



Report 99-003

Aerospatiale AS 350B

ZK-HBH

collision with terrain

Rowallan Forest, Southland

2 April 1999

Abstract

On Good Friday, 2 April 1999, Aerospatiale AS350B helicopter ZK-HBH was on a charter flight from Clifden, carrying a hunting party into Fiordland when some loss of control occurred. The helicopter collided with trees and the ground in the Rowallan Forest, killing all 5 occupants.

The cause of the loss of control was not conclusively established, but the pilot's ability to control the helicopter may have been medically impaired by the sudden onset of a cardiac event.

Safety issues identified include:

- the need for a cargo restraint system for helicopter operations
- the need for a passenger list system for helicopter operations.

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List of Abbreviations

amsl	above mean sea level
CAA	New Zealand Civil Aviation Authority
CG	centre of gravity
ECG	electrocardiograph
ELT	emergency locator transmitter
FM	frequency modulated
GPS	global positioning system
HF	high frequency
kg	kilogram
m	metre
nm	nautical miles
NZST	New Zealand standard time
RBBB	right bundle branch block
RCC	rescue coordination centre
SAR	search and rescue
SARSAT	search and rescue satellite
THL	The Helicopter Line (Tourism Holdings Limited)
UTC	universal coordinated time
VHF	very high frequency

Aircraft Accident Report 99-003

Data Summary

Aircraft type, serial number and registration:	Aerospatiale AS 350B, 1283, ZK-HBH
Number and type of engines:	one Turbomeca Arriel 1B
Year of manufacture:	1980
Date and time:	2 April 1999, 1301 hours ¹
Location:	in the Rowallan Forest, 8.5 nm north-west of Tuatapere latitude: 46° 02.7' south longitude: 167° 30.5' east
Type of flight:	air transport, charter
Persons on board:	crew: 1 passengers: 4
Injuries:	crew: 1 fatal passengers: 4 fatal
Nature of damage:	aircraft destroyed
Pilot's licence:	Commercial Pilot Licence (Helicopter)
Pilot's age:	47
Pilot's total flying experience:	14 693 hours on helicopters over 5000 hours on type
Investigator-in-Charge:	J J Goddard

¹ All times in this report are NZST (UTC + 12 hours)

1. Factual Information

1.1 History of the flight

- 1.1.1 On Good Friday, 2 April 1999, the pilot of South West Helicopters' Aerospatiale AS 350B Squirrel helicopter, ZK-HBH, had a busy day with several charter flights booked, principally for hunting parties going into various remote Fiordland locations. He began duty at 0700 hours, preparing the helicopter for the day's flying.
- 1.1.2 The first flight departed from his home base at Clifden, near Tuatapere, at 0808 hours, and arrived at Puysegur Point at 0841 hours. After visiting other locations in Preservation Inlet the helicopter returned to base at 0913 hours.
- 1.1.3 The second flight departed at 0923 hours, arriving at Lake Kakapo at 0947 hours. It departed at 0956 for Lake Poteriteri, arriving at 1001 hours. The helicopter was flown to Lake Hauroko where it was used to lift a jetboat across to Lake Poteriteri; returned to Lake Hauroko to pick up a passenger, and returned to base at 1041 hours.
- 1.1.4 After the pilot refuelled the helicopter, he departed on the third flight at 1056 hours, arriving at Lake Poteriteri at 1113 hours and returning to base at 1133 hours.
- 1.1.5 The fourth flight departed at 1148 hours, arriving at Lake Kiwi at 1219 hours, and returning to base at 1242 hours.
- 1.1.6 The fifth flight, a party of 4 hunters with their supplies for 10 days, was then loaded. The plan was to fly the party to Lake Poteriteri, pick up an inflatable boat belonging to the pilot, and fly on to Preservation Inlet.
- 1.1.7 The flight departed at 1255 hours. The pilot made a routine radio call at 1259 hours to the office of another helicopter company in Queenstown who were temporarily conducting flight-following for his operation. He reported their departure from Clifden for Lake Poteriteri, then to Puysegur Point. No further radio transmissions from ZK-HBH were heard.
- 1.1.8 At 1301 hours the helicopter flew into the canopy of the Rowallan Forest in a position 8 nm west-north-west of Clifden. It collided with numerous trees before the final impact with the ground at an elevation of 600 feet amsl. There were no witnesses to the flight.
- 1.1.9 The Queenstown flight-following operator reported concerns to the company at about 1420 hours, that ZK-HBH had not made any further radio call. The company's preliminary plan was to get their other helicopter, then about to leave Stewart Island, to start a search on returning to Te Anau.
- 1.1.10 The search and rescue response proper began when a SARSAT satellite detected an emergency locator transmitter (ELT) signal in the general area at 1449 hours. This position was refined by further SARSAT information at 1518 hours, and at 1542 hours the rescue coordination centre (RCC) commissioned a search by 2 local helicopters. Both helicopters were searching electronically for the ELT by 1655 hours, and reporting some difficulty in defining its position.
- 1.1.11 ZK-HBH was located at 1853 hours, at about nightfall. Rescuers were winched to the site in darkness, where they ascertained that no occupants of the helicopter had survived.

