No: 4/90 **Ref: EW/C1138/01** **Category: 2c**

Aircraft Type and Registration:	Hughes 369HS, G-FRGY
No & Type of Engines:	1 Allison 250 turboshaft engine
Year of Manufacture:	1973
Date and Time (UTC):	6 December 1989 at 1244 hrs
Location:	3 nm south of Carlisle Airport, Cumbria
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (fatal) Passengers - 1 (fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (Helicopters) issued by the FAA
Commander's Age:	29 years
Commander's Total Flying Experience:	113 hours (of which 28 were fixed wing and 85 were on type)
Information Source:	AAIB Field Investigation

History of the Flight

The purpose of the flight was to fly G-FRGY from its operating base at Newcastle to its maintenance base at Manchester Barton for a 50 hour inspection. This inspection had been due on 30 November 1989 but had been extended until 6 December 1989. The 0600 to 1200 forecast for the flight obtained by the pilot indicated that his intended route would be affected by fog and low stratus until 1100 hrs. The subsequent 1200 to 1800 forecast indicated the possibility of isolated fog and scattered stratus over the intended route. It is not known if the pilot had sight of the latter forecast before his departure from Newcastle. A meteorological aftercast for the time of the accident reported fog and stratus in the Carlisle area with a stratocumulus layer base 3000 feet. The temperature at 2000 feet was +3°C and the Relative Humidity 80%. The aircraft flight manual states 'Use engine anti-icing when OAT is below +5°C and visible moisture conditions prevail' The pilot of a Royal Air Force Search and Rescue helicopter who arrived in the Carlisle area at 1330 hrs reported the top of the fog layer as 1500 feet with no discernable horizon between there and the base of the stratocumulus at 2500 feet. He reported that visual flight between the layers was possible but reference to flight instruments was required to prevent disorientation. He also reported that the ground became visible at 350 feet agl on his descent in the accident area.

At 1210 hrs on 6 December 1989, G-FRGY took-off from Newcastle on a VFR departure with the stated intention of routing via Carlisle to Manchester Barton at 1500 feet. At 1222 hrs, the pilot reported overhead Hexham at 1500 feet and at 1226 hrs was released by Newcastle ATC to call Carlisle Approach. At 1228 hrs, the pilot called Carlisle stating his position as 3 nms west of Haydon Bridge at 2000 feet with the intention of routeing overhead Carlisle airport before turning south for Barton. At 1240 hrs, the pilot reported overhead Carlisle airport at 2000 feet. On receipt of an acknowledgement from Carlisle, the pilot stated that he was turning south. This was the last transmission received from G-FRGY. Throughout the flight, the pilots voice had sounded calm and up to this point there was no indication of any problem with the aircraft. A frequency spectrum analysis of the pilot's last transmission failed to detect any malfunction in the helicopter's transmission or rotor system. A print-out of the aircraft's track derived from radar indicated that G-FRGY was transponding on 4321 but no height encoding was observed. The track indicates that when the pilot called overhead Carlisle he was in fact overhead the town of Brampton some 3 nms to the East of Carlisle airport. From overhead Brampton G-FRGY executed a very gentle left turn on to the correct southerly track for Barton.

A speed profile derived from the recorded radar information shows that having turned onto south at Brampton, G-FRGY maintained its cruising speed of 85 kts for about 80 seconds before increasing speed to probably in excess of 135 kts (Vne - 130 kts). Some 20 seconds later, the speed was seen to be rapidly reducing to around 30 kts whereupon secondary radar contact was lost for 33 seconds. On resumption of radar contact, G-FRGY was 400 metres north-west of the previous position and heading south-west at about 90 kts. Twenty two seconds later, radar contact was finally lost at an estimated height of 400ft agl some 500 metres south of the crash site. The elapsed time from the initial speed increase to final loss of radar contact was just under 2 minutes.

At about this time, several witnesses on the ground in the area of How, a small village some 4 nms south-south-east of Carlisle airport, reported hearing an aircraft which was making unusual mechanical noises. Three witnesses reported hearing the aircraft either turning or flying on a westerly rather than a southerly track and this was supported by the radar track which showed a turn onto west shortly before impact.

G-FRGY was first seen by several witnesses emerging from cloud on a southerly heading in a position some 600 metres north of the crash site. It continued to descend while rocking from side to side with the main rotor turning slowly. At about 150 feet agl, G-FRGY was seen momentarily to slow its descent at which point a witness observed something detach from the aircraft and fly in an arc towards the west. At this point the main rotor was seen to stop and all sound ceased. The aircraft then fell vertically to the ground. On arriving at the crash site, rescuers observed a small fire which they attempted to put out with extinguishers brought from vehicles. However, the capacity of the extinguishers was inadequate and the fire eventually engulfed and destroyed the aircraft.

