ACCIDENT

Aircraft Type and Registration:	Agusta A109C, G-HBEK
No & Type of Engines:	2 Allison 250-C20R/1 turboshaft engines
Year of Manufacture:	1996 (Serial no: 7633)
Date & Time (UTC):	15 July 2021 at 0730 hrs
Location:	Organford, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Helicopter damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	1,187 hours (of which 687 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On approach to a private landing site, the helicopter experienced an uncontrolled yaw to the right. Despite applying full left pedal the pilot was unable to regain control of the aircraft and opted to cut the power, following which the aircraft hit the ground. In the absence of a mechanical defect, it is possible that the loss of control was due to a loss of tail rotor authority resulting from operating close to or at the controllability limits of the helicopter, or that the helicopter was overpitched, or a combination of both. The helicopter was damaged beyond economic repair and the pilot sustained minor injuries.

History of the flight

The flight departed a private site in Dorset at 0720 hrs with a planned destination of Dunkeswell Aerodrome in Somerset. After departure the landing gear would not retract, and the pilot kept the speed below 110 kt so as not to exceed the landing gear operating limit of 120 kt. Following a period of troubleshooting, the landing gear remained down and the pilot decided to return to the departure point. He stated he had experienced this problem with the landing gear previously and understood it was an issue with the 'weight on wheels' sensor.

The pilot recalled a very light north-easterly wind as the helicopter approached the landing site from the west. He described the local weather conditions ordinarily experienced at the landing site as predictable and benign. As the speed reduced, the helicopter transitioned from descending flight to slowing flight with the intention of entering a hover. The helicopter began its right turn to head south approximately 100 m from the landing site.

As the helicopter turned to head south toward the landing site, a greater amount of left pedal than usual was needed as the aircraft nose began turning to the right. The pilot increased his left pedal input until he had full left pedal applied, followed by left cyclic inputs to try to control the aircraft. At this point, the helicopter nose was still tending right but the helicopter was now drifting sideways to the left on an easterly track, whilst maintaining an approximate southerly heading (Figure 1). The pilot estimated his ground speed was approximately 15-20 kt. Additional application of the collective made the rotation to the right uncontrollable.

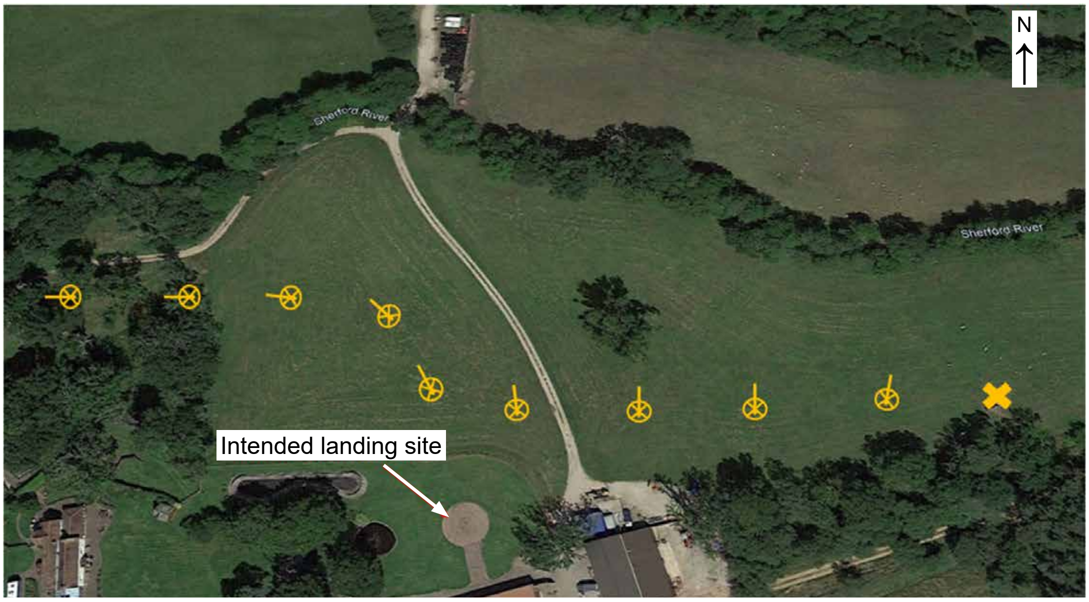

Figure 1

Approximate flight path of G-HBEK on approach to the landing site

The helicopter was drifting below the tree line and approaching the end of the field. The pilot reported that he did not want to climb as he was concerned that he might have lost tail rotor drive or control and therefore chose not to abort the landing. As he still did not have directional control of the helicopter, he believed his only option was to cut the power, with the expectation from his training being that the nose would then straighten up. After he did so, he did not regain control and has no memory of the subsequent accident sequence. The pilot did not recall any warnings or cautions prior to the event. The total flight time was approximately 15 minutes.

