ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-TGRR
No & Type of Engines:	1 Lycoming O-320-B2C piston engine
Category:	2.3
Year of Manufacture:	1989
Date & Time (UTC):	11 November 2004 at 1533 hrs
Location:	Cophams Hill Farm, Bishopton, Stratford-upon-Avon, Warwickshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Student pilot
Commander's Age:	57 years
Commander's Flying Experience:	118 hours (of which 117 were on type) Last 90 days - 26 hours Last 28 days - 12 hours
Information Source:	AAIB Field Investigation

Synopsis

The student pilot was returning to Shobdon from Wellesbourne Mountford on the second leg of a cross country navigation exercise. His instructor had become concerned that the weather might not be suitable for the student to return, and had flown to Wellesbourne in another helicopter with the intention of leading him back in loose formation. During the return flight to Shobdon, and shortly after establishing radio contact on a previously agreed enroute frequency, the student told his instructor that he was having difficulty following him, and subsequently, that he had lost sight of the lead helicopter. Despite numerous attempts, the instructor was unable to make further contact. The student's helicopter had crashed in a field 2 nm north-west of Stratford-upon-Avon, fatally injuring the pilot.

History of the flight

The student pilot had been authorised by his instructor to fly a solo cross country navigation exercise from Shobdon to Wellesbourne and return. Wellesbourne was approximately 45 minutes flying time to the east of Shobdon. Prior to departure the student and his instructor both signed a "Solo Navigation Briefing Certificate". This confirmed that the student had been briefed on a list of issues relevant to the exercise, including consideration of current and forecast weather conditions and action to be taken in the event of weather deterioration. At approximately 1230 hrs the student pilot departed in G-TGRR. The instructor took off shortly afterwards in another helicopter to carry out a radio navigation exercise with another student.

Whilst operating in the Redditch area, north-west of Wellesbourne, the instructor became concerned that the visibility was reducing and called Wellesbourne Radio to request that G-TGRR be kept on the ground. The instructor advised Wellesbourne Radio that he would return to Shobdon and then fly to Wellesbourne to lead the cross country student back.

On his return to Shobdon, the instructor contacted the pilot of G-TGRR at Wellesbourne by telephone to discuss the plan. The pilot of G-TGRR is reported to have said that he was happy to return to Shobdon without assistance, but the instructor insisted on carrying out his plan, because the visibility in the Redditch area was expected to be poor. The instructor departed for Wellesbourne shortly after 1400 hrs in another Robinson R22, G-TGRE, flown by a student who had originally planned to conduct another cross country flight. During the flight he noted that the visibility was good between Shobdon and Worcester, half way along the route, but that it deteriorated east of Worcester in conditions similar to those encountered on his earlier flight.

When he arrived at Wellesbourne the instructor met the pilot of G-TGRR and explained that the return flight to Shobdon would be flown at 85 kt at an altitude of 1,200 ft on the Wellesbourne QNH of 1024 hPa. He briefed that the two aircraft were to make contact on frequency 123·45 MHz, when passing north of Stratford, in order that they could converse freely without blocking any nearby aerodrome frequencies, but that otherwise the instructor would carry out all radio transmissions for both aircraft. The instructor intended that G-TGRR should follow 200 to 300 m behind G-TGRE, and indicated this distance by reference to a hangar at the airfield boundary.

Shortly before 1530 hrs, the aircraft departed in a loose line-astern formation and proceeded as planned to the north of Stratford. Approximately one mile north of Stratford, the instructor switched to frequency 123·45 MHz and made contact with the student pilot in G-TGRR at the second attempt. The student pilot said that he was having difficulty keeping up with G-TGRE, and shortly afterwards that he had lost sight of it. The instructor replied that they should slow down to 75 kt while maintaining an altitude of 1,200 ft. The instructor reported that the pilot of G-TGRR repeated the new speed, and shortly afterwards said "I can't see a thing".

