Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Beechcraft Super King Air 200 G-BGHR Report on the accident near Nantes, France, on 25 September 1979

Translation of the report by

The French Bureau Enquetes - Accidents

LONDON

HER MAJESTY'S STATIONERY OFFICE

List of Aircraft Accident Reports issued by AIB in 1980

No	*Short Title*	*Date of Publication*
1/80	Strojirni Prvni Potiletky Super Aero 145 G–ASWS Lydd Airport July 1978	May 1980
2/80	Piper PA 28 (Cherokee) Series 140 G–AYMJ Carlisle Municipal Airport Cumbria November 1978	August 1980
3/80	Fuji FA 200 G–BEUB Fowey, Cornwall July 1979	August 1980
4/80	Cessna F150L G–BAZP Socata Rallye 150ST G–BEVX Biggin Hill Aerodrome Kent November 1978	November 1980
5/80	Cessna F172L G–BFKS Wycombe Air Park December 1979	January 1981
6/80	Cessna 421 G–AYMM Stansted Airport Essex September 1978	March 1981
7/80	Piper PA-34 (Seneca) G–BFKO Beaulieu Heath Hampshire November 1979	
8/80	Canadair CL44 G–ATZH Waglan Island, Hong Kong	February 1981
9/80	Beechcraft Super King Air 200 G–BGHR Nantes, France September 1979	

ISBN 0 11 513176 0

CONTENTS

Synopsis

Date of the accident:

Tuesday 25 September 1979
at 2020 hrs GMT[1]

Location:

Le Tremblay
St Lumine de Clission (44)

Nature of flight:

High level training flight

Aircraft:

Beechcraft Super King Air 200
Registration G–BGHR

Owner and operator:

Eagle Aircraft Services Ltd
Leavesden Aerodrome

Occupants:

Instructor and Pilot

Brief summary of the accident:

While following an IFR flight plan from Stansted to Exeter, at FL 310, the pilot requested permission to carry out an emergency descent exercise. He was authorised by ATC to descend to FL 120. From that time onwards, G–BGHR failed to respond to calls from the controllers and began circling and drifting southwards. On reaching the end of its endurance the aircraft crashed 11 NM on 115° from Nantes Aerodrome.

Consequences

Crew	Aircraft	Cargo	Third Party
Commander and pilot killed	100% destroyed	None	Some ground damage

[1] *Times are quoted in GMT. Add two hours for French time at the date of the accident.*

2. Factual Information

Conduct of the Enquiry

The duty investigator at the French Accident Investigation Bureau (Bureau Enquête-Accidents) was notified at home on the evening of 25 September 1979 by the duty officer in the IFR room at CRNA Nord, that a Beech 200 was drifting over Brittany. The aircraft was being escorted by Mirage fighters and a Nimrod and was not replying on any frequency. The accident occured at around 2020 hrs.

The investigator went to the accident site the following morning. He returned there on 27 September along with Mr Smart of the UK Accident Investigation Branch, on board an SFACT aircraft. The Beechcraft representative in Europe and an engineer from the Beechcraft headquarters in Wichita were also involved in the work at the accident site.

In accordance with Annex 13 of the Chicago Convention the enquiry was conducted with the participation of the UK Accident Investigation Branch.

2.1 History of the Flight

Eagle Aircraft Services Ltd, based at Leavesden, is the UK distributor for Beechcraft. It sells Beech aircraft and in some cases provides crew training for customers; it also operates transport flights on request.

At the time of the accident, the company was negotiating a contract for the sale of a Beech 200 to the Angolan Diamond Company. It had been agreed that it would train three pilots of that company on the Beech 200. The pilots had already had ground instruction on this type of aircraft from Beechcraft in Wichita, and had reached the flight training stage.

On 25 September, after a flight from Leavesden to Stansted, the instructor had filed an IFR flight plan for Standsted-Exeter, at FL 310, the planned departure from Stansted being at 1400 hrs.

Take-off from Stansted was at 1303 hrs, and during the following 40 minutes G–BGHR flew locally in the Stansted zone where it conducted two ILS approaches followed by an overshoot. At 1345 hrs it was authorised to change from the Stansted frequency and contact the London Centre. The climb to FL 310 was normal. At 1421 hrs the pilot asked ATC whether it would be possible to perform an emergency descent exercise before reaching Exeter, his intention being to begin the descent after passing Dawlish. The controller agreed and asked the pilot to call back when he was ready to begin the manoeuvre. At 1435 hrs the Beech was almost over Dawlish and the crew announced they were ready to begin the exercise. They stated that they would keep a listening watch on the frequency during the descent, but would not be able to transmit while they were donning their masks. At 1436 hrs, G–BGHR was authorised to begin the descent, initially to FL 120. At 1438 hrs the controller gave the Beech a right-hand turn heading for Exeter. At 14.39 hrs he repeated the heading. At 1443 hrs, noting that the aircraft had commenced a turn to the left, he authorised it to turn left to head for Exeter. At 1444 hrs he asked for the pilot to give an identifying 'squawk' on the transponder. He did not receive a reply to any of these communications.

