INQUIRY
UNDER THE FATAL ACCIDENTS AND SUDDEN DEATHS INQUIRY (SCOTLAND) ACT 1976

DETERMINATION

by

Sheriff Principal Edward Bowen QC

In an Inquiry into the death of

Robert Steven Hislop

EDINBURGH, 30 MAY 2008

The Sheriff Principal having considered all the evidence adduced determines in terms of the Fatal Accident and Sudden Deaths Inquiry (Scotland) Act 1976 section 6(1):

(a) That Robert Steven Hislop born on 11 January 1962 latterly of 44 Buttermere Drive, Onchan, Isle of Man died at approximately 11.04 hours on Wednesday 30 July 2003 at Caerlanrig, near Teviothead, Hawick, Scottish Borders.

(b) That the cause of death was (I)(a) multiple injuries, (b) helicopter crash.

(c) That there are no reasonable precautions whereby the death of Mr Hislop might have been avoided.

(d) That no defects in any system of working contributed to the cause of death.

(signed) EB

(e) That the following facts are relevant to the circumstances to Mr Hislop's death.

FINDINGS IN FACT

1. G-EOUL was a Robinson R44 helicopter, owned by Universal Energy Limited, of which Mr Michael Holland is Principal Director. It had been bought new around the beginning of 2002 and was fully serviced and maintained. It had a certificate of air worthiness issued by the Civil Aviation Authority dated 5 September 2002.

2. Robinson helicopters have their manufacturing base in the United States of America. There are about 6,000 Robinson helicopters in service worldwide. The R44 is a responsive aircraft with light controls and is popular with private purchasers.

3. An R44 is powered by a single six cylinder petrol piston engine with fuel supply via a carburettor. It has two main rotor (MR) blades which turn at a normal speed of 400 to 408 rpm (referred to as 100% to 102%). The MR hub is pivoted to the top of the mast above the aircraft fuselage. This is known as a "teetering" rotor whereby the body of the helicopter hangs below the rotor. The moving main rotors are referred to as the MR "disc".

4. The R44 has four main controls, namely a collective lever, a cyclic stick, yaw pedals (left and right) and a throttle twist grip. The collective lever is held in the pilot's left hand. It controls the pitch angle of the main rotor blades. Raising the collective lever increases the pitch angle of the MR blades, thereby increasing main rotor thrust and causing the helicopter to lift. When the collective is raised more power is required to the main rotor. The collective lever is mechanically connected to the throttle such that raising the collective opens the throttle. The carburettor throttle can be manually controlled by the twist grip on the collective, but on an R44 the throttle is normally controlled automatically by an engine governor.

5. The cyclic stick, which is operated by the pilot's right hand, controls the "attitude" of the aircraft. It changes the pitch angle of the MR blades over part of their circle, causing the rotor disc to tilt. Pushing the cyclic forward tilts the disc forward and the helicopter's speed increases. Pulling it to either side causes the helicopter to roll in that direction. The yaw pedals change the pitch angle, and thus the side thrust generated by, the tail rotor blades. This controls the direction in which the helicopter points.

6. Mr Hislop had obtained a private pilot's licence for flying helicopters through training on an Enstrom helicopter. His licence was issued on 24 September 2002. He had about 76 hours flying experience on Enstroms. He subsequently carried out type conversion to the R44 and was issued with a rating certificate for that helicopter on 17 January 2003. As at 30 July 2003 Mr Hislop had about 20 hours flying experience on the R44. His licence permitted him to fly visually, that is to say clear of cloud and in sight of the earth's surface.

7. On the morning of 28 July 2003 Mr Hislop flew G-OUEL from Wycombe Air Park, Buckinghamshire, to the home of a friend Andrew Brodie at Horsleyhill, near Hawick. On Monday evening and on Tuesday 29 July Mr Hislop took Mr Brodie and other friends on short sightseeing flights. He refuelled the helicopter at a private airstrip at Midlem by Selkirk on 29 July.

8. Mr Hislop had intended to leave Horsleyhill early in the morning of 30 July. He was unable to do so due to bad weather in the form of rain and low cloud. He made two telephone calls to the National Air Traffic Services Weather Centre.

9. G-OUEL was fitted with a global positioning system navigation device which recorded time, position, ground speed, track and altitude during flight. Data recovered from the GPS device showed that Mr Hislop left Horsleyhill at 10.56 hours British Summer Time on 30 July. The helicopter passed down the

western edge of Hawick (where it was observed flying normally by several witnesses) and followed the general line of the A7 road at a speed of between 107 and 116 knots until it reached the area of Teviothead about six minutes after take-off. The Average altitude up to that point was 1,500 feet.