The instructor asked the student to clarify whether he meant that he couldn't see the lead helicopter or that he had lost all visual reference, but there was no reply. The instructor made numerous further attempts to contact G-TGRR on 123.45 MHz, on the Shobdon and Wellesbourne Airfield frequencies, and by mobile telephone, but without success. During this exchange Wellesbourne Radio informed the instructor of reports that a light helicopter had landed in a field 1 nm north-west of Stratford. When G-TGRE arrived at the scene, 27 minutes after losing radio contact with G-TGRR, the fire brigade and air ambulance were already in attendance.

Pilot information

The student pilot of G-TGRR had completed 118 hours of flight instruction towards the issue of a Private Pilot's Licence for Helicopters (PPL (H)), of which 22 hours were cross country and six hours were solo. He had also completed four hours flying on instruments. The accident flight was his second solo cross country involving a landing away from Shobdon. Although training records revealed that the student had made slow and unremarkable progress, the instructor commented that he had reached a standard typical of students carrying out solo cross country exercises. A survey of helicopter training organisations in the UK suggests that, on average, students take approximately 70 hours to gain a PPL (H).

Commenting on his decision to lead the student back to Shobdon, the instructor told the AAIB that he did not want the student to return on his own in the prevailing conditions. He was concerned that the student might become unsure of his position, particularly in relation to a 984 ft mast and an area of laser activity at Pershore, 3 nm south of his intended track. The instructor hoped to reduce the student's workload by having him follow at a range of a few hundred metres.

Wreckage and impact information

The accident site was an area of soft, ploughed field. The direction of the short wreckage trail was on a magnetic heading of approximately 275°. Impact marks indicated that the helicopter struck the ground tail first, banked to the right by approximately 110° with a slight clockwise rotation and no horizontal motion. The right side of the helicopter was extensively damaged and perspex from the canopy had been thrown up to 2 m forward and approximately 8 m to the right of the cockpit. Both fuel tanks had ruptured and at least five gallons of fuel had pooled under the wreckage. The rotor mast was bent and had fractured at the gearbox interface. A number of the control rods had also bent or fractured. There was no evidence of damage to the leading edge of either of the main rotor blades, both of which had bent on impact. The rivets securing the tail pylon had failed at the frames in Bay 4 and 5, and there was also evidence of two low energy blade strikes on the top and the left side of Bay 5. The tail pylon had failed aft of Bay 5 and the tail rotor and stabiliser assembly were found lying on the left side of the pylon facing the opposite direction.

In the cockpit the mixture control was selected to fully RICH, the carburettor heat control was out by 25 mm, the fuel cock was set to ON, the primer was locked in, the cyclic right trim was out and the magneto switch was set to BOTH. The governor switch on the end of the collective was in the OFF position. Both emergency landing circuit breakers were in the 'pulled', (ie out) position; the remaining circuit breakers were all in the in position. The pilot was wearing an intact three point inertia seat harness.

Medical and pathological information

The pilot held a current JAA Class II medical certificate with limitations requiring him to fly by day only and to have near vision lenses available while flying. A spectacle lens was recovered from the crash site, suggesting that he was complying with the latter limitation.

The post mortem examination carried out by a consultant aviation pathologist revealed no evidence of natural disease or the presence of any substance which may have caused or contributed to the accident. The severity of the crash was such that the provision of additional or alternative safety equipment would not have altered the fatal outcome.

Recorded information

Secondary radar returns corresponding to the flight paths of G-TGRE and G-TGRR were recorded at Clee Hill, 33 nm west-north-west of the crash site. These indicate that G-TGRR followed approximately 1/3 nm behind G-TGRE, while maintaining an average ground speed of 75 kt. This corresponds to an air speed of approximately 85 kt in the prevailing 10 kt wind from the west. G-TGRR and the lead helicopter appeared to maintain a generally constant altitude, although the altitude of G-TGRR fluctuated briefly between 900 and 1,400 ft amsl during a ten second period approximately one minute prior to the final radar return. The final recorded position of G-TGRR coincided with the accident site.