Since 1438 hrs G–BGHR had been describing large circles to the left at FL 310 (see Appendix 1). The wind at that altitude made the aircraft drift towards the south, and it was to pass successively over Guernsey, Jersey, Dinard and Rennes. At the end of its endurance at 2020 hrs the aircraft crashed near Nantes, 20 km to the east/south east of the town.

An RAF Nimrod escorted the Beechcraft during its progress to the vicinity of Nantes. G–BGHR was also followed by two Mirage III and three Mirage F1 of the French Air Force from 1810 hrs until 2010 hrs. The pilots of these aircrafts checked the external condition of the Beech, which appeared normal, the doors and emergency exits were in their normal position, the cabin and cockpit were illuminated and the navigation lights were operating. However, they were unable to make any contact on 121.5 but they all noted the presence of warning lights on the control panel.

2.2 Injuries to Persons

The two pilots were killed.

2.3 Damage to the Aircraft

The aircraft was completely destroyed.

2.4 Other Damage

Damage on the ground consisted of:

destruction of vines

fencing around a field demolished.

2.5 Crew Information

2.5.1 Aircraft commander Male aged 47 years. British.

Qualifications and licences:

Aircraft: US Airline Transport Pilot, IFR rating
UK Airline Transport Pilot, IFR rating
No 34274 of 19. 10. 1964 valid until 29 . 8. 1986

Flying Hours

The Commander joined the CAA in 1972. At that time he had a total of 7330 flying hours, covering a large variety of aircraft including:

as commander:

Baron, Cessna 185, Dornier 27, Duke, Harvard, Lincoln, Musketeer, Proctor, Queen Air, Beech 99, Canberra, Dart Herald, King Air 90 and 100, Meteor, Viscount, Boeing 720 (8 hours)

as co-pilot:

Boeing 707 and 720 (1200 hours), Viscount (36 hours).

From 1972 until the end of 1979, he accumulated around 2000 flying hours, bringing his total at the time of the accident to around 9400 hours. During this period he had flown the Beech 200 and had conducted demonstration flights of the type, but as the log book was not found it has not been possible to determine how many hours he had flown on this particular aircraft.

Helicopter:	UK private helicopter pilot's licence No 34274/H of 30. 3. 1968, licence expired on 21. 3. 1973. Approximately 50 flying hours.

2.5.2 *Pilot:* Male aged 43 years. Portuguese.

Qualifications and licences:	Lieutenant Colonel in the Portuguese Army Reserve, trained in the USA in 1954 on F 84's Portuguese professional pilot's licence ATPL 269/PLAA/1 of 13. 3. 1974, licence valid at the time of the accident.
Flying hours at last renewal of licence on 27. 3. 1979	9550 hrs, including: 7028 hours day; 830 hours night; 1691 hours instrument flying
Type ratings:	Nord Atlas, DC3 and Skyvan.

The pilot attended a theoretical course on the Beech 200 in Wichita on 17–21 September 1979. At the time of the accident he had completed 7 hours flying on this type (not including the accident flight).

2.6 Aircraft Information

Owner and operator:	Eagle Aircraft Services Limited Leavesden Airport, Watford, Herts (UK)

2.6.1 Airframe

The aircraft was practically new, with very few flying hours (total 47 hours 15 minutes). It was a Super King Air 200, serial No BB508, manufactured by the Beech Aircraft Corporation.

UK registration certificate:	G/BGHR/R1 of 16. 1. 1979
Airworthiness certificate:	8690–1 of 23. 5. 1979
Declared use:	Passenger transport
Operating hours since last inspection on 23. 5. 1979:	21 hrs 30 mins[1]

2.6.2 Power Units

Manufacturer:	Pratt & Whitney – Canada
Type:	P T 6A–41
Serial Nos:	PCE 81146 and PCE 81147

2.6.3 Propellers

Manufacturer:	Hartzell Propeller Inc
Type:	HC–B 3 T N–3 G
Serial Nos:	BU 9612 and BU 9620

2.6.4 Equipment

The aircraft had very full radio communication and navigation equipment, covered by Certificate of Approval of Aircraft Radio Installation No 9/94/G–BGHR of 31. 5. 1979.

Between 16 July and 30 July 1979 major modifications were carried out on the aircraft, including the installation of HF communications and long-range navigation equipment. This work involved stripping out some of the cockpit internal trim and the disconnection of the oxygen masks from their outlets. On completion of the work the masks were re-connected and a high altitude test flight was conducted to check the pressurisation. The aircraft had subsequently made five flights up to the day of the accident.

2.6.5 Weight and C.G.

On take-off from Stansted, after topping-up with fuel, the weight on the aircraft was 12,200 lb compared with a maximum authorised take-off weight of 12,500 lb. The centre of gravity, which was close to the forward limit, was within the permitted range.

