Civil Aviation Authority

Republic of Vanuatu

Fuel starvation and collision with terrain involving Britten-Norman Islander BN2A-20, YJ-AT2

6 km east-south-east of Port Vila International Airport, Vanuatu on 15 July 2024

Civil Aviation Authority of Vanuatu – Aviation Safety Report

Aviation Occurrence Investigation

AA-2024-008 (CAAV investigation number: 136272/AIG/A2.5)

Final – 14 August 2025

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Addendum

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Investigation summary

An Investigator in Charge (IIC) has been appointed by the Civil Aviation Authority of Vanuatu (CAAV) to conduct an accident investigation into the fuel starvation and collision with terrain involving Britten-Norman Islander BN2A-20, registered YJ-AT2, on 15 July 2024.

The CAAV IIC publishes this final report on the accident investigation as a delegate of the CAAV Director and in accordance with the statutory function in the Civil Aviation Act (2021 Consolidated Edition) to investigate and review civil aviation accidents and incidents.

The CAAV IIC acknowledges the technical assistance provided by the Australian Transport Safety Bureau, the independent accident investigation authority of Australia, as an Annex 13 accredited representative to the accident investigation.

What happened

On 15 July 2024, the pilot of a Britten-Norman Islander BN2A-20 aircraft, registered YJ-AT2 and operated by Air Taxi Vanuatu, was conducting passenger-carrying charter flights under the visual flight rules. At 1229, the aircraft departed Port Vila International Airport, and transported 6 passengers to Tanna, 217 km to the south-south-east. The pilot then continued a further 106 km south-south-east to Mystery Island, Aneityum, arriving at 1402.

After picking up 4 passengers, the aircraft departed Aneityum at 1412, destined for Port Vila. About 130 km from Port Vila, the pilot observed the fuel quantity gauges indicating significantly less fuel remaining than expected. The pilot elected to continue over water to Port Vila, and about 24 km from the runway, the right engine surged and subsequently stopped producing power.

About 3 minutes later, the pilot advised air traffic control that they were 15 km from the airport at 4,000 ft, and the controller responded with a clearance to land on runway 29. No engine noise was detected in that transmission. Four minutes later, the pilot declared a MAYDAY and advised the controller that they were 9 km from the runway, at 1,500 ft and attempting to land at the airport. During that transmission, one engine surged briefly and then stopped. The pilot then radioed that they were losing altitude and would be landing in a farm.

The aircraft collided with 2 coconut trees before impacting the ground. One passenger was fatally injured, 2 passengers sustained serious injuries, the pilot and one passenger sustained minor injuries, and the aircraft was destroyed.

What the investigation found

The investigation found that the pilot did not ensure there was sufficient fuel on board for the planned flight from Aneityum to Port Vila.

During the return flight, when the pilot identified that there was less fuel on board and higher fuel flow than planned, they elected to continue to Port Vila rather than divert to other suitable aerodromes. Having committed to continue, the pilot then did not lean the mixture or attempt to transfer fuel from auxiliary tanks (unaware the right auxiliary tank contained usable fuel) to increase endurance. As a result, the engines stopped due to fuel starvation, with usable fuel remaining in one auxiliary tank.

The investigation also found that the pilot did not feather the propellers when the engines stopped and did not maintain optimal airspeed in the time between the first and second engines stopping. These actions reduced the pilot’s options and resulted in a forced landing into a coconut plantation. The forced landing was conducted with a tailwind and the pilot did not extend the flaps to allow a slower airspeed immediately prior to the collision, resulting in higher impact forces.

The passenger seats were fitted with lap belts only and no upper torso restraints. Both of these factors increased the injury risk; whether they contributed to the severity of the occupants' injuries could not be determined in this case.

Furthermore, the investigation found that the chief pilot misunderstood the chief engineer's verbal instructions regarding engine run-in requirements as a need to operate the engine with the mixture at full rich for at least 25 hours. The chief pilot then conveyed this to other company pilots without providing amended fuel flow figures for pilots' use in flight planning.

Finally, the investigation identified that the high operational tempo in the months leading up to the accident, and the absence of flight crew workload management, increased the risk of fatigue affecting pilot performance.

What has been done as a result

Following this accident, Air Taxi Vanuatu implemented the following safety action:

- The chief engineer issued an operations order requiring all memos, instructions, orders and operational communication between managers, chief engineer, safety, engineering, air operations, chief pilot, bookings, and between chief pilot and crew to be issued as an operations order. All operations orders are to be read and signed by all relevant parties prior to the commencement of the affected operations.
- The fuel planning policy within the standard operating procedures has been reviewed and revised to improve clarity and address any discrepancies or inconsistencies.
- A new, simplified flight log has been developed to help pilots record flight times more accurately and quickly identify slower legs caused by headwinds. Training has also been implemented on how to properly complete the new flight log to ensure standardisation among pilots. This will improve the review process by making it easier to identify issues and ensure all required information is consistently documented and understood.
- A structured recruitment process had been documented, which includes the following steps:
    1. Define Clear Job Requirements and Competency Standards
    2. Structured Interview Process
    3. Background and Reference Checks
    4. Psychometric and Aptitude Testing
    5. Safety Culture Fit
    6. Comprehensive Onboarding and Training
    7. Probation and Monitoring.

Air Taxi Vanuatu has advised that the following safety action will also be taken:

- Future risk assessments will place greater emphasis on operational tempo and fatigue management. Any significant risks identified will be addressed and corrective actions implemented promptly. These risk assessments will be conducted using the Safety Management System.
- Additionally, to address the risks of increased workload and inadequate fatigue management, more robust flight and duty tracking software has been implemented to better monitor pilot schedules and identify when flight and duty limits are at risk of being exceeded. Furthermore, the chief pilot will closely monitor all rosters, and any excessive flight or duty bookings will be adjusted or cancelled to ensure all pilots remain within regulated limits.
- All future pilots will receive comprehensive training on all aircraft equipment to ensure they are fully equipped with the necessary tools and knowledge. Additionally, if new equipment is installed in an aircraft, all current pilots will be trained in its use.

- Pilots will receive updated training and regular reviews on fuel planning procedures to ensure compliance with the procedures and to reinforce the requirement that all flights conclude with fuel reserves intact.
- All new aircraft introduced to the fleet will be assessed to determine whether differences training is required. This assessment will consider factors such as aircraft type, model, avionics, configuration, instrument layout, switch and control placement, and any other variations that could lead to confusion, hesitation, or accidental inputs. This approach aims to reduce the risk associated with unfamiliarity between aircraft within the fleet.
- Fuel consumption will be reviewed by comparing the remaining fuel at the end of each flight against the planned fuel quantity. This process aims to ensure pilots maintain awareness of expected fuel usage and to identify any inconsistencies or excessive consumption—whether due to pilot error or mechanical issues—so that these can be addressed promptly.

The CAAV examiner has amended their examination and check flight protocols to include:

- observing pilots completing a flight plan including consideration of the forecast weather
- amending flight and fuel planning in flight
- ensuring pilots understand the importance of, and actions to, feather a propeller following an engine failure.

Additionally, CAAV:

- will require pilots to submit a copy of their logbook records as part of a licence renewal application for verification and record keeping, and require the aircraft operator to certify a pilot's logbook as correct
- mandated that chief pilots are to be allocated at least 40% of their time to non-flying duties.

Safety message

This accident highlights the importance of effective fuel management. It is vital to use all available means, including accurate fuel records and quantity cross-checks, to ensure that pilots accurately know their aircraft's fuel state. Aircraft operators should also ensure pilots are proficient at using all available instruments for fuel management. CAAV encourages pilots to refresh their knowledge on fuel planning and management and encourages operators to review their procedures for fuel planning and in-flight fuel management.

Accidents due to engine malfunctions or stoppages in twin-engine aeroplanes are rare, but often fatal. As such, training to manage one engine inoperative (OEI) flight is important. Effective OEI flight management relies on the pilot conserving altitude, maintaining the nominated airspeed for optimal performance, appropriately configuring the aircraft, and advising air traffic control of the non-normal situation.

A loss of power to both engines is less likely to occur and may not be specifically addressed in multi-engine aircraft training and guidance. However, pilots should know the appropriate actions, speed and configuration required to manage an all-engines-out forced landing as safely as possible. The United Stated National Transportation Safety Board Safety Alert *Know when to feather your propeller if one engine loses power*, provides information about feathering propellers in a timely manner.

The FAA General Aviation Joint Steering Committee's Safety Enhancement Topic – *Emergency Procedures Training* (FAA, 2013), stated:

> Every pilot needs to prepare for the unexpected. Engine failures and inflight emergencies have a nasty habit of cropping up at the most inopportune times. However, with the right training and preparation, you can be ready for any hazardous situation that comes your way.

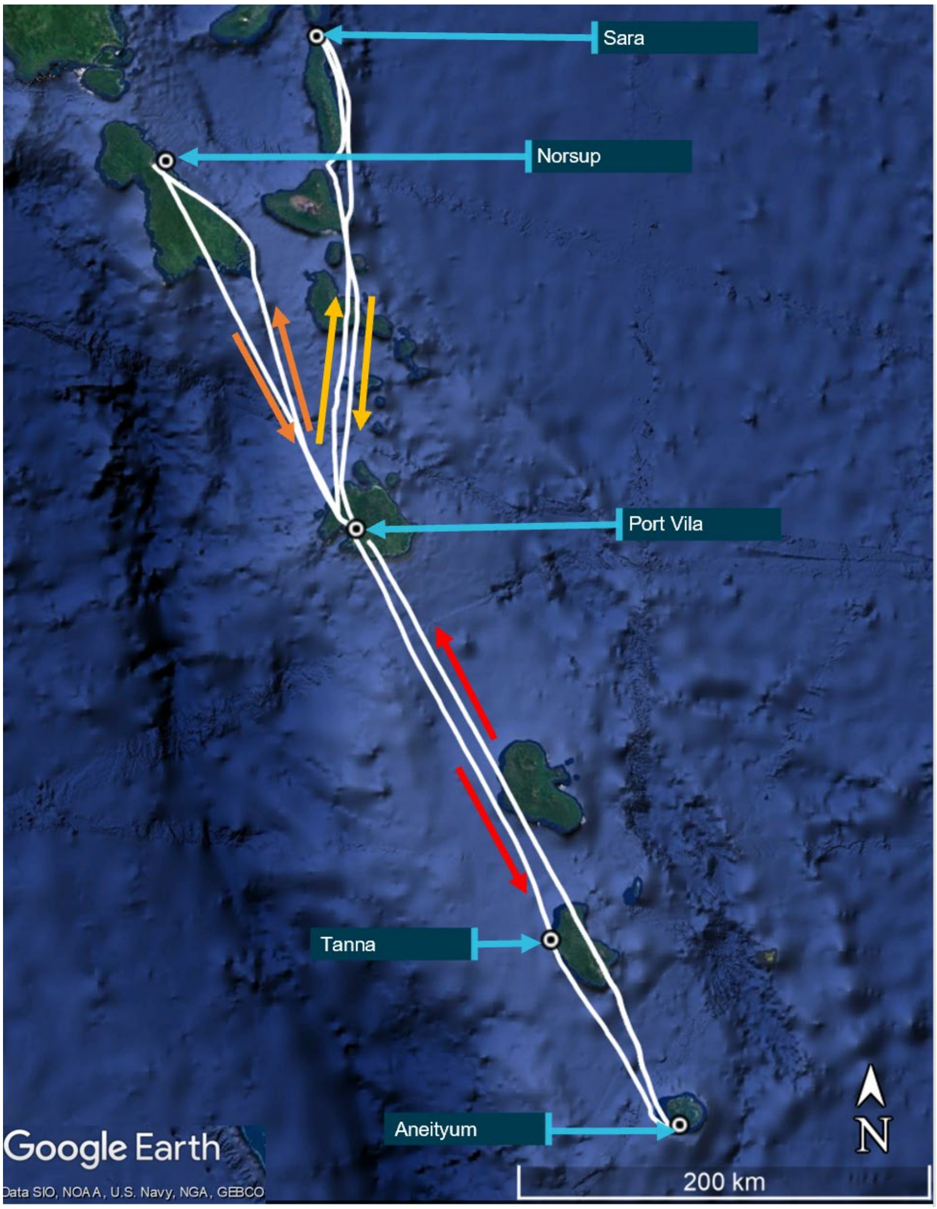
Contents

The occurrence

On 15 July 2024, the pilot of a Britten-Norman Islander BN2A-20 aircraft, registered YJ-AT2 and operated by Air Taxi Vanuatu, was preparing to conduct passenger-carrying charter flights under the visual flight rules.[1] The pilot arrived at the Air Taxi Vanuatu office at Port Vila International Airport at about 0530 Vanuatu Time.[2] Three return flights had been assigned to the pilot that day – 2 north and north-north-west from Port Vila and one to the south-south-east (Figure 1).

The pilot submitted a flight plan for the first flight, which involved transporting 5 passengers to Sara, Pentecost Island. The pilot then conducted a pre-flight inspection of the aircraft and arranged for it to be refuelled.

Figure 1: Recorded GPS tracks for YJ-AT2 on 15 July 2024



Source: Aircraft operator flight data overlaid on Google Earth and annotated by the ATSB accredited representative to CAAV IIC investigation

1 Visual flight rules (VFR): a set of regulations that permit a pilot to operate an aircraft only in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

2 Vanuatu Time (VUT): Coordinated Universal Time (UTC) + 11 hours.

Recorded data from the aircraft's GPS showed that the aircraft took off from Port Vila at 0652 and arrived at Sara at 0808. The passengers disembarked, and the aircraft departed 8 minutes later, arriving back at Port Vila at 0922.

The pilot then arranged for the aircraft to be refuelled again, before departing for Norsup, Malekula Island with 5 passengers on board, at about 0946. The aircraft arrived at Norsup at 1044 and the passengers disembarked. The aircraft departed for the return flight to Port Vila at 1049, arriving at 1141, and was again refuelled.

The pilot and refueller reported that on all 3 occasions that day, the aircraft's left and right main tanks were filled to full, with 245 L of usable fuel[3] in each tank.

At 1229 the aircraft departed Port Vila for Tanna, 217 km to the south-south-east, with the pilot and 6 passengers on board. The aircraft arrived at Tanna at 1322, where the passengers disembarked. The pilot then continued another 106 km south-south-east to Mystery Island, Aneityum, arriving at 1402.

