CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

SAFETY INVESTIGATION REPORT
CAA OCCURRENCE NUMBER 14/1194
PA-38-112, Tomahawk
ZK-FTP
DEPARTURE FROM CONTROLLED FLIGHT
NGARURORO RIVER 5.5 NM WEST OF HASTINGS AERODROME
23 MARCH 2014

Source: Owner

Foreword

New Zealand's legislative mandate to investigate an accident or incident are prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and Civil Aviation Act 1990 (the CAA Act).

Following notification of an accident or incident, TAIC may conduct an investigation. The Civil Aviation Authority (CAA) may also investigate subject to Section 72B (2) (d) of the CAA Act 1990 which prescribes the following:

> **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

The purpose of a CAA safety investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level of a similar occurrence arising in the future. The investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based regulatory intervention tools may be required to attain CAA safety objectives.

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Glossary of Abbreviations:

agl	above ground level
amsl	above mean sea level
ATPL	Airline Transport Pilot Licence
CAA	Civil Aviation Authority (of New Zealand)
CAA UK	Civil Aviation Authority United Kingdom
CFI	Chief Flying Instructor
CFZ	Common Frequency Zone
CPL	Commercial Pilot Licence
ECG	Electrocardiogram
EFATO	Engine failure after takeoff
ELT	Emergency Locator Transmitter
ft	foot or feet
hPa	hectopascals
ICAO	International Civil Aviation Organisation
JAA	Joint Aviation Authority
KIAS	knots indicated air speed
lb	pound(s)
LFZ	Low Flying Zone
MHz	megahertz
NM	nautical miles
NW	north west
NZ	New Zealand
NZDT	New Zealand Daylight Time
UK	United Kingdom
UTC	Coordinated Universal Time
VHF	very high frequency

Data Summary

Aircraft type, serial number and registration:	Piper PA-38-112, Tomahawk, s/n 38-78A0185, ZK-FTP
Number and type of engines:	One, Lycoming O-235-L2C
Year of manufacture:	1978
Date and time of accident:	23 March 2014, 1106 hours[1] (approximately)
Location:	Ngaruroro River, Hastings Latitude: S 39° 38' 34.2″ Longitude: E 176° 38' 53.6″
Type of flight:	Flight training
Persons on board:	Crew: 2
Injuries:	Crew: 2 (Fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Commercial Pilot Licence (Aeroplane)
Pilot-in-command's age	47 years
Pilot-in-command's total flying experience:	552.30 hours, 367.45 on type
Investigator in Charge:	Mr D Foley

1 All times in this report are NZDT (UTC + 13 hours) unless otherwise specified.

Executive Summary

ZK-FTP was a PA-38-112, being operated on a dual low flying training exercise over the Ngaruroro River, near Hastings, Hawkes Bay on 23 March 2014. A British Airline Transport pilot was seeking to gain a New Zealand Commercial Pilot Licence, and this flight was to prepare him for the Commercial Pilot Licence flight test, booked for the following day.

The Rescue Coordination Centre of New Zealand received an Emergency Locator Transmitter signal from ZK-FTP by satellite at 1108 hours. An aerial search by one of the local Aero Club's pilots located the aircraft wreckage in the Ngaruroro River. Both occupants were observed to be motionless inside the aircraft.

The accident occurred as a result of the aircraft departing controlled flight and subsequently impacting terrain. The departure from controlled flight most likely occurred when the aircraft's critical angle of attack was exceeded, resulting in an aerodynamic stall[2] and spin entry. From the height the aircraft was estimated to be operating at, it would not have been possible for either pilot to recover the aircraft from the stall.

The safety investigation could not conclusively determine why the aircraft reached a point where the departure from controlled flight had occurred. Two likely scenarios are: incapacitation of one of the pilots or a handling error.

Four Safety Observations have been raised and addressed as a result of this accident.

Following this accident and several other dual flight training accidents, the CAA conducted a flight training review. Multiple safety initiatives have resulted.

1. Factual Information

1.1 History of the flight

1.1.1 A resident of the United Kingdom (UK) was in New Zealand (NZ) and had a job prospect as a pilot in NZ. The individual, ('the student'), was an experienced corporate jet pilot and the holder of a Joint Aviation Authority Airline Transport Pilot Licence (JAA ATPL). He did not hold a NZ Commercial Pilot Licence (NZCPL) which is a requirement to fly commercial operations in New Zealand.

1.1.2 The student had obtained a Civil Aviation Authority of New Zealand (CAA) Class 1 Medical Certificate and an examination credit for a NZATPL Law.

1.1.3 The CAA can issue a NZCPL if a pilot holds a current JAA ATPL. However, as the student's JAA ATPL was not current he was required to pass a NZCPL flight test.

2 Aerodynamic stall, put simply: is a condition where the wing's angle of attack increases beyond a certain point such that lift begins to decrease. The angle at which this occurs is called the critical angle of attack.

The student booked a flight test with the next available flight examiner which was in Napier on 24 March 2014. There was some urgency for the student to complete the flight test, as he was leaving for the UK on Tuesday, 25 March 2014, to collect his family to relocate to NZ. This gave the student three days to complete the training and reach the NZCPL flight test standard.

1.1.4 The student had not flown a light, piston engine aircraft for a number of years, was not familiar with the local area, or the NZCPL flight test syllabus. Therefore, flight training was required in order to reach the NZCPL flight test standard. The flight examiner recommended the student contact the local Flight Academy at Hastings Aerodrome to undertake this training due to its proximity to the testing venue.

1.1.5 The student first contacted the Aero Club/ Flight Academy office, at Hastings Aerodrome, on the evening of Thursday 20 March 2014. The student told an instructor that he was scheduled for a NZCPL flight test the following Monday and wanted to do a "run through".

1.1.6 The Aero Club owns a subsidiary, a CAA certificated flight training organisation, (the 'Flight Academy'). These two entities utilise the same premises and aircraft, however they operate separately with their own governance, management, staff and procedures.

1.1.7 The Aero Club's primary role is to facilitate Aero Club activities and promote recreational aviation primarily during the weekend.

