ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 24-1003

30 July 2025

OPERATOR	:	North Coast Aviation Limited
REGISTRATION	:	P2-SAM
MANUFACTURER	:	Pilatus Britten-Norman
MODEL	:	BN2B-26 Islander
CLASS/CATEGORY	:	Controlled flight into terrain
LOCATION	:	32 nm Northeast of Nadzab Airport, Morobe Province
OCCURRENCE DATE	:	22 December 2024

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DEFINITIONS AND INTERPRETATION

Accident	An occurrence associated with the operation of an aircraft resulting in fatal or serious injury, or substantial damage.
Accredited representative	A person designated by a State, on the basis of his or her qualifications, for the purpose of participating in an investigation conducted by another State. The accredited representative would normally be from the State's accident investigation authority.
Adviser	A person appointed by a State, on the basis of his or her qualifications, for the purpose of assisting its accredited representative in an investigation.
Causes	Actions, omissions, events, conditions, or a combination thereof, which led to the accident or incident. The identification of causes does not imply the assignment of fault or the determination of administrative, civil or criminal liability.
Contributing Factor	An action, omission, or condition that increased the likelihood or severity of the accident.
Investigation	A process conducted for the purpose of accident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and/or contributing factors and, when appropriate, the making of safety recommendations.
Investigator-in-charge	A person charged, on the basis of his or her qualifications, with the responsibility for the organization, conduct and control of an investigation.
Safety Recommendation	A proposal of an accident investigation authority based on information derived from an investigation, made with the intention of preventing accidents or incidents and which in no case has the purpose of creating a presumption of blame or liability for an accident or incident.
State of Design	The State having jurisdiction over the organization responsible for the type design.
State of Manufacture	The State having jurisdiction over the organization responsible for the final assembly of the aircraft, engine or propeller.
State of Occurrence	The State in the territory of which an accident or incident occurs.
State of Registry	The State on whose register the aircraft is entered.

ACRONYMS

AGL	Above Ground Level
AIC	Accident Investigation Commission (PNG)
AAIB	Air Accidents Investigation Branch
amsl	Above Mean Sea Level
AOC	Air Operator Certificate
ATC	Air Traffic Control
ATS	Air Traffic Service
CASA PNG	Civil Aviation Safety Authority of Papua New Guinea
CAR	Civil Aviation Rules
CPL	Commercial Pilot License
COM	Company Operation Manual
CSN	Cycles Since New
CVR	Cockpit Voice Recorder
Deg	degrees
FDR	Flight Data Recorder
Ft	feet
Hrs	hours
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IIC	Investigator in Charge
Kg	Kilogram(s)
Km	Kilometer(s)
Kts	knots (nm/hours)
Min	minute
MOC	Maintenance Organisation Certificate
MTOW	Maximum Take-off Weight
NCA	North Coast Aviation
NSPL	NuiSky Pacific Limited
NTSB	National Transportation Safety Board
Nm	Nautical mile(s)
PIC	Pilot in Command
Sec	seconds
S/N	Serial Number
TSN	Time Since New
TTIS	Total Time in Service
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

INTRODUCTION

Investigation AIC 24-1003

At 12:14 (02:14 UTC) on 22 December 2024, NiuSky Pacific Limited (NSPL) notified the Accident Investigation Commission (AIC) via phone of an unreported position report at a designated location of a BN2B–26 aircraft, registered P2-SAM, owned and operated by North Coast Aviation (NCA) Limited. The AIC monitored the developing situation in coordination with the NCAL and NSPL. At 1:53, after being informed by NSPL that the unresponsive aircraft had not arrived at Nadzab Airport and was stationary on the Operators third party fleet track monitoring system, the AIC immediately commenced an investigation into the occurrence pursuant to *Section 247 of the PNG Civil Aviation Act 2000.*

The AIC classified the occurrence as an accident and categorized it as a missing aircraft event. The accident was re-categorized to an Impact accident when the wreckage site was discovered the next morning. In accordance with *ICAO Annex 13, Chapter 4, paragraph 4.1,* the AIC promptly notified relevant foreign authorities of the State of:

- Airframe Manufacture/Design: United Kingdom (AAIB)
- Engine Manufacture/Design: United States of America (NTSB)

This investigation was conducted, and other States participation was permitted in line with the AIC's Investigation Policy and Procedures Manual, which is fully aligned with *ICAO Annex 13, Chapter 5, paragraph 5.18.*

This Final Report was prepared by the AIC, P.O. Box 1709, Boroko 121, NCD, Papua New Guinea. It has been authorised for public release by the Commission in accordance with Paragraph 6.5 of ICAO Annex 13. The report is available on the AIC website at www.aic.gov.pg.

The report is based on the investigation carried out by the AIC under the Civil Aviation Act 2000, and Annex 13 to the Convention on International Civil Aviation. It contains factual information, analysis of that information, findings and contributing (causal) factors, other factors, safety actions, and safety recommendations. All times in this report are in local time (UTC+10 hours) unless otherwise stated.

AIC investigations explore the areas surrounding an occurrence, and the facts relevant to understanding how and why the accident occurred are included in the report. The report may also contain other non-contributing factors which have been identified as safety deficiencies for the purpose of improving safety.

In accordance with ICAO Annex 13, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents.

Synopsis

On 22 December 2024, at 10:12[1] local time (00:12 UTC[2]), a Pilatus Britten-Norman BN2B-26 Islander aircraft, registered P2-SAM, owned and operated by North Coast Aviation Limited (NCAL) departed on a VFR[3] single pilot passenger charter flight from Wasu to Nadzab, Morobe Province. Upon departure the pilot contacted Air Traffic Services informing them that he was tracking to intercept the 170 track to Nadzab not above 10,000 ft amsl[4], with an estimated arrival time of 10:47.

The aircraft was fitted with *V2 Track* equipment which is a hybrid dual-mode cellular/satellite GPS tracking system.

The V2 Track data for the accident flight showed that the aircraft initially tracked west along the coastline established in a cruise climb before turning southwest and continuing the climb inland to intercept the Nadzab track.

The final recorded data point showed that the aircraft at 8,002 feet, 1.68 nautical miles from the accident site, with a climb rate at 433 feet per minute and a groundspeed of 85 knots. It was established during the investigation that the aircraft collided with terrain at 10:28[5], 1.68 nautical miles south of this last recorded position (32 nm north of Nadzab). All five persons on board were fatally injured on impact.

The evidence shows that the aircraft impacted terrain with powered, high-speed impact forces and was destroyed. A post-impact fire disintegrated the wreckage. There was no evidence that suggested that there was any pre-impact mechanical issue with the aircraft's engines, controls, or systems.

The investigation found that between the last recorded position and the accident site coordinates, the aircraft flight path was not along the usual flight tracks observed from V2 track historical flight records.

The V2 Track data also had missing recording, which means there was intermittent obstructions of transmission signals. Historical records from the V2 history show consistent cellular position data transmission from previous flights in the same area. The AIC, therefore, associated the signal interruptions on the day of the accident with flight in or under heavy cloud cover and/or precipitation.

Further details and factors, including analysis and findings are contained in the main report. The report also includes safety recommendations derived from safety deficiencies observed by the AIC during the investigation addressed to the operator and CASA PNG.

According to *ICAO Annex 13 Standards*, identified safety deficiencies and concerns must be raised with the persons or organisations best placed to take safety action. Unless safety action is taken to address the identified safety deficiencies, death or injury may result in a future accident.

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[1] Departure time from Wasu from the V2 Track recorded data.

[2] The 24-hour clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

[3] Visual Flight Rules.

[4] Above mean sea level

[5] Estimated time of the accident based on recorded pre-accident flight path and performance data.

1 FACTUAL INFORMATION

1.1 History of the Flight

Aircraft Registration	:	P2-SAM
Operator	:	North Coast Aviation Limited
Type of Operation	:	VFR Charter Flight
Persons on Board	:	five
Accident Site	:	Latitude 6° 3.149'S, Longitude 146° 52.122'E, approximately 32 nm north of Nadzab
Elevation	:	8,400 ft above sea level
Time of occurrence	:	10:28 local time (00:28 UTC)

Table 1: Accident Summary

On 22 December 2024, at 10:28 local time (00:28 UTC[6]), a Pilatus Britten-Norman BN2B–26 Islander aircraft, registered P2-SAM (SAM), owned and operated by North Coast Aviation (NCA) Limited, on a VFR[7] single pilot charter flight from Wasu to Nadzab, Morobe Province, collided with terrain 20 nm[8] southwest of Wasu, (32 nm north of Nadzab) (see Figure 1). All persons on board were fatally injured upon impact. The aircraft was destroyed by impact forces and an intense post-impact fuel-fed fire.

