Robinson R44, G-TLME, 1 February 2000 at 1645 hrs

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Aircraft Type and Registration:	Robinson R44, G-TLME
No & Type of Engines:	1 Lycoming O-540-F1B5 piston engine
Year of Manufacture:	1994
Date & Time (UTC):	1 February 2000 at 1645 hrs
Location:	Wheelton Moor, 2 nm east of Chorley, Lancashire
Type of Flight:	Private
Persons on Board:	Crew - 2 - Passengers - 1
Injuries:	Crew - 2 Fatal - Passenger - Fatal
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence with Instructor Rating
Commander's Age:	32 years
Commander's Flying Experience:	737 hours (of which 11 were on type) Last 90 days - 69 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

History of the flight

At 1300 hrs on the day of the accident a Bell 206 helicopter arrived at Blackpool from Coventry Airport bringing a crew to collect the Robinson R44, G-TLME. This helicopter was to be flown to Coventry where it was to be used for pilot training for a period of one week. In addition to the pilot of the Bell 206 and the two pilots for the R44, there were two passengers on board who had asked to accompany the flight for the experience. On arrival at Blackpool the Bell 206 was shutdown and all five people had a light lunch together whilst final preparations were made for the departure of the R44.

The crew of the R44 consisted of the commander, who was a helicopter flying instructor, and another pilot, who was in the process of converting to this type of helicopter. The commander occupied the left seat and the other pilot occupied the right seat, which is the normal single pilot position. Also on board this helicopter was one of the passengers from the Bell 206 who had asked to return to Coventry in the R44. The commander of the Bell 206 and the remaining passenger

returned to Coventry in the Bell 206. The two commanders had agreed to return in loose formation, with the R44 leading since this helicopter contained a more capable navigation system and its commander was the more experienced.

The two helicopters left Blackpool at 1633 hrs in good weather and contacted Warton Radar at 1635 hrs. At this stage the Bell 206 was following the R44 and both helicopters were at 700 feet amsl. Once due south of Warton they climbed to 1,000 feet amsl. The commander of the R44 confirmed with Warton his intention to fly to the Manchester Low Level Route and then to Coventry (the Manchester Low Level Route allows aircraft to transit through the Manchester Control Zone, along a designated route, without the need for individual clearances from ATC).

At 1642 hrs the commander of the R44 informed Warton radar that he was descending to 600 feet in order to remain clear of cloud. He also confirmed his intention to follow the M6 motorway to the Low Level Route. At 1644 hrs he transmitted that he was now just to the south of Leyland and intended to turn through 180° in order to remain clear of the cloud. The Bell 206 pilot, following at a distance of about 60 yards, saw the R44 enter a turn to the left and then enter cloud. The Bell 206 pilot continued the left turn, remaining clear of cloud, before settling on a westerly heading.

An eye witness who was travelling by car along the B6228 road to the east of Chorley, saw the two helicopters flying at an estimated height of 600 feet and about 100 yards apart. He saw the lead helicopter enter a gentle turn to the left and saw the second helicopter follow. He described the entry to the turn as a perfectly normal manoeuvre with no apparent problems affecting either helicopter.

Warton Radar asked the commander of the R44 if he was happy with his position since he was now 3 nm to the north west of Winter Hill, a prominent hill with a radio tower that rises to 2,452 feet amsl. The commander replied "WE'RE ACTUALLY IN THE CLOUD NOW YOU CAN GIVE US SOME VECTORS": this transmission was timed at 1644:10 hr. The following transmissions were then made between Warton and the R44.

From	To	Recorded message	Time
Warton	R44	Head west now make the heading two seven zero (PAUSE) I'll take you back towards the M6 and you can pick up the M6.	1644:16
R44	Warton	Affirm we are turning right east (PAUSE) was that east to follow the M6.	1644:24
Warton	R44	No go west onto heading two seven zero (PAUSE) can you fly the heading.	1644:30
R44	Warton	Affirm (PAUSE) west turning left onto west two seven zero.	1644:33
Warton	R44	Squawk for me three six four one.	1645:00

R44	Warton	Three six four one (PAUSE) we're actually in a bit of trouble now (PAUSE) if you can give us a bit of assistance (PAUSE) we're climbing to one thousand five hundred feet to get out of the cloud.	1645:04
Warton	R44	Just confirming I do have you identified you're twelve miles south east of Warton make the heading two seven zero take you back track back towards the M6.	1645:27
R44	Warton	Helicopter Golf Mike Echo we're in trouble.	1645:42

At 1645:44 hrs and thereafter here was no response to transmissions from Warton from the R44.

