

SHERIFFDOM OF SOUTH STRATHCLYDE, DUMFRIES AND GALLOWAY AT
LANARK

**INQUIRY UNDER THE FATAL ACCIDENT AND INQUIRIES (SCOTLAND)
ACT 1976**

DETERMINATION

by

SHERIFF NIKOLA C STEWART

in Fatal Accident Inquiry in terms of the Fatal
Accidents and Sudden Deaths Inquiry (Scotland)
Act 1976

into the circumstances of the death of

COLIN STEELE McRAE;

GRAEME ARTHUR DUNCAN;

BEN TELFER PORCELLI

and JOHN GAVIN McRAE

APPEARANCES:

For the Crown: Ms MEIKLE, Principal Procurator Fiscal Depute.

For the McRae family: Mr McBRYDE, QC, Mr Anderson, Solicitor, Levy & McRae

For Eurocopter: Mrs Anwar, Solicitor, DLA Piper.

For the Civil Aviation Authority: Mr ANDERSON, Solicitor, Simpson & Marwick

WS

LANARK, 2 September 2011

The sheriff, having resumed consideration of the evidence adduced, FINDS AND DETERMINES in terms of section 6(1) of the Fatal Accidents and Sudden Deaths Inquiry (Scotland) Act 1976:

1. In terms of section 6(1)(a):-

Colin Steele McRae, date of birth 5 August 1968, Graeme Arthur Duncan, date of birth 14 December 1970, Ben Telfer Porcelli, date of birth 7 June 2001 and John Gavin McRae, date of birth 6 December 2001, died in the wooded area adjacent to Jerviswood House, Bellefield Road, Lanark at 1610 hours on 15 September 2007.

2. In terms of section 6(1)(b) the cause of death was:-

(a) in relation to Colin Steele McRae

1a: head injuries due to

1b: aviation incident (helicopter)

(b) in relation to Graeme Arthur Duncan

1a: chest injury due to

1b: aviation incident (helicopter)

(c) in relation to Ben Telfer Porcelli

1a: head injury due to

1b: aviation incident (helicopter)

(d) in relation to John Gavin McRae

1a: head injury due to

1b: aviation incident (helicopter)

3. In terms of section 6(1)(c) of the Act it would have been a reasonable precaution to refrain from flying helicopter G-CBHL into Mouse Valley wherein the pilot engaged in low level flying when it was unnecessary and unsafe for him to do so and whilst carrying passengers on board. The accident occurred when, due to an unknown occurrence, the aircraft deviated from its intended flight path and crashed into trees lining the side of Mouse Valley. The aircraft was in powered flight at the time of the collision and attempts were being made by Mr McRae to recover from that unknown event. These attempts were rendered ultimately unsuccessful because of the position and speed of the helicopter within Mouse Valley and the resultant restrictions on opportunity to land or fly the helicopter to safety. Such options would have been available to him had he adhered to rules of good airmanship and desisted from flying in the valley at low height and high speed.

Introduction

1. This is an Inquiry instituted by the Lord Advocate under the discretionary provisions of the Fatal Accidents and Sudden Deaths Inquiries (Scotland) Act 1976. It was considered expedient in the public interest that such an Inquiry should be held into the circumstances of the deaths of Colin Steele McRae, aged 39, Graeme Arthur Duncan, aged 36, Ben Telfer Porcelli, aged 6 and John Gavin McRae, aged 5, which occurred when the helicopter piloted by Mr McRae and in which they were passengers crashed on 15 September 2007.
2. The Inquiry took place at Lanark Sheriff Court and evidence was heard over 12 days between 12 January and 26 May 2011. A locus inspection of the crash site and points along the helicopter's final flight path took place on 25 January 2011. Written submissions were prepared and lodged, and on 8 August 2011 parties were given the opportunity to make additional oral submissions. The evidence, although often complex, was in great measure uncontroversial, resulting in fewer court days being required than originally contemplated. Whilst parties are to be congratulated on their determination to focus attention on the salient issues, this had the unforeseen consequence of delay being encountered between blocks of evidence which had been carefully timetabled in advance and which could not be re-scheduled because of the unavailability of non-local and expert witnesses. Further delay was occasioned when, as a result of concern voiced that eye witness accounts given in court may have differed in important areas from statements given to Air Accident Investigation Branch (AAIB) investigators and founded upon in

AAIB report Crown Production 34, transcripts of that evidence were made available to investigators in order that any such discrepancies could be taken into account by them in oral evidence.

3. The McRae family became a party to the Inquiry and were represented by senior counsel. The families of Graeme Duncan and Ben Porcelli did not become parties and were not represented, albeit family members were regularly in attendance during the Inquiry, and I understand that Ms Meikle on behalf of the Crown liaised closely with them and was careful to take their views and comments into account in her preparation and presentation of the case. Evidence was placed before the Inquiry from family members in the form of affidavits.

4. Evidence was led from the following witnesses.

- 1) Roslyn Douglas, Scene Examination Branch, Strathclyde Police
- 2) Louise Nixon, Identification Bureau, Strathclyde Police
- 3) Elaine Paul, Identification Bureau, Strathclyde Police
- 4) Edward Brown, Scottish Police Services Authority.
- 5) Catherine Louise Murray, Strathclyde Police.
- 6) Raymond Walker, Identification Bureau, Strathclyde Police.
- 7) Constable Kevin Brown, Strathclyde Police.
- 8) Sergeant John Watt, Strathclyde Police,
- 9) Karen Porcelli.
- 10) Mark Porcelli.
- 11) Alexander Steele.

- 12) John Watson.
- 13) John Crawford.
- 14) Kenny Moore.
- 15) Christine Currie Moore
- 16) William Kirk Hope
- 17) Katherine Anderson
- 18) Louise Nixon, Identification Bureau, Strathclyde Police.
- 19) Detective Inspector Fiona Brown, Strathclyde Police.
- 20) David Lowry.
- 21) Alexander Fleming.
- 22) Iain Ross.
- 23) Detective Constable Mark Brown, Strathclyde Police.
- 24) Robert Campbell Roy.
- 25) Jean Telfer.
- 26) Graeme Henderson.
- 27) Margaret Fowler.
- 28) Alfred Scrambler.
- 29) Shirley Cook.
- 30) Ann Rosemary Cooper.
- 31) Jordan Hill.
- 32) Robert Muncie.
- 33) Ian Muncie.
- 34) Donald Cook.
- 35) Sergeant John Watt, Strathclyde Police.
- 36) Constable Ian Thomson, Strathclyde Police.

- 37) Stewart Anderson.
- 38) Detective Inspector Fraser Lamb, Scottish Government, Police Division.
- 39) Stephen Kitchen.
- 40) Dr Gerard Murphy, Police Casualty Surgeon, Strathclyde Police.
- 41) Ian McLean, Strathclyde Fire and Rescue.
- 42) Sergeant Robert Logan, Strathclyde Police.
- 43) Inspector Angela Jennings, Strathclyde Police.
- 44) Inspector Alan Bowater, Strathclyde Police.
- 45) Detective Sergeant Craig Willison, Strathclyde Police.
- 46) Acting Detective Inspector Alan Bankier, Strathclyde Police.
- 47) Detective Constable Steven Bertram, Strathclyde Police.
- 48) Detective Sergeant Alex McArthur, Strathclyde Police.
- 49) Detective Sergeant Grant McLeod, Strathclyde Police.
- 50) Detective Constable Mark Henderson, Strathclyde Police.
- 51) Dr John Clark, University of Glasgow.
- 52) Constable James Baird, Strathclyde Police.
- 53) Constable Robert Paterson, Strathclyde Police.
- 54) Thomas Mathers, Prestwick International Airport.
- 55) Stephen Aspin, Scottish Air Traffic Control Centre, Prestwick.
- 56) Hugh Sutherland.
- 57) Brian Park, PDG Helicopters, Aberdeen.
- 58) Patricia Allan, Strathclyde Fire & Rescue.
- 59) Craig Brackenridge, Bond Air Services, Glasgow.
- 60) Angela McHutchison, Scottish Ambulance Service, Law.
- 61) Dr Alan Downie, Paisley.

- 62) Raymond Elgy, Civil Aviation Authority, Gatwick.
- 63) Fred Cross, Civil Aviation Authority, Gatwick.
- 64) Alistair Gwilt, Wickford, Essex.
- 65) Mrs Alison Jane McRae.
- 66) Mrs Jenifer Dawn Love Duncan.
- 67) Neil Robert Gatt
- 68) Alistair Sutherland, Sloan Helicopters, Majorca.
- 69) Andrew Robinson, AAIB, Aldershot.
- 70) Ken Fairbank, AAIB, Aldershot.
- 71) Geoffrey Alexander William Connolly.

Findings in Fact

I found the following facts admitted or proved:-

1. Colin Steele McRae lived with his wife and two children at Jerviswood House, Bellefield Road, Lanark. Johnny Gavin McRae was his 5 year old son. Mr McRae was the owner and pilot of an Eurocopter AS350B2 Squirrel helicopter, call sign G-CBHL. Mr Graeme Arthur Duncan lived with his wife and son at 3 Cleghorn Street, Lanark and in France. Ben Telfer Porcelli lived with his parents at Lochside, Braidwood.
2. The helicopter G-CBHL was manufactured in 1992, used in Japan and then Canada before being registered in the UK for the first time in January 2002. It was purchased by Mr McRae in November 2003. Whilst it's exact number of

flight hours is not known, at an annual inspection carried out on 7 June 2007, 4158 flight hours are recorded. A 12 Year Inspection was successfully carried out on 1 June 2006 and it had a European Aviation Safety Agency Standard Certificate of Airworthiness, valid until 1 May 2008. The helicopter was not fitted with flight recording data or cockpit voice recorder and was not required to be.

