No: 5/92	**Ref: EW/C92/02/04**	**Category: 2c**

Aircraft Type and Registration:	Robinson R22 Mariner, G-BPPC	
No & Type of Engines:	1 Lycoming 0-320-B2C piston engine	
Year of Manufacture:	1989	
Date & Time (UTC):	23 February 1992 at 1045 hrs	
Location:	Heyside, Royton, Oldham, Lancashire	
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 (Helicopters)	
Commander's Age:	44 years	
Commander's Flying Experience:	81 hours (of which 31 were on type)	
Information Source:	AAIB Field Investigation	

History of the Flight

The pilot started helicopter training in July 1989. By March 1991 he had flown a total of 50 hours on Enstrom helicopters (5 hours solo and 45 hours dual), flying from Barton Airfield, near Manchester. In December 1991 he commenced training on the Robinson R22 at Blackpool flying a further 30 hours (7 hours solo and 23 hours dual). His Final Handling Test (FHT) was completed on 24 January 1992 and his PPL(H) licence was issued on 12 February 1992. He held a current Class 3 medical certificate with no restrictions. During Robinson training he flew four hours on the Mariner version, which is fitted with permanently inflated floats. His Robinson instructor described him as "a student of average ability who understood the mechanics well but was slow to appreciate the aerodynamic aspects. He was level headed and concentrated well throughout the training which included vortex ring, engine off landings, practice forced landings and recovery from low rotor speed conditions".

Having successfully completed an FHT, the pilot was qualified to carry passengers and was keen to take his wife flying in a Robinson helicopter. He had to wait until he was actually in possession of his PPL(H) licence and during this delay he mentioned to his instructor that he would appreciate a check flight prior to flying solo again. He had booked the helicopter, G-BPPC, for a flight on Saturday 22 February 1992 but the weather that day was not suitable. The instructor, however, flew the aircraft to the refuelling pumps and filled the tanks to full before returning to park the helicopter outside the company headquarters on Blackpool Airfield ready for the following day's flying. On Sunday 23 February 1992 the weather had improved and at approximately 0930 hrs the pilot and his wife arrived at Blackpool having hired the helicopter for the morning intending to return by 1300 hrs.

An aftercast issued by the Meteorological Office, Bracknell, confirmed that the area was covered by a weak ridge of high pressure, visibility of 15 km, no low cloud and broken cirrus above 25,000 feet. Sea level pressure was 1026 mb with a surface temperature of +8°C (Relative humidity of 75%) and a temperature at 1000 feet of +6°C (Relative humidity of 68%). The surface wind was recorded as 240°/07 kt.

With his pre-flight planning complete, the pilot booked out with Blackpool Air Traffic Control (ATC) for a local flight. He was seen to carry out his pre-flight checks before he and his wife boarded the aircraft. The pilot occupied the right hand seat and the passenger the left. At 0959 hrs the pilot requested clearance from ATC to lift off to "east abeam" the tower. His instructor, who was refuelling another helicopter some distance away, noticed the pilot preparing to depart and was surprised, but not concerned, that he was flying solo before completing the check flight that he (the pilot) had requested. At 1002 hrs the helicopter departed Blackpool to fly via Barton to Oldham where the pilot owned a house and some commercial property.

At 1030 hrs the pilot made contact with Barton radio and advised them that he was "north of their zone travelling east along the M61". This was a courtesy call and no further transmissions were received by Barton or any other ATC unit. At approximately 1043 hrs several witnesses saw the helicopter flying east at about 500 feet to 800 feet in the vicinity of Oldham Edge. A couple, walking in the area, spotted the helicopter and used their video camera to film its progress. The aircraft was seen by them to be flying normally, under control, in a gentle left hand turn, with the engine sounding normal.

Witnesses positioned further along the flight path stated that, as the helicopter approached them, it appeared to be at a height of approximately 400 feet. One witness stated that the note from the engine then appeared to change becoming somewhat laboured " like a car being in the wrong gear". Another witness described the sound from the engine as "fading down". The helicopter was then seen to yaw to the left between 30° and 40° then yaw right and pitch nose up. Coincident with this manoeuvre was the abrupt cessation of noise from the engine. The aircraft then rolled to the left with the rotor blades rotating very slowly. The helicopter rapidly adopted a heading the reverse of its original in a slight nose down attitude with 30° left bank. The rotor blades where then seen to stop rotating. One witness described them as forming "an 'L' shape with one blade lying flat and the other pointing straight up". Witnesses described the helicopter as then falling vertically with no noise and the rotor blades stationary.

