

AIRCRAFT ACCIDENT REPORT
OCCURRENCE NUMBER 03/2955
DE HAVILLAND DH82A
ZK-DHA
TAUMARUNUI AERODROME
18 OCTOBER 2003



Glossary of abbreviations used in this report:

AD	Airworthiness Directive
C	Celsius
CAA	Civil Aviation Authority
DVD	Digital Versatile Disc
E	east
ELT	emergency locator transmitter
GAP	Good Aviation Practice (booklet)
hPa	hectopascals
kg	kilogram(s)
M	magnetic
min	minute(s)
mm	millimetre(s)
mph	(statute) miles per hour
nm	nautical mile(s)
NZDT	New Zealand Daylight Time
rpm	revolutions per minute
S	south
sec	second(s)
UK	United Kingdom
UTC	Coordinated Universal Time
WGS 84	World Geodetic System 1984

AIRCRAFT ACCIDENT REPORT

OCCURRENCE No 03/2955

Aircraft type, serial number and registration:	DH82A (Tiger Moth), DHNZ103 ZK-DHA
Number and type of engines:	One de Havilland Gypsy Major 1
Year of manufacture:	1942
Date and time:	18 October 2003, 1450 hours ¹
Location:	Taumarunui Aerodrome Latitude ² : S 38° 49.85' Longitude: E 175° 16.31'
Type of flight:	Private
Persons on board:	Crew: 1 Passengers: 1
Injuries:	Crew: 1 fatal Passengers: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Commercial Pilot Licence (Aeroplane)
Pilot-in-command's age:	54 years
Pilot-in-command's total flying experience:	1490 hours, 24 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr T P McCready

¹ Times are NZDT (UTC + 13 hours)

² WGS 84 co-ordinates

Synopsis

The Civil Aviation Authority was notified of the accident which had occurred at 1450 hours on Saturday 18 October 2003. The Transport Accident Investigation Commission was also notified, but declined to investigate. A CAA field investigation was commenced the following day.

The aircraft was participating in an annual Tiger Moth Club event at Taumarunui Aerodrome. The aircraft had just taken off to fly a low-level circuit for a bombing competition. It commenced a right turn, and was then seen to spin to the ground where it caught fire on impact. Both occupants were killed.

1. Factual information

1.1 History of the flight

- 1.1.1 On Saturday 18 October 2003, the pilot flew the aeroplane from Ardmore to Taumarunui to participate in the Tiger Moth Club annual competitions.
- 1.1.2 The pilot attended a competition briefing by the event organisers, in which two practice wooden bombs were provided for the bombing competition. This involved flying low-level circuits and dropping the bombs as an accuracy exercise.
- 1.1.3 The aeroplane took off with the pilot and one passenger; four other aircraft were already in the circuit. One witness, a pilot, expressed the opinion that the aeroplane seemed slow, and that the flight path looked “steepish”. She was too far away to hear the engine sound, and in any case, there were other similar-sounding aircraft in the circuit and on the ground at the time.
- 1.1.4 The aeroplane was watched by witnesses up to when it started a turn to the right; when it was next seen a few seconds later, it was in a spin (and at this point one witness recorded it on video). It descended vertically to the ground, where it caught fire on impact.
- 1.1.5 The aeroplane was well alight by the time other persons arrived at the scene. Neither of the occupants had survived the accident.
- 1.1.6 The accident occurred in daylight, adjacent to Taumarunui Aerodrome, at an elevation of approximately 650 feet; latitude: S 38° 49.85', longitude: E 175° 16.31'.

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Other</i>
Fatal	1	1	0
Serious	0	0	0
Minor/None	0	0	

1.3 Damage to aircraft

1.3.1 The aeroplane was destroyed as a result of impact and fire.

1.4 Other damage

1.4.1 A set of domestic power lines were struck and severed in the accident sequence.

1.5 Personnel information

1.5.1 The pilot held a Commercial Pilot Licence (Aeroplane) endorsed with a C Category Instructor rating. Her Class 1 medical certificate was valid until 18 February 2004. She had satisfactorily completed a biennial flight review and instructor rating check on 16 August 2003, in which she was recommended for an upgrade to B Category.

1.5.2 The pilot's last logbook entry was dated three days before the accident, and recorded 1487.78 hours total flying experience, including 591.24 hours instructing. Her recorded time on type was 22.1 hours, plus an estimated two hours for the Ardmore-Taumarunui flight.

1.5.3 She obtained her DH82 type rating with the Kapiti Aero Club in February 2002, and after that she began flying the syndicate-owned ZK-DHA, based at Ardmore. All of her flights on type had been local flights from Paraparaumu or Ardmore and although not specified in her log book, probably one hour in the Taumarunui circuit at the previous years Tiger Moth Club's annual event. She had commented at Taumarunui on the day of the accident that the Ardmore to Taumarunui flight had been her first cross-country flight in a Tiger Moth.