3. The McRae family home at Jerviswood House was equipped with a helipad and an aircraft hanger. It is situated above the south side of the Mouse Valley, yards from the edge of the wooded glen with the River Mouse at its foot which comprises the Mouse Valley. The helicopter, G-CBHL, was based at this location, and was frequently flown by Mr McRae both for business and for pleasure. It was a common sight in Lanark and the surrounding area.
4. Mr McRae had significant flying experience, amassing 965 hours in total, of which 490 were on this type of helicopter. He continued to fly regularly in the weeks and months prior to this incident.
5. On the afternoon of 15 September 2007, Mr McRae was at home in the company of his daughter and some male friends. His son was returned home in the company of his friend Ben Porcelli by Mrs Porcelli. At or about 1400 hours Mr McRae set off in the company of Mr Graeme Duncan, Johnny McRae and Ben Porcelli to undertake a short, 8 nautical miles, flight to a friend's farm near Larkhall. It was not unusual for Mr McRae to use his helicopter for short, domestic flights such as this. Ben's parents had no knowledge of the proposed helicopter flight and had not been asked for their consent to it.

6. Mr Duncan filmed much of the outbound and return flights on his personal camcorder. 5.3 minutes of video and sound track were recovered in total. The video was taken from his front passenger seat and ended approximately 55 seconds prior to the accident. This source provides confirmation from pre-flight checks at the start of the outbound journey that all engine and system indications were normal and flight instruments appeared serviceable. Fuel levels were sufficient for 1 hour 40 minutes flying time. Indicated air speed generally varied between 110 knots and 115 knots; a typical cruise speed. Dual flight controls were fitted but front passenger, Mr Duncan, appeared able to sit without interfering with them. The pilot was seen to remain in full control of the helicopter throughout, giving no sign of any concerns about its performance. Passengers were seen and heard to be enjoying the flight. Cabin noise levels prevented the picking up of conversations conducted at normal levels, although louder comments were recorded.
7. The outbound flight took approximately 6 minutes in the course of which no concerns were raised in respect of the performance or condition of the helicopter. Mr McRae was seen piloting the aircraft in a confident and competent manner albeit exhibiting what was described by expert witnesses as “spirited” flying. The party spent less than an hour at Little Sunnyside Farm prior to re-boarding the helicopter for the return journey to Jerviswood. The helicopter took off at or about 1500 hours to commence the homeward journey.

8. The return journey took approximately 5 minutes. In the course of it the pilot performed a zoom climb from take off before descending into a narrow, steep-sided valley next to Larkhall. He flew over trees at the valley's edge at speed with a separation of less than 30 feet between aircraft and trees. The helicopter was then pitched nose-down into the valley coming into similar proximity to trees on either side of it, before zoom climbing out of the valley. Passengers were seen and heard to enjoy the manoeuvre.
9. Weather conditions were generally favourable for flying. Wind conditions were reported as gusty in the Mouse Valley area with some turbulence, although not severe in nature. It was dry and visibility was good.
10. Both flights were conducted at low levels of altitude, on occasion flying well within the recognised minimum. The transponder on board the helicopter did not record altitude but witness sightings together with video evidence enable informed estimates of height and separation to be made.
11. Ground speed of the helicopter *en route* is estimated from available radar detail together with Indicated Air Speed taken from video recorded cabin readings and meteorological information. Radar tracking captured the majority of the flight, but contact was lost approximately 20 seconds prior to the helicopter reaching the accident site, as it descended out of sight behind obscuring terrain. Speed thus recorded shows an average ground speed for the second half of the flight, fluctuating between 100 knots and 120 knots, increasing to 122 knots in the last 30 seconds of data. Speed further increased as it descended into the valley.

12. Witnesses to the return flight reported no visual signs of distress to the aircraft.

It appeared to be handling appropriately, under the control of the pilot, albeit its low altitude and the resultant high level of noise generated, attracted attention and some concern.

13. Mr McRae's usual approach to Jerviswood involved flying to the east of the helipad before making a slow, controlled descent to land, albeit other approaches were also utilised as appropriate. On this occasion and very unusually he approached the area from the west, initially flying across the Mouse Water Valley before making a brief right hand turn then banking steeply to the left and descending into the valley. The helicopter adopted a marked nose-low, banked attitude as it descended and was described as flying faster than normal. Its indicated air speed as it entered the valley was reliably estimated at approximately 130 to 135 knots which together with a 20 knot tail wind, would have resulted in a ground speed of approximately 150 knots. Having entered the valley the helicopter was not seen again by witnesses. Prior to it disappearing from view the aircraft was not seen to be in obvious difficulty. There were no witnesses to the crash itself.

14. The helicopter crashed into the steeply sloping, heavily wooded ground on the south bank of the Mouse Valley water. An extensive post-accident fire consumed a large part of the aircraft structure.

15. Post mortem findings in respect of the deceased found no evidence to suggest that any of them were alive when the helicopter was ablaze, death in respect of

all occurring at impact. All four sustained severe multiple injuries in the impact which were immediately fatal.

16. The helicopter impacted initially with the upper branches of 2 large trees growing on the south bank: the left side of the rotor disc impacted with the trunk of a fir approximately 30 feet from its top, whilst the fuselage and the rest of the rotor disc struck an oak tree. The damage thus sustained to the rotor head resulted in the release of the main rotor blade, which was seen to fly above the height of the trees and land in an adjacent field, approximately 150 metres beyond the initial impact point. The main gearbox was torn from its mountings on impact and fell to the ground nearby. The tail boom separated into two major sections on impact, and the cabin section together with the engine struck the rising valley side, coming to rest approximately 45 metres from the initial impact point. Most of the cabin structure, furnishings and instruments were destroyed in the fire which broke out in the cabin section. The aft section of the tail boom, including the tail rotor assembly and horizontal stabiliser, remained lodged in the upper branches of a tree immediately down track from the fir tree initially struck.

17. Damage to the trunk of the fir tree which took the initial impact and to one of the main rotor blades is consistent with contact between the two. Examination of the orientation of a broad horizontal scar on this tree, together with the general disposition of the wreckage, suggests that the helicopter struck the tree in an upright attitude with no significant bank angle. The pitch angle was estimated to be nominally level or slightly above the horizontal. The main

impact area was at a similar elevation to that of the initial tree strike, at or about 550 feet above sea level, indicating an almost level trajectory. The high degree of airframe break up suggests a relatively high impact speed.

18. The high speed of the aircraft as it entered the valley, the high energy nature of the impact together with the nature of the manoeuvres carried out by Mr McRae in the approach to and descent into the valley indicate that he was not making an approach to land at Jerviswood at the time of the accident. In any event, such an approach to the helipad was not open to him as all necessary points of reference would be obscured by the topography. All indications point to an intention to descend into the valley before executing a steep right turn, possibly with a planned zoom climb out of the valley

19. All wreckage recovered in the course of a comprehensive and detailed police operation was sent to the Air Accident Investigation Branch (“AAIB”) facility at Farnborough where it was subjected to painstaking inspection and technical examination, assisted where necessary by representatives from the engine and airframe manufacturers and from the French Air Accident Investigation Authority.

20. All the extremities of the helicopter were accounted for and there was no evidence of any pre-impact failure or detachment. All failures in the structure, the rotor head and the main rotor blade attachments were consistent with violent impacts with the trees and ground.

21. The engine had been extensively damaged in the accident. Detailed testing revealed that the engine was delivering power at the time of the impact and there was no evidence of an engine malfunction. The hydraulic system had also sustained significant impact damage but examination and testing of its component parts effectively ruled out hydraulic failure. Many of the flying controls components had been severely affected by the post-impact fire which made verification that the entire system was intact and operative at the time of impact difficult. Further testing discounted concerns that a server rod eye end may have become disconnected prior to the accident and it was concluded that there had been no failure of the internal components. These tests did reveal that some of the flying control servos operated in a less than satisfactory manner but on further investigation it was concluded that this was consistent with damage sustained in the impact, together with the likelihood of contamination of the valve components with dirt from the accident site. The possibility of a pre-impact seizure of the valve in the forward cyclic actuator cannot be entirely discounted. However, such a failure is unknown in practice and is an extremely remote possibility. Were it to occur, the pilot would probably experience some prior stiffness in the controls and would therefore be alerted to a difficulty in advance of failure and be able to return to manual control.

22. The autopilot system had been damaged in the fire, allowing only partial examination of the system. Whilst the theoretical possibility of a fault developing in the final moments of flight cannot therefore be discounted, the system has only limited effect on the range of movement and force on the

flying controls, which could be easily overcome by the pilot even in the event of a major fault developing.

23. The thorough examination carried out under the auspices of the AAIB therefore failed to identify any unrectified defects affecting the helicopter. It did not discover any structural or system failure responsible for the accident. The helicopter was functioning appropriately as it entered the valley. Had it not been, Mr McRae would have had the opportunity to seek a safer option than a rapid descent into a heavily wooded valley and a pilot of his experience is likely to have taken it.

24. The video recording provides detailed information as to the manner in which Mr McRae piloted G-CBHL that day. He consistently flew the helicopter at unnecessarily low heights. He clearly breached the 500 feet minimum separation requirement on at least one occasion when he detoured to fly at 275 feet over farm buildings and may well have done so on others. He undertook significant manoeuvring at low level and the helicopter seems to have encountered significant g-loading as a result, to the evident enjoyment of his passengers.

25. The episodes of extremely low level flying and the excessive manoeuvre parameters, particularly the descent into the valley by Larkhall, all as captured on the video recording, are indicative of an aircraft being flown imprudently, without due regard to the principles of good airmanship, and in such a way that normal safety margins would be reduced.

26. The video recording ends an estimated 3500 mm from the accident site, approximately 55 seconds flying time and prior to its entry into the Mouse Valley. At that time Mr McRae appears to be relaxed and in control of the aircraft which seems to be operating satisfactorily. The manner in which he handles the aircraft suggests he continues to have no concerns about its serviceability.

27. There was no evidence of passenger interference with the aircraft controls. The helicopter was fitted with dual controls which could be simply removed by maintenance crew or by the pilot himself. They were *in situ* at the time. There was no evidence of loose objects interfering with the controls. The video recorder was the only substantial loose object recovered at the site and it bore no signs of damage from such interference.