[1] *Airframe, engine and propeller hours are identifical*

2.7 Meteorological conditions

At take-off, around 1300 hrs, the ceiling at Stansted was about 1200 feet. Part of the cruise at FL 310 was in IMC conditions above a layer of cirrus. This information was obtained from the recording of the communications between the Mirage pilots and Menhir radar.

The chart on which the path of G–BGHR was traced is shown on Appendix 2. The wind in the vicinity of FL 300 was 30–40 kt at 340/360°.

In the Nantes region between 2000 hrs and 2100 hrs there was a lateral sky with 2 to 5/8 altocumulus at 3000 m, estimated visibility 10 km.

2.8 Aids to navigation

No interruption was noted in the operation of the radio navigation aids along the route of the aircraft over the UK or France.

2.9 Telecommunications

From the first contact with Stansted Tower at 1257 hrs until loss of radio contact with London ATC at 1436 hrs, communications were conducted normally and did not present any problem of comprehension for either party.

At 1436 hrs, G–BGHR confirmed, in response to a question from the controller, that during the time required for donning oxygen masks it would maintain a listening watch on the frequency but would not be able to transmit. Thereafter, at 1438 hrs and 1439 hrs the controller gave G–BGHR a right turn heading direct to Exeter. He did not receive any reply to these calls and the aircraft then began turning to the left.

From that time onwards, the various attempts to contact the aircraft by London ATC, Exeter approach and the aircraft which later escorted the Beech were in vain.

Throughout the flight, from the English coast to the vicinity of Nantes, the aircraft kept the same transponder code which was monitored by CRNA Ouest and CRNA Nord until the moment of impact.

2.10 Aerodrome and ground installations

Not relevant in the investigation of this accident.

2.11 Flight recorders

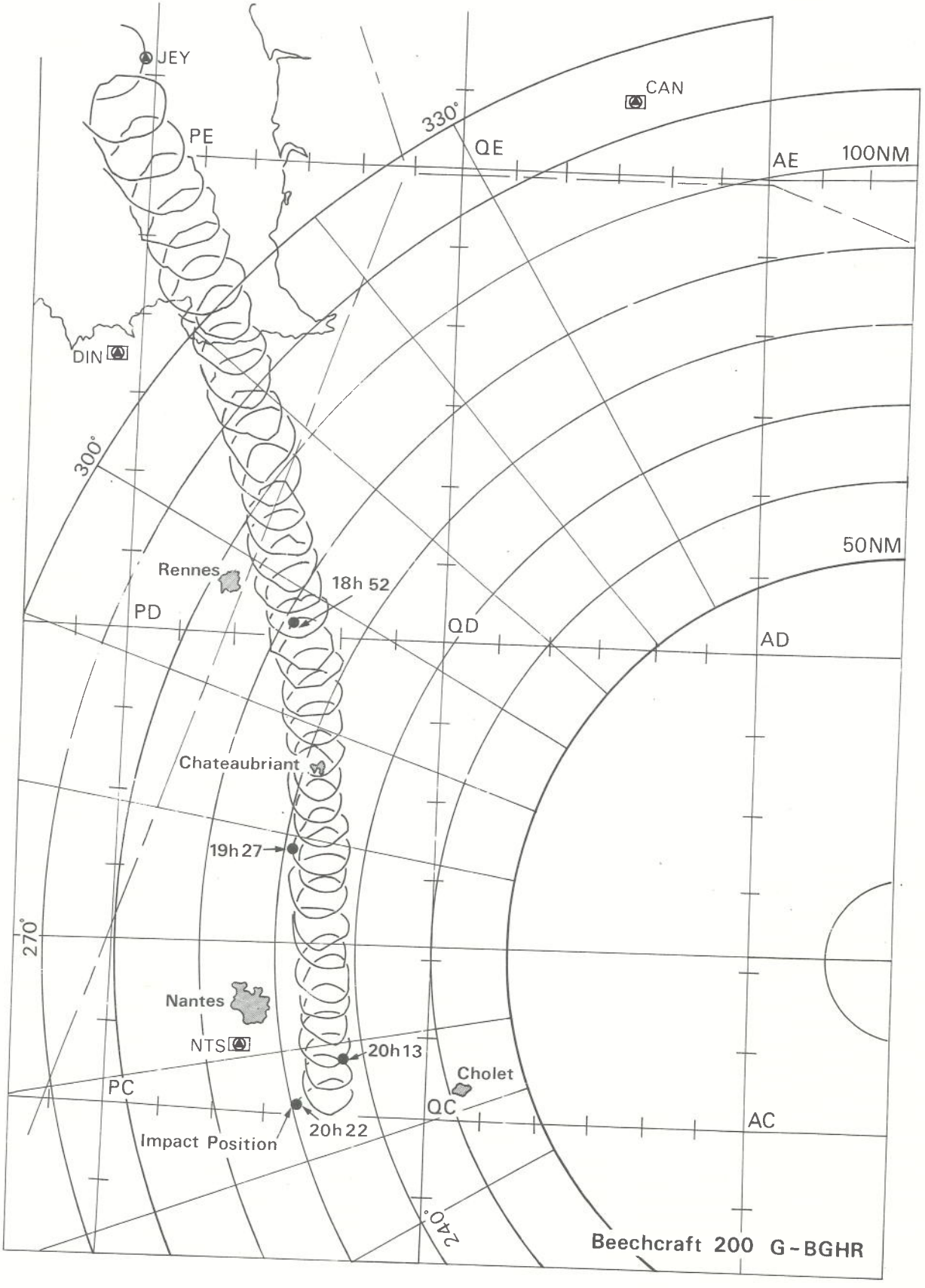
UK regulations do not require the installation of accident recorders on this aircraft, and it was not so equipped.

