SAFETY INVESTIGATION REPORT

CAA OCCURRENCE NUMBER 13/1524

BEECHCRAFT BARON G58

N254F

DEPARTURE FROM CONTROLLED FLIGHT

31 KM SOUTH-WEST of RAGLAN - TASMAN SEA

30 MARCH 2013

Photo: Rodney Maas

Foreword

The Civil Aviation Authority (CAA) is tasked with the regulation and oversight of New Zealand's civil aviation system. Among others, the CAA has the function of investigating accidents and incidents.

The Civil Aviation Act 1990 provides:

> **72B Functions of Authority**
>
> (2) The Authority has the following functions…
>
> (a) to promote civil aviation safety and security in New Zealand:
>
> (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 and form of an investigation conducted by the CAA is determined by the nature of the accident or incident concerned. In most cases the CAA investigates accidents and incidents to identify safety learnings that may benefit the New Zealand Civil Aviation system. An investigation with this objective is typically referred to as a 'safety investigation'. This report follows the conduct of a safety investigation.

Purpose of CAA Safety Investigations

Safety investigations are principally conducted to identify deficiencies in the New Zealand civil aviation system. A safety investigation is not an 'accident investigation', such an investigation being focused solely on establishing the predominant *cause* of the accident. While a safety investigation may also try and identify the cause of the accident, its fundamental purpose is to understand the circumstances of an accident or incident and to identify any factors that may have contributed to an occurrence, or other safety or system issues.

Information obtained during the course of a safety investigation informs the application of risk-based regulatory intervention tools to deliver CAA's other functions. It is not the intention of a safety investigation to apportion blame or legal liability.

While a safety investigation may involve establishing the cause of an accident it is not always possible to do so. In some circumstances the CAA may conclude an investigation without conclusively establishing or excluding the cause(s) of an accident if safety learnings have been, or can be, sufficiently established.

The information gained from a safety investigation may result in a range of outcomes, including safety recommendations or actions, rule changes, Airworthiness Directives, changes to an organisation's operating procedures, or promotion and dissemination of information of an educational nature.

This Investigation & Report

This report captures the key findings of the safety investigation and any relevant safety learnings or recommendation arising from the investigation.

Notwithstanding that the American registered aircraft (N254F) involved in the accident was the only one of its type and modification operating in New Zealand and the pilot and third parties connected to the aircraft (including maintenance providers) were operating in accordance with the American regulatory system, the CAA determined that there may be relevant safety learnings to the New Zealand civil aviation system, and accordingly, elected to investigate. The safety investigation was able to determine the active failure in the accident sequence and also identify a number of safety actions. The CAA is satisfied that significant safety lessons arising from the accident have been identified, with the investigation being concluded on that basis.

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Glossary of abbreviations

ATC	Air Traffic Control
ATSB	Australian Transport Safety Bureau
BFR	Biennial Flight Review
C	Celsius
CAA	Civil Aviation Authority
CAR(s)	Civil Aviation Rule(s)
FAA	Federal Aviation Administration
FAR(s)	Federal Aviation Regulation(s)
ft	foot or feet
GP	General Practitioner
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
km	kilometre(s)
kt(s)	knot(s) – nautical miles per hour
m	metre(s)
mm	millimetre(s)
MSL	mean sea level
NM	nautical mile
NTSB	National Transportation Safety Board
NZ	New Zealand
NZDT	New Zealand Daylight Time
PIC	Pilot in Command
POB	persons on board
P/N	part number
PSI	pounds per square inch
RPM	revolutions per minute
STC	Supplemental Type Certificate
US	United States of America
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	very high frequency
WGS84	World Geodetic System 1984

Data summary

Aircraft type, serial number and registration:	Beechcraft Baron G58, TH-2169, N254F
Number and type of engines:	Two, Continental IO-550-C
Year of manufacture:	2006
Date and time of accident:	30 March 2013, 12:20[1] (approximately)
Location:	Tasman Sea, 31 km South-West of Raglan Latitude[2]: S 37° 58.83' Longitude: E 174° 35.07'
Type of flight:	Private, Day IFR
Persons on board:	Crew: 1 Passengers: 1
Injuries:	Crew: 1 (Fatal) Passengers: 1 (Fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	Federal Aviation Administration, Private Pilot Certificate.
Pilot-in-command's age	59 Years
Pilot-in-command's total flying experience:	1240.7 Total fixed wing (approximately). 750 Multi-engine fixed wing time (approximately).
Information sources:	Civil Aviation Authority Field Investigation
Investigator in Charge:	Mr D Foley

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

2 NZ WGS-84 co-ordinates.

Synopsis

The Civil Aviation Authority (CAA) was notified of the accident at approximately 1349 hours on 30 March 2013. The Transport Accident Investigation Commission was in turn notified, but chose not to investigate. The CAA initially supported the Police, providing technical aviation expertise during the search phase, subsequently electing to conduct a safety investigation.

At around 1147 hours on 30 March 2013, N254F an American registered Beechcraft Baron aircraft took off from Ardmore Aerodrome on a private IFR[3] flight to Timaru Aerodrome with two people on board. After approximately 28.5 minutes of flight the aircraft reached its assigned cruise altitude of Flight Level[4] 180 (approximately 18,000 ft). About one minute into the cruise the aircraft's groundspeed decreased, it then departed from controlled flight and entered into a spin. Approximately two minutes later, the aircraft disappeared from radar coverage. Later that day, search and rescue personnel located aircraft wreckage floating on the ocean surface 31 km south-west of Raglan.

The safety investigation concluded that the accident occurred because the aircraft departed controlled flight and entered a spin from which it did not recover. The departure from controlled flight occurred because the aircraft's airspeed decreased to a point where control of the aircraft could not be maintained.

As a result of this accident, four safety actions have been raised.

1. Factual information

1.1 History of the flight

1.1.1 On 29 March 2013, the day before the planned flight to Timaru Aerodrome, the aircraft received two separate fuel uplifts totalling 359.72 litres of aviation gasoline.

1.1.2 On 30 March 2013, the pilot/owner filed an IFR flight plan showing his intention to depart from Ardmore Aerodrome and fly to Timaru Aerodrome at Flight Level 180 (FL180), with two people on board. Although the flight plan indicated Timaru Aerodrome as the destination, additional evidence indicated that the pilot intended to conduct a scenic flight in the vicinity of Mount Cook and land at Mount Cook Aerodrome, overnighting at a local hotel.

1.1.3 The aircraft departed from Ardmore Aerodrome climbing to FL180. During the climb, which took approximately 28.5 minutes, an Air Traffic Controller re-routed the aircraft for sequencing purposes. The aircraft was to fly towards New Plymouth Aerodrome, taking the aircraft over water off the coast of Raglan.

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[3] IFR: Instrument Flight Rules, which are used to govern a flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to aircraft instruments.

[4] Flight Level: An altitude above sea level, referenced to standard barometric pressure.

1.1.4 Radar plots indicate that the aircraft levelled at FL180, where it started to accelerate, for 62 seconds, towards its cruise speed of approximately 200 kts. The aircraft's speed remained constant for 10 seconds, then steadily decreased for 38 seconds. The aircraft started a slow rate of descent for approximately 19 seconds; while simultaneously tracking to the left, towards the coast. At this point, a much higher rate of descent occurred.

1.1.5 Approximately 23 seconds into the high rate of descent, the Air Traffic Controller asked N254F 'you okay?', having observed the aircraft descending through 13,700 ft on radar.

1.1.6 The conversation concluded between Air Traffic Control (ATC) and the pilot of N254F, approximately one minute and 25 seconds after the initial transmission, with the pilot stating 'okay we have two engines out'. This was the final transmission heard from the pilot of N254F.

1.1.7 The last accurate radar plot indicated that the aircraft was still experiencing a high rate of descent while descending through 3,900 ft.

1.1.8 The time elapsed between the commencement of the high rate of descent and the calculated time of impact was 2 minutes and 6 seconds.

1.1.9 Search and rescue personnel located several pieces of aircraft debris, including the utility doors, in the general location where the aircraft is thought to have struck the water.

