AIRCRAFT ACCIDENT REPORT 5/90

Air Accidents Investigation Branch

Department of Transport

Report on the accident to Bell 206 B Jetranger, G-SHBB, 2 miles east south east of Biggin Hill Aerodrome, Kent on 18 December 1989

LONDON: HMSO

First published 1991

ISBN 0 11 551006 0

LIST OF RECENT AIRCRAFT ACCIDENT REPORTS ISSUED BY AIR ACCIDENTS INVESTIGATION BRANCH

3/89	Sikorsky S61N helicopter G-BDII near Handa Island off the north-west coast of Scotland on 17 October 1988	June 1989
4/89	Boeing 747 N605PE at Gatwick Airport on 1 February 1988	August 1989
5/89	Boeing 747-136 G-AWNM on approach to Runway 27L at London (Heathrow) Airport on 11 September 1988	December 1989
6/89	Concorde 102 G-BOAF over the Tasman Sea, about 140 nm east of Sydney, Australia on 12 April 1989	December 1989
1/90	Sikorsky S61N G-BDES in the North Sea, 90 nm north-east of Aberdeen on 10 November 1988	May 1990
2/90	Boeing 747 N739PA at Lockerbie, Dumfriesshire, Scotland on 21 December 1988	September 1990
3/90	Sikorsky S61N G-BEID 29 nm north-east of Sumburgh Shetland Isles on 13 July 1988	September 1990
4/90	Boeing 737 G-OBME near Kegworth, Leicestershire on 8 January 1989	October 1990
5/90	Bell 206 B Jetranger, G-SHBB 2 miles east south east of Biggin Hill Aerodrome, Kent on 18 December 1989	

These Reports are available from HMSO Bookshops and Accredited Agents

Department of Transport
Air Accidents Investigation Branch
Royal Aerospace Establishment
Farnborough
Hants GU14 6TD

19 December 1990

The Right Honourable Malcolm Rifkind
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr R C McKinlay, an Inspector of Air Accidents, on the circumstances of the accident to Starline Helicopters Limited Bell 206B helicopter, G–SHBB, that occurred near Biggin Hill Aerodrome, Kent on 18 December 1989.

I have the honour to be
Sir
Your obedient servant

K P R Smart
Chief Inspector of Air Accidents

Contents **Page**

SYNOPSIS

1	**FACTUAL INFORMATION**	
1.1	History of the flight	4
1.2	Injuries to persons	5
1.3	Damage to aircraft	5
1.4	Other damage	5
1.5	Personnel information	5
1.6	Aircraft information	6
1.7	Meteorological aspects	8
1.8	Aids to navigation	10
1.9	Communications	10
1.10	Aerodrome information	12
1.11	Flight recorders	12
1.12	Wreckage and impact information	12
1.13	Medical and pathological information	17
1.14	Fire	18
1.15	Survival aspects	18
1.16	Tests and research	18
1.17	Additional information	18
1.18	New investigation techniques	20
2	**ANALYSIS**	
2.1	General	21
2.2	Impact parameters	21
2.3	Technical failure	22
2.4	Witness evidence	24
2.5	The weather	24
2.6	Disorientation	25
2.6	Lack of DGI	26
2.8	Pilot training and qualifications	27
3	**CONCLUSIONS**	
3a	Findings	28
3b	Causes	29
4	**SAFETY RECOMMENDATIONS**	29

APPENDICES

Appendix 1 - General layout
Appendix 2 Ground track of G-SHBB from Biggin Hill Airport
Appendix 3 Power turbine governor drive

Air Accidents Investigation Branch

Aircraft Accident Report No: 5/90
(EW/C1141)

Owner		Fagin's Bookshops Plc
Operator:		Starline Helicopters Limited
Aircraft:	*Type and Model:*	Bell 206 B Jetranger III
	Nationality:	British
	Registration:	G-SHBB
Place of accident:		2 miles east south east of Biggin Hill Aerodrome,Kent
		Latitude: 51° 19' North
		Longitude: 000° 04' East
		Elevation: 164 metres
Date and Time:		18 December 1989 at 1208 hrs

All times in this report are UTC

Synopsis

The accident was notified to the Air Accidents Investigation Branch (AAIB) at 1300 hrs and an investigation began the same day. The AAIB investigation was conducted by Mr R C McKinlay (Investigator in Charge), Mr A N Cable (Engineering) and Mr R StJ Whidborne (Operations). The accident occurred shortly after the helicopter had departed from Biggin Hill aerodrome for Folkestone, Kent. The commander encountered weather conditions that were unsuitable for continued flight solely with visual reference to the surface and announced his intention of returning to the aerodrome. One minute later the helicopter crashed out of control into woodland near Cudham village. The report concludes that the accident was most likely due to the commander suffering from spatial disorientation following his inadvertent entry into Instrument Meteorological Conditions (IMC). He was neither experienced nor qualified to fly in such conditions. The helicopter's Directional Gyro Indicator (DGI) had been temporarily removed due to its unserviceability. Its absence as a primary flight instrument, although allowable under certain conditions, may have hampered any attempted recovery from an inadvertent entry into IMC. No safety recommendations have been made.

1 Factual Information

1.1 History of the flight

During the morning of 18 December 1989 a request from Southend Jet Centre, an air charter company, had been received by the operator to convey four passengers from Biggin Hill to a racecourse near Folkestone, Kent. Three other helicopters from another operator had been similarly chartered to convey the remaining eight passengers of the charterer's party. The helicopter, G-SHBB, was prepared for flight by the commander who was assisted by the operator's managing director / chief pilot. Using a small 250 gallon capacity tanker which was located in their hangar, they refuelled the helicopter with Jet A1 aviation turbine fuel until the fuel tank contained 52 US gallons. Having inspected the helicopter prior to flight, the commander air taxied to the executive terminal which is located in the control tower building at the west side of Biggin Hill aerodrome. He shut down the helicopter and went into the terminal to meet his passengers who had been waiting there for about one hour. After a further 20 minutes, the commander escorted them to the helicopter and they all boarded it. It has not been possible to determine the seating positions of the four passengers.

At 1200 hrs the first party of passengers departed in a Jetranger on an initial departure track to the north east. At 1204 hrs the commander received instructions from the aerodrome air traffic controller to depart from the aerodrome on an initial heading of 110° magnetic (M). The commander reported that he was departing to the east under Visual Flight Rules (VFR)[1]. One minute later the commander radioed a request that ATC inform one of the other helicopters that was to carry more of the party to Folkestone and was parked outside the terminal building, that he planned to meet up with them in the area of Sevenoaks before continuing in their company towards Folkestone. At 1207 hrs the commander radioed that he was unable to maintain Visual Meteorological Conditions (VMC) and that he intended to return to the aerodrome. ATC acknowledged this information and asked whether the second helicopter should be instructed to remain on the ground. The commander replied "Affirm" and this was the last transmission received from G-SHBB. At 1208:23 hrs a brief half second of radio transmission carrier wave was recorded on the aerodrome ATC tape.