1.6 Aircraft information

1.6.1 The DH82A Tiger Moth aeroplane was originally constructed in 1942 and had accrued 2552.50 total airframe hours as at the last logbook entry on 7 August 2003. The technical log, on which subsequent hours would have been recorded, was carried in the aircraft and was destroyed.

1.6.2 The de Havilland Gypsy Major 1 engine had run 590.55 hours since overhaul. Although the last recorded logbook entry was on 23 December 2002, the engine hours were updated to 7 August 2003 using the times recorded in the airframe logbook.

- 1.6.3 A review of the logbooks back to 1990 found that routine maintenance had been carried out, consisting of the usual annual inspections together with the appropriate repetitive inspections.
- 1.6.4 The aeroplane had suffered a propeller strike during start-up at 377 hours since overhaul, requiring replacement of the propeller and crack-checking of the crankshaft. The crankshaft was again crack-checked at 432.50 hours, as part of a routine inspection required by Airworthiness Directive DCA/Gypsy/103.

1.7 Meteorological information

- 1.7.1 The weather was a fine and clear day with little or no wind and only scattered cloud cover. Weather was not considered to be a factor in this accident.

1.8 Aids to navigation

- 1.8.1 Not applicable.

1.9 Communications

- 1.9.1 Not applicable.

1.10 Aerodrome information

- 1.10.1 Taumarunui Aerodrome is a non-certificated aerodrome situated three nautical miles north of Taumarunui township. It is located in a valley, and the single grass runway is oriented 011°/191° M. There is significant high ground on the extended centreline three nautical miles from the departure end of runway 01, rising to 2529 feet. Aerodrome elevation is 650 feet.



Figure 1: Taumarunui Aerodrome, looking north-east (the accident site is circled) and the black line indicates the pilot's line of sight along the left side of the aircraft.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 The aeroplane struck the ground in a steep nose-down attitude, having collided with a set of domestic power lines immediately before ground impact.

1.12.2 The fabric covering the airframe was burnt away, leaving the tubular structure and controls exposed. Control run continuity and structural integrity were positively established, however the control positions were difficult to determine because of heat damage. Many of the control levers and hardware were melted by the intense heat of the post-impact fire.

1.12.3 The propeller spinner showed spiral twisting of the light alloy metal, indicating rotation. The engine was recovered from the site for strip examination at a later date.

1.12.4 The sliding fuel cock was found in the “OFF” position, and was removed for further investigation.

1.13 Medical and pathological information

1.13.1 Post-mortem examination found that both pilot and passenger died from traumatic injuries associated with impact, and that the fire was not a factor in either death.

1.13.2 Within the limits imposed by post-impact fire damage, no evidence was found of any pre-existing condition that could have led to pilot incapacitation prior to the accident.

1.13.3 Toxicological tests revealed nothing of significance.

1.14 Fire

1.14.1 The aeroplane was engulfed by an intense fire immediately after impact. The fuel tank, located between the upper mainplanes, was found to have split on the right side, and this would have permitted fuel to spill on to the hot engine. This impact failure of the fuel tank and subsequent fire has been identified on other Tiger Moth accidents.

1.15 Survival aspects

1.15.1 The aeroplane was equipped with a Pointer 3000 ELT, which was destroyed by fire.

1.16 Tests and research

1.16.1 The sliding fuel cock was dismantled and examined for correct operation and assembly, and no abnormalities were found. The cock itself is mounted on the underside of the fuel tank, and is connected by a series of rods and bellcranks to a knob on the left side of each cockpit. These knobs are on a ¼-inch steel rod, one metre in length, which passes through the inter-cockpit bulkhead.

1.16.2 The rod weighs 300 grams, and in a sudden longitudinal deceleration, would tend to move forward to the ON position. However, if the fuel tank buckles forward and/or downward, only 10 mm movement would counter the ON travel, returning the rod to the OFF position, held against further aft travel by a fibre clamp block on the rod in the front cockpit against the inter-cockpit bulkhead, designed to prevent strain on the fuel cock flange to fuel tank by over-enthusiastic use of force. A further 10 mm fwd movement of the tank would force the fuel cock forward against its brass slider plate, sliding the fuel cock OFF.

1.16.3 Uncommanded closure of the fuel cock had been identified as a problem over 50 years ago, with one possible cause being in-flight vibration causing the operating mechanism to move towards the closed position. A long-standing Airworthiness Directive (DCA/DH.82/110) requires an annual check of the force required to move the fuel cock slide, the minimum value being six pounds. An Australian AD (DCA/DH82/2) mandates a modification to the fuel selector control in the rear cockpit to ensure positive locking while still allowing rapid selection to OFF in emergency. The UK CAA has followed suit, and details can be found in Technical News Sheet (TNS) No 34 and Moth Modification 155.