1.1.10 The accident occurred in daylight, at a calculated time of 12:20:35 hours, in the Tasman Sea, 31 km south-west of Raglan. The aircraft wreckage was located at Latitude S 37° 58.83' Longitude E 174° 35.07'.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	1	0

Table 1

Table of injuries

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

1.5.1 The pilot, aged 59, held a Federal Aviation Administration (FAA) Pilot Certificate, which was issued in December 2005, and a FAA Pilot Medical Certificate.

1.5.2 The pilot also held a New Zealand Private Pilot Licence, which was issued in December 2009, and a valid New Zealand Medical Certificate.

1.5.3 As N254F was an American registered aircraft, the pilot was operating it under his FAA Pilot Certificate and FAA Pilot Medical Certificate.

1.5.4 A review of the pilot's historic logbooks indicates that the pilot achieved his Instrument Airplane rating during August 1985 and his Multi Engine Land rating on 18 December 2005.

1.5.5 The pilot's most recent documented recurrency training was conducted in a flight training device during September 2011 in Kansas, United States of America. This included his Biennial Flight Review (BFR) and pilot-in-command Instrument Experience. During the BFR the pilot was tested on his skills and knowledge of routine and emergency procedures. The pilot completed the training at a proficient level.

1.5.6 The pilot had also conducted some currency training in a simulator in New Zealand. However, this training was not able to be counted towards formal currency, as it was not conducted in accordance with FAA regulations, and hence was not logged in the Pilot's Logbook. The instructor who conducted the simulator training with the pilot in New Zealand was complimentary about the pilot's ability to handle emergency drills that were practised in the simulator.

1.5.7 The pilot had accrued approximately 1240 hours of total flight time, with approximately 750 hours having been conducted in multi-engine aircraft. Of these hours, approximately 540 were in Beechcraft Baron G58 aircraft, with approximately 20.6 hours accrued in the 90 days prior to the accident.

1.5.8 On the day of the accident the pilot and his wife encountered a personal friend of theirs. The friend has since stated that "[The pilot and his wife] were happy and excited about their trip […] everything seemed fine."

1.6 Aircraft information

1.6.1 The Beechcraft Baron G58 is a light, twin, piston-engine aircraft designed for personal and corporate use. The Baron 58 is a stretched model of Beechcraft's earlier B55, and first entered production in 1970. It is still being produced today, with several variants such as the G58, certified in 2005, which is named after the Garmin integrated avionics suite.

1.6.2 N254F, a Beechcraft Baron G58, was manufactured in the United States of America in 2006, where it was issued a Certificate of Airworthiness in 2006. It was then imported by the owner and arrived in New Zealand in October 2009, retaining its American registration. The aircraft operated in New Zealand under FAA Airworthiness Regulations and New Zealand's civil aviation operational rules (CARs).

1.6.3 The aircraft was powered by two Continental IO-550-C, fuel injected, air-cooled, six cylinder, 300 horsepower engines driving Hartzell propellers. The Hartzell propellers were clockwise rotating, three-bladed, constant speed, fully feathering, 76 inch diameter and manufactured of aluminium.

1.6.4 The Beechcraft Baron G58 Pilot's Operating Handbook specifies that the standard aircraft with wingtip tanks, has a fuel capacity of 200 US Gallons. This equates to 194 US Gallons of usable fuel.

1.6.5 The aircraft had seating for six people in various configurations. At the time of the accident, the aircrafts cabin was configured in a club seating arrangement; that is, the forward and rear passenger seats faced each other to allow ease of conversation between passengers.

1.6.6 The aircraft was equipped with a Garmin G1000 Integrated Avionics System. It is a fully integrated flight, engine, communication, navigation, autopilot and surveillance instrumentation system. It consisted of a primary flight display, multi-function display, and audio panel that together make up the instrument panel.

1.6.7 Integrated within the Garmin G1000 instrumentation system are features specifically designed to warn the pilot of a malfunction, or an unsafe flight condition. One such feature is the annunciation and alert warning system. For example, if the aircraft is approaching a stall the pilot would be warned visually and aurally of an imminent stall. Another such aid, designed to help the pilot to recover the aircraft from an unusual attitude, is the extreme pitch[5] indication display. When the aircraft is positioned in an unusual attitude, the primary flight display declutters the screen immediately removing unnecessary information, which is otherwise presented to the pilot.

1.6.8 Like most light aircraft, the Beechcraft Baron G58, does not have an instrument which directly measures the aircraft's angle of attack[6], and subsequent possible approach to a stall. In these aircraft, the pilot has to refer to the aircraft's airspeed indicator to gain this information.

1.6.9 N254F was certificated, by the FAA, to operate in known icing conditions. As such the aircraft had de-icing boots, heated propellers, a heated windshield, a heated stall warning vane, fuel vent heat and pitot heat.

1.6.10 Due to its certification and classification as a normal category airplane, aerobatic manoeuvres, including spins, are prohibited.

1.6.11 In February 2012, N254F overran the grass runway at Raglan Aerodrome, which caused moderate damage to the aircraft. As part of the repair scheme for the aircraft several areas of the aircraft skin were replaced. The propellers, engines and associated systems were disassembled and inspected for damage. The

[5] An aircraft pitch movement is the aircraft's rotation about the lateral axis.

[6] Angle of attack is the angle between the chord line of the wing and the vector representing the relative airflow.

appropriate repairs were completed and the aircraft was released to service in October 2012.

1.6.12 Concurrent with the repairs, the owner of the aircraft elected to have the aircraft modified by adding vortex generators and installing an oxygen system.

1.6.13 Maintenance records show that N254F was fitted with an after-market vortex generator kit in October 2012 and was released to service in accordance with the Supplemental Type Certificate[7] (STC). Vortex generators are generally fitted to aircraft surfaces, to permit flight at lower speeds while improving control authority.

1.6.14 As N254F was unpressurised, the owner had an after-market oxygen system fitted. Maintenance records show that the installation was also completed in October 2012, and the aircraft was released to service in accordance with the STC.

1.6.15 The oxygen system is capable of delivering regulated oxygen via a plumbed system to the pilot and passengers throughout the aircraft. When in use, the occupants of the aircraft have to connect a portable oxygen mask or nasal cannula dispenser and associated flow meter into the corresponding connection on the aircraft ceiling. The occupants then set the appropriate oxygen flow to correspond to the appropriate altitude flown.

1.6.16 N254F had two types of oxygen dispenser; face masks and nasal cannulas. On previous flights, the engineer who worked on the aircraft indicated that the pilot only used the nasal cannulas. The engineer accompanied the pilot on a test flight, two days before the fatal accident, and stated 'we had to use the oxygen system to go up to 20,000 feet'. Nasal cannulas were used on this flight.

1.6.17 Federal Aviation Regulation §23.1447, *Equipment standards for oxygen dispensing units*, stipulates that nasal cannulas can be used up to and including 18,000 ft. It goes on to exclude the use of nasal cannulas above this height, specifying that 'If certification for operation above 18,000 feet (MSL) is requested, each oxygen dispensing unit must cover the nose and mouth of the user.' During the test flight the pilot and engineer operated the oxygen system outside of its design limitations by not utilising the full face masks.

1.6.18 Further modifications were installed on the aircraft, with maintenance records showing that a turbocharger system was installed on N254F on 8 March 2013. The turbocharger system was imported from the United States of America and installed on each of the aircraft engines, in New Zealand. The installation was conducted by engineers, one of which is FAA certified.

One of the engineers commented that the pilot had operated N254F up to 17,000 ft several times since the Raglan Aerodrome overrun accident and noted that 'obviously with the lack of power for him that's what convinced [the pilot] to go the route of the turbo normalisation unit' and that 'he'd done his research'. The

[7] Supplemental Type Certificate is a certificate that is issued once an approval has been granted by the state of design for a modification or repair to an existing type certified aircraft, engine or component.

engineer reportedly asked the pilot 'was the money worthwhile spending?' and the pilot responded 'yes if you consider how long it took to get up to that altitude to get down to the South Island'.

1.6.19 Supplied with the physical turbocharger kit was the STC package. The latter comprised of a Certificate of Compliance, a flight manual supplement and installation instructions. These allowed the engineers to follow the instructions and fit the supplied components in accordance with the STC.

1.6.20 The STC for the Beechcraft Baron turbocharger kit also contains updated instrument markings and adhesive placards for amended operating limitations, such as airspeed limitations, engine handling limitations, and additional operating procedures.