By 1209 hrs the aerodrome controller expected to have sight of the returning helicopter and, when he could not see it, he called it several times by radio but received no reply. At 1212 hrs telephone reports about the accident were being received.

---

[1] VFR: In relation to a helicopter flying outside controlled airspace and below 3000 feet, Visual Flight Rules require that the helicopter is flown clear of cloud and in sight of the surface.

The helicopter had been seen and heard by a number of witnesses in the area and several reported hearing unusual mechanical noises coming from it. It was observed as it turned back towards the aerodrome and some builders working at the Restavon mobile home site, located some 1500 metres south of the accident site, watched it emerge from low cloud to the north of them and descend towards the accident site. Other witnesses saw the helicopter for some 30 seconds at a very low level before it then banked to the left and appeared to nose dive into the wood. A unit of the Metropolitan Police dog training school was exercising in the area and some of their personnel were first on the scene but it was immediately apparent that there were no survivors from the crash.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	4	-
Serious	-	-	-
Minor / None	-	-	

1.3 Damage to aircraft

The helicopter was destroyed.

1.4 Other damage

Small trees and saplings were cut and slashed as the helicopter crashed into Blackbush Shaw near Berry's Green, Cudham. Aviation fuel was spilled onto the ground and further tree damage was caused during the recovery of the wreckage.

1.5 Personnel information

1.5.1	*Commander:*	Male, aged 27 years
	Licence:	Commercial Pilot's Licence (Helicopters and Gyroplanes)
	Instrument Rating:	None (Simulated Instrument flight time:10 hours)
	Certificate of test:	Schedule 10 (ANO 1989) last completed on 21 April 1989. Latest date due for renewal 21 May 1990
	Base and Line checks:	18 April 1989 and 21 April 1989 respectively
	Medical :	Last examination 29 October 1989 Class one, with no limitations

Flying experience:	Fixed wing: 67 hours Rotary wing: 320 hours (of which 127 were on Bell 206 helicopters) Total last 28 days: 15 hours
Previous rest period:	24 hours

1.5.2 *Training and operational experience*:

The commander began his flying training with the Biggin Hill School of Flying and by November 1986 he had accumulated some 23 hours of fixed wing flying. He was then sponsored by Bristow Helicopters Limited (Nigeria) as a cadet helicopter pilot and received training at Redhill during the period January to March 1987. After some 24 hours of dual instruction on Bell 47 helicopters he was suspended from the course because of his failure to progress in the air and to achieve first solo standard. He next received instruction from Goodwood Blades Air Academy at Goodwood aerodrome near Chichester. He flew 44 hours on fixed wing aircraft and 100 hours on Enstrom F28 helicopters until November 1988 when he passed General Flying Tests conducted by a CAA examiner. He was then issued with a Commercial Pilot's Licence (Helicopters and Gyroplanes). In January 1989 he was employed by Bond Helicopters Limited of Aberdeen as a trainee co-pilot on AS332L (Super Puma) helicopters. Having completed ground technical training he was given 21 hours of flight training but was judged by the company to lack the potential to achieve the required standard as a co-pilot in this type of operation. In April 1989 he was employed by Starline Helicopters Limited. Initial flying checks, as required by the Air Navigation Order, were completed to the satisfaction of the company's chief pilot who was authorised to conduct such checks. Initially he was given relatively simple tasks such as pleasure flying while he built up experience of the operation. He also accompanied the chief pilot on several delivery and ferry flights and the chief pilot was thus able to monitor his ability and progress as he gained experience.

1.6 Aircraft information

1.6.1 *General information*

Manufacturer:	Bell Helicopter Company
Type:	Bell 206 B Jetranger III
Registration:	G-SHBB
Serial number:	291
Date of manufacture:	1977

Registered owner:	Fagin's Bookshops Plc
Total airframe hours:	5947 hours
Certificate of Airworthiness:	Transport Category (Passenger) awarded 14 March 1989

1.6.2 *Aircraft weight and centre of gravity*

The estimated weight of the helicopter at the time of impact was 2953 lbs. The maximum certificated weight at take-off was 3200 lbs. The helicopter was correctly loaded within its lateral and longitudinal centre of gravity limits.

1.6.3 *Description*

The Bell 206B is a single engined helicopter of conventional layout, of aluminium monocoque and aluminium honeycomb construction (Appendix 1). It has a two bladed teeter main rotor of comparatively high rotational inertia. The aircraft is provided with two forward seats, of which the right hand is the commander's seat, and three rear seats. The aircraft is powered by a single General Motors Corporation Allison 250-C20B gas turboshaft engine, rated at 420 shaft horsepower, mounted on the fuselage roof. A free power turbine (PT) in the engine, driven by a gas producer (GP) portion of the engine, delivers power through an accessory gearbox to a freewheeling unit located beneath the engine on the forward face of the accessory gearbox.

Dual controls can be fitted at the left forward seat position, but for G-SHBB's accident flight the left cyclic stick and collective lever were not installed. Left seat yaw pedals can be disabled by disconnecting the push rods.

Primary forward vision transparencies comprise two large sloping windshields, each of which is provided with an internal demist air nozzle. External ram air can be admitted to each nozzle from an inlet plenum on either side of the aircraft nose by manual operation by the pilot of a cable driven flapper valve. Alternatively, each nozzle can be fed with cabin air by an electric motorised fan. G-SHBB incorporated optional Modification No. 88-010, 'Bleed Air Heater', a Federal Aviation Administration (FAA) and Civil Aviation Authority (CAA) approved kit that altered the basic cabin heating system. The modification provided for cabin air heating by means of a feed of hot air bled from the engine compressor, selectable by a manual cabin heater valve mounted below the pilot's seat. An optional part of the Modification allowed for installation of a windscreen defrost system, whereby engine bleed air could also be fed to a jet pump ejector in each windshield nozzle. This option was not installed on G-SHBB.

1.6.4 *General history*

Records indicated that the aircraft had been owned from new by an operator in Florida, USA, until purchased by Starline helicopters Ltd and imported to the UK on 25 October 1988, having accumulated 5741 total operating hours. It was awarded a CAA Certificate of Airworthiness in the Transport Category (Passenger) on 14 March 1989 after incorporation of a number of modifications routinely required by the CAA. At the time of the accident the aircraft had accumulated 5947 hours since new. It had valid CAA Certificates of Airworthiness, Registration and Approval of Radio Installation.