Witnesses on the ground

Eyewitness statements were obtained from six individuals who saw the final moments of the flight, from three distinct viewpoints on the ground. All reported seeing the helicopter flying straight and level for some distance, then pitch nose up and cease all forward motion, before pitching nose down into its final descent. During this almost vertical descent, the helicopter was seen to yaw slowly in a clockwise direction and develop a slight roll to the right. Shortly before impact the main rotor appeared to have stopped or to be rotating unusually slowly, with the blades bent upwards at an extreme angle. Those closest to the accident also recalled an absence of engine noise. Each of the eye witnesses reported being able to see the helicopter continuously, clear of cloud, from the first moment they became aware of it, until the moment of impact or very shortly beforehand.

Meteorological information

1) Information available during the pre flight briefing

The UK low level forecast issued at 0835 hrs on 11 November 2004 showed a warm front moving southeast across central England and forecast to pass over the route between Shobdon and Wellesbourne at or shortly after 1500 hrs.

Birmingham International Airport (elevation 325 ft), 17 nm north-north-east of Wellesbourne, is the nearest station to the destination for which forecast information was obtained. The most recent forecast available during the pre-flight briefing was recorded at 1204 hrs. It predicted visibility greater than 10 km and broken cloud at 2,500 ft, but temporarily between 1300 and 2200 hrs, broken cloud at 1,400 ft with a 30% probability, in the same period, of 8 km visibility in light rain and broken cloud at 900 ft.

The operator's Flying Order Book stated that:

> *"Cross country flights will not be flown without a clearly discernable horizon, and weather minima in accordance with (relevant extract reproduced below - Table 1), expected along the whole of the route to be flown:"*

Wellesbourne Airfield is situated 159 ft amsl, and Shobdon is 318 ft amsl. The highest terrain on a direct track between the two airfields is high ground approximately 827 ft amsl, 5 nm east of Leominster. The aeronautical chart used by the student showed two masts within 5 nm of this direct track, one 984 ft amsl (886 ft agl) at Pershore and another, 900 ft amsl (700 ft agl), near Bromsgrove. Worcestershire Beacon in the Malvern Hills rises to 1,394 ft amsl and is 7 nm south of the direct track.

2) Aftercast

Archived weather reports were obtained for the period covering the return flight. At 1520 hrs Birmingham International airport reported visibility of 4,800 m in light drizzle and mist, with cloud scattered at 500 ft and overcast at 600 ft. At 1550 hrs, the reported visibility was 3,000 m in mist with cloud scattered at 500 ft and broken at 700 ft.

An aftercast produced by the Met Office for the same period indicated that the area was likely to have been generally overcast with drizzle, surface visibility of between 2,000 and 5,000 m and cloud overcast with a base between 800 and 1,200 ft. The temperature and dew point were both estimated to be 6.5°C.

3) Pilot reports

The air ambulance was tasked at 1542 hrs and took off shortly afterwards from its Strensham base, 17 nm west south west of the accident site. It arrived at the scene at 1555 hrs. The direct route between these points would have been broadly parallel to the forecast warm front.

	DAY		**NIGHT**	
	Cloud base above highest obstacle en-route	Visibilty	Cloud base above highest obstacle en-route	Visibility
SOLO	1500 ft	8 km	2000 ft	10 km

Table 1

The pilot of the air ambulance said that whilst enroute to the accident site he had been concerned that the lowering cloud base and failing light might restrict the choice of trauma hospitals to which he could fly a casualty. He judged that the visibility was approximately 5,000 m with the cloud base generally at 1,000 ft, but occasionally as low as 800 ft, causing him to fly at 700 ft in order to maintain good visibility. He expressed surprise that a student had been allowed to fly solo in these conditions.

Another instructor, who had flown a Robinson R22 from Gloucester Airport to Wellesbourne in the late morning, reported that the weather had deteriorated throughout the day. Later, while flying in the circuit at Wellesbourne as G-TGRR departed, he noted that the weather over Stratford was overcast, with mist in places. He commented that, throughout the day, he had used more carburettor heat than he considered normal.