1.1.8 Professional training[3] such as that required by the student is normally conducted, between Monday to Friday by the Flight Academy. However, due to the student's time constraints he was booked to fly with the Aero Club's Chief Flying Instructor (CFI) on Saturday, 22 March 2014.

1.1.9 On Saturday, 22 March 2014 the Aero Club's CFI clarified with the student what his circumstances and intentions were. The CFI also contacted the Flight Examiner to clarify some aspects of the NZCPL flight test.

1.1.10 The CFI conducted a 36 minute familiarisation flight in a Cessna 172 aircraft with the student. The CFI said "he flew well but was not used to light aircraft, and not that familiar with the Garmin 1000 glass cockpit".

1.1.11 It was decided that one of the Aero Club's part time C-Category Instructors ('the instructor') would carry out a second flight that day with the student. This was conducted in a PA-38-112 aircraft as the hourly charge rate was less than the Cessna 172 aircraft. This flight, 1.10 hours in duration, was completed without incident and included flying in the Low Flying Zone (LFZ) NZL462[4]. After the flight, the

3 Professional training is defined as training that is required for a student to pass a commercial licence or foreign licence transfer.

4 Low Flying Zones are designated portions of airspace where pilot training in low level manoeuvres may be conducted.

instructor contacted the Flight Examiner stating it would be unlikely the student would be ready for Monday's flight test.

1.1.12 Due to a lack of available accommodation in the area, the student stayed the night at the home of the instructor and his partner. The instructor's partner reported they all shared a meal and then the couple went out for the evening. The student stayed behind in order to study. When the couple returned home it was assumed that the student was asleep. The couple went to bed around 2300 hours.

1.1.13 On the morning of the accident flight the instructor, his partner, and the student shared what was described as a "relaxed" breakfast and then the two men drove separately to the Aero Club. The instructor's partner reported that the two men seemed to be "getting on well" and "were in no hurry to get to the airport".

1.1.14 The CFI observed the instructor conducted a one hour briefing with the student prior to the flight.

1.1.15 It was estimated from fuel records that the aircraft departed with 50 litres of fuel on board. This fuel quantity gave a flight endurance of approximately two hours.

1.1.16 The Aero Club Base Station Radio recorded a radio call from the student pilot in ZK-FTP at 1029 hours stating they were taking off from Runway 01 Hastings departing for the Maraekakaho training area at 2500 ft.

1.1.17 After they departed, the CFI contacted the Flight Examiner advising that it was unlikely that the student would be ready for the flight test on Monday. The examiner advised "don't put him up for it [the flight test] if he is not ready" and that he was available to conduct the test that Thursday or Friday. The CFI intended to provide this information to the student and instructor on return from their training flight.

1.1.18 A witness observed an aircraft matching the description of ZK-FTP at approximately 1030 hours climbing from the direction of the Runway 01 and then descending again to about 100 ft above ground level (agl), before climbing away again and flying to the north-west. This was most likely a simulated Engine Failure After Take-off (EFATO) exercise which is part of the NZCPL flight test syllabus. The witness regularly observes aircraft flying in a similar manner due to his proximity to the aerodrome.

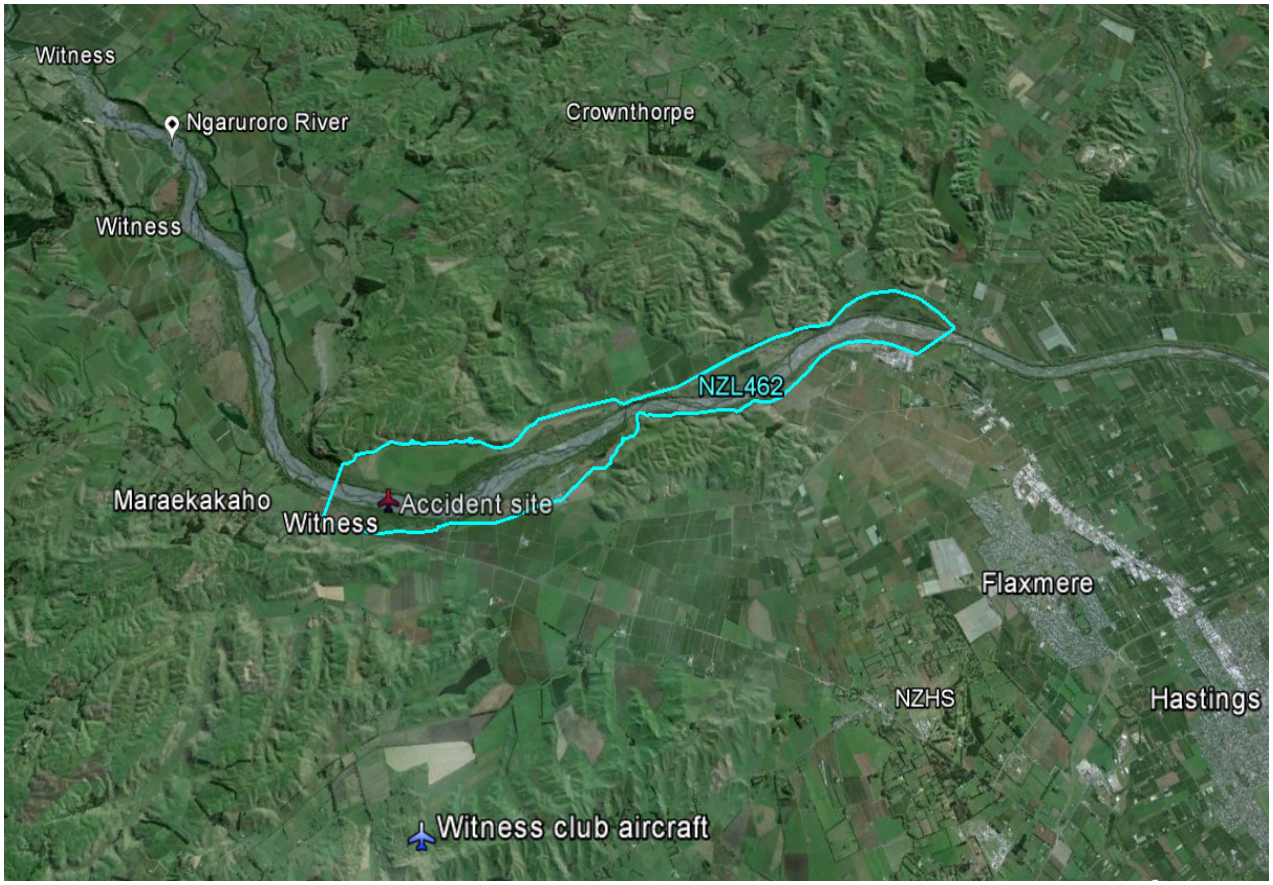
1.1.19 An aircraft matching the description of ZK-FTP was observed between 1030 and 1100 hours by witnesses from various locations along the Ngaruroro River to the west of the LFZ NZL462. See Figure 1. These witnesses watched the aircraft flying at between estimated heights of 30 ft to 200 ft agl, alternatively banking the wings left to right and pitching up and down "aggressively".