2.12 Wreckage

The accident occurred on land belonging to the commune of St Lumine de Clisson (Loire Atlantique), approximately 11 NM on 115° from Nantes Airport.

Appendix 2

Track of G-BGHR Derived from French Radar Sources



The point where the aircraft crashed is a small field bordered to the west by a vineyard, to the south by a copse of trees and to the south east by a road. The ground is flat, surrounded by fields and meadows and by the houses of the village of Le Tremblay, some 50 metres away.

The approach axis of the aircraft was roughly 300°. The clump of trees, 12 metres high and less than 10 metres from the centre of the wreckage on the path of the aircraft, was untouched, so the final approach angle of the aircraft would have been more than 50°.

The wreckage was extremely compact, the extent of debris scattering along the longitudinal axis being less than the true length of the aircraft. The two engines were driven almost vertically into the ground. The right wing was on the left of the fuselage and vice versa. The aircraft therefore struck the ground almost vertically in an inverted position.

The wreckage was severely broken up. The wings were separated from the fuselage. The wing spars were broken in several places and the skin of the leading edge of the right wing was crumpled from the root to the tip, indicating that this wing struck the ground in a near-vertical position.

The cockpit was entirely destroyed and due to its condition it was not possible to obtain any useful information about the control panel or the engine controls.

The oxygen cylinder was found in the middle of an area severely damaged by fire. All inlet and outlet lines at the regulator were broken. The angle piece at the head of the regulator, for opening and closing the cylinder, was separated from its control cable and moving freely on its rotational axis.

Fire was restricted to a small area on the oxygen cylinder. The two pilots' oxygen masks were found in the wreckage. The first contained teeth and the second contained part of a jaw, indicating that the pilots were wearing their masks at the moment of impact.

It was not possible to determine whether they were set for dilution or 100 per cent oxygen.

2.13 Fire

The impact was immediately followed by fire; witnesses from the nearby village, alerted by the impact, saw flames rising to a height which they estimated at about 10 metres.

The fire was restricted to a small area centred on the location of the oxygen cylinder. The tail and wings of the aircraft were not affected by the fire. This would lead one to conclude that:

there was no fuel remaining in the tanks on impact

on impact, the oxygen lines to the regulator broke, and the cylinder ignited like a blow torch in the presence of a spark.

There was therefore an appreciable quantity of oxygen remaining in the cylinder at the time of the crash.

2.14 Survival aspects

The autopsy carried out on the two pilots determined that they died from hypoxia.

The violence of the impact was such that the accident would not have been survivable.

The two pilots were wearing their lap straps, but not their shoulder harness.

2.15 Witness statements

During the enquiry, statements were taken from a number of people, including

ground personnel who had worked on the aircraft

the pilots who intercepted the B 200 in flight

pilots of the operating company, Eagle Aircraft Services Ltd

ground witnesses who observed the fall of the aircraft.

2.16 Tests and research

2.16.1 Autopsy on the pilots

The autopsy on the two pilots was carried out by forensic pathologists in Nantes. Dr Underwood Ground (Royal Air Force – Institute of Pathology – Halton), a doctor specialising in aircraft accidents, was in attendance. Examination of the bodies and the analyses were made very difficult by the fragmented nature of the remains recovered.

Nevertheless, it was possible to conclude from the findings that the two pilots died of hypoxia.

Toxicological examinations could be carried out only on the body of the commander. The results are as follows:

blood alcohol level:	less than 5 mg/100 ml
bile alcohol level:	less than 5 mg/100 ml
carboxyhaemoglobin (in a muscle):	less than 1 per cent

2.16.2 Oxygen used for topping up the cylinder in G–BGHR

The oxygen cylinder in G–BGHR was filled on 25 September 1979 at Eagle Aircraft Services Ltd, at the request of the aircraft commander, and the morning flight did not require the use of oxygen masks by the crew.

The oxygen remaining in the cylinders used for the topping-up was analysed by BOC Limited and back-up analyses were carried out at Bridgwater Laboratory (Ministry of Defence). The results of these analyses were in agreement, giving an oxygen purity of 99.7 per cent, the remaining 0.3 per cent consisting of nitrogen and a trace of methane.

