AIRCRAFT ACCIDENT REPORT 3/86

Accidents Investigation Branch

Department of Transport

Report on the accident to Piper PA31 G–BHIZ at Bluebell Hill, Burham, Kent, on 20 November 1985

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

3 October 1986

The Rt Honourable John Moore
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr R C McKinlay, an Inspector of Accidents, on the circumstances of the accident to Piper PA31, G–BHIZ, which occurred at Bluebell Hill, Burham, Kent on 20 November 1985.

I have the honour to be
Sir
Your obedient servant

G C WILKINSON
Chief Inspector of Accidents

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Accidents Investigation Branch

Aircraft Accident Report No. 3/86
(EW/C943)

Operator:	GEC Avionics Limited
Registered Owner:	Oxaero Limited
Aircraft: Type:	Piper PA 31
Model:	Turbo Navajo
Nationality:	British
Registration:	G–BHIZ
Place of Accident:	Bluebell Hill, Burham, Kent
	Latitude 51° 20′ N
	Longitude 00° 29.5′ E
Date and time:	20 November 1985 at 1848 hrs
	All times in this report are UTC

Synopsis

The accident was notified to the Department of Transport Accidents Investigation Branch at 1910 hrs on 20 November 1985. An investigation began the next morning.

The accident happened when the pilot was making a second visual approach at night to Rochester aerodrome and flew into the steep upper slopes of Bluebell Hill, some 2000 metres to the south west of the aerodrome. Weather conditions throughout south east England were generally poor with warnings of snow, frost and fog in force. Following ground impact there was a severe fire which destroyed the aircraft. The three occupants of the aircraft were killed.

The report concludes that the accident was caused by the pilot's failure to maintain adequate terrain clearance during a visual approach at night in poor meteorological conditions. The proximity of an escarpment 137 feet above the runway threshold 2000 metres from touchdown, and the visual illusion created by an approach over featureless and unlit terrain contrasting with relatively bright urban lighting to the north of the airfield, known as the "black hole" effect, were contributory factors.

Two safety recommendations are made.

1. Factual Information

1.1 History of the flight

The aircraft left Rochester aerodrome at 1140 hrs on 19 November 1985 on a private business flight to Paris, landing at Le Bourget. The pilot and his two passengers, who were all employed by the same company, remained overnight in Paris. During the early afternoon of that day the pilot was the victim of a criminal assault and robbery. His hand wallet containing personal documents and cash was stolen. The pilot made a statement to the French police and listed the items that had been stolen from him. This list did not include the spectacles that the pilot was required to wear for correction to his near vision.

At 1705 hrs on Wednesday 20 November 1985 G–BHIZ, with the same pilot and two passengers, left Le Bourget and flew to Southend Airport where it landed at 1816 hrs following a Surveillance Radar Approach (SRA) to runway 06. The pilot and passengers were cleared by H.M. Customs, and the pilot checked with the duty air traffic control assistant who had already booked him out for his onward flight to Rochester. The aircraft took off from Southend at 1831 hrs and climbed to 1500 feet before turning right on to a heading of 180°.

At 1839 hrs the aircraft was south of the Southend Special Rules Zone (SRZ) and at this point descended below the radar cover of the London Terminal Control Area. The aircraft was seen to pass over the village of Lower Upnor which lies on the direct track to Rochester from Southend. At 1842 hrs the pilot of G–BHIZ established radio contact with Rochester Aerodrome Flight Information Service (AFIS). The AFISO reported to the pilot his unofficial estimation of the weather conditions at Rochester which were: Wind 010° at 10 knots, visibility 2000 metres in rain and snow, cloud base 600 feet. He also reported an accumulation of approximately 2 centimetres of snow on the runways. At 1844 hrs the pilot asked if the AFISO could see the aircraft. When the pilot reported "downwind" the aircraft was seen by the AFISO to be in a downwind position at an estimated height of 300 to 400 feet. The pilot reported that he was "losing the field". The AFISO next saw the aircraft overhead the aerodrome at a similar height, it was heading in a north westerly direction. The pilot was told by the AFISO that he could be seen passing overhead the aerodrome. The aerodrome pressure setting (QFE) of 1007 millibars was confirmed. At 1845 hrs the pilot again reported "downwind" and was observed at the same position and height as before. About one minute later the pilot reported "2½ miles finals with three greens". He added that if he was not happy with the approach he might try an approach to runway 21 (the reciprocal runway).

The aircraft was not seen again from the aerodrome visual room. Several eye witnesses in the village of Burham (Sheet 188 O.S. TQ 7262) saw the aircraft approach from the north along the River Medway Valley and follow a left hand curved track, putting it on course for the aerodrome. The aircraft flew directly over the centre of Burham. It was judged to be lower than normal, the landing lights were on, and both engines were running normally.

Eye witnesses saw a ball of flame shortly after hearing the aircraft impact with the steep upper slopes of Bluebell Hill which is 500 metres north of Burham. The aircraft fuselage was completely destroyed by an intense fire which caused the deaths of two of the occupants. The third occupant was killed on impact.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	2	–
Serious	–	–	–
Minor/none	–	–	

1.3 Damage to aircraft

The aircraft was moderately damaged by the ground impact and destroyed by the subsequent fire.

1.4 Other damage

A small area of uncultivated woodland was flattened and burnt in the accident.

