**AIRCRAFT ACCIDENT REPORT**

**CAA OCCURRENCE NUMBER 06/4477**

**DH 82A (TIGER MOTH)**

**ZK-BAR**

**MITCHAM ROAD, ASHBURTON**

**2 DECEMBER 2006**

# Foreword

As a signatory to the Convention on International Civil Aviation 1944 ("the Chicago Convention") New Zealand has international obligations in respect of the investigation of accidents and incidents. Pursuant to Articles 26 and 37 of the Chicago Convention, the International Civil Aviation Organisation ("ICAO") issued Annex 13 to the Convention setting out International Standards and Recommended Practices in respect of the investigation of aircraft accidents and incidents.

New Zealand's international obligations are reflected in the Civil Aviation Act 1990 ("the Act") and the Transport Accident Investigation Commission Act 1990 ("the TAIC Act").

Section 72B(2)(d) and (e) of the Civil Aviation Act 1990 Act also provides:

> 72B Functions of Authority
>
> (2) The Authority has the following functions:
>
> (d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in section 14(3) of the Transport Accident Investigation Commission Act 1990:
>
> (e) To notify the Transport Accident Investigation Commission in accordance with section 27 of this Act of accidents and incidents notified to the Authority:

Following notification to the Transport Accident Investigation Commission ("the Commission") of any accident or incident which is notified to the Authority, an investigation may be conducted by the Commission in accordance with the TAIC Act. CAA may also investigate subject to the requirements of the TAIC Act.

The purpose of an investigation by the Commission is to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person.

CAA however investigates aviation accidents and incidents for a range of purposes under the Act. Investigations are primarily conducted for the purpose of preventing future accidents by determining the contributing factors or causes and then implementing appropriate preventive measures - in other words to restore safety margins to provide an acceptable level of risk. The focus of CAA safety investigations is therefore to establish the causes of the accident on the balance of probability.

Accident investigations do not always identify one dominant or 'proximate' cause. Often, an aviation accident is the last event in a chain of several events or factors, each of which may contribute to a greater or lesser degree, to the final outcome.

CAA investigations may also inform other regulatory-safety decision making or enforcement action by the Director.

In the case of a fatal aviation accident, the final CAA investigation report will generally be highly relevant to an inquiry, and in some circumstances, an inquest, conducted by a Coroner.

**Contents** **Page Number**



**Tables**



**Figures**



**Addendum**

## Glossary of abbreviations used in this report:

| | |
|---|---|
| AGL | above ground level |
| AMSL | above mean sea level |
| BFR | Biennial Flight Review |
| CAA | Civil Aviation Authority |
| E | east |
| ft/min | feet per minute |
| lbs | pounds |
| NZDT | New Zealand Daylight Time |
| PPL (A) | Private Pilot Licence (Aeroplane) |
| RNZAF | Royal New Zealand Air Force |
| S | south |
| WGS 84 | World Geodetic System 1984 |

# AIRCRAFT ACCIDENT REPORT

## OCCURRENCE No 06/4477

| | |
|---|---|
| **Aircraft type, serial number and registration:** | DH 82A (Tiger Moth), S/N 1123, ZK-BAR |
| **Number and type of engines:** | One, de Havilland Gypsy Major 1 |
| **Year of manufacture:** | 1958 |
| **Date and time:** | 2 December 2006, 1000 hours[1] |
| **Location:** | Ashburton<br>Latitude[2]: S 43° 52.28'<br>Longitude: E 171° 46.70' |
| **Type of flight:** | Private |
| **Persons on board:** | Crew: 1<br>Passengers: 1 |
| **Injuries:** | Crew: 1 fatal<br>Passengers: 1 fatal |
| **Nature of damage:** | Aircraft destroyed |
| **Pilot's licence:** | Private Pilot Licence (Aeroplane) |
| **Pilot's age:** | 48 years |
| **Pilot's total flying experience:** | 219 hours,<br>28.3 hours on type |
| **Information sources:** | Civil Aviation Authority field investigation |
| **Investigator in Charge:** | Mr T.P. McCready |

[1] All times in this report are NZDT (UTC + 13 hours) unless stated otherwise

[2] WGS 84 co-ordinates

**Synopsis**

The Civil Aviation Authority was notified of the accident at 1025 hours on Saturday 2 December 2006. The Transport Accident Investigation Commission was also notified, but declined to investigate. A CAA site investigation was commenced later the same day.