The pilot of the Bell 206 requested radar vectors from Warton radar to take him back to the last recorded position of the R44, but he could not reach that location because the high ground was covered with cloud. He then requested radar vectors to the Manchester Low Level Route and subsequently returned to Coventry. A police helicopter, returning from another task, had heard the transmissions between Warton Radar and the R44, and offered assistance. It flew towards the last recorded position of the R44 but, despite making attempts to locate the helicopter from a number of different altitudes and directions, the crew were unable to locate the wreckage and returned to their base since they were now short of fuel.

Pilot experience

The commander of the Robinson R44 held a Private Pilot's Licence (Helicopters) and was qualified to fly both the Robinson R22 and the Robinson R44 as pilot-in-command. He was also qualified to instruct on both types of helicopter and to fly at night. He had last flown an R44 on 8 September 1999.

The type converting pilot also held a Private Pilot's Licence (Helicopters) and was qualified to fly the Robinson R22 and the Bell 206 as pilot-in-command. He had flown a total of 88 hours in helicopters of which 2 hours were on this type. His previous two recorded flights had been in the R44, which he had flown in the US on 27 January 2000.

Neither pilot was trained or qualified to fly by sole reference to flight instruments.

Meteorological conditions

The Meteorological Office at Bracknell provided an aftercast for the area of the accident. This indicated that at the time a cold front was moving south through the area. To the north of the front the visibility was good and there was no significant cloud. To the south of the front there was extensive cloud and reduced visibility in light rain.

A police helicopter arrived in the immediate area of the accident site at 1650 hrs and the pilot of that helicopter provided a comprehensive description of the local meteorological conditions at the time. He reported that to the north of the accident site the visibility was greater than 10 km with little or no low cloud, no precipitation and no turbulence. As he approached Winter Hill the

conditions deteriorated, and stratus cloud with a base of 500 to 800 feet surrounded the higher ground. Initially he tried to operate above this stratus layer but as he approached the high ground the cloud below became thicker. Furthermore, a bank of strato-cumulous, which lay above this cloud, became more extensive and eventually merged with the stratus. The pilot then attempted to reach the moor by operating below the stratus. He managed to fly just to the east of Anglezarke reservoir but the cloud then obscured the rising ground. He then attempted to approach the accident site from both the north and the south but on each occasion cloud obscured the higher ground and made further progress impossible. The police helicopter pilot considered that the conditions in the immediate area of the accident site were totally unsuitable for visual flight.

A Search and Rescue (SAR) helicopter from RAF Valley, on the Isle of Anglesey, was tasked to locate the Robinson R44. It took off at 1713 hrs and routed directly to the last recorded position of the R44. The commander of the SAR helicopter reported that the visibility en route was excellent and there was no cloud below 5,000 feet. From a distance of 10 to 15 miles he could see clearly a layer of cloud covering the high ground. He arrived over the moor at 1755 hrs and noted that the stratus cloud was approximately 300 feet thick with no cloud above this layer. The accident site was located approximately100 feet above the base of the layer with a further 200 feet of cloud above. During the next 30 minutes this cloud dissipated completely.

Radar data

Recorded radar data from the ATC area control radar situated at St Annes, near Blackpool, were obtained. The ground track of the R44, derived from this data, is shown at Figure 1. The ground track indicates that the R44 crossed over the M6 at Leyland before following the M61. Abeam Chorley it then commenced a left turn towards the high ground. It was immediately after this left turn that the pilot reported that he was now in cloud. The subsequent groundtrack indicates an erratic flight path.

The derived data also reveals that, prior to entering cloud, the groundspeed had been steady at 100 kt ±5 kt. (In the prevailing light winds the groundspeed would be approximately equal to airspeed.) Coincident with the pilot stating that he was in cloud the groundspeed increased to 113 kt before reducing to 65 kt over the next 60 seconds. It then recovered briefly to 83 kt before reducing to 67 kt.

