No: 11/92 **Ref: EW/C92/5/6** **Category: 2c**

Aircraft Type and Registration:	Robinson R22 Beta, G-HETH
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Year of Manufacture:	1989
Date & Time (UTC):	29 May 1992 at 2257 hrs
Location:	Near Latimer, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - Fatal Passengers - Fatal
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (H) with Night Rating
Commander's Age:	48 years
Commander's Flying Experience:	420 hours (all of which were on type) Last 90 days - 68 hours Last 28 days - 25 hours
Information Source:	AAIB Field Investigation

History of the flight

The helicopter was privately owned and based at a private facility at Ugley Park, near London/Stansted Airport. On the evening of 29 May 1992 it was flown by the owner/pilot with one passenger on board. The pilot's Private Pilot's Licence included the restriction that the holder was not permitted to fly the helicopter either "out of sight of ground or water, or by sole reference to instruments." Her flying log book records that she had previously undertaken dual instruction in instrument flying, and a flying instructor reported that she displayed a high standard of proficiency.

At about 1803 hrs the helicopter took off from Ugley Park for a flight to a private field near Yattendon, Berkshire. It is not known whether the pilot had obtained a weather forecast prior to departure. The helicopter landed at Yattendon at about 1900 hrs, where the two occupants attended a private function at a local hotel. Subsequently the helicopter took off from Yattendon at about 2233 hrs for the return flight to Ugley Park. There is no evidence that the pilot obtained a weather forecast prior to this departure.

At 2236 hrs the pilot contacted Benson Radar, reported her intended route and destination, and requested a Flight Information Service. The cruising altitude was confirmed as 1800 feet on the London QNH of 1008 mb. Radio transmissions between the pilot and the Benson radar controller continued routinely until 2247 hrs when the radar service was transferred to Thames Radar. The pilot reported to the Thames radar controller that her position was one mile south of Wycombe and that she was flying at 1500 feet. The routeing, destination and London QNH were confirmed, and the helicopter's position was positively identified by selective transponder coding. At 2254 hrs the Thames radar controller, noticing an alteration of heading to the left, asked the pilot if she was changing her route to fly via the Bovingdon VOR. The pilot replied that she was not, but that she was flying in cloud. When asked what her present altitude was she replied that it was 700 feet. When further asked if she required navigational assistance she replied that she did not. This was the last radio transmission received from the helicopter, and was timed at 2256 hrs. Throughout all her radio transmissions the pilot appeared to be calm and there was no hint of any difficulty.

The radar recording shows that from first contact with Benson radar until 2254 hrs the helicopter flew on a direct track between Yattendon and the destination. At 2254 hrs it turned left towards Bovingdon and then continued further left until it appeared to be on a reciprocal heading when its radar return disappeared. This occurred over a position slightly north west of Latimer at 2256 hrs, when the pilot reported that she was flying at 700 feet. The altitude could not be confirmed from the radar picture as the helicopter's transponder had no altitude read out (Mode C facility). However, when flying at 700 feet on the London QNH at the position where radar return disappeared an aircraft would be flying at less than 300 feet above ground level. At the same time witnesses who lived in the area reported hearing the sound of a low flying helicopter which, from the changes in its engine and rotor noise, they assumed to be manoeuvring. This was shortly followed by the sound of an impact. The glow of a post impact fire was observed in weather conditions that were described as low cloud with mist. Ground impact marks suggested that the helicopter had struck the ground in a spiral dive.

Engineering examination

The accident site was in a large field of cereal crop that was located on top of a ridge that ran in a general north west, south easterly direction. The height of the accident site above sea level was 440 feet. The surrounding area, which was sparsely populated consisted of rolling hills covered in woods and a mixture of crop and grazing land. To the east and west of the accident site the land fell away steeply; to the east there was agricultural land and to the west there was dense woodland. The land to the north and south was fairly level and consisted mainly of cereal crop.