10. About one mile south of Teviothead, where the A7 turns slightly to head due south, G-OUEL's speed reduced to 98 knots. In the next 30 seconds it climbed from 1,500 to 2,400 feet; turned right through 32 degrees and reduced its speed to 50 knots. It then continued to turn right through a further 83 degrees, increased speed to 86 knots and climbed a further 200 feet. The final recording timed at 11.00 hours showed that it continued to turn through a further 130 degrees, descended 150 feet and increased speed to 120 knots.

11. At about 11am on 30 July witnesses at Teviothead and Caerlanrigg Farm heard the sound of an engine, probably of a helicopter, which was "labouring" or misfiring. One of the witnesses heard a bang; the other heard the engine suddenly stop.

12. The wreckage of G-OUEL was found at about 16.30 hours on 30 July, along with the remains of Mr Hislop's body. Detailed examination of the wreckage showed it to be spread over a trail of 400 metres long and 100 metres wide, down the southeast face of a steep sided valley and across the valley floor between Caerlanrig Farm House and Lymecleuch Farm House. The first items on the trail were multiple white paint flakes and a copy of Pulley's Flight Guide which had clearly come from the cabin of the helicopter. Part of the anti-collision beacon mounted on the top part of tail boom was 90 metres along the trail. A significant section of the tail boom was found 250 to 320 metres along the trail, along with a fragment of main rotor blade. The main body of the aircraft was towards the end of the trail. It was deeply embedded in the ground and had impacted at high vertical speed. The position of the right forward cabin door indicated that it had opened before ground impact.

13. Detailed examination of the wreckage at the Air Accident Investigation Bureau Headquarters at Farnborough confirmed that the tail boom had sustained three strikes from the MR blades which had separated the boom into seven major parts and a large number of fragments. The tail rotor blades were undamaged. There was little damage at the MR hub.

14. Abnormal behaviour of the MR blades resulting in tail boom strike in a helicopter of an R44 can result from one of two conditions. The first is known as "low vertical g". This can arise due to turbulence, or from a sudden forward movement of the cyclic stick in forward flight, causing the helicopter to pitch nose down and at the same time reducing MR thrust. The forces which keep the fuselage aligned with the MR disc are reduced. If the cyclic stick is pulled back the MR disc tilts and may not align itself with the fuselage due to reduced thrust. In that event the disc may tilt back relative to the fuselage.

15. If the MR disc tilts far enough, the inner end of the MR blades will make contact with the mast on which they pivot. This is a condition known as "mast bumping". Devices known as teeter stops cushion the effect of the end of the blades coming in contact with mast, which occurs normally when the blades are not rotating and the tension in them is reduced. Mast bumping in flight will almost certainly result in severe damage to the teeter stops and can in extreme cases fracture the mast. There was little sign of damage to the teeter stops on G-OUEL.

16. The second condition in causing abnormal behaviour of the MR blades is low rotor rpm. It is vital for any helicopter to keep the main rotor speed of rotation (rpm) within a "normal" band whilst in flight. If the rotor rpm falls too much below normal part of the MR blades can stall: the blades can flap too much, bend too much or twist too much. This leads to MR imbalance which imposes extremely high vibration forces on the helicopter. If a stall affects a substantial part of a blade, a further reduction in MR rpm is extremely rapid. RPM reduction below 72% is irreversible; MR thrust will be lost and the

aircraft will descend at high vertical speed. In that event, upward air flow on the helicopter tail surfaces pitches the fuselage nose down; backward tilting of the disc and the nose down attitude of the aircraft tilt the disc closer to the tail boom. In a case of drastic reduction of rotor rpm the MR blades will strike the fuselage, usually on the left side.

17. The absence of evidence of mast bumping on G-OUEL indicates that blade strike did not occur because of a low vertical g condition. The evidence of damage from heavy vibration (the open cabin door and contents at the first part of the debris trail) and of MR blade strike on the tail boom lead to the conclusion that G-OUEL crashed because of a low rotor rpm condition.

18. Low rotor rpm occurs either because the engine power available to turn the rotors is too low, or the rotor power required is too high. The former can arise from a variety of conditions including transmission failure and engine failure from mechanical reasons or reasons relating to fuel supply. The most frequent in the latter category is carburettor icing, which can occur when the ambient temperature is well above freezing. The R44 has an arrangement whereby the pilot can divert warm air into the engine feed air. It is of particular importance for a pilot of an R44 to watch the carburettor temperature gauge and to maintain the carburettor temperature slightly above zero degree centigrade. Excessive heating of the carburettor air can cause loss of engine power.