1.2 Injuries to personnel

Injuries	Crew	Passengers	Others
Fatal	1	4	-
Serious	-	-	-
Minor/nil	-	-	-

1.3 Damage to aircraft

1.3.1 ZK-HBH was substantially damaged by numerous collisions with trees and with the terrain.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

1.5.1

Pilot: Male, aged 47 years
Licence: Commercial Pilot Licence (Helicopter)
Aircraft ratings: Hughes 269 and 369, Bell 206, AS 350
Medical certificate: Class 1, valid to 27 April 1999 (included waiver 054: hearing - annual audiometry required)

Last annual pilot competence and emergency procedures check:

13 May 1998

Last Biennial Flight Review:

13 May 1998

Flying experience:

Total, all types: approx. 14817 hours

Total, AS 350 type: over 5000 hours

Total, last 90 days (all ZK-HBH): 148 hours

Duty time:

6 hours

Rest before duty:

15 hours

1.5.2 The pilot was one of 3 principals of South West Helicopters Limited, who had formed the company in March 1996 to take over the southern part of The Helicopter Line (THL) (subsequently Tourism Holdings Limited) operations. He was also the chief pilot and operations manager of the company.

1.5.3 He had previously been employed by THL since 1982, flying in the same area and from his home base. He had, in addition, since 1990 been periodically employed on seismic survey work in Burma, flying AS 350B helicopters.

1.5.4 He had completed his Private Pilot Licence (helicopter) in 1978, followed by his Commercial Pilot Licence (helicopter) in 1980, and had been employed as a helicopter pilot since that time. He had completed conversion training to the AS 350B type in August 1990.

1.5.5 During the routine medical examinations for his pilot's licence, long-standing electrocardiogram (ECG) abnormalities had been observed since 1974, but considered to be within normal limits. In October 1987, a change to his ECG, recording right bundle branch block (RBBB) was noted, requiring further assessment by a consultant cardiologist. A further ECG showed increased left axis and flattening of T waves, while other tests showed no abnormality. He was accordingly assessed as fit.

1.5.6 His next routine ECG, in 1990, was assessed as normal, with a comment on previous partial RBBB as in 1974, and a note that normal T waves were recorded.

- 1.5.7 His subsequent annual ECGs were assessed as variable, with occasional intermittent recurrence of incomplete RBBB and low T waves being noted.
- 1.5.8 His 1998 ECG was assessed as possibly more abnormal, with RBBB and flattened T waves recorded. He was referred to a cardiologist for a stress exercise ECG. This showed no abnormalities, and an above average performance for his age, and resulted in his being assessed as fit.