1.6.5 *Maintenance history*

Maintenance records for 1989 indicated that maintenance had been in accordance with the CAA Light Aircraft Maintenance Schedule, Rotary Wing (CAA/LAMS/H/1978). There was no evidence that the aircraft had suffered from an unusual history of defects. At the time of the accident the only recorded unrectified defect was the absence of the directional gyro indicator, which had been removed on 2 September 1989 and sent for repair. This indicator, which provides a gyroscopically stabilised indication of aircraft heading, was listed as an Allowable Defect in Appendix B to Section 5 of the Operations Manual for the aircraft. Operations were restricted to day only and the standby compass had to be serviceable.

At the time of the accident the aircraft was being maintained under an interim arrangement pending the granting by the CAA of Group M3 approval to the operator. The last maintenance check on G-SHBB had been a 100 hour Inspection carried out on 6 December 1989, 5 operating hours prior to the accident. The aircraft had in force at the time of the accident a Maintenance Statement and Scheduled Maintenance Inspection Certificate of Release to Service.

1.7 Meteorological aspects

1.7.1 *Synoptic situation*

A moist potentially unstable warm sector existed over the Biggin Hill area with a warm front lying from Colchester to Taunton moving slowly northwards. A cold front lay from Jersey to Plymouth moving northeastwards at 30 knots. There were outbreaks of rain which were moderate at times. Dynamic convergence over France acted as a trigger for releasing potential instability which was advected northwestwards over south east England. The surface wind was southeasterly at

10 to 15 knots and the surface temperature was +9°C. In general the visibility was 6 to 10 kms but with moist air and upslope motion the visibility may well have deteriorated to between 1000 and 3000 metres or less. Lowest cloud was broken Stratus at 600 feet but with upslope motion the base may well have become 300 to 400 feet. The 0°C isotherm was at 7000 feet and the mean sea level pressure was 983 mbs.

1.7.2 *Actual observations*

Observations made at 1150 hrs and 1220 hrs by a trained observer at Biggin Hill aerodrome included the following:-

Surface Wind: 150° /15 knots. Visibility: 10 kilometers with recent rain.
Lowest cloud: 3 oktas[2] of Stratus at an estimated height of 600 feet above the aerodrome and 6 oktas of Stratocumulus at an estimated height of 3000 feet above the aerodrome.
Temperature: +9° C Dew Point: +8° C.
The sea level pressure setting (aerodrome QNH) was 982 millibars.

1.7.2 *Forecasts*

The Terminal Airfield Forecast (TAF) for Biggin Hill issued by the Central Forecasting Office, Bracknell at 0900 hrs on 18 December 1989 and valid for the period from 1000 hrs to 1900 hrs included the following:

Wind:-170° at 12 knots:
Visibility:-8000 metres:
Weather:-intermittent light rain
Cloud:-3 oktas Stratus at 600 feet and 7 oktas Stratocumulus at 1700 feet

In the period 1000 hrs to 1600 hrs, temporary changes (lasting less than one hour) would reduce the visibility to 3000 metres in moderate intermittent rain with the cloud base lowering to 400 feet. During the period 1400 hrs to 1700 hrs the visibility would gradually improve to greater than 10 km although there would be temporary conditions in the period 1600 hrs to 1900 hrs when visibility was forecast to reduce to 5000 metres in heavy showers with Cumulus cloud based at 1000 feet.

---

2 Cloud amounts are given in oktas or the amount of total cloud cover divided into eighths. Forecast and reported cloud base for a named airfield is given above airfield elevation. Area forecasts give cloud base above sea level.

1.7.3 *Special features*

It was likely that upslope motion of moist air from the southeast over the North Downs would have produced Stratus cloud and hill fog. The moderate southeasterly airflow over the North Downs, supported by 15 knots (reported by Biggin Hill at 1150 hrs and 1250 hrs), is most likely to have produced low level turbulence.

Pilot reports from aircraft operating in the area at the time confirmed the presence of low stratus close to the ground along the escarpment. Conditions to the north and east were generally better.

1.8 Aids to navigation

The primary radar returns from the helicopter were observed and recorded by the radar at London Heathrow airport (51° 28' North 000° 27' West). A simplified plot of these returns is shown at Appendix 2 superimposed on an Ordnance Survey 1:25000 map showing the ground track of the helicopter's flight.

1.9 Communications

1.9.1 *ATC Recording*

Radio and telephone communications with Biggin Hill ATC were continuously recorded throughout the aerodrome's operating period. The relevant transcript of the aerodrome control frequency on 134.8 MHz is reproduced below:

To	*From*	*Recorded intelligence*	*Time*
G-SHBB	BIGGIN	BRAVO BRAVO LIFT APPROVED DEPARTING VFR TO THE (*?one word unintelligible)* EAST ITS ONE FIVE ZERO ONE FIVE KNOTS	
BIGGIN	G-SHBB	LIFT APPROVED DEPARTING VFR TO THE EAST	1204:00
BIGGIN	G-SHBB	AND BRAVO BRAVO TO CROSS TWO ONE	
G-SHBB	BIGGIN	BRAVO BRAVO AFFIRM CROSS	1204:30
BIGGIN	G-SHBB	ER BIGGIN TOWER BRAVO BRAVO	1205:00
G-SHBB	BIGGIN	BRAVO BRAVO	
BIGGIN	G-SHBB	ER YES IF YOU COULD PASS A MESSAGE TO THE OTHER JETRANGER	

		WE'LL BE WAITING FOR THEM IN THE SEVENOAKS AREA AND THEN FOLLOW DOWN THE MOTORWAY TO FOLKESTONE	
G-SHBB	BIGGIN	ROGER THATS FOR DELTA FOXTROT IS IT	1205:30
BIGGIN	G-SHBB	ER ERM THE OTHER JETRANGER ON THE APRON SIR	
G-SHBB	BIGGIN	ROGER	
G-SHBB	BIGGIN	GOLF BRAVO BRAVO REPORT AT SEVENOAKS	
BIGGIN	G-SHBB	CALL YOU SEVENOAKS BRAVO BRAVO	
BIGGIN	G-SHBB	ER BIGGIN BRAVO BRAVO	1207:00
G-SHBB	BIGGIN	BRAVO BRAVO	
BIGGIN	G-SHBB	ER YES SIR WE'RE NOW UNABLE TO MAINTAIN VICTOR MIKE CHARLIE I'LL COME BACK INTO YOU	
G-SHBB	BIGGIN	GOLF BRAVO BRAVO ROGER QFE IS NINE SIX ONE MILLIBARS AND REPORT THE FIELD IN SIGHT	
BIGGIN	G-SHBB	NINE SIX ONE CALL YOU FIELD IN SIGHT	
G-SHBB	BIGGIN	AND SHALL I TELL DELTA FOXTROT TO REMAIN ON THE GROUND	
BIGGIN	G-SHBB	AFFIRM	1207:25
G-SHBB	BIGGIN	ROGER	
G-LFDF	BIGGIN	GOLF LIMA FOX DELTA FOX BIGGIN	1207:30
G-LFDF	BIGGIN	I'VE JUST HAD A MESSAGE FROM BRAVO BRAVO HE IS IN FACT RETURNING TO BIGGIN HE'S UNABLE TO MAINTAIN VMC	
		Open microphone 0.5 second	1208:23
G-SHBB	BIGGIN	GOLF BRAVO BRAVO BIGGIN	1209:00
G-SHBB	BIGGIN	GOLF SIERRA HOTEL BRAVO BRAVO BIGGIN	

