Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report –200404085
Final

Collision with terrain
20 km SW St George, Qld
19 October 2004
VH-ZXZ
Gyroflug Speed Canard

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Collision with terrain, 20 km SW St George, Qld. 19 October 2004, VH-ZXZ, Gyroflug Speed Canard

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Abstract

At 0944 Eastern Standard Time on 19 October 2004, the Gyroflug Speed Canard aircraft departed Bundaberg, Qld, on a private flight to Parafield, SA, with a planned refuelling stop at Bourke, NSW. At about 1145, the pilot, who owned the aircraft and was the only occupant, radioed another pilot who was operating in the St George, Qld, area and advised that he was feeling dizzy, faint and disoriented, and was having difficulty lining up the aircraft to land on the St George runway. The aircraft remained airborne in the vicinity of St George for approximately 90 minutes. At about 1335, the aircraft impacted terrain 20 km south-west of St George and the pilot sustained fatal injuries.

There was no evidence that the aircraft was not capable of normal operation at the time of the accident.

During a routine aviation medical examination in 2003, the pilot was diagnosed with diabetes.

The pilot apparently became incapacitated during flight and was unable to manoeuvre the aircraft to a successful landing.

It could not be established why the pilot became incapacitated, however a diabetes-related condition could not be ruled out.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances in order to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau prefers to report positive safety action in its final reports rather than making formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

FACTUAL INFORMATION

History of the flight

At 0944 Eastern Standard Time[1] on 19 October 2004, a Gyroflug Speed Canard aircraft, registered VH-ZXZ (ZXZ), departed Bundaberg, Qld, on a private flight to Parafield, SA, with a planned refuelling stop at Bourke, NSW. At about 1145, the pilot, who owned the aircraft and was the only occupant, radioed another pilot who was operating in the St George, Qld, Common Traffic Advisory Frequency (CTAF) area, and advised that he was feeling dizzy, faint and disoriented, and was having difficulty lining up the aircraft to land on the St George runway. During subsequent radio transmissions, the pilot advised that he had water on board the aircraft, but no food, and that he was lapsing in and out of consciousness. A local doctor who listened to the pilot's voice said that he was talking slowly in a low tone, and sounded sleepy and anxious about blacking out.

For approximately 90 minutes, the aircraft flew left orbits of between 4 and 8 NM diameter in the vicinity of St George, varying between 500 ft and 4,500 ft above ground level (AGL). During this time, the pilot attempted to land on the active runway at St George, but discontinued the attempt after expressing concern that St George town was under his approach path. He said that he would try to land in a paddock, but was finding it difficult because he was unable to stay conscious long enough. The length of time between radio transmissions from the pilot gradually increased. A witness reported that, towards the end of the flight, the pilot sounded coherent but did not appear to have heard anything that had been said to him previously.

A local pilot flew a chase aircraft near ZXZ for about an hour while it was near St George. He reported that the second last orbit of ZXZ was to the right, the aircraft was maintaining about 140 kts and, at about 1335, the aircraft was banked slightly to the left when it impacted the ground.

The pilot sustained fatal injuries.

Recorded information

There was no recorded radar data of the aircraft, and radio transmissions on the St George CTAF were not recorded. The pilot's recorded radio transmissions on the Bundaberg CTAF during departure were unremarkable.

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time, when particular events occurred. Eastern Standard Time is Coordinated Universal Time (UTC) + 10 hours.

Meteorological information

The terminal area forecast for St George, issued at 0402, indicated that from 1000, the conditions would be CAVOK[2]. Area forecasts indicated that the expected conditions between 1000 and 1200 from Bundaberg to St George were for broken [3] stratocumulus and cumulus cloud between approximately 3,000 and 8,000 ft, and a temperature of 11 degrees Celsius at the reported cruise altitude of 4,500 ft.

The local pilot flying the chase aircraft did not report any significant meteorological phenomena in the area. He had no difficulty maintaining visual contact with ZXZ.

Aircraft information

Manufacturer	Flugplatz (Gyroflug MBH)
Model	SC01 B-160 Speed Canard
Serial number	S 43
Registration	VH-ZXZ
Year of manufacture	1989
Total airframe hours	1132.4 hrs
Maintenance release valid to	19 December 2004 or 1228.5 hrs

The Gyroflug Speed Canard was a factory-built, two-seat (tandem), canard configured light aircraft constructed primarily of composite fibre (Figure 1). The engine was mounted at the rear and fitted with a pusher propeller. The cockpit canopies were clear plexiglass.

Figure 1: Gyroflug Speed Canard VH-ZXZ

2 Used when the following conditions occur simultaneously:
- a) visibility of 10 km or more;
- b) no cloud below 5,000 ft and no cumulonimbus; and,
- c) no precipitation, thunderstorm, shallow fog, low drifting snow, or dust devils.