The pilot had flown 26 hours on fixed wing aircraft in 1981 but there is no record of him having flown again until, in November 1988, he undertook a course of instruction in the United States. The course lasted 3 weeks at the end of which he was awarded a Private Pilot's Licence (Rotorcraft - Helicopters) by the FAA. The pilot recommenced flying in the United Kingdom in March 1989 and had completed 26 hours, all on G-FRGY, up to the time of the accident flight.

A postmortem examination of the occupants failed to reveal any condition that could have caused or contributed to the accident.

Wreckage Examination

The helicopter had crashed onto a gently undulating grass covered field approximately 100 metres from a minor road. Examination of the helicopter at the crash site, and later at AAIB Farnborough, revealed it to have descended vertically at a high rate, striking the ground on a heading of 284°M and with a 30° nose down attitude. It was also laterally level and erect. A post impact fire had consumed most of the helicopter's structure, instruments and flying control linkages in the cabin area, but most of the main and tail rotors, their transmissions and the engine were available for examination. The helicopter was complete at the moment of impact except for the outer half of the horizontal stabiliser. This was found some 330 metres to the NE of the impact site with a number of small fragments from the stabiliser structure and a main rotor blade end-cap.

It was established from the condition and distribution of the main rotor blades (MRB) which were mutually at 90 degrees and centered to the main rotor head, and their impact marks with the ground, that the main rotor had not been turning at the time of impact. In addition, the input shaft to the main rotor gearbox had suffered a double bending failure in the impact, the characteristics of which confirmed that this also had not been rotating at that time. There was, however, tip damage to each of the four MRB leading edges over a distance of approximately six inches in from their tips.

Examination of the unburnt tail boom revealed an area of severe damage not consistent with having occurred at impact, beginning some 20 inches forward of the upper vertical fin leading edge attachment. The boom structure had failed circumferentially some 13 inches forward of this same attachment. The aft portion of the boom, complete with the empennage, had remained attached to the helicopter by the unbroken, but damaged, tail rotor pitch control rod. It was established that the most forward area of this boom damage was co-incident with the point on the tail boom where the tip of a MRB would make contact if any were to be deflected sufficiently far down, the shape of this deformation later being matched to that of the MRB cross-section. It was also established that two additional blade strikes had occurred futher aft on the tail boom, as well as to two more in the region of the failure on the horizontal stabiliser. These four strikes could have only occurred after structural separation of the aft boom. There was generally no sign of any major rotational damage to the two tail rotor blades, or their tips, but light damage was present on the inner face of one blade close to the tip. The location of this damage was consistent with the blade striking the damaged boom a glancing blow, once the aft section of the boom had become detached from the helicopter, with commensurate damage

present on the tail boom. The one piece tail rotor drive shaft had also suffered a failure at the same region as the initial MRB strike, the characteristics of which suggested that this had occurred whilst it was rotating and as a result of bearing against the deformed boom structure.

After sectioning the tail boom, it was possible to see where the major section of the drive shaft had continued to rotate (normal speed 2140 RPM) and flail against the boom internal structure. Heavy witness marks in the plane of the failure indicated that these were caused after the boom had been deformed.

A strip examination of the rotor transmission system revealed integrity of drive from the engine through to the main and tail rotors, all damage observed being caused by the various impacts or subsequent ground fire. The engine and fuel system strip examination did not reveal any evidence of pre-impact defects, but the presence of unburnt and unchopped grass throughout the turbine section showed the engine to have been cool and rotating only very slowly at the time of impact. In addition, there was almost no sign of contact between the rotating and static compontents within the engine in areas known to rub following such impacts with an engine under power.

Although this type of helicopter is not cleared for flight into cloud or known icing conditions it had been equipped with both an auto re-ignition and an anti-icing system for the engine. These systems are often fitted to engines of this type as it is possible for ice to form in the engine intake, with the consequent risk of engine rundown due to air starvation, at temperatures upto +5°C above freezing and in conditions of high humidity. The engine intake anti-ice system operates by bleeding hot air through a simple valve at the compressor output and injecting into and around the compressor intake. The valve is opened by the action of the pilot ungating and pulling forward a handle, to which is connected a Bowden cable, in the roof of the helicopter. This cable was found complete in the wreckage and still connected to the valve, the frozen relative position of its inner and outer sections revealing the valve to have been closed at the time of the impact. Analysis of the deformation of the cabin structure showed that this cable was more likely to have been pulled rather than pushed in the impact, thus supporting the above view of valve position prior to impact. Due to the effects of the post impact fire, it was not possible to establish whether the auto re-ignition system had been armed or was operating prior to the impact.

The helicopter had been imported from the United States late in 1988 and placed on the UK register in March 1989 after complying with the appropiate CAA requirements and satisfactory completion of a flight test. During the wreckage examination two defects, not related to the accident, were identified. One was that the tail rotor pitch links operating beam had been assembled onto the tail rotor shaft one spline pitch out, resulting in both pitch change links being out of the required parallel alignment with the tail rotor shaft. The other was that one of the six stiffnuts attaching the freewheel clutch housing to the engine was missing.