28. The trajectory of the helicopter as it entered the Mouse Valley would not have brought the helicopter to the impact site. As the valley changes course eastwards it is likely that the helicopter would follow the line of the river, undertaking a 90 degree right turn as it did so. The high speed of the helicopter as it entered the valley necessitated a rapid rate of descent into the valley. Executing such a right turn in ideal conditions would require a steady loading of 2 g. Conditions on that day were not ideal and the manoeuvring required to execute such a turn would have placed considerable demands upon pilot and machine. Accurate judging of the point of turn would be hampered by high speed, strong tailwind, lack of a horizon and the nature of the valley.

Misjudgement or delay would have brought the helicopter within dangerously close proximity to the terrain. Any transitory handling difficulty with the helicopter would have had the same effect. Recovery would involve manoeuvring the helicopter at maximum performance and in turn increase the risk of deviation from the intended flight path.

29. The helicopter struck the trees on the south slope of the Mouse Valley as a result of a significant deviation from its flight path. What caused that deviation cannot be positively determined. The possibility of a sudden onset technical malfunction cannot be entirely ruled out albeit scrupulous investigation renders such a fault unlikely. Accidental interference with the flying controls cannot be entirely ruled out but in the circumstances would seem to be unlikely. There was no evidence of bird strikes but such an event cannot be entirely ruled out. Pilot disorientation or misjudgement as a result of low flying at speed in difficult terrain cannot be discounted. The servo transparency phenomenon if encountered at these low levels, could have delayed pilot response and efforts to avoid collision. Servo transparency leading to or contributing to deviation cannot be ruled out in circumstances such as these when a pilot is undertaking unexpectedly high performance manoeuvres. All of these possibilities could have been avoided or mitigated had the decision to fly G-CBHL into Mouse Valley not been taken. Each, whether encountered singly or together, were capable of safe resolution had the pilot been flying in an environment which increased the margin for error and offered the opportunity of safe landing or manoeuvre.

30. The deaths and the accident resulting in the deaths might have been avoided had Mr McRae not flown his helicopter into the Mouse Valley. Such a precaution would have been entirely reasonable. There was no necessity to enter the Mouse Valley. There were no operational or logistical reasons to enter the Mouse Valley. Mr McRae chose to fly the helicopter into the valley. For a private pilot such as Mr McRae, lacking the necessary training, experience or requirement to do so, embarking upon such demanding, low level flying in such difficult terrain, was imprudent, unreasonable and contrary to the principles of good airmanship.

31. In order to pilot an aircraft in the UK it is necessary to hold a pilot's licence, a valid relevant medical certificate, to have had the pilot's licence validated with the type of aircraft to be flown and to hold a Licence Proficiency Check ("LPC") in respect of the type of aircraft to be flown. On the date of the accident Mr McRae possessed the necessary medical certificate.

32. On the date of the accident Mr McRae did not hold a valid flying licence or a valid AS350B2 type rating. He was accordingly in breach of Article 26 of the Air Navigation Order 2005 when he flew his helicopter on 15 September 2007 and should not have flown that machine at that time.

33. His private pilot's licence was first issued on 15 February 2000 and expired on 14 February 2005. It bore a five year validity period on its title page. Mr McRae qualified to fly type AS350BS helicopters on 17 November 2003. Type rating is valid for one year and is a test of competency to fly that

particular type of aircraft. In order to revalidate type rating a pilot is required to pass a Licence Proficiency Check in the same helicopter type. Mr McRae had last completed a “LPC” on 21 March 2006 which expired on 21 March 2007. No application had been made by or on behalf of Mr McRae to renew it. Mr McRae had previously allowed his type rating to expire on two occasions and continued to fly the helicopter during periods of invalidity.

NOTE

34. It is clear from the evidence of all who taught Mr McCrae to fly, who tested him on his ability and who flew with him, that he was a technically competent pilot. Many spoke highly of his abilities and of their confidence in flying with him and no witness within this category offered criticism of his skills.
35. Weather conditions that afternoon were generally good for flying, albeit a moderate south, south west wind was described with moderate turbulence being experienced in the valley area.
36. There were no eye-witnesses to the accident and no flight recorder on board. Air Accident investigators therefore required to undertake extensive and comprehensive investigations in order to piece together the aircraft's final moments by building up a picture of all known or deducible facts and by eliminating where possible all factors which could have brought about such a sudden catastrophic event. They were assisted in this by eye witness accounts of the final flight, by radar data of the flight collected by the Lowther Hill

radar and by video evidence recorded in a handheld camera operated by Mr Duncan, which survived the crash.

Eye witnesses.

37. The Inquiry heard from a number of eye witnesses who viewed the helicopter flying overhead at different stages of its final journey. AAIB investigators spoke to all such witnesses at an early stage in their investigation. Whilst many gave useful information of location and height which was supportive of other evidence, such as the onboard video film and radar plotting, some raised concerns as to the noise coming from the engine, which was at odds with other evidence in the case.

38. Some evidence given during the Inquiry differed markedly from evidence the same witnesses had given in the immediate aftermath of the accident when, it may be thought, recollections would be at their freshest and most acute. Others were internally consistent but conflicted with other accounts of similarly located witnesses. Mr Fairbanks explained that in his experience of accident investigation adult witnesses try to make sense of what they see and in so doing may inadvertently alter or place undue stress on aspects of their sightings and thus simply get it wrong. To guard against this tendency he looks for evidence of what they have seen as opposed to what they think they have seen and asks them to reproduce what they have seen using a model. He also personally goes to the location of such sightings to get a feeling for their position at the time, the topography of the ground etc.

39. Importantly, no witness spoke to seeing any parts of the helicopter falling off, of flames coming from it, of uneven flight or any other visual indicators of machine breakdown or difficulty.
40. Mr Lowrie, who had a panoramic view of the helicopter in its approach to the valley, had seen it in flight often, albeit only once flying into the Mouse Valley. He described hearing no unusual noises coming from it as it made a slight turn to the right then a significant roll to the left prior to descending into the valley. He was supported in his account by Mr Henderson, an off-duty policeman, and, to an extent, by Mr Scrambler.
41. Mr Scrambler gave evidence in court that he was concerned at the helicopter's closeness to housing at the periphery of Lanark which, with hindsight, he suggested must have been indicative of the pilot struggling to get control so as to avoid collision with the houses. Examination of his account given directly to Mr Fairbanks within days of the accident showed, however, that at that time he had spoken of his anger that the helicopter was so close to houses and made no mention of any concern that it might be in trouble. This, suggested Mr Fairbanks, was indicative of the phenomenon he had spoken of whereby witnesses in good faith with the operation of hindsight try to deduce from what they have seen rather than simply recording what they did see. Experts were agreed that a four-second glimpse of a helicopter, occurring unexpectedly, was insufficient to allow the formation of any coherent or useful view of its condition or performance. Mr Scrambler does however agree with

other witnesses that the helicopter descended into the valley in a left banking manoeuvre. He describes a steady flight path without any significant changes.

42. Eye witnesses in Lanark thus confirmed the radar tracking of the helicopter as it turned left at a steep angle of bank into the Mouse Valley, where it went out of sight, rolling to the left when last seen.

43. Whilst some eye witnesses, such as Cathleen Anderson, describe hearing the helicopter make a different noise – “a labouring chugging”- Mr Fairbanks thought this was consistent with the blade slap which occurs when a helicopter is being manoeuvred, the “swoosh” heard 2 or 3 minutes later being the explosion on collision. Mr Connolly, the expert witness for the McRae family, agreed.

Radar Tracking

44. Radar data was available for most of the flight and from this the flight path could be plotted and an estimate of the speeds at which it was travelling obtained. The data tracks all but the final 20 seconds of the flight, when the aircraft’s position becomes obscured by the topography of the landscape.

45. The average ground speed of the aircraft in the early part of the flight is between 90 knots and 100 knots, increasing to between 120 knots and 130 knots as the flight continues. In the last 30 seconds of data, up until the point it goes off radar at Lockhart Mill, and just before it descends into the Mouse Valley, speed is increasing to 122 knots. As the helicopter turns down wind into the valley, its ground speed increases due to the effects of tailwind. Flight

trials based on the helicopter's radar profile, witness accounts and expert experience of trying to reproduce the flight pattern, suggest a figure of approximately 150 knots: that is, an airspeed of 120 -135 knots overlaid with wind speed of 15 -20 knots.

Video

46. The outbound and return flights were captured in part on film. Mr Graeme Duncan used his Sony RDC-DVD106E Handycam recorder to record portions of each flight. In total approximately 5 minutes of recording showed scenes from the two flights undertaken that day.

47. From the video it is clear that on the return flight to Jerviswood Mr Duncan was in the passenger seat with Ben Porcelli occupying the right hand outboard or window seat and Johnny McRae occupying the right inboard seat. All were appropriately restrained by the fitted safety belts and wearing headsets.

48. The video footage ends 55 seconds before impact. A soundtrack accompanies the video footage. Whilst much of the conversation carried on at normal conversational level is drowned out by normal engine noise, occasional snippets of raised voice remarks and exclamations from the passengers can be heard. The video footage also provided accident investigators with useful access to the majority of control panel instruments, from which the lack of any concerning or abnormal readings could be confirmed. The helicopter is seen to suffer no apparent technical defect, flight instruments are functioning

normally and Mr McRae appeared at all times to be relaxed and in control of the helicopter.

49. The outbound flight was conducted at low heights, never in excess of 500 feet and probably considerably below this altitude for much of the time. The video also revealed significant low-level manoeuvring. At one point Mr McRae deviates slightly from his route to pass over a farm building, descending to an altitude of approximately 205 feet to do so. This is in conflict with the universally recognised good practice of maintaining a minimum separation of 500 feet between aircraft and any structure, person or vessel and constitutes a contravention of Rule 5 of the United Kingdom Rules of the Air Regulations 1996. There appears to be no operational reason for doing so.

50. The video reveals what was described as a “spirited approach” to land at Little Sunnyside Farm involving the undertaking of a number of simultaneous manoeuvres. All experts described this as showing a level of competence on the part of Mr McRae. Mr Fairbanks made specific reference to the soundtrack at this point, where Mr Duncan was heard to say,

“Ah yes -feel the G force!”

