AAIU Report No. 2002-003
AAIU File No. 2001-036
Report Published:11 March 2002

Name of Operator:	Eirecopter Helicopters Ltd
Manufacturer:	Robinson Helicopter Company
Model:	R22 Beta
Registration:	EI-CMI
Nationality:	Irish
Location:	Field adjacent to Birr Airfield
Date and Time (UTC):	12 June 2001 at 18:45 hours approx
Injuries:	None

SYNOPSIS

While transitioning out of Birr Airfield during a solo navigational exercise, the student pilot observed that he was not climbing as normal and felt that the helicopter was suffering from a lack of power. Fearful of imminent impact with a number of obstructions ahead of his position the pilot decided to carry out an emergency landing in a field adjacent to the airfield. During the final phase of the run-on landing, the helicopter started to drift to the right and subsequently rolled over onto its right-hand side just prior to coming to a halt. The pilot evacuated the helicopter without injury.

NOTIFICATION

The accident was reported to the Air Accident Investigation Unit (AAIU) by the Watch Manager, Shannon Airport at 20:05 hours on the 12 June 2001. An AAIU inspector arrived at the crash side at 21:45 hours on the day of the accident to commence an investigation into the accident. The Chief Inspector of accidents appointed Mr J. Whyte (Operations) and Mr J. Hughes (Engineering) to carry out an investigation into the circumstances of this accident and prepare a report for publication.

1. FACTUAL INFORMATION

1.1. History of the Flight

The student pilot had flight planned for a solo navigation exercise (Navex) namely, Weston Aerodrome (EIWT) Kilkenny Airfield (EIKL) Birr Airfield (EIBR) and return to EIWT. A dual instruction flight for the route had been completed on the 30 May 2001. Prior to departure the instructor fully refuelled the helicopter (3 hours 30 min endurance approximately). The pilot completed the pre-flight walkround. The only defect found was an un-serviceable (U/S) tail navigation light.

Departing EIWT at 17:15 hours the pilot flew an uneventful flight direct to EIKL. Arriving overhead EIKL at 18:05 hours (approx) the pilot carried out an approach to a low ground speed hover along the duty runway, but did not land. He then transitioned away and continued his Navex to EIBR. Overhead EIBR at 18:35 hours (approx), the pilot identified the wind conditions from the airfield windsock as a light 5-10 kt south-westerly wind and decided to turn right downwind at 1,000 ft for Runway (RWY) 25. Downwind checks included the selection of full carburettor heat. Full carburettor heat remained applied for the remainder of the flight. The pilot flew a constant angle approach towards the threshold of RWY 25, which is intersected at its threshold by RWY 18/36. The into wind approach terminated just beyond the threshold of RWY 25 at a height of 15 ft and a ground speed hover of approximately 20 kts. No landing was carried out. The pilot's intension at this point was to transition away into wind along RWY 25/07 and return direct to EIWT.

1.1.1 Pilot's Recall of Events

The Pilot's re-call of events, from his transition out of EIBR to the point of impact, are punctuated with elements of uncertainty. This the investigation considers was most likely attributed to the fact that the pilot, who would have had obvious concerns at the time for his own safety and well being, was quite traumatised by the subsequent unfolding of events.

No one was present at EIBR to witness the movements of EI-CMI or the subsequent events during the transition away. However, three witnesses observed the final moments of EI-CMI's flight as the pilot attempted to carry out the emergency landing.

Two interviews with the pilot (one of which included a re-visit to the cockpit of EI-CMI) were conducted in an attempt to re-construct the flight. The following most likely sequence of events was developed.

1.1.2 Likely Sequence of Events

The pilot recalls that from an into wind ground speed hover, he pulled collective and pitched the nose down for a transition away. It cannot be determined whether this transition was level or initiated with a degree of climb. At approximately 40 kts the pilot selected a pitch attitude for a constant rate of climb, the helicopter crossed the main Roscrea to Birr road and entered a large field adjacent to the airfield. Shortly thereafter, he felt that the helicopter was not climbing as it should and it appeared to him that the helicopter was suffering from a lack of power.

In the belief that he may have been pulling too much collective, the pilot lowered the collective slightly to reduce power and applied forward cyclic to gain airspeed. After a short time the collective was again lowered slightly and forward cyclic was applied to gain airspeed. As these recovery actions had no effect on the climb performance of the helicopter and being confronted with an obstacle ahead of his position (most likely a tree positioned within a hedgerow at the western end of the field) the pilot wound the throttle fully open and turned left (east) through 180º back towards the airfield. As he crossed this field he flew over a set of electricity supply poles that were running at right angles (north/south) across his flight path. At the eastern end of this field the pilot was once again confronted with a number of obstructions ahead of his position (most likely electricity supply poles, trees and hedgerow along the main Roscrea to Birr road) so he turned the helicopter right (west) through 180º. On completion of this turn the pilot observed a farmhouse ahead of him so he elected to land-on immediately. The most likely "track made good" is presented as Fig (1) below.