The sample analysed therefore complies with the MIL–O–27210 D standards for oxygen in the gaseous state.

The ground personnel who carried out the filling operation had checked that the cylinder pressure shown on the gauge beside the cylinder and on the cockpit gauge was 1800 psi.

2.16.3 Examination of parts removed from the wreckage

The following items were removed from the wreckage and examined at the Saclay Propulsion Test Centre:

oxygen cylinder and regulator

the levers for opening the oxygen cylinder and for manual deployment of the passenger oxygen masks

eleven opening mechanisms for the passenger oxygen mask compartments

one connector from the end of a pipe leading to a pilot oxygen mask.

Description of the oxygen system

The oxygen cylinder, which is situated in an unpressurized zone at the rear of the aircraft, is opened or closed manually from the pilot's position. A cable connects the controls to an angle link at the top of the regulator. This link, when moved in one direction, allows a piston to rise, sending oxygen at 70 psi to the pilots' masks and to a barometric pressure switch; when moved in the other direction it lowers the piston, cutting off the oxygen supply to the line.

When the cabin altitude exceeds 12,500 ft, the barometric pressure switch releases oxygen to the passenger mask compartments. The build-up of pressure in the compartment opening mechanisms displaces pistons and the compartment doors fall away, freeing the passenger masks. This can only operate if the cylinder is open or if there is sufficient residual pressure in the system to actuate the pistons.

In the event of failure of the pressure switch the crew can operate the manual over-ride lever, thereby opening the passenger manual over-ride shut-off valve in the circuit and delivering oxygen to the passenger mask compartments.

The two levers for cylinder opening and manual deployment are on the cockpit roof between the two pilots and slightly to the rear of their seats. The first is marked 'PULL ON SYS READY' and the second 'PASSENGER MANUAL O'RIDE'.

The pilots' masks, which have a constant supply when the cylinder is open, have their outlets on a bulkhead just behind the pilots' shoulders.

(a) Oxygen cylinder and regulator

X-ray examination showed that the piston was almost fully out. Its position was such that the spherical portion was projecting slightly beyond the body of the regulator.

In addition, visual inspection of the regulator head revealed traces of heating which showed that the angle link was in a position corresponding to three-quarters open after the impact.

(b) Controls

The levers for opening the oxygen cylinder and for manual deployment of the passenger oxygen masks were found to be pushed fully home, one being bent upwards and the other downwards.

It is not possible to be categorical about their position before impact, but it seems probable that they were both 'in', since:

their similar state after impact leads one to believe that they were in the same position before the accident, because the pilots, in the absence of any passengers in the cabin, had no reason to operate the manual deployment control;

it is also difficult to imagine a series of impacts in the crash which would have pushed the levers home before twisting them on their axis.

It therefore seems logical, on the basis of these considerations and the state of the controls, to suppose that the lever for operating the oxygen cylinder was in the closed position, and that the cylinder was therefore closed during the flight.

(c) Mechanisms for opening the passenger oxygen mask compartments

There are six of these compartments, each containing two opening mechanisms. A total of eleven actuators was found.

These actuators consist of a spring and a piston. The spring keeps the piston in place within the mechanism; an inflow of oxygen displaces the piston, the end of which then emerges from the actuator housing and strikes the door of the compartment. The door falls away, freeing the passenger masks. Displacement of the piston compresses the spring which resists its movement.

The actuator can thus be in two conditions:

no oxygen pressure: spring relaxed, piston emerging slightly from the housing;

with oxygen pressure: spring compressed, piston fully protruding.

The two actuators in each compartment differ slightly and are linked by a tube. They each include a line to a mask, but only one is connected to the main oxygen line. It was possible to reconstruct the six compartments, apart from one which had an actuator missing.

The actuators were X-rayed. The results are shown on page 11.

In compartment No 2, the springs of the two actuators were compressed and the pistons were fractured level with their housings. In all the other compartments the springs of the two actuators were relaxed, but in each compartment the piston of at least one of the actuators was fractured in the same way as the pistons in compartment No 2.

There must therefore have been oxygen pressure in compartment No 2 at the moment of impact, the pistons being in the 'out' position and fractured level with their housings. The nature of the fractures held the pistons and their springs in position in spite of the

TABLE OF RESULTS

Box No	Type of Mechanism	Remarks
1	A	Spring relaxed. Space occupied. Piston 5 mm out (closed position) and twisted
	B	Different type of mechanism. Spring relaxed. Unoccupied space. Piston broken about 4 mm from change of section.
2	A and B	Springs compressed. Spaces occupied. Pistons fractured level with housing. Mechanisms stuck open due to nature of break.
3	A	Spring relaxed. Unoccupied space. Piston fractured at about 4 mm from change of section
	B	Spring relaxed. Occupied space. Piston intact in closed position, ie 5 mm out (not visible on X-ray print).
4	A and B	Springs relaxed. Unoccupied spaces; pistons fractured about 4 mm from change of section
5	B	Spring relaxed. Unoccupied space. Piston fractured about 4 mm from change of section
6	A	Spring relaxed. Unoccupied space. Piston fractured about 4 mm from change of section
	B	Spring relaxed. Occupied space. Piston intact in the closed position (5 mm out).

oxygen supply being cut off on impact. In the other compartments, the fact that one of the two pistons revealed the same type of break, with the spring relaxed, indicated that this piston was in the 'out' position on impact, and that since it was not held in that position by oxygen pressure or by the fracture it had been returned by the spring.