The pilot and passenger were on a private flight from Ashburton Aerodrome and were intending to carry out a short flight around the local area. The aircraft was seen to commence a left climbing turn and then enter a spin from which it did not recover before striking the ground. The aircraft caught fire on impact.

## 1. Factual information

### 1.1 History of the flight

1.1.1 The flight originated from Ashburton Aerodrome and was intended as a brief local flight. The accident occurred approximately 10 minutes after takeoff.

1.1.2 The aircraft was observed just prior to the accident flying in level flight over a golf course and farming area at between 500 and 800 feet AGL, when it was seen to enter a left climbing turn and then spin towards the ground.

1.1.3 A second aircraft was lining up for take-off from Ashburton Aerodrome, about two nautical miles away, and the pilot of that aircraft observed the Tiger Moth spin to the ground. He immediately became airborne and orbited the accident site, confirming the colour of the aircraft and that fire had engulfed the fuselage.

1.1.4 The accident occurred on 2 December 2006 at approximately 1000 hours NZDT, at Mitcham Road, Ashburton, at an elevation of 298 feet AMSL, Latitude: S 43° 52.28', Longitude E 171° 46.70'.

### 1.2 Injuries to persons

| *Injuries* | *Crew* | *Passengers* | *Other* |
|---|---|---|---|
| Fatal | 1 | 1 | 0 |
| Serious | 0 | 0 | 0 |
| Minor/None | 0 | 0 | |

**Table 1: Injuries to Persons**

### 1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

### 1.4 Other damage

1.4.1 Not applicable.

## 1.5 Personnel information

1.5.1 The pilot held a current PPL(A) licence and a valid Class 2 medical certificate which was appropriate for that licence.

1.5.2 The pilot commenced his flying training in July 1996, flying predominantly the Piper PA28-140 aircraft type, and obtained his PPL(A) in December 1997 after 111 flying hours including 85.45 hours of dual instruction.

1.5.3 In May 1998 the pilot obtained a type rating on the DH 82A Tiger Moth aircraft over three successive days, comprising 2.15 hours of dual instruction and 0.15 hours (9 minutes) of solo flight. The pilot did not fly the DH 82A aircraft type again until December 2004.

1.5.4 The pilot then obtained an aerobatic rating on a Cessna 150 aircraft in December 1998 after 10.5 hours of dual instruction. As part of that rating he was certified as having '*demonstrated competence in spinning recognition and recovery technique*'.

1.5.5 In April 2005 the pilot successfully completed his BFR in a PA28-181 aircraft. He did not fly again until his first flight in the recently imported and assembled DH 82A Tiger Moth ZK-BAR (the accident aircraft) in December 2005.

1.5.6 The pilot underwent 8.3 hours of dual instruction refresher training in ZK-BAR in December 2005 and January 2006, including brief spin training.

1.5.7 Over the next year the pilot recorded 16 hours flight time (all in ZK-BAR) before the accident in December. The majority of the flights were with a passenger on board, the names of whom the pilot recorded in his pilot logbook.

1.5.8 The flights were usually brief, typically around 30 minutes duration.

## 1.6 Aircraft information

1.6.1 The DH 82A Tiger Moth, serial number 1123, was manufactured in 1958. It spent much of its life in parts, stored in Australia, and as a result had only accumulated 601 airframe flying hours at the time of the accident.

1.6.2 The aircraft was registered in Australia as VH-AHB. It was imported into New Zealand by the owner/pilot involved in this accident and registered as ZK-BAR on 4 November 2004.

1.6.3 The Annual Review of Airworthiness subsequently expired and the aircraft was granted a Special Flight Permit for the period 18 July 2006 to 31 July 2006 to enable it to be flown from Ashburton to West Melton for maintenance.

1.6.4 The current Annual Review of Airworthiness was certified on 21 July 2006 and no discrepancies were noted by the certifying aircraft engineer on the Annual Review of Airworthiness report.