1.16.4 Some actual testing was carried out on a Tiger Moth aeroplane to investigate the effects of turning off the fuel cock. The entire fuel system downstream of the fuel cock, including filter, carburettor and jets was drained and refilled, and was found to hold 420 millilitres. With the aeroplane chocked, the engine was then run and the time to use this amount of fuel was noted. Results as follows were obtained for two different power settings, and a further test was made with the aeroplane taxiing:

RPM	AIRCRAFT	FUEL	RESULT
1,000	Chocked	Off	1.06 min to engine about to stop
2,050 (full throttle)	Chocked	Off	16 sec to immediate dead stop
1400 rpm on grass, average 1100 rpm and 2 bursts to 1200	Taxiing	Off	50 sec to engine stop, after 120 metres taxi
Atmospheric conditions: 1014.5 hPa, 16° C, wind 10 knots.			

1.16.5 The Gypsy Major engine employs automatic carburettor heat, in the form of a spring-loaded butterfly valve, interconnected with the throttle control so that at full throttle cold air is admitted, but at cruise, warm air from the engine bay is admitted through a flame trap. The spring applies 4-5 kg of load to keep the valve in the warm air position in cruise. If the throttle friction nut is not firmly applied before take-off, the spring will cause the throttle to back off if the pilot's hand is removed from it. Tests were conducted on a Tiger Moth, and the following results were obtained:

Configuration	Power	RPM	Spring-back	Result
Ground run	Full throttle	2050	to 1975 rpm	
Climb out (trimmed to 65 mph)	Full throttle*	2150	to 2025 rpm	Speed drops to 60 mph and below unless attitude changed

*After take-off normal climb-out RPM is usually set at 2000 at 65 mph

- 1.16.6 Strip examination of the engine at an overhaul facility found that the engine had been in very good condition, and no pre-existing defects that could have led to a power loss or engine failure were found. The magnetos and fuel distribution components were unable to be tested or examined because of fire damage.
- 1.16.7 The fleet of vintage aeroplanes at this event were being refuelled with 98-octane fuel sourced from a local automotive petrol station and transferred into a 44-gallon drum. This was supplied to the aeroplanes via a pump and filter system. It is accepted that older aeroplanes run better on lower octane fuel more suited to automotive specifications rather than the higher octane aviation fuel, so this method of sourcing automotive fuel is not unusual. The ground fuel supply system was examined and found to be in good condition. No other aircraft reported experiencing any fuel contamination problems from this source.

1.17 Organisational and management information

- 1.17.1 Nil.

1.18 Additional information

- 1.18.2 A feature of the Tiger Moth, with all its struts and wires, is high drag. With its slow overall speed and low inertia, any power reduction must be accompanied by an immediate adjustment to the attitude if speed is to be maintained. Even a rate 1 level turn commenced at 65 mph will drop the airspeed to 60 mph. Steeper turns require full power to initiate and maintain the turn at a safe margin above stall speed, which increases with the angle of bank. An engine failure requires an immediate lowering of the nose to avoid stalling and to maintain control.
- 1.18.3 The pilot in command position of a Tiger Moth is in the rear cockpit. Forward visibility from this position is restricted in a climb by the aircraft structure and engine, as well as the front seat occupant. The aeroplane has a small access door on the left side of the cockpit and when this is opened, it allows the pilot to look along the left side of the fuselage for directional control and visual orientation. (see cover photo and the light green doors flipped down at the open position in flight)
- 1.18.4 During climb, or while turning, a pilot flying by visual reference will position the nose of the aeroplane relative to the horizon, with only occasional glances at the aeroplane instruments. If the natural horizon is obscured by high ground, a falsely

elevated perception of the position of the horizon can be gained. This results in a higher than normal nose attitude being selected, which will lead to an airspeed loss. If the airspeed reduction is not detected, and if there is already little margin above the stall speed, a stall can ensue. The principles are discussed in CAA educational material, specifically the Good Aviation Practice (GAP) booklet on mountain flying, and a related video. These are available on request from CAA and in the case of the booklet, are commonly found at flight training organisations.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