Examination of the accident site showed that the helicopter impacted the ground in a nose down attitude, about 28°, banked to the left at about 46°, turning to the left and descending at a speed of around 75 mph. At initial impact the helicopter was on an east south easterly heading. The initial contact was made by the helicopter's left forward skid which dug into the soft ground causing the main body of the helicopter to rotate over and to the left of the skid. This was followed by the forward cockpit and main rotor blades impacting the ground which caused severe disruption. The main body of helicopter travelled a further 42 feet before coming to rest. The severe disruption to the helicopter's fuel system allowed fuel to flow over the hot engine exhaust area and an intense post impact fire occurred. Examination of the main rotor blades and the ground impact marks made by them indicated that they were rotating at a speed near their normal operating speed. The power transmission system between the engine and the main and tail rotors was found intact and functioned correctly. The severity of the post impact fire and evidence of fuel staining of the cereal crop in the area of the wreckage indicated that there was a considerable quantity of fuel on board the helicopter at impact.

A detailed examination of the wreckage showed that the helicopter was structurally complete at impact and that it had not been involved in an airborne collision. Because of the severe post impact fire it was not possible to conduct a complete check of the flying control or engine fuel systems. Those parts that were available were found to be correctly connected and had no indications of a restriction or blockage. Examination of the engine drive belt system and the cockpit instruments that were available indicated that the engine was running at impact and that the main rotor was rotating within the normal operating speed range. The carburettor heat control was found to have been set at or very near the fully HOT position. The engine was taken to an approved workshop facility and a strip examination carried out. When the rocker cover was removed from the No.4 cylinder the exhaust valve rotator was found to be lying free inside the cover. Examination of the valve stem and the rocker arm showed that the rotator had been liberated by the exhaust valve sticking in the open position, which was the only possible way for this to have occurred. The strip examination of the engine did not reveal any impact marks between the valve and the top of the piston but did indicate that the engine had been operating in a hot and lean fuel/air mixture condition for some considerable time. Examination of the valves showed that they were all within the manufacturer's dimension tolerances except the No. 4 exhaust valve which had excessive carbon deposits on the stem in the area of the valve head. The sticking of this exhaust valve would have resulted in severe engine vibration and a loss of between 30 to 40% of the engine's power.

Examination of the maintenance history of the helicopter showed that one week before the accident, whilst being flown by the accident pilot, the engine had suffered partial power failure and severe vibration whilst climbing after take-off. A successful emergency landing was carried out. The helicopter was ground run by a flying instructor who confirmed the loss of engine power and severe engine vibration which was present to the same magnitude when either or both magnetos were

selected. The following day a licensed engineer removed the spark plugs from the engine, found that they had heavy lead deposits around the electrodes and replaced them with new ones. The helicopter was ground run and flight tested and declared serviceable. Later testing of the spark plugs which had been removed by the engineer found that five of the eight were unserviceable due to wear or failure on test. Five days prior to the accident the helicopter was flown to its regular maintenance organisation by the accident pilot and an examination and ground run by them found it to be serviceable. The pilot had written two days prior to the accident "I had another shudder on my way to Lichfield today and was ready for an autorotation, but it wasn't necessary". There was no record of this having been reported to an engineer or maintenance organisation.

Documentation showed that helicopter had been correctly maintained in accordance with an approved maintenance schedule. Lycoming Service Bulletin No. 388a, the Procedure to Determine Excessive Exhaust Valve Guide Clearance and Carbon Build-up, which should be complied with every 300 engine hours had been carried out approximately 82 engine hours before the accident and the clearances found to be within the limits specified. There was clear evidence that the helicopter had been kept in very good condition.

Two Ground Illuminating Flares had been fitted to the helicopter as required for night flying. Both flares survived the impact relatively undamaged. Neither flare had been fired and so they were taken to the manufacturer where they were examined and test fired successfully.