TRACK MADE GOOD

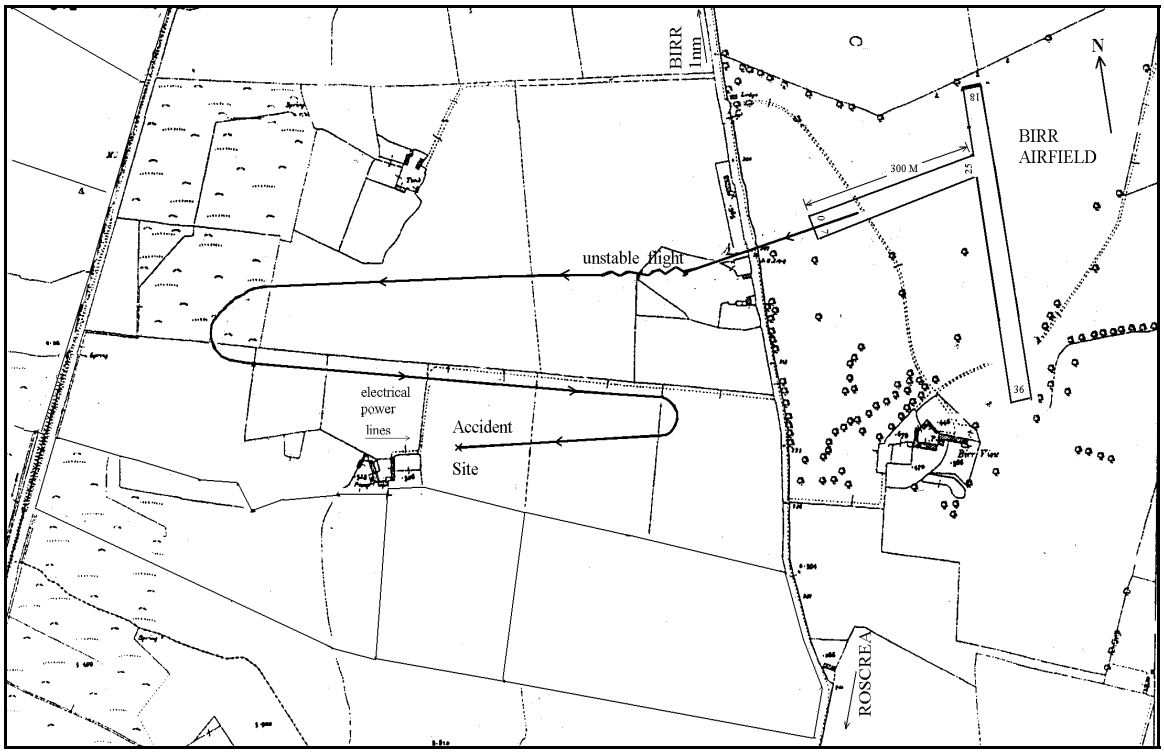

Fig 1.

The pilot recalled carrying out a skids level, gentle, run-on landing at an estimated speed of 20 kts. During ground deceleration the helicopter started to drift towards the right so the pilot inputted full left rudder while lowering the collective. Just prior to coming to a halt the helicopter rolled over onto its right-hand side. The engine stopped once blade contact was made with the ground. The pilot evacuated through the left-hand door without injury.

He then ran over to a number of people, who were standing outside the farmhouse, and advised them not to approach the helicopter due to the possibility of fire. Some moments later, the pilot re-entered the cockpit to confirm that all switches were in the "Off" position.

In discussions with the pilot the investigation determined that:

- The maximum height achieved after transitioning out of the airfield was estimated by the pilot to be somewhere between 200-250 ft.

- Up to the time when he believed that he had a power/climb performance problem, the pilot recalled that the engine had been running normally and no prior indications of a problem were evident.

- From the time that he believed that he had a power/climb performance problem, up until ground contact, the pilot confirmed that he did not hear any unusual engine noises or the low (Rotor) revolutions per minute (RPM) warning horn. In addition, he did not observe any instrument panel warnings, in particular the illumination of the low (Rotor) RPM warning light.