3 The cloud amount 'broken' refers to cloud covering 5 to 7 eighths of the sky.

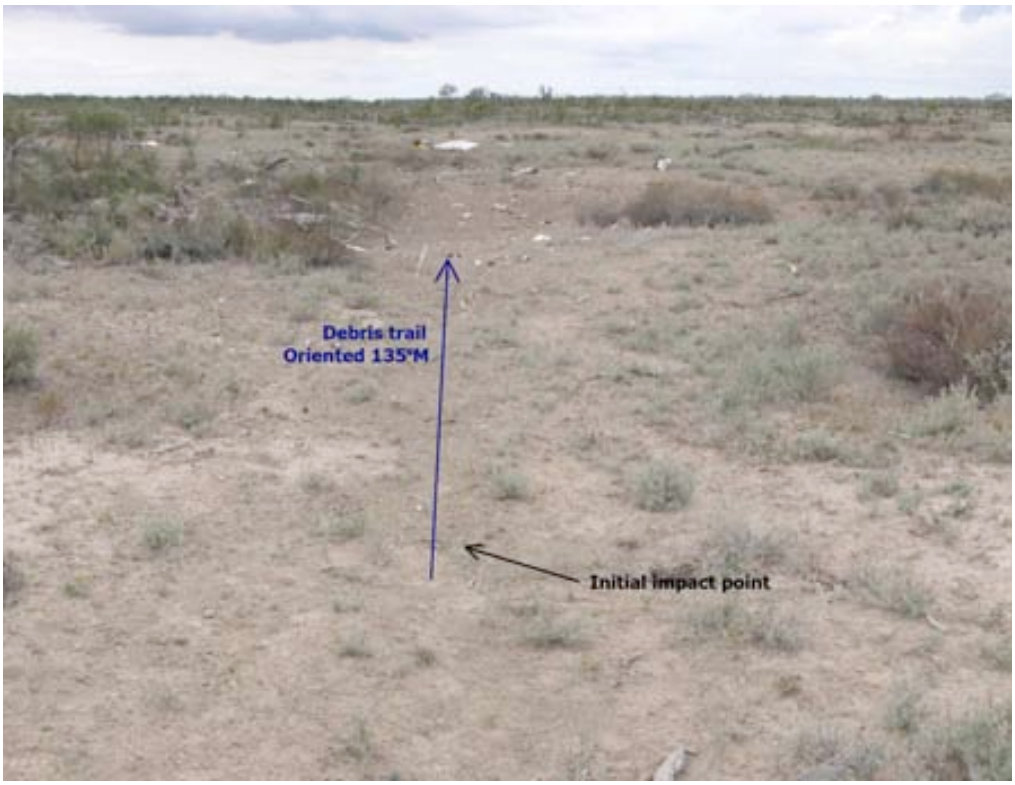
A review of the aircraft's records indicated that it had not been flown between 8 June 2002 and the day of the accident. During that time it had been stored in a hangar at Bundaberg aerodrome. A 100-hourly periodic inspection was completed on 19 December 2003.

The aircraft was fitted with a cabin heating system. Heated air was obtained from a manifold attached to the engine exhaust system and ducted into the cabin. A cable-operated valve controlled the amount of heated air delivered to the cabin.

Wreckage information

The accident site was located 20 km south-west of St George. The terrain was largely level, with occasional grass and small scrub vegetation, and the remnants of pulled timber. The aircraft impacted the ground slightly left wing low, and in an approximately level pitch attitude. It disintegrated on impact, leaving a wreckage trail of approximately 150 m in length, and oriented 135 degrees M (Figure 2). An empty box and empty blister pack of pain relieving tablets were located with the pilot's personal effects. It could not be determined when the tablets had been used.

Figure 2: Initial impact point and debris trail



An examination of the wreckage and accident site established that the propeller impact marks and the damage to the propeller blades were consistent with the engine delivering power at the time of impact. There was no evidence of any pre-existing cracks or leaks in the exhaust system within the cabin heater manifold/heat exchanger. The firewall was extensively damaged, however there was no evidence of any pre-existing cracks or defects that could have allowed air from the engine compartment, or engine exhaust, to enter the cabin. The investigation did not locate a 'spot'-type carbon monoxide detector at the accident site.

There was no evidence that the aircraft was not capable of normal operation at the time of the accident.

The accident was not survivable.

Personnel information

Experience

The pilot held a commercial pilot (aeroplane) licence, a grade 1 instructor rating, a private IFR (instrument flight rules) rating, and a class 2 medical certificate. His logbook indicated that he had accrued 2,639 hrs flight experience, including 275.7 hrs in the Speed Canard. The last flight recorded in the pilot's logbook was a grade 1 instructor rating renewal flight which was conducted on 1 September 2003[4]. The logbook did not include any record of the pilot having piloted an aircraft between his instructor rating renewal in 2003 and the accident flight[5].

History

The investigation reviewed the pilot's activities during the days preceding the accident in order to identify any information that could have been relevant to the development of the accident. The review indicated that on 17 October, the pilot travelled by scheduled airline services from his home in Adelaide to Bundaberg, arriving in Bundaberg at 1925. The airline bookings were made on the morning of his departure.