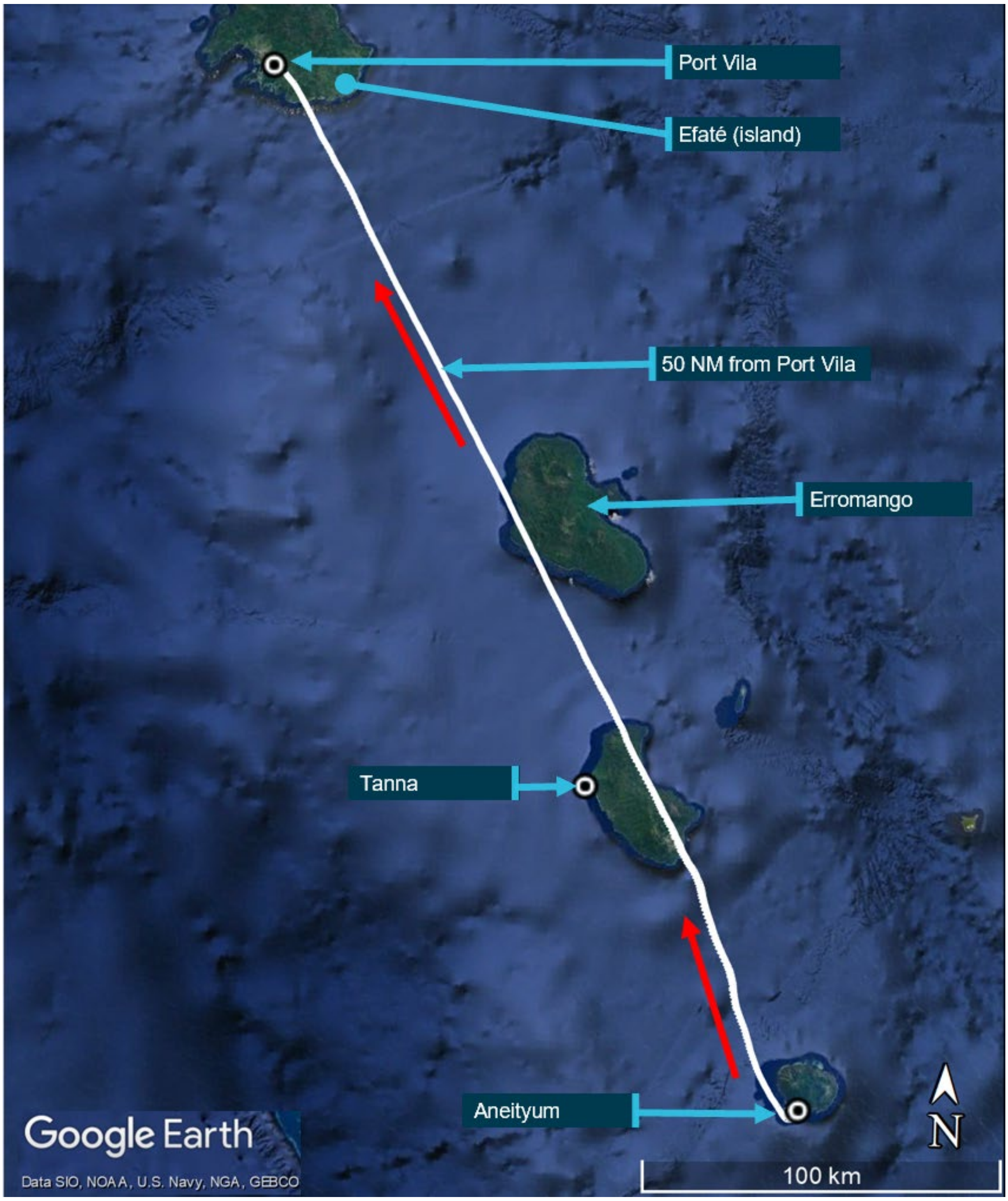
After picking up 4 passengers, the aircraft departed Aneityum at 1412. The aircraft climbed for about 30 minutes to just above 10,000 ft as it tracked over the southern shore of Tanna. However, due to stronger headwinds at that altitude, about 6 minutes later, the pilot elected to descend and maintain an altitude of about 7,500 ft.

The aircraft passed over the west coast of Erromango between 1509 and 1511 (Figure 2). The pilot reported that, after passing Erromango, they identified that the main tank fuel quantity gauges indicated there was less fuel remaining than expected. Additionally, the left main tank fuel gauge indicated slightly more fuel than the right main tank gauge. In response, the pilot reported twice briefly cross-feeding fuel from the left main tank to the right engine until the main tank quantity indications matched.

The pilot reported that at about 1525, when about 93 km from Port Vila, the fuel quantity gauges indicated about 10 USG (38 L) remaining in each main tank, when they were expected to have about 30 USG (114 L) in each tank. The pilot also reported that, at that time, the installed digital Fuel Scan instrument was displayed a fuel flow of about 80 L/h on the left engine and 87 L/h on the right engine. Despite the discrepancy, as the aircraft was past halfway to Port Vila from the last available fuel at Tanna, the pilot elected to continue the flight.

[3] Usable fuel: fuel on board that is available to the engines in normal flight attitudes.

Figure 2: Accident flight GPS track



Source: GPS data overlaid on Google Earth, annotated by the ATSB accredited representative to CAAV IIC investigation

The pilot commenced descending about 46 km from Port Vila. At about 1546, the pilot contacted Vila Tower air traffic control (ATC) and advised they:

- were approaching the south coast (of Efaté) at an altitude of 5,000 ft and 13 NM from runway 29 (Figure 3)
- had 'engine problems' and required assistance.

During that radio transmission, engine surging was audible in the last 2 seconds of the transmission. In response, the controller alerted the Aviation Rescue and Fire Fighting Services (ARFFS) to standby. The pilot reported that, as the aircraft descended towards Port Vila, the right engine surged, ran roughly and then stopped producing power.

Figure 3: Aircraft's recorded ADS-B track from 1545 to 1553

Source: FlightRadar24 data overlaid on Google Earth, annotated by the ATSB accredited representative to CAAV IIC investigation

At about 1549, the pilot advised ATC that they were 8 NM from the field at an altitude of 4,000 ft, and the controller responded with a clearance to land on runway 29. Audio analysis indicated that no engines were operating at that time, although the pilot reported that, shortly after that transmission, the left engine surged and then stopped.

The pilot reported that following the engines ceasing to produce power, their initial actions were to push the respective mixture, pitch and power levers to the full forward position, but they did not at any stage feather[4] the propellers or attempt to transfer fuel from the auxiliary tank.

4 Feathering: the rotation of propeller blades to an edge-on angle to the airflow to minimise aircraft drag following an in-flight engine failure or shutdown.

At about 1552, the pilot declared a MAYDAY[5] and advised ATC that they were 5 NM from the field, at an altitude of 1,500 ft and attempting to land at the airport. During that transmission, one engine surged briefly then no further engine noise was detected. Shortly afterwards, the controller advised the pilot that they had the aircraft's landing light in sight. Just over one minute later, the pilot radioed that they were losing altitude and would be 'landing somewhere in the farm'. Still transmitting on the tower frequency, the pilot told the passengers to 'BRACE, BRACE, BRACE' and to put their heads down. At the end of that radio transmission, the aircraft's stall warning horn[6] was audible. A short time later the aircraft collided with 2 trees, before impacting the ground and coming to rest upright (Figure 4).

At 1554, the air traffic controller logged that they had no visual or audio contact with YJ-AT2, notified ARFFS of the accident, and 3 minutes later, notified Air Taxi Vanuatu. At 1608, Noumea Rescue Coordination Centre notified air traffic control of a COSPAS[7] message, indicating detection of an emergency locator transmitter beacon activation. The ARFFS arrived at the accident site at about 1630, where Vanuatu ProMedical ambulance and paramedics and Police were already in attendance.

One passenger was fatally injured during the accident sequence, with 2 passengers sustaining serious injuries. The pilot and one passenger sustained minor injuries and the aircraft was destroyed.

Figure 4: Accident site

Source: CAAV

[5] MAYDAY: an internationally recognised radio call announcing a distress condition where an aircraft or its occupants are being threatened by serious and/or imminent danger and the flight crew require immediate assistance.

[6] An audible stall warning was provided by an airframe mounted stall warning horn which sounded when the airflow passed through it at a specific angle.

[7] COSPAS-SARSAT: an international satellite-based search and rescue (SAR), distress alert and detection system.

Context

Pilot information

The pilot held a Republic of Vanuatu commercial pilot licence (aeroplane), first issued on 12 July 2010 and re-issued on 26 August 2016. The pilot also held a Republic of Vanuatu Class 1 aviation medical certificate valid to 10 November 2024.

The pilot's total aeronautical experience at the time of the accident was about 4,600 hours. That experience included more than 2,000 hours operating the twin-turboprop Harbin Y-12 and another 2,000 hours operating twin, piston-engine Britten-Norman Islander aircraft. The pilot commenced operating the Y-12 in July 2010, operated both aircraft types from August 2012, and last flew the Y-12 in November 2014.The pilot then continued operating Britten-Norman Islander aircraft, including 658.2 hours accumulated with Air Taxi Vanuatu.

According to the pilot's logbook, the pilot successfully completed 20 checks between July 2010 and April 2015 while operating with Air Vanuatu. These included operational competency assessments, route and aerodrome proficiency checks and instrument rating renewals. Their last recorded flight at Air Vanuatu was on 15 July 2015, lasted 0.3 hours, and appeared to be an incomplete instrument rating renewal. The pilot had 2 subsequent successful checks, including an instrument rating renewal, with another employer in 2016.

After ceasing flying in January 2018, the pilot commenced employment at Air Taxi Vanuatu in November 2023. At that time, the actual total flight time documented in the pilot's logbook was about 4,000 hours, although the 'grand total aeronautical experience' was stated as over 10,000 hours. This discrepancy occurred because on multiple pages, 10 times the actual hours recorded each month had been added to the total.

Documents provided by Air Taxi Vanuatu indicated that, during refresher training after the pilot's absence from flying, they completed Britten-Norman Islander aircraft type rating requirements and line training, conducted by the chief pilot. Following that training, the pilot completed an operational competency check on 28 November 2023, in which the pilot demonstrated the ability to:

- conduct aircraft weight and balance assessments
- complete flight and fuel planning, including the:
  - identification of minimum fuel requirements
  - assessment of the effect of weather conditions on fuel usage.

On 4 December 2023 the pilot completed a route check with a Civil Aviation Authority of Vanuatu (CAAV) flight examiner, in which the pilot was assessed as competent to perform emergency procedures, including the correct response to a simulated engine failure.

The pilot was involved in a motor vehicle accident on 11 July 2024 and sustained a knee injury. The pilot had a medical certificate stating that they were unfit for work until, and including, 15 July 2024. However, the pilot self-assessed being fit to return to work, returning on 15 July. The pilot also reported that the increased workload and amount of flying in the months leading up to the accident had affected their sleep pattern, and they were waking more frequently in the night. Further, in hindsight, they assessed that this had affected their cognitive function.

Aircraft information

General

The Britten-Norman Islander is a twin engine, high wing aircraft with fixed landing gear. YJ-AT2 was manufactured in the United Kingdom in 1971 as a BN2A-2, serial number 188, and subsequently certificated as a BN2A-20 model. YJ-AT2 was issued a certificate of registration on

25 August 2023 to be operated by Air Taxi Vanuatu in the standard category and had seating capacity for one pilot and 9 passengers. A certificate of airworthiness was issued on 17 November 2023. The aircraft was powered by 2 Lycoming 6-cylinder 300 horsepower (hp) fuel-injected IO-540-K1B5 engines, each driving a 2-bladed Hartzell HC-C2YK-2CUF propeller.

Air Taxi Vanuatu also had 2 BN-2 aircraft fitted with 260 hp engines; YJ-AT2 was the only 300 hp aircraft in the operator's fleet. Consistent with the aircraft flight manual, the Air Taxi Vanuatu operations manual stated YJ-AT2's maximum take-off weight was 2,980 kg, slightly less than the 2,994 kg for the 260 hp powered versions.

The aircraft was fitted with single-slotted flaps, electrically operated by an actuator through a system of push-pull rods. The actuator was controlled by a selector switch on the pilot's console and a flap position indicator was situated on the cabin roof instrument panel.

The aircraft flight manual detailed stalling speeds with the throttles closed, and the flaps retracted (UP), in the take-off position (TO) and extended (DOWN), and at several weights. The closest listed weight to the aircraft's weight prior to the collision with terrain was 2,722 kg (Table 1).

The aircraft flight manual also included a procedure for landing with one engine inoperative but not for a forced landing due to a complete power loss. The manual stated that with one engine inoperative, the initial approach speed was 65 kt indicated airspeed with the flaps selected to TO (25°). When committed for landing, select flaps to DOWN (56°) and reduce speed over the threshold in accordance with the landing performance chart. The manual also detailed the following conditions for optimal climb performance with one engine inoperative:

- operative engine at maximum continuous power
- propeller of the inoperative engine feathered
- flaps retracted
- airspeed 65 kt.

Table 1: Stalling speeds at 3 flap settings, throttles closed

Flap angle	Stalling speed (kt) at maximum take-off weight	Stalling speed (kt) at 2,722 kg
UP	50	48
TO	43	42
DOWN	40	38

Britten-Norman advised that the best glide speed was 75 kt indicated airspeed, which correlated with the maximum lift/drag speed of about 65 kt plus a 10 kt margin.

Fuel tanks

The aircraft had one left and one right main wing fuel tank, each with a capacity of 245.4 L usable fuel and 13.2 L unusable fuel. Additionally, the aircraft was fitted with auxiliary fuel tanks under an engineering order approved by a delegate of the Australian Civil Aviation Safety Authority in January 2012. The purpose of the installation was to provide the aircraft with increased range and endurance.

The installation comprised 2 integral fuel tanks of 125 L nominal capacity, referred to as 'tip' or auxiliary tanks, situated between the main fuel tank and wing tip on the left and right wings. A placard on the overhead panel in the cockpit stated usable fuel in each auxiliary tank was 32.5 USG (123 L), indicating 2 L was unusable. Despite that placarding, the Air Taxi Vanuatu chief engineer advised that they were unable to get more than 100 L of fuel into each auxiliary tank and had consequently affixed a placard stating each auxiliary tank capacity was 100 L usable fuel.

Each auxiliary tank had a pump to transfer fuel from the auxiliary tank to the same-side main tank, with an on-off switch adjacent to the main tank gauges and switches. There was no fuel quantity indicator for the auxiliary tanks. However, when a transfer pump was switched on, an associated light on the overhead panel would flash while the pump was transferring fuel to the main tank, then illuminate continuously when no usable fuel remained in the auxiliary tank. Each auxiliary tank also had a drain valve installed at the bottom of the sump.

There were no special continued airworthiness instructions related to the engineering order with on-condition inspection required in accordance with the normal maintenance schedule.

The aircraft's logbook contained the following recent maintenance relevant to the auxiliary tanks system:

- 11 December 2023: The right auxiliary tank could only transfer fuel to the main tank until it reached 70 L. Engineers rectified the defect by replacing a blown fuse. They performed a function test of the system, and the aircraft was released to service.
- 18 December 2023: The right auxiliary tank transfer pump was found unserviceable. Engineers replaced the transfer pump and tested the system was functional.
- 31 January 2024: The right auxiliary transfer tank pump was found unserviceable. Engineers found a loose wire, rectified the defect and tested the system was functional.
- 29 February 2024: Both auxiliary tank fuel filters were replaced in scheduled maintenance with no contamination found.
- 17 April 2024: The right auxiliary tank transfer pump was reported inoperative. Engineers carried out a check and found it operating satisfactorily.

Fuel Scan instrument

The aircraft was fitted with a J.P. Instruments Fuel Scan 450 Twin instrument (Figure 5). Without any pilot input, the instrument displayed instantaneous fuel flow for the left and right engines. Pilots could enter start up fuel quantity, tank capacities and any added fuel. The instrument could then display fuel used, fuel remaining and time to empty. Additionally, the instrument could be interfaced with the aircraft's GPS and provide the calculated fuel required to the next GPS waypoint or destination, and fuel reserves at the next waypoint or destination.

The instrument also had low time or low fuel alarm limits, which would trigger the alarm based on the selected time or fuel remaining at the current fuel flow rate.

Figure 5: Fuel Scan instrument

Source: www.jpinstruments.com

The pilot reported monitoring the fuel flow displayed on the instrument, but not inputting any fuel figures, and therefore not using the functionality of constant fuel state indication or low fuel/time warnings.

Recent maintenance

On 5 July 2024, a 100-hourly inspection was completed, during which the aircraft's right engine was replaced with an overhauled engine. A technical log[8] was issued on that day, with the aircraft's total time in service recorded as 21,986.15 hours. The last entry of recorded flight hours in section 2 of the technical log was on 14 July 2024 with 22,027.65 total time in service. There were no defects recorded on the technical log.

The 'Maintenance required' section of the log stated that the engine was to be operated with 'straight'[9] oil until 22,011.15 hours (that is, for the 25-hour break-in period after install). This had subsequently been annotated and extended to 22,021.15 hours by the chief engineer due to ongoing elevated oil consumption. That information was also written on a whiteboard in the Air Taxi Vanuatu operations office.

The chief engineer verbally advised the chief pilot of the break-in requirements for the engine, including the requirement to use straight oil and record all oil added to the right engine. Additionally, the chief engineer reported stating that the right engine was to be run at 75% cruise power for the first hour, then alternating between 65–75% power for the second hour, not excessively lean[10] and to avoid prolonged time at low/idle power settings, for the first 2–3 hours.

The chief pilot reported having misinterpreted this advice and relayed the instruction to the company pilots to operate the right engine with the mixture full rich for the entire break-in period. Furthermore, to avoid having to cross-feed to maintain fuel balance, the chief pilot advised the company pilots that it was at their discretion whether to also operate the left engine mixture fully rich.