1.5 Personnel information

1.1.5 *Pilot:* Male, aged 50 years

Licence: United Kingdom Commercial Pilot's Licence (CPL) issued by Civil Aviation Authority in November 1976. Instrument Rating last renewed 7 December 1984. Certificate of Test last completed 11 April 1984. (See Note.)

Last medical examination: 12 July 1985. Limitation stating "Pilot is required to wear spectacles to correct for near vision and to have available a second pair of spectacles whilst exercising the privileges of the licence".

Flying experience

– total:	5525 hours
– on type:	3011 hours
– last 28 days:	30 hours
– last 24 hours:	1 hour 30 minutes

(NOTE: An Aircraft Rating – Certificate of Test may be signed by an authorised examiner on FCL Form 150/C and placed inside the cover of a pilot's licence. An appropriate entry recording the test is made in the pilot's personal flying log book. In those circumstances where the pilot is required to carry his licence with him during a flight it is possible that the certificate may be destroyed in an accident. Non public transport operators are not required under current legislation to maintain crew training records. For this accident, evidence of the last Certificate of Test being completed was obtained from the pilot's log book.)

Duty time:	3 hours (estimated)
Flight time:	1 hour 28 minutes on the day of the accident.

1.6 Aircraft information

1.6.1 General

The aircraft was a piper PA–31 Navajo fitted with twin six cylinder Avco Lycoming TIO–540–A2C turbo-charged and fuel injected engines, driving three bladed Hartzell variable pitch propellers. The aircraft was manufactured in May 1970 by the Piper Aircraft Corporation of the USA.

1.6.2 Leading particulars

Registration:	G–BHIZ
Type:	PA–31, Serial No: 36–672
Certificate of Airworthiness:	Transport Category (Passenger) issued 12 April 1985. Valid to 11 April 1986.
Certificate of Maintenance:	Issued: 5 September 1985 at 4077.27 airframe hours. Valid to 5 December 1985 or 4177.27 airframe hours, whichever was sooner.
Total airframe hours:	4150 hours
Maximum authorised weight:	6500 lb.
Maximum landing weight:	6200 lb.
Weight at the time of the accident:	5617 lb.
CG range:	Datum is 137 inches forward of the wing main spar centreline. At 4800 lb or less – 120 inches to 138 inches aft. At 6000 lb – 128.5 inches to 138 inches aft.
CG the time of the accident	128.5 inches aft.

1.7 Meteorological information

1.7.1 Synoptic situation

An anticyclone centred over Scandinavia maintained a cold north easterly airflow over the British Isles. A weak occlusion moved slowly southwards, lying from a position at Latitude 54° North Longitude 03° West to Wittering and Bristol at 1900 hrs.

1.7.2 *Forecast conditions*

The area forecast for Kent, Surrey and Sussex, issued by the Meteorological Office at Heathrow for the period 1400 hrs to 2000 hrs on 20 November 1985, included the following details:

Surface wind:	360° – 020°/10 – 15 knots
Temperature:	–4°C at 2000 feet
Cloud:	Scattered broken stratus especially in precipitation base 1000 feet, tops 1500 feet, isolated base 600 feet, covering hills. Overcast stratocumulus layers base 2000 feet, occasionally 1500 feet, tops 7000 feet.
Visibility:	3000 metres to 6 kilometres. Isolated 1500 metres in snow, 300 metres in hill fog.
Weather:	Outbreaks of rain or snow or rain and snow.
Height of 0°C isotherm:	Below 500 feet.
Airframe icing:	Moderate, isolated severe.
Warnings:	Fog and snow.

1.7.3 *Reported conditions at Southend 1820 hrs and 1850 hrs*

Surface wind:	010°/10 knots and 360°/13 knots at 1850 hrs.
Visibility:	4500 metres in rain and snow.
Cloud:	3 oktas stratus at 700 feet 4 oktas stratocumulus at 2000 feet 8 oktas stratocumulus at 2800 feet
Temperature:	+ 2°C
Dew point:	+ 1°C

1.7.4 *Aftercast conditions at Rochester 1844 hrs*

The Meteorological Office, Bracknell have assessed the following conditions based on actual conditions reported to them:

Surface wind:	360°/15 knots
Visibility:	3000-5000 metres (but less than 500 metres in any hill fog).

Cloud:	Broken stratus at 600-1000 feet (may be hill fog to south and west south west of Rochester). Possibly broken stratocumulus patches at 1500 feet with overcast stratocumulus at 2800-3000 feet.
Weather:	Intermittent rain or mixed rain and snow.
Freezing level:	Approximately 500 feet.
Icing Index:	Moderate to severe in any cloud.

1.7.5 The following meteorological warnings were in force having been issued by the Meteorological Office, Heathrow.

Snow warning:	Number 116 for the period 1800 hrs 20 November 1985 to 0600 hrs 21 November 1985. Snow occasionally rain turning to rain and snow at times but not expected to lie with negligible amounts.
Frost warning:	Number 117 for the period 1600 hrs 20 November 1985 to 0900 hrs 21 November 1985. Slight frost expected overnight with minimum air temperature zero to −1°C.
Fog warning:	Number 115 for the period 1100 hrs 20 November 1985 to 1800 hrs 20 November 1985. Stratus may lower at times, reducing visibility to 200 metres or less.

1.7.6 The accident occurred in darkness 2 hours and 33 minutes after sunset at Latitude 51°30′ North on 20 November 1985.