The next day, 18 October, the pilot established that the aircraft battery was flat and the tyres were deflated. After inflating the tyres, the pilot washed the aircraft and arranged to have the battery charged at a local maintenance facility. Although the pilot was keen to depart, he was informed that the aircraft would not be ready until the following day. The pilot stayed the night with friends. During the evening, he mentioned that he was very thirsty.

On the morning of the accident, 19 October, the pilot had a shower at about 0730. He refused an offer of breakfast and a cup of tea, the latter on the basis that he had a long flight in front of him and wanted to minimise the need to urinate. He accepted a 1 or 1.5 L bottle of cold water, and was dropped off at the Bundaberg aerodrome at about 0815. He was wearing black trousers, a dark shirt and no hat.

When the pilot arrived at the maintenance facility, the engineers were installing the now-charged battery. One of the engineers then helped him push the aircraft around to the fuel bowser. The pilot refuelled the aircraft with 100 L of avgas and after starting the aircraft, conducted an extended ground run of approximately 20 minutes.

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4 Civil Aviation Regulation (1988) 5.108 stipulated that the renewal of an aeroplane pilot rating (such as a flight instructor rating) constituted an aeroplane flight review.

5 *Civil Aviation Regulation (1988)* 5.109 required a commercial pilot flying an aircraft which was carrying any other person to complete 3 take-offs and 3 landings within 90 days of the day of the flight. There was no such obligation applicable to a pilot flying an aircraft not carrying any other person. (A similar regulation (5.82) was applicable to a private pilot.)

Witnesses reported that the pilot did not appear unwell prior to the flight.

Medical certification

At the time of the accident, the pilot held a class 2 aviation medical certificate, which was valid until 7 February 2005. That certificate was issued with the condition that it be renewed by the Civil Aviation Safety Authority (CASA) only.

The pilot was first issued with an Australian aviation medical certificate in 1995. He was not diagnosed with any significant abnormalities during the subsequent seven aviation medical examinations.

During an aviation medical examination conducted in February 2003, when the pilot was employed as a flying instructor at Bundaberg, the designated aviation medical examiner (DAME) identified a high level of glucose in the pilot's urine. This finding, in combination with the identification of an elevated level of blood glucose, resulted in the pilot being diagnosed as having type 2 diabetes mellitus. The DAME referred the pilot for additional blood tests, a stress electrocardiograph, and an eye examination. Additional blood testing indicated that the pilot's HbA1C (glycosylated haemoglobin)[6] level was significantly higher than the normal range. The DAME forwarded the medical questionnaire and examination form, and the additional test results to CASA.

The pilot consulted a diabetes educator on 12 February and 4 March 2003, during which the educator discussed hypoglycaemia and the complications of diabetes. He was assessed by a dietician on 18 February 2003.

CASA wrote to the pilot on 21 February 2003, advising him that he was not permitted to exercise the privileges of any aviation license until CASA cleared him to do so. CASA also requested the following information:

- a recent report from a consultant endocrinologist[7]
- a diary of 3 months duration of ambulant blood glucose levels
- the most recent HbA1C estimation
- a cardiovascular assessment by a cardiologist or consultant physician
- the results of a recent renal function test
- evidence of completion of a course in diabetic management education.

On 14 March 2003, the DAME faxed the following documents to CASA:

- results of blood and urine tests (including HbA1C level)
- an ophthalmologist's report

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6 The HbA1C level provides an indication of the control of the level of blood sugar for the previous two to three months.

7 In Australian regional areas, such as Bundaberg, there can be a significant delay in obtaining a consultation with a medical specialist such as an endocrinologist. Bundaberg doctors estimated that it may have taken 12 months before the pilot would have been able to see an endocrinologist in Bundaberg.

- an exercise and fitness log (covering 11 February 2003 to 13 March 2003 inclusive)
- a weight and body mass index log (covering 11 February 2003 to 13 March 2003 inclusive)
- a blood glucose log (covering 11 February 2003 to 13 March 2003 inclusive).

On 20 March 2003, CASA advised the pilot by letter that he failed to meet the medical standard for the issue of an aviation medical certificate. However, CASA advised that they would be prepared to issue him a special medical certificate with the stipulated condition that the '[h]older to fly as or with a qualified co-pilot'. The pilot agreed to this condition, and on 21 March 2003, CASA faxed him a copy of the conditional special medical certificate, which was valid until the end of 7 August 2003.

In the subsequent 24 March 2003 letter accompanying the special medical certificate, CASA advised the pilot that when the medical certificate was due for renewal, the following additional information would be required:

- a recent report from a consultant endocrinologist or GP detailing the current status of diabetes control and any history of hypoglycaemia/hyperglycaemia
- a 3 month diary of ambulant blood glucose levels immediately before the DAME examination (with an aim of no readings below 2.8 mmol/L and "90% of values greater [sic] between 5.5 mmol/L and 10 mmol/L")
- the most recent HbA1C estimation
- the results of renal function tests.