The helicopter crashed in marsh land in an upright position, slightly nose down with approximately 30° left bank. The helicopter was totally destroyed in the impact and there was no subsequent fire. The emergency services were on the scene within five minutes, however, the pilot and passenger who were still restrained by their lap and diagonal harnesses had sustained fatal injuries.

In view of the deceleration forces involved and the degree of deformation of the aircraft structure it is considered that the accident was not survivable. Both occupants were wearing lap and diagonal safety harnesses which were still intact post impact. Pathological evidence confirms that the pilot did not have any pre-existing medical condition that could have contributed to the accident.

Video recorded evidence

AAIB arranged for video film taken at the time of the accident to be electronically enhanced and its sound-track was frequency analysed. The video confirmed the weather conditions at the time and showed the aircraft approaching Oldham Edge from overhead Oldham hospital at a height estimated to be 800 feet to 1000 feet. The helicopter appeared to be flying normally, under control, in a gradual left turn. Frequency analysis of the sound-track confirmed that the rotor RPM was steady at approximately 101% (normal range 100% to 104%). The video evidence was not a continuous record of the accident. It is estimated that the camera was switched off for approximately 20 seconds before capturing the final 4.5 seconds of the helicopter's descent. In these final seconds before impact the video record confirmed the witnesses descriptions of the helicopter's flight path. The record also confirmed that the rotor blades were stationary throughout the vertical descent.

Wreckage examination

The aircraft examination commenced on the night of the accident. The helicopter lay on a narrow strip of boggy ground between a railway track and an industrial estate. It was clear that it had fallen absolutely vertically with no signs of forward motion The impact heading was roughly the reciprocal of the helicopter's reported track and it had been banked about 30° to the left. The main mass of the engine had caused a deep depression in the very soft ground which had filled with water . The tail boom and rotor lay behind it, albeit separated into three pieces by the impact.

There were no signs of any main rotor blade strikes on the boom nor on the cockpit canopy structure. The main and auxilliary fuel tanks were ruptured and empty but there was a considerable quantity of fuel evident in the ground. The condition of the main and tail rotor blades was consistent with there having been no rotation at all at impact (see Photograph 1).

The wreckage was recovered to the AAIB at RAE Farnborough for detailed examination. It was established that there were no significant defects in the main or tail rotor drive-trains. The clutch had been engaged and the gearboxes turned freely. There were no signs of any pre-impact disconnection of the engine or flying controls whilst it was noted that the mixture control was set to full rich and, significantly, that the carburettor heat control had been in the "COLD" position. The set of cockpit warning lights were examined and the amber light associated with low rotor RPM was found to exhibit hot stretching of the bulb filament, indicating that it had been illuminated at impact.

The engine was removed and subjected to strip inspection which showed that there had been no mechanical defects in the basic unit. The magnetos were tested and found to be still operable despite some damage. The technical documentation showed that the helicopter had been maintained in accordance with the statutory requirements and it possessed current Certificates of Airworthiness and Maintenance.

Piston Engine Icing

The Safety Promotion Section and the Public Relations Department of the Civil Aviation Authority issue safety information, on a non-regular basis, in the form of General Aviation Safety Sense leaflets. Leaflet No. 14 highlights the problem of piston engine induction system icing, commonly referred to as carburettor icing. Extracts of the leaflet are reproduced below:

> *"Carburettor icing can occur even on warm days, particularly if they are humid. It can be so severe that unless correct action is taken the engine may stop (especially at low power settings during descent, approach or during helicopter autorotation). Every year there are several accidents in the UK where engine induction system icing may have been a factor. Unfortunately the evidence rapidly disappears.*
>
> *The most common, earliest to show, and most serious type of induction system icing is carb icing caused by the sudden temperature drop due to fuel vaporisation and pressure reduction at the carburettor venturi. The temperature drop of 20°-30°C results in atmospheric moisture forming ice which gradually blocks the venturi. This slowly*

strangles the engine upsetting the fuel/air ratio causing a progressive smooth loss of power. Conventional float type carburettors are more prone to icing than pressure jet types.

Atmospheric conditions. *Carb icing is not restricted to cold weather, and will occur on warm days if the humidity is high, especially at low power settings. Flight tests have produced serious icing at descent power with the ambient (not surface) temperature over 25°C, even with relative humidity as low as 30%. At cruise power, icing occurred at 20°C when the humidity was 60% or more. In the UK and Europe where the high humidity is common, pilots must be constantly on the alert for the possibility of carb icing and take corrective action before an irretrievable situation arises. If there is an engine failure due to carb icing, the engine may not re-start and even if it does, the delay could be critical. Specific warnings of induction system icing are not included in standard weather forecasts for aviation and you must be prepared to deal with it on the basis of your knowledge and experience."*

The chart reproduced at Figure 1 shows the wide range of ambient conditions conducive to the formation of carburettor icing. Particular note should be taken of the much greater risk of serious icing with descent power. The ambient conditions prevailing on the surface and at 1000 feet in the Olham area at the time of the accident fall within the serious icing range.