1.6.21 The Pilot's Operating Handbook for the Beechcraft Baron G58, specifies characteristics of flight to 16,000 ft, and in rare cases such as a fuel flow table, to 17,000 ft. Limited technical information on handling, fuel flow or speeds are available for higher altitudes.

1.6.22 The turbocharger system increases the aircraft's service ceiling[8]. Therefore, a pilot operating the aircraft above the altitudes stipulated in the Pilot's Operating Handbook is operating with limited guidance on handling characteristics from either the aircraft or the turbocharger manufacturers.

1.7 Meteorological information

1.7.1 On the day of the accident, an anticyclone east of New Zealand extended a ridge of high pressure over the North Island. A small depression west of the South island was moving slowly east, and its associated cold front over the eastern Tasman Sea was moving towards the North Island.

1.7.2 The MetService of New Zealand was commissioned to report on the weather conditions on the day of the accident. They stated that in the general area of the accident the wind was from the north to northwest around 15 knots at 18,000 ft to less than 10 knots at sea level.

1.7.3 'Radar echoes and satellite images strongly suggest there was cumulus-type cloud west of the coast, and there was precipitation, or at least there was liquid water providing reflection targets for the radar.'

1.7.4 The report also stated that 'the aircraft was in cloud at 18,000 ft when it was west of Raglan about the time of the accident, and may have been in and out of cloud during the descent from 18,000 ft to the cloud base about 2,000 ft.'

1.7.5 The report concluded that 'at about 18,000 feet altitude the ambient temperature was about -12 degrees Celsius, a temperature suitable for airframe icing. There was probably super-cooled liquid water available at that altitude west of Raglan at the time of the accident. Any airframe icing that may have occurred would have

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[8] Service ceiling is the altitude at which the aircraft's achievable rate of climb decreases to less than 100 ft per minute.

been light and mostly clear or glaze ice.' Airframe icing was not considered to have been a contributing factor in the accident.

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 As part of the safety investigation, the ATC audio tapes were quarantined and sent to the National Transportation Safety Board (NTSB) and the Australian Transport Safety Bureau (ATSB) for analysis. The analysed section of the ATC audio tapes starts with the controller asking "November two five four foxtrot Christchurch you okay?" This exchange was initiated because the controller noticed 'the Mode C[9] readout showing from [his] memory A137' (the radar showed that N254F was descending from FL 180 through 13,700 ft).

The NTSB reported the following comments (ATSB interpretation in brackets):

Speaker	Time	Communication
ATC	0:00	November two five four foxtrot Christchurch you okay?
N254F	0:06	Uh two five four foxtrot we have an emergency.
ATC	0:10	November two five four foxtrot roger. Uh when can you report the nature of the emergency?
N254F	0:15	We have dead engines (er dead engine)
ATC	0:20	November two five four foxtrot roger.
ATC	0:35	November two five four foxtrot report your POB please.
N254F	0:38	Two POB.
ATC	0:39	Roger.
ATC	0:48	Two five four foxtrot just advise if I can uh be of any more assistance.

[9] Mode C is a transponder code that is paired with pressure altitude and sent from the aircraft to a radar facility to help ATC monitor that aircraft's altitude.

N254F	0:51	Say again.
ATC	0:53	Roger you let me know if I can help you anymore.
N254F	1:25	Okay we have two engines out.
ATC	1:26	November two five four foxtrot roger.

Table 2

Communication between ATC and the pilot of N254F.

1.9.2 The NTSB commented that from their analysis of the ATC recording 'it does not appear oxygen masks were in use by the pilot' and 'no engine noise was audible or present in the frequency analyses'.

1.9.3 Neither the NTSB or the ATSB could conclusively identify any audible warning alerts in the background of the ATC recording.

1.10 Aerodrome information

1.10.1 Nil

1.11 Flight recorders

1.11.1 The aircraft was not fitted with a designated flight recorder, nor was it required to be. The Garmin G1000 has an ability to record certain parameters onto an SD card, which can be downloaded at the completion of a flight. This function can help with the analysis of flights and with system trend monitoring. However, this function was not being utilised on board N254F.

1.12 Wreckage and impact information

1.12.1 Video footage was taken by search and rescue personnel of the general location of where the aircraft is thought to have struck the water. This video footage shows a moderate fuel/oil slick, and several pieces of aircraft debris including the utility doors.

1.12.2 On 2 April 2013, the Royal New Zealand Navy located the aircraft, largely intact, on the ocean floor in 56 metres of water. Due to operational limitations limited photographic imagery of the aircraft was taken on the ocean floor, however, it was evident that the aircraft was inverted. Hydrodynamic deformation to the underside of the aircraft structure was visible.

1.12.3 On 6 April 2013, Navy divers located and retrieved the body of the passenger from the aircraft. The following day, the aircraft wreckage and the pilot's body were recovered by the Navy onto its specialist dive vessel, the HMNZS Manawanui. The aircraft had been immersed in salt water for nine days.

1.12.4 Following the recovery of the majority of the aircraft, the wreckage was transported under the oversight of a CAA Safety Investigator to the Royal New Zealand Naval Base in Devonport, Auckland.

1.12.5 A detailed examination of the aircraft wreckage was undertaken by CAA Safety Investigators, assisted by Safety Investigators from Beechcraft and Continental Motors Inc.

1.12.6 The examination confirmed that the underside of the wings, main fuselage and general aircraft structure exhibited significant amounts of, almost symmetrical, hydrodynamic deformation. The undersides of the wings exhibited hydrodynamic deformation to such an extent that the wing skin was pushed hard against the underlying structure.

1.12.7 The right wing exhibited compound span-wise buckling, from the wing tip towards the outer nacelle area.

1.12.8 Both wings exhibited 'ballooning' in the area of the wing tip. Of note was the left wing tip which, associated with the 'ballooning', exhibited tearing and failure of the rivets which hold the wing skin to the wing tip.

1.12.9 The pilot door was missing from the aircraft wreckage and was not recovered.

1.12.10 The utility doors and associated door framing showed signatures consistent with being under compression at the time that they departed from the aircraft fuselage. It is most likely that this occurred because the right side of the fuselage was under compression, from a combination of aircraft yaw and impact forces, when the aircraft struck the ocean surface.

1.12.11 Components associated with the oxygen delivery system were found in situ above the front left seat (pilot seat), and the rear forward facing seats in the aircraft.

1.12.12 The pilot was removed from the front left seat, where he was found secured wearing a lap and shoulder seat belt. The pilot's seat rails had failed during the accident sequence in a downward and sideways direction.

1.12.13 The passenger had been removed from the rear right forward facing seat, where she was found secured by her lap belt. The safety investigation could not conclude whether the passenger was wearing the shoulder component of the seat belt, although this had no bearing on survivability for the passenger.

1.12.14 Although the rudder pedals on the pilot's side were heavily damaged from impact forces it appeared that the right rudder pedal was fully deflected.

1.12.15 The fuel selector panel, located on the floor between the pilot and co-pilot seats, allows the pilot to select whether the fuel supplied to each engine is turned on, off, or being cross fed from another fuel tank.

1.12.16 The fuel selector, for the left engine, was displaced half way between the 'on' and 'off' positions.

1.12.17 The fuel selector, for the right engine, was orientated to the 'on' position.

1.12.18 The flap and landing gear selectors were in the fully retracted position, as was the landing gear. The aileron and rudder trim were in a near neutral position, however, the elevator trim was trimmed 21 units, aircraft almost full nose up.

1.12.19 Both throttle levers were in the closed position. The mixture levers were both in the idle cut off position. The left propeller control lever was in the feathered[10] position. The right propeller lever was in the full fine position.

1.12.20 Examination of the aircraft's propellers indicated that neither propeller was feathered.

1.12.21 Pre impact control integrity was established as far as possible.

1.12.22 The engine mounts for both engines had failed. This resulted in the engines remaining attached to the aircraft by the control runs and associated engine plumbing.

1.12.23 During the process of removing the engines from the wreckage, it became evident that the left engine's number 5 upper deck pressure line was dislodged from the upper deck manifold assembly (See Figure 1). When the upper deck pressure line was reinserted into the Viton tubing on the upper deck manifold assembly it could only be inserted a maximum of 4 mm, not sufficient to adequately secure it by the constant tension clamps. Inserting the upper deck pressure line into the Viton tubing until it is past the full width of the constant tension clamps, would achieve the full restraining force available.

