ACCIDENT INVESTIGATION REPORT

BUREAU OF AIR SAFETY INVESTIGATION

BASI REPORT B/901/1047

Beech King Air E 90 VH-LFH
Wondai Queensland
26 July 1990

BASI
Bureau of Air Safety Investigation

Transport and Communications

Department of Transport and Communications

Bureau of Air Safety Investigation

ACCIDENT INVESTIGATION REPORT

Beech King Air E90 VH-LFH
Wondai, Queensland
26 July 1990

Report B/901/1047

BASi Bureau of Air Safety Investigation

Released by the Director of the Bureau of Air Safety Investigation under the provisions of Air Navigation Regulation 283

ISBN 0 642 16090 2 April 1991

This report was produced by the Bureau of Air Safety Investigation (BASI), PO Box 967, Civic Square ACT 2608.

The Director of the Bureau authorised the investigation of this accident and the publication of this report pursuant to his delegated powers conferrred by Air Navigation Regulations 278 and 283 respectively. Readers are advised that the Bureau investigates for the sole purpose of enhancing aviation safety. Consequently, Bureau reports are confined to matters of safety significance and may be misleading if used for any other purpose.

CONTENTS

SYNOPSIS

The aircraft was conducting a night departure from Runway 36 at Wondai, Queensland. After an apparently normal take-off, it struck the ground 600 metres beyond the end of the runway in a shallow, wings level descent and at high speed. The aircraft was destroyed by impact forces and fire, and five of the six occupants on board were killed.

1. FACTUAL INFORMATION

1.1 History of Flight

Beech E90 VH-LFH was being flown by the owner as pilot-in-command for the flight. The pilot had submitted a flight plan nominating a private category, single pilot, instrument flight rules (IFR) flight, from Cairns to Wondai and thence to Camden.

VH-LFH, with six passengers on board, departed Cairns at 1830 hours EST and arrived at Wondai at 2142 hours after an uneventful flight. One passenger left the aircraft at Wondai. The aircraft was refuelled with 800 litres of aviation turbine fuel and the pilot reported taxying for Runway 36 at Wondai to Brisbane Flight Service at 2243 hours EST. The aircraft was issued an airways clearance at 2245 hours which the pilot acknowledged correctly. The last radio contact with the aircraft was at 2248 hours when the pilot reported airborne.

Witnesses observed the aircraft take-off and a short time later heard the sound of impact. The aircraft struck a line of small trees slightly left of the runway extended centreline and 600 metres from the end of the runway in a wings level attitude and in a very shallow descent. Forty-eight metres beyond this point, the aircraft impacted the ground and began to break up. It then contacted a number of large trees and caught fire, finally coming to rest 90 metres further on.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	1	4	–
Serious	–	1	–
Minor	–	–	–
Total	1	5	–

1.3 Damage to Aircraft

The aircraft was destroyed by impact forces and fire.

1.4 Other Damage

Other damage was confined to a section of fence and a number of trees destroyed.

1.5 Personnel Information

The pilot in command was aged 55 years. He held a current Commercial Pilot Licence and a Command Instrument Rating for multi-engined aircraft. His licence was appropriately endorsed for him to fly Beech E90 aircraft.

At the time of the accident, the pilot had a total flying experience of 2654 hours, of which 1100 were flown in rotary winged aircraft in the period 1960 to 1963 and 1365 were in command of fixed wing aircraft. The pilot had flown 285 hours on Beech E90 aircraft including 49 hours in VH-LFH in the last 90 days and 18 hours in the last six days. His most recent proficiency check was on 20 July 1990 when he completed a day/night check flight in VH-LFH.

1.6 Aircraft Information

The aircraft was manufactured by Beech Aircraft Corporation in the U.S.A. in 1977. It was a low wing, twin turbine engined, propeller driven aircraft with a maximum take-off weight of 4581 kilograms. At the time of the accident, the aircraft was equipped with seven seats including two cockpit seats and five passenger seats in a "club seating" arrangement where the front row passenger seats faced aft.

The aircraft was equipped with a Bendix M4D autopilot and flight director system. It had an electric as well as manual elevator trim control system. There was a standby attitude indicator in the right (co-pilot's) instrument panel. The aircraft was equipped with two independent pitot-static air systems, one supplying the pilot's and the other the co-pilot's pressure instruments.

The weight and centre of gravity of the aircraft were within specified limits, and there was adequate fuel on board the aircraft for the completion of the flight.

The aircraft had a current Certificate of Airworthiness and a valid Maintenance Release. According to aircraft records, there was no maintenance outstanding at the time of the accident.

1.7 Meteorological Information

No actual weather observations were available for Wondai around the time of the accident. However, the weather at Kingaroy (30 kilometres south of Wondai) at 2100 hours EST was fine with a temperature of 18.5 degrees and visibility greater than 10 kilometres. The surface wind was 020 degrees at 5 knots and the atmospheric pressure 1018.8 hectopascals.