Safety Notices

The Robinson Helicopter Company issues, from time to time, Safety Notices arising as a result of previous accidents and incidents to Robinson R22 helicopters. These Safety Notices are included in the Pilots Operating Handbook (POH) to acquaint pilots new to the Robinson R22 with potential problems. Extracts of the relevant Notices are reproduced below:

Safety Notice SN-2 (issued on 2 February 1981).

<u>Pilot checkouts.</u> Several accidents have been caused by pilots becoming too confident too quickly after being checked out in the R22. The ship has very quick and responsive handling characteristics which most experienced pilots like. Its quickness also increases the need for a very thorough checkout and a high degree of caution and alertness on the part of new pilots, particularly during their first 50 to 100 hours in the R22 .

Safety Notice SN-10 (Issued on 4 December 1981 and reissued on 4 October 1982).

<u>Fatal accidents caused by failure to lower collective</u>. The primary cause of fatal accidents in light helicopters, including the R22, is failure to maintain rotor RPM and airspeed. To avoid this, every pilot (including students and instructors) must have his reflexes conditioned so he will instantly add throttle and lower the collective lever to maintain RPM in any emergency.

When the pilot fails to add throttle and lower the collective lever, the rotor RPM rapidly decays, and the rotor stalls. If the pilot not only fails to lower collective, but instead pulls up on the collective to keep the helicopter from going down, the rotor will stall almost immediately. When it stalls, the blades will either "Blow Back" and cut off the tail cone, or, it will just stop flying allowing the helicopter to fall at an extreme rate. In either case, the resulting crash is likely to be fatal.

Rotor stall can occur at any airspeed. It is very similar to the stall of an aircraft wing at low speeds. As the airspeed of an aircraft reduces the angle of attack of the wings must be increased to produce the required lift to support the weight of the aircraft. At a critical angle, (around 15°) the airflow over the wing will separate and stall causing sudden loss of lift and a very large increase in drag. The same thing happens in a helicopter except it occurs due to low rotor RPM. As the rotor RPM gets lower and lower, the nose up angle of attack of the rotor blades must be higher and higher to generate the lift required to support the helicopter. Even if the collective lever it not raised by the pilot to provide the higher blade angle, the helicopter will start to descend until the upward movement of the air through the rotor provides the necessary increase in blade angle of attack. Again at the critical angle the blade will stall resulting in the sudden loss of lift and a large increase in drag. The increase in drag acts like a huge rotor brake causing the rotor RPM to reduce even more, further increasing the rotor stall. As the helicopter begins to fall, the upward rushing air continues to increase the angle of attack on the slowly rotating blades making recovery virtually impossible even with full down collective.

Low rotor RPM can be caused by running out of fuel, operating at high density altitude, inadvertently pulling the mixture control, poor coordination, etc. No matter what the cause, the pilot must first lower the collective lever to maintain RPM <u>before</u> investigating the problem. It must be a conditioned reflex. Whenever the pilot feels, hears, or sees anything unusual, his first reaction must be to <u>start down with the collective lever.</u>

Safety Notice SN-13 (issued 24 January 1983)

Use of carburettor heat. *Several incidents have occurred where carburettor ice during descent or autorotation was suspected. To prevent further incidents, the following procedure is recommended.*

When conditions conducive to carburetor ice are known or suspected, such as fog, rain, high humidity, or when operating near water, use carb heat as follows: During hover or cruise flight, apply heat as required to keep carburettor air temperature (CAT) gauge needle out of the yellow arc. If an unexplained drop in manifold pressure or RPM occurs, apply full carb heat for about one minute and check for an increase in manifold pressure or RPM. Regardless of CAT gauge temperature, apply full carb heat prior to reducing power for descent or autorotation. When power is reapplied, return carb heat control to full cold or partial heat position.

Safety Notice 25 (issued 11 December 1986)

CARBURETTOR ICE SEASON IS HERE! *It is the time of year again when we begin receiving reports of carburettor ice. It seems to occur most often when the temperature is between 25°F to 55°F (-4°C to +13°C) and there is high humidity or visible moisture. It usually happens because the pilot forgets to always apply full carb heat whenever the throttle is rolled off during an approach or a practice autorotation.*

Remember, applying partial carb heat to prevent ice by keeping the CAT gauge out of the yellow is only effective during hover, climb and cruise when the ice tends to form in the carburetor venturi or on the upstream side of the throttle butterfly. That is where the temperature probe is located. It is not effective when the throttle is closed and a large pressure and temperature drop occurs across the butterfly allowing ice to form on the downstream side of the butterfly. Ice can occur at any point even though the CAT gauge is indicating a temperature well above the yellow arc.