## 1.7 Meteorological information

1.7.1 The weather on the day was calm and clear.

## 1.8 Aids to navigation

1.8.1 Not applicable.

## 1.9 Communications

1.9.1 Ashburton Aerodrome uses a common, unattended aerodrome radio frequency. No communications were heard from the accident aircraft but at the time of the accident, another aircraft was preparing for take-off and transmitting his intentions on the radio. Given ZK-BAR's close proximity to the aerodrome it is highly probable that the accident pilot heard those transmissions.

## 1.10 Aerodrome information

1.10.1 Ashburton Aerodrome is situated about two nautical miles from the accident site. The aerodrome circuit direction is left hand. The accident site was in line with a wide left hand downwind leg of the circuit.

## 1.11 Flight recorders

1.11.1 Not applicable.

## 1.12 Wreckage and impact information

1.12.1 Witnesses saw the aircraft enter a spin and descend, but did not see the impact with the ground because the aircraft disappeared from view behind a house.

1.12.2 Ground impressions of the leading edges of the main-planes (wings) indicate that the impact was in a steep nose down attitude with the starboard (right) main-planes striking the ground first followed by the port (left) main-planes. The wreckage then rebounded backwards pivoting around the starboard main-plane tips.

1.12.3 The wooden propeller had remained attached to the hub but had shattered, leaving ground impact marks.

1.12.4 The fuel tank had ruptured allowing liquid fuel and vapour to rapidly escape. The fuel ignited and produced an intense fire which quickly consumed the majority of the aircraft. The ignition source of the fuel was most likely a hot section on the engine.

1.12.5 The sliding fuel cock valve was in the 'ON' position.

1.12.6 The engine had moved rearwards into the occupiable space of the forward (passenger's) cockpit.

1.12.7 The rear (pilot's) cockpit showed some compression deformation along the longitudinal structure.

1.12.8 Integrity of the primary control runs was established, but the position of the throttle could not be determined due to heat damage caused by the fire.

## 1.13 Medical and pathological information

1.13.1 Post-mortem examination showed that the pilot died due to inhalation of fire and fumes. He sustained only Grade 3 (severe) impact injuries which would have immobilized him, but not caused death.

1.13.2 The pathologist further noted that the location of the aircraft fuel tank and very early generation of the fire on impact would have led to his death within seconds of the impact.

1.13.3 Toxicology tests were conducted on the pilot. No evidence of alcohol was detected in his blood or urine. There was also no evidence of medicinal or recreational drugs found.

1.13.4 Post-mortem examination of the passenger revealed that his death was due to high energy impact injuries to the head, neck, chest and limbs. Both cockpit areas were consumed by fire.

## 1.14 Fire

1.14.1 An intense fire engulfed the aircraft shortly after it had impacted the ground. The fire started as a result of the aircraft's fuel tank rupturing on impact, allowing fuel to escape rapidly and make contact with a hot section on the engine.

1.14.2 Inspection of the fuel tank showed a large opening on the right side seam of the tank, and a smaller opening on the left side. (see Figure 1)

**Figure 1: Open side seam (right side) of fuel tank.**

**Figure 2: Position of the ruptured fuel tank.**

1.14.3 An investigation into the two most recent fatal Tiger Moth accidents in New Zealand revealed similar fuel tank rupturing.

## 1.15 Survival aspects

1.15.1 The accident was not survivable for the passenger due to the high impact forces involved and the rearwards movement of the engine into the forward cockpit occupiable space. He died from impact injuries.

1.15.2 The airframe forward of the pilot acted in a similar manner to a modern automobile crush zone along the longitudinal axis, lessening the impact forces for the pilot compared with the passenger. The accident was possibly survivable for the pilot had there not been a post-impact fire.

## 1.16 Tests and research

1.16.1 The engine was removed from the wreckage and a strip-down inspection was conducted at an engine overhaul facility under CAA supervision. It was determined that the engine was in good mechanical condition and that there was no evidence of internal mechanical failure. The fire and impact damage prevented any test running of the engine.

1.16.2 Examination of the CAA database showed that there had been three fatal accidents in New Zealand (including this one) involving DH 82A Tiger Moth aircraft in the preceding 12 years, resulting in six fatalities. All were low altitude stall/spin accidents.