- 2.1 The discovery of the sliding fuel cock in the off position caused some concern during the initial stages of the investigation. However, the possibility of a take-off with the fuel cock selected off was eliminated by testing - the engine simply could not have operated for as long as it did.
- 2.2 Research also revealed a previous history of the sliding fuel cock fitted to this type of aeroplane having a tendency to vibrate closed during flight. The tests carried out in this investigation, although eliminating a take-off in this configuration, could not exclude the possibility that this occurred in flight. It does, however, seem unlikely. The pilot was an instructor, and would have been well-practised in engine failure drills. The critical part of the procedure is to lower the nose to maintain airspeed. Had an engine failure occurred in this case, there was ample farmland ahead, suitable for a forced landing. The observed manoeuvres of the aeroplane were not compatible with a forced landing attempt.
- 2.3 The aeroplane entered a spin during a “steepish” climb and right turn. An engine failure at this point would be coincidental and the spin is more likely to have been initiated by the loss of airspeed as discussed in 1.18.4. The twisting of the propeller spinner tends to indicate that the propeller was at least turning at impact, but at what power setting could not be determined. It is likely that the pilot had reduced power to idle anyway, as part of the normal spin recovery procedure.
- 2.4 The limited visual cues in this case may have played a major part, given the difficulty with forward visibility in the climb on this aircraft type, and the lack of a true horizon in the valley system. Also, commencing a right turn when visibility in a left turn would have been better, with the pilot’s view from that side of the aeroplane; and the pilot’s unfamiliarity with this aeroplane in these specific conditions may have compounded the situation. The pilot’s previous DH82A experience was at Paraparaumu and Ardmore, where lack of a horizon is not generally a problem. The pilot may have previously conducted an hour’s circuit flying at Taumarunui 12 months previously however.
- 2.5 As noted in paragraph 1.16.5, it is possible for the throttle to spring back from the fully open position, if the throttle friction is not tight and the pilot’s hand is removed from the throttle. This can cause a significant power drop, which is

normally manageable, but at a critical stage of flight such as existed here, it could be a problem if not detected and rectified immediately. A pilot would typically keep that hand on the throttle but if something unusual happened, such as loose articles in the cockpit moving at the commencement of the turn, the throttle hand would be the one moved as opposed to the hand on the control column, or at least the throttle hand would have been brought across to hold the control column if that hand was required. There is no evidence to support this scenario, but it is a possible factor contributing to a loss of control by an experienced pilot. Tiger Moth pilots have related their experiences of this throttle spring back happening before.

- 2.6 Loose articles would normally be secured in a cockpit, particularly an open cockpit, but the unusual factor in the accident was the use of two wooden bombs carried by the pilot. It is not known where the pilot placed these bombs in the cockpit, but they could have been just placed on her lap, which may have allowed their movement at the commencement of the turn. Again, there is no evidence to support this scenario, but it is a possible factor contributing to a loss of control by an experienced pilot.

3. Conclusions

- 3.1 The pilot was appropriately licensed and rated for the flight, and held a current medical certificate.
- 3.2 The aeroplane was airworthy at the time of the accident.
- 3.3 The aeroplane stalled and spun at an altitude too low for recovery, while commencing a right turn after take-off.
- 3.4 The pilot probably perceived a false horizon on the initial climb, because of the high terrain ahead, resulting in an inadvertently lower than normal climb speed.
- 3.5 The already narrow margin above the stall speed was probably further eroded when the aeroplane commenced turning, and any possible distraction such as loose articles in the cockpit and subsequent throttle spring-back would have compounded the situation.
- 3.6 The pilot's restricted view along the left side of the aeroplane during the right turn, which was towards rising terrain, may have contributed to the false horizon illusion.
- 3.7 This was possibly the pilot's first take-off in this aircraft type from an aerodrome where high terrain had the potential to cause such an illusion or at best the first such take-off in 12 months. The seating position and view for the pilot is unique when compared to the more modern aircraft that she was experienced on.
- 3.8 The pilot had relatively low experience on the aeroplane type, which has unique handling characteristics.

4. Safety recommendations

4.1 Nil

5. Safety actions

- 5.1 Publishing of a CAA Good Aviation Practice (GAP) booklet covering spin avoidance and recovery is underway for distribution to all New Zealand pilots. This is a joint venture between CAA who will provide publishing expertise and the Tiger Moth Club who will give technical input.
- 5.2 Associated with the GAP booklet will be the distribution of a DVD to complement the booklet contents which will highlight the problem of spinning, and give tools for all pilots to both avoid and recover from a spin.
- 5.3 A targeted flying training programme covering spin avoidance and recovery is being developed for completion by October 2006 for Tiger Moth Club members. This involves utilising two experienced flying instructors and the programme is being contributed to by some of New Zealand's most experienced Tiger Moth pilots including the current Tiger Moth aerobatic champion and also the current New Zealand unlimited aerobatic champion.
- 5.4 In recognition of the broad field of aircraft that have been involved in spin accidents, all the training material produced as detailed above will be made available at no cost to the wider aviation community.

Report written by:

Authorised by:

(Signed)

(Signed)

Tom McCready
Safety Investigator
29 August 2005

Alan Daley
Acting Manager
Safety Investigation

Civil Aviation Authority of New Zealand
Aviation House 10 Hutt Road Petone
P O Box 31 441 Lower Hutt New Zealand
Tel: +64-4-560 9400 Fax: +64-4-569 2024
www.caa.govt.nz