1.9.2 *Open microphone transmission*

After the final transmission from G-SHBB at 1207:25 hrs the ATC recording contained a brief "open microphone" transmission. The microphone switching transient signals were examined and compared with those present during previous transmissions from the helicopter. This indicated that the "open microphone" signal had originated from G-SHBB. A normal transient was present at the end of the transmission, indicating that it had ceased before the time of impact.

A frequency spectral analysis was carried out on this final transmission, the duration of which was only 0.5 second. Four discrete frequencies were found to be present. Two of these, 580 Hz and 1160 Hz were somewhat higher, by some 5%, than the 100% once per revolution frequency of the power turbine and its first harmonic. The other two frequencies were 860 Hz and 1705 Hz. The first of these was close to the demisting fan blade passing frequency and the second was close to the 90° gearbox meshing frequency at 100%, although it could also be a first harmonic of the 860 Hz signal. Because the short duration of the signal prevented the frequencies being tracked over a period, it was not possible to be positive about the sources of the frequencies detected.

Because there were no quiet periods during previous transmissions from the helicopter, it was not possible to compare the derived frequency spectrum of the "open microphone" signal with that from the normally operated helicopter.

1.10 Aerodrome information

The height of Biggin Hill aerodrome is 600 feet above mean sea level. The operator had specified certain low level arrival and departure routes so as to avoid built up areas in the vicinity of the aerodrome and to minimise the noise nuisance caused by low flying aircraft. For easterly departures this required skirting the southern edge of Leasons Wood and passing between the villages of Berry's Green and Single Street (see Appendix 1).

1.11 Flight recorders

None was fitted and there was no requirement for any to be fitted under existing regulations.

1.12 Wreckage and impact information

1.12.1 *Crash Site and impact parameters*

The aircraft crashed approximately 1.4 nautical miles east-south-east of the centre of Biggin Hill Airport. Impact was into Blackbush Shaw, a wood on the west side of a north-south orientated valley, at a point where the ground level was 480 feet above mean sea level (amsl). In the area of the crash the trees grew to approximately 30-35 feet height and the terrain sloped upwards around 15° to the horizontal along a bearing of 255° True (T). The surface was of heavy wet clay and chalk with dense undergrowth.

The crash site was characterised by indications of a steep descent through the trees, a very hard ground impact and comparatively short forward travel of the wreckage.

Wreckage, tree and ground markings positively indicated that at contact with the trees the aircraft was erect, tracking approximately 300°T and descending at an angle of approximately 40° to the horizontal. Tree markings from main rotor blades indicated that the flight path and attitude of the aircraft had not materially altered during its descent through the trees. Ground impact parameters could not be established with precision. However, wreckage and site features were consistent with an estimated groundspeed along the flight path of 60-100 kts. Additionally, a detailed assessment of tree markings made by the main rotor during the latter stages of its passage through the trees indicated that at this point the descent rate had been approximately 5000 feet/minute, and that the aircraft had been pitched nose down approximately 20° relative to the horizontal and rolled right around 5°. The evidence indicated that the yaw angle on initial contact with the trees had probably been small. The rates of pitching, rolling and yawing of the aircraft during its descent through the trees and at ground impact could not be established, but the evidence from the wreckage distribution suggested that there had not been a high rotation rate about any axis.

The aircraft sustained some damage during its descent through the trees, including a major tree strike on the leading edge of the left horizontal stabiliser. Wreckage distribution indicated that this caused fracture of the tail boom, but that the remainder of the aircraft did not suffer major break-up before ground impact. Landing gear and fuselage deformation and break-up showed that the aircraft contacted the ground in a nose down attitude with moderate degrees of right roll and left yaw, with a high rate of descent. At ground contact the aircraft suffered gross deformation and break-up, with most of the cabin fragmenting. The evidence suggested (para 1.12.2.2) that some damage may have resulted from main rotor contact with the cabin but that the majority of the damage had been caused by ground impact forces. The largest fuselage remnant, consisting of the upper rear portions of the cabin together with the engine and the forward part of the tail boom, came to rest approximately 12 metres beyond the initial ground contact crater. The remainder of the wreckage was scattered, generally within a 20x12 metre area. One main rotor blade was found impaled tip-first deep into the ground, and the main rotor head and parts of the main blades and other small items were thrown up to 45 metres from the initial ground impact point.

After on-site examination the wreckage was removed to the AAIB at Farnborough for more detailed examination.

1.12.2 *General*

Much of the aircraft suffered gross deformation and break up. The powerplant and forward parts of the tail rotor drive shafting remained in place on the roof of the largest fuselage remnant. With these exceptions, all other parts of the aircraft and its systems were separated, and generally broken up. No evidence was found to indicate pre-impact structural failure of the aircraft, or detachment of any of its components.

1.12.3 *Rotors and rotor drive system*

The main rotor blades suffered a number of complete fractures and the two blades had broken into five main pieces, by generally chordwise fracturing. One blade also exhibited marked bending in a chordwise plane, with the leading edge bent, in plan view, into a concave curve centred around 1.2 metres from the tip and with a convex curve centred around 2.4 metres from the tip. Fracture, bending and marking characteristics were indicative of the combined effects of a major rotational strike on a substantial tree of the leading edge of one blade, around 1.2 metres from the tip, and the impaling tip-first into the ground of the other blade. The only markings consistent with substantial contact of the blades with parts of the aircraft were spanwise scrapes present on a small area of the underside of one blade.

The main rotor head and blade root attachments remained intact, but the main rotor mast was fractured near its top. Mast fracture characteristics were indicative of the effects of combined bending and torsion overload. Main transmission strip examination revealed no evidence of pre-accident failure. Analysis of samples of main transmission oil by the Ministry of Defence Directorate General of Defence Quality Assurance (DGDQA), Woolwich, showed that it met specification requirements for an approved oil.