Witnesses at Wondai Airport reported clear but very dark conditions with no moon or visible horizon and a light northerly breeze at the time of the accident. They observed no fog or low cloud at the aerodrome.

The moon set time at Wondai on 26 July 1990 was 2127 hours EST. At the time of the accident, the moon was 17 degrees below the horizon.

1.8 Aids to Navigation

Wondai Aerodrome was not equipped with any radio navigational aids.

1.9 Communications Equipment

Brisbane Flight Service frequency 123.9 megahertz, which covers the Wondai area, was functioning at the time of the accident. The automatic voice recording (AVR) tape of communications between Brisbane Flight Service and the aircraft indicated that satisfactory two-way communications existed at the time of the accident.

1.10 Aerodrome Information

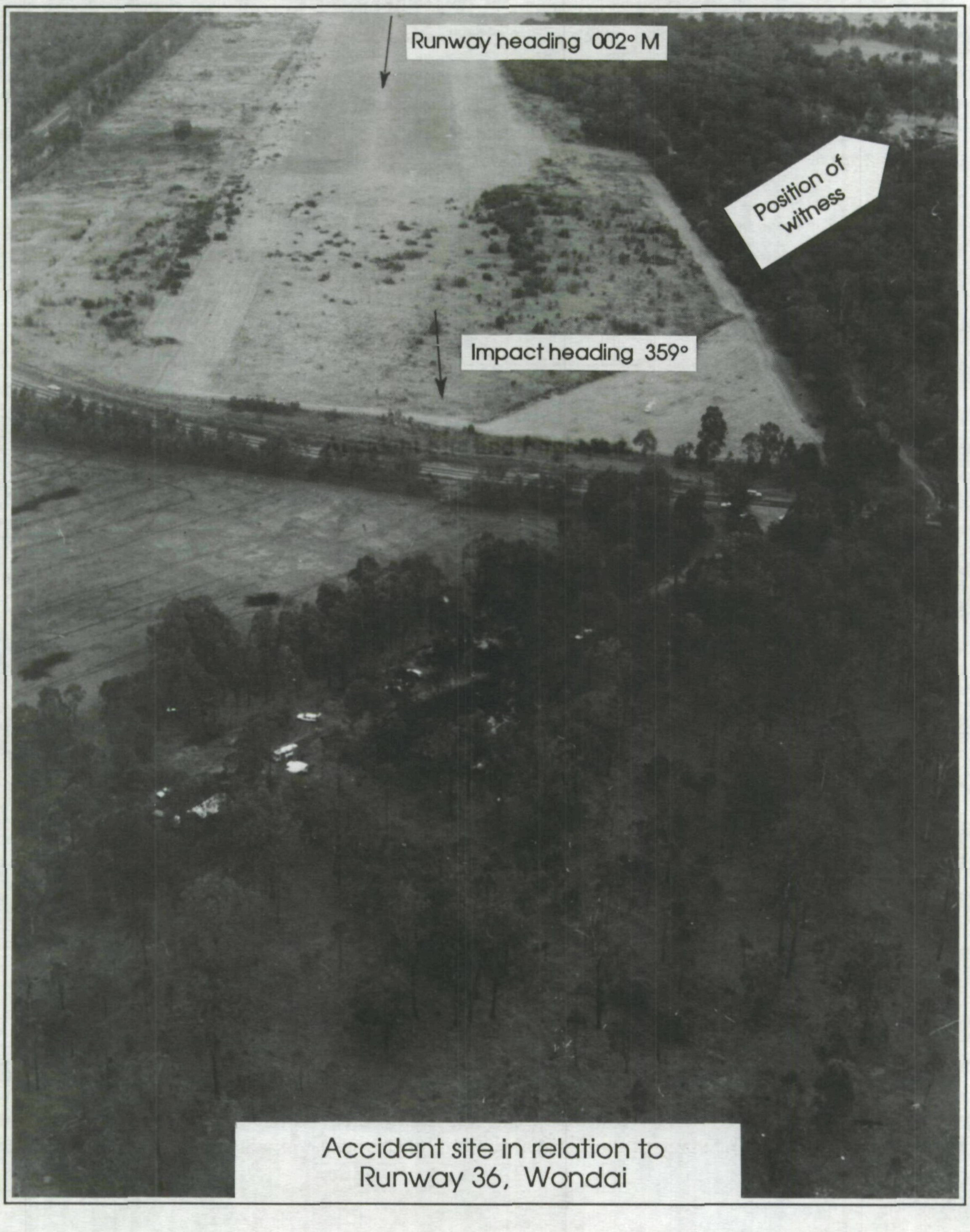
Wondai Aerodrome is situated 26°17'00"S 151°51'30"E and is 1050 feet Above Mean Sea Level. It is owned by the Wondai Shire Council. The single runway, Runway 18/36, is constructed of grassed sand clay, and is 1404 metres long and 30 metres wide with a 0.1 percent down slope to the north.