1.1.20 At the same time, the CFI and a student were operating in another Aero Club aircraft, ZK-FTQ approximately 3 NM to the south of NZL462. Just prior to 1100 hours they heard a radio call from the instructor in ZK-FTP stating their intentions to descend from 1600ft and enter NZL462. The instructor observed ZK-FTP descend from Maraekakaho along the Ngaruroro River and into NZL462 towards the east. They

both noted that no radio call was heard from the pilots of ZK-FTP to notify that the aircraft was established within NZL462, as is normal procedure.

1.1.21 Another witness who was approximately 1.5 NM from the accident site reported seeing an aircraft, matching the description of ZK-FTP, flying just above the height of nearby trees at approximately 30ft agl. The aircraft then made a sharp turn and headed towards the river, within the NZL462. This was the last reported sighting of the aircraft and occurred minutes before the accident.

1.1.22 The accident occurred in daylight, at an estimated time of 1106 hours, 5.5 NM west of Hastings Aerodrome (NZHS) at Latitude: S 39° 38' 34.2″ Longitude: E 176° 38' 53.6″.



Source: Google Earth

Figure 1:
Map of Accident Area (for illustrative purposes only).

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	2	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 Nil.

1.5 Personnel information

Pilot in Command-Instructor

Flying hours	All types	PA-38-112
Last 24 hours	1.10	1.10
Last 90 days	4.20	1.40
Instructing	137.50	106.90
Low flying instruction	8.80	8.30
Total hours	552.30	367.45

Table 2:
Instructor flight hours.

1.5.1 The instructor was an aeroplane and microlight instructor who had flown a total of approximately 552 hours of which 367 hours were on PA-38-112 aircraft.

1.5.2 The instructor commenced flight training with the Aero Club in September 1992 and gained a Private Pilot Licence (PPL) in July 1993.

1.5.3 After gaining his PPL the instructor's Pilot Logbook showed several interruptions to his flight training until he gained his CPL in 2011, and a C-Category Instructor Rating in March 2012.

1.5.4 The instructor flew regularly for the Aero Club after gaining the C-Category Instructor Rating, completing 100 hours instruction under direct supervision[5] on 27 January 2013.

1.5.5 A C-Category Instructor renewal was completed with the Aero Club CFI on 16 March 2013. It was valid until 10 April 2014.

1.5.6 In the three months prior to the accident a total of 4.20 hours flight time were logged of which 1.7 hours were in the PA-38-112 aircraft. This included the 1.10 hour instructional flight with the student the day prior to the day of the accident.

5 All newly rated C-Category Instructors must be under direct supervision by either an A or B Category Instructor until they have logged 100 hours flight instruction time.

1.5.7 At the time of the accident a total of 137.50 hours of instruction had been logged, of which 106.90 hours were in a PA-38-112 aircraft. Approximately 8.8 hours low flying[6] instruction had been conducted, which included approximately 0.3 hours from the previous day's flight.

1.5.8 A review of the instructor's Pilot Logbook was conducted by the CAA's Training and Standards Development Officer (SDO). This review identified 'several gaps in the instructor's training' which 'appeared to be non-standard' with 'no logbook evidence of robust supervision'. The SDO commented that this training programme 'didn't provide a sound example for a new C Cat [C-Category Instructor]'.

1.5.9 The instructor held an unrestricted valid CAA Class 1 Medical Certificate issued on 6 June 2013 with an expiry date of 17 June 2014. No medical issues of aeromedical significance were identified at the time of his last medical assessment.

1.5.10 The CFI and the instructor's partner reported that the instructor was relaxed and in good spirits on the day prior and on the day of the accident. His partner said that "[the instructor] had slept well the previous night and did not state feeling tired".

Personnel information

Student

1.5.11 The student pilot held a JAA ATPL issued by the Civil Aviation Authority in the UK (CAA UK) on 1 March 2000. His instrument rating renewal was valid until 31 March 2014.

1.5.12 The student commenced his flying career with the Royal Air Force of the British Armed Forces before progressing to his most recent position as a corporate jet captain in Europe. He held ratings on various business jets with the last recorded flight on a Dassault Falcon 2000 on 12 November 2012. It is unknown how much single engine flight experience he had. The Aero Club CFI understood that he had flown the Cessna 152 aircraft approximately twenty years ago but had never flown the PA-38-112 aircraft. He had logged 7778 hours total flight time, of which 5461 were pilot in command.

1.5.13 The student held an unrestricted European Union Class 1 Medical Certificate issued by the CAA UK on 29 January 2014 with an expiry date of 15 July 2014 for single pilot commercial operations carrying passengers and an expiry of 15 January 2015 for other commercial operations.

1.5.14 The student's relevant medical information from the CAA UK was reviewed by CAA when the student applied for a CAA Class 1 Medical Certificate. The CAA UK file identified that the student had been extensively investigated in the UK for the presence of frequent ectopic beats[7] identified on his electrocardiogram (ECG).