1.12.24 Further examination revealed an historic impression mark within the Viton tubing, which indicated that the upper deck pressure line had only ever been inserted a maximum of 4 mm.

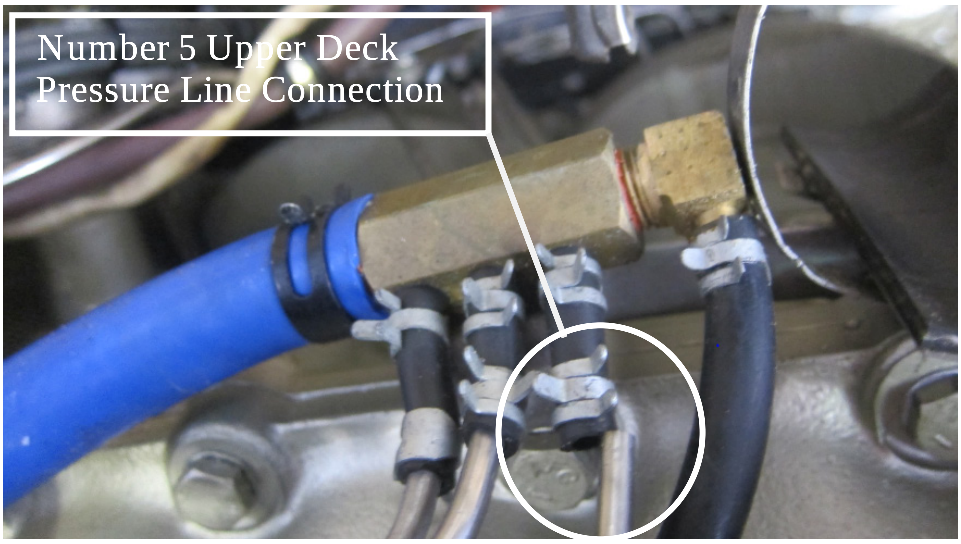

Figure 1
Left engine number 5 upper deck pressure line connection.

[10] Feathered propeller: A propeller which has its blades rotated so that the leading and trailing edges are nearly parallel with the aircraft flight path, to minimise drag.

1.12.25 Following this observation the right engine's number 5 upper deck pressure line was checked. It was dislodged. However, following the examination of photographic evidence, it was discovered that the dislodgement occurred during the transfer of the aircraft wreckage from the HMNZS Manawanui to the naval base. This aside, it was noted that the maximum that it could be inserted into the connection on the upper deck manifold assembly was 7 mm; again insufficient to guarantee adequate security.

1.12.26 Examination of the wreckage revealed a discrepancy in the manufacturing of the left and right turbo charger induction inlet ducting. The ducting on the left engine has a section of stiffener significantly shorter than its counterpart on the right engine. The reduced stiffener length would render the left induction inlet ducting more prone to collapse when exposed to differential pressures, than its counterpart on the right engine. As such, CAA Safety Action (CAA 14A1468) was raised bringing the inconsistent manufacturing and production of the turbo charger induction inlet ducting to the attention of the FAA.

1.12.27 The gauge fitted to the oxygen bottle, located in the nose compartment of the aircraft, indicated that the bottle contained approximately1500 PSI of oxygen. The oxygen bottle and regulator unit had not suffered damage during the accident sequence. The switch, located on the instrument panel, to turn on the oxygen to the cockpit and cabin was in the 'on' position.

1.12.28 The engine fuel system, throttle body, and metering units for both engines were removed and examined. No anomalies were found with the units for the right engine. However, on the left engine the fuel filter screen was approximately 95 per cent covered in a porous, grey coloured foreign substance.

1.12.29 As all of the wing fuel tanks had been breached; there was no fuel in any of the tanks when the aircraft wreckage was recovered.

1.12.30 The wreckage examination found that, generally, the aircraft's pilot-activated switches were in appropriate positions for normal flight; however, of note was the magneto selector for the left engine. This selector was in the 'left' position; normally it is orientated to the 'both' position for flight.

1.13 Medical and pathological information

1.13.1 Post-mortem examination showed that the pilot died of multiple significant impact and deceleration injuries, and the passenger of multiple injuries.

1.13.2 A report produced by the pathologist stipulated that for the pilot 'no significant natural disease was detected at autopsy which could be considered to have been contributory or causative of the accident'.

1.13.3 'Post-mortem toxicological showed a very low level of alcohol in the blood […]. This almost certainly represents post-mortem artefact due to decomposition and is not indicative of there being the issue of alcohol prior to flight.' Carbon monoxide levels detected were normal.

1.13.4 The antidepressant drug Duloxetine[11] was found to be present in the pilot's blood. According to a report from the Principal Medical Officer of the Civil Aviation Authority, this observation was 'consistent with entries recorded in his NZ and US GP [General Practitioner] notes suggesting his long term usage of that drug'.

1.13.5 No evidence of other drugs was detected in the pilot's blood.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 Given the significant vertical forces involved when the aircraft struck the water, the accident was not survivable for the pilot or the passenger.

1.15.2 It appears that the pilot was wearing both the lap and shoulder portions of his seatbelt, and the passenger was wearing the lap portion. This kept them restrained in their seats during the accident sequence and subsequent descent to the ocean floor.

1.16 Tests and research

1.16.1 An authorised maintenance provider, while supervised by a CAA Safety Investigator, dismantled and inspected both of the engines as part of the safety investigation. Their report stated that the left hand 'magneto on the L/H engine secondary coil winding [was] found to be [an] open circuit.' The report concluded that 'in summary, there was nothing evident during the bulk strip inspection that would have caused the engines not to function normally except possibly that the L/H engine magneto may have been an issue' and concluded that there was 'no evidence of mechanical failure found.'

1.16.2 Both propeller assemblies were removed from the engines and sent to an authorised maintenance provider to be inspected and dismantled under the oversight of a CAA Safety Investigator. The authorised maintenance provider reported that both propeller assemblies' blades were found in the 'latched position[12]'. The propellers were cycled from the fine position to the feathered position. The deice boots were also tested and found to operate as specified.

1.16.3 The authorised maintenance provider concluded that for both propeller hub assemblies; 'in order for the propeller to have been in the latched position and the amount [of] damage to the blades that the propeller was under little or no power' when the aircraft struck the water.

1.16.4 A science and research facility was contracted to take a sample and confirm the contents of the oxygen bottle. Three, one litre samples were taken and analysed.

[11] Duloxetine is used for the treatment of depression, anxiety and neuropathic pain.

[12] Propeller 'latches' prevent the propeller from feathering during normal engine shut down on the ground. For the latches to engage, the propeller RPM must be below 800 RPM during shut down.

Their report noted that the sampling method was unconventional, due to the regulator on the oxygen bottle being compromised. This meant the moisture content of the gas was unable to be measured. The three samples analysed indicated the gas from the oxygen cylinder was made up of on average of 93.3 per cent Oxygen and 6.6 per cent Nitrogen. Despite the unconventional sampling method, the safety investigation concluded that these results are thought to be consistent with aviation oxygen.

1.16.5 The engine manufacturer was asked to comment about the contaminated fuel filter screen located inside the fuel metering unit, and the likely reduction in fuel flow and associated engine performance, if any. They commented that 'the screen is many times the size of the fuel line to the manifold, so it would have to be nearly completely blocked to cause a reduction in engine power'. In previous tests conducted by the manufacturer they blocked 90 per cent of the screen and the engine continued to produce rated horse power.

1.16.6 The turbocharger system was certified by the FAA under Supplemental Type Certificate (STC) SA01663SE. The STC package was supplied, with the physical turbocharger kit to the maintenance organisation, who installed this modification to N254F.

1.16.7 The STC installation instructions state that the turbocharger system requires alteration of the fuel injection system. The fuel injectors each individually reference upper deck pressure from the upper deck pressure manifold.

1.16.8 In order to achieve this, upper deck pressure lines are connected from the fuel injector shroud assemblies to the upper deck pressure manifold. These lines are pre-formed pipes, individually part numbered to correspond with individual cylinders to which each injector assembly is installed. The pre-formed pipes are connected by inserting them into sections of Viton tubing, and secured by constant tension clamps (See Figure 1, Page 16).