Runway 18/36 is equipped with pilot-activated lighting on frequency 122.3 megahertz. Witnesses at the aerodrome reported that the runway lights were on for the take-off of VH-LFH.

1.11 Flight Recorder

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was either required by regulation.

1.12 Wreckage and Impact Information



Accident site in relation to Runway 36, Wondai

The aircraft struck a line of small trees 600 metres from the end of the runway and about 20 metres left of the extended centreline, on a heading of 359 degrees magnetic, while in a very shallow descent. The aircraft was in a wings level attitude at this time and in balanced flight. The right propeller contacted the ground 40 metres beyond the tree line followed by the belly of the aircraft and then the left propeller. Immediately after this, as the aircraft skidded along the ground, it encountered numerous 20 metre high trees. This caused the break-up of the airframe and was accompanied by a fuel-fed fire which further destroyed much of the aircraft, including the cockpit and cabin area. The distance from the initial point of impact with the small trees to the end of the wreckage trail was 217 metres.

The damage to the aircraft from impact forces and fire was extreme. Both propellers had separated from the engines at the shaft and both engines were torn from the wings. The wings had separated from the fuselage, as had the tailplane and rudder. The fuselage had broken at the wing trailing edge position and, apart from an area around and aft of the cabin door in the rear fuselage, was destroyed by the fire.

In those portions of the aircraft not destroyed by fire, there was no evidence of any pre-existing fault which might have contributed to the accident. Component examination confirmed that the landing gear and flaps were fully retracted at impact. The position of flight controls, including trim tabs, at impact could not be determined due to the extensive disruption which occurred to the various systems during aircraft breakup.

Metallurgical examination of broken turbine blades from both engines confirmed that the engines were operating at impact. The marks on the ground from the left and right propellers were almost identical in terms of distance apart and orientation. Calculations from this data indicated that the aircraft speed when the propellers contacted the ground was approximately 183 knots (339 km/hour).

The aircraft instruments and avionics were effectively destroyed except for the engine instruments. No abnormal impact readings were present, nor were any non-impact related faults found. However, the degree of damage precluded a complete examination of the auto pilot, attitude reference, and pitot static systems.

1.13 Medical and Pathological Information

There was no evidence that incapacitation or physiological factors affected the pilot's performance. The pilot usually wore spectacles and was reportedly wearing them shortly before the accident.

1.14 Fire

Refer to paragraph1.12

1.15 Survival Aspects

All occupants of the aircraft had injuries consistent with high impact forces. The surviving passenger's injuries would have been fatal had it not been for the prompt arrival of medical assistance.

View looking back along flight path

1.16 Tests and Research

1.16.1 Automatic voice recording (AVR) tape analysis

Spectrographs of the pilot's transmissions did not reveal any consistent differences between the arrival, taxying, and departure transmissions so no interpretation as to signs of stress, workload or fatigue could be made. An unusual noise appearing on the tape after the pilot's airborne call was identified as some form of interference rather than an impact related transmission. The stage of the flight at which the airborne call was made could not be determined.

1.16.2 Aircraft Flight Simulator Trials

Trials were conducted in a flight simulator in an attempt to determine the likely flight path of the aircraft from the known parameters obtained from on-site data, and to evaluate the effects of various elevator trim settings and failures on the aircraft flight path. The simulator used was a Beech 200 simulator modified by the selection of a take- off weight and engine power setting to closely approximate Beech E90 performance.

The tests conducted, and relevant results, included the following:

a. The correct setting of elevator trim at take-off (3 degrees nose up) would ensure safe climb away if no other pilot inputs were made after landing gear was selected up.

b. Following retraction of the landing gear, to maintain a normal climb profile and prevent the aircraft overpitching, it was necessary to apply nose-down elevator trim using either the electric pitch trim control or the manually operated elevator trim wheel.

c. At the correct elevator take-off trim setting, only light control forces were required to rotate the aircraft clear of the ground. For trim settings down to neutral (0 degrees nose up), increasing control forces were required to rotate the aircraft to the take-off attitude. The assessment was made that, at a 0 degrees setting, the forces would probably feel abnormal to a pilot experienced on the aircraft.

d. If the flight instruments failed or were ignored and the elevator trim was set correctly, considerable push force was required to overcome the natural tendency for the aircraft to pitch up as speed increased after the landing gear was retracted.

e. With trim settings of between 0 degrees and 1 degree after landing gear retraction, (either because the trim was set incorrectly before take off or because the trim was adjusted by the pilot after the landing gear was retracted), the control force required to produce a shallow descent was negligible.

f. With the pitch trim set at 0 degrees and the aircraft flown "hands off" after the landing gear was up, the aircraft began descending and impacted the ground 1735 metres after lift-off at a speed of 165 knots. A repeat of this test resulted in the aircraft striking the ground at 180 knots 985 metres from the lift-off point. The time interval from lift-off to impact was 11.5 seconds.