- The pilot did advise the investigation that, at the time that he believed that he was experiencing a loss of power/climb performance, the manifold pressure did seem higher than normal, moving out of yellow arc, above 25 inches. (Yellow arc 21.0 to 25.2 Hg and Red line 25.2 Hg)

- He also advised that the helicopter was yawing from side to side and in order to maintain a steady heading he had to continually input left and right rudder.

- The pilot indicated that on this particular helicopter, and at certain frequencies, the low (Rotor) RPM warning light would flash on, when the transmit button was pressed.

1.1.3 Eyewitness Accounts

Three (3) occupants of a farmhouse located in the field opposite the threshold of RWY 07 stated that while sitting in the kitchen, they heard an unusual noise. Rushing out of the house they saw a helicopter flying over the electricity supply pole beside the house. It was clear to them that the helicopter was in trouble. Being familiar with the sound of aircraft and helicopters operating to and from the airfield, they said that there was a grinding noise coming from the helicopter as it was turning downwind prior to the final run on landing. *"It sounded like a tractor"*. The helicopter then turned right around the house and came in for a landing. It was noted by the witnesses that the helicopter was rocking from side to side and that the engine RPM was increasing and decreasing just prior to the helicopter landing on.

After the helicopter landed the witnesses felt that it would satisfactorily come to a halt, but at the last minute it rolled over onto its right-hand side. One (1) of the eyewitnesses said that the pilot exited the helicopter. She said that he had to return to complete safety checks as he had been instructed to carry out during training in the event of such an emergency landing.

Another eyewitness of the same family said that fuel was leaking from the helicopter and continued for some time after the accident. The pilot informed this eyewitness that he was anxious that she should not go close to the helicopter as it contained a "*lot of fuel*".

1.2 Injuries to Persons

There were no injuries.

1.3 Damage to the Aircraft

The helicopter was damaged beyond economic repair.

1.4 Other Damage

Apart from some ground staining from fuel spillage, there was very little damage to the landing area.

1.5 Personnel Information

1.5.1 Flying Experience

The student pilot started his Robinson R22 helicopter conversion course on the 3 March 1999. On the 21 May 1999, the pilot was "signed off" by the helicopter school chief instructor as having completed a course of Dual Flight Instruction. This "sign off" is a confirmation at the time that the pilot has an adequate knowledge of local control procedures, rules of the air and that he is fully competent to undertake solo flight on R22 helicopters. The Personnel Licensing Office of the Irish Aviation Authority (IAA) endorsed the pilot's logbook and issued a student pilot's licence (SP/257671 W/H) on the 24 May 1999. (The licence was subsequently renewed on the 31 May 2001).

On the 21 March 2000, following a nine-month break from flying, the pilot re-commenced dual flight instruction. On the 14 April 2000, he completed the European Safety Course for Robinson R22 Helicopters at Sloane Helicopters, Sywell, UK. After completing 42 dual instruction flights totalling 32 hours the pilot achieved "First Solo" on the 9 June 2000. During the remaining twelve months leading up to the day of the accident, the pilot had two further breaks from flying totalling eight months. In the four-month period that he was flying the pilot received an additional 18 dual instruction flights and completed nine solo flights. These solo flights consisted mainly of circuits, hovering and take-off/landing practice. A dual instruction flight for the solo Navex route had been completed on the 30 May 2001. Table (1) below gives a breakdown of the total flying hours accumulated by the pilot over the twenty-seven month period:

Period	Dual	Solo	Total	Grand Total
3 March 99-15 June 99	17.5 hours		17.5 hours	17.5 hours
9 Months - No flying				
21 March 00-6 Sept 00	22.3 hours	3.6 hours	25.9 hours	43.4 hours
4 Months - No flying				
20 Jan 01-20 Jan 01	0.5 hours	0.7 hours	1.2 hours	44.6 hours
4.2 Months - No flying				
1 May 01-13 June 01	7.4 hours	2.0 hours	9.4 hours	54.0 hours
Total	47.7 hours	6.3 hours	54 .0 hours	

1.5.2 Instructor Comments

In a discussion with the chief instructor of the training school regarding the temperament and disposition of the student pilot, it was revealed he was a sound, calm individual, very conscientious and meticulous in his preparation both technically and operationally.

1.5.3 Air Medical

The student pilot completed an air medical on the 22 May 2001 and was certified as medically fit (Class 2).

1.6 Aircraft Information

1.6.1 Leading Particulars

Registration:	EI-CMI
Manufacturer:	Robinson Helicopter Company (USA)
Model:	R22 Beta
Serial Number:	1129
Year of manufacture:	1989
Engine:	(1) Lycoming O-320-B2C

1.6.2 General Description

The Robinson R22 Beta is a two-place, single main rotor, single engine helicopter constructed primarily of metal and equipped with skid type landing gear.