6 Low flying is flight conducted below 500 ft agl.

7 Ectopic beat - a cardiac beat originating elsewhere than at the sinoatrial node of the heart.

The investigations included magnetic resonance imagery (MRI) of his heart. The MRI test showed 'no myocardial fibrosis, infarction or infiltration'[8]. He was advised by CAA UK to make lifestyle changes to reduce the cardiac arrhythmias[9]. His medical history was free of any other condition of concern; in particular there was no history of any granulomatous[10] disease such as sarcoidosis[11]. The ECG completed in NZ showed no abnormal rhythm.

1.5.15 The student's relevant medical information was referred to the CAA Consultant Cardiologist for review. Based on their assessment, CAA issued the student with an unrestricted CAA Class 1 Medical Certificate on 14 February 2014 with an expiry of 14 February 2015.

1.6 Aircraft information

1.6.1 Piper PA-38-112, serial number 38-78A0185, was manufactured in the United States of America in 1978 and imported into NZ in April 1989. It was registered as ZK-FTP and a Restricted Certificate of Airworthiness was issued by the CAA in July 1989. It was subsequently issued a Standard Certificate of Airworthiness in May 2000 following the conversion from petrol (MOGAS) to aviation fuel (AVGAS).

1.6.2 The aircraft was powered by a Lycoming O-235-L2C, 112 horsepower engine, driving a Sensenich 72CK-C-56 two bladed propeller.

1.6.3 At the time of the accident the aircraft had accrued 14,134.1 hours total flight time. The last scheduled maintenance was a 50 hour inspection on 12 March 2014.

1.6.4 It was determined by calculation that at the time of the accident, the aircraft all up weight was 1658 pounds (lbs) which is within the maximum allowable all up take-off weight of 1670 lbs. The aircraft's centre of gravity was within the limits stipulated in the aircraft Flight Manual.

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8 Myocardial fibrosis - a condition that involves the impairment of the heart's muscle cells with associated hardening or scarring of tissue.

Myocardial infarction - medical term for heart attack – death of part of the heart muscle as the result of insufficient blood supply.

Myocardial infiltration - when abnormal substances are deposited into the heart muscle.

9 Cardiac Arrhythmias - irregular heartbeat.

10 Granulomatous - describes a condition where small inflammatory lumps (granulomas) form in tissue.

11 Sarcoidosis - is an inflammatory condition that may result in lumps (granulomas) within the heart muscles, possibly causing malfunctioning, such as arrhythmia.

1.7 Meteorological information

1.7.1 An automatic weather briefing station installed at NZHS recorded a 3 knot wind from the NW, humidity in the region of 90% with a temperature of 19 degrees Celsius. Napier Aerodrome Automatic Terminal Information Service reported the QNH as 1024 hPa.

1.7.2 The CFI and student in ZK-FTQ reported the cloud as; overcast at 2000 ft above mean sea level (amsl) with a lower level estimated at 1500 ft amsl towards the Maraekakaho training area. The cloud was observed to be shelving lower to the north and the wind reported as light. ZK-FTP was seen below the reported cloud base by the student in ZK-FTQ.

1.7.3 A witness who lives close to the accident site area reported the weather as "cloudy with no wind, no sun and good visibility".

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 The Aero Club's Base Station Radio records radio transmissions on the local frequency 125.8 MHz which covers the NZHS Common Frequency Zone (CFZ)[12]. The Base Station recorded the transmission of ZK-FTP at 1029 hours when the aircraft departed NZHS "for the Maraekakaho Training Area at 2500 ft". No further transmissions were recorded.

1.9.2 Three Aero Club aircraft were flying in the vicinity of NZL462 just prior to the accident. Being in closer proximity to ZK-FTP and operating at a higher altitude than that of the Base Station these pilots were able to receive the transmissions from ZK-FTP. The last transmission from ZK-FTP stated they were in the Maraekakaho training area at 1600 ft and descending to enter the low flying area.

1.9.3 No further radio calls were heard from ZK-FTP.

1.9.4 The Rescue Coordination Centre of New Zealand received an Emergency Locator Transmitter (ELT) signal from ZK-FTP by satellite at 1108 hours and informed the Aero Club.

1.9.5 At approximately 1115 hours the three Aero Club aircraft were contacted by the Aero Club to say an ELT had been activated.

12 In certain areas of NZ, Common Frequency Zones (CFZ) have been established. These areas are not designated airspace, but they are where common frequencies have been established in order to enhance safety in areas of concentrated aviation activity, generally recreational aviation.

1.9.6 One of these aircraft, located the wreckage and remained overhead the accident site to provide communication support to the Napier Tower Controller, NZHS Base Station and a rescue helicopter.

1.10 Aerodrome information

1.10.1 Low Flying Zone NZL462 is bounded by the Ngaruroro River south bank from S 39°35'34.7″ E 176°44'57.7″ up to the Ngaruroro River north bank to S 39°38'23.7″ E 176°38'07.7″.

1.10.2 The Aero Club is the designated agency for operations in NZL462. Pilots not associated with the Aero Club are required to obtain a briefing and comply with any conditions that may be applicable. The Aero Club operates a booking system for NZL462 and only one aircraft is permitted to operate in the LFZ at any one time. The Aero Club records showed only ZK-FTP had been booked for NZL462 at the time of the accident.

1.10.3 Additionally, there are inflight requirements including: checking the LFZ is clear prior to entry, performing aircraft safety checks and for making radio calls on entry and exiting of the LFZ.

1.11 Flight recorders

1.11.1 No tracking or recording devices were installed in ZK-FTP, nor were they required to be.

1.12 Wreckage and impact information

1.12.1 The aircraft wreckage was observed from the air by Aero Club pilots partly submerged in the river in an approximate 50° to 60° nose down attitude with the fuselage and empennage rotated to the right. See Figure 2.

1.12.2 Later that day the wreckage was photographed by the Police, before it was removed from the river.

1.12.3 The engine and propeller had been fully submerged in the river. Inspection revealed the engine mounts and propeller spinner had twisted to the right. One propeller blade exhibited damage consistent with impact with river stones while under rotation.