g. A runaway electric pitch trim after the landing gear was retracted was controllable, given that the simulator pilot was anticipating the malfunction. However, high elevator control forces were involved to the extent that, when the runaway trim was initiated at about 200 feet after landing gear retraction, the aircraft descended to less than 50 feet before control was regained. The high control forces also caused unintended bank inputs and resulted in the aircraft diverging well left of the runway centreline.

h. A person of similar build to that occupying the front right seat of the aircraft at the time of the accident simulated incapacitation and slumped forward in the seat. Although his head and shoulders interfered with the control column, the pilot had little difficulty in maintaining proper control of the aircraft.

i. On a normal take-off and climb profile, with a target climb speed of 140 knots, the aircraft had reached a height of 400 feet above the runway elevation after travelling a horizontal distance of 1100 metres after lift-off.

1.17 Additional Information

1.17.1 Take-off performance

The aircraft performance charts indicated that, for an estimated take-off weight of 4330 kilograms, the take-off distance required under the prevailing conditions would have been 875 metres.

1.17.2 Information from witnesses

Witnesses at the aerodrome noted nothing unusual as the aircraft taxied and then took off on Runway 36. They observed the aircraft become airborne about 950 metres along the 1404 metre runway and heard the sound of impact a short time later. The runway lights were on at the time of the take-off as were the aircraft anti-collision and landing lights.

A witness who lived adjacent to the northern end of Runway 36 frequently heard and observed aircraft arriving and departing the aerodrome both at day and night. During night departures from Runway 36, he usually saw on the wall of his room the reflection from the red anti-collision lights as the aircraft climbed above the level of the trees between the runway and his house. He recalled hearing the sound of VH-LFH as it took off and then the sound of impact but could not recall seeing the reflection on the wall of the anti-collision lights.

The surviving passenger was seated in the aft facing seat on the right side of the aircraft immediately behind the cockpit. He observed and heard nothing abnormal during the taxi and take-off up to the time of impact.

Persons who had flown with the pilot reported that his habit was to not engage the autopilot until the aircraft was established in the cruise, and to use the manual elevator trim during the take-off and climb phases of flight. They commented generally on his careful habits with regard to cockpit checks, describing him as "meticulous", and as one who "checked and rechecked". The pilot used a headset and boom microphone. It could not be established whether it was the pilot's habit to transmit a departure call immediately after take-off.

1.17.3 Terrain features and visual cues

The area directly north of Wondai Aerodrome has few cultural features apart from farm dwellings. At the time of the take-off, most of these would probably have been unlit. The township of Murgon is nine kilometres north-north-east of Wondai, some 60 degrees to the right of the flight path of VH-LFH. The topography between Wondai Aerodrome and Murgon is such that Murgon is not visible below about 250 feet above the northern end of Runway 36.

As the pilot lost sight of the runway lights after lift-off, he would have been faced with a textureless view outside the cockpit in the prevailing conditions of good visibility (in the meteorological sense), but close to total darkness.

Four kilometres south-south-east of Wondai Aerodrome lies the township of Wondai. Twenty-six kilometres south of the aerodrome is the town of Kingaroy. A number of small hamlets lie on the New England Highway which links Wondai and Kingaroy. There were, then, a number of cultural features which would have provided an outside visual reference following take-off from Runway 18.

The pilot had flown into Wondai on ten previous occasions since February 1988. Night take-offs from Wondai were involved on four of these occasions, the most recent of which was on 22 July 1990 when the pilot departed using Runway 18. Which runway the pilot used on other occasions was not established.

1.17.4 The somatogravic illusion

Under acceleration, the combination of gravity and the inertial forces produce a resultant force at an angle aft of the true vertical. Acting upon the human vestibular system, and in particular the semi-circular canals of the human inner ear, such forces can, in conditions of reduced or no visibility, give a pilot a false pitch up sensation. That is, while the aircraft and pilot may be flying straight and level or climbing slightly, the pilot may have the sensation of climbing at a much steeper angle than they in fact are. Without some visual input to override this false sensation, the pilot will usually react to it as a real and accurate perception of his/her position and travel in space. The normal response to this situation is for the pilot to gradually push the nose of the aircraft down, resulting in the aircraft descending. This phenomenon is known as the somatogravic illusion.

The somatogravic illusion has been linked with a large number of accidents in which aircraft impacted unlit terrain under control shortly after take-off on dark nights. Although the illusion is generally associated with high performance military aircraft, it can arise in lower performance aircraft. For example, an aircraft accelerating from 100 to 130 knots in 10 seconds generates an acceleration on the pilot of 0.16 G, which is sufficient to produce the sensation of a 9 degree pitch-up.

Accident studies indicate that long pilot experience is no certain protection against "dark night take-off accidents". Pilots with limited recent night or instrument flying experience appear more susceptible to spatial disorientation, possibly because they may not be fully accustomed to (misleading) acceleration sensations. The level of recency may also affect instrument scan technique.