The main rotor has two all-metal blades (with stainless steel leading edges) connected to the hub by individual coning-hinges. The hub is mounted to the shaft with a teeter-hinge located above the coning-hinges. The tail rotor has two all-metal blades and a teetering hub with a fixed coning angle. The tail rotor blades are constructed with wrap-around aluminium skins, honeycomb spars and forged aluminium root fittings.

The R22 is powered by one Lycoming four-cylinder, horizontally opposed, overhead-valve, air-cooled, carburetted engine with a wet sump oil system.

A vee-belt pulley is bolted directly to the output shaft of the engine. Vee-belts transmit power to the upper pulley which has an overrunning clutch contained in its hub. The inner shaft of the clutch transmits power forward to the main rotor and aft to the tail rotor. An electric actuator, located between the two drive sheaves, raises the upper sheave when the pilot engages the clutch switch. The actuator senses the compressive load (belt tension) and switches off when the vee-belts are tensioned to the prescribed value. A caution light on the panel is on whenever the actuator is operating i.e. either engaging, disengaging, or re-tensioning the belts. The light does not go out until the belts are tensioned or completely disengaged.

The two seats are configured side by side in the cabin within a curved two-panel windscreen. Dual controls are standard equipment and all primary controls are actuated through push-pull tubes and bellcranks. The cyclic control stick, known as the T-Bar, is centrally mounted with handgrips on a swing arm, which allows access from either seat.

The collective stick has a twist grip throttle control. When the collective is raised, the engine throttle is opened automatically by an interconnecting linkage. An electronic governor (active above 80% engine RPM) makes minor throttle adjustments required to maintain the design RPM of between 102-104%. The illumination of the low RPM light and the sounding of the warning horn indicates rotor RPM is at or below 97%.

1.6.2.1 Engine Details

Engine Type:	Lycoming O-320-B2C
Normal Rating:	160 BHP at 2700 RPM
Maximum continues rating in R22:	124 BHP at 2652 RPM (104% on tachometer)
5 minute take off rating:	131 BHP at 2652 RPM

1.6.3 Maintenance

A 10-year or 2000 hour overhaul had been completed on EI-CMI in the UK in December 1999. All the manufacturers service bulletins were satisfied and certified previous to the rebuild or competed at rebuild. The engine was also removed at this time and overhauled to zero hours.

A 100-hour inspection, which was in accordance with Light Aircraft Maintenance Schedule – Helicopter (LAMS-H-1999) was carried out on EI-CMI on the 10 May 2001. A 50-hour inspection was also carried out on the 5 June 2001. At the time of the accident the log book records show that the helicopter had completed 2635 hours since manufacture.

1.6.4 Technical Inspection

An AAIU engineer carried out a technical investigation on EI-CMI at the AAIU facility in Gormanston, Co Meath. In addition, a fully certified UK Civil Aviation Authority (CAA) Inspector and licensed Robinson R22/R44 engineer was engaged to carry out an independent in-situ technical investigation of EI-CMI. Of particular interest to the investigation was the determination of whether any defects existed in the engine, which could have caused a lack of power.

An inspection of the auxiliary fuel tank revealed no dipstick reading, however, a total of 0.3 litres of fuel was subsequently drained from the tank. The main tank was also drained and a quantity of 12 litres was measured. Carburettor de-ice was checked and found to be selected “On” and functioning correctly. An over-all visual inspection of the engine found no obvious defects. The engine oil level was measured to be four (4) QTS. The lower spark plugs were removed, and found to be in reasonable condition. In both the right cylinders, No’s 2 and 4, the plugs were soaked in engine oil. This was attributed to the helicopter lying on its right side for some hours at the accident site. Prior to engine rotation the rocker covers were removed and the valve operating gear was recorded as normal. The engine was turned over by hand and was observed to rotate freely. The fuel filter was checked and found to be satisfactory.

A check was carried out on the Magneto Synchronization and Timing. Synchronization was good with the points opening approximately 21 degrees before top dead centre (BTDC).