On 15 April 2003, CASA received a blood test report indicating that the pilot's HbA1C level was 7.2%, within the 'adequate control' range specified by the pathologist.

CASA subsequently removed the 'as or with a co-pilot' condition from the pilot's aviation medical certificate, and reissued the class 2 certificate as valid until 7 February 2005. The accompanying letter, dated 17 April 2003, specified that when the certificate became due for renewal, the pilot would be required to supply the information specified in the letter of 24 March 2003.

There was no available record of any further formal contact between the pilot and any medical personnel during the 18 months between April 2003 and the accident.

The pilot owned a blood glucose monitoring device, which was examined as part of the investigation. Only three blood glucose test results were found, but it could not be established whether the tests were conducted in 2003 or 2004. The dates of the test results were, in chronological order, 7 May, 5 October, and 6 October. No test results had been deleted from the device. All three test results were between 5.5 and 7.3 mmol/L.

The pilot's medical records from various general practitioners, dating from 1974 to 2003 were also examined. Most presentations were for typical general medical issues not relevant to the accident. However, the medical records indicated a history of migraine headaches, including one period in 1988 during which the pilot

experienced a migraine headache once or twice a fortnight over a three to four month period. The headaches were sufficiently severe to be incapacitating, with associated unilateral throbbing pain, distorted vision, and vomiting. The pilot underwent a pre-employment medical in 1991, in which he stated that he had experienced a migraine headache about 1 year previously. In 2002, he advised his general practitioner of his migraine history, which was recorded as him being 'prone to migraine'. The available medical records did not include any presentation to a medical facility with a migraine after 1988. There was no reference to migraine headaches in any of the pilot's aviation medical examinations, or in the pilot's medical records maintained by CASA.

Post-mortem information

A post-mortem examination of the pilot identified significant coronary atherosclerosis (60%) of the right coronary artery. The other two coronary arteries showed no significant narrowing, although a complete examination was not possible. There was no evidence of an old or recent heart attack (myocardial infarction). The pathologist concluded that the pilot died of multiple injuries sustained in the accident, with coronary atherosclerosis identified as an associated significant condition.

It was not possible to conduct toxicological testing for the purpose of establishing the level of blood glucose or carbon monoxide. The pathologist did note that carbon monoxide poisoning seemed very unlikely as the typical pink tissue colouration was not evident during the post-mortem examination.

Other medical information

DAME Handbook

The Civil Aviation Safety Authority (CASA) promulgated its procedures and guidance related to aviation medicine in the *Designated Aviation Medical Examiners Handbook*. Version 3.1 of the manual, dated January 2004, stated that the manual contained 'guidance material intended to assist CASA officers and delegates in carrying out their regulatory responsibilities and may be made available to the public for information purposes only.'

Migraine

A migraine is a throbbing headache with moderate to severe pain, which is usually felt on one side of the head, and is associated with nausea and vomiting. It can cause visual disturbance, muscle weakness, incoordination or paralysis, and cognitive disturbance. From an aeromedical perspective, a migraine may be incapacitating.

The DAME Handbook stated that CASA would consider all migraine cases individually.

Bites and stings

According to the St John Ambulance Australia *Australian First Aid* (2004), symptoms of spider bites and insect stings include sharp pain at the site of the bite or sting.

Cardiac Event

The most recognisable symptom of a heart attack is chest pain, which may spread to the back, jaw or left arm. Other symptoms include faintness, sudden heavy sweating, nausea, shortness of breath, and palpitations. About one third of people who have a heart attack do not experience chest pain. Cardiac arrhythmia may result in fainting that begins and ends suddenly. Other symptoms of cardiac arrhythmia include dizziness, palpitations, sweating, shortness of breath, fatigue, weakness and chest pain.

Cerebrovascular event

A cerebrovascular event, or stroke, occurs as a result of a blockage or rupture of the arteries that supply blood to the brain. Strokes generally occur suddenly. Symptoms vary depending on the area of the brain affected, but include weakness or paralysis of a limb or one side of the body, dimness or loss of vision particularly in one eye, confusion with difficulty speaking and understanding speech, loss of balance and coordination, severe headache and abnormal sensations or loss of sensation in a limb or on one side of the body. Many other symptoms may also occur. Significant strokes may cause a coma. Major risk factors for strokes include atherosclerosis, high blood pressure, and diabetes.

Dehydration

Symptoms of mild to moderate dehydration include thirst, reduced urine production, and a dry mouth. Severe dehydration leads to dizziness, confusion and coma.