The pilot who flew the aircraft the day prior to the accident reported that the extended break-in hours had been completed that day. Further, due to the increased fuel flow while operating with the mixtures fully rich, they had completed the day's flight with only the minimum required fuel reserves remaining, which was unexpected based on their planning. Additionally, when operating the engines with the mixture fully rich, they had observed the digital fuel flow reading up to 98–99 L/h, compared to the normal leaned fuel consumption of 60 L/h.

The chief engineer was not advised that the break-in hours had elapsed. Consequently, they had not signed off the technical log or removed the requirement for straight oil from the whiteboard in the operations office.

However, the chief pilot reported advising the operations manager on the morning of the accident that the break-in period was complete. The operations manager in turn sent a group chat message to the company pilots. However, the pilot reported not receiving the message prior to the accident.

When the pilot identified the low fuel state in flight, they contacted another company pilot in the vicinity via radio, advised them of YJ-AT2's low fuel state, and asked whether the requirement to operate with the mixture full rich was still in place. That company pilot had reportedly not flown YJ-AT2 and advised the occurrence pilot they were unaware of the requirement.

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8 A technical log is a document required to be carried in the aircraft. Its primary purpose is to provide information indicating the aircraft's maintenance status to flight crew.

9 Straight oils are mineral oils blended from high viscosity index base oils, which contain almost no additives and are commonly used during new or overhauled engine running-in.

10 The mixture lever is used to adjust the ratio of the fuel/air mixture to the engine. Leaning is required to create the optimum fuel/air ratio for engine performance.

The engine overhaul organisation's chief engineer reported that they referenced the engine manufacturer's documentation and did not provide any operational documentation to operators or maintainers for overhauled engines. Their only requirement was to use straight oil for the first 50 hours. A review of relevant Lycoming documents – *SI1427C Engine break-in and oil consumption test limits* and *SI1094D Fuel mixture leaning procedure* identified that neither mentioned a requirement to operate the engines fully rich other than in the take-off and climb. Document SI1427C provided guidance to lean in accordance with the pilot's operating handbook when flight testing new or overhauled engines, and SI1094D included advice to lean when above a density altitude of about 5,000 ft as needed 'to obtain smooth engine operation'. Lycoming advised that there was no further published information regarding mixture settings during the engine break-in period.

Mixture control

The Lycoming Operator's Manual for IO-540 series engines stated:

> Improper fuel/air mixture during flight is responsible for many engine problems, particularly during take-off and climb power settings. The procedures described in this manual provided proper fuel/air mixture when leaning Lycoming engines; they have proven to be both economical and practical by eliminating excessive fuel consumption and reducing damaged parts replacement. It is therefore recommended that operators of all Lycoming aircraft power-plants utilize the instructions in this publication any time the fuel/air mixture is adjusted during flight.
>
> Manual leaning may be monitored by exhaust gas temperature indication, fuel flow indication, and by observation of engine speed and/or airspeed. However, whatever instruments are used in leaning the mixture, the following general rules should be observed by the operator of Lycoming aircraft engines.

The manual then prescribed general rules, which included:

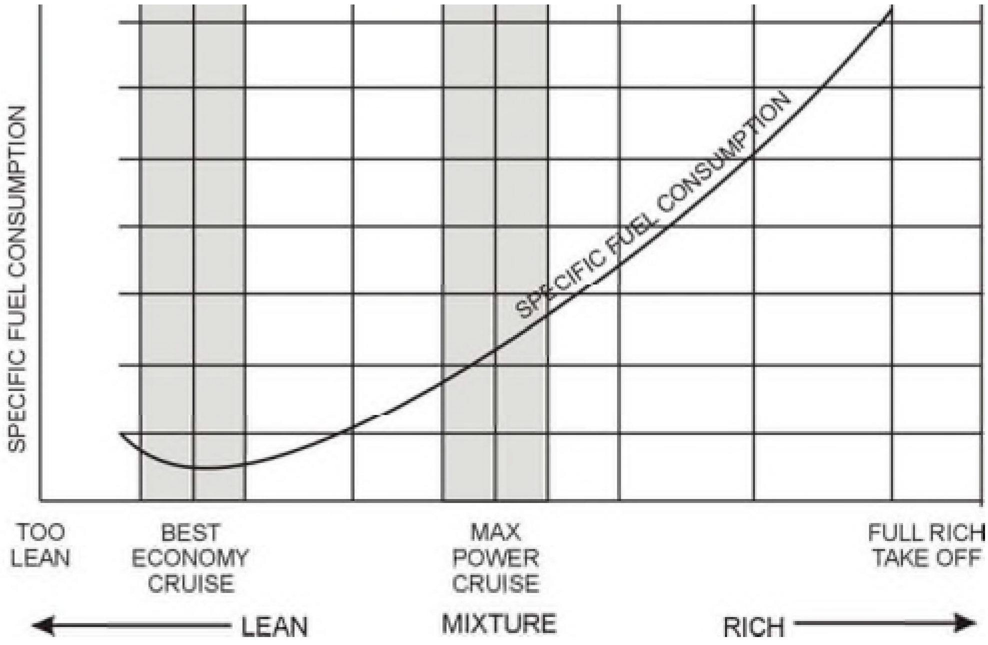
> On engines with manual mixture control, maintain mixture control in "Full Rich" position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from high elevation airport or during climb, roughness or loss of power may result from over-richness. In such a case adjust mixture control only enough to obtain smooth operation – not for economy. Observe instruments for temperature rise. Rough operation due to over-rich fuel/air mixture is most likely to be encountered at altitudes above 5,000 feet.

Regarding leaning to exhaust gas temperature (EGT) gauge, the general rules stated:

> (a) Maximum Power Cruise (approximately 75% power) – Never lean beyond 150°F on rich side of peak EGT unless aircraft operator's manual shows otherwise. Monitor cylinder head temperatures.
>
> (b) Best Economy Cruise (approximately 75% power and below) – Operate at peak EGT.

The manual included a diagram showing the representative effect of leaning on cylinder head temperature, EGT, engine power and specific fuel consumption. Figure 6 is an extract of that diagram, showing a significant increase in fuel consumption from lean to a fully rich mixture.

Figure 6: Extract of Lycoming Operator's Manual Figure 3-1, showing specific fuel consumption with change in power and mixture



Source: Lycoming Operator's Manual

Air Taxi Vanuatu's standard operating procedure for leaning the mixture was consistent across the fleet. The operations manual section titled *Power settings* included the following procedure for leaning:

- Passing 3,000 ft during climb, lean mixture 'to 1/2 scale of the quadrant'.
- In the cruise, lean to peak EGT then enrich by 50 °F.
- During descent, enrich 'to avoid fuel starvation'.

In the section titled *Cruise*, the procedure for leaning stated:

> Once cruise power has been stabilized for five minutes, the fuel mixture should be leaned, using the following procedure:
>
> a) Reduce the fuel flow to peak EGT.
>
> b) Richen [sic] the fuel mixture 50°F.
>
> *NOTE: Alternative leaning procedure*
>
> *1. Slowly move mixture control from "Full Rich" position toward lean position.*
>
> *2. Continue leaning until engine roughness is noted.*
>
> *3. Enrich until engine runs smoothly and power is regained.*

On 24 May 2024, the operations manager issued an operations order titled *Leaning procedures,* which presented the above cruise standard operating procedure for the aircraft fleet. The pilot and chief pilot had signed the operations order acknowledging having read and understood its content.

Meteorological information

Air Taxi Vanuatu pilots could obtain aerodrome forecasts (TAF),[11] area forecasts (ARFOR),[12] and condition reports (METAR),[13] from Vanuatu Meteorological Services and they could also access

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[11] Aerodrome Forecast (TAF): a statement of meteorological conditions expected for a specific period of time in the airspace within a radius of 5 NM of the aerodrome reference point.

[12] Area forecast (ARFOR): routine forecasts for designated areas and amendments when prescribed criteria are satisfied.

[13] METAR: a routine report of meteorological conditions at an aerodrome.

Airservices Australia's National Aeronautical Information Processing System (NAIPS) for weather information and NOTAMS.[14]

A copy of an Airservices Australia Location Briefing prepared for Air Taxi Vanuatu at 0622 on 15 July 2024 was retrieved from the accident site. It contained the following information for Port Vila and locations to the north and north-west:

- TAFs and METARs for Port Vila and Espiritu Santo
- TAFs for Norsup and Longana
- NOTAMs for Port Vila and Espiritu Santo, with no NOTAMs current for Norsup, Longana or Lonorore.

The TAFs for Port Vila and Espiritu Santo were issued at 0400 and valid for 24 hours from 0500. They forecast variable winds of 3 kt, visibility greater than 10 km, scattered[15] cloud at 2,000 ft[16] and broken cloud at 4,000 ft. Between 0500 and 1100, the forecasts included periods of up to 30 minutes of showers of moderate rain, reducing visibility to 8 km with associated scattered cloud at 1,000 ft, broken cloud at 1,800 ft and overcast conditions at 3,800 ft. The Norsup TAF was the same, except the wind speed was 1 kt.

The location briefing did not contain an area forecast, which would have provided additional information, including forecast winds at 2,500 ft, 5,000 ft, 10,000 ft and 18,500 ft above mean sea level.

CAAV operates in accordance with the Civil Aviation Authority of New Zealand (NZ) civil aviation rule set . NZ Civil Aviation Rules (CAR) did not specify a requirement for planning an alternate aerodrome for flights under the visual flight rules (VFR). CAR 91.301 specified that the pilot of an aircraft must not perform a take-off or landing or fly in the vicinity of an aerodrome under VFR when the cloud ceiling and flight visibility for daytime operations, were respectively less than:

- 1,500 ft and 5 km in a control zone
- 600 ft and 1,500 m in uncontrolled airspace.

Additionally, consistent with the above, the Vanuatu Aeronautical Information Publication specified VFR minima at Port Vila aerodrome of 1,500 ft and 5 km.

CAR 91.301 also specified VFR meteorological minima for Class G (non-controlled) airspace (Table 2).

Table 2: Airspace VFR meteorological minima for Class G airspace

Altitude/height	Distance from cloud	Flight visibility
Above 3000 feet AMSL or 1000 feet above terrain whichever is the higher	2 km horizontally 1000 feet vertically	8 km at or above 10 000 feet AMSL 5 km below 10 000 feet AMSL
At or below 3000 feet AMSL or 1000 feet above the terrain whichever is the higher	Clear of cloud and in sight of the surface	5 km

CAR 91.303 Special VFR weather minima stated:

> A pilot-in-command of an aircraft may perform a VFR operation within a

[14] NOTAM: A Notice to Airmen (NOTAM) contains information or instructions essential to flight operations personnel about the establishment, condition or change in any aeronautical facility, service, procedure or hazard.

[15] Cloud cover: in aviation, cloud cover is reported using words that denote the extent of the cover – 'few' indicates that up to a quarter of the sky is covered, 'scattered' indicates that cloud is covering between a quarter and a half of the sky, 'broken' indicates that more than half to almost all the sky is covered, and 'overcast' indicates that all the sky is covered.

[16] All TAF cloud heights are above aerodrome elevation.

control zone in meteorological conditions below those prescribed in 91.301

if—

(1) the ceiling and flight visibility is—

(i) at least 600 feet and at least 1500 m respectively; or

(ii) for helicopters, less than 600 feet and less than 1500 m respectively if the helicopter is operated at a speed that will give adequate opportunity to observe other traffic or any obstructions in order to avoid collisions; and

(2) the aircraft is equipped with two-way radio capable of communicating with ATC on the appropriate frequency; and

(3) the operation is conducted—

(i) in compliance with an ATC clearance and any ATC instructions; and

(ii) only during the day; and

(iii) clear of clouds.

CAR 135.155 Meteorological conditions – VFR flight stated:

(a) A person performing an air operation must ensure that a VFR flight is not commenced unless current meteorological information indicates VFR minima prescribed in Part 91 [Table 2] and in paragraphs (b), (c), (d), and (e) can be complied with along the route, or that part of the route to be flown under VFR.

(b) A pilot-in-command of an aeroplane performing a VFR air operation outside controlled airspace must fly in meteorological conditions

(1) of not less than a ceiling of 1000 feet AGL and a flight visibility of not less than 5 km; and

(2) if the operation is by night, of not less than a ceiling of 3000 feet AGL and a flight visibility of not less than 16 km.

(e) A pilot-in-command of an aircraft may not perform an air operation under VFR above more than scattered cloud unless—

(1) the aircraft is authorised for IFR flight and the required minimum flight crew for IFR operation, holding current instrument rating qualifications, is performing the operation; and

(2) the instruments and equipment, including radio navigation equipment, required for IFR flight are operative; and

(3) the aircraft carries radio navigation equipment to enable it to be navigated by IFR to an aerodrome where an instrument approach procedure may be carried out for landing; and

(4) the aircraft carries sufficient fuel and fuel reserves to proceed by IFR to an aerodrome where an instrument approach procedure may be carried out for landing.

Vanuatu Meteorology and Geo Hazards Department provided meteorological information for the accident investigation. This included the area forecast for 15 July issued at 1005 and valid from 1100 to 2300. The summary forecast weather for the period was for partly cloudy to cloudy conditions with possible showers and light north-easterly winds. For the area south of 15° S latitude (passing through the northern tip of Espiritu Santo, about 343 km north-north-east of Port Vila), the forecast winds (in degrees True) at altitude were:

- at 2,500 ft, from 350° at 25 kt
- at 5,000 ft, from 350° at 20 kt
- at 10,000 ft, from 310° at 30 kt.

The forecast clouds were:

- few to scattered stratus with bases at 1,000 ft and tops at 1,500 ft
- few to scattered cumulus with bases at 1,800 ft and tops at 6,000 ft
- broken to overcast stratocumulus with bases at 3,800 ft and tops at 5,800 ft
- broken altocumulus/altostratus above flight level[17] 110 (11,000 ft).

The METAR at Port Vila airport at 1500 and 1600 recorded wind from 230° at 5 kt and 240° at 6 kt respectively, with scattered cloud at 2,000 ft and a temperature of 29 °C.

Based on the aerodrome forecasts, the aircraft would have been able to operate the planned flight from Port Vila to Tanna, Aneityum and return to Port Vila within the VFR requirements provided they did not operate above the forecast 4,000 ft broken cloud. However, based on the forecast, there was a likelihood the aircraft would have been unable to remain clear of cloud during the climb from sea level at Aneityum to 10,000 ft. Additionally, as the aircraft departed Port Vila at 1225, it was after the forecast 30-minute periods of reduced visibility and ceiling.

Recorded data

Recorded data from an onboard GPS and ADS-B[18] data was obtained for the accident flight. As far as possible the air traffic control communications have been correlated with the recorded data.

Tracking south-south-east between Tanna and Aneityum, the aircraft climbed to about 3,200 ft, briefly recorded a maximum ground speed of about 140 kt then commenced descent to Aneityum. During the descent the maximum ground speed was about 160 kt.

After departing Aneityum, the aircraft climbed to about 10,000 ft overhead Tanna, where its ground speed was about 100 kt. The aircraft then descended to about 7,200 ft and achieved ground speeds of between 100–110 kt.

Figure 7 shows the aircraft's altitude, ground speed and distance to the Port Vila International Airport runway 29 threshold for the last 20 minutes of the flight. Key events depicted by dashed green lines are:

- 1540:15 top of descent (TOD); 25 NM from the runway, the aircraft commenced descent approaching Port Vila. Over the next 4 minutes, the aircraft descended at about 500 fpm, and the ground speed increased to about 135 kt, before the aircraft briefly stopped descending at an altitude of about 5,100 ft.
- 1546: the aircraft was at about 5,000 ft, 110 kt ground speed and 13.5 NM from the runway, when the pilot reported engine problems. This was the approximate time the right engine stopped.
- 1549: the aircraft was at 8 NM, 4,000 ft, this is the approximate time the left engine stopped as no engines were audible in the transmission.
- 1552: MAYDAY broadcast.

Between 1552:23 and the last recorded position at 1553:49, the ADS-B data ground speed trended down, averaging 63 kt. The last recorded position was about 55 m before the aircraft struck the first of 2 coconut trees with the slowest recorded ground speed of 59 kt.