1.16.3 Video footage taken at one of those accidents (ZK-DHA) was studied. The footage recorded a very steep nose-down attitude of the aircraft after the stall and no appreciable recovery. This was consistent with ground impact marks found at the accident sites of both ZK-DHA and ZK-BAR accidents.

1.16.4 Research was conducted into the crashworthiness of the aircraft fuel tanks. This involved studying the fuel tank design and making comparisons by photographs taken of the aircraft fuel tanks at the same three accidents.

1.16.5 Research was also conducted into RNZAF Tiger Moth training accidents during the Second World War, and post-war civil Tiger Moth accidents. Data was gathered specifically on stall/spin accidents and accidents in which post impact fires occurred.

1.16.6 Research was carried out into the various aerodynamic modifications incorporated to improve spin characteristics, and previously conducted stability flight tests.

1.16.7 Research was conducted on spin characteristics of the aircraft. This involved actual flight testing and review of records of previously conducted testing.

## 1.17 Organisational and management information

1.17.1 As a result of a fatal DH 82A Tiger Moth accident which followed a stall and spin situation at Taumarunui in October 2003, the Tiger Moth Club of New Zealand has embarked on a training programme entitled *"Spinning – Avoidance and Recovery"*.

1.17.2 Concurrent with this training programme was the development of a CAA Good Aviation Practice booklet *"Spin Avoidance and Recovery"* into which The Tiger Moth Club of NZ has provided significant input.

## 1.18 Additional information

1.18.1 The investigation revealed that the aircraft had encountered some fuel contamination problems after its initial reassembly and test flight in New Zealand. The contamination had originated inside the fuel tank as a result of internal corrosion, probably as a consequence of the aircraft being kept in long term storage. This problem was rectified using standard engineering practices which involved flushing and cleaning the fuel tank, fuel line, and fuel filter. No further fuel contamination problems were reported.

1.18.2 From a test flight and research into Tiger Moth spin characteristics, it was determined that in a spin the aircraft airspeed is usually low and the descent rate is high. A Tiger Moth in a spin typically rotates once every two or three seconds and descends at 4000ft/min. Therefore one full turn equates to a height loss of about 200 feet.

1.18.3 Recovery from a spin, if done quickly, correctly, and precisely, would require about half a turn to stop. The aircraft will recover in a dive with airspeed increasing rapidly, resulting in further height loss. Therefore any spin entered during climb out from take-off, or from circuit height[3], makes a recovery highly

[3] Typically 1000 feet AGL.

unlikely. Analysis of accident records shows that a considerable number of stall/spin accidents commence from a relatively low altitude.

1.18.4 Records show that stability testing was conducted in New Zealand during 1952 due to various hopper modifications being fitted to the Tiger Moth for use in the agricultural role. Typically 400 lbs was carried in the hopper placed in the forward cockpit.

1.18.5 The tests conducted with an aft centre of gravity and aircraft weight of 1675 lbs, improved the aircraft's stability making it possible to fly with hands-off the control column. With a forward centre of gravity and an aircraft weight of 2000 lbs, good flying characteristics were also achieved.

## 2. Analysis

2.1 The aircraft was seen by numerous witnesses as it flew over the golf course and farming area just prior to the accident. At that stage none of the witnesses reported anything unusual about the aircraft or the way in which it was being flown. The aircraft was then seen to enter a left climbing turn between about 500 feet and 800 feet AGL. According to witnesses the aircraft appeared to enter a stall and subsequent spin during the climbing turn.

2.2 The surrounding countryside was very flat farming terrain offering ample safe forced landing opportunities if the aircraft had suffered any engine or fuel problems. No unusual engine noise was reported by witnesses. If such problems had occurred a pilot's first visible and expected reaction would be to lower the aircraft nose to maintain airspeed and establish a glide, not to initiate a climbing turn.

2.3 The aircraft was in a wide downwind position in the Ashburton Aerodrome circuit area. The wind was calm meaning that any of the various vectors and runways could be used in those conditions. It is possible that, in reaction to the transmitted intentions from the aircraft lining up for take-off from Ashburton Aerodrome, the Tiger Moth executed a hasty turn to reposition due to anticipated circuit traffic movement.