Calculations showed that VH-LFH accelerated at an average rate of 8.79 feet/second/second (0.275 Gs) from lift-off to impact. This would have been sufficient to produce the sensation to the pilot of a pitch-up of about 15.3 degrees.

1.17.5 Fatigue

Fatigue can result in a number of potentially significant performance decrements including increased reaction time, lowered arousal, increased susceptibility to distraction, poor self monitoring, and reversion to previously well learned skills.

The pilot did not fly on the two days prior to the accident and was engaged in only light activities during this time. On the day of the accident, his duty time commenced at about 1500 hours and involved flight preparation followed by a 20 minute flight from Mareeba to Cairns and later the Cairns – Wondai flight of 3 hours 15 minutes. At the time of the accident, therefore, the pilot had been awake for 15 hours and on duty for eight hours.

1.17.6 Stress

Compared to a pilot facing "normal" levels of stress, a pilot experiencing excessive stress is more likely to have channellised attention, make poor decisions, and accept information from vestibular (balance) or kinesthetic (muscle/joint) senses.

Although no evidence was found of any change in the pilot's personality or other outward sign of stress in the period leading up to the accident, a number of life-event related aspects came to light which were identified as potential sources of stress for the pilot.

1.17.7 Human factors training

During his instrument rating training, the pilot did not receive any formal instruction on the human factors aspects of instrument flying, nor was there any requirement for him to be so instructed. This compares with other flying related aspects which are formally tested prior to licence or rating issue.

The pilot's awareness of the "human factors" aspects of flying, particularly as they related to dark night take-offs was not determined. However, there was evidence of the pilot having conducted at least one fully dark night take-off previously in company with another pilot and being made aware of the importance of attention to flight instruments.

Human factors figure prominently in aviation safety publications in general. The Autumn 1989 issue of the *Aviation Safety Digest*, Issue 140, contains an article titled *The false climb – a fatal illusion* which explains the mechanism of the somatogravic illusion and the situations in which it may occur. This article is reproduced with permission in Appendix A. It was not established whether the pilot read this article or what other aviation safety publications he might have read.

1.17.8 Airborne reporting requirement

Aeronautical Information Publication Australia *Air Traffic Rules and Services Operations (RAC/OPS)-1-71 Operations From Non-Controlled Aerodromes* paragraph 4.1 states "Aircraft shall report airborne before reaching 1000 feet above aerodrome elevation".

2. ANALYSIS

2.1 Flight Status Prior to Impact

The aircraft was in controlled flight, in a shallow descent with wings level, at impact.

There was metallurgical evidence that the engines were operating at impact. The propeller ground impact marks indicated that the aircraft speed at impact was about 183 knots. This figure was supported by the flight simulator trials and theoretical calculations. The very close similarities in the left and right propeller ground impact marks weigh against there having been an asymmetric power condition.

The serviceability of the attitude and pressure instruments at impact could not be conclusively established. However, given the independence of the various systems, the possibility of multiple failures having occurred is remote. Thus, if an attitude or pressure instrument or system did fail, there would have been sufficient information available from the other instruments for the pilot to retain proper control of the aircraft.

It was the pilot's habit to fly the aircraft using the manual trim until the aircraft was established in the cruise at which time the autopilot was engaged. Further, the pilot had a reputation of taking great care with checklist procedures. It seems unlikely, then, that the accident flight was begun with the auto pilot engaged and the pilot operating the electric elevator trim. In any event, no fault was found with the pitch trim motor to indicate a runaway condition.

2.2 Aircraft Flight Profile

Evidence from the witness who lived adjacent to the north-western end of the strip indicated that the aircraft flew a low trajectory path after lift-off. This was supported by flight profile data from simulator trials which pointed to the maximum height reached by the aircraft being about 70 feet above the level of the runway.

2.3 The Pilot

The pilot had considerable recent day and night flying experience on the aircraft. He had recently operated from Wondai at night, but from Runway 18, beyond which there were cultural features which would have provided outside visual reference after take-off.

There was evidence of a number of events in the pilot's life leading up to the accident which could have placed him under some stress and affected his performance during the take-off.

Although the pilot was well rested and of normal behaviour on the day of the accident, he had nevertheless been awake for fifteen hours and on duty for eight hours when the aircraft departed Wondai. Thus, while fatigue cannot be eliminated as a factor in the accident, there is insufficient evidence to draw any conclusion as to what role it might have played.

While there were avenues through which the pilot could have become aware of the "human factors" aspects associated with dark night take-offs, there was no formal system in place to ensure that the pilot possessed this knowledge.