Diabetes[8]

Type 2 diabetes mellitus is a disease which involves inadequate control of blood glucose levels, because the body does not use insulin properly. Insulin is a hormone released by the pancreas which controls the level of blood glucose. Glucose is absorbed into the blood from food and drink. The presence of glucose in the blood stimulates the pancreas to produce insulin, which allows glucose to enter cells. Glucose is the energy source that allows cells to function, and once absorbed into a cell, is either used immediately or stored. If insufficient insulin is produced, glucose cannot be absorbed by the cells, and the resulting high blood glucose levels and inadequate energy available for cellular function, results in the symptoms and complications of diabetes. Diabetes represents a failure of the metabolic control of the level of glucose in the blood. The prevalence of diabetes has been increasing

8 For more information about diabetes, see ATSB Aviation Research Investigation Report *B2005/0027 Diabetes mellitus and its effects on pilot performance and flight safety: A review*.

world wide – the United Nations World Health Organization has described it as an epidemic.

The normal blood glucose level is between 3.9 and 6.0 mmol/L. CASA considered that a person with a fasting blood glucose level of 7.0 mmol/L or higher had diabetes mellitus.

Diabetes is a significant disease, which can result in many acute and chronic complications. Acute complications are generally the result of either a reduced or elevated level of blood glucose.

Hypoglycaemia results from an excess of insulin, and is much more common among those with type 1 diabetes. Symptoms and signs of hypoglycaemia include sweating, anxiety, palpitations, weakness, tremors, hunger, faintness, double vision, headaches, irritability, confusion, motor incoordination, and convulsions and coma.

Hyperglycaemia involves an excess of blood sugar, and can result from stress, changes in diet or exercise, or illness such as a cold or infection. As the level of blood sugar increases, the kidneys increase urine production, which in turn results in a reduction in hydration. Signs and symptoms of hyperglycaemia include dehydration, reduced blood volume, confusion, and coma in the fully developed state. It can also cause visual impairment and poor performance of cognitive tasks.

According to the CASA DAME Handbook, the 'major aeromedical risk of diabetes relates to incapacitation (either overt or subtle)'. Civil Aviation Safety Regulations Part 67 stated that a 'person who suffers from diabetes mellitus may be assessed as meeting medical standard 2 if … the condition is satisfactorily controlled without the use of any anti-diabetic drug'. The DAME Handbook detailed various information and test results which were required from applicants for an aviation medical certificate who had been diagnosed with diabetes (see Appendix A).

Specialist report

The medical evidence was examined on behalf of the ATSB by an aviation medicine specialist. His report concluded that:

> From an aeromedical perspective, the medical records provide evidence of a medical condition that may have had a contributory role to play in the accident involving VH-ZXZ. The accident pilot had developed diabetes, had lost and then regained his medical category within 2 months, and then appears to have been lost to all forms of medical follow-up and diabetic supervision for the 18 months prior to the accident. CASA appears not to have followed its own policy in relation to renewing the aeromedical certification of the accident pilot. While there is insufficient evidence to definitively link the accident directly with the pilot's diabetic condition, the circumstantial evidence suggests that such a link cannot be positively and conclusively ruled out.
>
> The adverse effects on pilot performance of the combination of poorly controlled diabetes, hyperglycaemia and dehydration cannot be discounted as contributory or causal factors in the accident. In particular, the possibility that the pilot's confusion, disorientation, cognitive dysfunction and ultimate loss of control of the aircraft were the result of a hyperglycaemia-induced nonketotic hyperosmolar syndrome also cannot be discounted.

ANALYSIS

Introduction

The available evidence indicated that the pilot became incapacitated during flight, and was unable to prevent the aircraft from impacting the ground. The identification of the reasons why the pilot became incapacitated was hampered by the lack of recorded and post-mortem information. An examination of the pilot's medical records and the events leading up to the accident provide some indication of why the pilot became incapacitated.

Evidence from the accident site and witnesses indicated that there was no mechanical malfunction of the aircraft. Those who saw and spoke to the pilot prior to his departure from Bundaberg said that he did not appear to be affected by any condition which could have impaired his ability to operate the aircraft. The evidence available from witnesses who saw the aircraft manoeuvring, and heard the pilot shortly before the accident indicate that he was not capable of effectively manoeuvring the aircraft to a successful landing. However, the aircraft remained airborne in the vicinity of St George for about 90 minutes, suggesting that the pilot retained some degree of control of the aircraft.

Reason for incapacitation

There are various medical and environmental conditions which could result in a pilot becoming incapacitated. In this case, there was no direct evidence available to establish why the pilot apparently became incapacitated. Possible reasons for the pilot becoming incapacitated are discussed in the following paragraphs.

It is highly unlikely that the pilot was affected by carbon monoxide poisoning. There was no evidence of any leaks of combustion gases from the exhaust system or through the engine firewall. In addition, the pink tissue colouration typical of carbon monoxide exposure was not evident during the post-mortem examination.

It is unlikely that the pilot was incapacitated by a migraine, a bite or sting, or any other condition of which pain is a symptom. According to witnesses, the pilot described himself as being dizzy, faint, disoriented, and unable to line the aircraft up with the runway. None of the witnesses recalled the pilot saying he was experiencing pain.

It is possible that the pilot was affected by a heart-related condition such as a developing heart attack or cardiac arrhythmia, given the post-mortem finding of significant coronary atherosclerosis. However, the pilot did not mention symptoms typically associated with a cardiac event such as chest pain, palpitations, sudden heavy sweating, nausea or shortness of breath. On this basis, it is less likely that the pilot was incapacitated by a heart-related condition.

