in front of him he may have positioned the helicopter's moveable landing light almost horizontal to illuminate the ground ahead for take off.

The take off profile, to return for a further approach, would normally have been to carry out a climb to a height of approximately 1,000 feet agl turning to the left 30° in order to subsequently carryout out a level turn through at least 210° to the right to setup for an approach. Eye witness evidence however suggests that the maximum height achieved on departure was of the order of 200 to 300 feet. This modification from the normal climb was probably initiated by the pilot because of the strong possibility that at that height he encountered a layer or layers of mist or fog and he could not afford to loose sight of the ground since he was neither trained nor qualified to fly by sole reference to instruments.

At this time, by coincidence, the pilot may possibly have been repositioning the landing light beam downwards for the forthcoming approach. The beam from the landing light, not normally visible in clear air, would have been very apparent as it shone forward through the mist. Its downward movement, although initiated by the pilot, may have given him the visual illusion that the helicopter was pitching up requiring forward movement of the cyclic control for correction. Also the transition from climbing to level flight may have caused excessive stimulation of the sensory organs for gravity and linear acceleration, thereby creating the illusion of tumbling backwards. To correct this the pilot would have moved the cyclic pitch control forward to lower the helicopter's nose, thus intensifying the original false impression. All this, combined with a degree of spatial disorientation brought about by inadvertently flying into mist, and losing sight of the ground, could have confused the pilot's senses. By the time he had realised the pitch attitude of the helicopter and its high rate of descent, corrective action was not adequate in averting a collision with the ground. Furthermore, the moving ribbon of light formed by car headlamps on the motorway and the lack of ground lights to the west beyond the motorway could have created a compelling false horizon further adding the pilot's spatial disorientation.

Spatial disorientation

This phenomenon is described in Aviation Medicine (2nd edition) [edited by Air Cdre J Ernsting and AVM P King, London 1988]. The following edited extract is relevance to this particular accident:

> 'Pilots have described many different types of spatial disorientation that occur in different flight conditions. Not surprisingly, the mechanism underlying the disordered perceptions is commensurately varied. It is convenient to discuss aetiology under two main headings, even though they are not mutually exclusive: (1) when erroneous or inadequate sensory information is transmitted to the brain (an

input error); and (2) when there is an erroneous or inadequate perception of correct sensory information by the brain (a central error).

External visual cues

Disorientation is very uncommon when the pilot has well-defined external visual cues; but when he attempts to fly when sight of the horizon is degraded by cloud, fog, snow, rain, smoke, dust or darkness he quickly becomes disorientated unless he transfers his attention to the aircraft instruments. The ability to maintain control of an aircraft without adequate visual cues is quite short, typically about 60 seconds, even when the aircraft is in straight and level flight at the time vision is lost, and shorter still if the aircraft is in a turn. In such circumstances, loss of control occurs because the non-visual receptors give either inadequate or erroneous information about the position, attitude and motion of the aircraft.'

The terrain warning provided by the AVAD system would have given only 1 to 2 seconds warning of ground impact in this high rate of descent situation. Nevertheless, post impact evidence suggests that the pilot had realised the situation, albeit too late, since full UP collective pitch control had been applied before impact.