2.4 This pilot had received brief spin recognition and recovery training while obtaining an aerobatic rating in another aircraft type (Cessna 150) and only briefly during refresher training in ZK-BAR. The training being conducted within the Tiger Moth Club of NZ is more formalised and specific and exceeds what was available to this pilot. Stall recognition and spin recovery training is generally not carried out with the same frequency or duration in modern flight training as it was in the early era of aviation. This is due to the more docile handling characteristics of modern aircraft.

2.5 During the engine inspection particular attention was paid to the condition of the fuel jets in the carburettor for any evidence of fuel blockage, due to the reports of earlier fuel contamination problems. None was found. The fuel filter was unable to be inspected due to damage caused by the fire. The aircraft had flown approximately 25 hours since the fuel problems with no reported repeat occurrences.

2.6 Analysis of the CAA database for fatal accidents recorded for the last twelve years shows some similarities in the three Tiger Moth accidents. All of the accidents involved a stall and spin from low altitude, had two persons on board, and resulted in aircraft fire following impact with the ground. All three pilots had low hours on the aircraft type, the highest having 33 hours on type:

| Reg | Date | Injuries | DH 82A Experience | Details |
|---|---|---|---|---|
| ZK-BGP | 27 Sep 1997 | 2 Fatal | 33 hours | Stalled in Taieri Gorge, less than 500 feet AGL. Spun, caught fire. Witnessed by train passengers. |
| ZK-DHA | 18 Oct 2003 | 2 Fatal | 24 hours | Stalled while turning on climb out. 500 feet AGL. Spun, caught fire. Witnessed and recorded on video. |
| ZK-BAR | 2 Dec 2006 | 2 Fatal | 27 hours | Stalled in climbing turn. 500-800 feet AGL. Spun, caught fire. Witnessed. |

**Table 2. Fatal NZ Tiger Moth accidents in the last twelve years.**

2.7 Further analysis of Tiger Moth accidents has been published by Cliff Jenks and David Phillips *"New Zealand Tiger Moths 1938 to 2000"*. A reference on page 119 of that publication is made to civilian aircraft stall/spin accidents:

*"103 accidents (over three times as many as the RNZAF). Of the 123 occupants involved in these accidents 18 died and 18 seriously injured".*

On page 117 the RNZAF statistics are noted:

*"Spins and stalls usually occurred when pilots lost control while manoeuvring at comparatively low altitudes (e.g., in the aerodrome circuit) and were unable to recover in time. These were quite damaging to the aircraft, 25 of the 30 being written off. In six spin accidents the occupants were unscathed, and in the remainder the 30 occupants were injured, but only nine fatally so".*

2.8 Most aircraft will spin. The DH 82A Tiger Moth aircraft if not flown well and in balance is known for its tendency to stall and spin, more so than modern light aircraft which typically have more docile handling characteristics.

2.9 Further analysis of Tiger Moth spin characteristics was carried out. Due to the high number of pilots trained by the RNZAF during the Second World War using Tiger Moth aircraft, the training literature provided during that era was studied. A copy of the "RNZAF Flying Instructors Handbook for the DH 82 Aircraft" was obtained. Emphasis on spin recognition and recovery was detailed in chapter 13 of that handbook which reads:

***Spin From A Gliding Turn OR From Any Turn With Insufficient Power –*** *Glide at a speed below that at which a gliding turn should be made. Start a turn and try to increase the rate of turn with the rudder (a misuse of the controls).*

*As the nose drops, try to hold it up by a backward movement of the stick.*

*The aeroplane will stall and spin.*

*The same thing is liable to happen if the stick is pulled back too far (in an endeavour to raise the nose) during any turn at too low an airspeed or with insufficient power.*

*Now practise the correction of the incipient spin during a turn. The method is the same as from a straight glide.*

***Spin From A Turn Using Full Power –*** *During a turn it is quite possible to induce a spin even at full throttle if the loading is increased beyond the safe maximum, by moving the stick back too far or too harshly. Open the throttle fully and go into a steep turn. If the stick is moved back sufficiently to increase the loading above the safe maximum, the aeroplane will stall and may spin. To recover, close the throttle and recover as before.*

It is this level of detail of spin training that the Tiger Moth Club of NZ is attempting to re-introduce to civilian training.