1.8 Aids to navigation

1.8.1 *In the aircraft*

The aircraft was fitted with sufficient radio and navigational aids to permit flight under Instrument Flight Rules in controlled airspace.

The equipment included twin installation of very high frequency omni range (VOR), an area navigation system (R Nav – KNS 80), automatic direction finder (ADF) and a radio altimeter (height).

1.8.2 *On the ground*

There are no radio aids to navigation located at Rochester aerodrome. The nearest radio beacon is the Detling VHF Omnidirectional Radio Range and Distance Measuring Equipment (VOR/DME) which radiates on a frequency of 117.3 MHz. It is located at a range of 4.5 nautical miles on a bearing of

136° magnetic from Rochester aerodrome. There is also a VOR/DME beacon at Biggin Hill located at a range of 18 nautical miles on a bearing of 272° from Rochester aerodrome. It radiates on a frequency of 115.1 MHz. Both VOR/DME beacons were serviceable and operating at the time of the accident.

1.9 Communications

Transcriptions of all radio telephone (RTF) communications between G–BHIZ and Southend approach and aerodrome control were obtained. The final communication was at 1839 hrs when the pilot of G–BHIZ reported clear of the Southend Special Rules Zone and was instructed by the Southend approach controller to "Continue with Rochester". This instruction was acknowledged by the pilot.

There is no requirement to record RTF transmissions at Rochester and no such facility is maintained. The following summary is based upon log entries made by the duty AFISO.

1842 hrs G–BHIZ established contact and was passed the following details: Runway in use 03 left hand. Surface wind 010°/10 knots: visibility estimated to be 2000 metres in rain and snow: cloud base estimated to be 600 feet; QFE 1007 millibars; Runway wet with accumulations of approximately 2 centimetres of wet snow.

1844 hrs Reply in negative to pilot's enquiry as to whether the AFISO was in visual contact with the aircraft. G–BHIZ reported downwind and was seen from the visual room. G–BHIZ was seen overhead approaching from the south and heading in a north westerly direction at an estimated height of 300 to 400 feet. After reporting "downwind" the pilot said that he was "losing the field". The QFE of 1007 millibars was confirmed.

1845 hrs G–BHIZ reported downwind. Aircraft in visual contact again.

1846 hrs Reported final, 2½ miles, 3 greens. The pilot said that if he was not happy with the approach he might try an approach to runway 21.

1848 hrs Loss of RTF contact with G–BHIZ.

1.10 Aerodrome information

1.10.1 Rochester

The elevation of Rochester aerodrome is 436 feet above mean sea level (amsl). The threshold elevation of runway 03 is 415 feet amsl; it is 827 metres long and 32 metres wide. The runway surface is grass. The aerodrome is licensed by the Civil Aviation Authority for use at night. At the time of the accident the elevated low intensity runway and threshold lights were switched on at maximum intensity. A white flashing strobe light located on the control tower was switched on. An Abbreviated Precision Approach Path Indicator (APAPI) set

Note: All times are approximate but are thought to be accurate to within one minute.

to indicate a 4° glide path had been approved for night use by the Civil Aviation Authority and a NOTAM to that effect was published on 13 November 1985. A visual approach using this aid would place an aircraft at a minimum height of 964 feet above the aerodrome elevation at a range of 2½ miles from the threshold of runway 03 and at 361 feet above the accident site. (See Appendix 1b.) APAPI lights are visual along a horizontal arc 15° either side of the runway centreline. It has been established by flight trials that the APAPI lights may have been seen from a position overhead the accident site and from a position overhead Burham village.

The APAPI equipment for runway 03 was switched on by the duty AFISO at about the time that initial contact was established with G–BHIZ (1842 hrs). The Manual of Aerodrome Licensing (CAP 168) recommends that APAPI units are switched on 15 minutes before an aircraft is due to make an approach. This is to allow time for the lens heater to clear any condensation which may cause the red lights to be refracted into the white lights. In such a situation the red light indicating a position below the safe glide path could appear as a white light indicating to the pilot that he is on or above the glide path.

1.10.2 *Southend*

The elevation of Southend airport is 48 feet amsl.

1.11 Flight recorders

Flight recorders were not required to be fitted and none were fitted.

1.12 Wreckage and impact information

1.12.1 *On site examination (see Appendix 2)*

The aircraft, whilst on a track of 050°(M) had struck the south west facing tree covered escarpment of the North Downs, to the north east of the village of Burham. Its point of impact was some 45 feet below the local crest of the ridge which was 510 feet amsl. Relative to the aircraft's path, the local upslope in the area was 12° with a 4° cross slope down to the left.

The aircraft had come to rest within approximately 80 feet but for the first 40 feet of this distance it had made only light contact with the trees and bushes which covered the slope.

From this point, the aircraft had suffered moderate damage as, in quick succession, the right wing outboard of the engine and the three undercarriage assemblies were torn off by tree and ground contact. The aircraft had come to rest on a heading of 026°(M), with the left outboard wing partially detached, but otherwise structually intact. An intense post-impact fire had consumed a large part of the fuselage and centre wing structure.

All the aircraft wreckage was contained within an approximate area of 60 feet by 45 feet, except for the battery, which had been thrown forward about 80 feet.

It was determined from the aircraft's path through the trees that it had been in a wings and nose level attitude with a flight path between 0° and 2° up.