51. The return flight commences with a zoom climb, whereby the forward motion of the aircraft is converted to height, the helicopter rolling left as it climbs to about 40 degrees of bank. Whilst this is competently carried out, Mr Fairbanks explained the increased risks attached to such a manoeuvre when compared to a more normal, gradual transition to height. He also described the method used by Mr McRae as not following the recognised method taught

to pilots. Passengers are heard to respond to this manoeuvre with laughter and shouts.

52. In the next segment of film, the helicopter is seen to fly at considerable forward speed and at extremely low height along the Avon valley, coming within 30 - 40 feet of trees at the valley edge. The helicopter pitches forward into the valley along the line of the river and descends below the level of the surrounding terrain, coming into close proximity of a number of tall trees growing on the valley sides. Minimum separation is thought to be less than 100 feet and probably much less, of the order of between 20 – 30 feet. It then climbs quite steeply out of the valley, coming close to houses at the top of the valley. Throughout this sequence, Mr Duncan and the children are heard to shout with enjoyment.

53. Mr Fairbank commented that when he flew the same route with a CAA examiner on board both agreed that they would not have come close to repeating these manoeuvres on safety grounds. He explained that apart from the proximity of the houses, the danger of flying into a wooded valley is that you get trees of different heights, increasing the work load on the pilot who requires to be super-sensitive to what lies ahead. As he explained,

“You don’t have the luxury of time and space because of the hazards all around you.”

54. As the helicopter flies at a separation of approximately 400 feet from a major roundabout, Mr Fairbanks comments that the pilot has no margin for error if

anything goes wrong, that one normally flies a single engine aircraft in such a manner that it can be landed if a problem arises but that here it would not even be possible to do a zoom climb to get out of it because of housing nearby.

55. The next segment of film shows the aircraft coming out of a steep right hand turn just north of Crossford. Mr Fairbank commented that there seemed to be no necessary reason for that turn in terms of the overall flight.

56. In the final segment of film the helicopter is following Auchenglen Burn in the Lee Castle valley. It again starts with the helicopter in a steep right bank which it rolls out of and the beginning of a left turn is seen. Again, Mr Fairbanks regards the right hand turn as an unnecessary manoeuvre towards rising ground and suggests it is for the benefit of the passengers. As the camera pans aft, Mr McRae appears to be in full control of the aircraft and to be handling the controls normally. His spirited handling of the aircraft is indicative of his confidence in its serviceability at that time. There is no air of concern apparent from the adults or the children. It is clear from the instruments that there continues to be adequate fuel on board, no warning lights are illuminated and the passengers all appear to be clear of the controls. The helicopter is flying at 110 knots at a height of approximately 440 feet, reducing as it rolls into the turns.

57. The video ends approximately 1.119 km from the landing site, 55 seconds from impact.

58. Mr Fairbanks considered as notable the spirited handling of the aircraft as seen in the 5 segments of the accident flight, accompanied in each case by laughter,

screams and shouts from the passengers. Mr Duncan is the source of much of this banter and seems to address his comments to the boys. Mr Fairbank reiterated in evidence, the terms of his note (Crown Production number 52) in which he observes that:

“... the operation at extremely low level and the excessive manoeuvre parameters, particularly the descent into the valley by Larkhall, is indicative of an aircraft being flown without due regard to the principles of good airmanship, and in such a way that normal safety margins would be reduced”

Mr Connolly, giving evidence on behalf of the McRae family, agreed that “it was imprudent to fly lower than necessary.”

59. No contradictory position was put and accordingly I have no difficulty in accepting their expert opinions.

LICENCE REQUIREMENTS

60. The licensing prerequisites for a private helicopter pilot are three-fold: A pilot must hold a current Private Pilot’s Licence certifying his qualification to fly helicopters; he must also pass annual Licence Proficiency Checks to renew his type rating on the type of helicopter flown by him; and he must hold a valid medical certificate. At the time of the accident Mr McRae’s licence had expired as had his AS350BS type rating. He did hold a current medical certificate.

61. Mr McRae was one of a group of pilots who gained their licences in a period of transition between different licensing regimes. Whereas pilots qualifying prior to 1 January 2000 held them for life, Mr McRae's licence was issued on 15 February 2000 and was therefore only valid for a 5-year period. Whilst his licence itself made it clear on at least five pages, all of which bore Mr McRae's signature, that it remained in force until/was to be reissued not later than 14 February 2005, there was at this time no external system of reminder to such licence-holders that their licences were about to run out.

62. In 2005 only 30% of those pilots whose licences required renewal, applied for renewal. Becoming aware of this, the Civil Aviation Authority (C.A.A.) in late 2006 began notifying those whose licences were approaching expiry of the need to renew. Mr McRae did not receive such a reminder as his licence had already expired by then. Whilst the need for renewal featured in specialist magazines Mr McRae did not receive any individually-targeted prompting to renew. Mr Sutherland, who prepared and examined Mr McRae for his pilot's licence, told the court that he had advised his client that he thought he would get a lifetime licence.

63. Revalidations tests, in the form of Licence Proficiency Check's (LPC's) require to be carried out annually in respect of the type of helicopter a pilot wishes to fly. This is an ongoing competency check involving a flying test and minimum flight hours in order to test the applicant's ability to handle the aircraft in normal flight and in emergency situations. Mr McRae's type rating had been due for renewal on 20 March 2007 and by 15 September 2007 he had failed to undertake the necessary LPC or to apply to renew it. The onus was

on him to do so. He had failed on three previous occasions to carry out LPC's in respect of G-CBHL within the one year period and evidence was led to show that despite the lapse of his type validation during these occasions, he had logged many flying hours and had flown alone on at least one occasion.

64. The law is clear in respect of the requirement. It is an offence punishable by imprisonment or unlimited fine to fly without a valid pilot licence, either because it has expired or because it does not have the relevant current type rating. It appears to be less clear in respect of its system of enforcement. Mr Gwilt gave evidence that he neither checked Mr McRae's pilot's licence prior to issuing a renewal of the LPC on either of the two examinations carried out by him, nor brought the lapses to McRae's attention and was not, at that time, bound to do so, although is now. Mr Fairbanks expressed his concern that at the time of the accident Mr McRae was flying despite not having demonstrated his fitness and competency to fly that aircraft in the prescribed period. This failure impacts upon insurance as well as competence.

65. As a result of the AAIB investigation into this accident, and their issuing of a Safety Recommendation (2008-070) the CAA now require all authorised examiners to check the licence and other applicable documentation of candidates for proficiency checks and skills test.

66. At the time of the accident Mr McRae did hold a current medical certificate. However, on two previous periods totalling 110 days he continued to fly despite not holding a valid medical certificate. Whilst there is no suggestion that he was in fact unfit medically to fly during these periods, he was in breach

of regulations at these times. As indicated above, he had previously failed to renew his type rating on another two occasions but continued to fly during these periods also. Again, there was no evidence to suggest that he would not have satisfactorily renewed his type rating had he applied to do so. The Crown did not suggest any causal connection between Mr McRae's failure to meet timeously the licensing requirements and the accident. The evidence would not support such a proposition. Mr McRae had considerable flying experience. He had logged 965 hours, 490 of which were on the Eurocopter AS350B2 Squirrel helicopter. His flying experience was current, having flown an estimated 50 hours in the three months prior to the accident. He was a competent and confident pilot and would have experienced no difficulty in renewing the required licences. There was nothing in the tests he would have had to pass which is likely to have better prepared him for the last flight. However, his tolerance of such lapses in licensing, some of which he must have become aware of and therefore should have been on guard against on future occasions, indicates a somewhat cavalier attitude to the safety regime imposed by the Civil Aviation Authority. Doubtless he put faith in his own ability, as did others, however the legislation requires an objective, external check of continuing knowledge and skill and to fail to engage with that assessment may be seen as reckless.

AIR ACCIDENT INVESTIGATION BRANCH ("AAIB") INVESTIGATIONS.

67. Mr Andrew Robinson, Senior Inspector of Air Accidents responsible for the engineering aspects of the AAIB investigation, attended the accident site on

Sunday 16 September 2007 and viewed the wreckage. He noted the extent of the physical damage to the air frame, and to surrounding trees. He concluded that these signs pointed to a high energy impact, with disintegration of the aircraft occurring after impact with two tall trees. The aircraft was travelling fast at impact. The main strike on the fir tree occurred at the same height above sea level as the main wreckage was found suggesting it was travelling at speed. Scrutiny of the point of impact on a fir tree, the shape of the mark and distribution of branches suggested that the aircraft struck it in an upright attitude with no significant bank angle. The pitch angle was estimated to be nominally level but the detachment of the tail boom suggests that the nose may have been pitched above the horizontal. The aircraft, at point of impact, was flying virtually at right angles to the valley and not on a diagonal trajectory. Such a trajectory did not make sense since it brought the aircraft into contact with the hillside. All major parts of the aircraft were accounted for at the crash site, indicating that there had been no structural failure and it had been intact on impact

68. It was immediately apparent to AAIB investigators that the helicopter was not making an approach to land at the landing pad at Jerviswood at the time of the accident, albeit the point of impact was only about 150 metres from the helipad. Whenever possible, helicopters land into the wind and the direction of travel was downwind and with any view of the landing site being impeded by trees. The impact speed was faster than that for an approach for landing.

69. AAIB investigators carried out an admirably thorough investigation into all aspects of the incident, including a detailed examination of the wreckage, an

analysis of the flight, ingathering and examining meteorological information, recorded data in the form of radar data and video recording and attempting to reproduce its final flight path and establish its flight parameters. Where initial investigation revealed any ambiguity, further detailed exploration, sometimes involving the expertise of others, was undertaken until a definitive position could be safely adopted. This scrupulous approach allowed them to dispose confidently of the vast majority of potential causes. It is a mark of the meticulous nature of their inquiry that where they are unable to dismiss utterly a potential cause, however remote, they rehearse clearly how it could impact upon events whilst also attempting to set in context the improbability of it in fact featuring.

70. Recovery of the wreckage by police and emergency services was painstaking and thorough. It was carefully logged and taken to the AAIB facility at Farnborough where a detailed inspection was carried out, assisted by the airframe and engine manufactures and by experts from the French air accident investigation authority.