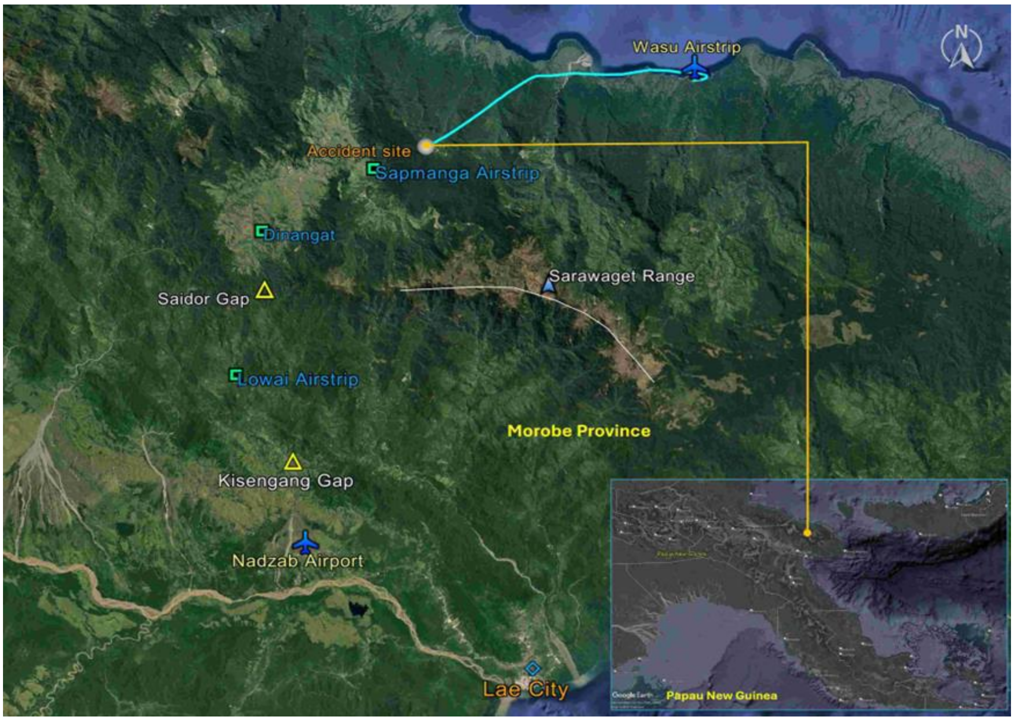

Figure 1: P2-SAM Accident recorded flight track from departure to accident

Earlier that morning, SAM flew from Nadzab to Wasu. After the completion of activities at Wasu, passengers boarded SAM for the return flight to Nadzab.

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[6] The 24-hour clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

[7] Visual Flight Rules.

[8] Nautical miles.

The aircraft departed at 10:12, and the pilot contacted Port Moresby Flight Information Service (FIS), informing FIS of their departure from Wasu and that they were tracking to intercept a 170 track to Nadzab not above 10,000 ft amsl[9] with an estimated arrival time of 10:47.

Records confirmed that there were five persons on board; the pilot and four passengers. The pilot occupied the left seat in the cockpit and all passengers were in the passenger cabin.

At 10:14 the pilot was instructed by FIS to call Nadzab Approach on VHF frequency 118.6 at 15 nm from Nadzab.[10]

According to the *V2-Track Software* used by NCA, after departure from Wasu SAM tracked west along the coast. Ten minutes after departure the aircraft commenced tracking southwest while climbing through 5,500 ft. The south-westerly track was maintained until the last recorded position at 10:26:59 when it turned 5 deg right. The aircraft was 5.7 nm northeast of Sapmanga, climbing through 8,002 ft at 433 ft per min and with a groundspeed of 85 kts. The GPS coordinates for the wreckage location was 1.68 nm southwest of the V2 Track last interrogation point.

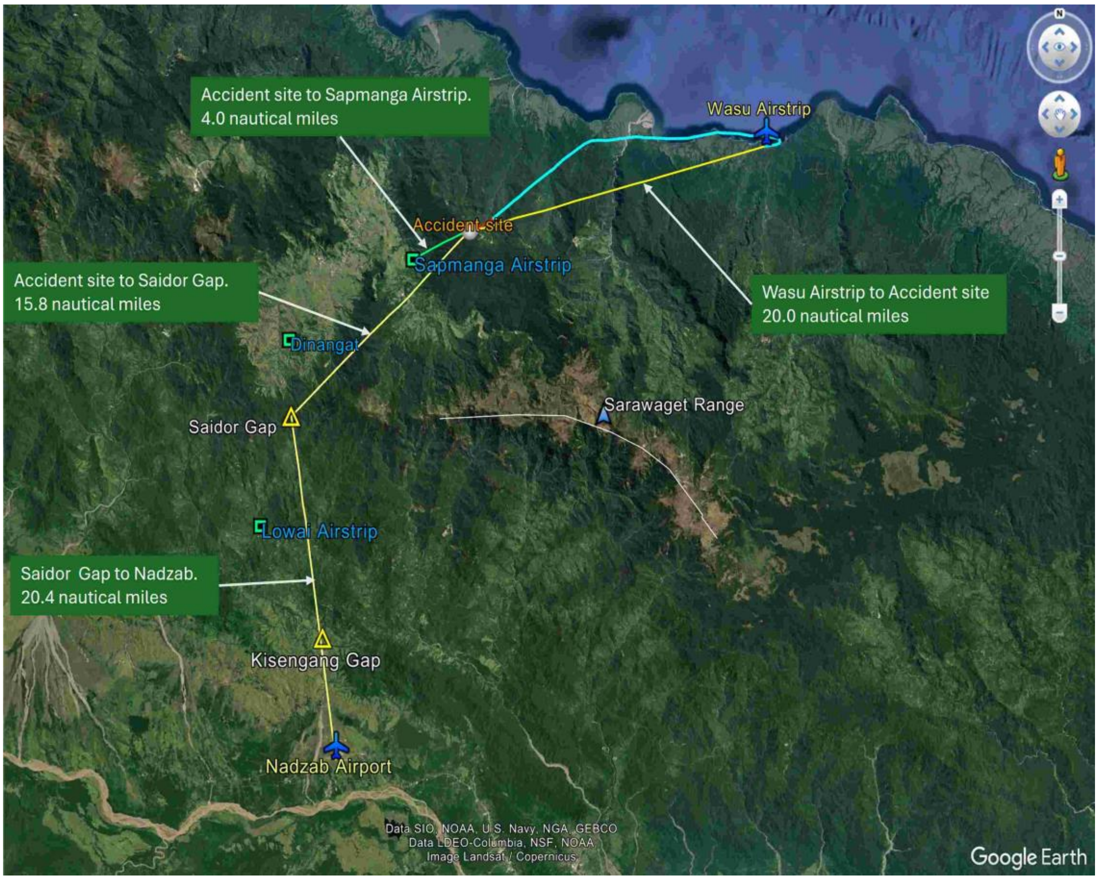

Figure 2: P2-SAM track with distances between Wasu and Nadzab depicted

At 10:30, the PNG Aviation Rescue Coordination Centre (RCC) received a COSPAS SARSAT[11] signal.

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[9] Above mean sea level

[10] The 15 nm Nadzab inbound call would normally be about 7 mins before arrival at Nadzab. In this case at approximately 10:40.

[11] A satellite system designed to detect and locate activated distress beacons transmitting in the frequency band of 406.0-406.1 MH. Source: ICAO/IMO IAMSAR MANUAL.

At 10:44, the Nadzab Approach Controller initiated communication checks to establish contact with SAM but did not receive a response. At 10:47, with no contact with SAM, a DISTRESS Phase[12] was declared.

At 11:30, the distress message, including the estimated coordinates of the ELT signal, was sent by ATC Port Moresby to Nadzab ATC. That message stated that the ELT signal was located 20 nm north of Nadzab. The Search and Rescue Coordinator contacted Manolos Aviation to commence a search. There was a delay in resolving the confusion of where the ELT was located. It was subsequently determined to be 32 nm north of Nadzab in the Sapmanga area, and therefore north of the Sarawaget Range.

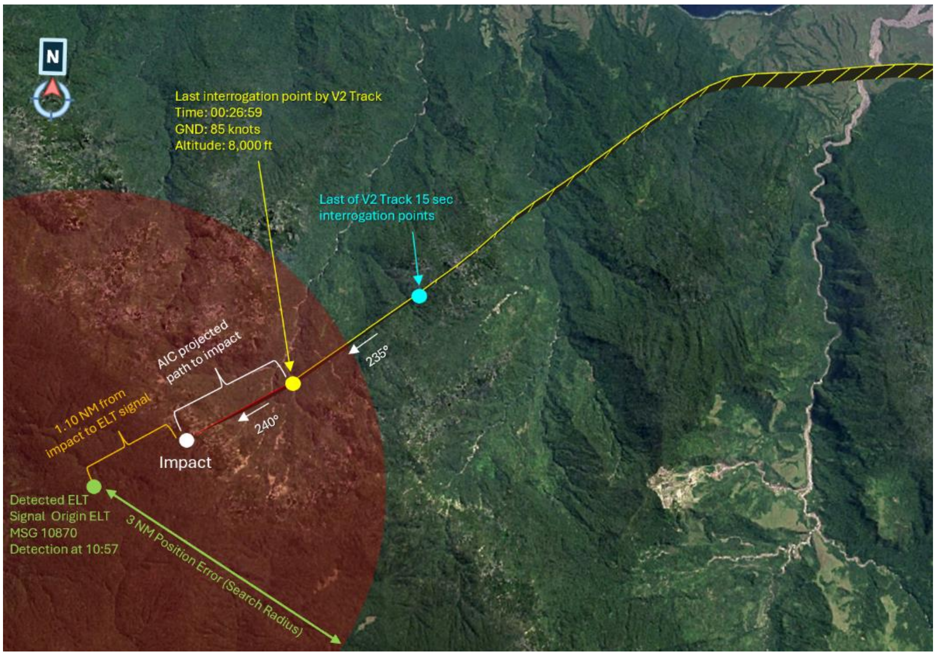

Figure 3: SAM final track and ELT error. Plot by PNG AIC

The Search aircraft were unable to reach the area of the accident on the afternoon of 22 December.

On 23 December, the search helicopter sighted the wreckage about 32 nm northeast of Nadzab, on the ranges east of the Sapmanga Valley about 06:45.

See *Section 1.15.2* for Search and Rescue details.

1.2 Injuries to Persons

INJURIES	*Crew*	*Passengers*	*Total in aircraft*	*Others*
Fatal	*1*	*4*	*5*	*0*
Serious	-	-	-	-
Minor	-	-	-	*Not applicable*
None	-	-	-	
TOTAL	*1*	*4*	*5*	-

Table 2: Injuries to persons

[12] Distress phase (code word DETRESFA): a situation wherein there is a reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger and require immediate assistance.

1.3 Damage to Aircraft

The aircraft was destroyed by impact forces and an intense post-impact fire.

Figure 4: Aircraft destroyed by impact forces and fire. View looking back along final track

Figure 5: Wreckage viewed towards point of impact

1.4 Other damage

The vegetation around the area of impact sustained localised damage from the impact and fire.