The student flying G-TGRE reported that the instructor had cautioned him to monitor his application of carburettor heat, since conditions were ideal for the formation of ice in the carburettor.

At 1515 hrs another pilot departed Gloucester Airport in an MD500 turbine engine helicopter, intending to carry out a navigation exercise to Junction 14 on the M40, 5 nm east of Wellesbourne, via Billesley Manor, 1 nm west of the crash site. The pilot reported that he was able to see the hangars at Wellesbourne clearly as he commenced an orbit of Billesley Manor, but that he was unable to see them shortly afterwards as he completed the orbit in conditions of increasing drizzle. He estimated that the visibility around Stratford had reduced to 3,000 m or less with a cloud base of 800 ft, and at 1545 hrs decided to terminate the exercise. He reported that the cloud base remained at 800 ft during the return flight to Gloucester.

Carburettor icing

Carburettor icing is caused by the sudden temperature drop of the air due to fuel vaporisation and pressure reduction at the carburettor venturi. The temperature can reduce by up to 30°C which could cause any moisture in the air to freeze, with a consequent build up of ice in the carburettor throat adjacent to the butterfly valve. The subsequent reduction in cross sectional area will gradually reduce the airflow and cause the engine rpm to decrease. Carburettor icing can occur when the ambient temperature is between -10°C and +30°C and the effect is most noticeable when the butterfly valve is closed.

If an engine subjected to carburettor icing is fitted with a governor, then it will attempt to maintain the engine rpm by progressively opening the butterfly valve without the pilot being aware of what is happening. If the pilot were to then close the throttle it is possible that the build up of ice adjacent to the butterfly valve might be sufficient to cause the engine to stop.

All pilots should be trained to appreciate the dangers of carburettor icing and to apply carburettor heat when necessary. The aircraft handbook for the R22 lists conditions when carburettor icing can be expected and warns the pilot that the governor system might mask the formation of carburettor icing. Moreover, the limitations section of the pilot's operating handbook, and a placard adjacent to the carburettor heat gauge, states "Caution below 18 in MP ignore gage and apply full carb heat".

Formation flying

Flying in formation is not included in the syllabus for either PPL or Flight Instructor training. The student pilot had received no training in how to conduct the flight in formation, nor had the instructor had any formal training in briefing for, or providing flight instruction in, formation flying.

The intended cruise speed of 85 kt, nominated by the instructor, is close to the maximum level cruise speed of a Robinson R22 helicopter. In the event that the following aircraft dropped back, the student pilot would have had little margin of speed to enable him to catch up with the lead aircraft and maintain sight of it.

When flying in line astern formation it is difficult to judge relative position and closing speed, even in good visual conditions. The closer that the formating pilot is to the lead aircraft, the easier it is to identify changes in relative position and closing speed. At distances of 200 m or more, this becomes more difficult and requires high levels of concentration, which would have reduced significantly the student's capacity to carry out normal monitoring actions. In this regard flying in loose formation is as demanding a task as flying in close formation.

Significant features of the aircraft

The R22 is a two seat, single engine helicopter powered by a four cylinder Lycoming air-cooled engine. Filtered induction air is supplied to the carburettor via an airbox. Ambient air enters the airbox via a duct connect to the right hand side of the aircraft and hot air is ducted from around the exhaust pipes. A slider valve in the airbox, operated by the carburettor heat control in the cockpit, regulates the proportion of ambient and hot air entering the carburettor. The normal procedure is for the pilot to monitor the carburettor air temperature gauge and apply sufficient carburettor heat to prevent the temperature in the carburettor orifice, which is sensed upstream of the throttle butterfly valve, falling below +10°C.