All the passenger oxygen mask compartments were therefore pressurised with oxygen at the time of impact.

(d) Connector from end of tube leading to pilot oxygen mask

This was found without the corresponding female connector and separated from the tube leading to the mask.

The other two end pieces for the second mask were not found.

The connector is of the bayonet type, and was slightly bent in the middle. Examination under magnification of the parts which receive the pins on the female connector did not reveal any scoring which would have confirmed that the corresponding mask had been connected in flight and detached by the impact.

The results of this inspection are therefore not positive and do not allow any conclusion as to whether the mask was connected or not during the flight.

2.16.4 Functional testing of the Beech 200 oxygen circuit

Ground tests were carried out to determine the capabilities of the oxygen circuit with the cylinder closed.

The aircraft used, a Super King Air, was in the hangar for major modification work. With the oxygen cylinder turned off, all the mask compartment doors fell when the manual deployment lever for the passenger oxygen masks was pulled. All the actuators worked properly. Then, wearing a pilot's mask, it was possible to draw three or four breaths of oxygen. On the fourth inhalation, all the actuator pistons retracted.

2.16.5 Background information on hypoxia

The term hypoxia relates to the difficulties encountered when the body is deprived of an adequate supply of oxygen.

The partial oxygen pressure in ambient air varies between 200 mb at sea level and 60 mb at FL 310, the altitude flown by G–BGHR during the accident flight.

The symptoms of hypoxia, as studied in decompression chambers, are well known and appear in the following order:

increase in respiratory rate

slight headache and slight sensation of vertigo

poor co-ordination and deterioration of judgement

reduction of visual acuity, then loss of vision and unconsciousness.

In every case, the pilot has a sensation of well-being and the impression that everything is going well, and this, combined with a slowing of the reflexes, will remove all critical awareness and will prevent him from being aware of his reduced capability. In a sense this process, once begun, is a vicious circle which is very difficult to break.

An FAA document entitled 'Physiological Training' suggests a consciousness duration of one to two minutes at FL 300. This seems excessive. In a test carried out in an unpressurized aircraft, a doctor in a passenger seat removed his mask at FL 300 and a descent was initiated at 2000 ft per minute. He was rendered incapable after 15 seconds and after 30 seconds had lost consciousness.

These measurements were carried out on someone who knew what was going to happen and was already at external ambient pressure, and was therefore not subjected to the shock of cabin decompression. It would therefore appear that the values quoted above should be further reduced in the event of a decompression.

Furthermore, certain factors can have an unfavourable effect on the useful consciousness time and these include:

physical activity

hyperventilation

the health of the subject

whether or not the subject is a smoker.

2.16.6 Oxygen dilution masks

The oxygen masks fitted to G–BGHR were by Sierra Engineering Co, part No 253-55.

These masks have a two-position lever on the regulator: dilution or 100%. In the '100%' position, inhalation by the pilot opens a valve and 100% oxygen is delivered. In the 'dilution' position, the pilot breathes a mixture of oxygen and air, the air entering through an opening in the side of the mask.

There is no locking system on the 100%/dilution selector. It has been found during tests that the selector could quite easily be moved from the '100%' to the 'dilution' position when donning the mask. In addition, the selector was damaged on several of the masks examined, preventing normal operation of these masks.

This type of mask has been tested at the RAF Institute of Aviation Medicine at Farnborough (Hants). The tests included the manufacturer's check procedures, tests with the mask at the dilution setting at 30,000 ft and tests with the mask in the 100 per cent oxygen position at 30,000 ft.

(a) The ground tests conducted according to the manufacturer's check procedures gave results in accordance with the manufacturer's specifications.

(b) The tests at 30,000 ft with the selector in the dilution position gave mediocre results. When breathing normally, it is difficult to achieve opening of the oxygen valve, respiration taking place almost wholly through the ambient air orifice. When

breathing heavily, the maximum percentage of oxygen obtained was 32%, which is distinctly inadequate for preventing a deterioration of capability.

(c) With the selector in the 100% oxygen position, the mask being tested still allowed ambient air to enter. With normal breathing, the oxygen concentration was 47%, which is below the acceptable minimum. When breathing heavily, the concentration rose to 80%. The poor performance of this mask is due to the fact that on the 100% setting the dilution opening does not close completely, a defect which has been observed on other masks of this type.