The helicopter was damaged beyond economic repair. The pilot reported that he did not sustain any visible head injuries. His loss of consciousness may have been caused by high sideways rotational accelerations of his head during the impact sequence.

Aircraft information

The A109C helicopter is powered by two Allison 250-C20R/1 turboshaft engines. It has a four-bladed main rotor which rotates anti-clockwise and a two-bladed tail rotor. It can accommodate seven passengers in addition to the pilot. The maximum gross weight is 2,720 kg and the actual takeoff weight on the accident flight was 2,240 kg. Its flight manual states that satisfactory stability and control in sideward flight have been demonstrated at all loading conditions, up to and including 20 kt. It further states that when operating at high weights with winds from the right greater than 10 kt, the left pedal stop may be reached.

No flight data or cockpit voice recorder was fitted or required.

Aircraft examination

The aircraft was examined by the AAIB and representatives from the aircraft manufacturer. The tail rotor blades were damaged but the tail rotor gearbox shaft rotated freely. There was sufficient oil in the tail rotor gearbox and no evidence of overheat. All tail rotor control linkages were secure and applying full left and right pedal in the cockpit produced corresponding tail rotor actuator and blade pitch changes. The tail rotor driveshaft was in good condition along the length of the tail boom. The tail rotor driveshaft had separated from the main rotor gearbox at a spline fitting. There was no damage to the splines, which indicated that the failure probably occurred as a result of the ground impact. The aircraft manufacturer's representative stated that they had only seen this type of spline separation once before and that it was the result of impact forces.

Figure 2

G-HBEK at the accident site

Meteorology

Bournemouth Airport is less than 10 nm from the landing site and publishes METARs every 30 minutes. At the departure time of 0720 hrs it reported wind from 350° at 8 kt with 2-3 octa's of cloud at 2,200 ft and a temperature of 19°C. The next METAR at 0750 hrs reported the wind direction had veered and was now from 020° at 11 kt.

Loss of tail rotor effectiveness

Loss of tail rotor effectiveness (LTE) manifests as an unanticipated yaw and is defined by the FAA as an *'uncommanded, rapid yaw towards the advancing blade which does not subside of its own accord'*[1]. Without correcting input from the pilot, which in the case of G-HBEK requires left pedal input due to its anti-clockwise main rotor, LTE can result in complete loss of control. LTE is caused by an aerodynamic interaction between the main and tail rotor and is not a technical malfunction.

LTE occurs when the airflow through the tail rotor is altered, resulting in a sudden change to the thrust produced by the tail rotor. This change of tail rotor thrust can be a result of several factors, described by the FAA as including the following:

- *'Airflow and downdraft generated by the main rotor blades interfering with the airflow entering the tail rotor assembly.*
- *A **high power setting**, hence large main rotor pitch angle, induces considerable main rotor blade downwash and hence more turbulence than when the helicopter is in a low power condition.*
- *A **slow forward airspeed**, typically at speeds where translational lift and translational thrust are in the process of change and airflow around the tail rotor will vary in direction and speed.*
- *The **airflow** relative to the helicopter.'*

Combinations of these conditions can create a situation where there is insufficient torque reaction available to control the helicopter in a particular environment.

Weathercock stability

When the wind is from 120°- 240° relative to the helicopter at wind speeds up to 40 kt, the nose attempts to weathercock into it. This can only be stopped by pilot input on the opposite yaw pedal. If a right yaw rate develops and the relative wind is in this region (Figure 3) the yaw rate can rapidly become uncontrollable. Maintaining positive control of the yaw rate is imperative when flying downwind, particularly with high power settings and low airspeed.

Footnote

1 Helicopter Flying Handbook, Chapter 11 '*Helicopter emergencies and Hazards*' Federal Aviation Administration (FAA), https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/media/hfh_ch11.pdf [accessed 17 December 2021]

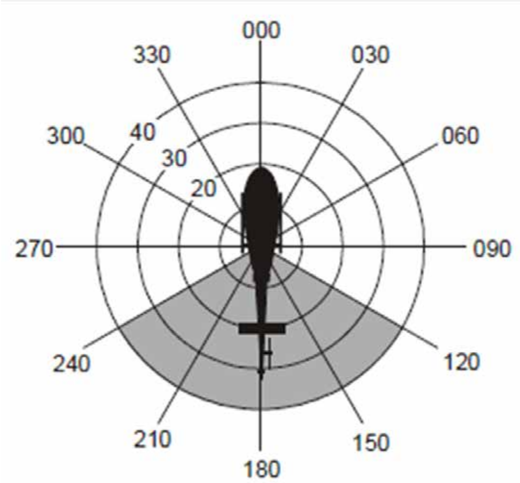

Figure 3

Weathercock stability – relative wind from 120° to 240° from 0-40 kt

LTE guidance

In 2014 the AAIB reported on an event which bore several similarities to this accident[2]. The report into that accident included a safety action by the CAA, which stated its intention to review and update Safety Sense Leaflet 17 *'Helicopter Airmanship'* to include information on LTE.