Engine rpm is controlled either manually, by a twist-grip control located on each collective lever, or automatically by the governor system. The main components of the governor system are: a toggle switch, control unit and actuator. The governor is switched on by the toggle switch mounted on the end of the right hand collective lever and operates between 80% and 115% engine rpm. Engine rpm is measured by mechanical points mounted in the right hand magneto and the electrical output is sensed by the control unit, which sends a signal to the actuator causing the throttle connecting rod between the two collective levers to move. Movement of the throttle connecting rod causes the throttle twist grips to rotate and the butterfly valve in the carburettor to move. The pilot can over-ride the clutch in the actuator by firmly gripping the throttle twist grip.

A correlator is connected to the collective lever such that movement of the collective lever causes the carburettor butterfly valve to move without providing any feedback to the throttle twist grips. The governor is designed such that there is a dead-band between 102.5 and 105.5% rotor rpm during which the correlator adjusts the engine rpm to compensate for movement of the collective lever. However, the design of the correlator is such that it over-compensates for movement of the collective lever at the lower end of its range of movement; consequently a correcting input is required either automatically by the governor, or manually by the pilot.

The rotor system consists of a two-bladed teetering main and tail rotor driven by two pairs of vee-belts connected between the output of the engine and a clutch assembly fitted between the tail rotor drive shaft and main rotor gearbox. The clutch assembly allows the rotor assembly to free wheel when the engine power is reduced. As there is a direct connection between the engine crankshaft and main rotor gearbox, any reduction of the main rotor rpm will cause the engine rpm to decrease with the possibility of stalling the engine. Correct tension in the vee-belts is obtained by the operation of a linear actuator mounted between pulleys on the crankshaft and rotor drive system. After the engine is started, a clutch switch on the centre console is set to ENGAGE, which causes the actuator to operate, forcing the pulleys apart against the increasing tension in the vee-belts. Once the correct tension is reached, microswitches operate breaking the power supply to the actuator. Should one of the vee-belts fail, tension in the remaining belt would be insufficient to operate the microswitches; therefore an over-travel microswitch is fitted, which breaks the power supply once the actuator has extended by 1·7 inches. An amber caution CLUTCH light illuminates whenever the actuator or the over-travel microswitch operates. Although it is normal for the CLUTCH light to come on momentarily as the belts warm up and stretch, the Operating Handbook states:

> *"if the light comes on in flight and does not go out within 6 or 7 seconds, pull the CLUTCH circuit breaker, reduce power, and land immediately".*

Detailed examination of wreckage

1) General

The magnetic plugs in the main and tail rotor gearboxes were clear and, with the exception of minor damage to the rotor head and strike marks on the tail cone, all the damage was consistent with the helicopter impacting the ground. The primary droop stops were intact and there was minor damage to the pads on the secondary stops; there was also some chipping of the paint on the up-coning stops. Only 4·15 kg (60%) of the canopy was recovered from the crash site. Overall the helicopter appeared to be well maintained and serviceable prior to the upset that resulted in the accident.

2) Engine

The right side of the engine, the left magneto and the carburettor had been badly damaged in the ground impact. Despite the damage there were five independent indicators that the engine was not turning when the aircraft impacted the ground:

a the pointer on the Manifold Pressure gauge left a distinct mark at 30 inches Hg.
b distortion of the filaments in the alternator and oil pressure warning lights was consistent with the lights having been illuminated at impact.
c the engine rpm needle was bent against the bottom of its scale.
d the fan-wheel slippage indicators were still aligned.
e the oil radiator had been forced onto the engine starter ring and the resulting damage could only have been caused if the engine had not been rotating.

The engine was partially stripped and there was no evidence to suggest that a mechanical engine failure had occurred prior to the crash. There were signs that it had been running slightly on the lean side, but this was not considered to be unusual.

3) Carburettor Heat

The carburettor heat control knob in the cockpit was found in a position 25 mm towards the selection of maximum available hot air; this represented 1/3 of its available travel. However, movement of the engine during the impact caused the air box slider control cable to be pulled off the bottom of the control knob and the slider to be partially pulled off its backing plate. It is, therefore, possible that the pilot had selected more than 25 mm and that the control knob had been pulled back into this position during the impact. In comparison with another R22 helicopter, 1/3 movement of the control knob corresponds to a 22% opening of the hot air port by cross sectional area.