A Cylinder Differential Pressure Check was carried out with the following results:

Cylinder	Reading
No 1	79/80
No 2	40/80
No 3	79/80
No 4	66/80

No 2 cylinder showed an excessive differential pressure drop. An exhaust valve check IAW Lycoming S.B 388 was carried out to determined if the valve was possibly sticking or had a worn valve guide. The result was 0.027 inch clearance, which is within the manufacturers tolerance of 0.015 to 0.030 inch. The valve moved freely by hand. The cylinder differential pressure check readings taken during the previous 100-hour inspection dated 10 May 2001 were:

Cylinder	Reading
No 1	77/80
No 2	76/80
No 3	77/80
No 4	78/80

The battery had insufficient charge to start the engine. With the use of jump leads the engine started first time and ran normally. The exhaust discharged a large quantity of blue smoke initially. This was attributed to the oil trapped in the No's 2 and 4 cylinders. Engine oil pressure was "in the green"(normal operating range). The manifold pressure gauge responded as expected with changes in the throttle settings at low RPM. The engine was run for approximately 5 minutes, opening the throttle to 80%. A Magneto drop check was carried out and the results were as follows:

RPM	Location	Mag drop
70%	Left	10%
70%	Right	6%

Both magneto's sustained the RPM at reduced levels. The engine shut down normally using the mixture control.

1.7 Meteorological Information

Met Eireann, The Irish Meteorological Service, supplied an aftercast for the Birr area for the time of the accident.

General Situation: A large low pressure system centred at about 53N 20W maintained a slack southerly airflow over the region.

Wind: At surface: 180/04 kt
At 2000 ft: 180/01 kt

Weather: Nil

Visibility: 10+ kilometres

Cloud:	FEW 4000 ft BKN 1400 ft
Temperature/Dew point:	16/08 Celsius
MSL Pressure:	1016 hPa

1.8 Aids to Navigation

Not applicable.

1.9 Communications

The airfield clubhouse frequency of 122.95 MHz was not manned at the time of the accident. The pilot did, however, transmit on the airfield frequency an advisory that it was his intension to carry out an approach to RWY 25.

1.10 Aerodrome Information

The airfield is located approximately 1 nm south of the town of Birr and is at a height of 250 ft above mean sea level (AMSL). It has two grass runways namely RWY 18/36 and 07/25. RWY 18/36 intersects the threshold of RWY 25.

1.11 Flight Recorders

There were no flight recorders on board nor were these required.

1.12 Wreckage and Impact Information

1.12.1 General

The helicopter ended up in a field across the Roscrea/Birr main road adjacent to the airfield. It came to rest on a heading of 240º magnetic (M), 52 metres east of the front wall of a farmhouse dwelling and 42 metres north of a hedgerow on the southern side of the field. The wreckage, apart from one of the tail rotor blades (which was never found) was contained within a 4.5 metre diameter area. The general condition of the field was found to be that of short grass on a level and firm surface.

1.12.2 Site Inspection

The Investigation found the helicopter on its right side with both main rotor blades attached to the helicopter rotor head but severely damaged. There were periodic wrinkles at approx 8 inches spacing along the blade skin of each main rotor blade. The tail rotor blades had broken off near the blade roots during impact with the ground. Both fractures were similar. One of these blades was found adjacent to the helicopter but the other blade was not present at the crash site. An extensive search of the hedgerows in the general area of the accident site failed to recover the missing tail rotor blade. The local Gardaí were requested to inform the adjacent field owners that, if a tail rotor blade were found, that this should be handed into them. Nothing was reported.

There were four marks on the turf out from one of the main rotor blades, which were caused by the final impact rotation of the blades. Both horizontal and vertical firewalls were buckled. The LH vertical push-pull tube (A121-7) to the swash plate was severed at the top of the fuselage 3 inches above the sleeve.

Both of the tank vent plastic pipes were also found disconnected at the tank outlet, one of the inner springs (B408-2) remaining attached to the tank. One of the upper swash plate lugs had fractured with the link to the main rotor blade attached. The other main rotor blade link had fractured at the rod end nearest the blade. The main rotor shaft vertical cover was also damaged as a result of the impact with the ground. The collective lever was found in the up position. The carburettor heat knob was found in the "pulled" (On) position. The cabin Perspex had been shattered on the right side and the tail boom bent at its junction with the fuselage.

There was a strong smell of fuel in the immediate area. A visual inspection revealed that little fuel remained in either the main or auxiliary fuel tank. This lack of fuel remaining was attributed to crash site leakage.

1.13 Medical and Pathological Information

Not applicable.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The pilot was wearing a lap and diagonal harness.

1.16 Test and Research

Not applicable

1.17 Organizational and Management Information

Nil.