Atherosclerosis and diabetes are both risk factors for a cerebrovascular event, and a stroke could result in pilot incapacitation. In this case, the pilot appeared to be lapsing in and out of consciousness, which is not typical of a stroke. In addition, the pilot did not mention that he was experiencing symptoms commonly associated with strokes, such as a loss of limb functionality on one side of the body or a severe headache.

Prior to departing Bundaberg, the pilot declined a drink on the basis that he was about to undertake a long flight and wanted to minimise the need to urinate during the flight. This reasoning suggests that it is unlikely that he consumed much of the drinking water he was carrying. The pilot's lack of fluid intake indicates that his level of hydration on the day of the accident was poor. Symptoms of severe dehydration include confusion and dizziness, followed by loss of consciousness.

The pilot's description of his symptoms and witness evidence from the days prior to the accident indicate that the pilot may have been incapacitated by a condition related to his diabetes. It is not possible to determine precisely what food and drink the pilot consumed during the days preceding the accident. The pilot mentioned that he was very thirsty on the night prior to the accident, although he did not apparently consume much liquid. He did not say he was thirsty on the day of the accident. One of the ways the body responds to high levels of blood sugar is to increase urine production in an attempt to reduce the concentration of sugar in the blood. Consequently, marginal or poor control of blood sugar, which can occur with less than optimal diet, can contribute to dehydration by increasing urine production. This increase in urine production results in a reduction in the effectiveness of extraction of sugar from the blood by the renal system. Thirst indicates a degree of dehydration, and if not addressed, would be likely to result in hyperglycaemia. Signs and symptoms of hyperglycaemia include dehydration, reduced blood volume and cognitive dysfunction such as confusion, and even coma in the fully developed state.

Preventing incapacitation

Pilot incapacitation is a high risk event in aviation, which is mitigated primarily through initial and recurrent medical certification, personal knowledge and responsibility, and professional back-up (in the case of two-crew operations).

The aircraft was being operated on a private flight by an appropriately endorsed and certificated commercial pilot, and there was no requirement that a second pilot be onboard the aircraft.

Minimising the risk of incapacitation requires that a pilot be aware of:

- the types of incapacitation to which s/he may be particularly susceptible
- the conditions which increase the risk of incapacitation
- measures that prevent or minimise the risk of incapacitation (for example, carrying and regularly drinking water to minimise the risk of dehydration).

At about the time of his initial diagnosis as a diabetic, the pilot consulted a diabetes educator, at which time various topics related to diabetes were discussed. There was no evidence that the discussion with the educator included aviation-related issues regarding diabetes. The diabetes educator's records indicated that she had not

discussed dehydration or hyperglycaemia with the pilot. No evidence was identified that the pilot participated in any formal education regarding the aviation safety implications of his diabetes between April 2003 and the accident. It is possible that the pilot was not aware that the interaction of diabetes and dehydration could increase the risk of incapacitation.

The process of issuing the pilot with a class 2 medical certificate after he had been diagnosed with diabetes did not comply with the guidelines specified in the Civil Aviation Safety Authority (CASA) *Designated Aviation Medical Examiners Handbook*. As a result, the class 2 medical certificate, which was valid for nearly two years, was issued based on limited information. On the basis of the evidence that had been provided, CASA could not have established that the pilot's diabetes was under adequate long-term control. The duration of the certification increased the risk that acute or chronic diabetes-related conditions could have developed without being identified by medical personnel. The apparent lack of medical follow-up and supervision for the 18 months prior to the accident reduced the likelihood that the pilot would have received potentially safety critical information related to his condition.

Inadequately controlled diabetes may have contributed to the development of a condition that prevented the pilot from effectively operating the aircraft. Aviation safety would be enhanced by increasing pilot knowledge and understanding of the types of medical incapacitation to which they are particularly susceptible.

FINDINGS

Contributing safety factors

- The aircraft collided with terrain.
- The pilot reported becoming incapacitated to the extent that he was unable to manoeuvre the aircraft to a successful landing.

Other safety factors

- The pilot may not have been aware of the potential acute complications of diabetes that could result in pilot incapacitation.
- The medical information provided to the Civil Aviation Safety Authority (CASA) did not provide sufficient evidence that the pilot's diabetes was under adequate long-term control.