71. Examination of the structure confirmed there was no evidence of a pre-impact failure, all damage being referable to impact.

Engine

72. The engine had been extensively damaged in the impact, resulting in distortion of the engine casing and the seizing of the rotating components as a result. Disassembly of the free turbine module revealed that the drive nut had slipped

rotationally relative to the turbine shaft and the direction of slippage indicated that the shaft was being driven and that therefore the engine was delivering power at the time of the impact, sufficient to maintain flight. There was no contamination of the magnetic plugs and no sign of clogging in the oil filter. Examination of the engine revealed no reason for the crash.

Hydraulic system

73. The hydraulic system had sustained damage on impact but examination of its component parts revealed that the pump mechanism remained functional, there was no sign of in-service deterioration of the drive belt which had snapped cleanly on impact, the hydraulic reservoir although holed on impact, still contained 50% of its contents suggesting there had been no pre-impact leaks and whilst the pressure regulator could not be subjected to a full production test due to damage on impact, its regulatory function was operating correctly without contamination or interference. Accordingly it was extremely unlikely that there had been any form of hydraulic failure.

74. In the event of a hydraulic system failure, the aircraft retains 30 seconds of hydraulic power as a safety feature. Such a failure would result in the tripping of a cockpit red warning light, notifying the pilot that he has 30 seconds to reduce speed, return the aircraft to manual control and get the aircraft to safety. This is sufficient for the pilot to fly the aircraft to a safer environment. Pilots receive mandatory training in respect of approaches and landings in the event of such a failure within the AS350B2 type rating.

Flying controls

75. Examination of the flying controls threw up some challenges to investigators.

As any disconnection or failure of the flying control components could have caused the pilot to lose control of the aircraft it was important to establish that they were in fact connected pre-impact. Fire damage to many of the components resulted in difficulty in identifying the specific airframe location of some of them. Careful forensic examination of the remaining components confirmed that the servo operating rods were intact at the time of the accident.

76. Apparent lack of damage to the lower eye end of one of the servo operating rods which remained attached to the servo input linkage on the gearbox, combined with uncertainty as to whether the original aluminium rivets connecting them had melted or failed or been replaced with bolts resulted in extensive investigation to try to ascertain whether a bolt or a rivet had been present at the time of the impact and thus whether the component was under load at the time. Tensile tests, in conjunction with examination of brinelling marks on the forward servo input rod lower eye end conclusively proved that the rod end and bellcrank components had been attached with an aluminium rivet, which failed on impact, preserving the intact servo operating rod from the tensile loads which led to failures in the remaining two rods. Investigators concluded therefore that this area of the flying control linkage was intact at the time of the accident.

Flying control servos

77. The four flying control servos were subject to intensive testing by their manufacturers under AAIB supervision. Initial problems were identified in the three damaged cyclic servos, but these responded to removal from their damaged location and being cleaned of accident site contamination, giving rise to the conclusion that there had been no failure in the internal components of these servos. The critical components would have been protected in service by dust covers which had been ripped off in the crash, permitting contamination at that point, together with distortion as a result of the impact.

78. Examination of the forward cyclic servo, which controlled the tail rotor, initially resulted in no actuator movement being detected. Stripping of the valve body proved difficult as it was found to be almost seized. Since any distortion caused by the gumming-up of the moving parts of the servo by swarf or other contaminants could prevent a pilot being able to control the direction of flight, it was important to investigate carefully the nature of the seizure noted in that component. Stripping of the spool valve revealed no internal debris but a slight discolouration in the fluid wiped from the spool stem. Cleaning of this resulted in satisfactory operation on retesting. Whilst it was concluded that the initial unsatisfactory operation was consistent with accident damage and accident-site contamination, its existence means that it was not possible to entirely rule out a pre-impact seizure of the valve in the forward cyclic servo. Despite the existence of this theoretical possibility, the operational history of this aircraft made this very unlikely to have in fact

occurred, no such seizure having come to the attention of manufacturers or the authorities in many millions of servo operating hours.

79. The flight manual contains procedural advice to be followed in the event of a main servo actuator valve seizure, whereby a return to manual control is recommended. Any such seizure would be preceded by stiffness resulting in resistance in the cyclic controls.

Autopilot system

80. An autopilot system had been fitted of which only the pitch and roll actuators were recovered and examined. It was established that they were in the mid point position, which is where they would be expected to be. Investigators encountered an initial problem getting the roll trim actuator to function but concluded it was most likely to be a consequence of accident damage. Other parts of the system were not recovered and therefore it is not possible to confirm that the entire system was functional.

81. However, even were a major fault to have developed in the autopilot system, the pilot could have easily regained control by moving the cyclic stick and breaking the weak links in the trim actuators. The weak links had indeed failed but it is probable that this was associated with impact.

82. Video evidence showed that the auto pilot yaw channel was disengaged. The yaw channel is an optional extra and it was not clear whether this disengagement was as a result of a fault or simply because Mr McRae had

chosen not to engage it. There was no suggestion that this disengagement played any part in the accident.

SERVO TRANSPARENCY PHENOMENON

83. Some time was spent by investigators and by witnesses exploring the “flight control servo transparency phenomenon”, also known as “jack stall”.

84. A helicopter operating within normal flight conditions is protected from the aerodynamic forces which act upon the main rotor blades by means of servo actuators within the hydraulic system. If a helicopter is manoeuvred in such a way that its airspeed and/or g –loading becomes excessive, aerodynamic forces on the rotor blades become greater than the hydraulic forces used to control them and can be fed back to the flying controls which then feel heavy to operate. A pilot who is not expecting to encounter this phenomenon, may have the impression that his controls have jammed.

85. If appropriate action is not taken to combat this, then the helicopter will roll to the right and may pitch up. If a helicopter is already in a right turn when servo transparency occurs, then the resultant further roll to the right and pitch-up will cause an increased rate of turn. To overcome and counter this phenomenon the pilot will require to use increased force on his controls. At no time does an aircraft thus affected become inoperable or the pilot lose control. It does however become more difficult to fly accurately as it is more difficult to move the controls. It may also cause a pilot who does not

recognise the phenomenon to panic that the aircraft is malfunctioning and the controls have jammed and thus fail to respond appropriately. If it occurs during a right turn, such a pilot may delay in recognising the increased angle of bank. A helicopter experiencing this phenomenon will respond automatically to correct by reducing collective pitch. A pilot seeking additional power at this point may be denied it.

86. This is a rarely encountered phenomenon with very few documented examples of it in the literature but is sufficiently recognised to feature in Eurocopter's published advice to AS350 series helicopter owners together with advice as to how to respond should it occur. It is a feature of this phenomenon that it only lasts less than 2 seconds before the aircraft reacts in response to reduce the factors contributing to it by slowing down and reducing control loads. It is therefore self-correcting. Pilots are told to immediately reduce the severity of the manoeuvre which caused it in the first place.

87. Helicopters which are flown within the normal flight envelope will not encounter this phenomenon. Those flown at or beyond it may. By definition therefore, the phenomenon can only be present when a pilot is performing manoeuvres which reach and exceed several aircraft limitations simultaneously.

88. The Eurocopter Service Letter SL 1648-29-03 indicates that,

“Basic airmanship should prevent encountering this phenomenon by avoiding combinations of high speed, high

gross weight, high density altitude and aggressive manoeuvres which exceed the aircraft's approved flight envelope.”

It also advises that the pilot should immediately reduce the severity of the manoeuvre on becoming aware of control forces feedback. This advice was first published in a service letter published in December 2003 and subsequently in a revision to the flight manual which was sent out to pilots and maintenance contractors in October 2004. The revision does not appear to have been inserted in this helicopter's flight manual and the service letter appears to have been sent only to the helicopter's maintenance engineers and not to Mr McRae. No attempt was made by PDG Helicopters, the helicopter's maintenance engineers, to forward it to Mr McRae or to update the manual during maintenance of G-CBHL. Whilst this information was available on the Eurocopter web site, there is no evidence that Mr McRae had accessed it or was aware of the contents of it.

89. Mr McRae should have been aware of the advice contained within his helicopter manual as part of his responsibility as a pilot, but that advice was out of date. The responsibility for keeping the flight manual current rested with Mr McRae as owner and pilot of the aircraft, albeit there is no evidence that he was aware that updates were available. The advice noted in the manual recovered at the accident site in respect of manoeuvring limitations contained a prohibition on exceeding “the load factor corresponding to the servo-control reversibility limit” and described servo-control transparency as being a smooth phenomenon which “presents no danger”. It warns,

“In maximum power configurations, it is advisable to decrease collective pitch slightly before initiating a turn, as in this manoeuvre power requirement is increased”

90. Whilst this original advice remains generally correct, the revisions to this entry give much greater information about how to avoid encountering the phenomenon and its effect once encountered, together with detailed advice on how to counter it:

“IMMEDIATELY reduce the severity of the maneuver (sic)...; follow the aircraft natural reaction to pitch up and induce a down collective movement; reduce overall load on the rotor system and smoothly counteract the right cyclic tendency to prevent an abrupt left cyclic movement as hydraulic assistance is restored. Transparency will disappear as soon as excessive loads are relieved.”

It also clarifies that the phenomenon is not dangerous, “if properly anticipated by a pilot during an abrupt or excessive high load maneuver such as a high positive g-turn or pull-up”.

91. The recommendations made in the AAIB report number 34 of process that:

“..the Civil Aviation Authority should circulate, by the most appropriate means, the content of Eurocopter’s Service Letter SL-1648-29-03 to owners and operators of applicable helicopter models, with a view to reminding them of the causes, symptoms, hazards and recovery actions relating to “servo transparency” or “jack stall encounters” (Safety Recommendation 2008-068); and

“... that the Civil Aviation Authority, in conjunction with the European Aviation Safety Agency, require an awareness of the causes, symptoms, hazards and recovery actions relating to “servo transparency” or “jack stall” encounters to be covered as a ground study item as part of the mandatory training for aircraft type ratings for those helicopter types likely to be affected” (Safety Recommendation 2008 – 069).

have been accepted and implemented by the C.A.A..