Meteorological information

The weather forecast fixed time chart, valid for flights between 1800 hrs and 2400 hrs on 29 May 1992 depicted a slow moving frontal system with the centre lying from North Wales to Suffolk. The weather conditions were described as rain and mist with 4000 metres visibility and cloud conditions of broken stratus base between 800 and 2000 feet with an overcast layer base 4000 feet. The chart contained a warning of occasional heavy rain showers and thunderstorms with visibility of 1500 metres and broken occasionally overcast cloud base of 300 feet. (Forecast cloud bases are issued in feet above mean sea level.) The recorded telephone message available on AIRMET SOUTH gave equally poor conditions and warnings.

An aftercast of the actual weather conditions prevailing at the time of the accident was prepared by the Meteorological Office, Bracknell. This shows that the forecast was substantially accurate and relevant extracts are as follows:

'Synoptic Situation: At 2200 hrs UTC showed a frontal system lying from Southport to Norwich moving slowly northwards with a very moist southeasterly airstream over the area.

Visibility: 3000 metres, locally 600 metres

Weather: Generally nil but the possibility of a light shower

Mean Sea Level Pressure: 1010 mb

Wind and temperature (at 1000 feet): 100°/08 knots Plus 15°C

Relative humidity: 92%

Cloud: Broken occasionally overcast Stratus base 400 to 600 feet probably covering high ground, overcast stratocumulus base 1600 feet.

Remarks: It would appear from the radar echoes that at the time of the accident there was no rain but there had been some heavy rain/shower or thunderstorm earlier on leaving very moist conditions with poor visibility and low cloud probably covering the highest parts. Further outbreaks of rain, heavy at times with thunder, developed and moved across the area soon after the accident.'

The significant change in weather conditions that occurred in the period from one hour before to one hour after the accident is shown on the radar composite illustrations in Figure 1.

Medical and Pathological information

Post mortem examination did not reveal any medical conditions that could have contributed to the causes of this accident.

R22 engine exhaust valves - history of sticking

Four major UK operators with a number of training and privately owned Robinson R22 helicopters under their care were questioned about engine problems. They and an approved engine overhaul organisation indicated that since the beginning of 1992 there had been a rapid increase in the number of sticking exhaust valves in the Lycoming 0-320-B2C engine, which is fitted to Robinson R22 Beta helicopters. It is understood that in nearly all these cases the cause of the sticking valve was carbon build-up on the valve stem in the area of the valve head. This increase in the number of incidents of sticking exhaust valves appears to be confined to UK registered R22s. Furthermore there does not appear to be any increase in the occurrences of sticking valves in the same model of engine that is fitted to many other aircraft types.

This informal survey of the instances where sticking valves have occurred on the Robinson R22 engine in UK over the past 12 months indicates the following factors:

1. All the helicopters involved were R22 Beta models

2. All were privately owned/operated and helicopters used mainly for instruction did not appear to exhibit this problem.

3. In all the cases the stuck valve was an exhaust one and in the majority of cases it was the No 4 cylinder exhaust valve.

4. The incidents of stuck valves generally occurred at between 300 and 500 engine hours since new/overhaul.

5. The majority of the helicopters engines had recently been examined in accordance with Lycoming Service Bulletin No. 388a, the Procedure to Determine Excessive Exhaust Valve Guide Clearance and Carbon Build-up and found to be within the tolerances specified.

6. All the helicopters were using approved engine oil which was being changed every 50 hours.

7. All the cylinders showed very good evidence of having run in a hot and lean condition for some considerable time.

The technical director of one UK operator had instrumented a R22 Beta engine so that all four cylinder head temperatures could be monitored. A one hour flight was then conducted for 30 minutes with no carburettor heat applied and for 30 minutes with full carburettor heat applied. The cylinder head temperatures noted during the flight were plotted graphically and are shown at Figure 2. It was noted that the application of carburettor heat does not appear to affect cylinder head temperature and that No 4 cylinder head temperature is about 14% higher than the other three cylinder head temperatures.