SAFETY ACTION

Civil Aviation Safety Authority

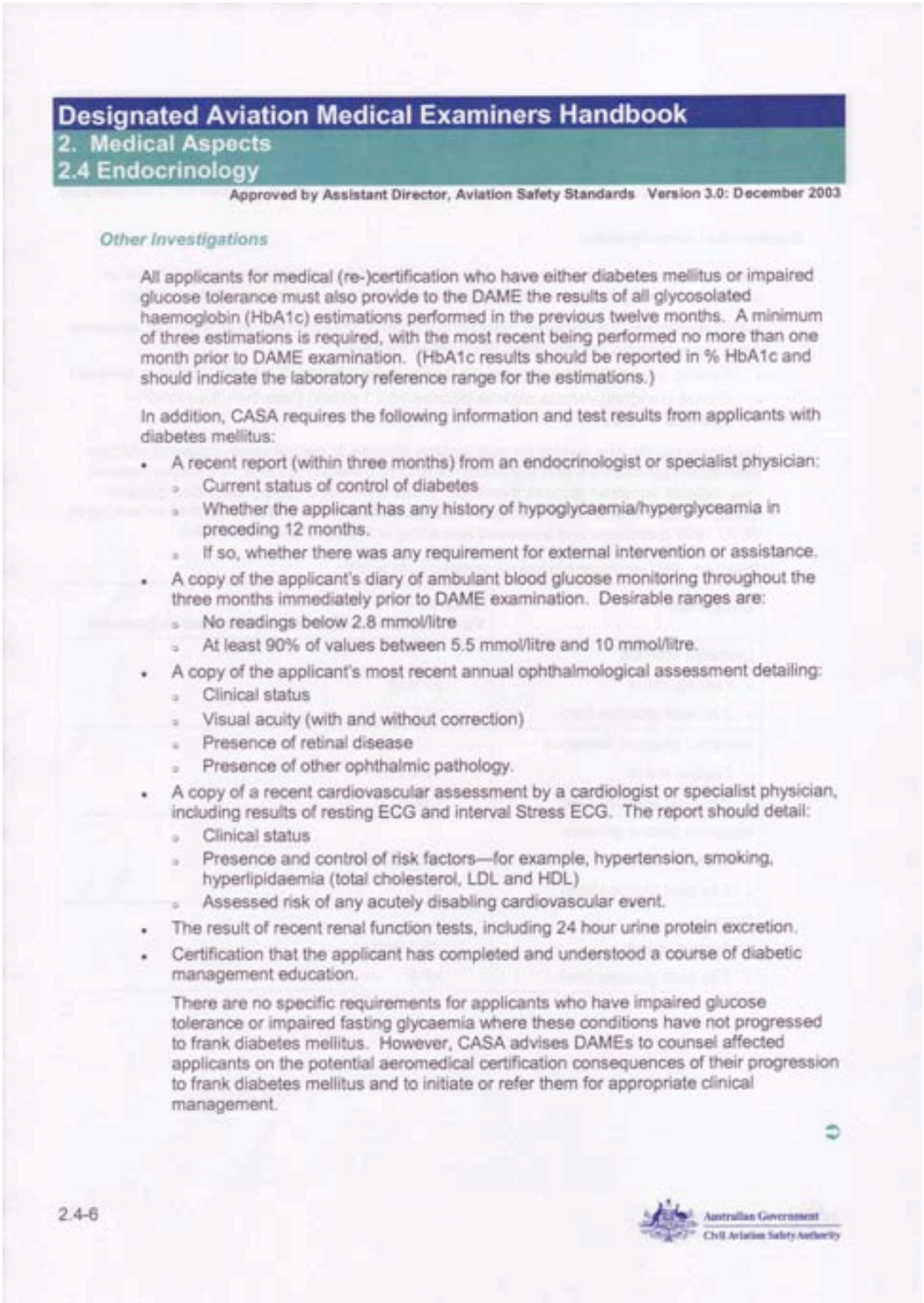
The Civil Aviation Safety Authority completed a literature review of diabetes mellitus and aeromedical certification. This review compared the requirements of various regulatory authorities regarding aeromedical certification of pilots with diabetes. It also considered the medical reporting requirements for Designated Aviation Medical Examiners (DAMEs).

Australian Transport Safety Bureau

In 2005, the Australian Transport Safety Bureau released Aviation Research Report B2005/0027, titled *Diabetes mellitus and its effects on pilot performance and flight safety: A review*.

APPENDIX A

Extracts from the Civil Aviation Safety Authority Designated Aviation Medical Examiners Handbook relating to diabetes



Designated Aviation Medical Examiners Handbook
2. Medical Aspects
2.4 Endocrinology

Approved by Assistant Director, Aviation Safety Standards Version 3.0: December 2003

Other Investigations

All applicants for medical (re-)certification who have either diabetes mellitus or impaired glucose tolerance must also provide to the DAME the results of all glycosolated haemoglobin (HbA1c) estimations performed in the previous twelve months. A minimum of three estimations is required, with the most recent being performed no more than one month prior to DAME examination. (HbA1c results should be reported in % HbA1c and should indicate the laboratory reference range for the estimations.)