1.6 Aircraft information

- 1.6.1 ZK-HBH was an Aerospatiale (now Eurocopter) single-engine helicopter, serial number 1283, manufactured in 1980 as an AS 350D model. It was imported to New Zealand in March 1988, and modified to become an AS 350B model. This essentially involved replacing the Lycoming LTS-101 engine with a Turbomeca Arriel engine. The helicopter was issued with a non-terminating Airworthiness Certificate in the standard category in July 1988.
- 1.6.2 The South West Helicopters operator's maintenance manual required the helicopter to be maintained in accordance with the THL (and subsequently with the Airwork [South Island] Limited) schedule M/S 1, which essentially incorporated the manufacturer's maintenance schedule for the type. The last scheduled maintenance, a 100 hour inspection, had been completed on 31 March 1999, at a total time in service of 8207 hours. The next scheduled inspection was recorded as due at 8217 hours (it was intended to be recorded as 8307 hours), and the next maintenance review was due on 12 June 1999. No deferred defects or inoperative equipment had been recorded on the aircraft technical log, but the high frequency (HF) radio was reported as intermittent.
- 1.6.3 A review of maintenance documents showed that all scheduled maintenance had been recorded, and all significant defects rectified. No outstanding airworthiness directives were found. The component service record cards indicated that all finite-life components were within their appropriate lives.
- 1.6.4 The helicopter had accumulated a total of 8211 hours in service.
- 1.6.5 The Turbomeca Arriel 1B engine, serial number 787, had run a total of 5571 hours.
- 1.6.6 The loading of the helicopter could not be completely determined because of the scatter and loss of items from the rear cabin and side locker areas at the accident site. The rear locker had approximately 111 kg of supplies stowed, and the fuel quantity in the tank was estimated to be 45%, with a weight of 188 kg.
- 1.6.7 Using these figures and standard passenger weights of 77 kg, the helicopter was estimated to be at its maximum permitted weight of 1950 kg, with the centre of gravity (CG) within its permitted range.
- 1.6.8 In addition to these weights, the scattered items, which included rifles, packs, cans of fuel and camping equipment may have totalled up to 100 kg. The distribution of such items between the rear cabin and the side locker would have caused a small forward shift of the CG.

1.7 Meteorological information

- 1.7.1 A slow-moving ridge of high pressure extended over central New Zealand from an anticyclone in the Tasman Sea, giving generally clear skies and a light to moderate westerly airflow over South Island. A series of weak fronts had moved past in the westerly flow, bringing a temporary increase in cloud and coastal showers. One such front which passed over southern South Island during the afternoon of 2 April produced showers on the south coast with a temporary freshening of the wind, but no significant effects inland.
- 1.7.2 The weather at Clifden during the afternoon was reported as clear and sunny with scattered cloud. A light westerly breeze was blowing.
- 1.7.3 Helicopter pilots involved in the search later that afternoon reported clear conditions, scattered cloud at 5000-6000 feet and a moderate westerly wind.

1.8 Aids to navigation

- 1.8.1 Not applicable.

1.9 Communications

- 1.9.1 The company normally provided a flight-following service for its operations, using a high frequency (HF) radio at the Te Anau base. On 2 April 1999 the pilot of ZK-HBH had reported the HF radio in the helicopter as intermittent, and had arranged for flight-following to be carried out by another company's office in Queenstown. This company had a network of very high frequency, frequency-modulated (VHF FM) repeater transmitters which gave extended coverage to much of the mountainous area.
- 1.9.2 ZK-HBH was equipped with normal aircraft VHF and HF radios, a VHF FM radio, 2 multiplex police radios and a cellular telephone.
- 1.9.3 Normal communications with ZK-HBH on the VHF FM radio were reported by the Queenstown office, both earlier in the day and on the accident flight.
- 1.9.4 A flight check carried out after the accident indicated that the VHF FM coverage did not extend down to a low altitude in the vicinity of the accident site.

1.10 Aerodrome information

- 1.10.1 Not applicable.

1.11 Flight recorders

- 1.11.1 No flight recorders were installed or required to be installed in ZK-HBH.
- 1.11.2 A Garmin Pilot III GPS (global positioning system) unit was installed in ZK-HBH. Although not intended as a flight recorder, its memory was able to be recovered, and the track data provided a valuable record of all the helicopter's flights on 2 April, including the accident flight, as well as several flights on 1 April.

- 1.11.3 The track data contained latitude/longitude coordinates and GPS time for each track point, and was used to establish the helicopter's movements for the day. Altitude was not recorded. For the accident flight the derived groundspeeds were initially about 70 knots for some 3 minutes, then accelerating to about 90 knots for the next 3 minutes.
- 1.11.4 A computer plot of the accident flight showed the helicopter initially followed closely the track flown several times earlier between Clifden and Lake Poteriteri. However, over the last 5 track points, a period of 24 seconds, the plot deviated to the right to indicate a track change of about 40°, with a decrease in groundspeed to about 75 knots. The final recorded coordinates were at the accident site.