To sum up, the tests conducted on this mask by the Institute of Aviation Medicine revealed that:

The mask does not supply adequate oxygen to the pilot when it is in the dilution position and even when it is on '100%' if the pilot is breathing normally.

In the case of the G–BGHR accident, if the masks had been connected and worn with the selector on 100% oxygen, it is probable that the crew, after a period of partial incapacitation, would have recovered fully.

On the other hand, if the masks had been connected and worn with the selector in the dilution position, the oxygen concentration supplied to the crew would have been distinctly inadequate to prevent loss of consciousness. However, after the shock of the cabin being opened to atmosphere, the deeper breathing of the pilot would have opened the valve sufficiently to provide them with enough oxygen to prevent loss of consciousness.

3. Analysis and Conclusions

3.1 Analysis

3.1.1 Period of lost radio contact

The last communication by the B200 with London ATC was at 14 h 36′ 18″. One of the pilots reported that they would be listening in on the frequency throughout the descent, but that they would not be able to broadcast during the period required for fitting the masks. The following two communications were broadcast by the controllers:

at 14 h 36′ 25″, Control authorised G–BGHR to begin the descent

at 14h 38′ 40″, Control gave the aircraft (which was on heading 260°) a heading of 010° for a direct flight to Exeter.

Examination of the radar plot (see Appendix 1) shows that the Beechcraft began turning to the left at around 14h 38′ 20″. Less than two minutes after receiving authorisation to begin the emergency descent, the crew at the controls were therefore unconscious. The aircraft then continued to drift towards the south, as far as the vicinity of Nantes, in wide circles. The 300 mb meteorological chart for 25 September 1979 at 1800 hrs GMT gave a wind of 30 to 40 knots at 340° to 360° at this level. The average ground speed of G–BGHR at FL 310 between Dawlish and Nantes was 40 knots, its route corresponding to the wind direction.

The first circle described by the aircraft after flying over Dawlish had a radius of approximately 8.5 NM. Over Jersey, the radius had tightened to 6.5 NM and over Rennes it was down to 4 NM remaining constant thereafter until reaching Nantes. From the radar readings in the vicinity of Dawlish the ground speed can be calculated as 210 kts, the wind in that area at FL 310 was 33 knots at 320° and in these conditions the aircraft speed was 245 kts.

The flight manual gives the following data for FL 310 at 1700 propeller RPM, at a weight of 11,000 lbs in ISA + 5° conditions: IAS:149 kts, TAS: 250 kts. At a speed of 245 kts, a turn with a radius of 8/9 NM is achieved with 5.5° of bank; over Jersey, the bank increased to 7°, and from Rennes to Nantes it was 12°, assuming constant speed with the ball centred.

However, it appears that the aircraft was flying in a skid turn. The first circle over the English coast took 12 minutes, which would have given a turn radius of 7.8 NM instead of the 8.5 NM observed. Between Rennes and Nantes, the circles took 4′ 45″, and the radius should have been 3.10 NM instead of 4.5 NM. In each case, the angle of the bank was therefore greater than the calculated bank. What is more, the pilots who escorted the aircraft noted a bank angle of some 30°, and an indicated speed of 140/150 kts, which matches the figures derived from the radar recording and the figures in the flight manual.

3.1.2 Role of the automatic pilot

G–BGHR was fitted with a Collins AP 105 autopilot, the control for which was at the top of the control pedestal.

From the English coast to the vicinity of Nantes, the controllers at CRNA Ouest and CRNA Nord had the aircraft on radar at a constant FL 308. There can therefore be no doubt that the altitude hold on the automatic pilot was engaged. As regards the circling by the aircraft, it is likely that the hand of one of the pilots, when he became unconscious at the controls, fell on the turn control wheel, ordering the autopilot to make a turn. On this type of autopilot the wheel does not come back to the neutral position if the turn angle is greater than 2°. During the course of the flight it appears that the turn control was moved slightly further, increasing the bank and reducing the turn radius. When the engines cut out (successively or simultaneously) the autopilot would combat the speed decay by increasing the pitch setting up to the point of stall or autorotation.

3.1.3 Analysis of events at the time of losing radio contact

It had been the intention of the crew to carry out an emergency descent exercise during this high-level training flight.

Two pilots interviewed by the investigators stated that during emergency descent exercises with the commander, he had depressurised the cabin by means of the dump switch. In the case of the first pilot, being tested in a King Air 90, the exercise was carried out at 15,000 feet. In the case of the second pilot the exercise was done twice, once in a King Air 90 at 17,000 feet and again in a Super King Air 200 at around 25,000–26,000 feet. The cabin was first of all opened to atmosphere and only afterwards did the pilots don their oxygen masks.

During the accident flight, according to the last communications between the aircraft and Control, the crew had not intended putting on the masks until after the start of the exercise. They were wearing the masks at the time of impact, as mentioned at the end of paragraph 2.12.

The cabin altitude had exceeded 12,500 ft, the actuator pistons were out on impact and the manual over-ride lever for the passenger masks was pushed in.