1.5 Personnel Information

1.5.1 Pilot in Command

Age	:	*54 years*
Date of Birth	:	*29 November 1969*
Gender	:	*Male*
Nationality	:	*Papua New Guinea*
Position	:	*Line Pilot*
Type of licences	:	*PNG CPL Aeroplanes*
Route	:	*Endorsed*
Type ratings	:	*BN2, C208, PA23, PA44, PAC750XL, DHC6, F28*
Instrument rating, multi-engine two pilot	:	*Expired 18 August 2016*
Total flying time	:	*13,694.3 hours*
Total on this type	:	*3,600.0 hours (estimated by the operator)*
Total hours last 30 days (21 December 2024)	:	*15.4 hours*
Total hours last 7 days (21 December 2024)	:	*3.1 hours*
Last Competency Check (BN2)	:	*13 February 2024*
Medical class	:	*One*
Issued	:	*9 August 2024*
Valid to	:	*12 February 2025*
Medical limitation	:	*Prescription lenses*

Table 3: PIC Personnel Information

The pilot had only flown on six of the previous 30 days and had not flown on the 2 days prior to the day of the accident. With respect to the pilot's duty time as it related to physiological fatigue, the investigation determined that the pilot should have been well rested.

There was no evidence of the pilot having undergone route and strip competency or recurrency check flights in the greater Kabwum Valley area of the Morobe Province since 8 October 2018. On that flight, the pilot was checked by a NCA Check and Training pilot in a PAC 750XL aircraft over the route from Nadzab via the 20-mile Gap (northeast of Lae) to Kabwum, Teptep, Indagen, Konge, Satwag, Wasu. Then on 9 October 2018 from Wasu to Bungawat and return to Nadzab via the Saidor Gap.

The pilot successfully completed a *BN2 Line Competency Check* on 12 February 2024. That was conducted by the NCA Chief Pilot and included knowledge and competency. The flight check was conducted over the route Nadzab to Wau to Nadzab and included local flight competency at Wau and Nadzab.

The pilot did not record sectors flown in his Pilot Logbook. His logbook entries simply stated "NZB OPS". The pilot's *Flight and Duty Records* and the operator's *Daily Flight Records* did not record sectors flown and Aerodromes (nor were they required to be recorded).

1.6 Aircraft Information

1.6.1 Aircraft

Aircraft manufacturer	*:*	*Pilatus Britten-Norman*
Model	*:*	*BN2B-26*
Serial number	*:*	*2197*
Year of manufacture	*:*	*1988*
Nationality of State of Manufacture	*:*	*UK*
Nationality of State of Registration	*:*	*PNG*
Registration	*:*	*P2-SAM*
Name of the owner & operator	*:*	*North Coast Aviation Limited*
Certificate of Airworthiness number	*:*	*321*
Certificate of Airworthiness issued		*18 December 2014*
Valid to	*:*	*Non-terminating*
Certificate of Registration number	*:*	*321*
Certificate of Registration issued	*:*	*10 December 2014*
Valid to	*:*	*Non-terminating*
Total airframe hours	*:*	*19,107.50 hours (at 3 December 2024)*
Total airframe landings	*:*	*38,276.0 (at 3 December 2024)*

Table 4: Aircraft Information

The aircraft's documents indicated that it was certified as being airworthy prior to departure from Nadzab on the day of the accident. The pilot did not inform the operator or the Operator's Wasu agent of any aircraft unserviceability during the Wasu turnaround.

1.6.2 Engines

Manufacturer	*:*	*Lycoming*
Model	*:*	*Lycoming 0-540-E4C5*
Engine Type	*:*	*Normally aspirated, six cylinder, horizontally opposed, direct drive, wing mounted*
Time to next overhaul	*:*	*2,200.0 hours*
Position	*:*	*Left*
Serial No.	*:*	*RL24078-40E*
Total Hours Since Overhaul	*:*	*1,362.2 hours (including 21 December 2024)*
Position	*:*	*Right*
Serial No.	*:*	*L21629-40A*
Total Hours Since Overhaul	*:*	*2,166.2 hours (including 21 December 2024)*

Table 5: Engine Information

From the recorded flight profile and performance, and the onsite evidence, the investigation determined that the engines were functioning normally prior to the accident.

1.6.3 Propellers

Manufacturer	:	*Hartzell*
Model	:	*HC-C2YK-2CUF*
Propeller Type	:	*Clockwise rotating, 2 bladed, full feathering*
Position	:	*Left*
Serial No.	:	*AU11100B*
Position	:	*Right*
Serial No.	:	*AU9611B*

Table 6: Propeller Information

From the recorded flight profile and performance, and the onsite evidence, the investigation determined that the propellers were functioning normally prior to the accident.

1.6.4 Aircraft Weight and Balance

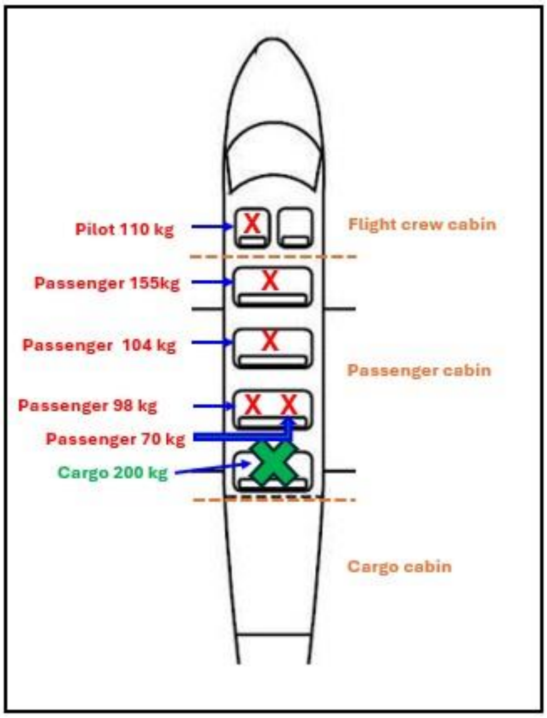

Figure 6: Weight Distribution Diagram

The pilots copy of the flight manifest for the accident flight was not recovered from the burnt aircraft wreckage. However, a copy was obtained from the Operator's agent in Wasu. The agent also provided details of where each passenger and the baggage/freight were located in the aircraft.[13]

The *Load Trim Sheet* (Weight and Balance Computation Sheet) for the flight from Wasu to Nadzab was not completed/computed electronically by the pilot at Wasu due to the lack of

[13] Figure 6 was prepared by the AIC from information supplied by the NCA agent at Wasu.

internet coverage at the time. The agent was not able to verify if the pilot had completed a paper *Load Trim Sheet*.

The Operator's agent at Wasu assisted the pilot to load the aircraft at Wasu. Using the weights listed on the manifest and the distribution of passengers in the aircraft cabin, and the baggage and freight, based on information provided by the agent, the operator subsequently completed a *Load Trim Sheet* which the AIC accepted as the likely weight and balance for the flight.

The investigation determined that the aircraft was likely within the approved weight and centre of gravity (balance) limitations.

1.6.5 Emergency Locator Transmitter (ELT)

Manufacturer	:	*Artex Aircraft Supplies*
Part Number	:	*453-6603*
Serial Number	:	*1029*

Table 7: ELT Information

The ELT was fitted in the aircraft in accordance with in accordance with PNG *Civil Aviation Rule (CAR) 91.529*. The ELT activated following the impact and transmitted on 406 MHz until it was consumed by the post-impact fire.

Figure 7: ELT destroyed by post-impact fire

1.6.6 V2 Track equipment

V2 Track is a hybrid dual-mode cellular/satellite GPS tracking system for aircraft, vehicles, marine, and telemetry applications. *V2 Track* uses both satellite and cellular networks, switching to satellite networks, like *Iridium*, only when out of cellular range. Shifting between cellular and satellite is completely automatic.

Cloud cover, especially heavy or dense clouds, can affect cellular signals, particularly during storms or when there's high atmospheric water density, potentially leading to signal loss or interruptions.[14]

[14] The V2 manufacturer explained that satellite interrogation normally commences 2 min after cellular interrogation drops out. During the intervening period cellular is stored and can be retrieved by V2 software.

The following information about factors affecting cellular interrogation was sourced online from Telecommunications providers globally.

- **Signal Reflection:**
  Clouds, particularly dense ones, can act as reflectors for radio waves, which are used by cellular networks to transmit signals. This reflection can cause interference and make it difficult for your phone to connect to the network.
- **Atmospheric Water Density:**
  Fog, clouds, and rain increase atmospheric water density, which can absorb and scatter radio waves, including those used for cellular communication.
- **Storm Clouds and Rain:**
  Storm clouds, especially those that produce rain, are particularly problematic as they can significantly degrade cellular signals.
- **Millimetre Wave Transmission:**
  Rain is a significant obstacle to millimetre wave transmission, leading to substantial signal loss, especially at frequencies above 100 GHz.
- **Temperature Inversions:**
  Temperature inversions, where a layer of warm air is trapped above a layer of cool air, can create atmospheric "ducts" that bounce radio signals over longer distances, potentially extending the reach of cell tower transmissions in some cases.
- **Other Factors:**
  While cloud cover itself can affect signals, other factors like terrain, buildings, trees, and even wind direction can also play a role in signal quality.

The following information about factors affecting satellite interrogation was sourced from the *V2 Track* company documents.

High-rate Tracking: V2 Track can be set to update at high rates, such as 10 or 15 second updates while connected to a cellular data network and 2 minutes while on satellite.

The Impact of Clouds on Satellite Imagery

Clouds are essentially water droplets or ice crystals suspended in the atmosphere. They can significantly affect the quality and usability of satellite imagery in several ways:

- **Obstruction:** Thick clouds can completely block the view of the Earth's surface, making it impossible for optical satellites to capture usable images.
- **Partial Obscuration:** Even thin clouds or haze can partially obscure the surface, reducing image quality and potentially affecting data interpretation.
- **Shadow Effects:** Clouds cast shadows on the ground, which can alter the spectral signatures of land features, potentially leading to misinterpretation of data.