1.12 Wreckage and impact information

- 1.12.1 ZK-HBH was lying on its right side against a tree, on a heading of approximately 210°. The forest consisted of large mature native beech trees, with a floor of ferns. The terrain was undulating, and rising to the west. The site was just south of a steep-sided creek bed.
- 1.12.2 The tail boom, left skid and most of all 3 main rotor blades were separated from the helicopter fuselage. The cabin floor had collapsed upwards, destroying the cabin space. This was consistent with a severe collision with the ground in an approximately upright, 45° nose-down attitude. The occupants had remained in place secured by their seatbelts, but the front double seat had separated from its floor tracks.
- 1.12.3 Scattered baggage and passenger equipment items in the vicinity of the main wreckage had evidently been stowed in the left rear of the cabin, and in side lockers. There was no evidence of any restraint such as a cargo net having been used in the rear cabin.
- 1.12.4 The first tree with identifiable main rotor slash damage was about 100 feet tall, and about 100m from the accident site. The track from this tree to the site was 300° magnetic, with a vertical angle of 31° down from the slash marks. Numerous trees along this track also showed damage from the rotors or from structural collision, and suggested that the track profile through the trees was initially nearly level but progressively steepened to become nearly vertical at the end. The attitude of the helicopter could not be determined from the slash marks.
- 1.12.5 The most distant piece along the wreckage trail was the yellow main rotor tip, which was followed by many other main rotor pieces. The left skid and ski-box was approximately 20 m from the main site, with the left front door nearby. These showed evidence of tree strike damage. The right front door was close to the main site, wrapped around a tree limb. The tail boom, complete with the tail rotor, gearbox and stabilisers, was also close, and showed evidence of separation from a tree strike on its right side in front of the horizontal stabiliser.
- 1.12.6 The complete helicopter, including all doors, hatches, cowlings, belly panels and main rotor extremities was accounted for at the site.
- 1.12.7 The engine, main transmission and flight control systems had remained in position, with some distortion. The main rotor blade damage was massive and similar on all 3 blades, consistent with numerous blade strikes on trees while under power and at normal rotational speed. The starflex arms in the main rotor head had 45° fractures. The orientation of these fractures indicated that the blue and yellow blades were being driven by engine torque, while the red arm fracture was consistent with inertia forces from the red blade. The tail rotor and driveshaft showed no rotational damage, consistent with little or no rotation when tail boom separation occurred, and indicating that the main transmission had been slowed or stopped by the main rotor blade strikes.

- 1.12.8 The fuel tank contained an estimated 45% of normal Jet A1 fuel. Samples from the tank and from fuel filters confirmed normal uncontaminated fuel.
- 1.12.9 The wreckage was lifted out by helicopter and recovered to storage. Further examination confirmed the mechanical integrity of the engine controls and the flight control systems from the pilot's controls through to the main and tail rotor blade pitch links. The hydraulic system and servos were intact. The pre-impact positions of controls could not be determined because of the cabin floor disruption. The dynamic components rotated normally, with no drive shaft failure except at the tail boom separation. The engine module 5 input pinion matched markings did not show the relative movement characteristic of main rotor blade strikes under high power.
- 1.12.10 No significant evidence was gained from the instrument panel. The audio panel was selected to the VHF FM radio. The ELT switch was in the "ARM" position.
- 1.12.11 Light bulbs from the caption panel were examined for evidence of filament hot stretch, which would indicate that they were illuminated at impact. Bulbs with hot stretch were: "DOORS, GENERATOR, MAIN GEARBOX TEMPERATURE and ENGINE OIL PRESSURE".
- 1.12.12 Some switches, complete with light bulbs, from the switch panel were recovered, and their filaments examined. All exhibited filament hot stretch to some extent. Among those recovered were the "W/LT TEST and INST LT" switches, which if switched on would have illuminated all the switch lights and most caption panel lights. Because of this, the light bulb evidence was probably of little significance.
- 1.12.13 All the chip detectors from the engine, oil tank, hydraulics, main transmission and tail rotor gearbox were free of any deposits.