1.12.4 The carburettor heat valve was in the closed position, which corresponded with carburettor heat selected off.

1.12.5 The first stage (21 degrees) of flap was found extended.

1.12.6 The left side of the fuselage and rear cockpit showed signatures consistent with being under tension at the time of impact. Conversely, the right side of the fuselage had been subjected to compression forces.

1.12.7 The rear empennage had partly separated and had folded over the rear of the fuselage forward and to the right.

1.12.8 Both occupants were observed slumped forward and to the right. They remained restrained by their lap belt and shoulder harnesses. The right seat was compressed and had failed to the right. Both control columns had been bent towards the right.

1.12.9 The aircraft wreckage exhibited several signatures consistent with the aircraft being in, or entering into, a spin.

1.12.10 The engine controls and switches were all set in a position appropriate for flight. It was not possible to determine the position of the fuel selector due to damage it had sustained. Readings from the engine instruments showed no anomalies. At the time of impact the engine RPM gauge needle was captured at 700 RPM.

1.12.11 Pre-impact control integrity was established as far as possible. No evidence was found of any mechanical or flight control system failure that may have contributed to the accident.

1.12.12 The aircraft clock had stopped at 1103:12.

Figure 2:
Accident Site

1.13 Medical and pathological information

1.13.1 Post-mortem examination showed that the occupants died of multiple injuries sustained in the accident.

1.13.2 A report produced by the Forensic Pathologist stipulated that the instructor 'had coronary artery disease that could be associated with sudden cardiac death. Of note, there are no autopsy findings to specifically suggest that [the instructor] has ever suffered a prior or current cardiac event. Specifically there is no myocardial fibrosis (heart muscle scarring) to suggest a previous episode of ischaemic heart disease due to his coronary artery atherosclerosis. However, any individual with significant narrowing of the left anterior descending coronary artery, and further narrowing of the left main coronary artery is at risk of a sudden cardiac death.'

1.13.3 With regard to the student, the Forensic Pathologist's report stipulated that the student 'had sarcoidal myocarditis, a form of inflammation of the heart muscle, which can also result in sudden cardiac death. Similarly, autopsy examination has not been able to prove or exclude a cardiac event occurring that has caused a collapse of [the student].'

1.13.4 The Forensic Pathologist concluded 'It could well be that despite having pre-existing natural disease that can, in some individuals, predispose to cardiac event, (heart attack or sudden cardiac death), that neither pilots were affected. Individuals with such cardiac disease can remain unaffected for some time, and die from other causes. As such, despite the presence of demonstrable cardiac disease at autopsy in each of the pilots, I am unable to say that an episode of cardiac disease has actually contributed to the aviation incident.'

1.13.5 Toxicological test results showed no presence of any substance that would have impaired either the student or instructor's ability to fly the aircraft.

1.13.6 It was not possible to ascertain from the autopsy or the wreckage signatures which pilot was manipulating the controls at the time of the accident.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 Both pilots were wearing the lap and shoulder portions of their harnesses which provided restraint during the accident sequence. However, due to the impact forces involved, the accident was not survivable.

1.15.2 The aircraft was fitted with an ELT which activated on impact as designed.

1.16 Tests and research

1.16.1 The engine was disassembled and inspected by a maintenance provider, under CAA supervision. The maintenance provider's report concluded that 'No evidence was found of any pre-impact abnormality that would have affected the engine's ability to produce power'.

1.16.2 Several studies have identified that the skills associated with safe and efficient flight degrade over time following the acquisition of those skills. A study sponsored by the Federal Aviation Authority examined the retention of private pilot flight skills following private pilot certification[13]. This study identified a proficiency loss for all subjects and stated 'flight skills, will degrade over time if not exercised sufficiently for the pilot to be able to retain or improve them'.

1.16.3 Currency and skill decay is explained further in an article included in Transport Canada Aviation Safety Letter 1/2012 (ASL 1/2012)[14], which states:

> 'Different types of skills, once learned and not practiced for periods of time, will degrade at different rates. Continuous movement skills, such as steering, guiding or tracking are relatively impervious to decay. Decision making, recalling bodies of knowledge and skill at tasks which require verbal communication between people, however, are subject to fairly rapid decay if not practised.'

The article further states that:

> 'Twenty-seven accidents resulted from mishandling the aircraft into an aerodynamic stall.' [….] 'In all cases, the stall which sometimes precipitated a spin or wing drop, occurred at low altitude and at low airspeed. The stalls and spins occurred at a height where recovery was very difficult and probably impossible'.

1.16.4 The analysis of the Canadian stall/spin accidents contained in ASL 1/2012, noted that several pilots were not current on their aircraft and several other pilots were either low time pilots, flew infrequently, or both. Furthermore, in unusual circumstances requiring quick assessment of the situation and rapid accurate decisions, skill decay was considered likely to affect such pilots. Periodic review or refresher activity for infrequent fliers was described, as a way to ensure that relevant knowledge is available for recall and that the information processing and decision making skills stay sharp.

1.17 Organisational and management information

1.17.1 The Aero Club's primary role is to facilitate Aero Club activities and promote recreational aviation. The instructor in ZK-FTP worked for the Aero Club on a pro bono basis. The Aero Club also owns a subsidiary, a professional flight training organisation, the Flight Academy, which would normally conduct this type of flight training, however, this did not occur.

13 Childs, J.M., Spears, W.D. and Prophet, W.W. (1983), Private Pilot Flight Skill Retention 8, 16, and 24 Months Following Certification. DOT/FAA/CT-83/34, Washington, D.C: U.S. Government Printing Office.

14 Transport Canada. (2012). Aviation Safety Letter TP 185E, Issue 1/2012. Retrieved July 20, 2017, from the Transport Canada website: http://www.tc.gc.ca/Publications/en/TP185/PDF/HR/TP185E_1_2012.pdf.

1.18 Additional information

1.18.1 Demonstration of proficiency in Low Flying procedures is a mandatory test item for the CPL Flight Test. Training for these procedures is normally conducted in designated LFZs such as NZL462.