In addition, CASA requires the following information and test results from applicants with diabetes mellitus:

- A recent report (within three months) from an endocrinologist or specialist physician:
  - Current status of control of diabetes
  - Whether the applicant has any history of hypoglycaemia/hyperglyceamia in preceding 12 months.
  - If so, whether there was any requirement for external intervention or assistance.
- A copy of the applicant's diary of ambulant blood glucose monitoring throughout the three months immediately prior to DAME examination. Desirable ranges are:
  - No readings below 2.8 mmol/litre
  - At least 90% of values between 5.5 mmol/litre and 10 mmol/litre.
- A copy of the applicant's most recent annual ophthalmological assessment detailing:
  - Clinical status
  - Visual acuity (with and without correction)
  - Presence of retinal disease
  - Presence of other ophthalmic pathology.
- A copy of a recent cardiovascular assessment by a cardiologist or specialist physician, including results of resting ECG and interval Stress ECG. The report should detail:
  - Clinical status
  - Presence and control of risk factors—for example, hypertension, smoking, hyperlipidaemia (total cholesterol, LDL and HDL)
  - Assessed risk of any acutely disabling cardiovascular event.
- The result of recent renal function tests, including 24 hour urine protein excretion.
- Certification that the applicant has completed and understood a course of diabetic management education.

There are no specific requirements for applicants who have impaired glucose tolerance or impaired fasting glycaemia where these conditions have not progressed to frank diabetes mellitus. However, CASA advises DAMEs to counsel affected applicants on the potential aeromedical certification consequences of their progression to frank diabetes mellitus and to initiate or refer them for appropriate clinical management.

2.4-6

Australian Government
Civil Aviation Safety Authority

Medical Certification of Persons with Diabetes Mellitus

On diagnosis, inform CASA Aviation Medicine Section and advise applicant not to exercise the privileges of his/her licence until cleared to do so by CASA.

Requirements for medical (re-)certification are set out in the following paragraphs.

1. Persons with diabetes mellitus controlled by diet may receive medical certification at Class 1, 2 or 3 provided they meet the following criteria:
   - Evidence of stable blood glucose control:
     - Glycosolated Haemoglobin (HbA1c) taken within one month of assessment <7.5%.
     - Satisfactory reports as detailed under *Other Investigations*
   - Absence of complications that could result in sudden or subtle incapacitation when exercising the privileges of a licence.

2. Persons with diabetes mellitus controlled by diet and oral hypoglycaemic drug(s) may receive unlimited medical certification at Class 2 or 3 levels only. Such persons who seek Class 1 (re-)certification may be offered (re-)certification with an *'as or with co-pilot'* restriction. Prior to their (re-)certification, CASA requires objective evidence that these applicants meet the following criteria:
   - No unacceptable side effects from drugs
   - Evidence of stable blood glucose control
     - No episode of symptomatic hypoglycaemia during the preceding 12 months
     - Glycosolated Haemoglobin (HbA1c), taken within preceding month <7.5%
     - Satisfactory reports as detailed in the previous section, Other Investigations
   - Absence of neurological, cardiovascular, ophthalmological, renal or other complications of diabetes mellitus that could result in sudden or unpredictable incapacitation when exercising the privileges of a licence.

3. Persons with diabetes mellitus who require insulin treatment do not meet the mandatory medical standards and are not fit for medical certification. However, in appropriate cases, the Director of Aviation Medicine may exercise discretion and issue a Class 2 medical certificate endorsed with the conditions *'as or with co-pilot only'* and *'valid in Australian airspace only'*. Prior to such certification, CASA requires:
   - Evidence of stable blood glucose control
     - No episode of symptomatic hypoglycaemia requiring intervention by others in the preceding 12 months
     - Serial Glycosolated Haemoglobin (HbA1c) estimations at two month intervals over the preceding 6 months—all results <7.5%
     - Satisfactory reports as detailed in the previous section, Other Investigations

- Absence of neurological, cardiovascular, ophthalmological or renal complications of diabetes that could results in sudden or unpredictable incapacitation when exercising the privileges of a licence.

Special Glucose Level Monitors

Individuals with diabetes mellitus who receive aeromedical (re-)certification must possess and use a memory chip glucose meter for ambulatory blood glucose monitoring. The meter, together with a readily absorbable source of glucose, must be carried by the applicant while exercising the privileges of a licence. (When real-time ambulatory glucose monitoring becomes readily available in Australia, CASA may require this form of monitoring instead of monitoring with memory chip glucose meters.)

Change in Treatment

When an applicant's oral hypoglycaemic medication is changed, or when its dosage is changed, he or she must not exercise the privileges of an aviation licence until the attending medical practitioner supervising the medication is satisfied that he or she is again stable and a DAME has recertified his or her fitness in accordance with CASA's relevant medical standards.

2.4.5 Thyroid Disorders

The major aeromedical concern accompanying thyroid disease is the potential for abnormally high or low levels of thyroid hormone to affect an applicant's cognitive function. Thyroid tumours have the potential to cause local symptoms or to metastasise to critical locations.

Investigation

Clinical suspicion of thyroid disease should be confirmed by appropriate investigations. These may include various imaging techniques, the use of fine needle biopsy, and biochemical thyroid function studies. CASA requires the results of thyroid function tests to establish that applicants are euthyroid prior to consideration for medical (re-)certification.