WHEN CONDITIONS CONDUCIVE TO CARB ICE EXISTS AND YOUR MANIFOLD PRESSURE IS BELOW 18 INCHES, IGNORE THE CAT GAUGE AND APPLY FULL CARB HEAT.

CARB ICING

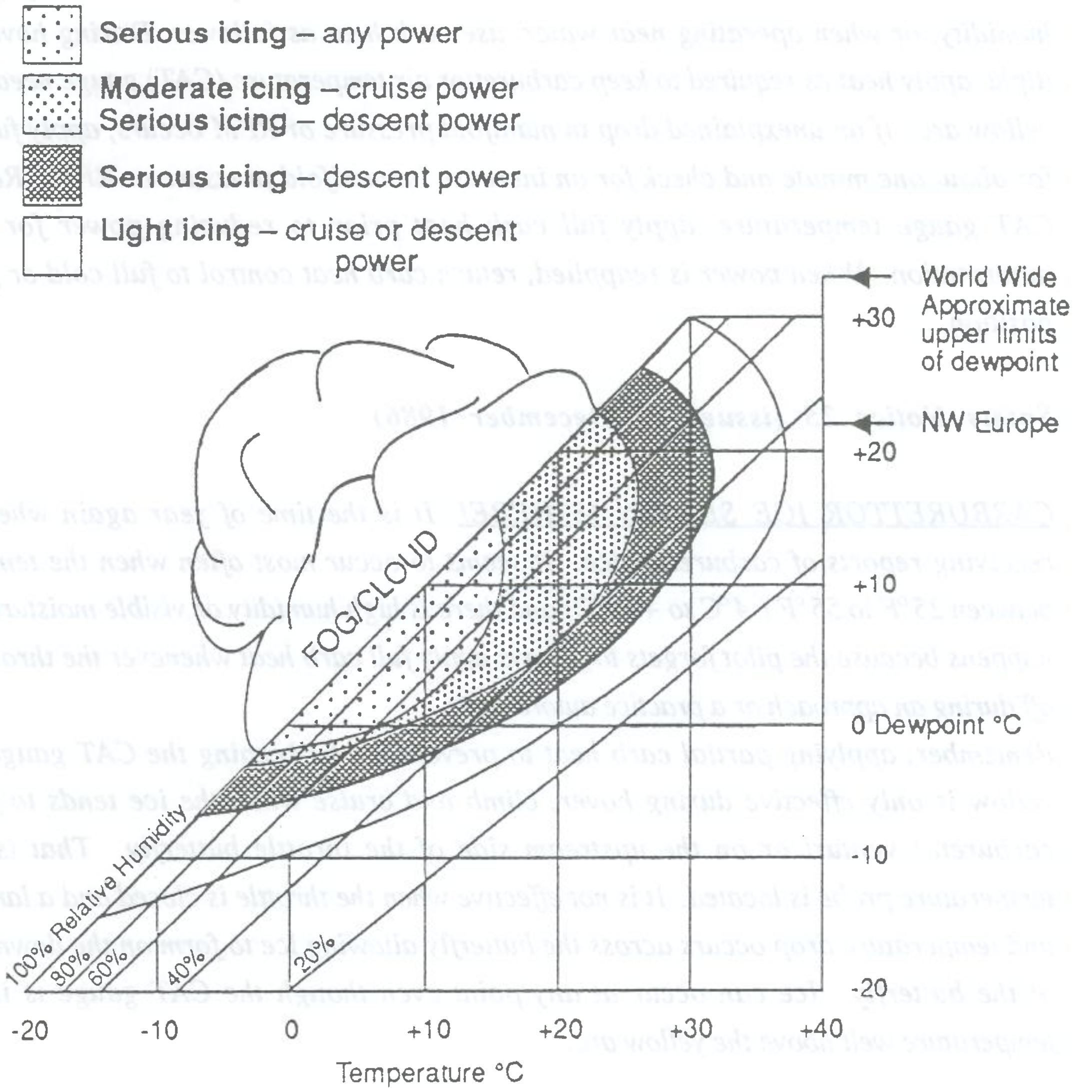

FIGURE 1

G-BPPC: Note lack of rotational damage to main rotor blades

G-BPPC: View of centre console showing carburettor heat control knob fully down (cold position)