1.16.9 This connection relies on adequate penetration of the pre-formed pipe into the Viton tubing, and the pressure maintained by the constant tension clamp. The clamps are suitable for applications where expansion or contraction of the joint may occur as they are designed to maintain a constant pressure.

1.16.10 Review of the documentation for the installation of the turbocharger system revealed that there are no specific instructions relating to how far the pre-formed pipes are to be inserted into the Viton tubes. Specific lengths of Viton tube are stipulated in the installation documents, however, there is no instruction to adjust the Viton tube length to suit. There is instruction to hand form the pre-formed pipes, however, this refers to clearance. No instruction is given to adjust the positioning of the pre-formed pipes, Viton tubing or the location of the constant tension clamps to ensure the security of the connections. This lack in clarity in the STC instructions has been notified to the FAA for their consideration, as CAA Safety Action (CAA 14A1467).

1.16.11 Examination of N254F's left engine number 5 upper deck pressure line revealed that although the manufacturer's instructions had been followed, when cut to the prescribed length, the Viton tubing was too short to ensure sufficient security of the connection.

1.16.12 The engineer who installed the upper deck pressure lines described them as ‘finicky’ and commented that it ‘wasn’t very stable’. He went on to say that if ‘you push slightly hard on [it] or just push on it; it will jump out of […] its position’. He also recognised that a problem with the pressure line could lead to a loss of power from the engine.

1.16.13 The aircraft engine manufacturer was asked to comment on the effects on the engine’s ability to produce power with a disconnected number 5 upper deck pressure line, despite the fact that these components were an independently manufactured after-market kit installed on the engine. The engine manufacturer communicated that its analytical department had conducted tests on a similar engine where the upper deck pressure line had been intentionally loosened and, at 32 inches of manifold pressure, a noticeable fuel leak was visible at the loosened fitting. They went on to say that ‘at 18,000 [ft] it is very probable that a significant fuel leak might be expected if the reference line is loose or disconnected’.

1.16.14 The turbocharger manufacturer also commented on the effects on the engine’s ability to produce power with a disconnected number 5 upper deck pressure line. They stipulated that ‘one cylinder might become too lean to run, but the other 5 would not be effected [sic]. This would cause a slight reduction of power (about 17%), but not a complete loss.’

1.16.15 The turbocharger units were sent to the manufacturer, located in the United States of America, where they were dismantled under the oversight of representatives from the NTSB, Beechcraft, and Continental Motors Inc.

1.16.16 A report produced by the manufacturer stated that for the left engine turbocharger ‘the condition and wear of the turbocharger was normal […] and no issues were found’.

1.16.17 For the right engine turbocharger it was discovered that ‘the turbine wheel shaft [had] fractured through the outboard edge of the snap ring groove. There were asymmetric impact marks on the turbine housing contour and heat shield consistent with the bent turbine blade. No evidence of circumferential scoring on either the turbine or compressor. This suggests that the turbo was not spinning at the time of impact and that the wheel fractured through the snap ring groove due to impact.’ The report concluded that ‘apart from the fractured turbine wheel the condition and wear of the turbocharger was normal’.

1.16.18 During a previous test flight the turbocharger on the left engine was believed to have failed. It was subsequently returned to the manufacturer under warranty. The manufacturer concluded that there were ‘no issues found’ with it.

1.16.19 Data gathered by the safety investigation was presented to the aircraft manufacturer, Beechcraft, about the rate of deceleration, indicated by the radar plots for N254F, while maintaining altitude in the cruise. The Beechcraft

Aerodynamic group concluded that 'based on the information […] provided the speed reduction is consistent with a single engine out situation'.

1.16.20 In respect to the aircraft elevator trim, Beechcraft calculated that, with 21 units nose trim up, the autopilot disengaged and the aircraft slowing down in level flight, the pilot would have to exert up to a maximum of 75 lbs forward pressure on the control column to initiate a small descent.

1.16.21 Additionally, Beechcraft was asked to comment on the rate of descent, derived from the radar data, in relation to the flight characteristics for this model of aircraft. Beechcraft could not comment on the spin characteristics of the Beechcraft Baron G58 as no spin testing data was available. However, Beechcraft supplied spin rate of descent data for a Baron 58P[13] with landing gear and flaps extended. The rate of descent was equated to 177 ft per second or 10,620 ft per minute.

1.16.22 The safety investigation determined that as far as possible that, at the time of the accident, the aircraft was most likely within permissible weight, balance and centre of gravity limitations stipulated in the Pilot's Operating Handbook.

1.16.23 The Complete Multi-Engine Pilot[14] book explains that 'when an engine fails on a twin, its wing is no longer being pulled forward and the opposite wing begins to move faster; the resulting yaw develops a rolling moment toward the dead engine'. It further explains that in a clockwise rotating propeller aircraft, such as the Beechcraft Baron, the left engine is the critical engine, which means that 'its failure would create the most control problems for the pilot.'

1.16.24 The Beechcraft Baron Pilot's Operating Handbook, Emergency Procedures section outlines the one-engine-inoperative procedures and stipulates that 'airspeed is the single most important factor in maintaining airplane control during single engine operations. The airplane can be safely maneuvered or trimmed for normal hands-off operations and sustained in this configuration by the operative engine AS LONG AS SUFFICENT AIRSPEED IS MAINTAINED.'

1.16.25 A Safety Communiqué from Raytheon Aircraft (the owner of Beechcraft), most recently reissued in March 2006; acknowledged the danger of entering a spin in a multi-engine aircraft and specifically referred to the Beechcraft Baron.

1.16.26 The Safety Communiqué warns that 'Recovery from a developed spin in a multi-engine airplane is, for a variety of reasons, unpredictable; it is possible, especially when the airplane is stalled under asymmetric power, to encounter a spin from which recovery cannot be affected.' Despite this danger, it states that 'At the point of stall – even with asymmetric power – if the control column is immediately and briskly moved forward, lowering the nose to regain flying speed,

[13] The Beechcraft Baron 58P is a similar aircraft to the Beechcraft Baron G58, one significant difference is that the Baron 58P is pressurised.

[14] The Complete Multi-Engine Pilot second edition, Bob Gardner, 2001.

and the power is simultaneously retarded, the airplane will recover immediately, reliably and smoothly.' It further states that 'A multi-engine pilot of ordinary skill can easily avoid an unintended spin'.

1.16.27 The safety information provided in the Pilot's Operating Handbook notes the following with regard to spins:

'In any twin engine airplane, fundamental aerodynamics dictate that if the airplane is allowed to become fully stalled while one engine is providing lift-producing thrust, the yawing moment which can induce a spin will be present. Consequently, it is important to immediately reduce power on the operating engine, lower the nose to reduce the angle of attack, and increase the airspeed to recover from the stall. In any twin engine airplane, if application of stall recovery controls is delayed, a rapid rolling and yawing motion may develop, even against full aileron and rudder, resulting in the airplane becoming inverted during the onset of a spinning motion.'

1.16.28 It further states 'THE LONGER THE PILOT DELAYS BEFORE TAKING CORRECTIVE ACTION, THE MORE DIFFICULT RECOVERY WILL BECOME'.

1.16.29 The Pilot's Operating Handbook Emergency Procedures section outlines the corrective actions that should be taken following unintentional spin entry:

1. The Control Column should be positioned full forward, the Ailerons neutral
2. Full Rudder should be applied, opposite the direction of rotation
3. The Power Levers should be reduced to idle.

These three actions should be done aggressively and simultaneously.

4. The controls should be neutralised when the rotation stops
5. Execute a smooth pull-out.

1.16.30 The Safety Information section of the Pilot's Operating Handbook, provides the following advice:

'Remember that if an airplane flown under instrument conditions is permitted to stall or enter a spin, the pilot, without reference to the horizon, is certain to become disorientated. He may be unable to recognize a stall, spin entry, or the spin condition and may be unable to determine even the direction of the rotation.'

1.16.31 The Pilot's Operating Handbook for the Beechcraft Baron states in the Emergency Procedures section; with both the propellers feathered, the flaps and landing gear retracted, the glide ratio for the Beechcraft Baron will be 2 NM for every 1000 ft of altitude.