In response to enquiries following the accident involving G-HBEK, the CAA commented that Safety Sense Leaflet 17 was not in fact updated because at the time it was providing input to an EU common document by the European Helicopter Safety Team (EHEST) '*Helicopter Flight Instructor Guide*'[3]. This document and the current version of the '*EASA Together4Safety Helicopter Flight Instructor Guide*'[4] both offer guidance to flight instructors on LTE. There is information on LTE contained within EHEST leaflet '*Safety Considerations*'[5], which is aimed at all helicopter pilots.

Overpitching

Overpitching is a condition which occurs when the pilot demands more power than is available by raising the collective[6]. Main rotor blade pitch increases to meet the power demand which, when exceeding the power limit, can result in a power-on rotor stall.

Footnote

[2] https://assets.publishing.service.gov.uk/media/5422eeb0ed915d137100020b/Hughes_369D_G-CCUO_07-14.pdf [accessed 20 December 2021]

[3] *EHEST Helicopter Flight Instructor Guide* available at https://www.easa.europa.eu/document-library/general-publications/helicopter-flight-instructor-guide [accessed 14 January 2022]

[4] *EASA Together4Safety Helicopter Flight Instructor Guide* available at https://www.easa.europa.eu/document-library/general-publications/helicopter-flight-instructor-guide [accessed 14 January 2022]

[5] *EHEST HE1 Safety Considerations*, available at https://www.easa.europa.eu/downloads/22663/en [accessed 21 January 2022]

[6] *Helicopter Flying Handbook*, Chapter 11 '*Helicopter emergencies and Hazards*' Federal Aviation Administration (FAA), https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/media/hfh_ch11.pdf [accessed 17 December 2021]

Overpitching usually occurs on approach when the helicopter experiences a high rate of descent. This may be a result of high operating weight, relative tailwind, high altitude, or an approach at a speed which is too fast or too slow, or a combination of these factors. As the pilot increases the power demand in order to control the rate of descent, the power limit is reached, and further power demand increases the torque as rotor rpm reduces. To keep the nose of the aircraft straight, the pilot must make a corresponding yaw pedal input. If the collective is raised further – normally to reduce the rate of descent – and torque increased, the tail rotor rpm (and therefore thrust) also falls. The relative authority of the tail rotor is reduced, and more pedal input is required to counteract the torque effect until the pedal reaches its limit. The rotation can no longer be controlled as the tail rotor has run out of authority.

As some symptoms are the same, overpitching can sometimes be confused with LTE.

Analysis

In the absence of recorded data the pilot's recollections were the principle source of information about the flight.

The aircraft examination did not reveal any fault with the tail rotor control system, and the tail rotor driveshaft separation was probably the result of impact; in addition, the pilot did not report any technical warnings or failures other than the original landing gear issue that had prompted his return.

The pilot stated that he was familiar with the weather conditions at the landing site and local weather reports such as from Bournemouth Airport, did not accurately represent the local conditions he would experience when operating at the site. He reported his impression that the weather conditions at the site were seldom beyond the limits of the helicopter and were always more favourable than the weather reports made nearby.

The wind at Bournemouth Airport at the time of departure was reported to be from 350° at 8 kt, which if present at the landing site would have been 170° relative to the helicopter as it took up a southerly heading. The next wind reported at 0750 hrs reported a wind of 020° at 11 kt, a relative direction of 200°. As the accident is estimated to have occurred at 0735 hrs, it is possible the relative wind was from behind the helicopter. This wind combined with the groundspeed of the helicopter as it turned towards the landing site, may have resulted in reaching the controllability limit for the helicopter for the wind conditions.

Events involving LTE ordinarily result in an uncontrollable yaw; however, it is possible that G-HBEK was close to, or at, its maximum demonstrated speed of 20 kt, and that full left pedal was needed to keep the nose from yawing further to the right. In this case, any increase in the relative wind speed or addition of torque by the pilot would have resulted in an increased right yaw, which may have become uncontrollable.

As the helicopter made its right turn towards the landing site, with a high power setting, decelerating and turning downwind, it could have been susceptible to the effects of LTE and overpitching. These might be challenging circumstances without a high level of pilot awareness of the flight conditions and risks associated with a turn downwind near the landing site.

Conclusion

The flight conditions, phase of flight and behaviour of the helicopter were such that a loss of tail rotor effectiveness, loss of tail rotor authority, or a combination of both, were possible causes of the pilot losing directional control of the aircraft and subsequent ground impact.