Due to the effects of the intense fire, examination of instrument readings and settings revealed no useful information.

Immediately before striking the surface of the slope, the propellers had each chopped through a tree trunk of 6 to 7 inches diameter with the left engine and 5 to 6 inches diameter with the right engine. The stump of the right side tree remained firmly embedded in the ground, the plane of the cut surface contributing to the assessment of the aircraft's attitude just prior to impact.

1.12.2 *Subsequent examination*

A detailed examination of the wreckage was conducted at the AIB Farnborough. Much of the aircraft's structure had been burned away. Generally those items manufactured from steel had not been consumed. It was, however, possible to determine that the aircraft had been structurally complete prior to the impact. The undercarriage had been lowered and the flaps were extended to 15°. Several overload failures had occurred in the aileron main and trim cables as a result of disruption to the outer wings but these systems were otherwise intact. The rudder trim tab operates through a normal range of 40° left to 18° right and was found to be 2.25° to the right. The elevator trim tab operates through a normal range of 29° down to 16° up and was found to be 2.5° down. Since no failures had occurred in the drive cables to either tab screwjack and there was no major disruption to the fuselage it is likely that the trims were found to be set close to their settings prior to impact. The aileron tab was found in the maximum down position which was consistent with the failure at impact of both drive cables. All the primary flying control surfaces were present in the wreckage with evidence to show that they had all been correctly attached to their respective parts of the airframe at impact.

Examination of the propeller assemblies revealed closely similar patterns of damage consistent with their delivering a low to medium level of power during impact sequence. Some circumferential score marks were present on one blade of each assembly.

Inspection of the engine and propeller control cables and their units on the engines revealed the propellers to be positioned towards their maximum RPM positions and the mixture controls to be towards the fully rich position. The power control for the right engine was set towards the high power end of its travel. The power control cable for the left engine had separated from the operating lever of the fuel injection unit. Deformation of the cable sheath mounting adjacent to this unit had occurred at impact in such a direction as to pull the operating arm over onto its low power stop which is the position in which it was found. The cockpit end of this cable was found in a high power setting to which it would have moved as a result of the impact disruption.

The major components of the fuel selection system were recovered from the wreckage. Despite being severely damaged by fire it was possible to determine that both firewall shut-off valves had been open, the crossfeed

cock had been closed and each engine had been drawing fuel from its respective main fuel tank. These selections are consistent with normal operation of the aircraft on approach to land.

Damage to the engines was caused primarily by the post-impact fire. No evidence was found of any mechanical disruption or pre-impact failures within the units or their accessories, although heat damage precluded functional testing of most components.

The airframe de-icing system of the PA 31 uses pneumatic boots which are fitted to the leading edge of the outer main planes, tailplane and fin. Since so much of the system had been consumed by fire it was not possible to establish fully the serviceability of the system. Those parts recovered had suffered damage that was consistent with the impact and fire.

1.13 Medical and pathological information

1.13.1 Post mortem examination revealed that the pilot and front seat passenger died from the effects of the severe post-crash fire, having been incapacitated by multiples injuries at impact. The third occupant of the aircraft died from multiple injuries, including a severe fracture of the skull, sustained at impact. There was no pathological evidence to indicate that the pilot was in other than good health prior to the accident.

1.13.2 The pilot was required under a limitation to his medical certificate to wear spectacles to correct for near vision and to have available a second pair whilst exercising the privileges of his licence. His eyesight was last tested on 13 November 1985 when his prescription was:

Left eye + 0.75 dioptre

Right eye + 0.5 dioptre

For reading add + 1.75 dioptre

Without correction the pilot would experience difficulty focussing on objects closer than about 31.5 inches and 25 inches to his left and right eyes respectively. The average distance from a pilot's eye to the PA 31 captain's altimeter is 20 inches. One pair of spectacles made up to the new prescription and to replace a broken pair, were awaiting collection from the pilot's optician. A tin spectacle case labelled inside with the pilot's name and containing a pair of Japanese sunglasses was recovered from the wreckage. In all probability the pilot had in his possession one pair of spectacles made to his original prescription. It cannot be determined whether he used them during the accident flight.

1.14 Fire

It is calculated that the aircraft was carrying 88 imperial gallons of 100 LL aviation gasoline at the time of the accident. Most of the fuel was likely to be contained in two main fuel tanks positioned in each wing leading edge and extending from the root to approximately the mid-span position. When structural disruption of the outer wings occurred during the impact these

tanks, as well as the auxiliary ones which are positioned behind and further outboard, were ruptured. This allowed the contents to spill out and pool around the wreckage, thus contributing greatly to the intense fire. Very little forward splashing of fuel occurred.

Units of the Kent Fire Brigade arrived at the scene of the accident at 1906 hrs. The fire was extinguished using a water hose from a fire fighting appliance.

1.15 Survival aspects

1.15.1 It is certain that one of the occupants did not survive the impact. Although the other two occupants, who were sitting in crew seats, died from the effects of the fire it is considered possible that they could have survived the impact, particularly if the seats had remained in their installed positions.

The passenger seats in this aircraft were mainly constructed from aluminium and did not survive the fire. The crew seats, however, were of tubular steel construction and available for examination. Each seat had been mounted on two aluminium rails attached to the cockpit floor. Rollers at the base of each leg supported the seat load and provided a means of fore and aft adjustment, whilst a claw shaped bracket retained each leg to the rail.