1.16.32 Beechcraft, was asked to comment on the glide characteristics of a Beechcraft Baron in a similar configuration to that of N254F at the time of the accident. Beechcraft concluded that a 'Baron 58 weighing about 5,500 lbs., descending at

115 knots (glide speed), with two wind milling (air driven) propellers will […] travel 1.58 NM across the ground for every 1,000 feet of lost altitude'. At approximately 18,000 ft this gave the aircraft a range of approximately 28.4 NM. When the aircraft departed controlled flight it was approximately 9 NM from the coast and 16 NM away from Raglan Aerodrome, that is, within gliding range of both.

1.16.33 The G1000 'SD' cards were recovered and sent to Jeppesen[15] for analysis. Jeppesen reported that the data contained on the multi-function display was valid from 5 May 2011 to 30 June 2011. The primary flight display was valid from 22 December 2011 until 1 March 2012. This means that at the time of the accident the information contained in the G1000 database was out of date.

1.16.34 Jeppesen further stated that this would have had no specific effect on the operation of the aircraft except that 'he would have been warned by the GARMIN G1000 that he had out of date data which he could then choose to override'. The engineer working on the aircraft brought the out of date database to the attention of the pilot, however, it does not appear that any action was taken. The out of date database was not considered to have been a contributing factor in the accident.

1.16.35 With regard to the pilot's medical status the CAA Principal Medical Officer requested the pilot's medical notes from his American and New Zealand GPs and also the FAA. The notes from the pilot's American GP indicate that the pilot had been prescribed Duloxetine for the purpose of treating a Major Depressive Disorder (MDD). The notes from his New Zealand GP suggest that duloxetine was prescribed for the treatment of Generalised Anxiety Disorder (GAD).

1.16.36 A report produced by the CAA Principal Medical Officer, after consultation with the FAA, suggests that had a diagnosis of GAD or MDD been known to the FAA, it 'would have resulted in medical certification denial unless the condition was in definite, and well documented, remission for at least twelve months without the need for medication.' It is also likely that the pilot would have been denied a medical certificate if the FAA had been aware of his long term use of Duloxetine.

1.16.37 The report goes on to stipulate that 'had the NZ CAA been aware of the pilot's diagnosis of MDD or GAD, and resultant use of Duloxetine (and other psychoactive medications), he would have had his pilot license privileges removed immediately, and would have been asked to provide additional information'.

1.16.38 The diagnostic criteria for GAD are provided in the widely-used Diagnostic and Statistical Manual published by the American Psychiatric Association and include 'a number of features that would impair flight safety'. In the broadest sense 'the anxiety could be expected to serve to distract the pilot from the matters that require attention', and further features of aeromedical significance include fatigue, difficulty with concentration and sleep disturbance.

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[15] Jeppesen provide updates for the G1000 system.

1.16.39 The diagnostic criteria for MDD also include ‘a number of features that would impair flight safety’. Some of these features of aeromedical significance are; depressed mood, loss of interest, fatigue or loss of energy, diminished ability to think or concentrate or indecisiveness and marked functional impairment.

1.16.40 ‘The aviation safety implications of Duloxetine lie in the effects and side effects of the drug in combination with the features of the condition that requires Duloxetine treatment. Dizziness, somnolence and headache are listed as very common side effects of Duloxetine, while tremor, paraesthesia (unpleasant sensations, often tingling feelings), insomnia, agitation and anxiety are listed as common’ according to the CAA’s Principal Medical Officer’s report.

1.16.41 Furthermore, the data sheet[16] for Duloxetine states under the heading ‘Effects on ability to drive and use machinery’ that ‘it may be associated with sedation. Therefore patients should be cautioned about their ability to drive a car or operate hazardous machinery’.

1.16.42 The pilot’s New Zealand GP notes indicate that the first entry in 2010, records the pilot’s condition of GAD and indicates that he had been on Duloxetine for the past two years. The notes further indicate that he had previously used other psychoactive medications prescribed for GAD, and ‘suggest that the treatment was understood by him to be lifelong and had been the situation for the last ten years’. Subsequent notes show that he had been on Duloxetine for most of the five years prior to the accident.

1.16.43 The significance of this information in relation to both the pilot’s 2009 CAA medical certificate application and 2011 medical certificate renewal application is evidenced by the fact that the pilot answered ‘no’ to the following questions:

- Have you taken any medication in the last 3 years for 2 weeks or more;
- Have you ever experienced… Diagnosed depression;
- Have you ever experienced … Anxiety disorder/panic disorder;
- Have you ever experienced … any other mental illness;
- Have you ever … taken any type of medication or alternative medicine for more than two weeks?

1.16.44 A review of the pilot’s most recent, 2011, FAA medical certification application form revealed that ‘the pilot had responses denying the use of any medication and any ‘mental disorder of any sort’, including depression or anxiety’.

1.16.45 This suggests that the pilot knowingly provided incomplete medical information to both the FAA and the CAA.

[16] Medsafe New Zealand Duloxetine data sheet, May 2011.

1.16.46 The Pilot's Operating Handbook for the Beechcraft Baron adds 'Self-medication or taking medicine in any form when you are flying can be extremely hazardous […]. The safest rule is to take no medicine before or while flying, except after consultation with your Aviation Medical Examiner.'

1.16.47 A review of other aircraft accidents involving similar aircraft configured with the same after-market turbocharger kit revealed two accidents in the United States of America. In both accidents a forced landing was conducted following a double engine power loss while flying in VFR conditions. Despite safety investigations being conducted into these two accidents the NTSB could not factually determine the reason for the loss of engine power.

1.16.48 In June 2005, the ATSB published a study on power loss related accidents involving twin-engine aircraft. The study analysed 63 twin-engine fixed-wing aircraft power loss accidents (11 fatal) during the period 1993 to 2002, and identified common themes. The report states that in 'ten of the 11 fatal accidents subsequent to a power loss in twin-engine aircraft were the result of an in-flight loss of control'.

1.16.49 A study completed by the NTSB found that 'the percentage of fatal accidents involving engine failure is more than four times greater in light-twins than in single-engine aircraft'. It continues, 'due to unique aerodynamic qualities associated with engine failures in light-twins with wing-mounted powerplants, control of these aircraft can be lost if airspeed is allowed to dissipate. Accidents involving loss of control are very serious and often fatal'.

1.16.50 The NTSB study also shows that pleasure and business flying accounted for the highest fatal accident rate within the light-twin category.

1.16.51 The CAA produces a GAP (Good Aviation Practice) booklet called Spin Avoidance and Recovery. The booklet is freely accessible to all aviation participants. The booklet provides the reader with educational material on spin entry, visual cues during, and the correct exit technique.

1.16.52 Dr Mica Endsley, Chief Scientist of the United States Air Force, describes situational awareness as knowledge of what is happening now, knowledge of what has happened previously, and knowledge of what is expected to occur in the future.[17]

1.16.53 One of the symptoms to indicate that a loss of situational awareness is occurring or about to occur is a propensity to fixate or tunnel attention.[18]

1.17 Organisational and management information

1.17.1 Beechcraft N254F, was an American registered aircraft. It was being operated in New Zealand in a manner permitted by the US and New Zealand regulatory

[17] www.pacdeff.com/pdfs/Situation%20Awareness%20in%20Aviation%20Endsley%201999.pdf

[18] Professor Mark Wiggins, ASTB Human Factors for Transport Safety Investigation, 14 Feb 2011.

frameworks. That is, the pilot being a US certificated pilot and operating a US registered aircraft in New Zealand airspace met the relevant civil/federal aviation rules/regulations in both New Zealand and the US.

1.17.2 Federal Aviation Regulation Part 91, *General Operating and Flight Rules, Sub part H—Foreign Aircraft Operations and Operations of US.-Registered Civil Aircraft Outside of the United States; and Rules Governing Persons on Board Such Aircraft* allows US registered aircraft to operate outside of the United States.

1.17.3 Section 4 of the Civil Aviation Act 1990 provides that the Act and Civil Aviation Rules shall apply to 'every foreign registered aircraft operating in New Zealand'.

1.17.4 New Zealand Civil Aviation Rule 91.107, *Aircraft registration,* allows foreign registered aircraft to operate in New Zealand, provided they are registered by the appropriate aeronautical authority of an ICAO Contracting State. There are special rules for foreign registered aircraft operated in New Zealand such as Rule 91.755, *Special rules for foreign aircraft operations,* which relates to, among other things, English proficiency and communication.