4) Throttle and Governor System

The governor components were tested, under AAIB supervision, and found to be serviceable. Score marks from the throttle linkage were found on the structure in the passenger's luggage compartment. Comparison with other R22 helicopters indicates that at the point of impact the throttle was closed and that the score marks were the result of the throttle connecting rod being pulled into the engine compartment as the luggage compartment distorted and the engine moved during the impact. The movement of the throttle linkage back into the throttle system would have been accommodated by distortion of the over-travel spring. The impact also caused the right hand collective lever to fracture, thereby freezing the position of the hand throttle on the collective levers. A comparison of the position of the hand throttle, and the collective throttle connecting rod, with the controls of other R22 helicopters confirms that at impact the hand throttle was closed and pressing against the over-travel spring.

5) Clutch and Vee Belts

Distortion of the clutch light filament was consistent with the light being illuminated when the helicopter impacted the ground. The aft vee belt was intact and the forward belt had been cut by the wreckage. However, there was no evidence that the belts had been slipping, or that the forward belt had failed whilst the engine was turning. The clutch actuator had distorted and fractured in overload consistent with the direction in which the helicopter impacted the ground. The length of the exposed actuator rod was measured as between 41·7 mm and 44·7 mm. At the time of the accident the vee belts had consumed 1,961 of their 2,200 hour life.

Analysis

There was no evidence of a mechanical failure that could have caused the engine to stop, or explain the loss of control of the helicopter. The presence of a large amount of fuel at the crash site indicates that there was sufficient fuel available for normal operations. Damage to the rotor system, low impact strikes on the tail cone, missing perspex and witness statements are all consistent with a loss of rotor rpm and stalling of the main rotor blades. Such a situation could arise if the pilot failed to respond quickly to an unexpected reduction in engine rpm. The position of the throttle is consistent with the pilot carrying out a forced landing with power available, as demonstrated in training, during which he would have been taught to close the throttle twist grip through a spring stop to overcome the tendency of the governor to apply more power at the conclusion of the manoeuvre. On relaxing his grip, the hand throttle would move, under spring pressure, to the position in which it was discovered. This would not be an appropriate technique in the case of low rotor rpm, because closing the throttle would make carburettor icing more likely for the reasons described earlier.

The clutch vee belts were nearing the end of their life and it is possible that the accumulated wear was sufficient for the actuator to go into an over-travel position. The pilot's initial reaction to the warning light would have been to reduce power by lowering the collective lever and land immediately. Alternatively, the clutch actuator might have been close to over-travel, and severe vibration resulting from the main rotor blades stalling caused the actuator to go into over-travel.

At the top of climb the pilot would normally be expected to engage the cyclic right trim by pulling it out, as it was found after the accident. It is possible that in undertaking this operation he may have inadvertently interfered with the governor switch on the end of the collective lever, causing it to move to the OFF position. In cruising flight, the action of the correlator in response to movement of the collective lever would be sufficient to trim engine speed. However, a build-up of ice in the carburettor could cause the engine and rotor rpm to decay until the low warning horn operated. The pilot's training required him to respond to the low rpm warning by opening the throttle and lowering the collective lever. If the pilot's initial reaction had been to lower the collective lever without manually opening the throttle then the correlator would act to close the butterfly valve thereby exacerbating the situation. However, tests undertaken on another helicopter to assess the likelihood of inadvertently interfering with the governor switch established that this was unlikely.

The investigation explored the possibility that the observed pitch up was initiated by the pilot as part of a "quick stop" manoeuvre, perhaps because he was concerned about continuing in poor visibility while unsure of the position of the other aircraft, which had declared it would be slowing down. A quick stop involves an application of aft cyclic, which induces a pitch up to reduce forward speed, and lowering of the collective to avoid gaining height. However, this is a highly unusual manoeuvre to execute from cruising flight and, having previously established radio contact, the pilot might have attempted to advise his instructor of his intention not to continue. Since neither the instructor nor the student accompanying him in G-TGRE recalls such an exchange, and given the unusual nature of the manoeuvre, it is possible that the pitch up manoeuvre itself was not a deliberate action by the pilot.