1.18 Additional Information

1.18.1 R22 Flight Training Guide Manual

1.18.1.1 R22 Manoeuvre Guide – Transition from hover to a normal climb (Extract)

*Begin the take-off (*hover or ground speed hover*) with a small amount of forward cyclic to get the helicopter moving forward. If the helicopter begins to settle, increase collective as necessary to hold altitude and maintain heading with pedals. As airspeed increases to approximately 10-12 knots (kts), effective translational lift (ETL) will occur, and can be felt as a lateral vibration.*

At ETL, lift will increase noticeably causing the nose to pitch up. Apply sufficient forward cyclic to continue the acceleration and prevent the nose from rising. As airspeed increases, the streamlining of the fuselage and the increased efficiency of the tail rotor will cause a left yaw, requiring a right pedal correction. Continue to smoothly accelerate, maintaining ground track. At an altitude of 300 ft and an airspeed of 55 kts adjust manifold pressure to climb power and select aft cyclic to establish a 60 KT climb attitude.

1.18.1.2 R22 Manoeuvre Guide – Recognition and recovery from low Rotor RPM (Extract)

The low RPM condition will be recognized by:

- *A noticeable decrease in engine noise*
- *Aircraft vibration and cyclic stick shake at higher speeds*
- *The low Rotor RPM warning horn and light at approximately 97% RPM*

Recovery Technique

Upon recognizing the low RPM condition, simultaneously add throttle and lower the collective to regain operating RPM. A gentle aft cyclic movement will help the recovery, but the primary recovery controls are the collective and throttle. Avoid any forward cyclic input, which will inhibit RPM recovery. Once RPM is regained, slowly raise collective to reduce the sink rate, while closely monitoring the RPM.

1.18.2 R22 Pilot's Operating Handbook

1.18.2.1 Section 4 Normal Operating procedures

1.18.2.1.1 Use of Carburettor Heat (Extract)

When conditions conducive to carburettor ice are known or expected to exist, such as fog, rain, high humidity, or when operating near water, use carburettor heat as follows:

During hover or cruise flight above 18 inches MAP (Manifold Pressure), apply carburettor heat as required to keep the CAT (Carburettor Air Temperature) gauge needle out of the yellow arc. If an unexplainable drop in manifold pressure or RPM occurs, apply full carburettor heat for about one minute and check for an increase in MAP or RPM.

During autorotation or reduced power below 18 inches MAP, apply full carburettor heat regardless of CAT gauge temperature. When power is reapplied, return carburettor heat control to full cold or partial heat position.

CAUTION

CAT gauge is effective only above 18 inches MAP. During descents or autoratation under conditions conducive to carburettor ice, ignore gauge and apply full carburettor heat.

1.18.2.3 Airspeed for Safe Operation (Extract)

Take-off and climb……60 Knots indicated airspeed (KIAS)

1.18.3 Safety Notices

A number of safety notices have been issued by the Robinson Helicopter Company as a result of various accidents and incidents, which have occurred. Safety Notice No 25 covers carburettor ice and is reproduced as **Appendix A** to this report.

1.19 Useful or Effective Investigation Techniques

Nil.

2 ANALYSIS

A detailed examination of the wreckage revealed no evidence of a technical malfunction to any component of the helicopter. The engine was successfully started on the first attempt and ran satisfactorily for the test period of five (5) minutes. No abnormalities or deficiencies were recorded which would account for a loss of power on the engine.

The readings of differential pressure drop for all cylinders taken during the previous 100-hour inspection were very satisfactory. Only 70 engine hours had elapsed between that time and the time of the accident and it is unlikely that any significant cylinder deterioration would have occurred during such usage. The engine fell on to its right side, which is the side containing No's 2 & 4 cylinders. Their plugs were then covered in engine oil, which leaked past the pistons and it is likely that some debris could also have found its way on to the valve seats, thereby causing reduced test figures. The low differential pressure drop in the No.2 cylinder and slightly low pressure drop in the No.4 cylinder, found on inspection of the engine following the accident, would not cause a significant noticeable power loss. The high manifold pressure observed by the student pilot is indicative of the throttle being nearly fully open or fully open and the engine in a condition of high torque.

The tail rotor was intact prior to impact, as the absence of a blade would render the rotor ineffective and lateral control impossible. Both blades severed from the tail rotor hub on impact with the ground. One of the two tail rotor blades was never recovered. The tip speed of the tail rotor blade at 100% RPM is 599 feet/sec giving the blade sufficient energy to travel beyond the field boundary. The other blade, having insufficient energy following the first rotor strike, was found adjacent to the wreckage.