The aircraft was interrogated by V2 Track after departing Wasu. At 10:22:58, the cellular signal briefly switched to satellite interrogation, which occurred 5 minutes and 16 seconds before impact, while the aircraft was climbing through 6,247 ft. Interrogation by cellular ceased 71 sec before impact when the aircraft was 1.68 nm from the accident site, climbing through 8,002 ft at 433 ft/min and a groundspeed of 85 kts.[15] (*Refer to Appendix 5.1 to view the V2 Track data table and P2-SAM track overlaid on terrain graphic*)

[15] The cellular interrogations briefly ceased, and a satellite interrogation was received at 10:22:58. The cellular interrogation recommenced 16 seconds later at 10:23:14. There were no cellular interrogations between 10:25:29 and 10:26:59. There were no further cellular interrogations after 10:26:59.

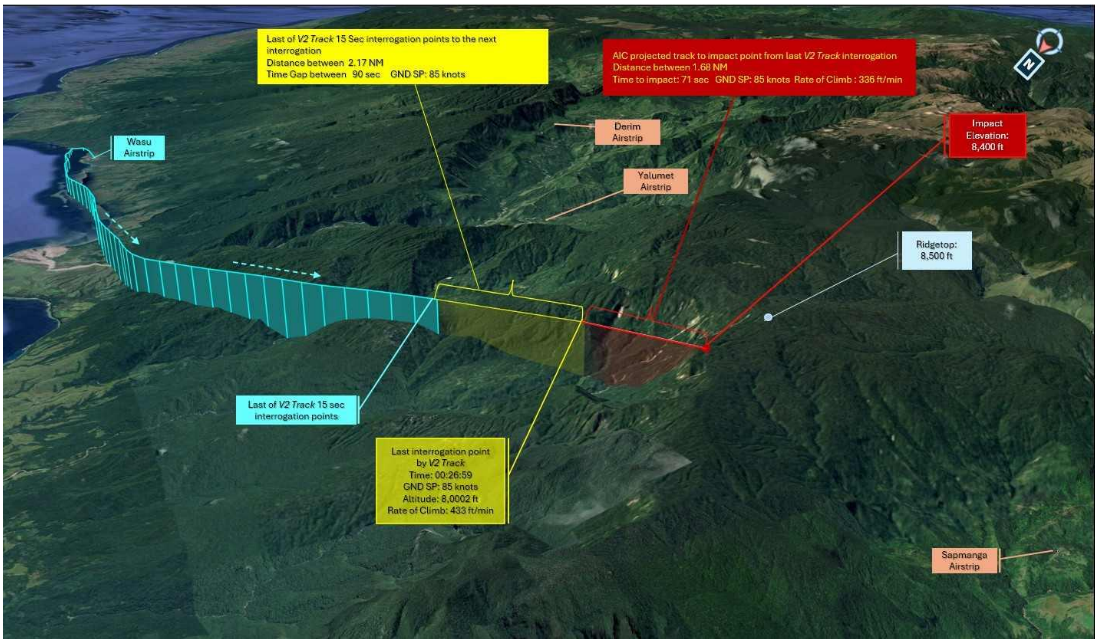

Figure 8: Aircraft track sourced from V2 Track data overlaid on terrain mapping[16]

1.6.7 BN2B-26 performance specifications

The Pilatus Britten-Norman BN2B-26 Operating Manual states:

- Best rate of climb speed 65 kts
- Rate of climb at sea level 950 ft per min
- Best angle of climb speed 65 kts

The BN2B-26 *best angle of climb speed* 65 kts is used to ensure maximum altitude gain over a given distance.

The aircraft was recorded climbing at 85 kts groundspeed 71 sec before impact. Based on the reported wind data, the investigation determined that the aircraft was being flown at 100 kts IAS, 35 kts above the aircraft manufacturer's promulgated airspeed to achieve best angle of climb and best rate of climb for terrain clearance[17].

1.6.8 Terrain Awareness and Warning System (TAWS)

The aircraft was fitted with a Garmin 430W Global Navigation System (GNS) receiver that contained a Jeppesen mapping data card and a Terrain Awareness and Warning system (TAWS) data card.

16 See Appendix 5.2 for expanded view of this graphic

17 Best rate of climb" (Vy) prioritises gaining altitude quickly, while "best angle of climb" (Vx) focuses on reaching the highest altitude in the shortest horizontal distance, particularly useful for clearing obstacles.

Figure 9: Instrument panel. Garmin 430W in centre console to right of flight instruments

The Garmin GNS 430W[18] *TAWS* system installed in SAM did not provide aural warnings of terrain proximity, it only provided colour warnings. Effective use of colour enhances a pilot's ability to see the aircraft's position relative to ground features. It graphically warns the pilot when proximity conflicts loom ahead, importantly terrain warnings. Aural warnings (auditory alerts) can be more effective for immediate reactions.

Figure 10: Garmin 430W receiver screen showing indicative terrain display

The operator informed the AIC that the installed *Garmin 430W* receiver was serviceable. The AIC found no evidence that it was not serviceable prior to departure from Nadzab.

18 The Garmin GNS 430W displays terrain in colour. It uses colour coding to graphically alert the user to potential proximity conflicts with terrain and obstacles, based on data from the built-in terrain and obstacle databases. This helps pilots maintain situational awareness by visually highlighting areas of concern. The Garmin GNS 430W does have aural alert capabilities. It can provide aural advisories for both terrain and obstacle conflicts when equipped with the optional Helicopter Terrain Awareness and Warning System (HTAWS). The GNS 430W also supports visual and aural alerts for traffic (TIS) when paired with a GTX 330 Mode S transponder and an optional GDL 69A XM receiver. The GNS 430W can be upgraded with the HTAWS option, which provides both visual and aural warnings for potential terrain and obstacle hazards. The HTAWS provides both visual pop-up alerts on the display and audible warnings to alert the pilot of potential conflicts.

If the Garmin 430W *TAWS* system becomes unserviceable during flight it is designed to display a green coloured “TERRAIN has failed” message on the receiver’s screen.

Accordingly, if the Garmin 430W *TAWS* feature of the receiver had become unserviceable during accident flight, the pilot would have received a green coloured “TERRAIN has failed” message on the receiver’s screen.

Figure 11: Garmin 430W receiver screen showing indicative terrain fail display

1.6.9 Warning systems[19]

Research into aircraft accidents has illustrated how pilots who are pre-occupied with a number of operational and /or complex tasks, have missed visual warnings even when they are in their field of view.

Studies have shown that warning systems in complex domains such as aviation and medicine were made more effective by supplementing the systems’ visual indications/warnings with aural warnings.

A pilot was more likely to detect the aircraft’s proximity to terrain and take immediate and timely evasive action when receiving a *TAWS* aural warning than a visual warning alone. This is particularly the case when operating in marginal visual conditions and navigating over mountainous terrain.

1.7 Meteorological Information

Weather patterns across the area are greatly influenced by topography. The Sapmanga Valley to the north of the Sarawaget Range, is surrounded by mountain ranges. Cloud forms rapidly when air is forced up the mountain slopes. This weather phenomena is well known to pilots who fly across and into the area.

The search pilot reported that on the day of the accident, the wind was westerly at 20 kts and that cloud had spilled over the lee side of ridge covering the ridge above the accident site. Cloud and rain increased during the search, and it had to be called off on the day of the accident and resumed the following day.

[19] See Appendix 5.3 for overview of Auditory and visual alerts for Terrain Awareness and Warning Systems

1.8 Aids to Navigation

Ground-based navigation aids, on-board navigation aids, and aerodrome visual ground aids and their serviceability were not a factor in this accident.

1.9 Communication

All communications between air traffic services (ATS) and the pilot were normal and did not contribute to this accident.

1.10 Aerodrome Information

Not relevant to this investigation.

1.11 Flight Recorders

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither were they required by *PNG Civil Aviation Rules*.

A cockpit image recorder was not installed on the aircraft, nor was it not required by *PNG Civil Aviation Rules.*

1.12 Wreckage and Impact Information

The aircraft's right-wing outboard of the engine impacted a tree trunk at 8,405 ft[20] and the aircraft then flew into the canopy of the forest. The initial tree impact was 19 metres above the ground[21] and it severed the outboard section of the right wing.

The right-wing fuel tank was ruptured during the impact with the tree and there was physical evidence of fuel loss due to the rupturing of the tank.

The right wing, inboard of the engine, then impacted on a larger diameter tree trunk about 5 metres beyond the first tree and 12 metres above the ground, which arrested the aircraft's speed and its forward trajectory and pulled it vertically to the ground. The impact point of the second tree was at 8,405 ft elevation. The general impact area on the cliff face sloped at an average of 55 deg. The elevation of the ground impact and accident site was 8,344 ft.

The impact damage indicated that the aircraft was flying at speeds that would normally be associated with engine-powered speeds. The aircraft had flown directly into the cliff face of the heavily vegetated steep mountain slope.

The aircraft was destroyed by the impact forces and the intense post-impact fuel-fed fire

20 Elevation of the first tree point of impact.
21 See Appendix 5.4 Graphic of slope and tree impacts.


Figure 12: View back along aircraft's track showing first tree impact trunk severed


Figure 13: Accident site showing large tree that arrested the aircraft's forward trajectory

1.13 Medical and Pathological Information

According to witnesses prior to SAM's departure from Nadzab and Wasu, and the pilot's ATS communications, there was no evidence that physiological factors or incapacitation affected his performance.

An autopsy was conducted for the Coroner at the Angau Memorial Hospital in Lae, Morobe Province. The Pathologist who performed the autopsies informed the investigation that as a result of the extensive traumatic injuries and the extent of the burns sustained by the pilot and passengers, pathological and toxicological findings were not possible. Furthermore, normal investigative physical evidence related to the pilot manipulating flight and engine controls at impact could not be determined.