1.18.2 The CAA Flight Instructor Guide provides training guidelines for the Low Flying exercise.

1.18.3 The Aero Club has standard lesson plans and briefings which incorporate the CAA guidelines. The instructor's personal copy of this lesson plan was recovered from the briefing room after the accident. Key points from this lesson plan include:

The Objective:

To compensate for the effects of visual illusions, inertia, and stress when operating the aeroplane close to the ground

Inertia:

Lag in response of the aircraft to pilot input. More room required for manoeuvres at high airspeeds - very noticeable at low level. Anticipate.

Aeroplane Management:

Use poor visibility configuration – Flaps 21°, decreased rpm, fly at 75kts, lights on. Frequent use of carburettor heat. Increase power in the turn due to an increase in drag. Limit angle of bank to 45°due to increased drag.

Threat and Error Management:

Threat: Close proximity to terrain - Nominate minimum height. Know LFZ Boundaries. Anticipate aircraft movement. Use poor visibility configuration.

Threat: Other aircraft in the LFZ – Appropriate radio calls and lookout. Communication during the exercise.

Error: Misjudging of nose attitude/failure to maintain safe airspeed – Be familiar with expected performance. Project a horizon from this. High scan rate.

1.18.4 The CAA Flight Instructor Guide also provides training guidelines for conducting steep turns (45° angle of bank) at low level:

'When entering the steep turn from normal cruise, backpressure is increased to maintain altitude and, although the increase in drag is not ignored beyond 30 degrees angle of bank, some decrease in airspeed as a result of the substantially increased drag is expected and acceptable.

When entering the steep turn at low level in the poor visibility configuration, however, absolutely no decrease in airspeed is acceptable, because of the small margin over the stalling speed.

So as to maintain this margin over the stall speed, power is increased on entry; the power increase required may be substantial, although not necessarily full power.

During the turn, attitude, angle of bank, speed, and balance are monitored.'

1.18.5 The PA-38-112, Flight Manual, Section 4.35 *Stalls and Slow Flight* states 'At 1670 lbs. gross weight with power off, outboard and inboard flow strips and full flaps the stall speed is 49 KIAS; with flaps up this speed is increased 3 knots.'

Additionally, Section 5.12, *Performance*; Stall Speed vs Angle of Bank graph shows that at 45 degree angle of bank the stall speed is 62 KIAS with flaps up and 59 KIAS with full flap. No speeds are given for flaps set to 21 degrees (first stage). It would be expected to be within these speed ranges.

1.18.6 The PA-38-112, Flight Manual, Section 4.35 *Stalls and Slow Flight* states 'loss of altitude during stalls can be as great as 320 feet, depending on configuration and power'.

1.18.7 Foreign pilot licence holders may approach NZ flight training establishments and aero clubs for the purpose of recognition of their foreign licence for a NZ document. While most state regulators issue an International Civil Aviation Organization (ICAO) recognised licence, the standards applicable are those set by that state and consequently some international variances exist. Exclusion of low flying and fully developed stalling in the flight training syllabi, and different procedures for simulated forced landings are some examples of the international variances.

1.18.8 The CAA Flight Training Standards Officer commented with regard to NZ foreign licence validations: 'The needs analysis in such circumstances is outside normal practice for most training providers, and is outside the training and guidance provided to new C Cat [C-Category] instructors. Consequently assumptions and knowledge gaps can exist for both the instructor and candidate. If not fully understood, these threats can create a layer of risk often not appreciated. Such circumstances present challenges for both the low experience instructors not prepared or briefed for such candidates, and for the candidate who regularly flies elsewhere albeit in a different aircraft type and circumstances. Unless an organisation or instructors within the organisation has any experience of such candidates to share, or use established relevant policy and procedures, both the instructor and candidate in such circumstances can be subject to a fundamental hazard of the lowest learning level: "not knowing what they don't know"'.

1.18.9 During the review of the instructor's Pilot Logbook, conducted by the CAA Training and Standards Development Officer, it was identified that there was no evidence from the instructor's logbook or training file that he had received specific instruction or guidance on the training needs or associated risks with conducting flight training for foreign pilot licence holders or experienced airline pilots. However, it should be noted that this is specialised training, and as such, does not form part of the standard instructor rating syllabus.

1.18.10 During flight instruction, the instructor is the pilot in command of the aircraft and effectively the leader or captain. This is a similar relationship or command structure to that of a captain and first officer in a commercial flight operation. This relationship is referred to as the trans-cockpit authority gradient[15]. Research in the airline and military environments have shown that a steep gradient is produced when an over-bearing or dictatorial captain/instructor is paired with a fairly inexperienced first officer/student. A flat gradient is produced when crew with equal proficiency are paired together. An inverse gradient is formed when the command function of the captain/instructor is obscured, especially when the co-pilot/student happens to be senior to the captain/instructor. While there is literature about trans-cockpit authority gradient in military and airline environments, there is little in relation to flight training. The potential for an inverse trans-cockpit authority gradient, is a specific threat that instructors should consider and manage when training students who are more experienced than themselves.

1.18.11 As such the CAA has raised a Safety Observation CAA 18F200, for the CAA to raise awareness in the flight training industry of the potential for an inverse trans-cockpit and the specific needs and threats associated with one. However, it should be noted that the status of the inverse trans-cockpit authority gradient was not established as a contributing factor in this accident; it is simply being raised as a Safety Observation.

1.18.12 Following this accident and several other dual flight training accidents, the CAA conducted a flight training review[16]. Findings from the flight training review and Safety Observations from this accident have been the focus of several CAA safety initiatives.

1.18.13 As part of the safety investigation, specialist Cardiologist opinion was sought. The report produced by the Cardiologist stipulates that the instructor 'did have an adverse lipid profile at autopsy, apart from some traumatic myocardial damage, he did show evidence of coronary disease with what was described as 75% narrowing of the mid left anterior descending artery and 60% narrowing of both the proximal left anterior descending vessel and for the left main coronary artery. 'I suppose with the 75% narrowing of the mid anterior descending artery, one could not exclude the possibility of ischaemia occurring. If that had been the case, admitting that the ECGs had been normal, one could not exclude the possibility of a cardiac arrhythmia that could have led to incapacitation'.