2.4 Simulator Trials

The simulator runs whose parameters fit best the distance flown and speed reached by VH-LFH were those in which the aircraft was in a trimmed condition after landing gear retraction and then flown "hands off". In other words, as the aircraft accelerated, and with no further control inputs, it gradually entered a shallow descent. The trials also showed that nose down trim was required after retraction of the landing gear to maintain a normal climb profile, assuming the correct takeoff trim setting had been made.

2.5 Flight Conditions

The outside environment was such that the pilot, immediately after lift-off, had to make a transition from outside visual references (runway, runway lights etc) to total reliance on the aircraft flight instruments for the aircraft to be flown safely away from the runway environment. If an effective cross reference of the instruments was not established immediately, potential existed for the aircraft to descend. The somatogravic illusion is one conditionthat could have made the pilot's concentration in this regard difficult. The presence of stress and/or fatigue would have increased his susceptibility to the illusion.

It is possible that the pilot took off with the elevator trim set incorrectly, but this would not, in itself, have led to the accident as the trim could have been adjusted simply and quickly to the correct position. A more likely scenario is that the trim was set correctly for take-off and that it was adjusted forward in the normal way afterthe landing gear was retracted in response to the aircraft nose-up tendency with which the pilot shouldhave been familiar. This aircraft characteristic could have made easier his acceptance of any illusory encouragement for nose down control inputs to be made.

There was no urgency for the pilot to transmit the airborne report. The evidence indicates that the call was made soon after lift-off when the pilot's attention should have been directed exclusively towards flying the aircraft. Making the call would have imposed an unnecessarily higher workload on the pilot at a critical stage of flight and may have distracted him from monitoring the flight instruments. The fact that the call was made is indirect evidence that the aircraft was functioning normally. It also indicates that the pilot considered himself to be in proper control of the aircraft.

2.6 Overview

The known facts concerning the aircraft's flight profile, the environment to the north of the aerodrome, and the prevailing visibility and darkness conditions suggest that the pilot experienced the somatogravic illusion in the seconds preceding the accident. The possible other influences relating to stress and fatigue may have been present at a level which allowed the illusion to become dominant in the pilot's decision making process.

3. FINDINGS

3.1 The pilot was medically fit, correctly licenced and qualified to undertake the flight.

3.2 There were no significant meteorological conditions existing at the time of the accident, but the night was dark with no moon and no visible horizon.

3.3 There was evidence of influences which could have resulted in the pilot experiencing the effects of fatigue and/or stress at the time of the accident.

3.4 The pilot received no formal "human factors" education during his instrument flying training.

3.5 The aircraft became airborne after a take-off roll of about 900 metres and probably reached a height of about 70 feet (21 metres) above the level of the runway before commencing a shallow descent.

3.6 The pilot transmitted an airborne call very soon after lift-off.

3.7 The aircraft speed at impact was approximately 183 knots.

3.8 The aircraft was in controlled flight, wings level and in a shallow descent at impact.

3.9 The aircraft landing gear and flaps were in the retracted position at impact.

3.10 No evidence was found that the aircraft was not capable of normal operation at the time of the accident.

4. FACTORS

The circumstances leading to the development of this accident could not be established conclusively. However, the evidence supports the following as probable factors:

4.1 The pilot might not have been aware of the human factors aspects associated with dark night take-offs.

4.2 The pilot could have been influenced by stress and/or fatigue.

4.3 The aircraft was taking off towards dark textureless terrain and no visible horizon.

4.4 By transmitting his airborne call very soon after lift-off, the pilot was not devoting his full attention to flying the aircraft.

4.5 The pilot became disorientated and placed the aircraft in a shallow descent as it accelerated after take-off.

5. SAFETY ACTION

A search of the Bureau's records revealed a number of accidents with circumstances generally similar to this accident. With some exceptions, a pattern emerged in which total pilot experience was moderate to high but hours on type were comparatively low. Pilot age was typically 40-60 years. The Bureau is undertaking a detailed analysis of these accidents with the aim, among others, of producing a profile of the "at risk" pilot. The results of the study will be published in the BASI Journal.

Some other aspects of this accident have also been identified as areas which warrant further research. These include:

5.1 Instrument rating tests and their effectiveness, particularly in such areas as the transition from visual to instrument flight and test effectiveness when conducted in aircraft of significantly lower performance than that normally flown by the pilot.

5.2 The training methods used in night take-off/no visible horizon situations and their effectiveness.

6. RECOMMENDATIONS

6.1 It is expected that at least one safety enhancement recommendation will be made as a result of this investigation.

16

The false climb — a fatal illusion

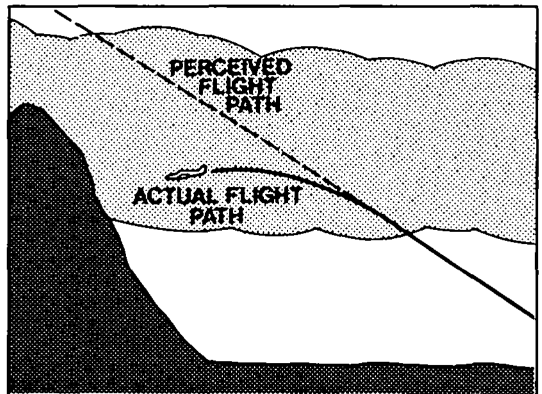
By CADUCEUS

The author of this article flew Spitfires on operations in World War II and later qualified as a flying instructor. After graduating in medicine he joined the RAAF as a Medical Officer and flew Mustangs and Vampires. As Senior Medical Officer at Point Cook in the 50's he was responsible for aircrew aviation medicine training and high altitude indoctrination in the decompression chamber. He is still flying light aircraft for pleasure.