1.14 Fire

The aircraft was destroyed by impact forces and an intense fuel-fed post-impact fire.

1.15 Survival Aspects

The accident was not survivable.

1.15.1 Weather and terrain

The search and rescue efforts were to a large extent affected by the weather in the area of the accident. The search helicopters were able to get into the area around the last known coordinates on the day of the accident but could not search for long before clouds and adverse weather encompassed the area.

Weather, terrain and vegetation made it impossible for a helicopter to land anywhere close enough to the accident site on the day of the accident to facilitate the rescue on foot.

The terrain was steep averaging a slope of 55 deg, and the forest vegetation was dense.

Figure 14: Drone view at staging point adjacent to accident site

1.15.2 Search and rescue

At 10:30, the Aviation Rescue Coordination Centre (RCC) received a *COSPAS SARSAT*[22]signal. A Distress Phase was declared at 10:47 when the aircraft failed to arrive at Nadzab. The aircraft's ELT activated immediately after the impact and emitted distress signals until it was destroyed by the fire.

At 11:30, the distress message, including the estimated coordinates of the *ELT* signal, was sent by ATC Port Moresby to Nadzab ATC. That message indicated that the *ELT* signal was located 20 nm north of Nadzab. The Search and Rescue Coordinator contacted Manolos Aviation in Lae to prepare to commence a search by helicopter. There was a delay in resolving the confusion of where the *ELT* was located. It was subsequently determined to be 32 nm north of Nadzab in the Sapmanga area, and therefore north of the Sarawaget Range.

The search helicopter was dispatched to the Sapmanga area for the search and rescue (SAR) of the aircraft (SAM) and the persons onboard. However, due to cloud cover in the area, the helicopter had to return to Lae and the SAR operation was called off at 14:40 on 22 December 2024.

Manolos Aviation dispatched a search helicopter from Lae to the Sapmanga Area at 06:01 on 23 December. The pilot tracked via the 20 Mile Gap, northeast of Lae and arrived in the Sapmanga area at 06:37 and commenced SAR operations.

The search helicopter pilot flew SAM's reported track using the *V2 Track* coordinates but was unable to see the wreckage from overhead due to the dense vegetation on the steep slope. However, when the pilot flew the track at a height that was level with the accident site, the wreckage was visible through a hole in the vegetation. The aircraft had flown directly into the face of the heavily vegetated steep cliff face about 20 nm west-southwest of Wasu on the mountain range northeast of the Sapmanga Valley.[23]

The SAR team could not access the accident site due to the weather. The search pilot logged the GPS coordinates of the accident site and then diverted to and landed at Sapmanga Airstrip at 06:49.

SAR operations continued on 24 December 2024 and a doctor who was engaged with the SAR operation was lowered by cable winch from a PNG Defense Force (PNGDF) helicopter onto the accident site and confirmed that there were no survivors. Recovery efforts continued with a team trekking to the accident site from Sapmanga, while another team was winched into the crash site by helicopter.

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[22] A satellite system designed to detect and locate activated distress beacons transmitting in the frequency band of 406.0-406.1 MH. Source: *ICAO/IMO IAMSAR MANUAL.*

[23] See Appendix 5.5 for graphical details of the search helicopter's track with cellular interrogations from the Digicel Cellular Tower PG3112. The cell tower is located 12.08 NM bearing 115 deg from the accident site. PG3112 is 3.35 NM on a bearing of 105.24 deg to Derim airstrip.

On 31 December 2024, the deceased occupants were transported by air to the Angau Memorial Hospital at Lae, Morobe Province.

Figure 15: Wreckage on the steep cliff covered with dense vegetation

1.16 Tests and Research

No tests or research were required to be conducted as a result of this accident.

1.17 Organizational and Management Information

1.17.1 The Operator

North Coast Aviation (NCA) is a general aviation charter company based at Nadzab, Morobe Province. It has been in operation for many years providing air transport to and from remote areas throughout the country, mainly within Morobe Province and surrounding Provinces.

NCA was issued with an *Air Operator Certificate (AOC) 119/009* on 11 April 2024 valid until 11 April 2026. The AOC was issued pursuant to section 47 (3) and 49 of the *Civil Aviation Act 2000* and *Civil Aviation Rule Part 119*. The certificate authorised NCA to perform commercial air operations, as defined in the approved operations specifications and expositions.

Operations specifications OPS/119/009-SAM was specific to Britten-Norman BN2B-26 aircraft registered P2-SAM. The permitted commercial operations were for the carriage of passengers and cargo.

Operations specifications OPS/119/009-PG was specific to PAC 750XL aircraft registered P2-NCA and P2-BJD. The permitted commercial operations were for the carriage of passengers and cargo.

A *Maintenance Organisation Certificate (MOC) 145/009* was issued to NCA on 1 November 2024 and was valid until 30 April 2025. The *MOC* was issued pursuant to *Section 47 (3) and 49* of the *Civil Aviation Act 2000* and *Civil Aviation Rule Part 145*. The certificate authorised NCA to perform maintenance activities, as defined in the approved operations specifications and expositions.

NCA had a subscription to a third-party aircraft cellular and satellite tracker, *V2 Track*[24]. The subscription the operator used provided cellular interrogation at 15 second intervals and when cellular signal was not available it automatically defaulted to satellite interrogation. This enabled the operator to track their aircraft in real time.

The *NCA Route Guide Manual* listed three areas of NCA operation into the areas north and east of Nadzab.

- *Area 1* listed seven routes originating Nadzab to and from the Kabwum Valley area.
- *Area 2* listed five routes originating Nadzab to and from the Mongi Valley area.
- *Area 3* listed four routes originating Nadzab to and from the Sapmanga Valley area.

The operator informed the investigation that their *Route Guide* described two main tracks from Wasu to Nadzab. Both involved flying via the Saidor Gap. That was listed in *Area 3*.

The operator also subscribed to an *Oz Runways Electronic Flight Bag* app. The app provided planning, briefing, flight plan filing and moving map navigation. Much of the functionality in *Oz Runways* requires a *GPS* position. Each aircraft in the fleet had one of the Wi-Fi with Cellular model Tablets with the *Oz Runways* app installed. The *Oz Runways* software was designed to automatically update when the aircraft was in or adjacent to the operator's hangar and the tablet was connected to WiFi.

The investigation found that the initial track details on the route charts supplied to the investigators taken from the operators *Oz Runways* app differed in some instances from the documented routes in the NCA hard copy *Route Guide*. (See *Appendix 5.6* for *NCA Route Guide).*

Furthermore, none of the *Route Guide Area* routes provided a NCA approved alternate route from Wasu and the Sapmanga Valley if the Saidor Gap was impassable and in the case of Wasu to Nadzab if the Sapmanga Valley area and to the west were impassable due to adverse weather.

An alternate route from Wasu to Nadzab via the Landslide Gap or the 20 Mile Gap northeast of Lae was not specifically listed.

The following Figures 16 to 19 are sourced from the *NCA Route Guide* in the *Oz Runways Electronic Flight Bag* app.

- Figures 17 and 19 show the track flown by SAM on 22 December 2024.

[24] *V2 Track* is a hybrid dual-mode cellular/satellite GPS tracking system for aircraft, vehicles, marine, and telemetry applications. V2 uses both satellite and cellular networks, switching to satellite networks, like Iridium, only when out of cellular range. Shifting between cellular and satellite is completely automatic.