FLIGHT PATH ANALYSIS

99. In an attempt to more fully understand what happened once the helicopter was out of radar and eyewitness sight, an attempt was made by the AAIB to piece together its likely flight plan.

92. Witnesses describe an initial right turn quickly followed by a steeply banked, descending manoeuvre into the valley. Albeit that left roll to a high bank angle attracted the notice of witnesses, the helicopter could not have actually turned very dramatically or it would have flown out of the valley to the north. It maintained this left bank as it descended into the valley and disappeared out of sight. This track would not have led to the impact site. To arrive there, the helicopter would have had to undergo a right turn through 90 degrees, probably following the line of the river as it followed the valley eastward.

93. Flight trials were undertaken under the auspices of the AAIB in an attempt to establish the maximum speed and rate of descent of G-CBHL as it entered the valley. To increase accuracy of results, parameters were applied to each flight

profile, based on known information as to helicopter mass, the limitations of the terrain, the position of the accident site and radar and witness information. Three different pilots were involved in flying these profiles, a Eurocopter test pilot, the C.A.A chief examiner and Mr Fairbanks and they obtained a consistent, repeatable result of an airspeed of 135 knots, with a rate of descent of 1500 ft/min to 2000 ft/min from a starting height of approximately 300 feet. Mr Fairbanks expressed his confidence that these figures were accurate. No direct challenge to these figures was taken in evidence, despite this estimate of airspeed featuring in Crown Production 34 (page 99).

94. In submission Mr McBryde for the first time, seeks to rely upon the last recorded airspeed of 100 knots based on the radar data as being reflective of speed in the final seconds and appears to cast doubt upon the AAIB figures of 135 knots. He did not deal in submission with Mr Fairbank's evidence that the recorded groundspeed of 122 knots in the last 30 seconds of radar data occurred at a point prior to entry to the valley, when the aircraft was flying across the valley and had not yet encountered the full force of the tail wind. A 15 -20 knot tailwind would accordingly have to be added to this as it flies up the valley. At that time airspeed was increasing. I prefer Mr Fairbanks assessment of speed.

95. A 90 degree right turn at a 60 degree bank angle, at an airspeed of 130 knots is calculated to require a steady loading of 2g in calm air and in level flight. Conditions were not ideal in the valley, with gusty winds of between 15 – 20 knots with some turbulence and such a turn would not have been sufficient to

keep the helicopter within the narrowest part of the valley, suggesting a tighter turn would have been attempted.

96. The main rotor disc hit the fir tree approximately 30 feet from its top, suggesting that Mr McRae had not simply misjudged the height of the tree line but had rather collided with it in the course of another manoeuvre. Had the aircraft continued on a trajectory consistent with the impact track, it would have headed towards rising wooded ground, suggesting that the aircraft was not on its intended path at the time of impact. The fact that it hit the tree in an upright, nose up attitude is suggestive of an attempt by Mr McRae to arrest a rate of descent into rising terrain.

97. Mr Fairbanks was of the view that the flight path analysis carried out by him is key to understanding the accident.

“In attempting to fly in the valley at relatively low height and high speed, the pilot was undertaking a demanding manoeuvre. With the aircraft initially banked steeply in the opposite direction of the intended turn, descending at relatively high speed and rate of descent and with a strong tailwind, accurate judgement of the required turn point would have been very difficult. The risk was that the pilot would start to turn late, come into unexpectedly close proximity of the terrain immediately ahead, and need to fly a harsh manoeuvre to avoid it. Even had the turn started in the correct place, it would have been difficult to judge, given the helicopter’s speed, the nature of the valley, the lack of a good horizon reference, and the effect of the wind” (page 99)

98. So, it seems likely that Mr McRae found himself having to manoeuvre at speed, without height and all within a challenging environment. In doing so he would be pushing his aircraft towards maximum performance.

99. The conditions precedent for the occurrence of servo transparency include excessive speed and/or g-loading. The transparency may be reached, according to Rush Revision 3A to the AS350B2 Flight Manual, “during manoeuvres such as steep turn, hard pull-up or when manoeuvring near V 6” (the never exceed speed of 155 knots).

100. If, as I accept, Mr Fairbanks analysis of the final flight path is correct, then G-CBHL was indeed operating at or towards the limit of its flight envelope and servo transparency becomes a possibility, albeit not a probability. We simply do not know whether Mr McRae increased the g-loading beyond 2, albeit he may inadvertently have done so in circumstances where he could have encountered turbulence, required to respond to circumstances and increase power or intensify a manoeuvre. If he encountered it we know that he was aware of the phenomenon, having studied it, at least as set out in his manual in its pre-2003 form, and should have been in a position to recognise it and even take steps to assist his aircraft to overcome it. However, in such extreme conditions, even momentary hesitation or recovery time could have proved fatal.

101. As indicated, this phenomenon is short lasting and self correcting, but could be extremely disconcerting for any pilot unexpectedly encountering it

and, if it occurs in a situation where reaction time and manoeuvring space is already limited, catastrophic. Flying within the Mouse Valley, at low level, at high speed, executing tight manoeuvres could constitute such a situation.

102. Investigators wanted to explore the necessary preconditions for the phenomenon arising in the present case. Using known data such as altitude of the crash site, temperature, weight of the helicopter and estimated data such as speed Eurocopter were able to produce a graph (reproduced at Figure 9 on page 92 of Crown Production 34) demonstrating predicted conditions for the onset of servo transparency in this machine. It shows that the faster the airspeed, the less g loading required to encounter it and at 130 knots, the onset of servo transparency is predicted to occur at a load factor of 2.1g. G-CBHL would, on the basis of the estimates of speed, rate of descent, angle of bank and the known components of gross weight etc, be nearing such load factors as it carried out the corrective right hand turn. Figure 10 of Crown Production 34 indicates the path such a turn would follow given the prevailing wind speeds. That path would have to be further corrected to keep the helicopter within the narrowest part of the valley. The more dramatic the manoeuvring, the closer to maximum performance the helicopter would be and the less needed to exceed it. Any sudden dramatic attempt to correct a slight misjudgement on a turn, or pull up to avoid oncoming terrain would make servo transparency more likely.

103. Attempts to induce servo transparency in flight trials carried out by Mr Connolly were unsuccessful, supporting other evidence that this aircraft has

not so far proved particularly susceptible to the phenomenon., albeit Mr Connolly was restricted in his attempts to push beyond the flight envelope because he was not engaged in an authorised flight trial, limited his speed to below that estimated in this case, and was reluctant to be more aggressive.

104. Mr Fairbanks believes that if servo transparency occurred in this case, it did not persist for long. The reason for this conclusion is that the aircraft was notionally upright, perhaps with its nose up at the time of impact, suggesting that the pilot was flying the aircraft, and trying to fly out of the position he found himself in, when he hit the tree, not rolling to the right as a result of the phenomenon. Servo transparency is, however, a possible explanation for the strange deviation from the flight path taken in the final seconds when the helicopter flew at right angles to the valley.

105. Other explanations for this deviation can also be suggested, but not factually established. As Mr Fairbanks commented,

- a. “We felt it looked that he was trying to get himself out of danger. Because the helicopter had turned more degrees than we would have expected, we felt something unusual had happened. But, because of the upright nature of the helicopter we feel he was trying to recover it.”

Dual Controls

106. Dual controls were fitted to the helicopter with the result that duplicate controls were located at both the pilot and front passenger positions. These

were active and working on this flight. The passenger side controls can be removed. The general advice from the Civil Aviation Authority is that it is advisable to remove such controls if the passenger is not a qualified pilot. There is no requirement to this effect but it is good practice to do so.

107. According to Mr Hugh Sutherland, whose firm was responsible for the maintenance of G-CBHL, the passenger side controls were simple to disconnect by pulling out a spring loaded pin and removing them. The pilot can do this himself, albeit 90% of his customers have the dual controls in their aircraft fitted at all times. Mr McRae's were in most of the time.

108. In his submissions on behalf of the McRae Family, Mr McBryde takes issue with this. He founds upon Mr Connolly's evidence that the signature of a second licensed pilot or engineer would be required to verify the controls being removed or refitted. He also quotes Mr Alastair Sutherland's evidence that he was familiar with Mr McRae's helicopter and he would not attempt to remove the dual controls. Not much may hang on this discrepancy, albeit I would prefer Hugh Sutherland's evidence as the man responsible for the maintenance of the helicopter since its purchase by Mr McRae in 2003. It is backed up by Mr Fairbanks account of receiving training in removing and refitting them using the screw type fixings, when he trained on that model. Mr Connolly agrees that removal is physically an easy operation to carry out, but maintains that Mr McRae would technically have been in breach of requirements had he done so without inspection.

109. Clearly had Mr McRae wished to have them removed the opportunity was there for him to do so, either personally or involving others, and having that certified if necessary. Had they not been in place, then any possibility of accidental interference with them would have disappeared.
110. The video shows that Mr Duncan's right foot is positioned forward, under the right pedal at the start of the outbound flight. There is no such evidence that it was in the same position during the return flight. There is no suggestion from the video footage that Mr Duncan interfered with the controls, even during bouts of "spirited" flying.
111. In an aircraft such as this, fitted with dual controls, if a passenger touches the collective lever unexpectedly, with sufficient force, the aircraft would deviate from its flight path. Any such accidental interference could be rapidly countered by the pilot but until he regained control, the aircraft would go into freefall.
112. Mr McBryde suggests as a possibility the sudden accidental lowering of the collective lever by Mr Duncan as he adjusted his position in his seat or sought to stow or recover the video camera. That, he suggested, would cause a reduction of power, a nose down pitch resulting in increased airspeed. It could also result in a yaw to the right. Whilst this is capable of correction, by the pilot using the left yaw pedal to correct the yaw, if Mr Duncan's foot was under the right yaw pedal his ability to do so would be impeded. Recovery from the induced high speed dive may then have been impeded by the onset of

servo transparency and further height would be thus lost with further disorientation occurring to the pilot.