Eyewitness reports of various engine/helicopter noises in the vicinity of the proposed landing area were considered. In the R22 the rotor dynamics affect engine performance and visa versa. It is possible during high collective angles to suddenly load the engine causing the RPM to fluctuate. In addition the witnesses could have heard a considerable amount of blade slap, which can occur during shallow low speed descents, particularly in turns.

The prevailing temperature and dew point conditions on the day of the accident were such that a risk of moderate engine icing (cruise power) existed. The pilot recalled selecting full carburettor heat on downwind and it remained in that position for the remainder of the flight. The selection of full carburettor heat was also recorded during the wreckage inspection at the crash site. The fact that full carburettor heat was applied would have militated against the engine suffering from carburettor icing. However, the application of continuous full carburettor heat will lead to approximately 10% loss of power on a standard day. With one person on board, approximately half fuel remaining and a near standard day (16°C) this reduction in power would not usually be a problem, but climb performance will be affected to some degree. It is possible that the pilot sensed this reduction in performance and associated it with a power loss. While the Robinson R22 Pilot's Operating Handbook does cover "Use of "Carburettor Heat" (See Section 1.18.2.2 this report) and "Carburettor Ice" under Safety Notice SN-25 (See Appendix A this report), neither make mention or warn of the fact that continuous full carburettor heat at high power settings can lead to approximately 10% reduction in available power on a standard day.

The pulling of too much collective pitch during the transition and initial climb would compound any power reduction problem. Over-pitching of the collective would cause the RPM to drop, which would add to the power problem and thus reduce climb performance. In addition, the initiation of pitch attitude for climb at 40 KIAS was less than the recommended speed of 55 KIAS as prescribed in the R 22 Flight Training Guide Manual (Section 1.6.4.1 of this report) and less than the recommended climb speed of 60 KIAS as prescribed in the R 22 Pilot's Operating Handbook (Section 1.6.5.1 of this report). Any attempt to climb the helicopter at a speed less than that recommended for climb will require a greater demand of power to maintain that speed due to reduced ETL. If power available is insufficient to maintain the selected airspeed, the helicopter will decelerate, settle and descend. Any further demand on power at this point will result in rotor RPM decay and a decrease in lift. A graph describing power required versus airspeed during ETL is presented as **Appendix B** to this report.

The recovery technique (Section 1.6.4.2 of this report) for reduced or low RPM requires the adding of throttle, lowering of collective and recommends the avoidance of any forward cyclic input. Lowering of the collective "slightly" and "pitching forward" would do little for RPM recovery. In fact "pitching forward" will inhibit RPM recovery. A significant reduction in collective followed by a wait long enough for the RPM to increase, before again gently applying collective, would be required. This action done several times in succession will restore RPM and climb performance.

The pilot reported (to the best of his recall) that the low rotor RPM warning light did not illuminate, nor did the low Rotor RPM Warning Horn sound at any time prior to or during the crash sequence. This would be an indication that while there may have been a reduction in engine RPM and Rotor RPM, Rotor RPM decay was not sufficient enough to brake the low Rotor RPM warning threshold of 97%. It is also possible, that a warning did activate, but under the stressful conditions that the pilot found himself in, he may not have noticed it at the time. In any event, it is clear that Rotor RPM did not decay to such a degree to cause an in-flight blade strike to the tail boom or canopy.

The loss of power/climb performance experienced by the pilot was most likely caused by a combination of a number of factors including, continuous selection of full carburettor heat during transition and initial climb, over-pitching of the collective and the initiation of climb at a speed less than that recommended. Having induced a condition of reduced RPM, it is considered that the pilot's overall experience was insufficient to affect a full RPM recovery, particularly within the height and time remaining. Eyewitness reports of the helicopter "*rocking from side to side*", of the engine RPM "*increasing and decreasing*" and the pilot inputting left and right rudder is an indication that the pilot was "fighting the controls" and had lost his "sensitivity of control" while responding to the reduction in RPM. Under these circumstances, the pilot's decision not to attempt to fly out of trouble, but to carry out an emergency landing was, in the opinion of the investigation, correct.

In an examination of the pilot's flying experience, it was noted that his total of 54 hours (all on type) were accumulated over a period of twenty-seven months, and punctuated with three periods of "no flying" totalling seventeen months. Just over 6 hours of solo time was achieved over a one-year period. The pilot's student licence complied with the requirements as laid down by the licensing authority (IAA).