1.17.5 New Zealand Civil Aviation Rule 91.101, *Aircraft airworthiness,* requires aircraft to hold an airworthiness certificate, be in an airworthy state, and be operated in accordance with any limitations issued with the airworthiness certificate.

1.17.6 The responsibility for regulatory oversight over the aircraft follows the registration of the aircraft. The FAA retained responsibility for airworthiness oversight of N254F while it was operating in New Zealand. One implication of this was that any maintenance and modification of N254F required the services of an FAA certified aircraft and power plant mechanic. This requirement was met.

1.17.7 In line with international agreements there is no requirement that private aircraft operators obtain prior approval from the Director of Civil Aviation to operate in New Zealand. New Zealand civil aviation rules and international practices place no limit on the length of stay for foreign registered aircraft while on private operations. This is in contrast to foreign registered aircraft used on commercial operations to which specific rule apply. The number of foreign registered aircraft operating privately in New Zealand is not known to the CAA. The implications of this are difficult to assess, but would obviously increase in significance if greater numbers of foreign registered aircraft were to enter the New Zealand safety system.

1.17.8 As the aircraft was American registered, the pilot was exercising the privileges of his FAA pilot and medical certificates. In accordance with international agreements, the CAA does not exercise any entry control over the pilot before commencing flying in New Zealand. The CAA does not exercise oversight over the pilot's American issued certificates, medical status or aircraft airworthiness.

1.17.9 Consistent with international practices, the CAA does not routinely assess whether a foreign aircraft operating in New Zealand meets the relevant rule requirements, such as Rule 91.101 and 91.107 or otherwise confirm that pilot holds the necessary foreign pilot licence and medical certificate required under Part 61, *Pilot Licences and Ratings.*

1.17.10 The CAA is able to make inquiries with other regulatory authorities to establish whether a pilot, and/or aircraft, is appropriately licensed, certificated or registered etc. There is no mechanism in the Civil Aviation Act or CARs to do this on a routine basis. The CAA would need a trigger, such as an unsafe event, to cause inquiries to be made.

1.17.11 The Civil Aviation Act provides for the Director of Civil Aviation to respond to safety risks presented by an overseas pilot or aircraft flying in New Zealand. Typically this would only be applied where there was good cause to do so.

1.17.12 In the course of this investigation it became apparent that the obligations for foreign registered aircraft operating in New Zealand on a semi-permanent basis are not easily understood.

1.17.13 Accordingly CAA Safety Action (CAA 14A1514) has been raised recommending that the CAA undertake an issue assessment to review the current situation regarding privately owned foreign registered aircraft operating semi-permanently in New Zealand.

1.17.14 It should be noted that the aircraft's state of registration and the pilot's overseas certificates did not have any apparent causative influence on the N254F accident. These observations have been made in light of potential issues as to the regulatory oversight of the aircraft and pilot identified during the investigation.

1.17.15 As the aircraft accident occurred in New Zealand, International Civil Aviation Organization guidelines stipulate that the country where the accident occurred has jurisdiction of conducting a safety investigation. As the aircraft was registered in the United States of America, the NTSB was appointed as accredited representatives. In turn the NTSB appointed representatives from the aircraft, engine and propeller manufactures to participate in the investigation. Specialist resources were also obtained from the ATSB. The input from the respective individuals and organisations is acknowledged.

1.18 Additional information

1.18.1 On 8 March 2013 following the completion of the installation of the turbocharger system, a flight test was conducted from Ardmore Aerodrome with the owner/pilot and an engineer on board. While climbing through 13,000 ft a significant drop in engine power occurred on the left engine. The engineer on board the aircraft indicated that the pilot did not handle the situation very well. 'He [the pilot] pushed the power levers forward and got a bit flabbergasted for a second until I said to him "let me take control of the power lever ok you just keep the nose down and get us level"'.

1.18.2 During the maintenance investigation following this flight the engineers discovered oil inside the induction system. The engineers believed that it had entered through the seal between the exhaust and compression unit of the turbocharger. This led them to conclude that the turbocharger had failed and they subsequently requested a replacement from the manufacturer which was then fitted to the aircraft.

1.18.3 Following the installation of a new turbocharger supplied as a warranty replacement, engine ground runs still indicated a power development problem, albeit slightly different to that experienced on the last flight. Engineering trouble shooting found that the induction inlet ducting was collapsing, which in turn was causing the engine to 'hunt'.

1.18.4 The induction inlet ducting was sent back to the turbocharger manufacturer for inspection and testing. The manufacturer confirmed that it pressure tested the induction inlet ducting and found 'it met the five inches of mercury, but it did distort some. But it still had a pretty good sized passage on it even though it distorted.'

1.18.5 The safety investigation considered the fact that the induction inlet ducting collapsed on N254F during engine runs on the ground, and yet it passed the manufacturer's tests; meant either the demands placed on it during the ground runs were greater than those for which it had been designed, or the manufacturers testing did not replicate the operating environment. This observation has been brought to the attention of the FAA, through CAA Safety Action (CAA 14A1466).

1.18.6 Two days before the accident the owner and the engineer that installed the turbocharger on N254F conducted a test flight to 20,000 ft. The flight proved uneventful, however, following this flight the engineer adjusted the fuel flow to the left engine as it 'just touched the red line on take-off'.

1.19 Useful or effective investigation techniques

1.19.1 N/A

2. Analysis

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

2.2 The departure from controlled flight, and subsequent spin, occurred because the aircraft's airspeed slowed to a point where control of the aircraft could not be maintained.

2.3 It could not be conclusively established what initially caused the aircraft to slow to the point from which the departure from controlled flight occurred. However, it is considered most likely that the pilot experienced an engine power loss of some form, which caused the aircraft's airspeed to reduce.

2.4 Information was provided to the aircraft manufacturer, Beechcraft, about the rate of deceleration, while maintaining altitude. Beechcraft suggest that the deceleration is consistent with a single engine failure or power loss.

2.5 Based on the aircraft manufacturer's assessment, it is most probable that the aircraft has experienced a reduction in power from the left engine. This assessment is likely supported by the following:

- The general pattern of the positions of the switches and the engine and propeller control levers, for the left engine;
- The direction of the flight track before the departure from controlled flight, towards the left;
- The anomaly noted with the number 5 upper deck pressure line connection, on the left engine; and
- The anomaly noted with the induction inlet ducting, on the left engine.

2.6 The safety investigation could not conclusively establish what caused a likely reduction in power or power loss in the left engine.

2.7 The safety investigation has two untested anomalies associated with the turbocharger installation on the left engine. These anomalies involve: The number 5 upper deck pressure line connection, and the induction inlet ducting. The impact of either of these anomalies on engine performance, if any, has not been conclusively established. The necessary testing was not completed due to the scope of the safety investigation.

2.8 The safety investigation team liaised closely with the NTSB Safety Investigators who conducted safety investigations into the two accidents in the United States of America. No common conclusive links associated with an engine power loss could be established between the two accidents in the United States of America and this accident in New Zealand.

2.9 With regard to the radar plots, they show a reduction in airspeed while level flight was maintained. For this to have occurred, it is most likely that the autopilot was still engaged and set to altitude hold[19]. As the elevator trim on the aircraft was nearly set to full nose up, it is most likely that as the aircraft's airspeed reduced, the autopilot trimmed the aircraft to maintain altitude. As the aircraft's airspeed reduced further the autopilot system continued to trim the nose up, to a point where the pilot probably became aware of the imminent stall and disconnected the autopilot.

2.10 The radar plots also show that from level flight at FL180 a small descent of 700 ft was initiated, lasting approximately 19 seconds. It is most likely for this to have occurred the aircraft was being hand flown with the auto pilot disconnected.

2.11 With the aircraft elevator trim set to 21 units nose up, the pilot would have had to overcome the control column forces of up to 75 lbs to check forward and overcome the trim state to initiate a small descent.

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[19] Altitude hold is an autopilot function that the pilot selects to maintain the aircraft at a selected altitude.

2.12 At this time the pilot would have had a considerable work load in holding the control column forward to maintain airspeed while conducting emergency procedure checks.

2.13 As stipulated in the Pilot's Operating Handbook, the single most important factor in maintaining control of the aircraft is airspeed. If the pilot had maintained an appropriate airspeed and trimmed the aircraft to fly at a given aircraft attitude, then he would have had time to conduct emergency procedure checks and configure the aircraft in an appropriate manner.