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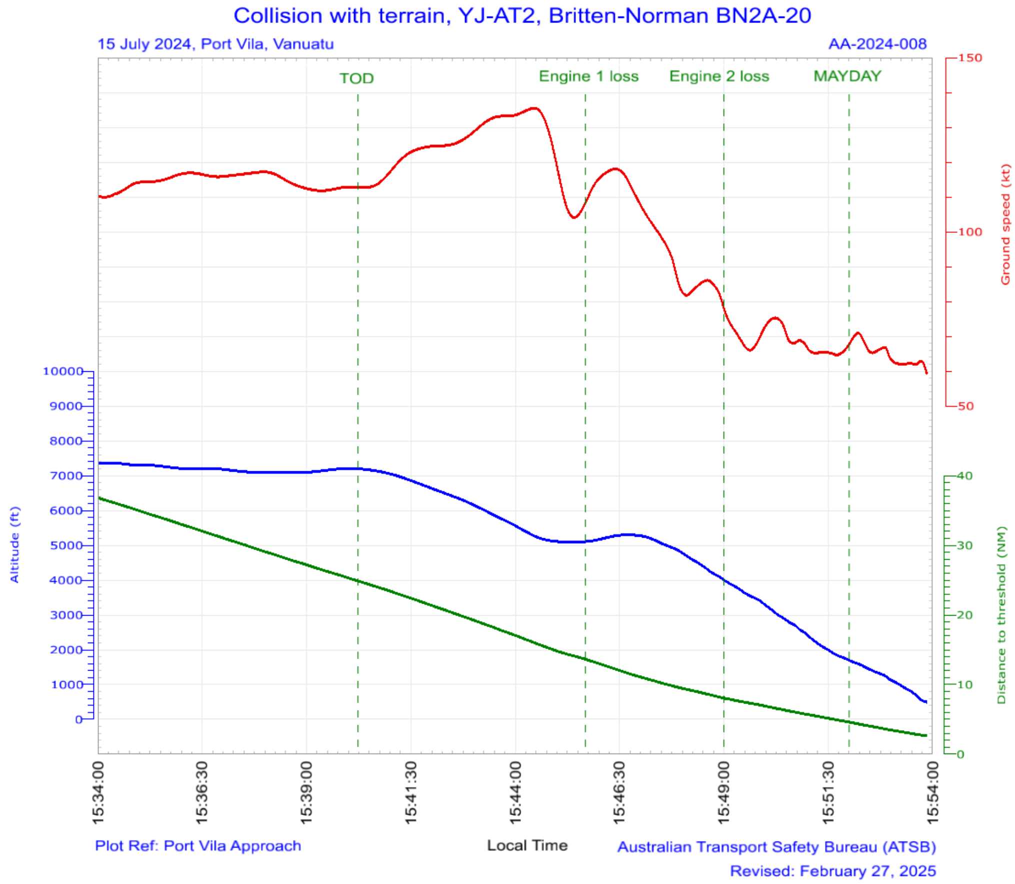
17 A flight level (FL) is an aircraft's altitude determined by a pressure altimeter using the International Standard Atmosphere.

18 Automatic dependent surveillance-broadcast (ADS-B) is a system in which electronic equipment on board an aircraft automatically broadcasts the precise location of the aircraft via a digital data link.(How ADS-B works - Airservices (airservicesaustralia.com))

Figure 7: Recorded data for the accident flight



Source: Recorded GPS and ADS-B data, technical analysis by the ATSB in support of CAAV IIC investigation

Site and wreckage

The accident site was in a coconut and guava plantation about 5 km south-east of the runway 29 threshold. The aircraft's nose was facing north-east, and the wings had rotated clockwise 57° about their fuselage attachment point (Figure 8). Other than a few small fragments, the entire aircraft was contained within a 7.5 m radius.

Figure 8: Accident site showing position of YJ-AT2 and rotation of fuselage about wings

Source: Vanuatu Government image overlaid with Britten-Norman aircraft data, annotated by the ATSB accredited representative to CAAV IIC investigation

The aircraft struck 2 coconut trees, the first at about 6.8 m and the second about 6 m above ground level. The first trunk struck the nose and right side of the fuselage, and the second tree trunk impacted the right wing just inboard of the wingtip. The aircraft contacted the ground nose-first and left wing-down, about 21 m beyond the first tree strike and about 12 m beyond the second.

Those who arrived on site within 30–60 minutes of the accident included Air Taxi Vanuatu staff members. They reported no smell of fuel and no evidence of fuel leaking. The Air Taxi Vanuatu chief engineer reported that when they arrived, the aircraft's avionics and lights were on. They removed the battery, and disconnected and removed the emergency locator transmitter, which had activated.

The chief engineer also visually inspected the right engine and could not identify any obvious signs of pre-impact failure. The staff members reported that witnesses had said that the aircraft engines were not running prior to impact and that they had heard an attempted restart but that the engine/s had 'coughed' and not run. The chief engineer reported that they looked in both main fuel tanks and did not find any visible fuel, and that none appeared when the tanks were dipped through the fuel caps. They also reported that no fuel could be drained from the sump valves.

After the initial attendees to the site left, including first responders and bystanders, site access was secured by the Vanuatu Mobile Force.

The morning after the accident, the operator, accompanied by the CAAV investigator in charge, retrieved flight documents from the site and photographed switch and engine control lever positions. The control levers had broken from their mounts, but remained connected to the engines via cables, and the wings had separated from the fuselage.

The throttle levers were found in the fully forward position. The left pitch lever was fully forward, and the right pitch lever was mid-range. The left mixture was rich, and the right mixture lever was in the cut-off position. However, there was coconut tree debris wedged in the control levers, suggesting contact with a coconut tree. Due to the possible tree contact and disruption of the airframe during the accident sequence, the as-found control positions may not have been reflective of their pre-impact positions.

Australian Transport Safety Bureau (ATSB) investigators arrived at the site on 20 July 2024 to assist with the investigation. The ATSB was unable to drain any fuel from the main or auxiliary tank drain valves and dipping the tanks indicated no fuel on board. However, some fuel was able to be pumped from the tanks. Less than 2 L was pumped from the left main tank and left tip tank and none from the right main tank. About 16 L was able to be pumped from the right auxiliary tank, indicating about 14 L of usable fuel remained in that tank (see the section titled *Fuel tanks*). The fuel was tested and found to be 100 low-lead Avgas.

There was no evidence of pre-existing airframe defects likely to have contributed to the accident. Flight control continuity was established. The left flap was in the up position and the right was slightly extended consistent with impact damage. The propellers were not feathered, and the propeller manufacturer advised that the damage to the blades showed no indications of rotation under power and no apparent evidence of windmilling.

On-site examination of the engines and engine-driven accessories found no evidence of mechanical failure or any pre-existing faults likely to have contributed to the accident. The engines were able to rotate and valve train continuity was established by removing the rocker covers and rotating the propeller blades. There was oil in both engines, and the oil filters were clear of debris.

The fuel lines were intact with no evidence of leaks or pre-impact discontinuity. The fuel filters and air induction system were clear. The spark plugs showed no evidence of fouling from oil or carbon deposits and there were no visible pre-impact defects with the ignition leads. The right engine fuel distributor manifold was empty of fuel and the diaphragm was undamaged. The left engine distributor was inaccessible. Both fuel control unit filters were clear.

The ATSB tested the fuel quantity senders with the assistance of Britten-Norman. There was a small stain on the hardware attaching the right sender to the aircraft, but no evidence of a significant fuel leak. The right sender was slightly outside the nominal resistance range at full and empty, but the resistance varied smoothly with normal movement of the sender arm. By contrast, the resistance of the left sender fluctuated with smooth movement of the sender arm and was outside the nominal resistance range at empty and full. Additionally, when the sender arm was moved to simulate fuel sloshing, the resistance varied significantly.

There were no records of problems with the fuel quantity gauges and the last documented fuel calibration was conducted on 13 January 2020. The chief engineer reported that a fuel calibration had also been conducted when YJ-AT2 was certified on its arrival in Vanuatu in 2023.

Operational information

Engine failure checklist

Figure 9 depicts the Air Taxi Vanuatu Britten-Norman Islander aircraft engine failure checklist from the Operations Manual. Memory items[19] are shown in bold.

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19 Memory items are those which a pilot must commit to memory to perform in an emergency, to bring the emergency under control before referring to the written checklist.

Figure 9: Air Taxi Vanuatu BN2A engine failure checklist

ENGINE FAILURE – CLIMB, CRUISE & DESCENT

1. **Control** ______ **MAINTAIN CONTROL OF THE AIRCRAFT**
2. **Mixture** ______ **FULL RICH**
3. **Propeller** ______ **FULL FORWARD**
4. **Throttle** ______ **FULL FORWARD**
5. **Flaps** ______ **CONFIRM UP**
6. **Failed Engine** ______ **DETERMINE FAILED ENGINE, DEAD LEG**
   ______ **DEAD ENGINE CONFIRM WITH THROTTLE**
7. **Propeller** ______)______ **FEATHER FAILED ENGINE**
8. **Airspeed** ______ **NOT BELOW 65KIAS**
9. Throttle (Live Engine) ______ ADJUST AS REQ FOR PHASE OF FLIGHT
10. Rudder Trim ______ ADJUST AS REQ
11. Generator ______ CHECK OPERATIVE ENGINE GENERATOR ON
12. Throttle ______ CLOSED ON FAILED ENGINE
13. Mixture ______ IDLE CUT-OFF ON FAILED ENGINE
14. Fuel ______ OFF ON FAILED ENGINE
15. Magnetos ______ OFF ON FAILED ENGINE
16. Aux Fuel Pumps ______ OFF ON FAILED ENGINE
17. Generator ______ OFF ON FAILED ENGINE

Source: Air Taxi Vanuatu Operations Manual

A laminated card titled *BN2 Islander quick reference emergency checklist* found at the accident site included the engine failure checklist in Table 3:

Table 3: Engine failure checklist

AIRSPEED	(blue line) 65 KIAS
DIRECTIONAL CONTROL	MAINTAIN
MIXTURES	RICH
PROPELLERS	FINE
POWER	FULL
FLAPS	UP
IDENTIFY	DEAD LEG DEAD ENGINE
CONFIRM	WITH THROTTLE
FIX OR FEATHER	
FUEL	ON
FUEL PUMP	ON, CHECK PRESSURE
MAGNETOS	ON
OIL Ts & Ps	CHECK
NO CHANGE	
PROPELLER (dead engine)	FEATHER
MIXTURE (dead engine)	CLOSE
LAND	as soon as practicable at nearest suitable airport

The was no dual engine failure procedure in either the aircraft flight manual or the operations manual.

Feathering propellers

Feathering the propeller of an inoperative engine stops engine rotation with the propeller blade streamlined with the airplane's relative wind, thereby minimising propeller drag.

The US FAA Airplane Flying Handbook Chapter 13 – *Transition to multiengine airplanes*, stated

> In a typical multiengine airplane, the parasite drag from a single, feathered propeller is a small part the airplane's total drag.
>
> At the smaller blade angles near the flat pitch position, the drag added by the propeller is large. At these small blade angles, the propeller windmilling at high revolutions per minute (rpm) can create enough drag to make the airplane difficult or impossible to control. A propeller windmilling at high speed in the low range of blade angles can produce parasite drag as great as the parasite drag of the entire airframe.

The reduction in drag from a feathered propeller increases the distance an aircraft can travel with one engine inoperative. With 2 engines inoperative, feathering the propellers significantly increases the available glide distance. Consistent with the above FAA advice, the CAAV examiner and another pilot who flew YJ-AT2 reported that without the propeller feathered on an inoperative engine, the aircraft would be unable to maintain altitude due to the significant drag from the windmilling propeller.

The Harbin Y-12 aircraft, in which the pilot had accrued more than 1,000 hours of flight time, was powered by a turbine engine and fitted with auto-feathering propellers. The Y-12 After Takeoff Checklist included 'Auto-feather – OFF' and the Descent checklist included 'Auto-feather – ARM'. As such, provided the auto-feather was armed, in the event of substantial loss of engine power, the propeller would automatically feather to reduce drag.

Abbreviated pre-flight check

Air Taxi Vanuatu's operations manual included a procedure permitting an abbreviated pre-flight check except for the first flight of the day or if the aircraft had been left unattended. The abbreviated pre-flight check was to consist of at least the following:

- An external walk around the aircraft checking for oil leaks & levels, fuel levels, propeller damage, panels and doors shut, and no obvious damage to the aircraft.

Flight and fuel planning procedures

According to Air Taxi Vanuatu's operations manual, the chief pilot was responsible for ensuring the operations manual was up to date and remained relevant to the company's operational requirements.

Air Taxi Vanuatu's operations manual section A3 – Fuel documentation stated:

> Before commencing each flight or flight segment, the pilot in command shall be personally responsible for checking the amount of any fuel dispensed into the aircraft and for verifying, by means of fuel gauges and/or visually (dipstick) that the total fuel on board is sufficient for the intended flight. The pilot in command is to verify the fuel quantity on board is sufficient for the intended flight. The preferred method for the piston engine aircraft is to use the dipstick specially calibrated for that aircraft.

Air Taxi Vanuatu's fuel policy included:

> A flight shall not commence unless the aircraft has sufficient fuel to complete the planned flight, considering weather and other conditions. The captain is to ensure that the flight can be completed safely and that the requirements of the fuel policy are complied with.

Air Taxi Vanuatu's operations manual section *General operating procedures – Fuel planning* included:

> When possible, aircraft should not return to base with more than 90 minutes of fuel. In no circumstance is an aircraft allowed to return with less than 30 minutes fuel.

The Air Taxi Vanuatu's standard operating procedures detailed fuel policy and planning requirements. These included that:

> Company policy is to take maximum fuel permissible for the payload being carried.

The minimum fuel policy required consideration of taxi, flight and reserve fuel. The *Fuel calculation* section of the operations manual stated the planned fuel consumption for YJ-AT2 was 120 L/h for cruise, climb and holding fuel. It also required allowance of 10 L taxi fuel, including for YJ-AT2 (Figure 10). However, in the *Taxi allowance* section of the manual, the taxi fuel for all departures was specified as 10 L for 260 hp engine aircraft and 15 L for 300 hp engine aircraft (YJ-AT2).

Figure 10: Operations Manual – Part B Standard operating procedures 2.5.3 – Fuel calculation

2.5.3 Fuel Calculation

	YJ-AT2	
	LITERS	**KGS**
Fuel Capacity (Useable)	810	584
Cruise Fuel	120/hr.	86/hr.
Taxi All Airports	10	7
Climb	120/hr.	86/hr.
Holding	120/hr.	86/hr.
Inst Approach	10	7

Source: Air Taxi Vanuatu

Flight fuel was to be calculated using the climb/cruise/descent chart in the aircraft flight manual, using Champagne Flight Planning System software, or by first calculating flight time for each sector using the sector distance divided by 120 kt plus 0.1 hour per landing. The resultant flight time was then to be multiplied by 120 L/h to obtain the planned fuel consumption.

Reserve fuel included fixed, alternate, contingency and 'final reserve fuel'. The fixed reserve was to be '35 L – 30 minutes', noting that 30 minutes at the above cruise rate of 120 L/h equated to 60 L. In comparison, Air Taxi Vanuatu's procedures for their single-engine aircraft required 30 L for 30 minutes fixed reserve. An alternate fuel reserve was only required when weather conditions did not meet the required minima. Contingency and final fuel combined was to be 15 minutes at cruise rate (30 L at 120L/h). Final reserve fuel was for manoeuvring in the vicinity of an aerodrome and contingency fuel was provision for:

1) Enroute winds or temperatures being different from the forecast.

2) Any deviation from the flight planned routes, altitudes, or flight levels.

3) Variations from optimum operating techniques.

For flights not requiring an alternate, the minimum reserve fuel was 65 L based on using the documented 35 L for 30 minutes fixed reserve and 30 L contingency/final reserve.

The chief pilot, who had trained and supervised the accident pilot, stated the required reserves were 30 minutes fixed reserve plus 15 minutes contingency reserve, totalling 90 L. This was consistent with the Air Taxi Vanuatu flight logs obtained for YJ-AT2, including from the accident flight, in which company pilots wrote 60 L and 30 L for fixed and contingency reserve fuel, totalling 90 L.

Based on the standard fuel planning procedure, the planned sectors (omitting en route waypoints) based on 120 kt ground speed were:

- Vila – Tanna: 117 NM, estimated elapsed time 59 minutes
- Tanna – Aneityum: 57 NM, estimated elapsed time 29 minutes
- Aneityum – Vila: 174 NM, estimated elapsed time 87 minutes

- Total flight time of 175 minutes.