Evidence was found of distortion of most of these claw brackets, sufficient to allow the seat either to detach completely from the rail or pitch and slide forward. The nature of this distortion suggested that both seats had experienced lateral and vertical loading.

The crew retaining harnesses consisted of lap straps which were attached to the seat frame and a diagonal strap running from the fastening buckles to inertia reel units mounted on the upper fuselage wall behind each seat. Both harness release buckles were recovered from the wreckage in a fastened condition including the diagonal strap attachment clip. It was not possible to assess the performance of the inertia reel units due to the effects of fire.

1.15.2 Current British Civil Airworthiness Requirements (BCARs) are similar to their American equivalent for the class of aeroplane in that they specify the safety of occupants must be fully considered up to the prescribed maxima of acceleration as defined in the emergency alighting case. The values quoted, up to a maximum resultant of 9g, are 9g forwards to 1.5g rearwards, 4g downwards to 4.5g upwards and 0 to 2.25g laterally. BCARs recommend, however, that inertia forces corresponding to higher accelerations than those prescribed should be used for the design of seat and equipment attachments, since in the event of a crash it is desirable to protect occupants from injury by detached equipment and seats.

Whilst the inertial loading on the crew seats in G–BHIZ during the accident cannot be determined exactly, it would appear to have been in excess of the figures quoted above but below levels known to be incapacitating or fatal. Most of these two occupants' injuries would appear to have resulted from contact with parts of the airframe following seat detachment rather than from high accelerative loading.

A wealth of data exists to illustrate the limits of human tolerance to accelerative forces. (See Note.) The USAF design guide, for example, specifies such limits as forwards 45g (for 0.1 secs or 25g for 0.2 secs), rearwards 45 g (for 0.1 secs), upwards 25g (for 0.1 secs) and sideways 11.5g (for 0.1) secs with lap and shoulder harness.

1.16 Tests and research

None.

1.17 Additional information

1.17.1 *Recommended Aerodrome Operating Minima (AOM): Non-Public Transport Flights by Aeroplanes.*

Guidance to pilots is published in the UK Aeronautical Information Publication (AIP) RAC Section 4–6. The following extracts are relevant:

"1.1 There are no statutory provisions in the United Kingdom for the observance of aerodrome operating minima on non-public transport flights. (The term "non-public transport" includes private and executive flying, and aerial work eg instruction in flying and photography.) However, guidance on how to calculate and apply minima for take-off and for approach and landing is set out in this section and is applicable to all non-public transport operations by United Kingdom and foreign registered aircraft whilst flying in United Kingdom airspace. Advice is also given for the operation of United Kingdom registered aircraft when overseas."

"*2.2.4* *Visual Manoeuvring After an Instrument Approach – All Aeroplanes*

2.2.4.1 Minimum heights for purposes of visual manoeuvring after an instrument approach are given at RAC 4–3, but visibility minima are not included. It is necessary to maintain continuous sight of ground features in order to remain within the visual manoeuvring area. Therefore an in-flight visibility of not less than 2,000m is recommended. Aeroplanes with circuit speeds greater than 100 kt will need greater visibility and an increment of 200 metres for each additional 10 kt is recommended.

2.3. Aerodromes without Published Instrument Approach Procedures – All Aeroplanes

2.3.1 Instrument approaches should not be made to aerodromes for which there are no published approach procedures. For landings at these aerodromes pilots should either:

NOTE: eg "Occupant Injury Tolerances for Aircraft Crashworthiness Design" (Snyder 1971).

"Impact" in NASA Biostronautics Data Book (Snyder 1973).

(a) Descend in VMC and visual contact with the ground, then fly to the destination in compliance with VFR and the minimum height rules; or

(b) Fly an instrument approach procedure at a nearby aerodrome and then transit to it as in (a) above."

1.17.2 Rules of the Air and Air Traffic Control Regulations 1985

The following Rules are relevant for the flight of G–BHIZ from Southend to Rochester:

"Rule 22

Choice of VFR or IFR

Subject to the provisions of Rule 21 of these Rules an aircraft shall always be flown in accordance with the Visual Flight Rules or the Instrument Flight Rules:

Provided that in the United Kingdom an aircraft flying at night:

(a) Outside a control zone shall be flown in accordance with the Instrument Flight Rules; or

(b) In a control zone shall be flown in accordance with the Instrument Flight Rules or the provisions of the proviso to Rule 23(b) of these Rules."

"Rule 25

Minimum height

Without prejudice to the provisions of Rule 5 of these Rules, in order to comply with the Instrument Flight Rules an aircraft shall not fly at a height of less than 1,000 feet above the highest obstacle within a distance of 5 nautical miles of the aircraft unless:

(a) it is necessary for the aircraft to do so in order to take-off or land; or

(b) the aircraft is flying on a route notified for the purposes of this Rule; or

(c) the aircraft has been otherwise authorised by the competent authority; or

(d) the aircraft is flying at an altitude not exceeding 3,000 feet above mean sea level and remains clear of cloud and in sight of the surface."