Aircraft information

The flight instrumentation fitted to this R44 consisted of an airspeed indicator, an altimeter, a vertical speed indicator, a magnetic compass and an artificial horizon. The content and layout of this instrumentation was identical to that of the R22 with which the commander was more familiar.

The helicopter was also equipped with a Garmin 150 Global Positioning System (GPS) which, together with a Skyforce Tracker, indicates the aircraft position on a map display. The GPS is a satellite based navigation system that has the advantage of being more accurate than traditional ground based systems. The GPS unit was destroyed in the accident and it was impossible to recover any navigational data from the electronic memory. The commander of the R44 was neither familiar with, nor in the habit of using this type of equipment and this particular system is not intuitive in its set up procedure. It is therefore not possible to say whether the GPS was used on this flight. Several topographical air navigation charts, of quarter million scale, relating to the intended route were recovered from the wreckage.

Medical and pathological information

Autopsies were performed on the deceased. Evidence revealed that all on board were fatally injured at impact and died instantly. The injuries sustained by all the deceased indicated a severe vertical force with a lesser horizontal component and the accident was not survivable. There was no evidence, in either pilot, of any pre-existing disease, alcohol, drugs or any toxic substance which may have caused or contributed to the cause of the accident.

Impact sequence

The shape and character of the initial ground impact marks, together with the distribution of the wreckage forward of the impact point, suggested that the helicopter had struck the ground at a moderately high descent rate on a track of approximately 060°M, pitched slightly nose down, and banked moderately to the right with some associated side-slip to the right. The horizontal velocity could not be determined with precision, but the forward throw of wreckage from the primary impact point was consistent with a ground speed of 60 kt or more.

During the initial ground contact, the skids dug into the soft terrain and the fuselage and lower part of the cabin was disrupted. As the impact progressed, the lower skins and cabin floor structure was dragged underneath the fuselage, and the aircraft rolled rapidly forward and over onto its right side, bringing the rotor mast and head into heavy contact with the ground at a position just beyond, and to the right of, the fuselage impact point. There was clear evidence of main rotor blade strikes in this region, one of which was very heavy. A 2 metre length of outer main rotor blade was found approximately 85 metres from the impact point in a direction consistent with it having separated as a result of a ground strike during the impact.

Following the primary impact with the ground, the bulk of the helicopter, comprising the fuselage frame and rear bulkhead with remnants of the cabin structure still attached, the engine, gearbox, rotor head and blade remains, tail boom and tail rotor, continued forward a distance of 22 metres before finally coming to rest. Debris from the disrupted fuselage and cabin was distributed mainly within a fan shaped area originating at the impact crater and extending forward to a position slightly beyond the main wreckage. One or two items were thrown further, the furthest of these being the complete instrument binnacle which was located some 45 metres from the initial impact.

It was notable that the left side forward door had burst clear of the helicopter and was virtually intact whereas the corresponding door on the right side was very heavily damaged, consistent with the helicopter having been banked slightly to the right at impact.

Detailed examination of the wreckage

The dual flying controls fitted to this aircraft are manually operated, with electrical trim. Although a number of components had suffered overload failures it was possible, in every case, to positively attribute these failures to the impact. All of the cyclic and collective control system components, including the collective levers, the control column and both pilot hand-grips were located and examined together with the swash plate assembly and the pitch links to the main rotor blades: no evidence was found of any pre-impact defect or abnormality. All of the yaw controls from the tail rotor pitch links through to the output linkage from the yaw pedals were also examined in detail. The yaw pedals themselves were extensively disrupted in the ground impact. No evidence was found of any pre-impact defect or abnormality in the yaw control system. It was not possible to

determine the pre-impact positions of any of the electrical actuators, all of which operate via over-ride clutches; however, the associated linkages and connections appeared sound.

Visual examination of the engine and transmissions revealed no evidence of abnormality. It was established that the mixture control was set to fully rich at the time of ground impact, and the carburettor hot-air slide was in the "hot" position. Scores were noted on the main drive belts, and several belts had jumped onto adjacent grooves of the drive pulleys consistent with rotation of the transmission at the time the aircraft hit the ground. The distance over which the detached section of main rotor blade had been thrown after separation, together with significant in-plane bending of the main rotor blades, was evidence that significant power was being delivered to the rotor at the time of impact. In the view of the evident high energy in the main rotor system at impact, it was concluded that the engine was delivering adequate power and no strip examination of the engine or transmission was judged necessary.