The investigation recognizes the difficulty faced by students who are attempting to gain flight time/experience for licence requirements outside of a structured full time training course. However, with that in mind, the investigation does have concern for the lack of currency achieved throughout the training period, but in particular with regard to the solo time. Student pilot's are at their most vulnerable during the early solo hours of training. A consolidated period of training, free from lengthy breaks of flying, will create better currency, and should lead to a better level of familiarity and confidence on type. This familiarity and confidence will increase experience and level of skill, which in turn should provide a pilot with the ability to reduce his exposure to risk and also increase his competence in dealing with non-normal/emergencies situations.

3 CONCLUSIONS

(a) Findings

3.1.1 The pilot had a valid Student Pilot's Licence (Rotorcraft) issued by the Irish Aviation Authority and a valid medical certificate (Class 2) at the time of the accident.

3.1.2 The pilot had accumulated a total of 54 hours (all on type) over a period of twenty-seven (27) months. This period was punctuated with further periods of no flying totalling seventeen (17) months. Just over 6 hours solo was achieved over a one-year period.

3.1.3 The helicopter was maintained in accordance with an approved maintenance schedule.

3.1.4 The investigation did not reveal any evidence of a technical malfunction to any component of EI-CMI. In addition examination of the engine showed no abnormalities or deficiencies that would account for a loss of engine power.

3.1.5 During his initial climb out the pilot experienced what he believed to be a loss of power/climb performance.

3.1.6 The student pilot observed no indications of a problem prior to the initial upset or no alarms/warnings after he suspected a loss of power/climb performance.

3.1.7 The selection of continuous full carburettor heat led to approximately 10% loss in power on a standard day. This loss of power would have an affect on the climb performance of the helicopter.

3.1.8 A further loss of power/climb performance most likely occurred as a result of the application of too much collective pitch during the transition and initial climb segments, and the initiation of climb at a speed that was lower than that recommended in the Pilot's Operating Handbook.

3.1.9 The student pilot failed to recognise that the continuous selection of full carburettor heat, combined with the subsequent mishandling was inducing a condition of reduced engine/rotor RPM.

3.1.10 The student pilot's recovery action of slight reduction of collective and pitching forward, prior to fully opening the throttle, would have inhibited engine/rotor RPM recovery.

Recognising the student pilot's level of experience, it is considered that even if the prescribed recovery technique was applied, the amount of height/time remaining after the initial upset was most likely insufficient to restore RPM and climb performance.

3.1.11 During the final deceleration phase of the run-on landing, directional control was lost and the helicopter rolled over onto its right-hand side, causing damage beyond economic repair.

3.1.12 The Robinson R22 Pilot's Operating Manual contains no warning to the fact that the application of continuous full carburettor heat at high power settings can lead to approximately 10% reduction in available power on a standard day.

(b) Cause(s)

3.2 Directional control was lost during the deceleration phase of an emergency run-on landing. The emergency landing was initiated by the pilot in the belief that he was suffering from a loss of power/climb performance.

3.2.1 A reduction in power/climb performance most likely occurred as a result of a combination of mishandling factors including:

- The selection of continuous full carburettor heat during transition and initial climb.
- Overpitching during the transition and initial climb, and
- The initiation of climb attitude at a speed less than that recommended for safe operation during take-off and climb.

4. SAFETY RECOMMENDATIONS

It is recommended that:

4.1 The Robinson Helicopter Company should provide a warning in the Pilot's Operating Manual indicating that, not withstanding the necessity to use carburettor heat in certain conditions, the application of excessive carburettor heat during take-off or at high power settings will have an adverse effect on engine power and helicopter performance. **(SR 6 of 2002)**

The Robinson Helicopter Company has since advised the AAIU that this safety recommendation will be given consideration at the next revision of the R 22 and R 44 Pilot's Operating handbook.

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-25

Issued: Dec 86 Rev: Nov 99

CARBURETOR ICE

Carburetor ice can cause engine stoppage and is most likely to occur when there is high humidity or visible moisture and air temperature is below 70°F (21°C). When these conditions exist, the following precautions must be taken:

During Takeoff - Unlike airplanes, which take off at wide open throttle, helicopters take off using only power as required, making them vulnerable to carb ice, especially when engine and induction system are still cold. Use full carb heat (it is filtered) during engine warm-up to preheat induction system and then apply carb heat as required during hover and takeoff to keep CAT gage out of yellow arc.

During Climb or Cruise - Apply carb heat as required to keep CAT gage out of yellow arc.

During Descent or Autorotation -

R22 - Below 18 inches manifold pressure, ignore CAT gage and apply full carb heat.

R44 - Apply carb heat as required to keep CAT gage out of yellow arc and full carb heat when there is visible moisture.

APPENDIX B

ROBINSON
HELICOPTER COMPANY

MODEL R22

ROTOR POWER REQUIRED