1.17.3 *Public transport standards*

1.17.3.1 GEC Avionics Limited and its predecessor companies, as the corporate operators of the aircraft, had issued instructions that company aircraft were to be operated to "public transport standards as laid down in the Air Navigation Order and Operating Manual for the aeroplane, except as these may be varied in the company aircraft flying instructions". It is not unusual for corporate aircraft operators to conform to a "shadow operations manual" and therefore to operate their aircraft at a standard which is similar to that of a genuine public transport operation. However, in the absence of an Aircraft Operators Certificate (AOC) issued by the CAA, a non public transport operation is not inspected by the authority neither are its operations and training manuals subjected to the authority's scrutiny. Some measure of self regulation is effected by the Business Aircraft Users Association (BAUA) who advise their members on the compilation of shadow operations manuals. They also publish codes of practice relating to crew fatigue and weather minima. GEC Avionics Limited are BAUA members, but at the time of the accident they did not posses a shadow operations manual. It is understood that since the accident the company has received appropriate advice and assistance from BAUA.

1.17.3.2 A public transport flight by a PA31 aircraft from Southend to Rochester on the night of 20 November 1985 would have been required by a typical Operations Manual to take account of the following considerations:

(a) Comply with UK AIP RAC Section 4–6.2.3 (see paragraph 1.17.1 above).

(b) Comply with the Air Navigation (General) Regulations 1981 Reg 8(7) to the effect that the landing distance required does not exceed 70% of the landing distance available.

(c) Comply with any other restrictions imposed on operations to airfields having certain characteristics and observe AOM as published or determined in writing by the aircraft operator.

2. Analysis

2.1 General

2.1.1 The pilot was attempting to land at an aerodrome with no instrument approach aids in poor weather conditions. Although the pilot was thoroughly familiar with Rochester aerodrome and the surrounding terrain, the combined weather phenomena on the evening of 20 November 1985 were by no means typical. The cold north easterly airflow associated with a slow moving occluded front produced some extreme winter conditions. The presence of snow and hill fog constituted serious hazards to visual flight.

Thus, whilst the pilot may have completed approaches successfully under similar conditions in the past it was not to him a familiar and well rehearsed situation. In contrast to the earlier flight from Paris to Southend, the flight to Rochester was made without the aid of either ground or airborne interpreted approach aids. It is likely that the pilot was induced into thinking that the weather conditions would not preclude a successful approach to Rochester based on his recent approach and landing at Southend. Certainly he had experienced the actual conditions at Southend during his approach under the guidance of the airport surveillance radar. He had navigated in Visual Meteorological Conditions (VMC) to Rochester and he was aware of the difference in height between the two airfields. This last factor would have been made more apparent to him as he reset his altimeter to the Rochester QFE of 1007 millibars from the Southend sea level setting (QNH) of 1023 millibars. When resetting the sub scale of the altimeter a decrease in height of 480 feet would be indicated.

2.1.2 It is most likely that the pilot relied initially on bearing and range information from Detling VOR/DME to fix his position overhead Rochester aerodrome. The R Nav equipment fitted to G–BHIZ made this a simple task giving considerable confidence in the accuracy of the fix. Such is the accuracy of modern R Nav equipment that it is possible to devise "home made" instrument let downs. The BAUA code of practice on weather minima contains a strong recommendation to operators who formulate their own approach procedures to consult the CAA for advice on the appropriate aerodrome minima to be applied.

Whilst the pilot of G–BHIZ almost certainly used his R Nav to locate the airfield and possibly to attempt his first approach, it is clear from the evidence of observers who saw the aircraft flying low along the Medway Valley and over the village of Burham that the final approach was flown visually using ground features for reference.

2.2 The weather

Although it is not certain that the pilot was briefed about the actual weather conditions in the Medway area he had available to him the unofficial observation of the Rochester AFISO and his own observation of conditions at Southend and over the Thames Estuary. Considering the synoptic situation (para 1.7.1), the area forecast of a cloud base at 600 feet amsl, and the actual observation of 3/8th stratus base 700 feet at Southend, it is most

likely that the cloud base at Rochester was between 600 feet and 700 feet amsl. The AFISOs on duty at Rochester are untrained meteorological observers. There is no measuring equipment to determine visibility or cloud base. In both cases the AFISO must make a subjective judgement on the conditions, aided in the case of visibility, by knowledge of the distance that certain landmarks may be seen from the visual control room. It was therefore reasonable for him to estimate the cloud base at 600 feet, an assessment perhaps influenced by his knowledge of the area forecast. The pilot was advised accordingly that the cloud base at Rochester was estimated to be 600 feet. The fact that he was later seen in the circuit at a height judged to be 300 feet or 400 feet suggests that the cloud base was more likely to have been at this height. The pilot would have realised this when resetting his altimeter to Rochester QFE and also by reference to the Radio Altimeter that was fitted to G–BHIZ. The pilot, who was thoroughly familiar with the terrain to the south of Rochester, would have realised that a cloud base of 300 feet at Rochester would be a mere 126 feet above the highest parts of Bluebell Hill. A spot height of 610 feet is printed on the 1:500,000 Topographical Aeronautical Chart of the area immediately adjacent to the A229 road.

2.3 Weather minima and aerodrome operating minima

2.3.1 Since the flight from Southend to Rochester was conducted below 3,000 feet and, once clear of the Southend Special Rules Zone, outside controlled airspace, the pilot was required to comply with Rules 22(a) and 25(d) of Rules of the Air. He was thus obliged to remain clear of cloud and in sight of the surface.