2.10 Various design modifications have been devised for the Tiger Moth to reduce the aircraft's susceptibility to stall and spin if mishandled. These include anti-spin strakes, wing slats, and a redesigned tail known as the 'Fokker tail'. These designs met with limited success, and were unpopular with pilots who questioned their effectiveness. The Fokker tail was never produced in any numbers, the strakes were removed, and the wing slats were either removed or locked in place.

2.11 All aircraft will lose significant height during a spin even when a perfect recovery technique is used. In this accident, a recovery could not have been achieved before the aircraft impacted the ground because the spin commenced at insufficient height above the ground. Knowledge and experience of flight situations which should be avoided to prevent entering a spin would have been the only safety defences available to avoid this accident.

2.12 Investigation into the repeated occurrence of post-impact fires of the three recent accidents was conducted. Discussions during the investigation suggested that modern Ceconite fabric covering was perhaps a contributing factor to the fires. Ceconite fabric, an acrylic fibre, has been used to cover Tiger Moths since about 1990. The original fabric coverings had been fine Irish linen and in later years American mercerised[4] cotton has been used.

2.13 However, the data displayed in Table 2 suggests that the fires have been common in accidents since the Tiger Moth was first introduced into New Zealand in 1939.

[4] Mercerisation is a treatment for cotton fabric and thread that gives fabric a lustrous appearance.

| Date | Reg | Place |
|---|---|---|
| 2 Dec 2006 | ZK-BAR | Ashburton - fire |
| 18 Oct 2003 | ZK-DHA NZ1423 | Taumarunui - fire |
| 27 Sep 1997 | ZK-BGP NZ1494 | Taieri Gorge - fire |
| 1978 | ZK-CZX | Inangahua Junction, Nelson. No fire due impact into river, but considerable fuel spillage. |
| 24 Oct 1976 | ZK-BDH | Motueka - fire |
| 31 Mar 1975 | ZK-AKH NZ807 | Waimate - fire |
| 26 Oct 1969 | ZK-AVI | Taumarunui - fire |
| 4 May 1965 | ZK-BFA | Matamata - fire |
| 7 May 1960 | NZ1424 | Parnassus – wire strike - fire |
| 1 Mar 1959 | NZ1498 | Takaka - fire |
| 13 Dec 1958 | NZ714 | Gore - fire |
| 19 Jan 1958 | NZ848 | Thames - fire |
| 28 Apr 1954 | NZ741 | Oparau - fire |
| 25 Feb 1954 | NZ797 | Rongotai - fire |
| 1 Dec 1946 | NZ713 | Omaka - fire |
| 25 Mar 1944 | NZ872 | Taieri - fire |
| 22 Mar 1944 | NZ832 | Taieri - midair collision - fire |
| 14 Jan 1943 | NZ805 | Taieri - fire |
| 6 Oct 1942 | NZ881 | New Plymouth - fire |
| 25 Jul 1942 | NZ778 | Harewood - midair collision - fire |
| 25 Jul 1942 | NZ1411 | Harewood - midair collision - fire |
| 7 Mar 1942 | NZ844 | Taumarunui - fire |
| 20 Feb 1941 | NZ886 | Harewood -fire |

**Table 3: Post-impact fires.**

2.14 Post-accident fires are also common in Tiger Moth accidents due to the susceptibility of the aircraft fuel tank to burst on impact with the ground. The fuel tank is mounted between the upper main planes where considerable twisting of the airframe is centralised.

2.15 The design of the tank results in a large opening in the side at impact which allows a large amount of fuel and associated fuel vapour to be released in a short timeframe, increasing the likelihood of a fire.

## 3. Conclusions

3.1 The pilot was appropriately rated and licensed to conduct the flight.

3.2 The accident was probably caused by the aircraft stalling and spinning, possibly due to an unbalanced left climbing turn being initiated by the pilot between about 500 and 800 feet AGL.

3.3 It is possible that the pilot initiated a hasty, unbalanced turn to reposition the aircraft. This could have been in response to anticipated aircraft circuit traffic preparing for take-off.

3.4 Numerous examples were noted of low altitude stall/spin accidents with Tiger Moth aircraft being mishandled by pilots inexperienced on the type. The Tiger Moth aircraft has a tendency to spin more easily than modern training aircraft. Recovery from a spin at an altitude below 1,000 feet AGL is highly unlikely.