2.14 If the aircraft had been configured appropriately, it would have been able to reach Raglan Aerodrome or an appropriate aerodrome for a multi-engine aircraft to land given single engine considerations.

2.15 However, this did not occur and the aircraft's airspeed decreased to a point where a departure from controlled flight occurred.

2.16 Based on the aircraft manufacturers' assessment that the aircraft slowed at a rate consistent with a single engine powerloss, it is likely that the aircraft would have been subject to considerable yawing moment at the time the aircraft departed controlled flight. The drag produced by the wind-milling left propeller and thrust from the right propeller would have created this yawing moment.

2.17 Once the departure occurred, the pilot would have had to act immediately to prevent a spin ensuing due to the aerodynamic forces present. This did not happen, however, with evidence, such as the rate of descent, the radar plots and the hydro deformation suggesting that the aircraft entered a spin from which it did not recover.

2.18 Although, the pilot disclosed to ATC, during the spin, that he had "both engines out…", it could not be conclusively determined why the pilot made the statement perceiving that he had a double engine failure. However, it is possible that mis-handling by the pilot or forces placed on the right engine during the spin may have effected its operation.

2.19 The safety investigation has not been able to identify why the pilot was likely 'task fixated'[20] on the operation of the engines while established in a spin as broadcast in the transmission to ATC. However, it is likely that the pilot had not been able to identify that the aircraft was in a spin due to the degradation of situational awareness. This was likely caused by the aircraft being operated in the cloud, rendering the pilot disorientated. The Pilot's Operating Handbook gives specific advice on this: 'if an airplane flown under instrument conditions is permitted to stall or enter a spin, the pilot, without reference to the horizon, is certain to become disorientated. He may be unable to recognize a stall, spin entry, or the spin condition and may be unable to determine even the direction of the rotation.'

[20] Task fixation occurs when all a pilot's cognitive capacity is focused on one task exclusively.

2.20 With regard to the pilot's use of Duloxetine for the mental condition known as GAD or MDD, it is possible that this medication could have caused fatigue, dizziness or a number of other side effects. These side effects may have added to the degradation in the pilot's situational awareness and may also have contributed to his lack of appropriate recovery action in a timely fashion.

2.21 Based on the data sheet for Duloxetine and the pilot's medical documentation, the Principal Medical Officer of the CAA concluded: 'A pilot suffering from GAD or MDD could not be relied upon to respond to challenging or emergency in-flight situations in a constructive and methodical manner. A pilot taking Duloxetine also has the potential to suffer a wide range of aviation unsafe side effects and complications of the drug. Thus the pilot's undeclared medical condition, and the drugs used in its treatment, cannot be excluded as contributing factors in the accident.'

2.22 At the later stages of the spin, most likely when the aircraft has encountered Visual Meteorological Conditions, the pilot has evidently tried to recover the aircraft from the spin. The pilot's right rudder pedal and fractures to the pilot's right leg reflect impact damage from the pilot likely commanding the right rudder. This is consistent with spin recovery instructions stipulated in the Pilot's Operating Handbook.

2.23 It is most likely that during the spin the aircraft was rotating to the left. This is supported by the signatures consistent with the applications of right rudder and the failure of the pilot's seat rails. The aircraft wreckage also reflects hydro deformation consistent with a slow yawing[21] moment in an anti-clockwise direction, a slight nose down attitude, and wings nearly level.

2.24 The damage caused by the entry into the sea reflects a high rate of descent with little to no forward groundspeed. It appears that, at the time the aircraft struck the sea, the engines were not producing any power. Following the impact with the sea, the aircraft sank, coming to rest inverted on the sea floor.

2.25 Although it appears that the pilot may have attempted to feather the left propeller, it is likely that when the pilot attempted this, the propeller mechanism was outside of its operational range, and hence could not be feathered.

2.26 The nasal cannulas thought to have been utilised at the time of the accident were at the upper limit of their operating range. Analysis of the contents of the oxygen tank showed no likely concern with the quality, or quantity of the oxygen supply. As far as could be ascertained, the oxygen system had been turned on and should have been able to deliver oxygen to the pilot and passenger. The pilot had demonstrated competency in using the system on previous flights, albeit above the upper altitude limit for the nasal cannulas. There is no evidence to suggest that hypoxia was a contributing factor to the accident.

2.27 While the pilot had demonstrated competence in handling engine failures at low altitude, it is unlikely he would have demonstrated engine failure competency at

[21] Yaw is the left or right movement of the aircraft nose, about its vertical axis of rotation.

high altitude. The engineer who was on board the aircraft for the flight on 8 March 2013 stated that during the power loss the pilot did not handle the situation very well.

2.28 Given the engineer's comments, as well as the numerous studies and data available about the risks associated with recreational pilots flying twin engine aircraft, such as those published by the ATSB and the NTSB, it would have been prudent for the pilot to have undergone dual instruction once the turbocharger system had been installed. This would have allowed the pilot to have experienced, in a safe environment, the implications of operating outside of the parameters and guidance of the flight manual, and associated handling characteristics of the aircraft at higher altitudes.

3. Conclusions

3.1 The accident occurred because the aircraft departed controlled flight and entered a spin from which it did not recover.

3.2 The departure from controlled flight occurred because the aircraft's airspeed decreased to a point where control of the aircraft could not be maintained.

3.3 The safety investigation could not conclusively establish what caused the aircraft's airspeed to decrease to the point from which the departure from controlled flight occurred. However, it is considered most likely that the pilot experienced a reduction in power or power loss from the aircraft's left engine.

3.4 The safety investigation could not conclusively establish what caused a likely reduction in power or power loss on the left engine.

3.5 As the aircraft's airspeed decreased, the auto pilot most likely trimmed the aircraft almost full nose up, likely catching the pilot unaware.

3.6 It is likely that the pilot lost situational awareness and became disorientated during, and subsequent to, the departure from controlled flight.

3.7 The pilot's loss of situational awareness was most likely caused by the aircraft being operated in cloud. The pilot's mental health condition, and the associated medication that the pilot was taking, likely exacerbated his loss of situational awareness.

3.8 It is likely that once, the aircraft was in a spin, the pilot could not have recovered from this situation.

3.9 The aircraft departed controlled flight while it was within gliding range of the coast.

3.10 For the pilot and passenger, the accident was not survivable.

3.11 It would have been prudent for the pilot to have undergone some form of flight instruction in order to identify aircraft handling and system differences subsequent to the modifications conducted on N254F.

3.12 It appears that the pilot knowingly did not disclose to the FAA or the CAA that he had been diagnosed with GAD or MDD, or that he was taking medication to treat that diagnosis.

3.13 Had the pilot declared the diagnosis of GAD or MDD, or the medication that he was taking for this condition, neither the FAA nor the CAA would likely have issued him with a medical certificate.

3.14 Although the turbochargers were installed in accordance with the STC instructions, the aircraft was released to service with an insecure number 5 upper deck pressure line, on the left engine.

3.15 An observation was made, that the STC instructions for the turbocharger system lack clarity.

3.16 The impact, if any, that the anomaly associated with the left engine's number 5 upper deck pressure line would have had on N254F's engine performance could not be determined within the scope of the safety investigation.

3.17 An observation was made that in this case, there are significant manufacturing inconsistencies in the production of the induction inlet ducting.

3.18 The impact, if any, of the induction inlet ducting manufacturing inconsistencies on engine performance could not be determined within the scope of the safety investigation.

3.19 There is limited oversight of permanently based, privately operated, foreign registered aircraft in New Zealand.

4. Safety actions

4.1 CAA Safety Action (CAA 14A1468) has been raised bringing the inconsistent manufacturing and production of the turbocharger induction inlet ducting to the attention of the FAA.

4.2 CAA Safety Action (CAA 14A1466) has been raised bringing the observation, to the attention of the FAA, that the manufacturers testing regime may not fully replicate the operating environment to which a turbocharger induction inlet ducting may be exposed.

4.3 CAA Safety Action (CAA 14A1467) has been raised, bringing the lack of clarity in the STC instructions to the attention of the FAA.

4.4 CAA Safety Action (CAA 14A1514) has been raised recommending that the CAA undertake an issue assessment to review the current situation regarding privately owned foreign registered aircraft operating semi-permanently in New Zealand.

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