Adding 6 minutes (0.1 hour) per landing resulted in 193 minutes, therefore total flight fuel required was 386 L. Adding 65 L reserves, total minimum flight fuel increased to 451 L and with 3 landings at 10 or 15 L, an additional 30 or 45 L taxi fuel was required.

Using 30 L of taxi fuel, a minimum of 481 L was required, and the flight could be planned in accordance with the standard operating procedures. However, the higher taxi figure of 45 L required 496 L, which was more than the capacity of the main tanks. Similarly, using 90 L combined reserve fuel, based on 45 minutes at cruise fuel flow, required more fuel than the main tanks' capacity. With the higher planning figures, the flight could not be planned to be conducted without either refuelling en route or using the aircraft's auxiliary tanks.

Flight plans were usually completed by the operations manager and faxed to air traffic control on behalf of the pilots. The operations manager could use the flight planning software or the company route guide to complete the flight plan. Data from the completed flight plan found on site for the accident flight is presented in Table 4.The total estimated elapsed time for the flight plan was 194 minutes.

Table 4: Flight plan for Port Vila – Tanna – Aneityum – Port Vila on 15 July 2024

Point	Flight level/altitude (ft)	Estimated elapsed time (min)
Port Vila	7,500	30
Seahorse (54 NM) (en route)	7,500	12
Erromango (en route)	7,500	22
Tanna (landing/departure)	3,500	31
Aneityum (landing/departure)	4,500	31
Tanna (en route)	7,500	31
Erromango (en route)	6,500	12
Seahorse (en route)	6,500	25
Port Vila (landing)		

The pilot transposed the times into the flight log 'Navigation management' section, amending the estimated elapsed times and altitudes, as depicted in Table 5. The reason for the changes could not be determined, but they resulted in the total estimated elapsed time for the flight log reducing to 180 minutes and an estimated elapsed time for the flight from Aneityum to Port Vila of 89 minutes.

Table 5: Flight log Navigation management section for Port Vila – Tanna – Aneityum – Port Vila on 15 July 2024

Route	Altitude (ft)	Estimated elapsed time (min)
Port Vila – Seahorse	7,500	27
Seahorse – Erromango	7,500	12
Erromango – Tanna	7,500	22
Tanna – Aneityum	5,500	30
Aneityum – Tanna	6,500	30
Tanna – Erromango	6,500	22
Erromango – Seahorse	6,500	12
Seahorse – Port Vila	6,500	25

During the flight, the pilot had entered take-off and landing times in the flight log, which correlated with the recorded flight data (Table 6). The total of these sector flight times was 193 minutes, indicating that the actual elapsed times were closer to the original flight plan than the pilot's revised estimates entered on the flight log. As the accident occurred before the aircraft reached Port Vila, the landing time there was the pilot's estimated arrival time, likely based on the GPS data in flight.

Table 6: Flight log take-off and landing times

Sector	Take-off	Land
Port Vila – Tanna	1229	1323
Tanna – Aneityum	1336	1403
Aneityum – Port Vila	1413	1557

The recovered flight log 'Fuel planning' section (Figure 7) contained the following handwritten entries:

- 180 L was incorrectly entered as the required flight fuel, instead of 180 minutes, which equated to 360 L of flight fuel
- the Total fuel required was entered in the 'Final' row as the pilots used the 'Total' row to record actual fuel on board
- consistent with their normal procedures, the pilot used 60 L for fixed reserves, but placed that in the Contingency row, and placed the 30 L contingency/final (30 L) reserve fuel in the Fixed reserve row
- there was no additional 0.3 hours of fuel allocated for 3 landings and the lower (10 L) taxi figure was used.

The pilot had not made any entries in the 'Fuel management' section of the flight log.

Table 7: Flight log fuel planning entries

Sector	Minutes	Litres
Taxi		30
Flight		180
Fixed reserve		30
Contingency		60
Alternate		
Final	150	300
Total		

The pilot, chief pilot and another company pilot who had also been operating YJ-AT2 during the engine run-in period reported that while running with the mixture/s fully rich, they were adding a notional amount of fuel to cater for the higher fuel flow.

As a basis of comparison with the occurrence pilot's fuel planning, the investigation reviewed the chief pilot's flight log from 6 July 2024, operating YJ-AT2 on the same route as the accident flight with an additional landing at Tanna on the return flight. The estimated elapsed times for each sector are depicted in Table 8 and associated fuel planning entries in Table 9. It could not be determined whether the chief pilot used the flight planning software to create the flight plan.

Table 8: Flight log for Port Vila – Tanna – Aneityum – Tanna – Port Vila on 6 July 2024

Route	Estimated elapsed time (min)
Port Vila – Seahorse	27
Seahorse – Erromango	13
Erromango – Tanna	22
Tanna – Aneityum	30

Aneityum – Tanna	30
Tanna – Erromango	25
Erromango – Seahorse	13
Seahorse – Port Vila	25

Table 9: Flight log fuel planning entries

Sector	Minutes	Litres
Taxi		40
Flight	185	370
Fixed reserve		60
Contingency		30
Alternate		
Final		500
Total		

According to the chief pilot's calculations, the minimum total fuel required for the planned flight was 500 L. As the aircraft's main tanks had a capacity of 490.8 L usable fuel, the minimum fuel required exceeded the main tanks' capacity. However, it was possible that the chief pilot had fuelled the auxiliary tanks and planned to use them on that flight. This was the aircraft's first flight since maintenance, including installation of the overhauled right engine, and no flight log was available for the last flight prior to that to indicate how much fuel remained in the tanks.

The fuel receipt for the morning of 6 July 2024, showed that 292 L of fuel was uplifted to YJ-AT2. Which tank/s were fuelled was not recorded. The refuelling was completed at 0545 local time, just prior to the chief pilot's planned flight. The refuel time was 9 minutes, and refuel times on 15 July, in which the tip tanks were not filled, ranged from 7–9 minutes for 247–364 L of fuel. This indicated it was unlikely that the tip tanks were filled on 6 July.

The chief pilot had used 40 L for taxi fuel – consistent with the lower figure in the standard procedures of 10 L for 4 departures, rather than 15 L per departure, and would have required an additional 0.1 hour of fuel per landing unless flight planning software was used to generate the flight plan. There was no record of additional fuel for operating with the mixture fully rich.

Effect of wind

The direct track from Port Vila to Aneityum is 174 NM, which approximated the distance covered in each direction on the accident flight. Planning at 120 kt true airspeed and nil wind, the return trip would have a flight time of 174 minutes, excluding allowance for climb.

Based on the forecast winds of 350°/20 kt at 5,000 ft and 310°/30 kt at 10,000 ft, using the average of these for a flight at 7,500 ft, results in a wind from 330° at 25 kt:

- for the outbound track of 152°, ground speed would be 145 kt and covering 174 NM would take 72 minutes
- for the return track of 332°, ground speed would be 95 kt and take 110 minutes
- total flight time would be 182 minutes – 8 minutes longer than in nil wind.

From the take-off and landing times documented by the pilot in the flight log, the flight from Aneityum to Port Vila would have taken 104 minutes had it reached the destination. This indicates that the aircraft experienced a 20 kt headwind, and the flight was 5 minutes longer than the pilot's estimated elapsed time in the flight log.

Fuel uplift

Based on fuel records for 15 July 2024 for YJ-AT2:

- 249 L was uploaded from 0630–0640
- 320 L was uploaded from 0927–0935
- 364 L was uploaded from 1203–1212.

The pilot and refueller reported that the left and right main tanks were filled at each refuelling.

Weight and balance

The investigation obtained weight and balance documents for the flights from Port Vila to Tanna and Port Vila to Sara, which were required to be completed by the pilot under Air Taxi Vanuatu's standard operating procedures. The reference maximum take-off weight printed on the document and used in the calculations was 2,994 kg, not the 2,980 kg stated in the aircraft flight manual and Air Taxi Vanuatu operations manual applicable to YJ-AT2. The weight and balance documents reported zero fuel in the auxiliary tanks and, as the pilot had not intended to use those tanks, they were not fuelled or dipped to establish the actual quantity.

The weight and balance calculation for the earlier flight from Port Vila to Sara stated 200 L usable fuel in each main tank and a take-off weight of 2,960 kg. However, the pilot and refueller reported that the main tanks were filled before that flight, in which case the aircraft would have departed with an additional 90 L (65 kg) of fuel on board and therefore was 31 kg above the maximum take-off weight of 2,994 kg stated on the document, and 45 kg above the maximum take-off weight of 2,980 kg for YJ-AT2.

The weight and balance assessment for the flight from Port Vila to Tanna included the pilot and 6 passengers, and 245 L fuel in the left and right main tanks. The take-off weight was calculated at 2,943 kg and the aircraft was within the centre of gravity envelope from maximum take-off to zero fuel weights. Based on the document, the aircraft would have been within the weight and balance limits throughout the flight to Tanna.

No document was found detailing weight and balance calculations for the return flight from Aneityum to Port Vila. However, company pilots had an application that they could use when away from the company base to complete weight and balance calculations and allocate seating according to the centre of gravity limits. Using the aircraft's basic empty weight of 2,007 kg, with no usable fuel on board, and the pilot and 4 passengers, the aircraft's approximate weight at the time of the accident was about 2,500 kg and was within balance limits.

Operator information

Air Taxi Vanuatu

Air Taxi Vanuatu held an air operator's certificate issued 15 November 2023 and valid for 1 year. Under the certificate, Air Taxi Vanuatu was permitted to conduct commercial air transport non-regular operations under visual flight rules. At the time of the accident, Air Taxi Vanuatu had 3 Britten-Norman Islander aircraft.

Key personnel at Air Taxi Vanuatu at the time of the accident were the:

- chief executive officer (CEO), who had been in that role since 2018, and was in the process of handing over to a new CEO
- maintenance controller (MC), who was also a company shareholder and in the process of handing over the MC role to the chief engineer
- chief engineer
- operations/office manager, whose role included monitoring pilot licencing and medicals, loading aircraft, and completing and submitting flight plans on behalf of the pilots
- director, who was also a line pilot, and an instructor and examiner for single-engine aeroplanes
- chief pilot
- safety manager.

Operational tempo

On 9 May 2024, Vanuatu's national carrier, Air Vanuatu, went into liquidation cancelling all domestic and international flights. At that time, there were 3 operators conducting non-regular air transport operations out of Port Vila, of which Air Taxi Vanuatu was the largest. The need for air transport between Vanuatu's 83 islands spanning nearly 1,000 km placed significant increased demand on Air Taxi Vanuatu's operations.

Flight statistics for Air Taxi Vanuatu from February–July 2024 showed a 100% increase in flights from April to May, when Air Vanuatu was grounded (Table 10). After the grounding, Air Taxi Vanuatu contracted 2 Air Vanuatu pilots and operated more aircraft, to increase the number of flights they could conduct. Air Taxi Vanuatu temporarily ceased operating following the accident on 15 July.

Table 10: Air Taxi Vanuatu flight statistics February–July 2024

Month	Total flights
February	152
March	172
April	224
May	450
June	391
1–15 July	204

All the Air Taxi Vanuatu key personnel reported that the increased demand for services in the wake of Air Vanuatu ceasing operation put pressure on both the engineering and flight operations. While this hazard was recognised, and reportedly some attempt was made reduce the number of flight bookings, it led to personnel being overworked and pilots exceeding flight and duty limits.

Flight and duty times

Air Taxi Vanuatu's operations manual stated that:

> The Company and its pilots share responsibility to ensure that flight and duty limitations as specified by CAAV for the Company's operations are not exceeded without specific CAAV approval.

Air Taxi Vanuatu maintained a record of flight and duty times and had an approved scheme for monitoring flight and duty limits. In recording duty time, company pilots were to allow 45 minutes prior to taxiing for the first flight of the day and 15 minutes after landing for the last flight of the day.

With some exceptions, the basic flight time limits were:

- 8 hours of flying in one duty period
- 35 hours in 7 consecutive days
- 100 hours in 28 consecutive days
- 300 hours in 90 consecutive days.

The basic duty time limits were:

- 11 hours in one duty period
- 200 hours in any consecutive 30-day period.

Depending on the length of the flight and duty period, a rest period of 10–12 hours was generally required, and pilots were required to have no less than 24 consecutive hours free of duty every 7 consecutive days.

Additionally, pilots conducting commercial transport operations were required to:

- not fly more than 100 hours in any 28 consecutive days for VFR operations

- have at least 2 days free in any 14-day period
- have not less than 2 consecutive days free in any 30-day period.

The pilot's flight and duty records from 1 April 2024 to 11 July 2024 included 12 exceedances of duty time limitations and 2 of flight time limitations. These consisted of:

- 7 duty periods exceeding 11 hours
- 5 exceedances of the 200 duty hours in the last 30 days requirement
- 2 exceedances of the 100 flight hours in the last 28 days requirement.

There were no flight and duty exceedances associated with the conduct of the accident flight.

Flight crew rostering

The chief pilot reported that Air Taxi Vanuatu pilots frequently exceeded their hours and flight and duty time exceedances had been raised twice at safety meetings with the pilots and safety manager. A safety meeting on 29 April 2024 included a record of discussing new safety issues which included 'Flight & Duty time'. A safety meeting on 11 July 2024 (4 days before the accident), included further discussion of 'new safety issues' including:

> 2. Flight and Duty
>
> - Looking into getting a new software
> - PIC responsible for their flight and duty
> - Bookings should be slowed down
> - Plan to roster pilots and not exceed flight and duty time… [chief pilot] to draw up roster starting Monday
> - Pilots have a say in scheduling their flights if they are not feeling up to it.

The safety manager reported that when they presented the CEO with the plan to commence a pilot roster, they were advised to delay implementation until a new chief pilot commenced, which was anticipated in the coming weeks. The plan was to schedule a pilot's work hours each day, such as, from 0700–1400, so that flights could only be booked for that pilot for that period, rather than operating until they ran out of flight/duty time or daylight. The CEO reportedly told the chief pilot that exceeding the limits was 'unacceptable', reminded the pilots that it was their responsibility to manage their flight and duty times, and had asked the operations manager to check the pilots' recorded times monthly.

Key hazards

The NZ CAR 119.124 required an air operator to 'establish, implement, and maintain a system for safety management in accordance with rule 100.3' – *System for safety management*. Air Taxi Vanuatu's safety management manual (SMM) first draft was effective on 1 July 2019. Following multiple iterations, including a full manual review in line with approval of the safety management system by CAAV completed in August 2023, version 6 dated March 2024 was accepted by CAAV on 18 July 2024. The manual stated that:

> The organisation will identify all significant influences that may impact aviation safety and/or Health & Safety, when determining contributing factors for the analysis of consequences of a hazard and deciding on risk mitigation measures.

The safety manager assessed that the key operational hazard since the grounding of Air Vanuatu, was that Air Taxi Vanuatu wanted to meet the demands of the travelling public. The safety manager described the effect of the demand as pilots were overworked and fatigued. In response, a newsletter was issued, which advised pilots to request a medical certificate if they were too fatigued to fly, and the bookings manager was asked to reduce the bookings. In the weeks leading up to the accident, flights were being cancelled daily because of pilots' limited flight and duty hours.

The Air Taxi Vanuatu director assessed that poor airstrip condition was the biggest risk to flight operations, due to inadequate maintenance and frequent heavy rainfall. The CEO also described the weather and airstrip conditions as the biggest challenges. The director also named as key hazards:

- a lack of (personnel) resources
- pilot inexperience
- high turnover of pilots, particularly post COVID (~2022).

The director reported that pilots would often only stay with the company for 2–3 months until they had accumulated sufficient twin-engine flight hours to be recruited by airlines.

In relation to this accident, the Air Taxi Vanuatu hazard register included the hazard of 'uplift of incorrect fuel type or quantity', leading to 'in-flight fuel starvation in a single-engined aircraft', with an 'acceptable' risk rating, without mitigation. It had not identified the risks of fuel starvation or exhaustion in twin-engine aircraft, which the director assessed were mitigated by following standard operating procedures. Other related hazards that had been identified included:

- Peak seasonal workload, resulting in:
  - pilots breaching duty time limits leading to fatigue
  - scheduling of flights with insufficient time between them for flight planning, refuelling, loading, etc.
- Single pilot operations, resulting in work overload leading to pilot errors
- Fatigue/time pressure, resulting in the risk of controlled flight into terrain or mid-air collision.