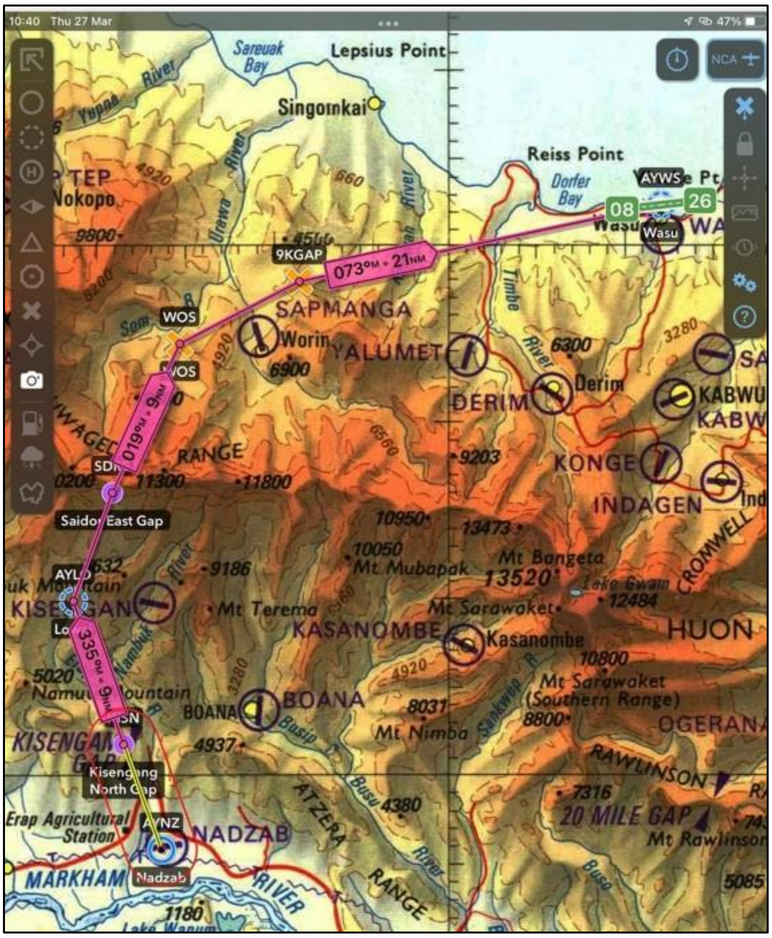

Figure 16: NCA Route Guide Chart for Area 3 Sapmanga 1 and 2

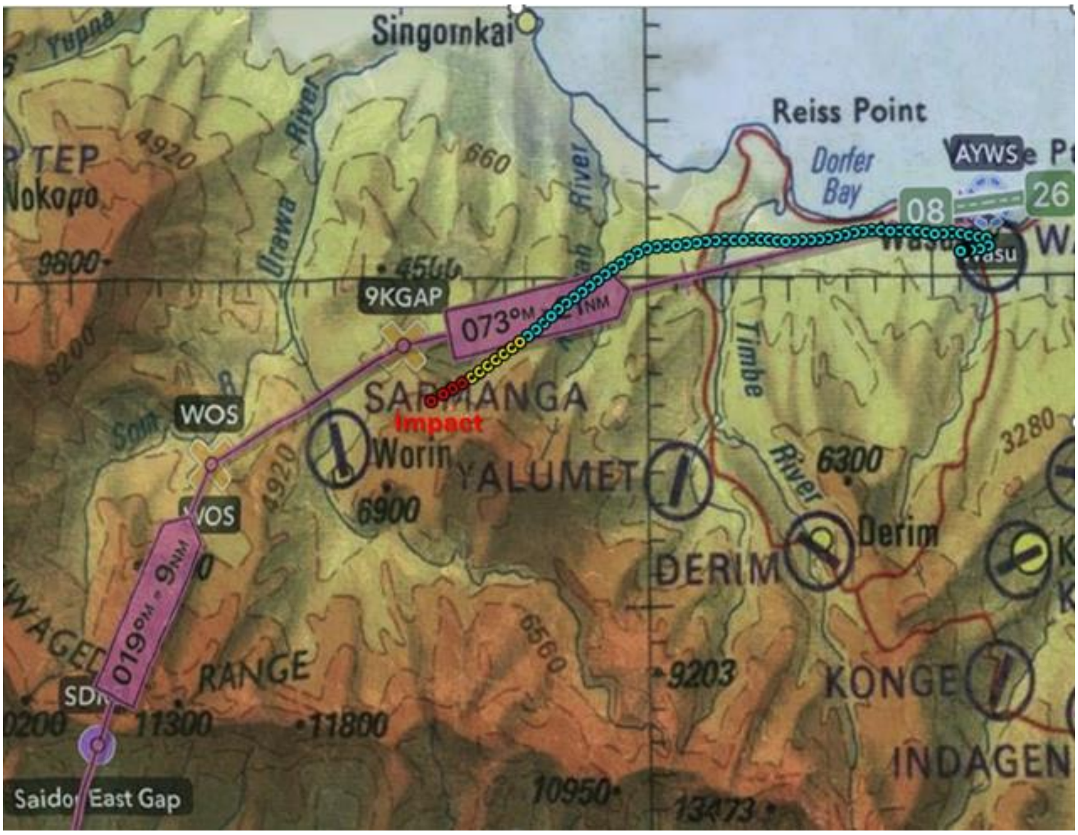

Figure 17:NCA Route Guide Chart for Area 3 Sapmanga 1 and 2 with SAM track depicted

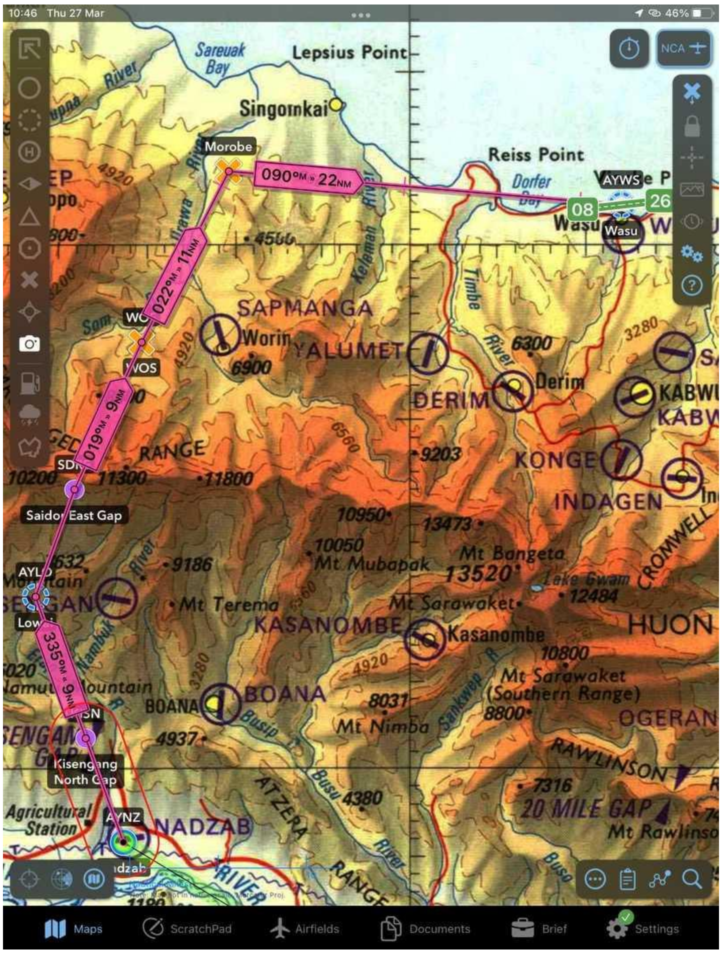

Figure 18:NCA Route Guide Chart for Area 3 Sapamanga 3 and 4

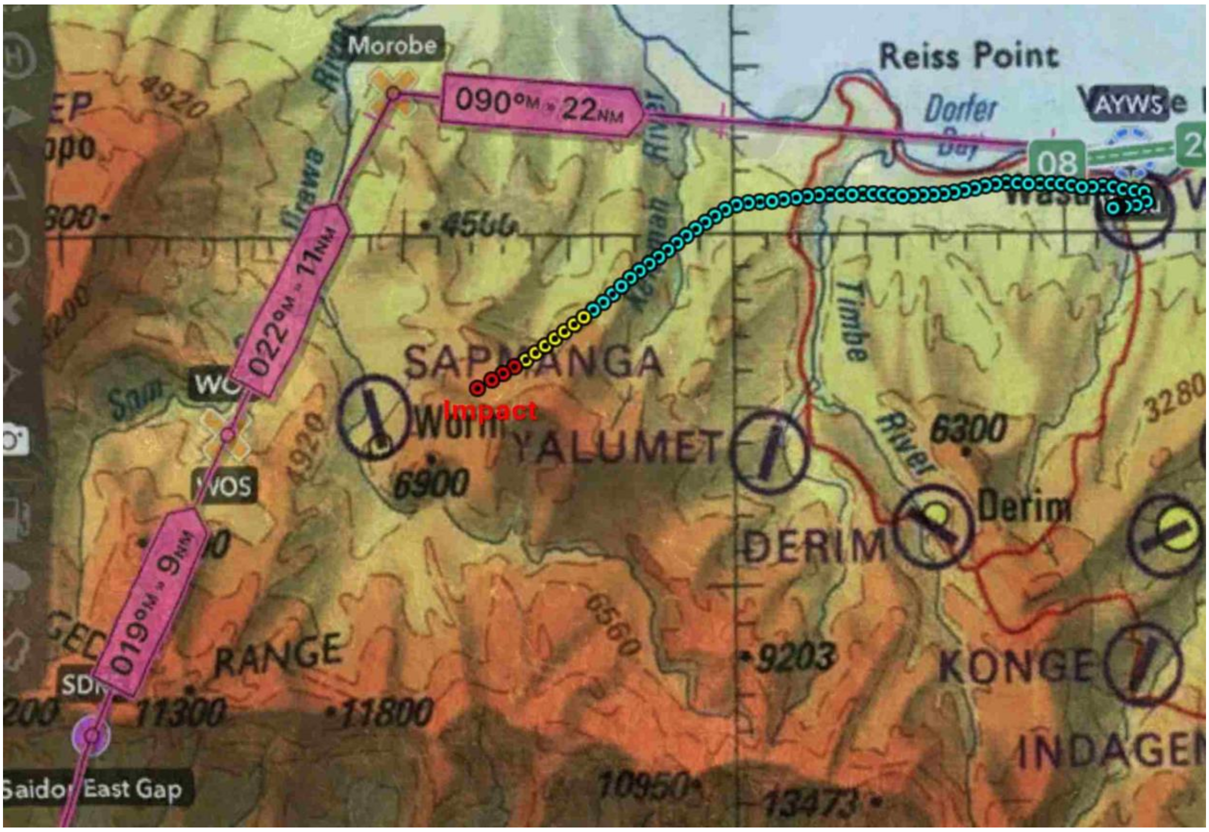

Figure 19:NCA Route Guide Chart for Area 3 Sapmanga 3 and 4 with SAM track depicted

See Appendix 5.6 for *NCA Route Guide* and supporting charts with recent flights depicted.

1.17.2 NiuSky Pacific Limited

NiuSky Pacific Limited, is a State-owned enterprise. It provides Air Navigation services that include communications, navigation, surveillance and air traffic management systems, and Search and Rescue Coordination services.

1.17.3 Civil Aviation Safety Authority of Papua New Guinea

The Civil Aviation Safety Authority of Papua New Guinea (CASA PNG) was established in 2010 by the *Civil Aviation Act 2000.* CASA PNG is the statutory body with legal mandate to promote aviation safety and security through effective safety regulation of the civil aviation industry, with particular emphasis on preventing aviation accidents and incidents within the civil aviation system in Papua New Guinea.