113. To cause lowering of the collective lever the passenger would require to apply a lot of pressure to it – to lean on it. Whilst this cannot be entirely ruled out, there is no evidence that it in fact occurred. Mr Duncan is seen from the video to be properly strapped in, to be behaving appropriately and at no time in contact with the controls. As a former quad bike racing champion and mechanical engineer with experience working with an aeronautical company, he would have some familiarity with and respect for the helicopter controls and their vulnerability. Had he uncharacteristically come into contact with the controls with sufficient force to interfere with the pilot's control, Mr Sutherland indicated he would expect a pilot in such circumstances to make a very rapid recovery - in less than 2 seconds, albeit meantime if the aircraft was flying horizontally it would continue forward at speed but drop rapidly and roll a bit.

114. Investigation of the contents of the cockpit, using the video and the search of the accident site, reveals that there were no loose items in the cockpit prior to the crash which could have interfered with the controls, with the exception of the camcorder and a soft cover book. The camcorder when found was intact. There is no evidence that it was dropped or otherwise became loose. The soft book cover could not bring to bear sufficient force to interfere.

115. In submission, Mr McBryde suggests that Mr Duncan is likely to have recorded the aircraft landing at Jerviswood at the conclusion of the flight since he recorded the earlier landing at Larkhall and since he didn't it is possible

that an incident or event could have occurred within the aircraft resulting in Mr Duncan ceasing filming.

116. It is possible, but there is no evidence to support this. Those responsible for recovering the video footage were unable to assist the Inquiry as to whether the video recording ceased due to the battery running out or the space to record footage becoming full. The recording was not a continuous record of the two flights. Mr Duncan clearly chose to cease recording at times. He may well have chosen not to record a final segment. There is no evidence that his recording was in any way interrupted.

117. Mr McBryde thus enumerates a number of potential causes. None can be conclusively ruled out, but there was no evidence capable of establishing any of them. Having considered them, I remain firmly of the view that whatever occurred in the final seconds to prevent Mr McRae using his undoubted skills to avoid colliding with the trees, the accident would have been avoided had he not chosen to fly down into Mouse Valley.

118. Had he encountered handling difficulties, by reason of servo transparency or any other temporary cause, there is every likelihood that he could have overcome them had he not been attempting to do so in a heavily wooded, restricted environment. Had such difficulties occurred during a routine approach to land at Jerviswood, although it is difficult to see how servo-transparency would in such circumstances, he would have had the

opportunity and time to gain height and take stock, or to put the helicopter down quickly on the open fields nearby.

119. Had the dual flight controls been inadvertently operated, he would have had the time and opportunity to overcome any momentary deviation. Open airspace and the availability of landing opportunities would militate against pilot misjudgement, and give opportunity to correct any that might arise. Likewise distractions are limited and can be overcome. Bird strikes were not investigated in evidence, but it is safe to assume, given the meticulous police retrieval operation and forensic examination of the scene and helicopter that there was no such evidence to place before the Inquiry. They cannot be entirely discounted however, particularly in the heavily wooded valley area.

120. The AAIB report also makes the point that,

“For an aircraft at low height in the valley and turning steeply to the right, an accurate assessment of the true horizon would have been difficult, as attention would primarily be focussed on the valley itself. There were several isolated trees in the immediate vicinity of the impact site, of which the fir tree that G-CBHL struck was not the most obvious. It was considered possible that shadow on the south side of the valley at the time of the accident could have further hindered an accurate assessment of flight path and hence separation from the trees.”

Disorientation in such an environment is a very real risk.

121. If Mr McRae did indeed encounter some event which temporarily disrupted his flight plan, he, or the helicopter, almost managed to recover from it. The tree was hit 30 feet from its top branches. Had Mr McRae managed to gain a little more height they may well have survived the event. Equally, had there been no obstacle to encounter in the path of the helicopter any such event could have been overcome without incident.

122. Whilst, therefore, it is accurate to state, as Mr McBryde invites me to do, that the proximate cause of the accident cannot be positively determined, it is possible to determine that this tragedy would not have occurred had Mr McRae not flown his helicopter into Mouse Valley. Whether that proximate event resulted from the difficult manoeuvring involved in flying within that environment or from an unconnected event which occurred when the aircraft was within a difficult flying environment, the common and fatal feature is the unforgiving nature of the valley.

123. Mr McBryde submits that it is not known whether he deliberately flew into the valley or whether there was a problem or incident within the aircraft that caused or contributed to it flying into the valley.

124. The evidence does not support this. The decision to descend into the valley was a deliberate one. He was seen to do so in a controlled manner. Mr Fairbanks is clear that Mr McRae could not have carried out such a tight manoeuvre into the valley had he not been in control of the aircraft. Further, if he had no control at a later stage of the flight, then how could he perform a tight manoeuvre to the right and then adopt an upright attitude as suggested by

the evidence at the accident site? Had there been a control fault, Mr Fairbanks would have expected to see signs of it earlier that day. Had there been anything wrong with the handling of the aircraft, the pilot would simply not have flown into the valley. It would go against all instincts to do so, as well as all training. Had he suffered engine failure, one would expect to see an attempt to manoeuvre out of the valley. No such attempt is made and for all these reasons, Mr Fairbanks concluded that the flight into the valley was deliberate. He believes that Mr McRae's intention was to descend into the valley before executing a steep right turn, possibly with a planned zoom climb.

125. Since no witness viewed or recorded the final seconds of the flight what caused an apparently fully functioning machine, flown by a competent pilot to make contact with trees within that valley cannot be positively determined. Whatever occurred did so within those final seconds. Had it been otherwise, had a fault developed prior to entering the valley, Mr McRae would not have flown into it. That is the universal judgement of all expert witnesses and pilots. Had he become aware of any technical problem during his descent into the valley, he would have aborted that descent, tried to achieve height or set up a controlled descent to a safe area. The valley is surrounded by fields and open ground which would have provided an opportunity for landing had that been required.

126. Whatever happened was sudden, unexpected and took place in circumstances where Mr McRae did not have scope to recover.

127. Why then did Mr McRae decide to fly G-CBHL into Mouse Valley?

The suggestion from Mr McBryde is that he may have been flying a flight path to avoid overflying his own house and a noise sensitive neighbour, extending his flight path eastbound before turning into wind to make his approach to the helipad. He bases this on evidence from Robert Campbell Roy that the routes he would take leaving and returning to the helipad related in part to a neighbour's sensitivity to noise.

128. If so, why did he so rarely take this approach? His housekeeper, Mrs Katherine Anderson, reported that she had heard him go in front of the house before, but not a lot. Mr Lowry who farms nearby and who regularly saw him flying, spoke to only once before seeing him using this approach . Mr Iain Ross had never seen the helicopter coming in from that direction before. Mr Roy, a passenger in the helicopter as often as once or twice a week, had never flown up Mouse Valley and Mr McRae had never done it to his knowledge. His usual route returning to the helipad, he stated, would be coming from the north and swing round to the west into the helipad.

129. In any event, any concern about neighbours does not explain why he descended into the valley. He presumably could have made that approach without losing so much height. Mr Connolly took the view that it was a practical route, if we leave aside the question of height. However, it is the height which is the critical factor and it cannot be left aside. Stewart Kitchen, police helicopter pilot who attended that day, was clear that he would not have flown that aircraft into the valley as a civilian pilot because to do so would be

in contravention of the rules of flying and he would deem it unsafe. He had been trained to minimise flying time over inhospitable areas such as this for the very reason that landing is problematic in the event of an aircraft malfunction. Stewart Anderson, air ambulance pilot and former military helicopter pilot and instructor, was of the same opinion. He would only go into a valley if he had to pick up a casualty. He assessed the 500 feet clearance rule as operating from the top of the valley, not from the river running along its floor. Even Mr Connolly agrees that he was flying lower than was prudent.

130. Mr Fairbanks indicated that he found the video evidence of the two flights to be instructive in this regard. He referred to the segments which featured the helicopter flying low into the Avon valley, followed by a zoom climb out and 3 hard turns, all to the evident enjoyment of the passengers. Based on this prior pattern and on the high speed maintained by him as he entered the valley, he formed the opinion that Mr McCrae was seeking to conclude the journey to the enjoyment of his passengers, by descending into the valley, executing a steep right turn prior to a zoom climb out of the valley.

131. If it is accepted, and it is, that Mr McCrae flew voluntarily into the Mouse Valley, then no other explanation so neatly fits the established facts. He was not making an approach to land for the reasons stated above. He did not require to descend into the valley in order to approach the helipad from this direction, even had he decided that this direction of approach was appropriate. To do so required a series of manoeuvres and stresses which could easily have been avoided had he chosen a more direct or familiar route

to the helipad. In short, there was no operational or logistical reason for him to descend into this difficult environment at all, never mind at speed. It is difficult to avoid the conclusion that his intention was to conclude the flight as he had started it, with a spectacular and dramatic fly-past of the valley and its vegetation, followed by a steep climb out prior to coming into land, all for the benefit of his passengers.

PARENTAL CONSENT

132. Ben Porcelli was dropped off by his mother to play with school friend Johnny McRae at Jerviswood on that Saturday afternoon. It is clear from Mrs Porcelli's affidavit, and that of her husband, that their understanding was that the boys would spend the afternoon playing together at Jerviswood. Whilst they were aware that Mr McRae had a helicopter, there had never been any discussion involving Ben going in it. At no point did Mr McRae seek their permission to take Ben on that helicopter flight. The pain and anguish resulting from Mr McRae's decision to take the boys on board is unimaginable.

133. I am asked by the Crown to determine that it would have been a reasonable precaution, firstly, in relation to Ben, that the accident and subsequent death might have been avoided if parental consent had been sought by the pilot prior to the child being carried as a passenger in the aircraft and secondly, that the Civil Aviation Authority be invited to consider regulation of this matter.