These were all assessed initially as unacceptable risks, but adequately mitigated with either or both of the following defences:

- rostered days off for pilots and closer monitoring of pilot hours
- flight rostering with 45 minutes between flights.

Previous accidents

This was Air Taxi Vanuatu's sixth accident, 5 of which had occurred in the previous 6 years, and the first that resulted in a fatality. The following were Air Taxi Vanuatu's previous reported accidents:

- 31 January 2024, BN2B-26 YJ-AL3 Sola runway overrun with the pilot, one trainee pilot, and 6 passengers on board. The aircraft was found to have been overweight. There were no reported injuries, and the aircraft sustained substantial damage.
- 29 September 2023, Cessna 206 YJ-ASH engine stoppage and ditching. There were 2 pilots on board – one in-command-under-supervision (ICUS) – and 3 passengers, with no reported injuries. The aircraft was not recovered, and the cause of the engine stoppage could not be determined.
- 3 January 2023, Cessna 207 YJ-TAN Emae Island runway overrun, with the pilot and 5 passengers on board. The runway was wet with pooled water. The pilot aborted the take-off, and the aircraft aquaplaned and overran the runway. The aircraft was substantially damaged, with no reported injuries.
- 23 October 2018, Cessna U206G YJ-AL5 engine failure en route from Port Vila to Tanna. The pilot conducted a forced landed at Erromango; one passenger sustained a fractured foot, the pilot and 3 other passengers were uninjured, and the aircraft was substantially damaged. An ATSB accredited representative arranged an engine examination, which found the crankshaft had fractured.
- 1 August 2011, a Cessna 207 landed on a golf course in bad weather. One passenger sustained serious injuries, and the aircraft was substantially damaged.

In addition, there were 3 reported serious incidents:

- 30 May 2020, Cessna 207 YJ-TAN engine failure en route from Pentecost to Port Vila; successfully glided to an unused airstrip, no damage or injuries.
- 1 June 2019, BN2 YJ-AL2 engine failure en route to Port Vila. Landed successfully with one engine inoperative.
- 23 December 2020, a Cessna 172 overran the runway at Sara. The aircraft was undamaged, with no reported injuries.

Safety action taken following these previous occurrences, included the following:

- All pilots were given a personal locator beacon following the ditching involving YJ-ASH, as the aircraft's emergency locator transmitter had not activated upon impact with the water.
- Training was provided for actions in the event of a ditching.
- The CAAV investigation into the ditching included a finding that there was no passenger manifest, and, although there was no requirement for one in the NZ CARs under which CAAV operated, Air Taxi Vanuatu subsequently implemented a procedure for a manifest to be completed before departure for every flight. This included when picking up 'stranded passengers', in addition to those booked for a charter flight.
- After the runway overrun in January 2024, the chief pilot implemented a minimum 50 hours' experience operating BN2 aircraft on sealed runways before pilots could progress to unsealed ones.
- A proposal to increase ICUS time, which had not been implemented at the time of the accident.
- The safety manager developed a PowerPoint presentation on safety management system awareness, which highlighted the importance of a positive safety culture in preventing accidents. The training was presented to Air Taxi Vanuatu staff, but was poorly attended.

Safety recommendations included in Air Taxi Vanuatu's internal investigation report following this accident involving YJ-AT2, included that all communications between engineering and operations were to be in writing, and that flight crew recruitment and training was to be improved.

Survivability

Passenger preparedness

The 4 passengers had flown in the aircraft 3 days prior to the accident. One passenger was interviewed by the investigation team after the accident. The passenger reported that the pilot had ensured everyone had their seatbelts fastened and doors were secure prior to take-off from Aneityum. The passenger also reported that the pilot appeared calm and reassured passengers when the first engine stopped. When the second engine stopped, the pilot told the passengers to keep their heads down and brace for impact.

Rescue response

Children from a nearby school were first to arrive at the accident site. Ambulance and paramedic services arrived about 10 minutes later, followed by the police. Firefighting crews arrived at the site at 1630 and confirmed there was no fire. The pilot had exited through the pilot door and the 2 rearmost passengers had exited through the rear door, which had opened on impact. The pilot and one passenger were taken to hospital by ambulance. The rearmost passenger was reported to have had minor injuries and left the scene.

The first and second row passengers were trapped in the aircraft and had to be cut from the wreckage. The chief engineer arrived at the site at about 1630 and found the aircraft lights and avionics fans on. They removed the battery to secure the electrics before the passengers were extricated. The passengers were then taken to hospital by ambulance. The first-row passenger died in hospital later that night, and the second-row passenger remained in hospital for 3 days.

Impact forces

The last recorded ground speed was 59 kt with the aircraft tracking 12° True, 55 m before the aircraft struck the first tree. The wind at the airport at the time was from 250° T at 7 kt. Therefore, if the aircraft was experiencing the same wind, its airspeed would have been 55 kt. As the pilot had not extended flap, the stalling speed at the probable aircraft weight would have been about 48 kt.

As the aircraft had not stalled, it was likely that the aircraft's initial impact with coconut trees probably occurred at about 50–60 kt. That impact rapidly decelerated the aircraft and increased its angle of impact with the ground. The aircraft impacted the ground nose first, left wing down, at an impact angle of about 30°, based on the distance between where the aircraft struck the second tree at 6 m and where it impacted the ground. Based on an estimated impact speed of less than 60 kt and impact angle of about 30°, in a slightly nose-down attitude, the ground impact severity was within the expected survivable envelope for deceleration injuries (NTSB, 1985).

Seats and restraints

The seats and seat belts were examined onsite. There were 2 separate pilot seats at the front, mounted on a common seat frame and fitted with 4-point harnesses. The pilot seats had been removed from their base, likely on the day of the accident to aid in removal of an injured passenger. The base frame had rotated forwards 90° and was upright on the right side of the open fuselage. The pilot seat belts had been cut.

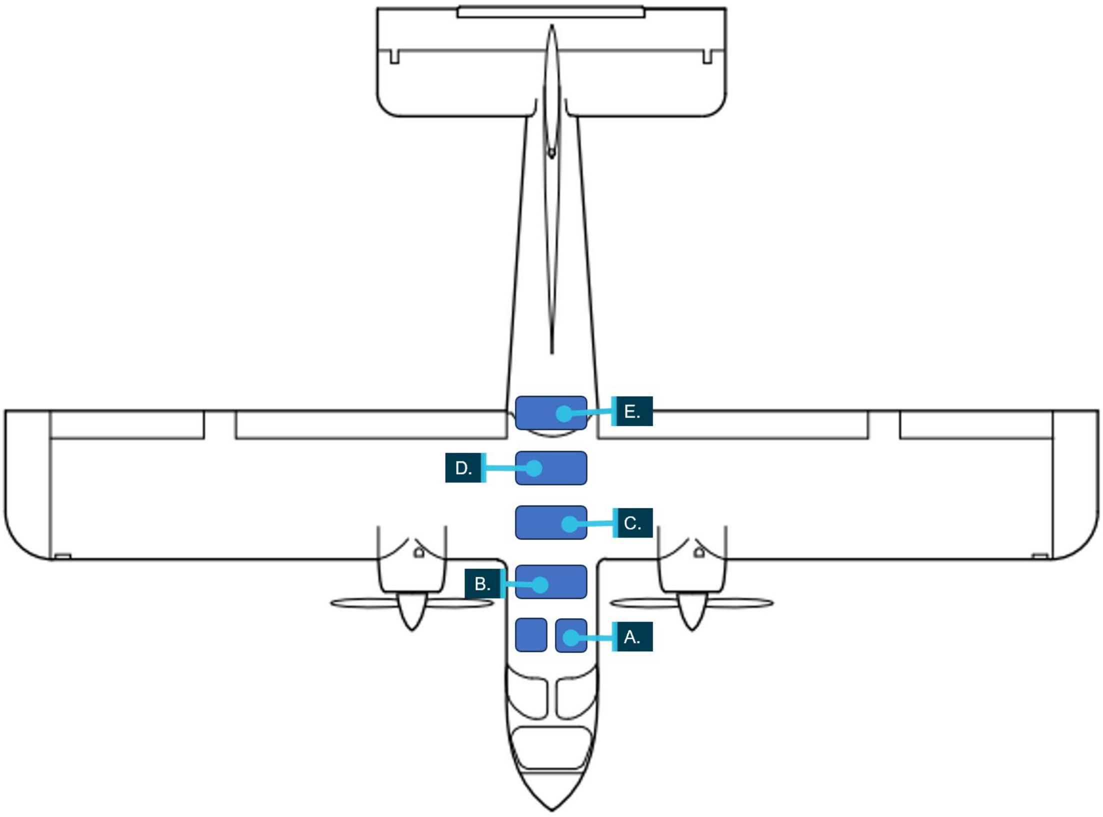
The 4 passenger seat rows had bench seats fitted with lap belts. The seats' frames were of a welded tubular construction and sustained the following damage.

- The first-row seat had collapsed forwards with the back rest also bent forward with crushing to the left rear back of the frame. The seat frame had evidence of failure in the frame welds and of being cut by first responders. The seat belt had been cut.
- The second-row seat had collapsed forwards. The seat base was angled downwards toward the floor. The forward seat structure and seat belt had been cut by first responders.
- The third-row seat base was angled down greatly at the seat front, likely due to impact forces.
- The fourth row was the least damaged with only slight buckling of the seat frame.

Injuries and seating positions

The pilot wore a 4-point restraint and the 4 passengers each wore a lap belt, with seating positions depicted in Figure 11 and injury information detailed in Table 11. Injury information was obtained from interviews, witnesses and CAAV, however, no medical records were provided to the investigation to detail or confirm the injuries. The injury mechanisms included deceleration, flail and impact with the aircraft.

Figure 11: Seating positions



The seating positions in the image are referenced in Table 6: Injuries sustained.
Source: Britten-Norman, annotated by the ATSB accredited representative to the CAAV IIC

Table 11: Injuries sustained

Image reference	Injuries	Injury classification	Survivability comments
A. (Pilot)	Bruising, hand laceration	Minor	4-point restraint; seat broke off floor; likely impact with control column and dash; self-extricated
B.	Compound fracture of right tibia and fibula, internal injuries, possible spinal injury	Fatal	Lap belt restraint ineffective; passenger found in front seat, unable to self-extricate
C.	Broken ankle, laceration to head, hospitalised multiple days	Serious	Lap belt only; trapped in aircraft
D.	Broken ankle, laceration and fractures of right hand, brain haemorrhage	Serious	Lap belt only; self-extricated
E.	Unknown	Minor	Lap belt only; self-extricated; did not receive medical attention

The aircraft struck one coconut tree on the right side of the nose and cockpit then into the wing root, destroying the majority of the right side of the fuselage forward of the wing. The tree entering the cabin, and its destruction of the airframe, exposed the first-row passenger to injury. The passenger's leg injury may have been due to contact with the exposed airframe or the fractured pilot's seat. The passenger was found in the front with the pilot, still wearing their restraint, which was anchored to their seat, but the seat was broken. The pilot's 4-point restraint probably reduced their risk of injuries compared with the passengers wearing only a lap belt. The destruction of the airframe, floor and roof resulted in the first and second-row passengers being trapped in the aircraft. The second-row passenger sustained leg injuries, consistent with failure of the seat, and head injuries from being wedged under the collapsed roof.

While there was less crushing to the rear part of the cabin, the opening of the side of the fuselage and the direction of forces on the seat exposed the third-row passenger to injury, who sustained ankle and hand fractures and a brain haemorrhage that was identified several weeks after the accident.

Restraint requirements

Rule 91.207 of the NZ CAR specified occupation of seats and wearing of restraints for passengers. It required (with some exceptions):

> *(a) A pilot-in-command of an aircraft must require* each passenger to occupy a seat or berth and to fasten their safety belt, restraining belt or, if equipped, shoulder harness or single diagonal shoulder belt—
>
> (1) during each take-off and landing; and
>
> (2) when the aircraft is flying at a height of less than 1000 feet above the surface; and
>
> (3) at other times when the pilot-in-command considers it necessary for their safety; and
>
> (4) during aerobatic flight; and
>
> (5) at all times in an open cockpit aircraft.

Rule 135.355 of the NZ CAR required that for a holder of an air operator's certificate each flight crew member seat be fitted with a shoulder harness or single diagonal shoulder belt.

Availability of upper torso restraints

Britten-Norman advised that upper torso restraints (UTR) for passenger seats have been fitted as standard on all Britten-Norman Islander 2B aircraft since 1991. They also have a factory modification to retrofit UTRs to aircraft that undergo a factory refurbishment. However, that modification was tailored for the factory installation and has not been converted to a service bulletin type format for third party installation. Further, to date there has been no demand for such a modification.

Research into the benefits of upper torso restraints

Research has shown that seat belts in small aircraft that include a UTR significantly reduce the risk of injury compared to lap belts only. UTRs minimise the flailing of the upper body and reduce the risk of impacts with surrounding structures involving the head and upper body. A safety study by the United States (US) National Transportation Safety Board (NTSB) in 1985 examined 535 accidents involving small aircraft in 1982. It estimated that 20% of the 800 fatally injured occupants would have had only serious injuries or minor injuries if they had been wearing a UTR. In addition, 88% of 229 seriously injured occupants would probably have had less severe head or upper body injuries, only minor injuries or no injuries if they had been wearing a UTR.

A 2011 safety study by the NTSB examined the rate of serious and fatal injuries of pilots in single-engine aeroplanes during the period 1983–2008. It found that pilots wearing only a lap belt had a 49% greater likelihood of a serious or fatal injury compared with pilots wearing a lap belt and a UTR. Another study, which examined take-off and landing accidents involving an engine power loss during 1983–1992, found that pilots wearing only a lap belt were 70% more likely to be fatally injured than pilots wearing a seat belt and a UTR (Rostykus and others, 1998).

Previous recommendations

An accident involving a Pilatus Britten-Norman BN2B-26 Islander that occurred in 2005 in the United Kingdom was investigated by the Air Accidents Investigation Branch (AAIB). The aircraft was engaged in an air ambulance task with a pilot and paramedic on board. Both the pilot and paramedic passenger were fatally injured, but survived the initial impact. The AAIB investigation report released in 2006 identified that the aircraft was fitted with UTRs; however, the lap straps were not compatible with the shoulder harness attachment points. Therefore, there was no shoulder harness available to the paramedic passenger, nor was there a requirement to have one fitted by the operator at the time. The AAIB concluded that the paramedic was probably rendered unconscious in the impact when their head hit the pilot's seat due to the lack of a UTR. The paramedic subsequently drowned.

As a result of that accident, the AAIB recommended that the European Aviation Safety Agency consider a regulation to mandate the fitment of UTRs on all seats of aeroplanes below 5,700 kg operated for commercial air transport. The requirement was implemented but only applicable to aircraft with a certificate of airworthiness issued on or after 8 April 2015.

As detailed in the ATSB report into a collision with terrain following an engine power loss in a Cessna 172M on 10 January 2017 (AO-2017-005), similar recommendations have been made by investigation agencies to regulators in the US, Canada and Australia. The US Federal Aviation Administration, Transport Canada and Australia's Civil Aviation Safety Authority mandated all small aeroplanes manufactured after 12 December 1986 be fitted with a UTR at each seat. However, retrofit of UTRs for earlier aircraft was not mandated, with the regulators citing cost and a lack of suitable engineering solutions for some aircraft types.

Similar occurrences

The ATSB's Avoidable Accidents publication *Starved and exhausted: Fuel management aviation accidents* (AR-2011-112) detailed 2 main reasons why fuel stops getting to an engine during flight:

- Fuel exhaustion occurs when there is no usable fuel remaining to supply the engine(s).
- Fuel starvation occurs when the fuel supply to the engine(s) is interrupted, although there is adequate fuel on board.

The report stated that the ATSB received an average of 21 reports of fuel exhaustion or starvation occurrences each year. Fuel exhaustion occurrences were normally either the result of an error in pre-flight fuelling, or a number of seemingly minor aspects of fuel planning and management during the flight. Consideration of different fuel consumption rates depending on the activity being conducted and flight conditions is a key component of fuel planning.