1.13 Medical and pathological information

- 1.13.1 The post-mortem examination of the occupants showed that they all received multiple severe injuries at ground impact, which would have resulted in immediate deaths.
- 1.13.2 The additional post-mortem and toxicological examinations of the pilot did not specifically show any abnormalities or any evidence of structural disease of any organ system. There was no evidence of interruption of the blood supply to the heart, causing myocardial infarction (heart attack), but significant post-mortem changes had occurred which may have eliminated any blood clot, had one been present.
- 1.13.3 Typical injuries to the pilot's hands and feet which usually result from his holding the controls at impact were not found.
- 1.13.4 Expert medical opinion was that the long-standing history of abnormal resting ECGs of the pilot suggested an intermittent minor defect in the conducting and electrical activity of his heart muscle. These abnormalities, even in the absence of any cardiac symptoms and where a stress ECG was normal, doubled his risk of sudden incapacitation from a cardiac event. This event would typically have been an irregular heart rhythm. This additional risk is approximately 0.25% per annum, based on major scientific studies of risk of sudden death associated with these abnormalities, and is within the acceptable range for medical certification of pilots, on the basis of internationally accepted criteria.

1.13.5 Expert medical opinion also was that a cardiac event may well have occurred, leading to symptoms causing the pilot to lose control of the helicopter. Symptoms may have been a slower or irregular heart rhythm causing faintness or possibly loss of consciousness, but not immediate severe heart failure or cardiac arrest. It was also considered possible that a transient blood clot in a coronary artery could have precipitated changes in heart rhythm and may have caused chest pain.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 The severe impact forces involved in the final impact of the helicopter with the ground made this accident unsurvivable.

1.15.2 The absence of any cargo restraint for the items carried in the rear cabin may not have affected the outcome of this accident, but it did raise the possibility of an unsecured object falling during flight onto controls such as the collective lever or the fuel control lever, which could be a potentially serious distractor for the pilot. No evidence was found to indicate or eliminate such an event, however.

1.15.3 The emergency locator transmitter (ELT) had been relocated to the forward section of the helicopter's tail boom, where it functioned as intended after the accident, and was the principal means of finding the aircraft. The nature of the forest and minimal visual evidence from above of the helicopter's passage through the trees could have prevented the accident site from being found at all without the ELT signal being available for an electronic search.

1.15.4 The normal location for the ELT on the AS 350 type is in the nose of the cabin. In the circumstances of this accident, such a location probably would have resulted in the disabling or destruction of the ELT.

1.16 Tests and research

1.16.1 Nil.

1.17 Organisational and management information

1.17.1 South West Helicopters Limited, based in Te Anau, was formed in September 1996 to take over the southern part of THL helicopter operations. The company was owned by 3 partners who had been employees of THL. Two AS 350B helicopters were operated, one based in Te Anau and ZK-HBH based in Clifden. The company had 4 staff: the 3 partners who comprised the chief executive/maintenance director, the pilot of ZK-HBH who was also the chief pilot/operations manager, the other pilot, and an operations coordinator also based in Te Anau.

1.17.2 The company flight crew training and checking was contracted to the THL training organisation. The aircraft maintenance, under the overview of the maintenance director, was similarly contracted to THL, but recently devolved to Airwork (South Island) Ltd following a reorganisation within THL.

1.17.3 This development and structure of the company provided a continuity of operational experience and practice which began a number of years before the company foundation in 1996.

- 1.17.4 The Civil Aviation Authority (CAA) conducted audits of the company in October 1997 and November 1998, after the issue of the company's Air Service Certificate. No major findings had been made, and other findings had been actioned and closed. One non-compliance found in 1997 was that records of passenger names were not being kept.

1.18 Additional information

- 1.18.1 After the SAR response began on the afternoon of the accident, the company was initially unable to advise police of either the names or number of persons on board the helicopter, because no passenger list had been made by the pilot before departure. After some delay, the name of the hunting party was found in the pilot's diary, and police enquiries were able to establish the names of persons in the party.
- 1.18.2 The company operations specifications issued by CAA required, as a condition of an exemption from loadsheets, that passenger lists be made. The company operations manual specified procedures requiring the pilot-in-command to generate passenger lists.
- 1.18.3 The company operations manual required cargo "to be properly secured with restraints having sufficient strength to eliminate the possibility of shifting under all normally anticipated flight and ground conditions . . .". There was no obvious system found in ZK-HBH for implementing this procedure, with the cargo carried in the rear cabin.
- 1.18.4 The company operations manual, in the flight and duty times section, specified a 30 minute meal break after each 4 hour duty time period. Pilots were individually responsible to ensure compliance with limitations.