3.5 Engine or fuel system malfunction is considered unlikely after inspection of the engine and considering witness statements. The terrain offered ample forced landing opportunities which did not require an immediate turn.

3.6 The design of the fuel tank and the positioning of the tank between the two upper main-planes makes it susceptible to twisting and tearing action during an accident. The rapid opening of the tank seam allows the fuel to then burst (either as fluid or vapour) onto a hot engine with a resulting fire. This is not an uncommon occurrence during accidents in this aircraft type.

3.7 There is no evidence to support the theory put forward during the investigation that recent accidents resulting in post-impact fire can be attributed to the modern use of Ceconite covering fabric. A review of the dates of accidents indicates fires have been occurring consistently throughout the history of Tiger Moth aircraft operations.

3.8 There is no evidence to support the theory that the weight of a passenger carried will induce any longitudinal instability or adversely affect stall recovery.

3.9 None of the various aircraft modifications to improve the spin characteristics of this aircraft type have made any appreciable improvement.

## 4. Safety actions

4.1 The Tiger Moth Club of NZ has embarked on a stall recognition and recovery training programme as a result of the ZK-DHA accident and earlier accidents. Information can be found at: www.tigermothclub.co.nz.

4.2 The Tiger Moth Club of NZ has conducted air-to-air filming of a Tiger Moth entering stalls to better understand the event and to assist in the training programme.

4.3 In July 2007, the Authority[5] sought a report on the publication of a Good Aviation Practice booklet on spin awareness and spin recovery training. In August 2007, the Director of Civil Aviation reported that the proposed Good Aviation Practice booklet on spin awareness and spin recovery was on a priority list to be published in 2008.

4.4 The CAA published the Good Aviation Practice booklet *"Spin Avoidance and Recovery"* in December 2008 to which The Tiger Moth Club of NZ had a significant input.

4.5 The CAA has raised a safety action (No. 9A1812) to address the safety issue with the state of design that the fuel tank in Tiger Moth aircraft is prone to rupturing in an accident.

Authorised by:

Peter Kirker
Manager Safety Investigation

Date:

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[5] The CAA is governed by a board of community and aviation industry representatives whose focus is strategic direction, accountability and performance. The five members of the Authority are appointed in accordance with section 28(1) of the Crown Entities Act 2004.

## Addendum to CAA Fatal Accident report ZK-BAR, Occurrence No. 06/4477

**ZK-BAR. Aircraft history.**
**CAA report paragraph 1.6**

The CAA history of ZK-BAR indicates that it was previously registered in 1958 in Australia as VH-AHB and given the serial number 1123. VH-AHB had an accident in October 1964 and it is believed was itself a partial rebuild of VH-AKF which had a fatal wire strike accident in January 1950. VH-AKF was first registered as a civil aircraft in 1947 after being released from the Royal Australian Air Force. The early history quoted for ZK-BAR is unofficial as it could not be collaborated by any official records.
This aircraft history also serves to illustrate how tracking vintage aircraft and vintage aircraft parts (both original parts and aftermarket parts) can be very difficult.

**ZK-BAR. Serial Number history.**
**CAA report paragraph 1.6.1**

De Havilland Services Limited (DHSL) have reviewed this accident report and have advised that serial number 1123 is not recognised in any record keeping by De Havilland, England or De Havilland, Australia. They also advise that Tiger Moths were not in series production in any countries in 1958.

The CAANZ acknowledge DHSL's comments that the precise history of serial number 1123 can only be traced back to the aircraft registration VH-AHB, and that VH-AHB seems to have been the product of a rebuild made up of parts mostly from VH-AKF which itself had experienced a previous accident.

**ZK-BAR. Fuel Tank history.**
**CAA report paragraph 3.6**

DHSL also advise that the fuel tank is not a standard DHSL fuel tank, based on the position of a visible solder joint seam in a picture used in the CAANZ report.

The CAA investigation could not determine any history of the fuel tank in respect to its age and condition at the time of the accident.

The CAANZ acknowledge that the fuel tank was not a genuine DHSL part and that the precise history, age, origin and condition of this fuel tank is not known and could not be established in respect to its crashworthiness capabilities.