O MOST pilots the term 'spatial disorientation' conjures up a picture of an inexperienced flyer, caught out in bad weather and forced to fly into cloud. Very soon the unfamiliar and conflicting sensations from the body's 'position sense' organs, conflict with the pilot's interpretation of the aircraft's instruments. Panic sets in — control is lost — often with fatal consequences.

This scenario is common enough as a cause of fatal accidents but there is also *a very subtle and dangerous form of disorientation to which even experienced pilots can fall victim*. The wings may be level, and the course steady and the pilot completely unaware that it is occurring. This is the 'false climb' illusion.

Many accidents are reported in which aircraft, flown by instrument-rated pilots strike the tops of hills in cloud or poor visibility, or crash into the ground after takeoff on dark nights (see Figure 1). The actual cause of these accidents is difficult to establish as they are usually fatal and the aircraft is extensively damaged. An inordinate number of such accidents occur within a few feet of safety and it seems reasonable to presume that many other aircraft, in similar circumstances, escape the same fate by a small margin and fly on without being aware of their proximity to a disaster.



The 'false climb' illusion occuring in VFR climb into IFR conditions.

Figure 1

In Britain during World War II, an investigation was carried out into a series of accidents which occurred at flying training units in which aircraft taking off on dark nights, crashed into the ground shortly after leaving the runway. No obvious cause of these accidents was found, but eventually investigators concluded that the pilots were deluded into thinking that their aircraft was climbing or at least in level flight, when in fact the aircraft was descending. The author called this phenomenon the 'false climb' illusion.

The main culprit in this illusion was found to be the otolith — an organ which forms part of the inner ear and vestibular apparatus, as illustrated in Figure 2. The otolith has its own special function — to sense and signal to the other organs, the position of the head relative to the vertical. In the absence of visual cues, this signal becomes a powerful influence on the balance and orientation of the body. Without the otolith, it would be impossible to maintain one's balance with the eyes closed.

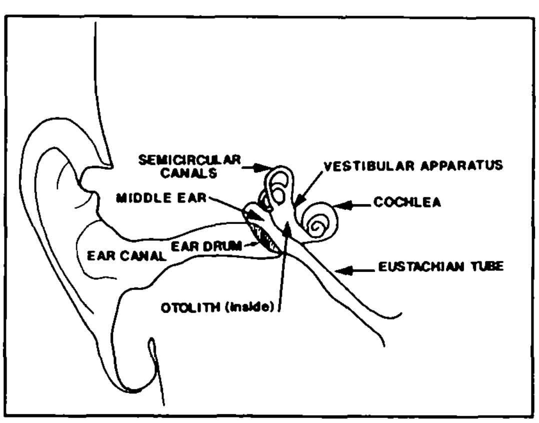


Figure 2

17

A detailed description of the structure and function of the otolith is outside the scope of this article but in relation to the 'false climb' illusion, it can be illustrated (see Figure 3) as a hair which stands vertically with a small stone at its tip. The base of the hair is inserted into a sensory cell which conveys information about the angle of the hair, to the brain.

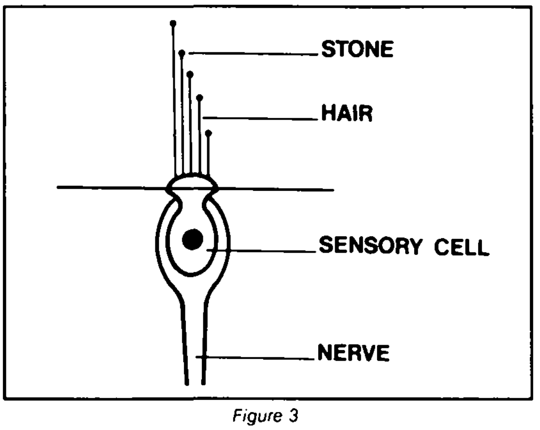


Figure 3

When the head is tilted backwards, as in Figure 4, the weight of the stone bends the hair and this message is relayed by the sensory cells to the brain, where it is interpreted as a backward tilt. If the head is held vertical and is accelerated forwards, the hair will bend in a similar fashion owing to the inertia of the stone. Thus, both tilt and acceleration produce the same response by the otolith. However, the brain is unable to differentiate between these responses. 'Acceleration' is read as 'tilt'.