Safety Recommendations

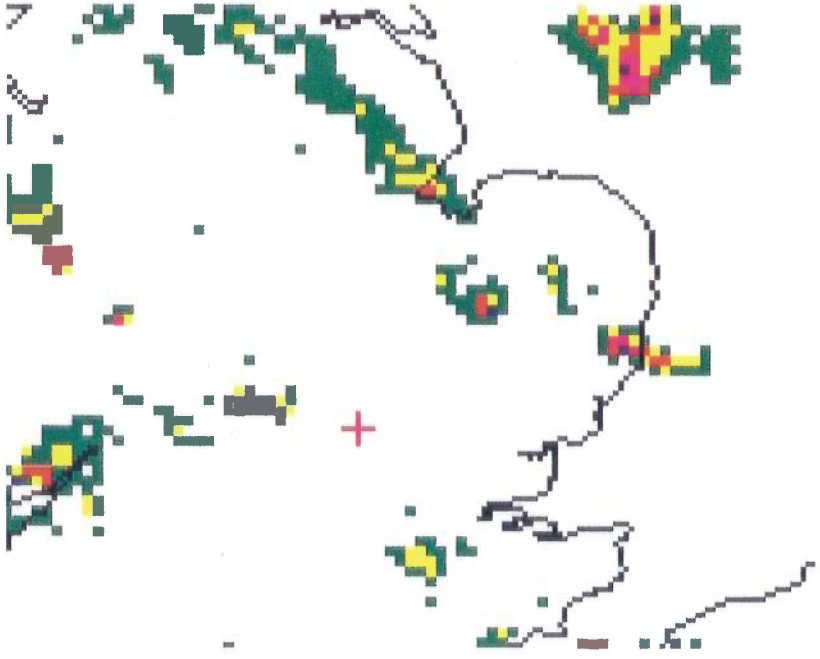
Two Safety Recommendations have been made to the CAA.

92-92 The CAA, together with the engine and airframe manufacturers, should determine the cause or causes of the increased incidence of sticking valves that have occurred in engines installed in UK

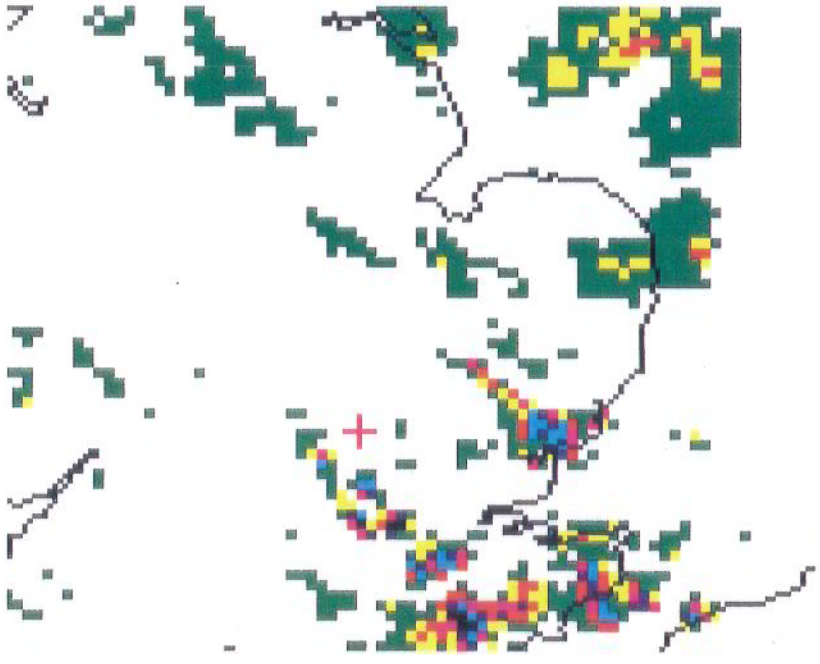
registered Robinson R22 Beta helicopters. Appropriate measures should be instigated to reduce the number of occurrences consistent with the rate experienced on other Lycoming 0-320 engine installations.

92-93 The CAA, together with the engine manufacturer, should examine the validity of Lycoming Service Bulletin No. 388a in determining whether there is excessive carbon build-up on the exhaust valve stem.