There are no statutory provisions in the United Kingdom for the observance of aerodrome operating minima on non-public transport flights. The guidance contained in the UK AIP in relation to an approach to Rochester aerodrome advises the pilot to fly an instrument approach procedure at a nearby aerodrome and then fly to the destination in compliance with VFR and the minimum height rules. The pilot of G–BHIZ followed this procedure which had the additional advantage of satisfying his requirement to obtain clearance from HM Customs. Since the flight was at night Rule 22 of the Rules of the Air required the flight to comply with Instrument Flight Rules (IFR) (Rule 25(d)). Although guidance is given in UK AIP (Sections RAC 4–4 and 4–6) for the calculation of decision heights, visibility/runway visual range, visual reference for landing and visual manoeuvring minima none of this applies to an aerodrome without published instrument approach procedures such as Rochester. However, in the absence of any other minima, it may be considered prudent to observe the limits recommended for visual manoeuvring after an instrument approach. Such limits applied to the accident flight would be:

Minimum visibility	–	2,000 metres
Visual manoeuvre height	–	937 feet (300 feet above highest obstacle within 4nm of the aerodrome reference point).

In the absence of published or calculated minima for approach and landing an important advisory action is denied to the pilot. Aerodrome air traffic services will advise pilots of non-public transport flights of the recommended minima when the visibility is 1500 metres or less or the cloud ceiling is at or below the visual manoeuvring height. In the case of Rochester this facility cannot at present be provided because:

(a) AFISOs are not necessarily trained Meteorological Observers and they have no means of assessing cloud ceiling or visibility other than by estimation.

(b) A visual manoeuvring height is not published in the UK AIP. It would, however, be possible to calculate an appropriate height based upon obstacles in the area of the aerodrome.

2.3.2 Since there are no statutory minima to be observed for a visual approach, the accident flight did not infringe any existing regulations. Furthermore, the flight being in the private category, there were no regulations made by the corporate operator to be observed. It was felt by the company that in a small flying unit agreed standards and procedures were best promulgated verbally. This coupled with the pilots' thorough knowledge of the local area was judged to ensure safe operations. It was clearly understood that adverse weather conditions at Rochester could normally result in passengers being disembarked at Southend. It was not unreasonable for the pilot to attempt an approach to Rochester although the actual conditions at Southend were indicative of the difficulties to be expected. What must be judged unreasonable is the failure to divert to a more suitable aerodrome once the cloud base at Rochester had been verified. Prudent airmanship should have directed a diversion.

2.4 The approach

2.4.1 The first indication that the pilot was experiencing difficulty with the approach comes from his inquiry of the AFISO as to whether the aircraft could be seen from the aerodrome. The pilot probably used his radio navigational aids in the aircraft to position himself overhead the airfield. It can be assumed that when he reported "downwind" on the first occasion he was reasonably sure of his position in relation to the aerodrome. He then experienced some difficulty in lining up his approach with the landing runway 03. He flew over the airfield from the south in a north westerly direction but was able to establish himself once more in the downwind position probably by reference to the lights of Chatham and Rochester. He appears to have adjusted his circuit during the left turn over the Medway Valley, thus compensating for the tendency of the wind (010°) to drift him towards the airfield. His track over the village of Burham to the accident site indicates that he was approaching the runway centre line from the left.

2.4.2 In view of the pilot's two accurate reports of his downwind position and his report of 2½ miles finals it is reasonable to conclude that the pilot was not uncertain of his position. He therefore realised that the Bluebell Hill ridge represented an obstacle to his approach profile, which was lower than normal because of the low cloud base. At the same time he was limited in the maximum height at which he could fly before his view of the airfield was

obscured by cloud. He thus had a "window" of some 162 feet to fly above Bluebell Hill and below the cloud base. Erosion of this height margin might occur quite quickly. Various considerations may account singly or in combination for the pilot's failure to maintain adequate terrain clearance.

2.4.3 An aircraft in a balanced and banked turn such as that performed by G–BHIZ will tend to lose height if the pilot leaves the pitch attitude and power settings unchanged. He makes appropriate changes only if he is aware of the loss of height. A small height loss can go unnoticed if the pilot, for whatever reason, makes no reference to flight instruments. It is likely that the pilot's attention would have been directed mostly outside the cockpit in an attempt to maintain visual contact with the airfield. The flight over the Medway Valley was made at low level in order to remain below the cloud base.

2.4.4 With the pilot's concentration focussed outside the cockpit, maintenance of height would have been mainly from visual clues. There are a number of features that can cause visual illusions especially relating to perceived height. Most notable of these is an approach over unlit terrain at night towards an aerodrome situated on the near side of an irregular matrix of urban lighting. The illusory effect of being at a greater height than is the case is compounded by reduced forward visibility.

The terrain to the south west of the aerodrome is featureless and unlit apart from some scattered lights in Burham. Such conditions can induce a pilot to descend whilst thinking he is maintaining height. This tendency to grossly overestimate height was considered to be a contributory factor to the accident which was the subject of Aircraft Accident Report 5/84.

2.4.5 The final track of the aircraft gradually brought it into the left hand limit of the APAPI arc. The pilot may have received some momentary indication of his vertical position in relation to the aerodrome. If the equipment was being affected by condensation on the lens it is possible that the pilot received an erroneous "too high" indication. This may have led him to reduce height, particularly if he was relying solely on external visual clues.