The tail rotor drive line, including the tail rotor gearbox, was intact and rotating freely at the time of impact. No evidence was found of any strikes on the tail boom by the main or tail rotor blades.

The instrument warning caption filaments were examined for evidence of illumination at impact and none was found; however, because of the relatively low impact forces suffered by the instruments, this evidence was inconclusive. The circuit breakers were all *set,* with the exception of the attitude indicator circuit breaker which had *popped*. The electrical wiring harness to the instrument panel had suffered a degree of damage in the impact and it was considered likely that the breaker had popped because of transient shorting during the impact sequence. However, in view of the circumstances of the accident, the attitude indicator was removed and taken to an approved service centre where it was subject to detailed examination and testing under AAIB supervision.

Initial checks of the attitude indicator showed that the electrical connections were sound and the electrical resistance of the motor windings was normal. With the unit powered up and mounted in a calibrated frame on the test bench, a small amount of drift in the pitch display was evident, reaching a maximum of approximately four degrees offset either up or down, depending upon which way the unit began drifting initially after the caging knob was pulled to align the gyro; the display was stable in the roll axis. Changes in the orientation of the unit in both pitch and roll produced a correct indicator response within approximately four degrees accuracy in the pitch axis, and with negligible error in roll. The unit was then tested whilst being subjected to low level vibration from a small electric motor driving an eccentrically mounted mass, to simulate more closely the conditions in normal use: with vibration present, the unit displayed no tendency to drift and the display responded accurately to movement of the unit in both pitch and roll. Removal of the casing and examination of the internal components revealed that the outer gimbal bearings were slightly 'notchy', such damage often being found in units known to have suffered impacts less severe than the ground impact of G-TLME, for example following a very hard landing. It was also noted that the bearings supporting the erection vanes (which provide long-term stabilisation of the gyro platform, to counter drift) were slightly sticky: a condition frequently noted on nominally serviceable units returned for overhaul. The combination of these two defects, the first clearly attributable to the accident and the second comprising a minor and relatively insignificant defect typical of units in service, would be expected to result in the gyro drifting in the absence of vibration. On the basis of the tests carried out it was concluded that even with the unit in its accident-damaged condition, if installed in a helicopter with vibration present in flight, the unit would provide satisfactory attitude reference in both pitch and roll. In summary, the evidence indicates that aircraft was intact and serviceable at that time of the accident.

Summary

The flight proceeded uneventfully until approaching the area of Leyland when the two helicopters crossed the M6 and began following the M61 motorway. This was at variance with the R44 commander's stated intention of following the M6 and suggests that the he was unsure of his position. As they approached deteriorating weather conditions, at a reported height of 600 feet, the R44 was seen to turn to the left and then enter cloud. If the commander had been certain of his position at this time it is unlikely that he would have turned to the left, towards high ground, when a turn to the right would have kept him over low lying, relatively flat terrain.

An eye witness on the ground and the pilot of the Bell 206 both described the left turn, prior to entering the cloud, as appearing to be a perfectly normal manoeuvre. The first acknowledgement by the commander that he was in difficulty was his transmission at 1644:10 hrs; 'WE'RE ACTUALLY IN THE CLOUD NOW YOU CAN GIVE US SOME VECTORS'. During the next 92 seconds the commander made 4 further radio transmissions but made no reference to any technical malfunction. His stated intention to climb to 1,500 feet to get out of the cloud is a further suggestion that his problem was not of a technical nature. Furthermore, following extensive examination of the wreckage no evidence was found of any technical failure. It is therefore considered to be unlikely that any technical failure contributed to this accident.

The erratic flight path, illustrated by the radar data during the 92 seconds that the helicopter was in cloud, together with the variations in airspeed, suggest that the handling pilot had become disorientated and was unable to control the helicopter. The commander's confusion of 'east' for 'west' might also be indicative of a high mental workload whilst he was attempting to resolve his disorientation. Neither pilot was trained or qualified to fly the helicopter by sole reference to flight instruments. It is therefore most probable that the helicopter was flown into the cloud inadvertently and the handling pilot became disorientated. He was then unable to control the helicopter, which subsequently struck the ground.