2. Analysis

- 2.1 The evidence from the passage of ZK-HBH through the trees suggested that it was in cruising flight, either level or in a slight descent, when it first flew into the forest canopy, and that some loss of control of the helicopter by the pilot was probably involved. The appreciable distance and flat angle of its path through the trees was not consistent with an autorotative descent, which would have been the only option in the event of an engine failure.
- 2.2 While the attitude of the helicopter at first impact could not be determined, the recorded GPS track plot indicated that it was turning slowly to the right, through about 40° in 24 seconds. Such a rate of turn would have required a bank angle to the right of up to 10° at its normal cruising speed of 100-110 knots, so the helicopter may have been banked similarly. The 40° track change was similar to the deviation between the track to Lake Poteriteri and the measured track through the trees of 300° magnetic.
- 2.3 The groundspeeds derived from the GPS track data were consistent with a normal flight profile into the reported 15 knot westerly wind. The initial 70 knots was probably a cruise-climb segment, then accelerating to a cruise groundspeed of 90 knots, or an airspeed of 105 knots. An overlay of the GPS track on a topographical map indicated that the helicopter would have climbed to over 1000 feet amsl to clear some high terrain.
- 2.4 The evidence from the wreckage of the helicopter indicated that no mechanical defect had occurred with its control systems, its dynamic components or with the supply of engine power to the rotors. There was no indication from the pilot's last radio call, made within 2 minutes of the accident, that anything was unusual about the flight. It is probable that the lift-off and departure from Clifden onto track was routine, similar to several the pilot had made that day.

- 2.5 The weather, clear and sunny with scattered cloud and a light westerly breeze, was unlikely to have been a factor in the accident. In addition, the pilot knew well what the local weather was, having flown over the route several times that day.
- 2.6 With no mechanical or environmental factors evidently involved in initiating the accident sequence, the likelihood is that some event occurred in flight within the cabin to distract the pilot or to reduce or compromise his control over the helicopter. Possible events included distraction by a passenger, movement of cargo stowed in the rear cabin, and impairment or incapacitation of the pilot following a cardiac event.
- 2.7 Distraction by a passenger is always possible in any aircraft without a separate cockpit or flight deck. However, there was no evidence of such an event. In addition, the pilot was very experienced in his role, and would have been well able to cope with a passenger problem without distraction. It is considered unlikely that a passenger problem was involved.
- 2.8 The cargo stowed in the rear cabin was not restrained in any way, and thus had the potential to move, perhaps with items falling onto the collective control lever, fuel control or switch panel. Again, there was no evidence, but the possibility of such an event could not be discounted. The potential severity of outcome of an item falling would depend on what the item was, and on what opportunity the available margin of distance from terrain allowed the pilot to overcome the problem. Such an event could directly affect the flight path of the helicopter as well as distracting the pilot, but any correlation between the final GPS track and any such flight path alteration could not be made.
- 2.9 The medical evidence and expert opinion did show that the pilot was subject to an elevated risk of incurring a sudden cardiac event which could cause him to partly or fully lose control of the helicopter. The post-mortem examinations did not produce any direct evidence that such an event had occurred, but also did not exclude the possibility. The post-mortem evidence of lack of typical injuries to the pilot's hands and feet did indicate, in the particular circumstances of this accident, that he was not holding the controls at the final ground impact. This could have been the result of symptoms following a cardiac event, but it might also have been a pilot reaction following the first collision with the trees.
- 2.10 The GPS track plot, showing a deviation occurring over the last 24 seconds, could be consistent with a cardiac event occurring some 30 seconds prior to impact, and causing the pilot to suffer impairment and diminished ability to control the helicopter or perceive its flight path. A more complete incapacitation was unlikely, because it would probably have led to a more rapid and severe deviation from track than that recorded, with typical light helicopter manoeuvrability and stability margins.
- 2.11 The pilot's ECGs had intermittently shown minor abnormalities throughout his career, since 1974, and had shown more marked abnormalities in 1997 and 1998 requiring referral to cardiologists for further tests. These cardiologists' affirmative opinions were principally based on their further tests rather than on the pilot's 25-year history. A number of epidemiological studies have indicated a doubling of age-specific risks of sudden cardiac events (including rhythm disturbance in the absence of a heart attack), spread over many years. The risk of such a cardiac event may have been approximately 0.25 % in a pilot of his age. This is a sufficiently small risk elevation to be acceptable to the CAA for pilot certification, but nonetheless presents an increased probability of pilot incapacitation occurring in flight.
- 2.12 It was apparent that the pilot, after starting duty at 0700 hours, had not taken a 30 minute break after 4 hours as specified in the company flight operations manual, but had been busy working for 6 hours when the accident occurred. The effect of any resulting stress or fatigue on his alertness, or on his susceptibility to any cardiac event was not quantifiable, but was probably