The tail rotor remained attached to the tail rotor gearbox, itself attached to the separated aft portion of tail boom. Both tail rotor blades had been heavily distorted, with evidence of a tree strike by one blade and inertial bending of the other. Analysis of samples of tail rotor transmission oil by DGDQA showed that it met specification requirements. Tail rotor gearbox strip examination revealed no evidence of pre-accident failure. The tail rotor drive shaft had fractured just forward of the gearbox, consistent with the tail boom fracture, and had disconnected at a splined adapter just aft of the freewheeling unit, consistent with the effects of the powerplant distortion and movement relative to the fuselage found to be present (para 1.12.5.). With these exceptions, the tail rotor drive shafting was intact The shafting was bent in places, and had contacted adjacent components, but no evidence of rotation was present. However, both the tail rotor forward shaft and the flexible couplings were distorted in a manner consistent with the effects of a degree of torsional overload.

The freewheel unit and the engine to transmission driveshaft were intact. However, the splined couplings at each end of the shaft had fractured in a manner consistent with the combined effects of excessive torsion and bending. A main transmission isolation mount located close beneath the input drive to the transmission had been heavily machined rotationally by a flange of the forward splined coupling. Strip examination of the freewheel unit revealed no evidence of pre-accident defect or malfunction.

1.12.4 *Flying control system*

The flying control system had been extensively fragmented, but almost all components of each of the four channels were identified and inspected. No evidence to indicate pre-accident disconnection was found. However, it was not possible to ascertain with confidence that a pre-accident jam had not occurred, given the gross damage and marking of the components. Examination showed that the dual yaw pedals in front of the left forward seat had been connected to the control system during the accident flight.

Strip examination of the three servo actuators of the flying control system revealed no evidence of pre-impact defect or malfunction. Markings within the actuators indicated that they had received major impact with the pilot's cyclic stick in a full right roll/full forward pitch position and the collective lever in a 57% raised position. The position of the yaw pedals could not be established.

1.12.5 *Powerplant*

The engine remained generally intact, but extensively damaged and with engine and accessory gearbox casings distorted. Analysis of samples of engine oil by DGDQA showed that it met specification requirements for ASTO 500 oil and exhibited no abnormal levels of wear metal debris. Analysis by DGDQA of a small sample of fuel recovered from the airframe fuel filter indicated that it met specification requirements for AVTUR (see Para. 1.17.1).

Strip examination revealed a number of features indicative of the engine state at impact. These included heavy axial compressor blade bending opposite to the direction of compressor normal rotation, associated with gross axial compressor casing damage; and extensive distribution of particles of interior lining material from the axial compressor casing through the gas passages of the engine downstream of the compressor. Additionally, there were marks of rotational rubbing of the centrifugal compressor impeller blades on the adjacent static shroud, and widespread signs of rotational rubbing of turbine wheels. There were also extensive deposits of aluminium particles throughout the combustion diffuser, power turbine and gas producer turbine sections. The aluminium particles had adhered firmly to the gas passage surfaces in these areas, but did not show signs of having been completely molten.

The internal shafting of the engine had been damaged in a number of areas, and two shafts had fractured. These were the PT shaft to pinion gear coupling, connecting the output shaft from the PT with the pinion forming the first stage of the PT drive train in the accessory gearbox; and the spur adapter gearshaft, connecting the compressor with a coupling shaft splined to the GP turbine. There were no indications of other than momentary engine running in this damaged condition, and both shaft failures were consistent with the effects of the misalignment of the rotating components of the engine caused by distortion of the engine and accessory gearbox casing. Additionally, all other engine damage was fully consistent with the effects of shock loading and casing distortion. There was no evidence to indicate pre-accident disconnection of the drive train within the engine and accessory gearbox.

Strip examination of the fuel control and power turbine governor units revealed a normal internal condition, with the exception of the drive shaft for the power turbine governor unit. The governor utilised the flexible drive arrangement with the epoxy bonding modification (para 1.17.2). The shaft exhibited heavy fretting near its outer end, to the point where the lip constituting the outer edge of the ring groove had been significantly reduced. Much of the fretting could only have been caused, while the unit was assembled, by contact with the bore of the drive spline, but this was virtually unmarked. The evidence was consistent with the majority of the fretting having occurred during previous running, with the shaft assembled onto the original type of drive spline. A proportion of the frettage was consistent with the unit having operated with the drive spline retaining split ring displaced outboard on the shaft from its correct position in the groove. However, the PT governor had partially detached from the accessory gearbox as a result of fracturing of the governor body flange, and the ring was not found among the wreckage.

Close inspection revealed no signs of abnormal deposits inside fuel system components (para 1.17.1). The fuel burner nozzle was rig tested for flow rate, flow pattern and function, and was found to satisfy requirements.

1.12.6 *Instrumentation*

The instrumentation was generally very severely damaged. Detailed examination provided the following evidence of probable indication at impact with the normal operating range of each parameter shown in brackets :

Dual Tachometer:		
Power Turbine speed N_2	-	99% [97-100%]
Transmission Oil:		
Temperature	-	Approximately 80° or 110°C [15-110°]
Pressure	-	Approximately 80 psi [30-70 psi]
Gas Producer speed N_1	-	80-83% [60-105%]
Engine Oil:		
Temperature	-	Approximately 40-60°C[3] [0-107°C]
Pressure	-	Approximately 100-120 psi [90-115 psi for N1=78.5-94.2%]
Airspeed Indicator	-	70 kt [0-130 kt]
Altimeter Subscale	-	982-983 mb
Radios:		
COM 1 Radio Frequency	-	132.65 MHz
VOR 1 Radio Frequency	-	114.10 or 115.10 MHz
Omni Bearing Selector 1	-	080°
Caution and Warning Panel:	-	No indications of caption illumination

1.12.7 *Cabin heating and screen demisting systems*

The evidence indicated that at impact the cabin heater valve was off. It also suggested that neither demister electric fan was operating, but the evidence was not totally positive. Examination and testing indicated that both demister fan motors were operable.

1.13 Medical and pathological information

Post mortem examination of the commander did not reveal any condition that may have impaired his ability to conduct the flight.

3 Evidence not positive and the indication could have altered as a result of the impacts.

1.14 Fire

There was no evidence of post impact fire.

1.15 Survival aspects

The accident was not survivable due to the high speed of impact and subsequent break-up of the helicopter.

1.16 Tests and research

None.