134. As a matter of simple, awful, logic, if Ben had not been on board the helicopter that day he would not have died in the accident. I do not doubt that his parents' suffering is compounded by their lack of knowledge that he was on board and their lack of opportunity to give or refuse informed consent to his being a passenger. I do not know what their decision would have been had they been asked for their consent. Their affidavits do not tell me. Decisions to give or refuse children a much-wanted treat are not always easy for parents to grapple with. If asked, the Porcelli's may have had no difficulty in saying no. They might have agreed that their child should have this opportunity. Mr McRae was an experienced and competent pilot. What greater reassurance can anxious parents have that the pilot's own son is also on board? Many parents doubtless would have given consent had the opportunity been afforded their child and could not be criticised for doing so. However, most parents and guardians who hand their child over into another's care for however limited a time would, in my view, have an expectation that the adult responsible for them would seek their consent before embarking with them upon any unforeseen, unforewarned event, particularly if it involved risks. It may be a mark of how casually and routinely Mr McRae regarded the use of his helicopter that he took no steps to seek such permission, but most parents, in my view, would regard it as appropriate to be asked before another takes their child on a car journey, a swimming trip, or indeed any deviation from the expected play date at home. There are good and cogent reasons behind such an expectation: parents can give vital information about the child and his ability to enjoy the proposed outing; there may be safety considerations; there

may be family boundaries crossed; the list goes on. Parents should have the opportunity to say no in respect of their child. The Porcellis were denied this.

135. However, in the absence of unambiguous evidence that Ben would have been refused permission to participate in the flight, it is not open to me to make a finding in terms of Section 6(1) (c). If permission had been granted, as it could have been, Ben would have been on the flight. The granting of that permission would not have been open to criticism.

136. Nor am I in a position to make a finding that the Civil Aviation Authority should consider regulation of this matter. There is simply insufficient evidence before me to entitle me to make such a finding. Regulation can be a blunt instrument and it should only be imposed when there is certainty about its purpose and its result, and a careful consideration of possible unforeseen and unintentional consequences undertaken. I suspect, but do not know, that commercial aviators require parental consent already. In the absence of any focus on this issue during the Inquiry, except insofar as already related, I do not have the evidential basis to determine whether there exists a significant problem in relation to children being carried without parental consent, whether mandatory prior consent would be a proportionate and reasonable response, how such regulation would sit with carriage in other forms of transport and so on. I also do not know whether or not in this case that any such regulation would necessarily have been complied with, in circumstances where so many other requirements were not.

FLIGHT DATA RECORDERS

137. The Crown seeks a finding that “all aircraft should be fitted with flight data recorder to include voice and video recording together with instrumentation recording.” They are supported in this by the McRae family.

138. They base this submission upon the evidence of Mr Fairbanks and Mr Robinson of the AAIB and of Mr Connolly. Mr Robinson explained that there is currently no requirement in the U.K or elsewhere for any type of flight data recording device to be installed in private aircraft of this weight. It is compulsory in public transport operations where 9 or more passengers are being carried. He agreed that given the uncertainty surrounding the cause of the crash it would have been helpful if any information of this type had been available for consideration as part of the overall investigation. It would have been particularly helpful in considering whether servo transparency might have occurred to have confirmation of the estimated airspeed of 130 knots along the valley and a measurement for the g force encountered during manoeuvres. However, he pointed out, I.T does not tell us everything we might wish to know. Sometimes, such flight data recorders don’t work; their calibrations can be out; as they get more complicated investigators become more reliant on manufacturers to decode them. They are, however, becoming more reliable and the possibility of fitting them to all aircraft in the future is probably increasing. Cost is a problem but digital technology is bringing that down.

139. Mr Connolly also spoke of the introduction by Eurocopter and by Agusta-Westland of light weight, low-cost system cockpit monitoring and recording systems as an alternative to Cockpit Voice Recorder or full Flight Data Recorder systems. The Eurocopter system, “Vision 1000” is intended as suitable for all aircraft where flight data recorders and cockpit voice recorders are not mandated. Such systems are, he says, available for less than \$10,000 albeit lightweight audio-video recorders are available which could do the job at less than \$2,000. Costs would be driven up by certification implications and tamper-proofing, together with routine maintenance and inspection costs. He told the Inquiry that the Ministry of Defence has mandated such lightweight cockpits voice recorders in all of its AS 250 helicopters following upon a recent collision.

140. This was not an area of investigation foreshadowed in any preliminary hearing or note of issues. It emerged during evidence. Mr Anderson, on behalf of the Civil Aviation Authority, took issue with the fact that at no time were the C.A.A. invited to consider and provide evidence in relation to this issue. Despite this, he was able to make helpful submissions in respect of the impracticability of such a recommendation – a recommendation upon which the C.A.A. would be obliged to act regardless of propriety. I précis the points made by him, some of which are based on evidence not otherwise put before the Inquiry, but in respect of which no point was taken or fact contradicted in oral submission.

141. His starting point was that the C.A.A. supports the principle and the issue remains under consideration by them. He recognised that flight recorders have a distinct benefit in safety terms in that they provide information about why an accident happened. They do not however, directly prevent it occurring. Any decision to mandate flight recorders must be balanced against possible other requirements to fit equipment with a more immediate and tangible safety benefit.

142. Such a requirement would involve significant costs which may vary significantly according to whether such regulations would affect existing aircraft or only new builds. Current flight recorders are designed to be robust enough to survive high impact accidents associated with large passenger transport aircraft. As a result they are heavy and expensive – perhaps disproportionately so for light aircraft use.

143. This issue has been under consideration by the C.A.A. for some time and following upon recommendations from a number of accident investigation agencies including the AAIB, The International Civil Aviation Authority amended their regulations to address lightweight flight recorders for smaller commercial and general aviation aircraft. This resulted in the development and publication of a technical specification for such lightweight flight recorders which designers and manufacturers can work to. However, due to the lack of operational requirements for them, few manufacturers are producing this type of equipment and thus it is difficult to accurately assess likely costs and factor these into any cost benefit analysis. Mr Anderson

raised the point that even this new specification may be excessive and thus too expensive for the lighter end of the general aircraft sector.

144. The Crown submission seeks to apply the proposed recommendation to “all aircraft” and thus would extend to gyroplanes and micro-lights as well as helicopters such as G – CBHL. Apart from considerations of cost, particularly acute in relation to such craft, such aircraft might be unable to fly under the weight of such a recorder. Before any decision is made regarding mandating flight recorders, consideration will need to be given to the availability of recorders of a suitable weight, capability and cost for the aircraft in question.

145. Image recording of the instrument panel can in some situations be used in place of a flight data recorder, but can also sometimes be misleading when used in isolation. All such data raises data protection issues which would require consideration. The C.A.A. supports the use of image recording but limited to views of the instrument panel until such time as further legal measures can be taken to prevent the misuse of image data.

146. The C.A.A. supports encouragement rather than regulation in respect of the general aviation community. It believes that encouraging individuals to fit flight recorders of their own volition when able to do so has a far greater chance of success than mandating them to do so against their will. They are concerned that coercion can result in organised challenge and avoidance and can be counter-productive. Mr Anderson points out that the lack of a direct benefit to the individual in the fitting of a flight recorder militates against an

enthusiastic take up of such devices, unless they can be combined with other practical and useful safety enhancements. The C.A.A. welcomes the voluntary fitting of forms of lightweight recorders to new-build aircraft by some manufacturers, including Eurocopter, and seeks to encourage other manufacturers to follow suit.

147. The C.A.A.'s support for the installation of flight recorders where it is practical to do so and where a duty of care exists has led to its support for international and European discussions relating to new regulations for flight recorder carriage. It also supports the principle that flight data recorders, cockpit voice recorders and image readers can aid accident investigation so long as they are not subject to misuse and/or misinterpretation. The C.A.A.'s concern that it is premature to require them to implement a recommendation in the form suggested by the Crown in the absence of further consideration of the availability of suitable and practical recorders for all types of aircraft, of associated costs, of competing safety-related equipment, of privacy issues and of the potential negative impact of disproportionate and unpopular regulation, appears to me to be well-founded.

148. There is no question but that this Inquiry, and therefore the public interest, would have benefitted from information of the type that interrogation of a flight data recorder might provide. Despite the very best efforts of the AAIB there remains uncertainty about what happened in the final seconds of flight to cause G-CBHL to come into contact with trees and disintegrate. Such information might assist in bringing some form of conclusion to those so

affected by this tragedy and could also have safety ramifications for the future. These are results which could only be welcomed and it is doubtless in this spirit that the Crown and the McRae family both seek a recommendation which would extend the requirement that aircraft be fitted with a form of flight data recording and video and voice recording to private aircraft.

149. However, such a recommendation would involve the enacting of regulation. Regulation of such matters is not solely a matter for the C.A.A. New regulations in this field would require to be addressed to the European Aviation Safety Agency. Given the lack of prior notice that this issue would feature in this Inquiry, the Agency has not had the opportunity to participate. The C.A.A's position has been admirably advocated by Mr Anderson, but I recognise that his opportunity to do so has also been restricted by the lack of prior notice. His submissions do, however, make very clear the danger that a well-intentioned desire to make good a lacuna in information could, contrarily, make for ill-informed and potentially unhelpful legislation.

150. The limited evidence produced to this Inquiry in relation to this subject is simply insufficient in scope and depth to enable me to formulate any such recommendation or to be satisfied that I should do so. I am reassured that this issue remains under consideration by the C.A.A who are in a better position than I am to consider and evaluate all aspects associated with the introduction of flight data recorders into general aviation, and that manufacturers are facilitating and assisting the expansion of that market by developing and producing lighter and cheaper models.

151. The principal procurator fiscal depute has, in the public interest, thoroughly investigated the circumstance of this accident and the deaths of Mr McRae and his son Johnny, Mr Duncan and Ben Porcelli. Her careful and competent preparation and presentation of that evidence, together with the high degree of cooperation and skill and compassion displayed by all agents and counsel involved allowed the Inquiry to focus on the relevant issues and enabled this inevitably painful process to be as brief and as informative as it could possibly have been. I express my profound gratitude to each of them.

152. At the heart of this Inquiry and never far from the thoughts of those involved in the conduct of it, were the tragically premature deaths of much loved and forever missed family members and friends. In submissions, all representatives expressed their sincere condolences to those bereaved. I take this opportunity to add mine.