slight. The variable nature of his work probably meant that he was well used to extended periods of duty without a break.

- 2.13 The estimates of weights of items found at the accident site indicated that the helicopter may have been loaded by up to 100 kg over the maximum permitted weight of 1950 kg. This could not be confirmed because of the loss of items, and because of the estimate of fuel quantity. It was likely, however, that the helicopter was overloaded by up to 5%, but that the centre of gravity was within limits.
- 2.14 This overloading was probably not significant because standard practice was for the pilot, on lifting to the hover, to check engine torque and control positions as indicators of acceptable loading before departing on the flight. In addition, the departure and climb performance appears to have been normal.
- 2.15 The absence of a passenger list had the potential to affect flight safety, because the SAR team did not know how many people to look for. It did, in addition, cause the company some embarrassment on being unable to readily determine who was on board. While it is understood that some helicopter operations make the compilation of a written passenger list impractical, this was not the case with ZK-HBH departing from the pilot's base. The company had a regulatory requirement as well as an operations manual procedure for passenger lists, neither of which were met on this flight. It was recommended to South West Helicopters that a practical means of meeting the company's requirements for passenger lists be adopted and complied with.
- 2.16 The absence of any means of cargo restraint in the rear cabin of ZK-HBH was a hazard, both in flight and in the event of an abnormal landing or sudden deceleration. The company operations manual procedure for cargo restraints was not met on this flight. It was recommended to South West Helicopters that a practical means of meeting the company's requirements for cargo restraints be adopted and complied with.

3. Findings

Findings and any safety recommendations are listed in order of development and not in order of priority.

- 3.1 The pilot was appropriately licensed and very experienced on the operation and the helicopter type.
- 3.2 The helicopter had a valid Airworthiness Certificate and had been appropriately maintained.
- 3.3 The helicopter may have been overloaded by up to 5%, but the centre of gravity was probably within limits.
- 3.4 This overloading probably had no effect on the outcome of the flight.
- 3.5 The helicopter was on a routine charter flight when some loss of control occurred, causing it to collide with trees in the Rowallan Forest.
- 3.6 The helicopter was probably functioning normally before the collision with the trees.
- 3.7 The pilot's ability to control the helicopter may have been medically impaired by the sudden onset of a cardiac event.
- 3.8 The pilot's minor ECG abnormalities were known to the medical licensing authority, but deemed within the acceptable range of risk.

- 3.9 The possibility of unrestrained cargo in the cabin causing a control interference or pilot distraction could not be ruled out.
- 3.10 The absence of a passenger list had the potential to compromise the effectiveness of the search and rescue, if this accident had been survivable.

4. Safety Recommendations

4.1 On 4 November 1999 it was recommended to the chief executive of South West Helicopters that he:

- 4.1.1 puts in place a practical means of meeting the company's requirements for cargo restraints and ensures that it is complied with (057/99)
- 4.1.2 puts in place a practical means of meeting the company's requirements for passenger lists and ensures that it is complied with (058/99).

4.2 On 4 November 1999 the chief executive of South West Helicopters responded as follows:

- 4.2.1 South West Helicopters has adopted a system using a combination of nets and tiedowns to, secure cabin cargo.
- 4.2.2 The company has adopted flight following procedures developed for the new Civil Aviation Rules which satisfies the recommendation regarding passenger lists.

Approved for publication 6 October 1999

Hon. W P Jeffries
Chief Commissioner