1.17 Additional information

1.17.1 *Acceptable defects*

The Operations Manual, Section 5 Annex B, stated that "The following defects may be carried, subject to the restrictions below:-

S/No	Item	Restriction
14	DGI	Day only standby compass must be serviceable"

This accorded with Schedule 4 of the Air Navigation Order 1989 which listed, at paragraph (13) (b) (i), the Scale of Equipment Required for 'a helicopter flying for the purposes of public transport and when flying under Visual Flight Rules with visual ground reference'. The required scale of equipment was Scale D which was listed at sub paragraph (i) as follows:

(a) In the case of a helicopter or gyroplane, a slip indicator;

(b) In the case of any other flying machine either;
(aa) a turn indicator and a slip indicator; or
(bb) a gyroscopic bank and pitch indicator and a gyroscopic direction indicator;

1.17.2 *Refuelling bowser*

A few weeks before the accident, the operator had acquired their own refuelling bowser, which had been used to refuel G-SHBB on 18 December 1989, before take-off on the accident flight. Samples of fuel delivered from the bowser after the accident were found to have a strong green colouration, rather than the normal 'water white' appearance of aviation kerosene. Detailed examination was made to establish the cause and possible consequences of the abnormality.

The bowser comprised a trolley-mounted 250 imperial gallon tank, from which fuel could be delivered to an aircraft via a 10 m hose by means of a manually operated pump. The bowser was not marked with its fuel contents type. The unit was around 9 months old, and had reportedly previously been used for aviation gasoline. After filter replacement, the bowser had been filled with Jet A-1 from the Biggin Hill Airport bulk supply on 22 November 1989. It had subsequently been used on two or three occasions to refuel G-SHBB, including the 18 December 1989 refuelling, and for one refuelling of another Bell 206B Jetranger, registration G-SHVV.

Checks after the accident showed that fuel initially delivered from the hose after the bowser had remained unused for around an hour or more was green coloured, and sample analysis showed that it had a grossly excessive level of existent gum, although fuel in the bowser tank was found to be within specification requirements in all respects. After a few gallons had been delivered, the fuel issuing from the hose became clear. Analysis of a sample of the hose showed that it was an ethylene propylene type rubber. This material is normally considered suitable for use with air or water only, and is not approved for aviation fuel use. DGDQA reported that hydrocarbon fuels would probably have a leaching effect on the hose rubber filler, and also that the characteristic blue colour of aviation gasoline AVGAS 100LL can change to green/yellow when contaminated from a hose. Analysis showed that a sample of fuel from G-SHBB contained a slightly higher level of existent gum than samples from the bowser tank, albeit within limits (Para. 1.12.4). A sample from G-SHVV showed no existent gum.

The ANO, Article 82, requires a person managing an aviation fuel installation to be satisfied that the installation will not render the fuel unfit for aircraft use, and is marked with the fuel grade. It is also required when fuel is dispensed that such a person is satisfied as a result of sampling that it is fit for aircraft use. CAA Civil Aviation Publication CAP 434 provides guidance on storage, handling and quality control of aviation fuels at aerodromes. It includes notes on fuel grade changes and hose cleanliness.

1.17.2 *PT governor drive*

A speed sensing element of the PT governor (Bendix Model AL- AA1, Part No. 2524769-10 LI K) is driven from a female splined shaft in the PT drive train of the engine accessory gearbox. This gearbox shaft registers with a drive spline fastened to the PT governor drive shaft (Appendix 3). With the original standard of governor, the bore of the drive spline was in turn splined to accept the splined PT governor drive shaft, but excessive wear of the shaft due to frettage led to modification to a flexible drive arrangement. In this configuration the female splines within the bore of the drive spline are deleted, and the drive is transferred from the drive spline by a spring, to a drive sleeve splined to the governor shaft near its inboard end. The drive assembly is axially retained by a split ring installed in a circumferential groove formed in the shaft near its outboard end. A ring retainer, comprising a rebated disc, is loaded axially against the ring by the drive spring via the drive spline and washer-type shims, and retains the ring in a radial sense. The PT governor of G-SHBB utilised this type of drive.

Excessive shaft frettage had also been experienced with this drive arrangement, and further modification was introduced, under Allison Commercial Engine Bulletin CEB 73-2018, issued 12 January 1981. This required disassembly and inspection for excessive wear, and the addition of epoxy resin to bond the drive sleeve and the ring and ring retainer to the shaft. This modification had been incorporated on the governor drive assembly of G-SHBB.

Information from the governor manufacturer and the aircraft manufacturer indicated that there had been cases of the drive assembly ring detaching in service, but that in all these case the drive spring had remained connected. No further details on these cases could be obtained. It was noted that in the event of disconnection of the governor drive, PT overspeed should be controllable manually by pilot modulation of the throttle twist grip and PT underspeed by application of collective pitch.

1.18 New investigation techniques

None.

2 ANALYSIS

2.1 General

The short duration of the flight, of about 4 minutes, indicated that the causes of the helicopter's final crash into the wood were suddenly induced. Furthermore, the commander's calmly stated radio message, 68 seconds before the accident, that he intended to return to Biggin Hill suggested that, at the time he made the transmission, all was well with the flight. It was highly unlikely, but not impossible, that the commander had suffered from some incapacitation during the interval between his last radio transmission and the eventual impact. Thus two main possibilities existed for the cause of the accident: either some catastrophic technical failure occurred during the last minute of the flight or the helicopter crashed due to loss of control. These possibilities are now examined in the light of the evidence available.

2.2 Impact parameters

The examination of the wreckage and crash site made it clear that G-SHBB had descended into the trees and struck the ground at a very high rate. Although the descent rate was not accurately quantifiable, analysis of tree markings caused by the main rotor provided an approximation, which was in the order of 5000 feet/minute, with the flight path at an angle of approximately 40° to the horizontal. The track of the aircraft at the time of the accident was 300°(T), which was generally downwind, based on the observed surface wind of 150°/15 kt at Biggin Hill, although there could have been considerable local variation at the crash site.

It was apparent from the wreckage characteristics and the site markings that the aircraft had been generally upright during its descent through the trees, and tree markings indicated that attitude relative to the horizontal had been around 20° nose down and 5° right roll. The site markings also suggested that the attitude and flight path of the aircraft had remained comparatively constant during its descent through the trees, and this was reinforced by the indications from the wreckage distribution that there had not been appreciable rates of rotation in pitch, roll or yaw. Some slowing of the aircraft as a result of its passage through the upper branches of the trees would have been expected, but the nature of the tree damage did not suggest that this had been a major effect. This being the case, it was likely that the airspeed indicator reading of 70 kt at the time of major impact, established by inspection of the indicator, approximately reflected the aircraft's airspeed along its longitudinal axis at the time of entering the trees. This was generally consistent with the above parameters, which equated to a groundspeed along the longitudinal axis of the aircraft of around 75 kt, and along the flight path of around 80 kt. It was considered that the extent and nature of the aircraft damage were consistent with these parameters.

It was therefore concluded that at entry to the wood the flight path was approximately 40° below the horizontal at around 80 kt, with the aircraft pitched nose up 20° relative to the flight path and banked slightly right.