2.4.6 There is no evidence either before or after the accident to suggest that the aircraft or its engines suffered any malfunction. Since the freezing level was at 500 feet and severe icing was forecast it is possible that the aircraft's performance was degraded by an accumulation of airframe ice leading to an undetected loss of height. Examination of the wreckage did not indicate that the engines were delivering a great deal of power at impact so it is unlikely that airframe icing was a causal factor.

2.4.7 The northerly wind on the evening of 20 November 1985 would have created some downdraught conditions over the south west slopes of the North Downs. Any inadvertent height loss by G–BHIZ as it neared the ridge of Bluebell Hill would be exacerbated in the final few hundred metres of the flight path. At the same time, the obtrusion of the ridge line into the approach path of the aircraft and hence the pilot's line of vision, could have been apparent to the pilot at the last moment. The time scale of this change is so short as to go unnoticed if the pilot was occupied with other duties such as a final check within the cockpit prior to landing. Furthermore, the pilot had experienced intermittent visual contact with the airfield previously and any temporary obscuration would not have been unexpected.

2.5 Pilot incapacitation

2.5.1 In view of the unfortunate circumstances of the assault on the pilot whilst he was in Paris it is pertinent to consider what effect the experience might have had on his performance as captain of the aircraft. Postmortem examination revealed no evidence of incapacitating injury caused by the assault. On at least two occasions he had confirmed his fitness to fly. This is substantiated by his successful flight from Le Bourget to Southend. In addition the attack had taken place some twenty four hours before the pilot took off from Le Bourget. It is most likely that any physical incapacitation would have manifested itself during this period. There remains the psychological aspect whereby the pilot would have an understandable desire to regain his home base without undue delay. It is natural that he would wish to reassure his colleagues and family about his welfare. Hence his motivation to land at Rochester may have been stronger than usual.

2.5.2 Although the evidence is not conclusive it is possible that the pilot was not wearing his spectacles. With uncorrected vision, particularly at night, he would have experienced difficulty in reading small print and adjusting instruments such as an altimeter sub scale or VOR bearing selector. Assuming the pilot set the QFE of 1007 millibars when it was passed to him on his initial contact with Rochester AFISO there is evidence to show that he checked the setting when he asked for confirmation of the QFE setting during his second orbit of the aerodrome. The radio altimeter would have been of limited value as a check against an altimeter setting error since it would have shown about 736 feet above the Medway Valley when the barometric altimeter should have indicated about 300 feet above the aerodrome elevation. The passenger in the right front seat had no aviation experience and was unable to provide the essential cross check that could have been provided by a trained co-pilot.

3. Conclusions

(a) *Findings*

(i) The pilot had held a Commercial Pilot's Licence since November 1976. He was experienced on PA 31 type aircraft but his Certificate of Test on this type had lapsed on 11 May 1985.

(ii) The aircraft was serviceable, correctly documented, and loaded within its CG limits.

(iii) The pilot was manoeuvring in the vicinity of Rochester aerodrome by means of visual reference alone. Forecast and actual cloud base was coincident with the highest ground within 4 nautical miles of the aerodrome.

(iv) The aircraft was seen flying in the Rochester circuit at an estimated height of 300 to 400 feet above the aerodrome elevation. It was at low level in the River Medway Valley immediately before the accident.

(v) The aircraft crashed in a level attitude 45 feet below the summit of a ridge 2000 metres from the threshold of runway 03. Its track before impact was 050°(M).

(vi) The pilot was medically fit to conduct the flight despite having been the victim of an assault some twenty four hours prior to the flight. He was required to wear spectacles to correct for near vision. It cannot be determined whether he was wearing spectacles at the time of the accident. If the pilot was not wearing spectacles he could have experienced difficulty in setting the sub-scale of the altimeter, although there was no evidence that this was incorrectly set.

(vii) The flight, being non-public transport, was not obliged to observe any weather minima other than those preventing flight clear of cloud and within sight of the surface.

(viii) Aerodrome operating minima, applicable to non-public transport flights, do not exist at aerodromes without a published instrument approach procedure.

(ix) The pilot navigated successfully from Southend to Rochester. He misjudged his first approach to runway 03 and on his second attempt he was to the left of the centre line and well below a safe glide slope. The APAPI may have given false indications due to condensation on its lenses.

(x) The occupants of the crew seats sustained serious injuries when these seats detached from their mounting rails under impact forces. Due to the lap harness attachment points being on the seats there was little restraint provided for the occupants once seat detachment had occurred.

(b) *Cause*

The accident was caused by the pilot's failure to maintain adequate terrain clearance during a visual approach at night in poor meteorological conditions. The proximity of an escarpment 137 feet above the runway threshold 2,000 metres from touchdown, and the visual illusion created by an approach over featureless and unlit terrain contrasting with relatively bright urban lighting to the north of the airfield, known as the "black hole" effect, were contributory factors.

4. Safety Recommendations

It is recommended that:

4.1 The aerodrome operating minima for non-public transport flights by aeroplanes, which are recommended in the UK AIP Section RAC 4–6, be reviewed to include calculation and publication of minimum heights applicable to aerodromes without a published instrument procedure. Such heights to be calculated on the same basis as those for visual manoeuvring after an instrument approach.

4.2 Consideration be given by the Airworthiness Authorities to a review of seat to airframe attachment strengths such that seat failure or detachment will not occur below accepted maximum human tolerance levels to inertia loading.

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Department of Transport

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