One can therefore conclude that the cabin, as in the two cases quoted above, was depressurized in flight.

On this aircraft type, when the dump switch is operated, the differential pressure drops from a maximum of 6 psi to 0 psi in about 20 seconds. The change in the differential pressure is not linear with time, the airflow of course increasing following the opening of the valve.

For practical purposes one can regard the cabin pressure as being equal to the external pressure after about 15 seconds.

The condition of the wreckage and the examination of the one oxygen mask hose connector recovered did not allow determination of whether the pilots' oxygen masks were connected during the flight. However, given that the crew were wearing masks and the oxygen circuit contained oxygen, if the oxygen cylinder had been closed and the masks connected the breathing of oxygen by the pilots would have caused the retraction of the actuator pistons for opening the passenger oxygen mask compartments. In fact, all these actuators were in the 'out' position on impact, and one is therefore led to the

conclusion that the pilots were wearing their masks, but that the masks were not connected and that they were breathing ambient air through the dilution opening on the side of the mask.

It should be noted that on G–BGHR the blinker (oxygen flow indicator) is situated on the pipe about 20 cm from the masks, in other words roughtly at waist level, and is therefore not in the pilot's direct field of vision.

The Flight Manual checklist, under the heading 'Before engine start-up', lists the following operations relating to the oxygen system.

BEECH AIRCRAFT CORPORATION — FLIGHT MANUAL

WICHITA – KANSAS — KING AIR 200 AND 200C

2ND EDITION

REVISION N°

---

18 Radiant heat OFF

19 Mike switches – NORMAL

20 Oxygen supply pressure – CHECK

21 Oxygen supply control handle

Auto deployment system – PULL ON System READY

Plug-in System – PUSH OFF

22 Quick-donning crew oxygen mask CHECK – selector lever 100%

23 Circuit breakers – IN

(Extract from flight manual, p IV – 5/27)

Item 22 'Quick-donning crew oxygen mask – CHECK' does not describe the check to be made in sufficient detail. In practice, once the cylinder is open, in order to check that the oxygen system and mask are operating correctly, one has to draw a minimum of four or five breaths through the mask, because the line holds enough for three or four breaths.

In addition, the 'before engine start-up' checklist gives no indication that the masks have to be connected.

3.2 Conclusions

3.2.1 Findings of the enquiry

1 The crew held the appropriate licences and qualifications for the flight.

2 The aircraft was in an airworthy condition.

3 The accident flight was a training flight for the purpose of obtaining a type rating.

4 While cruising at FL 310, the pilots were not wearing oxygen masks, contrary to UK requirements for this type of aircraft.

5 The intention of the crew had been to carry out an emergency descent exercise from FL 310 to FL 120.

6 At the start of the exercise the crew depressurized the cabin and donned their oxygen masks.

7 Very soon after the start of the exercise, the aircraft ceased to reply to the controllers and began to drift.

8 The pilots of the aircraft which escorted the Beech did not see any sign of life in the cabin.

9 The aircraft crashed at the end of its endurance.

10 The oxygen cylinder contained oxygen, and there was still an appreciable quantity remaining at the time of impact.

11 It has been possible to conclude from tests carried out that the pilots' oxygen masks were not connected.

12 The crew breathed ambient air through their masks and were rapidly overcome by hypoxia.

13 The autopsy carried out on the pilots confirmed death by hypoxia.

14 Tests carried out on the same type of mask as that used in G–BGHR showed that the mask examined was unsuitable for its intended use.

15 The Flight Manual checklist for 'before engine start-up' is insufficiently detailed as regards the checks to be carried out on the oxygen system.

3.2.2 Probable causes

The immediate cause of the accident was the aircraft striking the ground at a steep angle.

The cause of the accident was depressurization of the cabin at high altitude by the pilot. This exercise is too dangerous to be carried out on an aircraft in this class, in view of the useful consciousness time available to the pilots in the case of any failure of the oxygen circuit. In this particular case, the oxygen masks were not connected and the crew died in flight due to hypoxia.

4. Safety Recommendations

Following this accident, and in view of the work of the investigation and the results, the French Accident Investigation Bureau makes the following recommendations:

Pilots flying pressurized aircraft of this type at high altitude should be provided with full information on the dangers of hypoxia.

Cabin depressurization exercises at high altitude in aircraft of this range, should not be permitted without the crew wearing their masks, because of the very limited useful consciousness time available to pilots in such cases.

All necessary steps should be taken to ensure that pressurized aircraft flying at high altitudes are equipped with suitable oxygen masks.

On the Beech 200 Super King Air, the levers for opening the oxygen cylinder and for manual deployment of the passenger masks should be modified in order to differentiate between them, and their labelling should be changed to make it clear that the latter is an emergency control.

Produced in England by Her Majesty's Stationery Office, Reprographic Centre, Basildon

Bas 81823/R151 K6 3/80 TP