The chance of fuel exhaustion is significantly reduced if a pilot accurately determines the amount of fuel on board prior to starting, by cross-checking from multiple sources. These include fuel quantity gauges, dipsticks, totalisers/flow meters and calculations from previous refuels and fuel usage regularly checked for accuracy.

The reported also described factors affecting how much fuel is being consumed:

> Many variables can influence the fuel flow, such as changed power settings, the use of non-standard fuel leaning techniques, or flying at different cruise levels to those planned. If they are not considered and appropriately managed then the pilot's awareness of the remaining usable fuel may be diminished.

The ATSB occurrence database held 54 fuel exhaustion occurrences for the 10-year period 2011–2020. For 14 of the 54 occurrences, the total flight time of at least one pilot was recorded. The median total flight time of a pilot involved in a fuel exhaustion occurrence was 1,227 hours with a range of 20 to 14,500 hours. This suggests that experience is not a mitigation against fuel exhaustion occurrences.

Safety analysis

Introduction

On 15 July 2024, the pilot of Britten-Norman Islander BN2A-20, YJ-AT2, arranged for the aircraft's main fuel tanks to be filled, before transporting 6 passengers from Port Vila to Tanna. The pilot then continued to Aneityum (Mystery Island), where they picked up 4 passengers for a planned flight to Port Vila.

During that flight, the pilot identified less fuel remaining and higher fuel flow than planned and elected to continue towards Port Vila. About 24 km from Port Vila, the right engine surged and then stopped, followed shortly by the left engine. The aircraft descended and collided with coconut trees, before it impacted the ground and was destroyed. One passenger was fatally injured, 2 passengers sustained serious injuries, and the pilot and one passenger sustained minor injuries.

Examination of the aircraft found no pre-existing defects likely to have contributed to the accident. After the accident, about 14 L of usable fuel was drained from the right auxiliary tank, and no usable fuel remained in the left auxiliary tank or either main tank.

This analysis will discuss the pilot's fuel-related planning, management and decision-making, actions leading to the accident, and training. Additionally, it will examine Air Taxi Vanuatu's:

- processes and procedures for fuel planning and fuel management
- communications
- management of flight and duty times.

The analysis will also examine survivability factors.

Fuel planning

The flight plan found at the accident site for the return flight from Port Vila to Aneityum via Tanna, included elapsed times between sectors based on 120 kt speed and nil wind, and appears to have included a time to climb allowance for each landing/departure. The pilot had transposed the estimated elapsed times for each sector from the flight plan into the navigation management section of the flight log, and amended some of the times. Those changes reduced the total planned flight time from 194 to 180 minutes. It could not be determined why the pilot amended the times and whether the pilot had accessed an area forecast.

Based on the forecast winds, at the planned cruise altitudes a tailwind of about 25 kt tracking south and a headwind of similar speed tracking north was expected. This was not reflected in the pilot's planned elapsed times, which estimated the flight south taking 2 minutes longer than the return to Port Vila.

Having experienced a 20 kt tailwind southbound to Aneityum, the pilot could have expected a similar strength headwind on the return journey. That was reflected in the expected elapsed time from Aneityum to Port Vila recorded in the take-off and landing times section of the flight log, which was 104 minutes, 5 minutes longer than planned. That estimated time was likely obtained from the aircraft's GPS when en route to Port Vila. A review of the area forecast would also have identified that the winds were stronger at 10,000 ft than the planned cruise altitude of 6,500 ft.

When not using flight planning software, Air Taxi Vanuatu's standard operating procedures required an additional 6 minutes per landing to be added to the calculated flight time. The minimum fuel required was then calculated using 120 L per hour of that increased flight time. The pilot's planned flight time of 180 minutes required 360 L flight fuel. Assuming the pilot did not use flight planning software for the amended flight time, an additional 18 minutes of fuel (36 L) was required for 3 landings, totalling 396 L of flight fuel. However, the pilot entered a total of 180 L of flight fuel in the flight log.

The standard operating procedures also required reserve fuel, which included 15 minutes at cruise fuel flow rate (30 L) of contingency/final reserve fuel, and fixed reserve of 30 minutes, which was also stated as '35 L'. However, there was no documented procedure for how or when pilots would reduce fuel flow from the cruise rate of 120 L/h to 70 L/h to achieve the 30 minutes' endurance with 35 L of fuel. Instead, company pilots were using total reserve fuel of 90 L for 45 minutes at cruise fuel flow rate. According to the documented procedure though, the minimum required total reserve fuel was 65 L.

Taxi fuel was also required. In one table of the procedures, taxi fuel was 10 L per departure for the fleet, and was elsewhere specified as 15 L per departure for YJ-AT2. Therefore, an additional 30 L or 45 L of taxi fuel was required for 3 take-offs, for which the pilot entered 30 L on the flight log. The total minimum fuel required was therefore 491 L. As there was 490.8 L usable fuel with the main tanks full, rounding up to 491 L usable fuel, and using 10 L taxi fuel per take-off and 65 L reserve, there was just enough fuel available to plan the return flight. However, the pilot had entered a total fuel required of 300 L in the flight log.

Significantly, the cruise fuel flow of 120 L/h was based on leaning of the air-fuel mixture. However, the pilot operated the aircraft with both mixtures fully rich, which increased the fuel flow from 60 L/h to at least 80 L/h per engine. At that increased fuel flow rate, a 180-minute flight (480 L) with 3 intermediate stops required at least 510 L of fuel, which exceeded the main tanks' capacity, without the required additional 6 minutes of fuel per landing, or any reserve fuel. Therefore, planning to operate the flight with the mixtures fully rich would have required a plan to refuel and/or fill and use the auxiliary tanks.

Air Taxi Vanuatu had fuel available at Tanna. However, after arriving at Tanna, the pilot did not dip the fuel tanks to check the remaining fuel quantity, which was the preferred method for doing so. Had the pilot identified then that there was insufficient fuel remaining for the return flight from Aneityum to Port Vila, they could have refuelled while in Tanna. The pilot also did not dip the fuel tanks prior to departing Aneityum, but reported that the fuel gauges indicated there was 160 L of fuel in each tank.

The pilot had entered take-off and landing times in the flight log, which were consistent with the recorded flight data. The log times showed 54 minutes between take-off at Port Vila and landing at Tanna, then 27 minutes between take-off at Tanna and landing at Aneityum. Flight fuel for 81 minutes of flight time at 80 L/h per engine was 213 L, and taxiing twice at 10 L per taxi, meant the total fuel used on arrival at Aneityum was about 234 L, or 117 L per tank. Therefore about 128 L remained in each tank, or 256 L total, at Aneityum.

Testing of the fuel gauge senders found the left sender could potentially have led the fuel quantity gauge to misread at empty and full, but that would not have been the case at Aneityum. Additionally, there had been no reports of the gauges indicating incorrectly. The reason for the discrepancy between the likely fuel remaining and the pilot's interpretation of the fuel gauges at Aneityum could not be determined. However, had the pilot been using the available functionality of the Fuel Scan instrument, accurate fuel state could have been displayed to the pilot throughout the flight, including early low fuel warnings.

The pilot's estimated elapsed time from Aneityum to Port Vila recorded on the flight log was 89 minutes, only 2 minutes longer than the nil wind sector time. At a fuel flow of 60 L/h per engine, this required 178 L flight fuel plus 10 L for taxiing and 12 L (6 minutes) for 1 landing, totalling 200 L plus at least 65 L reserve fuel. Therefore, with 256 L of usable fuel in the main tanks, and nil wind, there would have been insufficient fuel to plan to return to Port Vila and land with reserves intact.

At 80 L/h per engine, 236 L flight fuel was required, and the aircraft may have just had enough fuel to land at Port Vila prior to fuel starvation. However, taking in to account the effect of the wind encountered on the outbound leg, about a 20 kt headwind was to be expected on the return to Port Vila. In that case there was insufficient fuel for the aircraft to reach its destination. Had the pilot identified this prior to departing Aneityum, the aircraft had adequate fuel to return to Tanna and refuel.

The 15 minutes (30 L) of contingency reserve fuel was to allow for un-forecast winds, amended operating altitudes and 'variations from optimum operating techniques'. While this reserve would have been sufficient to allow for the (forecast) wind, operating the flight with both mixtures full rich increased the nominal flight fuel by at least 120 L, and the contingency reserve alone was insufficient to offset the increased fuel consumption.

As the pilot had not dipped the tanks to verify the quantity of fuel on board, the aircraft departed Aneityum with insufficient fuel on board to reach Port Vila, operating with the mixtures fully rich, the forecast wind and intended operating altitude. Although there was no fuel available at Aneityum, the aircraft overflew Tanna, 104 km away, where fuel was available.

Contributing factor

The pilot did not ensure there was sufficient fuel on board for the planned flight from Aneityum to Port Vila.

In-flight fuel management

The pilot identified that there was less fuel remaining and higher fuel flow than expected when abeam Erromango, 137 km over water from Port Vila. Unaware that the overhauled right engine's run-in period had ended the previous day, the pilot radioed another company pilot and asked whether the requirement to operate the mixture fully rich was still in place. The other pilot had not flown YJ-AT2 and was unaware of the requirement. Despite the identified fuel deficit, the pilot continued to operate the engine mixtures fully rich.

The pilot also elected to continue towards Port Vila rather than land at an airstrip on Erromango, where the pilot had landed previously but there was no company fuel available, or turn back to Tanna, 70 km south, and refuel. Additionally, although the pilot cross-fed twice to keep the left and right main tank quantities even, they did not attempt to transfer fuel from the auxiliary tanks, unaware an earlier issue with the right transfer pump had been rectified and that the right auxiliary tank contained usable fuel. Unlike for the main tanks, there were no fuel quantity gauges for the auxiliary tanks.

Fuel calculations conducted by the investigation identified that, from abeam Erromango, had the pilot maintained altitude at cruise power and leaned to achieve a fuel flow of 60 L/h per engine, there would probably have been sufficient fuel to reach Port Vila.

However, as the pilot continued operating both mixtures full rich, the engines stopped due to exhaustion of fuel in the main tanks less than 6 km from the runway.

Contributing factor

When the pilot identified that there was less fuel on board and higher fuel flow than planned, they elected to continue to Port Vila rather than divert to other suitable aerodromes. Having committed to continue, the pilot then did not lean the mixtures or attempt to transfer fuel from auxiliary tanks (unaware the right auxiliary tank contained usable fuel) to increase endurance. As a result, the engines stopped due to fuel starvation, with usable fuel remaining in one auxiliary tank.

Not feathering propellers or maintaining optimal speed

The pilot commenced descent to the runway from their normal approach point about 46 km from Port Vila, at a descent rate of about 500 ft per minute, and with ground speeds up to about 135 kt. Aware of the very low fuel state at that stage, a more conservative approach would have been to maintain altitude and lean the engine mixture to peak exhaust gas temperature and reduce power to about 75%, in accordance with the published best fuel economy settings.

The aircraft had levelled off when the right engine stopped just over 5 minutes later. The pilot did not feather the propeller to reduce drag, and over the next 2.5 minutes, the aircraft descended 1,800 ft as the ground speed reduced gradually to the optimal one engine airspeed of 65 kt. This delay in attaining the optimal airspeed ultimately reduced the glide range and options available when the left engine stopped, following which the pilot also did not feather the left propeller to reduce drag.

Effective flight management with one engine inoperative relies on the pilot conserving altitude where possible, maintaining the nominated airspeed for optimal performance on one engine, and appropriately configuring the aircraft.

The pilot reported aiming to land in a school field, but abandoned the approach on seeing children in the field. However, flight path data indicated that the aircraft was probably too high to have landed there safely, and subsequently overflew another cleared area while continuing to track directly for the threshold of runway 29.

Although feathering the propellers would have increased the glide distance, it could not be determined whether the aircraft would have made the runway had the pilot feathered the propellers when each engine failed. However, feathering the propellers would have allowed the pilot more forced landing options as there were several cleared areas that would have been within gliding distance when the second engine stopped.

Contributing factor

The pilot did not feather the propellers when the engines stopped and did not maintain optimal airspeed in the time between the first and second engines stopping. These actions reduced the pilot's options and resulted in a forced landing into a coconut plantation.

No landing flap

The pilot's recollection of not extending the flaps was consistent with the wreckage having flaps in the fully retracted position. The pilot reported targeting 65 kt airspeed to prevent a stall. The aircraft flight manual stated that 65 kt was the target initial approach speed with one engine inoperative and the flaps selected to the take-off position. When committed to landing, flaps should be selected to the fully down position and speed reduced accordingly.

The pilot's last transmission to air traffic control, during which the pilot also called for the passengers to brace, occurred in the seconds immediately prior to impact. During that transmission, the stall warning was audible twice. At the aircraft's probable weight, the stall speed with flaps retracted was about 48 kt, although this may have been increased due to the unfeathered propellers. As the stall warning sounded at 5–10 kt above the stall, the aircraft was probably flying at about 53–58 kt airspeed just prior to the collision. This was consistent with the last recorded ground speed of 59 kt about 55 m prior to impact with the first tree, average ground speed in the last 39 seconds of about 62 kt, and a tailwind component of about 4 kt.

Had the pilot extended the flaps, the final approach could have been conducted about 10 kt slower while maintaining the same airspeed margin above the stall. As impact force is proportional to the square of velocity, a higher speed significantly increases impact forces. As such, the tailwind component also likely increased the impact forces.

The initial tree impact destroyed the front right side of the airframe, exposing the occupants, and making the first-row passenger more vulnerable to injury. The specific effect of the higher forward speed on the ground impact severity was not possible to assess as the contact with the trees resulted in a more vertical impact with the ground.

Additionally, approaching with full flap results in a lower nose attitude than no flap. A lower nose attitude would potentially have provided the pilot more visibility of the trees ahead, but may also have led to a lower nose attitude on impact.

Substantial research has shown that higher velocity and higher impact angle increase the injury risk. The higher velocity resulting from the tailwind and flapless approach significantly increased injury risk, while the associated slightly higher nose attitude may have slightly reduced injury risk but also reduced forward visibility. However, it could not be determined whether the severity of the passengers' injuries in this accident were increased by the impact velocity.

Other factor that increased risk

The forced landing was conducted with a tailwind and the pilot did not extend flaps to allow a slower airspeed immediately prior to the collision to reduce impact forces, which increased the injury risk.

Training and knowledge

The investigation considered whether the pilot's actions and inactions for fuel planning and in-flight management and handling of the occurrence were a result of a training and knowledge deficiency. The pilot had accumulated over 4,600 hours total flying time, mainly while conducting commercial air transport operations, including about 2,000 hours in the Britten-Norman Islander aircraft type. Those operations required 1 to 2 flight checks per year, one of which required demonstration of emergency procedures including managing a simulated engine failure.

Although an entry in the pilot's logbook in July 2015 appears to have been an incomplete instrument rating renewal, the pilot subsequently passed several check flights. The most recent of those occurred about 8 months prior to the accident, and included a simulated engine failure, and demonstration of fuel planning with consideration of forecast winds.

The chief pilot and CAAV examiner reported that the pilot had demonstrated in their most recent flight training and checks that they had the ability to perform flight and fuel planning and in-flight fuel management, in accordance with the standard operating procedures. However, the pilot's fuel management on the accident flight was not consistent with company procedures for ensuring that the flight could be completed safely.

The occurrence pilot, together with other company pilots, had also used standard fuel consumption based on leaning the mixture, not allowing for significantly increased fuel flow while operating with the mixture/s full rich. This was despite the pilots having digital fuel flow information presented to them in flight. That practice did not ensure adequate fuel was on board for the flights in YJ-AT2 during the engine run-in period.

While this may have indicated a deficiency in understanding the effect of mixture on fuel flow, the pilot's radio transmission to check whether the requirement to operate full rich was still in place, indicated that the pilot understood the mixture setting was the cause of the increased fuel consumption. However, the pilot did not then apply that knowledge and lean the mixtures.

As the pilot had completed about as many flight hours in the Harbin Y-12 as Britten-Norman Islander type aircraft, it was possible that the pilot expected the propeller to auto-feather as a result of power loss. However, it would only do so when armed, and there was no such action for the Britten-Norman Islander aircraft. Additionally, the pilot had not operated Harbin aircraft for 10 years prior to the accident and feathering the propeller was a mandatory memory item in the Britten-Norman Islander engine failure checklist, required to be demonstrated in a check flight.