1.18.14 The Cardiologist's report stipulated the student 'did have patch granulomatous myocarditis which […] the pathologist states was sarcoidosis'. 'He had a history of ventricular arrhythmias.' 'The sarcoid myocarditis would have made him susceptible to such rhythm disturbances and if that occurred, it could have led to incapacity[…]'. The Cardiologist concluded 'with that background, [the student] may have been incapacitated by an abnormal heart rhythm which could have contributed to the cause of the crash'.

15 Edwards, E. (1975). Stress and the Airline Pilot BALPA Medical Symposium. London, United Kingdom.

16 Civil Aviation Authority website: http://www.caa.govt.nz/assets/legacy/pilots/flt_trg_rev.pdf

1.19 Useful or effective investigation techniques

1.19.1 Not applicable.

2. Analysis

2.1 Evidence gathered during the safety investigation indicates that the accident occurred as a result of the aircraft departing from controlled flight and beginning to enter a spin from which it did not recover.

2.2 The departure from controlled flight most likely occurred when the critical angle of attack was exceeded, resulting in an aerodynamic stall.

2.3 The safety investigation could not determine what altitude the aircraft was at when the stall occurred. However, given the intended low flying exercise, and from prior witness observations, it was most likely between 100 to 300 ft agl.

2.4 Given the PA-38-112 Flight Manual states 'loss of altitude during stalls can be as great as 320 feet' it would not have been possible for either pilot to recover the aircraft from a stall in the height available.

2.5 The safety investigation could not determine why the aircraft reached a point where a departure from controlled flight occurred, but has been left with two likely possibilities:

- Pilot incapacitation, or
- A handling error.

2.6 With regard to pilot incapacitation; a CAA Senior Medical Officer (SMO) was requested by the safety investigation team to conduct a review of both of the pilots' medical history, the results of autopsies, and the Cardiologist report. The SMO's review agreed with the Pathologist's conclusion, that 'despite the presence of demonstrated cardiac disease at autopsy in each pilot, I am unable to say that an episode of cardiac disease has actually contributed to the aviation incident'.

2.7 If either of the pilots had experienced a sudden incapacitation it would have been difficult for the other pilot to recognise this, and maintain controlled flight given the likely low flying air exercises being conducted.

2.8 Given the inconclusive medical analysis, the possibility of pilot incapacitation cannot be excluded as a contributing factor in this accident.

2.9 With regard to a possible handling error; the safety investigation was unable to establish which pilot was manipulating the controls of the aircraft at the time of departure from controlled flight and which low flying air exercise was being conducted.

2.10 The aircraft was being operated just under the maximum all up take-off weight and within the aircraft centre of gravity limits.

2.11 Prior to the accident, an aircraft matching the description of ZK-FTP was observed conducting low flying operations to the NW of NZL462. Several witnesses observed the aircraft alternatively rolling the wings from left to right and pitching up and down "aggressively". The observed aircraft manoeuvres were likely, exercises to familiarise the student with the characteristics of the PA-38-112 aircraft.

2.12 Low flying lessons include manoeuvres such as steep turns at low level. The CAA's Flight Instructor Guide advises manoeuvres such as these must be conducted accurately as there is less safety margin to recover from a handling error. There is also insufficient height to recover from a stall condition; therefore the emphasis must be on stall avoidance.

2.13 The safety investigation could not identify why, if a handling error had occurred, the instructor allowed the situation to develop to the point where the departure from controlled flight occurred. The instructor and the student were aware of the hazards associated with the low flying exercise, as these were covered during the briefing prior to the flight.

2.14 The instructor was appropriately licensed and fit to carry out the flight. However, he only just met the currency requirements of his licence and instructor rating[17] having only flown 4.2 hours in the past 90 days and not at all for the five months prior.

2.15 Research[18] has shown that pilots likely experience a level of degradation in cognitive skills necessary for safe flight, if these skills are not often practiced. Skill degradation can affect a pilot's ability to recognise the cues, of such circumstances as an impending stall, and recall the appropriate responses to recover the situation. To mitigate skill degradation, pilots who fly infrequently should engage in periodic recurrency or refresher training.

2.16 Although the safety investigation has not concluded that skill degradation was a contributing factor in this accident, it serves as a timely reminder to other pilots of the possibility of suffering from skill degradation. As such, the safety investigation has raised a Safety Observation CAA 18F195, for the CAA, through its routine activities, to focus attention on the provision and supervision of recurrency training for instructors to ensure the required skills are maintained.

2.17 The instructor's flight training records showed a lack of continuity and consistency of instruction, which although met Civil Aviation Rule requirements, was not considered best industry practice. The lack of continuity in the instructor's flight

17 The currency requirement for a C-Category Instructor Rating is to conduct three take-off and landings in the aircraft type in the last 90 days and to hold a current C-Category Instructor Rating and Class 1 Medical Certificate.

18 Childs, J.M. and Spears, W.D. (1986), Flight-skill Decay and Recurrent Training. Perceptual and Motor Skills, 62(1), 235-242. doi: 10.2466/pms.1986.62.1.235

Wickens, C.D., Hollands, J.G., Banbury, S. and Parasuraman, R. (2013). Engineering Psychology and Human Performance. Fourth Edition. Pearson Education Inc. United States.

training was primarily due to his personal circumstances. When flight training continuity is not possible, then training organisations should be alert for the possible threats posed which could be introduced during inconsistent instruction.

2.18 Although, the Aero Club and Flight Academy have structured programmes to monitor and supervise student and instructor flight training consistency and continuity, a Safety Observation CAA 18F199, has been raised for the CAA to educate and evaluate other training organisations in respect of the provision of consistency and continuity of flight instruction and training. It should be noted that although a Safety Observation has been raised, the safety investigation has not concluded that the lack of consistency or continuity during the instructor's training was a contributing factor in this accident.