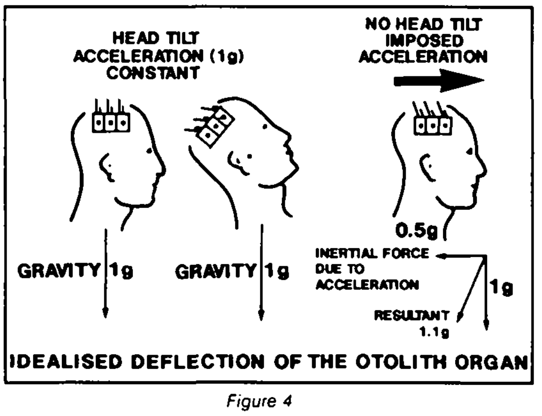


Figure 4

If tilt and acceleration are experienced simultaneously, and in the same direction, the interpretation is that of a much steeper tilt. This is the explanation of the 'false climb' illusion. *When a pilot is subjected to climb and forward acceleration at the same time, and deprived of external visual cues, he experiences a strong sensation of a steeper than actual climb.* It is this illusion which tempts the pilot to lower the nose of the aircraft. This increases the forward acceleration component — and increases the illusion of climbing steeply. Owing to lag in the altimeter and VSI, the loss of height may go unnoticed until it's too late to avoid ground contact. (By the way, this illusion is known as the 'somatogravic illusion' in the U.K. and the 'posturogravic illusion' in the U.S.)

It has been shown that a relatively low linear acceleration of 0.2g if sustained for several minutes, is sufficient to produce this illusion. After a brief acceleration, such as a catapult launching (5g for 2-3 seconds), the apparent nose-up illusion takes a minute or so to die away. Similar but opposite sensations are produced by tilting the head forward or by decelerating the subject.

There are three common situations in which the 'false climb' illusion may occur. In these cases, it is assumed that visibility outside the cockpit is absent or at least inadequate for visual flight. These situations are:

- Takeoff — night or IFR.
- Overshoot (missed approach).
- Climb from VFR into IFR conditions.

The takeoff or overshoot, on dark nights or IFR conditions, are clear cut situations where the pilot is set-up for the illusion.

During a climb from VFR into IFR conditions the illusion can be compounded by turbulence, turn or an AH that wasn't quite erect. This situation may well have been responsible for many accidents where aircraft have crashed into hillsides. Usually the decision to climb has been dictated by deteriorating weather conditions and is unplanned — this is enough to cause some anxiety and to interfere with correct decision-making. As the aircraft is already flying at reduced power and airspeed, the full-throttle climb will produce the illusion.

Summary

All pilots irrespective of experience or skill are susceptible to the illusion.

It is particularly lethal as the effect is subtle and there are few cues to what is going wrong.

The effect is an apparent positive climb as sensed by the body and perhaps even a nose-up attitude indicated by the AH, whereas in fact the aircraft may be descending. Eventually the performance instruments will show the descent but perhaps not in time to avoid impact.

The bottom line is to anticipate the illusion and ignore it, to establish a positive climb attitude, to hold that positive pitch attitude and to check the performance instruments for confirmation of the climb — then adjust the attitude to maintain the optimum climb airspeed. (In some situations this may be the speed for best angle-of-climb rather than best rate-of-climb.) □

BASI CONTACTS:

Adelaide
GPO Box 1112
Adelaide SA 5001
Telephone: (008)011 034
Facsimile: (08) 237 7791
10th Floor
CPS Building
44-46 Waymouth Street
Adelaide SA

Brisbane
PO Box 10024
Brisbane
Adelaide St
QLD 4000
Telephone: (008)011 034
Facsimile: (07) 832 1386
Australia House
12th Floor
363 Adelaide Street
Brisbane QLD

Canberra (Central Office)
PO Box 967
Civic Square ACT 2608
Telephone: (008) 020 616
Facsimile: (06) 247 3117
24 Mort Street
Braddon ACT

Melbourne
PO Box 1
A'Beckett Street
Melbourne VIC 3001
Telephone: (008) 011 034
Facsimile: (03) 662 1952
2nd Floor
6 Riverside Quay
South Melbourne VIC

Perth
PO Box 63
Guilford WA 6055
Telephone: (008) 011 034
Facsimile:(09) 337 1566
Lot 3
Kalamunda Road
South Guilford WA

Sydney
PO Box K237
Haymarket NSW 2000
Telephone: (008) 011 034
Facsimile: (02) 218 7687
Sydney Plaza Building
59 Goulburn Street
Sydney NSW

CAIR
Freepost 747
The Manager
CAIR
PO Box 600
Civic Square ACT 2608
Telephone: (008) 020 505
24 Mort Street
Braddon ACT

ACCIDENT INVESTIGATION REPORT B/901/1047

ISBN 0 642 16090 2

Published for the Department of Transport and Communications