The CASA PNG website states:

> *The Civil Aviation Safety Authority of Papua New Guinea (CASAPNG) has the legal mandate to promote aviation safety and security through effective safety regulation of the civil aviation industry, with particular emphasis on preventing aviation accidents and incidents within the civil aviation system in Papua New Guinea and as a member of the Convention of International Civil Aviation (ICAO) on international civil aviation, Papua New Guinea is responsible for maintaining an ongoing compliance with its international obligations and CASA PNG provides for this in its management of the civil aviation sector.*
>
> *VISION: to be respected as an industry regulator and as a partner in regional and international Civil Aviation*
>
> *MISSION: we promote compliance and achieve safety and security outcomes in Papua New Guinea through positive and productive engagement with our stakeholders. CASA PNG's roles and functions include; to monitor, enhance and promote Civil Aviation Safety and Security.*
>
> *FUNCTION:*
>
> - *Developing, establishing, and promulgating safety and security standards relating to entry into the civil aviation system;*
> - *Monitoring adherence to safety and security standards;*
> - *Conducting comprehensive aviation industry surveillance on an individual and industry-wide basis;*
> - *Ensuring regular reviews of the civil aviation system to monitor performance and to promote improvement and development of its safety and security;*
> - *Maintain aviation documentation including the register of aircraft;*
> - *Investigating and reviewing civil aviation accidents and incidents in its capacity as the responsible safety and security authority.*[25]

[25] While CASA PNG may investigate accidents and incidents, the PNG Accident Investigation Commission is an independent statutory agency within Papua New Guinea (PNG) with primary carriage of aircraft accidents and serious incidents and is entirely separate from the judiciary, transport regulators, policy makers and service providers. Civil Aviation Act 2000, Sections 219 and 220.

On 9 November 2022, as a result of AIC *Safety Recommendation AIC 20-R027/19-1003*, CASA PNG issued *Safety Alert Bulletin SAB NO:02/2022*, titled *PNG Helicopter Operations – Inadvertent Flights into Instrument Meteorological Conditions (IIMC) and Lost Procedures.*

The SAB was applicable to PNG helicopter pilots. It's stated objective was:

> *This SAB provides safety guidance information to help helicopter pilots avoid accidents when:*
>
> - *Encountering disorientation, flying over unfamiliar territory, or in visibility conditions that is low enough to render familiar terrain unfamiliar; and*
> - *flying in unforecast weather conditions that may quickly deteriorate into degraded visibility conditions placing the pilot in a situation of increased risk of unintentional flight in Instrument Meteorological Conditions (UIMC).*

See Appendix 5.7 for CASA PNG *Safety Alert Bulletin SAB NO:02/2022.* The AIC considers that this Safety Bulletin is also relevant to PNG fixed wing pilots flight operations.

1.18 Additional Information

Not Applicable

1.19 Useful or Effective Investigation Techniques

The accident site was on a steep cliff face about 30 metres below the top of a ridge. It was densely vegetated and wet. The recovery team and the AIC investigator were winched into the site from a hovering helicopter. Movement around the site during the on-site phase was difficult and dangerous. The investigator who travelled to the accident site made effective use of drone technology to capture evidence in video and photographic form.

Figure 20:Wreckage viewed from above vegetation canopy (AIC drone pilot investigator in yellow PPE)

2 ANALYSIS

2.1 Flight Operations

A BN2B-26 Islander aircraft, registered P2-SAM owned and operated by North Coast Aviation Limited, was on a charter flight from Wasu to Nadzab, Morobe Province, with five persons on board. It departed Wasu at 10:12 local (00:12 UTC) and failed to arrive at Nadzab Airport. Satellite tracking data showed the aircraft's last position at 10:27, southwest of Wasu. The aircraft impacted terrain 20 nm southwest of Wasu when flying at a groundspeed of 85kts and was destroyed by impact forces and an intense fuel-fed post-impact fire. The accident was not survivable.

2.2 Pilot

The pilot had extensive flight operations experience in Papua New Guinea. His recency and currency in the area of the accident was not able to be fully determined because the pilot did not record sectors flown in his Pilot Logbook. His logbook entries briefly stated "NZB OPS". The pilot's *Flight and Duty Records* compiled by NCA and the NCA *Daily Flight Records* did not record sectors flown and aerodromes, nor were they required to be recorded.

2.3 Aircraft

The flight performance of the aircraft indicated that the engines and propellers were functioning normally during the lead up to the accident and to the point of impact with terrain. There was no evidence to suggest that any system, component or equipment malfunction was a factor in the accident.

The ELT installed on the aircraft emitted signals until it was consumed by the post-impact fire.

The aircraft documents indicated that it was certified as being airworthy prior to departure from Nadzab on the day of the accident. The pilot did not inform the operator or the Operator's Wasu agent of any aircraft unserviceability during the Wasu turnaround.

2.3.1 Weight and Balance

There was no evidence that the pilot calculated the aircraft loaded weight and balance for the flight.

However, the AIC accepted a post-accident Load Trim Sheet compiled by the operator based on the NCA Wasu agent's completed flight Manifest and the agent's evidence of the location of passengers and baggage/freight observed prior to departure. The investigation determined that the aircraft was likely within the approved weight and centre of gravity (balance) limitations.

For decades, pilots of General Aviation (GA) aircraft in PNG with a maximum takeoff weight of less than 5,700 kgs have used a variety of methods to determine weight and balance. These have included weighing and standard load configurations, experience based "rule of thumb" methods, and paper Load Trim Sheet calculations. The nature and frequency of rural "bush" flights and rapidly changing weather in PNG often necessitated fast turnarounds at remote airstrips.

There have been few accidents and serious incidents reported that were attributed to overloading and weight and balance that were outside the aircraft manufacturers certified limitations.

However, notable examples of the rare cases of GA aircraft accidents in PNG attributed to weight and balance issues are:

> *On 6 November 1967, a Beechcraft C55 aircraft accident at Goroka, Eastern Highlands Province.*
>
> *After becoming airborne and with the undercarriage still extended, the aircraft began climbing with an extreme nose-up attitude. At about 200 feet the aircraft stalled, rolled, and descended from a height from which recovery was not possible and impacted the ground. The pilot and six passengers were fatally injured. The aircraft's centre of gravity exceeded the aft limit.*
>
> *On 13 April 2016, a Britten Norman BN-2T Islander aircraft registered P2-SBC at Kiunga, Western Province.*
>
> *The aircraft departed Tekin, West Sepik Province for Kiunga with one pilot, eight adults and three infant passengers and a significant quantity of vegetables as cargo. On final approach the aircraft suddenly pitched up, almost to the vertical, after which the right wing dropped and the aircraft rapidly descended and impacted the ground about 1,200 metres west of the threshold of runway 07. The occupants were fatally injured. The weight and Balance Computation sheets for the accident flight and the flight for 12 April 2016 was not carried out and documented by the pilot.*
>
> *The investigation found that the aircraft's weight and centre of gravity (c of g) exceeded the permissible limits and exceeded the aft limit of the c of g.*

With the introduction of *Electronic Flight Bag (EFB)* apps, computation of weight and balance has become simple, fast and accurate. The use of internet for such computations should only be needed to enable printouts at the location and/or transmission from the remote location to the operator's base. However, CASA PNG had not approved an *EFB* app for use by NCA for computing aircraft weight and balance for its flights.

2.4 The flight

The GPS coordinates for the wreckage location was 1.68 nm southwest of the V2 Track last interrogation point. The aircraft was tracking 235 deg at 85 kts groundspeed and climbing through 8,002 ft at 433 ft/min.

No weather reports were available for the Sapmunga Valley area. The Search and Rescue helicopter pilot informed the investigation that the wind in the search area was westerly at 20 kts.

Based on the reported wind data the investigation determined that the aircraft was being flown at 100 kts IAS (35 kts above the aircraft manufacturer's promulgated airspeed to achieve best angle of climb and best rate of climb for terrain clearance[26]).

The BN2B-26 Operating Manual states that the *Best angle of climb speed 65 kts* is used to ensure maximum altitude gain over a given distance.

From the V2 Track data, the last cellular interrogation signal was 1.68 nm about 1 minute before the impact with terrain. The investigation determined that it was likely that factors such

26 "Best rate of climb" (Vy) prioritises gaining altitude quickly, while "best angle of climb" (Vx) focuses on reaching the highest altitude in the shortest horizontal distance, particularly useful for clearing obstacles.

as cloud or rain, Terrain interference and possibly lack of powered tower signal may have interrupted those signals.

From the time the aircraft turned southwest to track towards Sapmanga the aircraft was flown on an almost constant south-westerly track.

The investigation obtained an accurate GPS location of the accident site from the investigator at the site.

Because there were no cellular interrogation recorded over the last 1.68 nm, the investigation determined that the short track from the initial tree impact to the ground impact was 240 deg. The track from last cellular interrogation to the ground impact was also 240 deg.

The investigation calculated that the aircraft was flying towards the cliff face at 85 kts groundspeed (100 kt IAS).

The investigation determined that if the pilot had visual reference with terrain (below cloud) and so close to the mountain, he would have:

- attempted to climb and also reduced the IAS to 65 kt to achieve best angle of climb speed and thereby markedly increase the aircraft's altitude in the shortest distance; or
- he would have sharply turned away from the rapidly approaching cliff face.

Since neither of these manoeuvres were undertaken, and the track was maintained towards Sapmanga, (necessitating crossing the ridge) it is likely that the pilot was flying in cloud or if beneath cloud, in markedly reduced visibility and he did not have visual contact with the terrain.

2.5 Search and rescue

There was a delay in resolving the confusion of where the *ELT* was located. It was subsequently determined to be 32 nm north of Nadzab in the Sapmanga area, and therefore north of the Sarawaget Range.

Although there were some delays to the commencement of aerial search due to the SAR Coordinator and NCA seeking to resolve the discrepancies between the *ELT* data and *V2 Track* data, the investigation determined that the search and rescue initiation and subsequent activities were conducted appropriately.

The Air Traffic Services personnel commenced appropriate and timely Search and Rescue procedures to engage search and rescue aircraft while the location details were being resolved.

Ultimately, adverse weather after midday on the day of the accident was the primary factor in delays to the search and recovery operations.

Due to the impact rendering the accident not survivable the aerial search commencement delay did not have any bearing on the prospect of survival.