2.3 Technical failure

Tree markings clearly showed that the main rotor had been rotating at high speed during the descent through the trees. The appreciable in-plane bending of one main rotor blade, together with tree damage, showed that the blade had made high speed rotating impact with its leading edge, 1.2 metres from the tip, on the trunk of one of the larger trees on the site. While the marked bending suggested that the rotor was probably being driven by the engine at the time of the strike, it did not prove possible to positively differentiate between the effects of torque applied by the engine, and polar inertial effects of the main rotor. The latter effect would have been significant, given the comparatively high rotational inertia of the main rotor on this type of aircraft. However, the characteristics of the damage to the couplings of the shaft connecting the freewheeling unit and the main transmission indicated that the engine was delivering significant torque at the time of major impact.

The witness mark on the dual tachometer corresponding to 99% PT speed was probably a reliable reflection of PT rotational speed at ground impact, as it was considered unlikely that the instrument would have received sufficient shock loading before this point to produce the witness. There were few signs of rotation on drive train components, but considerable evidence within the engine of rotation of both the gas producer and PT spools. The axial compressor blade damage and the wide distribution through the engine of the lining material from the axial compressor and of the aluminium particles from the centrifugal compressor rub, suggested that the engine had been operating at a moderately high power setting at impact. However, it was considered likely that, had the engine been delivering take-off power at the time of the accident, the aluminium particles would have melted and fused more firmly, in the form of a spatter, onto the combustion chamber diffuser and the turbine section than was in fact the case. Experience suggested that the form of the aluminium deposit was consistent with a cruise power setting. It was therefore concluded that the engine had probably been operating at around cruise power at the time of the accident, with PT speed approximately 99%.

The internal damage within the engine, including the shaft failures, was fully consistent with the effects, with both gas producer and PT spools rotating, of the engine casing and accessory gearbox casing deformation found. While there were no clear indications as to the stage at which this had occurred during the impact, the evidence was consistent with the reaction to the major main rotor strike having displaced the transmission back into the engine, causing the deformation of the compressor and accessory gearbox casings and consequent failure of the engine shafts. It was clear from the lack of indications of engine running in this condition, other than momentarily, that the shafts had not failed prior to the accident. A detailed examination revealed no other signs of pre-impact malfunction of the engine or its accessories, with the possible exception of the PT governor.

The condition of the PT governor shaft was a matter of concern. The lack of damage to the drive spline bore indicated that the majority of the shaft frettage had occurred during previous running, possibly with the shaft assembled onto the original type of drive spline. The suggestion from parts of the frettage pattern that the governor had operated with the drive assembly split ring displaced along the shaft could not be confirmed, as the ring was not recovered. However, it raised the possibility of the split ring having detached during normal operation. However, in such a case the drive spline should have been retained by the drive spring, as had reportedly occurred in all previous cases where the ring had detached, and there was no evidence to indicate that the governor had operated with the drive spline detached. Such evidence would have been expected, had this occurred. It was also noted that PT speed, and hence rotor speed, should be controllable with the manual throttle in the event of governor drive loss or erratic operation.

The defect found in the refuelling bowser raised the possibility of gum deposition on fuel system components, causing restriction or blockage of flow passages. The FCU and fuel burner nozzle would be expected to be the most prone parts of the system to such an eventuality, but detailed inspection revealed no evidence of gumming, and flow tests demonstrated that the burner nozzle was not blocked or restricted. Additionally, the analysis of fuel recovered from the aircraft showed that, although some existent gum had apparently been introduced by the bowser hose, the level remained within specification limits. No existent gum was present in the sample taken from G-SHVV, albeit some time after its refuelling from the bowser, and no problems with the fuel system or engine of this aircraft, possibly associated with fuel contamination, were reported. It was therefore concluded that the fuel contamination had not effected the operation of G-SHBB.

From the indications that there had not been pre-accident failure of the main transmission or its drive train, including the freewheel unit, coupled with the evidence of the condition of the powerplant, it was concluded that the main rotor had been operating at about 99% speed at the time of the accident. The tail rotor drive system showed no signs of rotation at impact, but the indication of shaft and coupling overtorsion and the damage to one tail rotor blade were indicative of a significant degree of rotation, and there was no evidence throughout the drive train of pre-accident disconnection. The evidence was consistent with the tail rotor blade having contacted the trees after the PT shaft to pinion gear coupling within the engine had fractured as a result of the main rotor blade major strike. It was therefore concluded that the tail rotor drive train had been intact and operating at around 99% speed at the time of the accident.

The detailed examination of the flying control system showed evidence of major impact with the cyclic stick fully forward and fully right and the collective lever 57% raised. However, the possibility that the controls may have been moved to these positions by crash forces could not be dismissed. The examination found no evidence of a pre-accident malfunction of the flying controls, but the possibility of a jam by a foreign object could not be dismissed. Any marking of the flying control system components resulting from such an occurrence could well have been masked by the extensive crash damage and, while no suspicious objects were found, this could not be considered conclusive, given the nature of the crash site.

2.4 Witness evidence

The thorough examination of the wreckage revealed no apparent failure of any vital component. Several eye and ear witnesses reported unusual noises emanating from the helicopter shortly before it crashed. It is difficult to differentiate between the noise of mechanical components which are in distress and the noises produced by main and tail rotor blades as they operate in disturbed air. Only the most experienced observer of light helicopters could distinguish between the two. Furthermore, detailed examination of the wreckage failed to substantiate any evidence of 'grinding, screeching or backfiring' reported by observers. It must be concluded that they were hearing unusual sounds with an aerodynamic origin and from a helicopter that was flying unusually low and probably erratically.

2.5 The weather

Actual conditions at Biggin Hill aerodrome at the time of the accident were relatively good and could be fairly described as being suitable for VFR flight. The commander was entirely justified in setting off for the flight to Folkestone, indeed a similar type of helicopter had flown the same route a short time earlier, although his initial departure was in a north easterly direction. However, weather conditions in the immediate vicinity of the aerodrome were varied. The local effect of weather conditions on the North Downs escarpment was well known and recognised. The commander, who had flown regularly from Biggin Hill since May 1989, would have been aware of this feature. It is clear that the cloud base was lower along the ridge of the North Downs and visibility was probably reduced in such conditions. It is a mistake to visualise a cloud base at the reported height as being in a horizontal line and, while it was reported at 600 feet at the aerodrome, it may well have lowered in tendrils towards the surface of the ridge.

With the surface air temperature and dew point separated by barely 1°C the local humidity would have been of the order of 98%. Under such conditions the likelihood of condensation 'misting up' the interior of the perspex canopies of the Jetranger would have been considerable although it is quite feasible for the pilot to wipe a clear area of the panel within his reach. Nevertheless, downwards vision through the "chin" panels would be difficult. It is significant that, during examination of the wreckage, there was no indication of any demisting facilities having been selected prior to impact. Thus there was a high probability of extensive misting up of the transparencies, particularly as the cabin air humidity increased due to the presence of the recently embarked passengers.