2.19 The weather conditions at the time of the accident were conducive to carburettor icing. As this type of icing melts quickly it was not possible to ascertain if carburettor icing had occurred. However, carburettor icing is a well know phenomenon and is usually rectified with the application of carburettor heat. It is likely that the instructor was aware of the conditions conducive to carburettor icing and when to apply carburettor heat as this was detailed in his lesson plan. If carburettor icing had occurred and caused an engine power limitation, a forced landing could have been made on the river bed. The instructor was familiar with the area and they had practised a low level simulated EFATO approximately 40 minutes prior on departure from NZHS. Therefore carburettor ice is considered unlikely to have been a contributing factor in the accident.

2.20 The weather conditions at the time were suitable for the low flying exercise. The wind was light and visibility was reported as good. As such, the weather was not deemed to have been a contributing factor in the accident.

2.21 It appeared that there was a certain amount of urgency on the student's part to gain a NZCPL, as he was leaving for the UK on Tuesday, 25 March 2014. He commenced training on Saturday 22 March 2014. This gave the student three days to complete the training to reach NZCPL flight test standard. This time constraint placed pressure on the student, instructor and CFI. The Aero Club CFI stated he felt pressured to get the training done to meet the deadline and cautioned the instructor; "do your best, don't get pressured. If it can't be done, it can't". The instructor's partner reported that both pilots seemed relaxed and in no hurry to get to the Aero Club. It did not appear that either pilot was adversely affected by the time pressure.

2.22 Because the student approached the Aero Club office with no advance notice and a short time frame to complete the training, this led to the situation of the Aero Club providing the student's training whereas normally it would have been conducted by the professional pilot training side of the organisation; the Flight Academy. With the Aero Club conducting the training, and insufficient time to conduct a full needs analysis and develop a training plan for this student, assumptions and knowledge gaps may have existed for the instructor. It may have been prudent that the student's training was referred to the Flight Academy.

2.23 As such Safety Observation CAA 18F188, has been raised and addressed by the Aero Club and Flight Academy, suggesting that all training for experienced foreign pilot licence holders be conducted by the Flight Academy. The Aero Club will not provide this training. It should be noted that the nuances associated with training a foreign licence holder was not established as a contributing factor in this accident; it is simply being raised as a Safety Observation.

2.24 The provision of training for professional foreign and national pilot licence holders was a special focus topic at the Chief Flying Instructors' Seminar in 2014 following this accident. The seminar participants discussed procedures and policies used by their organisations to ensure the safe delivery of this type of training. This will continue to be a focus for instructor training.

3. Conclusions

3.1 The accident occurred as a result of the aircraft departing controlled flight and entering a spin, from where there was insufficient height to recover.

3.2 The departure from controlled flight most likely occurred when the aircraft's critical angle of attack was exceeded, resulting in the aircraft suffering an aerodynamic stall and subsequently entering into a spin.

3.3 The safety investigation could not conclusively determine why the aircraft reached a point where a departure from controlled flight occurred. Two likely scenarios are: incapacitation of one of the pilots or a handling error.

3.4 Incapacitation of either of the pilots could not be excluded as a contributing factor in this accident.

3.5 If either of the pilots had experienced a sudden incapacitation it would have been difficult for the other pilot to recognise this, and maintain controlled flight given the likely low flying air exercises being conducted.

3.6 It could not be determined which pilot was manipulating the controls at the time of the accident.

3.7 If a handling error had occurred, the safety investigation could not determine why the instructor had allowed the situation to develop to the point where the departure from controlled flight occurred.

3.8 The safety investigation found no evidence that the instructor had received specific instruction, or guidance, on the training needs or associated risks with conducting flight training for experienced, foreign pilots.

3.9 The instructor was appropriately licensed and fit to carry out the flight. However a review of his flight training records showed a lack of continuity and consistency of his flight instruction and training.

3.10 Pilots likely experience a level of skill degradation in those skills associated with the pilot's ability to recognise the cues and recall the appropriate responses for safe flight, if those skills are not often practiced.

3.11 It may have been prudent that the student's training was referred to the Flight Academy.

3.12 There is limited literature or general awareness about a trans-cockpit authority gradient in the flight training environment.

3.13 Manoeuvres conducted at low level must be conducted accurately as there is little safety margin to recover from a handling error.

3.14 The accident was not survivable.

4. Safety Actions

4.1 The safety investigation has raised four Safety Observations. It should be noted that the Safety Observations have been identified to improve aviation safety and are not deemed to be contributing factors in the accident.

4.2 Safety Observation, CAA 18F200, has been raised for the CAA to promote awareness in the flight training industry of the potential for an inverse trans-cockpit authority gradient and the specific needs and threats associated with one.

4.3 To address Safety Observation, CAA 18F200; in October 2014 the CAA facilitated a Chief Flying Instructor workshop that focused on the 'supervision' of instructors. Significant focus was directed to the risks posed by non-standard students with particular needs such as overseas pilots, preparation of foreign pilots for BFR or flight tests, and a situation where a cockpit authority gradient potential exists.

4.4 Safety Observation, CAA 18F195, has been raised for the CAA, through its routine activities, to focus attention on the provision and supervision of recurrency training for instructors to ensure the required skills are maintained.

4.5 To address Safety Observation, CAA 18F195; during CAA routine activities, recertification, audit, and safety investigation, evidence of recurrent training is examined and where deficiencies exist, findings are issued. Routine Aviation Safety Advisor mentoring is also being conducted on an ongoing basis.

4.6 Safety Observation, CAA 18F199, has been raised for the CAA to educate and evaluate a training organisation's ability to provide and monitor the consistency and continuity of flight instruction and training.

4.7 To address Safety Observation, CAA 18F199; in 2016, at the Flight Examiners Seminar participants at the seminar discussed and agreed to focus attention on; student records, training programmes, and supervision of students and instructors.

In May 2017 the CAA produced a 'How to be a Chief Flying Instructor'[19]. The booklet offers the reader guidance on many aspects of flight instruction oversight. Of note the Record Keeping section reminds the reader of the importance of maintaining meticulous training records 'They facilitate continuity in the training programme for both the student and the instructor'.

4.8 Safety Observation, CAA 18F188, has been raised, and already addressed, by the Aero Club and Flight Academy, suggesting that all training for experienced foreign pilot licence holders be conducted by the Flight Academy.

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