19. The possible reasons for "excessive rotor power required" are transmission failure and "over-pitching", the technical term for excessive main rotor drag caused by keeping the collective lever raised too high for the prevailing conditions. If MR rpm falls much below normal the collective must be lowered very rapidly to allow rpm to recover.

20. Engine power loss, partial or complete, of itself does not cause a helicopter to descend uncontrollably. In the event of power loss, lowering the collective lever fully causes the helicopter to descend in a condition known as "auto rotation". The air flowing up through the MR rotates it at normal speed and

provides lift whilst because of the gearing system MR rotation keeps the tail rotor rotating at normal speed.

21. Flying a helicopter into cloud, or other conditions in which it becomes necessary to rely on instrument flying, is highly stressful for those inexperienced in instrument flying. Pilots are trained that if cloud is entered, it is appropriate to turn 180° to come out of it. To carry out a manoeuvre of turning a helicopter relying solely on instruments is nevertheless a difficult task. A sense of disorientation occurs very easily, caused by the acceleration of the aircraft in the absence of outside vision. If, on emerging from cloud, the ground appears to be coming up rapidly, there would be a tendency to raise the collective quickly and pull back on the cyclic. This could result in "over-pitching".

22. The weather on 30 July 2003 was damp with outbreaks of rain and drizzle at times and hill fog over much of the high ground of southern Scotland. Scattered clouds were at a relatively low level, drifting in from the east, also causing transitory hill fog.

23. An RAF Chinook helicopter commanded by Squadron Leader John Rigby, in the course of a flight from RAF Lossiemouth to a military training area 30 miles south of Hawick, flew southwards down the line of the A7 about 10 minutes after G-OUEL. The Chinook had entered cloud after crossing the Forth estuary and pulled up to approximately 3,500 feet where it was flown on instruments. It descended about four minutes after G-OUEL crashed, at which point it was a few miles to the north of Hawick. The crew were in a position to observe the ground and weather conditions to the south. They considered that the cloud base was too low to the south of Teviothead to continue flying down the A7 valley visually. At a point two to four nautical miles north of the crash site the Chinook diverted to the west and passed over the Eskdalemuir Forest at a height of 100 to 200 feet.

24. Two RAF Harrier jets flew northwards at low level up the A7 valley at about 11.41am British Summer Time. They were forced by bad weather to abort the flight in the vicinity of Hawick. Part of the Borders are designated as "low flying" areas for the purposes of military training. Pilots intending to fly in a low flying area are required to book into it with a "low flying booking cell" at West Drayton. Middlesex. That cell maintains a record of low flying activity. The only two aircraft recorded as entering the Borders low flying area on 30 July were the said two Harrier jets.

25. On the evidence adduced no military aircraft caused or contributed to the crash of G-OUEL.

(signed) *E Bowen*

NOTE

1. The circumstances of this tragic accident were very fully investigated, as is customary, by officials of the Air Accidents Investigation Branch of the UK Department of Transport. To a significant extent the factual conclusions set out above are based on the evidence of three witnesses from that organisation, with expertise respectively in the examination of flight recorders; operational aspects relating to the pilot and aircraft; and engineering findings in particular on examination of the aircraft debris. The findings which I have arrived at do not go significantly beyond those reached by the AAIB. The Fatal Accident Inquiry nevertheless served as a public forum in which the opinions of those investigators, along with the testimony of other witnesses could be scrutinised in open court.

2. Mr Hislop was a competent and careful helicopter pilot with a natural affinity for handling fast machines. Although on one view it might be said that his experience of helicopter flying was limited on the other hand he was meticulous in his planning of flights and in particular conscious of the need to avoid cloud and bad weather. He was not trained in instrument flying.

3. The aircraft in question was a fairly new one and was well maintained. There was no evidence of fuel deficiency and no evidence of mechanical failure was detected from the debris, although this cannot be entirely ruled out due to the extensive nature of the impact and fire damage. Helicopters of the type in question are in extensive use worldwide. They have a slightly higher than average accident record, but this is considered to be due to their frequent use by inexperienced pilots.

4. The wreckage provides indisputable evidence of tail boom strike by the main rotor blades, resulting in most of the tail boom detaching in flight. That event makes the helicopter uncontrollable. There are two possible causes which are dealt with in findings in fact 14, 15 and 16 above. For the reasons given in finding in fact 17 I am satisfied, on balance of probabilities, that Mr Hislop's helicopter crashed because of a low rotor rpm condition.