MODIFIED WEATHER RADAR COMPOSITES 29 MAY 1992



2200 UTC



2359 UTC

FIGURE 1

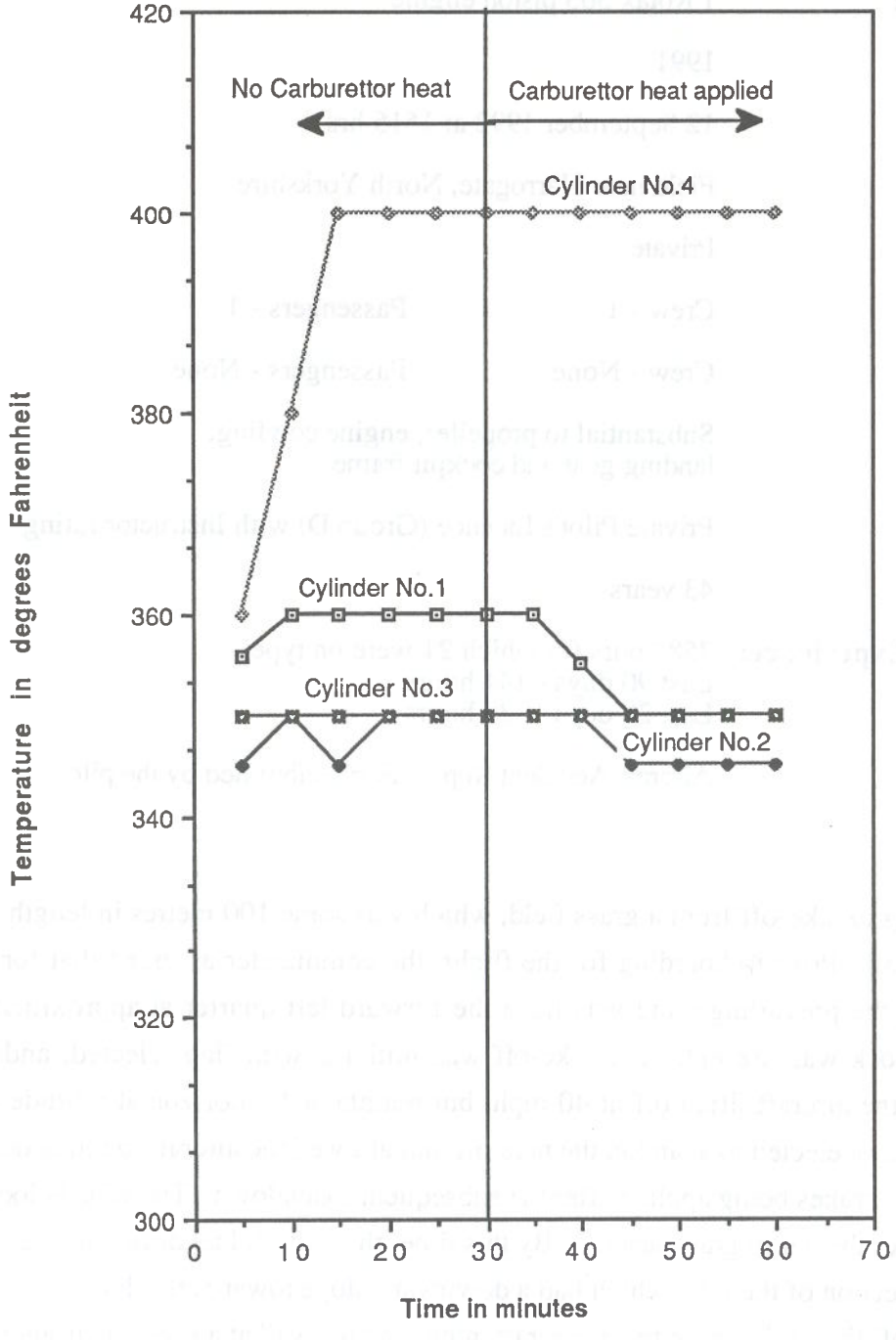


FIGURE No.2 CYLINDER HEAD TEMPERATURES MEASURED DURING CRUISE FLIGHT

IAS 80 knots, manifold pressure 22", OAT 21 C