It is noteworthy that the commander was instructed by ATC to depart from the aerodrome on a heading of 110° (M). This was a routeing with which the commander was familiar and he had been briefed as to its suitability for noise environmental considerations. Having been so instructed, he may have been reluctant on his own initiative to depart on another heading, even though it was more favourable from the point of view of weather.

2.6 Disorientation

Provided the helicopter was fully serviceable up to the time of impact, it probably struck the ground as a result of loss of control. Considering the weather conditions in the vicinity of the accident site and the fact that the commander had turned through 180° in order to return to the aerodrome, it was entirely possible that he had temporarily lost sight of the ground and thus inadvertently entered IMC. This may have occurred prior to his decision to turn back or, more likely in view of the calm nature of his radio transmission announcing his decision, during the early part of the return. Analysis of this radio message indicates two alternatives. Firstly, the commander was implying that if he were to continue in his existing direction he considered that he would be unable to remain in VMC. Secondly, he was implying that he had encountered conditions that were not VMC (i.e. IMC) and in order to vacate such conditions, he was reversing his heading back towards the aerodrome. Knowledge of the commander's flying training and background suggest that the former implication was the more likely.

Another possibility was that during the turn back towards the aerodrome the commander inadvertently encountered IMC. This situation is given greater credence by several eyewitnesses who "saw the helicopter emerge from low cloud". The likelihood of such a situation would be greater whilst the commander's workload in planning and arranging his recovery to the aerodrome would have been high. His reaction to this state of affairs may only be surmised but in any case he would have been immediately deprived of his primary visual reference for attitude control which was by reference to external features. Although he had limited experience of operating by sole reference to flight instruments, he was neither qualified nor experienced to do so, neither was his helicopter adequately equipped for such operations.

2.7 Lack of DGI

Bell 206 Jetranger helicopters are normally equipped with with basic flight instruments that include an Artificial Horizon (AH) and Direction Gyro Indicator, however, the type is not approved for flight in IMC. In VMC, flight instruments are an aid to the maintenance of attitude and heading which is normally accomplished by reference to external features. In the event of inadvertent entry into IMC, the pilot must obviously refer to such flight instruments as he has in order to recover safely to flight in VMC. G-SHBB was not fitted with a DGI at the time of the accident. It removal, due to unserviceability, had been noted in the technical log as a deferred defect awaiting the repair of the defective instrument or receipt of a replacement. The company Operation Manual listed such a deficiency as acceptable for day VFR flights provided that the standby compass was serviceable which it was. It must be recognised that any pilot finding himself inadvertently in IMC would be hampered in his recovery by the omission of such an essential flight instrument. He could attempt to maintain attitude by reference to the artificial horizon but for turning indications he would be obliged to rely on a small standby compass (E2 type) which falls outside his normal instrument scan and is subject to turning and acceleration errors associated with such direct reading types of compass.

Study of the helicopter's ground track (see Appendix 2) shows that the initial 180° turn back was continued onto a more northerly heading than that required to return to the aerodrome. This could be explained by the commander's failure to appreciate the turning and acceleration errors associated with the E2B direct reading compass. The second turn onto a northerly heading may have been either an attempt to avoid low lying cloud or, possibly, an attempt to avoid overflying the houses and school located north east of Biggin Hill town. Equally, the turn could have been made whilst out of sight of the ground: accounting for the witnesses at the Restavon mobile home park seeing the helicopter emerge from low cloud.

2.8 Pilot training and qualifications

Despite the commander's abortive first attempt to obtain a Commercial Pilot's Licence (Helicopters), he had persevered and reached a satisfactory standard on completion of his training with Goodwood Blades Air Academy, Chichester. He had demonstrated an acceptable standard of flying proficiency and airmanship to a CAA examiner. Thereafter, he was judged unlikely to reach the standard required of a co-pilot operating off-shore oil support charters but he was accepted by Starline Helicopters Limited as a commander of public transport light helicopters. In this role his chief pilot found him to be proficient, subject to the chief pilot's own close monitoring of the operations in which he was involved.

The holder of a professional pilot's licence for either aeroplanes or helicopters is not required to pass an Instrument Rating (IR) test as part of his licence qualification. Nevertheless, in the case of an aeroplane pilot the lack of an IR severely limits the use to which he can put the privileges of his licence. Aeroplanes used for public transport frequently operate in controlled airspace, in IMC and at night. In the case of a helicopter pilot, the lack of an IR presents little problem when he is employed to conduct non scheduled public transport flights in helicopters which are permitted to operate only by day and under VFR. In the context of this accident, had the commander been in possession of an IR, it would have added little to his operational capability to cope with adverse weather conditions. However, it may have improved his ability to cope with an inadvertent entry into IMC conditions even though his initial training had included some practice in flight by sole reference to instruments. It would be an anomaly to recommend that commanders of public transport flights in helicopters which are not cleared for flight in IMC require an IR as part of their licence.

3 Conclusions

(a) Findings

i. The commander was properly licensed, medically fit and rested to conduct the flight.

ii. The helicopter had been correctly maintained and prepared for the flight.

iii. The helicopter was correctly loaded within its permitted weight and centre of gravity limits.

iv. Weather conditions at the time of departure from Biggin Hill were suitable for flight in VMC, but conditions over the North Downs escarpment to the south east of the aerodrome were probably unsuitable.

v. The helicopter entered cloud on the return to Biggin Hill following the Commander's reported inability to continue VMC.

vi. Having turned through 180° back towards the aerodrome, the helicopter completed an "S" track pattern prior to impact.

vii. The Directional Gyro Indicator had been removed from the instrument panel due to unserviceability. In accordance with the operator's manual this was acceptable for day flying. Without such a flight instrument recovery from an inadvertent entry into IMC would have been hampered and was probably beyond the experience and skill level of the commander.

viii. Eyewitness reports of hearing unusual mechanical noises from the helicopter and its engine were not substantiated by a detailed examination of the wreckage.

ix. The accident was not survivable due to the high speed of impact.

(b) Causes

The following causal factors were identified:

i. The commander had most likely entered Instrument Meteorological Conditions inadvertently and probably became spatially disorientated.

ii. The commander was neither experienced nor qualified to fly in IMC.

iii. The helicopter's Directional Gyro Indicator had been temporarily removed due to its unserviceability and its absence was likely to have hampered any attempted recovery from an inadvertent entry into IMC.

4 Safety Recommendations

Nil.

R C McKINLAY
Inspector of Air Accidents
Air Accidents Investigation Branch
Department of Transport

December 1990