The witnesses stated that the aircraft was clear of cloud and in steady level flight prior to the initial pitch up. Nevertheless, in the degraded visual environment the student pilot may have had limited visual references, especially whilst in a nose up attitude, and may have become disorientated.

The atmospheric conditions prevailing at the time of the accident were conducive to serious carburettor icing at any power setting and it is likely that the pilot made some attempt to apply carburettor heat. However, with his attention focused on following the lead helicopter, he may have been unable to monitor the carburettor temperature gauge regularly enough to ensure that sufficient carburettor heat was applied at all times. Normal operation of the governor would have compensated for any build-up of ice in the carburettor by opening the throttle, until sufficient ice accumulated to stop the engine, even at full throttle. Furthermore, any lowering of the collective lever to reduce height, slow down, land or react to the low warning horn would result in closure of the butterfly valve via the correlator, and increase the risk of engine stoppage. It is also possible that the pilot, in this tense situation, gripped the collective sufficiently tightly to override the governor, or that, contrary to standard training, his instinctive reaction to a gradual loss of power was to raise the collective to maintain height. This would eventually lead to a critical reduction in main rotor rpm in the absence of sufficient engine power.

Following a power loss, the rotor blades would slow down and the low rpm warning horn would operate at 97%. The pilot would need to enter autorotation quickly to avoid a further reduction in rotor rpm. Below 76%, rotor rpm would be unrecoverable and the blades would stall. Increased drag from the rotor blades would then cause the engine to stall and the blades would flap, striking the tail cone and canopy.

AAIB bulletin EW/C98/3/1 describes a fatal accident involving a Robinson R22 helicopter. The report discusses research into the time available, following a range of failures, for the pilot to initiate an autorotation before rotor rpm decays to a value below which recovery is no longer possible. Although the Robinson R22 meets current certification criteria, these studies suggest that the time taken to intervene successfully is typically greater than the time that must be demonstrated to satisfy the certification criteria. It is therefore highly likely that, in the stressful and unfamiliar circumstances arising from the need to follow another aircraft in deteriorating weather, the pilot was unable to react in a timely manner to the engine failure, however caused.

Discussion

Training organisations and their instructors have a duty of care to students flying under their supervision. When authorising a student for any solo flight the instructor must satisfy himself that the actual and forecast conditions, including any transient conditions, are suitable for the flight and not expected to fall below the minima published in the training organisation's Flying Order Book or operations manual at any time during the exercise. If a subsequent deterioration in weather conditions causes the exercise to be curtailed, recovery of the aircraft must not involve the student in any further solo flying until conditions exceed the relevant minima. If the conditions are suitable for the student to fly solo then there is nothing to be gained from requiring him to follow another aircraft.

The student pilot was attempting to fly in loose formation whilst in poor visibility. He had not been trained to conduct this task and his briefed position and speed allowed no margin for error. The instructor had intended to reduce the student pilot's workload, but had inadvertently increased it, thus reducing significantly the student's capacity to carry out normal monitoring actions.

Conclusion

The student pilot was attempting to follow his instructor's aircraft in loose formation, despite having received no training in this demanding task. The student was, nevertheless, flying solo in weather conditions which, the available evidence indicates, were below the training organisation's minima. In the absence of sufficient carburettor heat, the helicopter probably encountered a severe build up of carburettor ice which either significantly reduced the available power or caused the engine to stop. The student probably acted in accordance with his training, but, faced with the added stress of having to follow another aircraft in reducing visibility, did not react quickly enough to prevent a critical reduction in rotor rpm. Consequently the main rotor stalled, causing the helicopter to fall to the ground with no possibility of recovery.