5. The manoeuvre executed by Mr Hislop immediately before the fatal crash was a somewhat dramatic one, involving a rapid climb and a turn through 245 degrees. The rate of climb strongly indicated that there was no engine failure. The experts were unanimous that such a manoeuvre through cloud was one in which disorientation was extremely likely. It was described as "a very difficult manoeuvre, beyond most pilots". Low rotor rpm occurred at the end of the manoeuvre, and although the possibility of some form of mechanical failure or carburettor icing cannot be eliminated, "over-pitching" caused by raising the collective lever too quickly is a recognised scenario in such a situation. It only falls to be added that the evidence of witnesses on the ground who heard the sound of a helicopter engine "labouring" lend weight to the conclusion of low rotor rpm.

6. The question which might be viewed as critical is of course what caused Mr Hislop to deviate from his intended course and to climb so steeply. The presence of low flying military aircraft in the area at about the material time has given rise to the suggestion that they were in some way responsible.

 (signed) EB

7. In this respect a number of civilian witnesses gave evidence, some claiming to have seen or heard two jet aircraft in the vicinity of the crash site within seconds of seeing Mr Hislop's helicopter. It has to be said that although I have no doubt that all witnesses were attempting to be of assistance to the court their evidence was, in certain respects, not only inconsistent with each other but inconsistent with what they themselves had initially told the police.

8. In addition to the evidence of the presence of jet aircraft, there was also civilian witness evidence of the presence of one or more Chinook helicopters. In that respect I am in no doubt that the best evidence came from Squadron Leader Rigby who was the Flight Commander of the only Chinook helicopter in the vicinity at the time who was able to support his evidence by reference to a chart showing the position and timings of the position of his helicopter, further supported by radar data recorded from the Scottish Radar Centre at Prestwick. The Chinook helicopter was several miles north of Hawick at the moment of the fatal accident. Squadron Leader Rigby had a clear recollection of the difficulties caused by weather, and the decision which he and his crew took to divert at low level over Eskdalemuir Forest thereby avoiding a need to fly higher into a radar controlled area operated from Carlisle.

9. In relation to the presence of low flying aircraft the AAIB examiners impounded radar tapes from Prestwick, examined records of radio transmissions and made enquiries at the RAF low flying booking cell at West Drayton. Apart from radar traces of aircraft at 10,000 feet there was nothing to indicate the presence of a jet aircraft in the vicinity of the crash site until two RAF Harrier jets passed heading northwards at 11.41. The presence and timing of these two aircraft is consistent with the evidence of two civilian witnesses Ms Stavert, a Gamekeeper who saw them whilst working in the hills above Roberton and Mrs Elliot who saw them in the vicinity of Selkirk.

10. Squadron Leader Rigby was not aware of any other aircraft in the vicinity of his flight, and whilst the matter was not explored in evidence it has to be

assumed that any other low flying aircraft present would have been in flagrant breach of RAF low flying regulations. In the whole circumstances I am satisfied on balance of probability that no military aircraft caused or contributed to the crash of G-OUEL.

11. The conclusion of the AAIB was that "it was likely that the helicopter had entered IMC (instrument meteorological conditions) during a turn away from an area of low cloud on its planned route. Shortly afterwards control had been lost and the aircraft descended rapidly, possibly as a result of spatial disorientation. An excessively low rotor rpm had probably resulted". Taking into account the evidence of Squadron Leader Rigby regarding weather conditions this explanation does appear to be the most likely. I regret that it is not possible to reach a conclusion with any greater degree of certainty.

12. Following its investigation the AAIB made two safety recommendations in the following terms:

"2005-021 It is recommended that the Robinson Helicopter Company consider including in the R44 and R22 pilots operating handbooks a specific warning highlighting the possibility of a rapid and excessive collective pitch demand causing a hazardous loss of rotor rpm together with guidance on the appropriate handling of the collective lever.

2005-022 It is recommended that the Federal Aviation Administration and the European Aviation Safety Agency reassess the "corrective action time delay" in reducing the collective control after sudden power loss on a single engine helicopter, with the aim of ensuring, so far as possible, that the minimum reaction time required is realistically within the capability of an average qualified pilot."

The Federal Aviation Authority responded to the first recommendation by stating that the correct handling was already included in the pilots operating handbook. To the second recommendation they responded that "One second

on pilot reaction time" was correct and the European Agency responded that the proposal would be considered in future rule making.

13. There seems little purpose in repeating these recommendations in terms in this Determination. The circumstances of this accident simply serve to highlight to all helicopter pilots (1) the dangers of flying into low cloud or other conditions of restricted visibility; (2) the acute dangers created by over-pitching and (3) the need for very rapid corrective action in the event of low rotor rpm.