During the pilot's recent check flights, the only requirement was for the pilot to touch the pitch lever before the examiner simulated a feathered propeller using zero thrust. Due to the brief time the propeller was windmilling during the simulation, the pilot may have been unaware of the significant increase in drag it created. Additionally, as the pilot reported having not feathered the propeller previously, this may have been an insufficiently rehearsed action to perform in the event of an engine stoppage.

The pilot's logbook had been endorsed multiple times by instructors and examiners, but no one had identified the significant error in the pilot's summed total aeronautical experience. Although it was possible the pilot had not been trained in completing the logbook accurately, there were many correct entries before and after the erroneous ones. Additionally, the pilot's error in entering flight time as fuel required in the inflight log had occurred previously and not been identified.

On the accident flight, the pilot did not apply their previously-demonstrated knowledge to lean the mixture and manage the aircraft's fuel state. Nor did they respond to the subsequent emergency in accordance with the aircraft flight manual procedures.

In that context, as the pilot had undergone numerous training and check flights without issue, there would likely be a safety benefit in Air Taxi Vanuatu reviewing their pilot training to ensure fundamental knowledge and skills are adequately developed. A similar review of the examination and checking processes used by CAAV would probably be beneficial. Furthermore, it is essential that pilots can use all available means to manage the aircraft's fuel state. In this case, a working knowledge of the functions of the Fuel Scan instrument would have provided the pilot with accurate in-flight fuel state and an early low fuel warning.

Informal communication

Consistent with service instructions from the engine manufacturer, the chief engineer recalled verbally advising the chief pilot not to run the engine overly lean during the run-in period. The pilots were also instructed to use 'straight' oil for the first 25 hours, which was subsequently extended a further 10 hours. That oil requirement was written on the aircraft's technical log and on the whiteboard in the Air Taxi Vanuatu office at Port Vila airport.

However, the chief pilot misunderstood the chief engineer's instructions about not leaning the mixture excessively, and verbally advised the pilots to operate the right engine mixture full rich for the duration of the engine run-in period. Additionally, the chief pilot agreed that company pilots could operate with both engine mixtures full rich to avoid having to cross-feed fuel to maintain fuel balance.

The chief engineer's verbal communication to the chief pilot did not ensure a common understanding of the engine operating requirements for the run-in period. This differed from when the chief engineer identified in May 2024 that pilots were using an incorrect technique for leaning the mixture, and issued an operations order that the pilots were required to read and sign, to show they understood the correct procedure. Additionally, a formal order from the chief pilot to amend fuel planning figures to operate with the mixture full rich, would have been an opportunity to clarify the chief engineer's instructions, and identify the misunderstanding regarding the duration of that requirement.

Contributing factor

The chief pilot misunderstood the chief engineer's verbal instructions regarding engine run-in requirements as a need to operate the engine with the mixture at full rich for at least 25 hours. The chief pilot then conveyed this to other company pilots without providing amended fuel flow figures for pilots' use in flight planning.

Flight and duty exceedances

Following the grounding of Vanuatu's national carrier in May 2024, Air Taxi Vanuatu experienced a significant demand for charter services. As such, the operational tempo was high, and the number of flights conducted had doubled in the few months leading up to the accident. This resulted in pilots, including the occurrence pilot, being overworked and exceeding flight and duty times.

Although the number of flights conducted by Air Taxi Vanuatu had increased significantly in the 2 months leading up to the accident, there was evidence that Air Taxi Vanuatu was already not adequately managing flight and duty times prior to that.

As the pilot had 3 days off prior to the accident to recover from a minor motor vehicle accident and reported feeling fit and ready to operate that morning, they probably had adequate rest prior to the flight. The pilot had been on duty from 0530–1553 (10 hours 23 minutes) and was within the 11-hour duty period when the accident occurred. The pilot had flown 7 hours and 33 minutes of the allowable 8 hours at the time of the accident. Although approaching the flight and duty time limits, the pilot had not exceeded them at the time of the accident.

However, the pilot had exceeded flight and duty time limits several times in the weeks leading up to the accident, and the chief pilot also reported having exceeded these limits. Both reported sleeping throughout the day on their occasional days off, consistent with accumulated fatigue. Furthermore, the pilot reported the long duty times and limited rest between them had affected their cognitive function. However, in the context of this accident, they did recognise that there was less fuel remaining/higher fuel flow than expected during the return flight to Port Vila when resolution options existed.

The company pilots and safety manager, having raised excessive duty as a safety issue at 2 safety meetings (including 4 days prior to the accident), had proposed a flight crew work hours roster and reduce bookings. However, at the time of the accident, these had not been implemented. Senior management had advised that no changes would be made until a replacement chief pilot commenced work, scheduled for the coming weeks, and in the interim pilots were reminded of their responsibility to manage their flight and duty times and fatigue.

Other factor that increased risk

High operational tempo in the months leading up to the accident, and the absence of flight crew workload management, increased the risk of fatigue affecting pilot performance. (Safety issue)

Passenger restraints

The passenger seats in YJ-AT2 had lap belts only, and the 2 pilot seats were fitted with 4-point restraints – a lap belt and 2 upper torso straps. The pilot and passengers were wearing the fitted restraints at the time of the accident. The accident impact forces were likely within expected survivable tolerances, and the lack of upper torso restraints (UTRs) for the passenger seats increased the risk of injuries due to flailing of the head, neck and upper body. The tree impact also damaged the fuselage, exposing the passenger seated in the first row on the right side of the aircraft to greater injury risk.

The pilot sustained minor injuries while several passengers were more seriously injured. This was likely a result of the pilot being more effectively restrained. However, due to the lack of detailed information available about the passengers' injuries, it could not be determined whether UTRs would have reduced the severity of the passengers' injuries in this accident.

Despite that, substantial research shows that wearing UTRs significantly reduces the risk of injuries compared to wearing only a lap belt. However, consistent with international regulators, CAAV's regulations, based on the New Zealand Civil Aviation Regulations, did not require passenger seats to be fitted with UTRs in older, small aeroplanes, nor was there a commercially available option for YJ-AT2.

Other factor that increased risk

The passenger seats were fitted with lap belts only and no upper torso restraints, increasing the risk of injury during a ground collision.

Findings

The investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to fuel starvation and collision with terrain involving Britten-Norman Islander, YJ-AT2, 6 km east-south-east of Port Vila International Airport, Vanuatu, on 15 July 2024.

Contributing factors

- The pilot did not ensure there was sufficient fuel on board for the planned flight from Aneityum to Port Vila.
- When the pilot identified that there was less fuel on board and higher fuel flow than planned, they elected to continue to Port Vila rather than divert to other suitable aerodromes. Having committed to continue, the pilot then did not lean the mixtures or attempt to transfer fuel from auxiliary tanks (unaware the right auxiliary tank contained usable fuel) to increase endurance. As a result, the engines stopped due to fuel starvation, with usable fuel remaining in one auxiliary tank.
- The pilot did not feather the propellers when the engines stopped and did not maintain optimal airspeed in the time between the first and second engines stopping. Thes actions reduced the pilot's options and resulted in a forced landing into a coconut plantation.
- The chief pilot misunderstood the chief engineer's verbal instructions regarding engine run-in requirements as a need to operate the engine with the mixture at full rich for at least 25 hours. The chief pilot then conveyed this to other company pilots without providing amended fuel flow figures for pilots' use in flight planning.

Other factors that increased risk

- **High operational tempo in the months leading up to the accident, and the absence of flight crew workload management, increased the risk of fatigue affecting pilot performance.** (Safety issue)
- The forced landing was conducted with a tailwind and the pilot did not extend flaps to allow a slower airspeed immediately prior to the collision to reduce impact forces, which increased the injury risk.
- The passenger seats were fitted with lap belts only and no upper torso restraints, increasing the risk of injury during a ground collision.

Safety issues and actions

Central to the CAAV's investigation of transport safety matters is the early identification of safety issues. The CAAV expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation industry, the CAAV may issue a formal safety recommendation or safety advisory notice as part of the final report.

All the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out or are planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions will be provided separately on the CAAV website on release of the final investigation report, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the CAAV website after the release of the final report as further information about safety action comes to hand.

Safety issue description

High operational tempo in the months leading up to the accident, and the absence of flight crew workload management, increased the risk of fatigue affecting pilot performance.

Issue number:	136272-AIG-A25-SI-01
Issue owner:	Air Taxi Vanuatu
Transport function:	Aviation: Air transport
Current issue status:	Open – Safety action pending
Issue status justification:	The CAAV acknowledges that inclusion of operational tempo and fatigue management risks in Air Taxi Vanuatu's SMS with appropriate mitigations including better tracking and monitoring of flight and duty times should prevent a similar occurrence. The issue remains open pending documented evidence that the SMS has been updated, and the monitoring of flight and duty times has been implemented.

Proactive safety action taken by Air Taxi Vanuatu

Action number:	136272-AIG-A25-PSA-01
Action organisation:	Air Taxi Vanuatu
Action status:	Open – Safety action pending

Air Taxi Vanuatu's future risk assessments will place greater emphasis on operational tempo and fatigue management. Any significant risks identified will be addressed and corrective actions implemented promptly. These risk assessments will be conducted using the Safety Management System.

Additionally, to address the risks of increased workload and inadequate fatigue management, more robust flight and duty tracking software has been implemented to better monitor pilot schedules and identify when flight and duty limits are at risk of being exceeded. Furthermore, the chief pilot will closely monitor all rosters, and any excessive flight or duty bookings will be adjusted or cancelled to ensure all pilots remain within regulated limits.

Safety action not associated with an identified safety issue

Additional safety action taken by Air Taxi Vanuatu

- The chief engineer issued an operations order requiring all memos, instructions, orders and operational communication between managers, chief engineer, safety, engineering, air operations, chief pilot, bookings, and between chief pilot and crew to be issued as an operations order. All operations orders are to be read and signed by all relevant parties prior to the commencement of the affected operations.
- The fuel planning policy within the standard operating procedures has been reviewed and revised to improve clarity and address any discrepancies or inconsistencies.
- A new, simplified flight log has been developed to help pilots record flight times more accurately and quickly identify slower legs caused by headwinds. Training has also been implemented on how to properly complete the new flight log to ensure standardization among pilots. This will improve the review process by making it easier to identify issues and ensure all required information is consistently documented and understood.
- A structured recruitment process had been documented, which includes the following steps:
    1. Define Clear Job Requirements and Competency Standards
    2. Structured Interview Process
    3. Background and Reference Checks
    4. Psychometric and Aptitude Testing
    5. Safety Culture Fit
    6. Comprehensive Onboarding and Training
    7. Probation and Monitoring.

Further safety action proposed by Air Taxi Vanuatu

- All future pilots will receive comprehensive training on all aircraft equipment to ensure they are fully equipped with the necessary tools and knowledge. Additionally, if new equipment is installed in an aircraft, all current pilots will be trained in its use.
- Pilots will receive updated training and regular reviews on fuel planning procedures to ensure compliance with the procedures and to reinforce the requirement that all flights conclude with fuel reserves intact.
- All new aircraft introduced to the fleet will be assessed to determine whether differences training is required. This assessment will consider factors such as aircraft type, model, avionics, configuration, instrument layout, switch and control placement, and any other variations that could lead to confusion, hesitation, or accidental inputs. This approach aims to reduce the risk associated with unfamiliarity between aircraft within the fleet.
- Fuel consumption will be reviewed by comparing the remaining fuel at the end of each flight against the planned quantity. This process aims to ensure pilots maintain awareness of expected fuel usage and to identify any inconsistencies or excessive consumption—whether due to pilot error or mechanical issues—so that these can be addressed promptly.

Additional safety action taken by CAAV

The CAAV examiner has amended their examination and check flight protocols to include:

- observing pilots completing a flight plan including consideration of the forecast weather
- amending flight and fuel planning in flight
- ensuring pilots understand the importance of, and actions to, feather a propeller following an engine failure.

Additionally, CAAV:

- will require pilots to submit a copy of their logbook records as part of a licence renewal application for verification and record keeping, and require the aircraft operator to certify a pilot’s logbook as correct
- mandated that chief pilots are to be allocated at least 40% of their time to non-flying duties.

General details

Occurrence details

Date and time:	15 July 2024 – 1553 Vanuatu Time (UTC+11)	
Occurrence class:	Accident	
Occurrence categories:	Fuel starvation and collision with terrain	
Location:	6 km east-south-east of Port Vila International Airport, Vanuatu	
	Latitude: 17.7343° S	Longitude: 168.3608° E

Aircraft details

Manufacturer and model:	Britten-Norman Islander, BN2A-20	
Registration:	YJ-AT2	
Operator:	Air Taxi Vanuatu	
Serial number:	188	
Type of operation:	Part 135 Air transport operations – smaller aeroplanes	
Activity:	Commercial air transport – non-scheduled passenger transport charters	
Departure:	Aneityum, Vanuatu	
Destination:	Port Vila International Airport, Vanuatu	
Persons on board:	Crew – 1	Passengers – 4
Injuries:	Crew – 1 (minor)	Passengers – 4 (1 fatal, 2 serious, 1 minor)
Aircraft damage:	Destroyed	

Glossary

ADS-B	Automatic dependent surveillance-broadcast
AAIB	Air Accidents Investigation Branch
ARFFS	Aviation Rescue and Fire Fighting Services
ATC	Air traffic control
ATSB	Australian Transport Safety Bureau
CAAV	Civil Aviation Authority of Vanuatu
CAR	Civil Aviation Regulations
CEO	Chief executive officer
EGT	Exhaust gas temperature
FAA	Federal Aviation Administration
FL	Flight level
hp	Horsepower
IAS	Indicated airspeed
ICAO	International Civil Aviation Organization
ICUS	In command under supervision
MC	Maintenance controller
METAR	A routine report of meteorological conditions at an aerodrome.
NOTAM	A Notice to Airmen (NOTAM) contains information or instructions essential to flight operations personnel about the establishment, condition or change in any aeronautical facility, service, procedure or hazard.
NTSB	National Transportation Safety Board
NZ	New Zealand
SOD	Start of descent
SMM	Safety management manual
SMS	Safety management system. A systematic approach to organisational safety encompassing safety policy and objectives, risk management, safety assurance, safety promotion, third party interfaces, internal investigation and SMS implementation.
TAF	Aerodrome forecast: a statement of meteorological conditions expected for a specific period of time in the airspace within a radius of 5 NM of the aerodrome reference point.
TOC	Top of climb
TOD	Top of descent
UK	United Kingdom
US	United States
UTR	Upper torso restraint

VFR	Visual flight rules

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot of the accident flight and other pilots who conducted flights for the operator
- Air Taxi Vanuatu
- the (former) chief pilot of Air Taxi Vanuatu
- the chief engineer of Air Taxi Vanuatu
- the Civil Aviation Authority of Vanuatu
- Britten-Norman
- Port Vila Air Traffic Services
- accident witnesses
- ADS-B data
- recorded data from the GPS unit on the aircraft
- Lycoming
- Hartzell
- United Kingdom (UK) Air Accidents Investigation Branch
- New Zealand (NZ) Civil Aviation Authority.

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Submissions

In accordance with ICAO Annex 13, CAAV may provide a draft report, on a confidential basis, to any person it considers appropriate. That allows a person receiving a draft report to make significant and substantiated comments to CAAV about the draft report, but the person must take measures to ensure that it is not disclosed to the public.

A draft of this report was provided to the following directly involved parties:

- the pilot
- the (former) chief pilot of Air Taxi Vanuatu
- Air Taxi Vanuatu
- the chief engineer of Air Taxi Vanuatu
- the safety manager of Air Taxi Vanuatu
- Britten-Norman
- Lycoming
- Hartzell
- UK Air Accidents Investigation Branch
- United States National Transportation Safety Board
- New Zealand Transport Accident Investigation Commission.

Submissions were received from:

- Air Taxi Vanuatu
- the chief engineer of Air Taxi Vanuatu
- the safety manager of Air Taxi Vanuatu
- Hartzell
- New Zealand Transport Accident Investigation Commission.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.