2.6 Accident site

The accident site was on heavily timbered steep cliff with dense vegetation. The aircraft impacted trees and immediately descended steeply into the vegetation canopy. It was not visible from overhead, but almost horizontally through the canopy in the direction of the flight. The recovery team and the AIC investigator were winched onto the cliff face from a helicopter. It was an unstable site.

The nature of the terrain and vegetation, together with the crushed and burnt-out wreckage rendered the site hazardous.

2.7 Survivability

The magnitude of the deceleration (impact) forces due to the high-speed impact and the severity of the fuel-fed post-impact fire rendered the accident not survivable.

On 31 December 2024, the deceased occupants were transported by air to the Angau Memorial Hospital at Lae, Morobe Province.

2.8 The aircraft operator

The investigation found that the operator provided its pilots with route guidance material for routinely flown routes.

The pilot's knowledge and competency of terrain and gap flying over the route Nadzab to Wasu to Nadzab, via the Saidor Gap had been tested in October 2018 in a PAC 750XL aircraft. (The same route as the accident flight.) The pilot passed the check flight and was cleared for line flying. There was no evidence of subsequent competency checks in the area of the accident and the Saidor Gap. Nor was there evidence of a subsequent competency check flight in the BN2B-26 aircraft; an aircraft with different performance characteristics from the PAC 750XL.

The operator informed the investigation that their *Route Guide* described two tracks from Wasu to Nadzab. Both involved flying via the Saidor Gap. That was listed in the *Table of Routes* as *Area 3* in the *NCA Route Guide*. However, the initial track details in the *Route Guide* differed from the route charts supplied to the investigators from the operator's *Oz Runways Electronic Flight Bag* app[27]. The outbound track from Nadzab in the *Route Guide* was 350 deg and the outbound track depicted on the *Oz Runways Route Chart* was 335 deg.

None of the *Route Guide* area routes provided a NCA approved alternate route from Wasu and the Sapmanga Valley to Nadzab if the Saidor Gap was impassable and in the case of Wasu to Nadzab if the Sapmanga Valley area and areas west and south were impassable due to cloud and adverse weather.

An alternate route from Wasu to Nadzab via the 20 Mile Gap or the Landslide Gap (NE of Lae) was not listed.

[27] *Oz Runways* is not a TSO approved app and is not approved as a primary navigation source as is a TSO-certified GPS. A TSO (*Technical Standard Order)* approval, specifically a TSO Authorization (TSOA), is a design and production approval granted by the Federal Aviation Administration (.gov) (FAA) to a manufacturer for an article that meets a specific minimum performance standard. It signifies that the article has been tested and found to meet the FAA's established standards for that particular type of article. This allows the manufacturer to produce the article and potentially incorporate it into aircraft designs.

2.9 Terrain warning systems

The aircraft was fitted with a *Garmin 430W* receiver which had a data card installed that provided colour coded *Terrain Avoidance and Warning System (TAWS)*. The operator had not subscribed to the Garmin manufacturer's audio alert interface and so the receiver's *TAWS* warnings and alert functionality was only visual.[28]

It is not uncommon for pilots flying in PNG under visual flight rules (VFR) to disregard warnings from these systems when flying across PNG terrain in visual conditions, with full situational awareness.

However, when flying in cloud or non-visual meteorological conditions, a pilot must comply with lowest safe altitude requirements and also immediately act on any terrain warning from the aircraft's on-board systems.

The investigation was unable to determine if the pilot received any terrain warnings.

2.9.1 Visual and aural warnings

Research into aircraft accidents has illustrated how pilots who are pre-occupied with a number of operational and /or complex tasks, have missed visual warnings even when they are in their field of view.

A pilot was more likely to detect the aircraft's proximity to terrain and take timely evasive action when receiving a *TAWS* aural warning than a visual warning alone. This is particularly the case when operating in marginal visual conditions and navigating over mountainous terrain.

2.9.2 Safety oversight

The CASA PNG is the statutory body with legal mandate to promote aviation safety and security through effective safety regulation of the civil aviation industry, with particular emphasis on preventing aviation accidents and incidents within the civil aviation system in Papua New Guinea.

On 9 November 2022, as a result of AIC *Safety Recommendation AIC 20-R027/19-1003*, CASA PNG issued *Safety Alert Bulletin SAB NO:02/2022*, titled *PNG Helicopter Operations – Inadvertent Flights into Instrument Meteorological Conditions (IIMC) and Lost Procedures.*[29] The AIC considers that this *Safety Bulletin* is also relevant to PNG fixed wing pilots' flight operations.

2.9.3 V2 Track

V2 Track cellular interrogation ceased over the last 1.68 nm (71 seconds). The manufacturer advised that satellite interrogation normally commenced 2 min after cellular drop out. However, the manufacturer's representative agreed that on the balance of probabilities, as detailed in *Section 2.4* above, that the aircraft was likely flown in cloud or precipitation.

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28 The Garmin GNS 430W has aural alert capabilities. It can provide aural advisories for both terrain and obstacle conflicts when equipped with the optional Helicopter Terrain Awareness and Warning System (HTAWS). The GNS 430W also supports visual and aural alerts for traffic (TIS) when paired with a GTX 330 Mode S transponder and an optional GDL 69A XM receiver. The GNS 430W can be upgraded with the HTAWS option, which provides both visual and aural warnings for potential terrain and obstacle hazards. The HTAWS provides both visual pop-up alerts on the display and audible warnings to alert the pilot of potential conflicts.

29 See Appendix 5.7 for CASA PNG Safety Alert Bulletin SAB NO:02/2022.

3 CONCLUSIONS

3.1 Findings

3.1.1. Aircraft

a) The aircraft had a valid *Certificate of Airworthiness*.

b) The maintenance records indicated that the aircraft was equipped and maintained in accordance with existing *PNG Civil Aviation Rules* and CASA PNG accepted maintenance procedures.

c) The aircraft was certified as being airworthy when dispatched for the flight from Nadzab.

d) The ELT installed on the aircraft emitted signals until it was consumed by the post-impact fire.

e) Based on the NCA agent's evidence and post-accident computations of load and trim the mass (weight) and the centre of gravity of the aircraft were likely within the prescribed limits.

f) There was no evidence of any defect or malfunction in the aircraft that could have contributed to the accident.

g) The aircraft was structurally intact prior to impact.

h) The aircraft was destroyed by high-speed impact forces and an intense post-impact fuel-fed fire.

i) The aircraft was fitted with a Global Navigation System receiver capable of providing visual terrain awareness warnings.

j) The aircraft was not fitted with a terrain aural warning interface.

k) Incorporation of an aural warning in conjunction with the visual terrain warning, may have prevented the accident.

3.1.2. Pilot

a) The pilot was licensed and qualified for the flight in accordance with the existing PNG Civil Aviation Rules.

b) The pilot was in compliance with the flight and duty time limitations in accordance with the existing PNG Civil Aviation Rules.

c) The pilot was properly licensed, certified as medically fit and was adequately relieved of operational duties for two days prior to 22 December 2024, which should have ensured he was adequately rested to operate the flight.

d) The pilot had been tested in October 2018 (6 years prior to the accident flight) in a PAC 750XL aircraft and found to have the knowledge and competency required to fly the route.

e) There was no evidence of subsequent competency checks in the area of the accident and the Saidor Gap in the BN2B-26 aircraft; an aircraft with different performance characteristics from the PAC 750XL.

f) The pilot's records including his logbook entries were incomplete and brief precluding any accurate assessment of his route and airstrip competence and recency.

g) There was no evidence that the pilot calculated the aircraft loaded weight and balance for the flight.

h) The pilot's injuries were severe and precluded any means of determining if he was holding the flight and engine controls at the time of impact.

3.1.3. Flight Operations

a) The flight was not conducted in accordance with the procedures in the company Operations Manual because the pilot likely continued flight below VMC when below lowest safe altitude for the track.

b) The pilot carried out normal radio communications with the relevant ATC units.

c) The pilot likely attempted to continue visual flight in instrument meteorological conditions.

d) In an area of rising terrain, the pilot likely tracked in cloud or heavy precipitation towards steeply rising terrain at an indicated airspeed 35 kts above the manufacturer's (flight tested) promulgated best angle of climb speed to avoid obstacles.

e) The investigation determined that the aircraft was likely flown in cloud or in marginal visual conditions when below the lowest safe altitude over the route, at a cruise climb speed. It struck vegetation and the face of a steep ridge with a resultant controlled flight into terrain.

3.1.4. Operator

a) The operator provided its pilots with route guidance material for routinely flown routes.

b) The operator's check and training of its pilots included testing knowledge and competency of terrain and gap flying.

c) There were some anomalies between the operators *Route Guide* and the route charts *Oz Runways Electronic Flight Bag* (EFB) app in the IT tablets in each aircraft.

d) Oz Runways used by NCA is not a TSO approved app and is not approved as a primary navigation source as is a TSO-certified GPS.

e) The *EFB* app used by NCA was not approved by CASA PNG for use by NCA for computing aircraft weight and balance for its flights.

f) The operator's Route Guide did not cover an alternate route from Wasu to Nadzab via the 20 Mile Gap or Landslide Gap northeast of Lae for use in the event of the tracks southwest of Wasu and the Saidor Gap being impassable.

3.1.5. Air Traffic Services and Airport Facilities

a) Communications between the pilot and Air Traffic Services were appropriate.

b) The Air Traffic Controller followed correct procedures for the declaration of the SAR phases.

c) There were some delays to the commencement of the aerial search due to the SAR Coordinator and NCA seeking to resolve the discrepancies between the *ELT* signal and *V2 Track* data.

d) The Air Traffic Services personnel commenced appropriate and timely Search and Rescue procedures to engage search and rescue aircraft while the location details were being resolved.

3.1.6. Flight Recorders

a) The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither were required by regulation.

b) The aircraft's track data, including altitude and groundspeed, was recorded on a third-party system, providing accurate tracking data that included track, speed and altitude.

3.1.7. Medical

a) Pathological or toxicological findings were not possible due to the extensive traumatic injuries and the extent of the burns sustained by the pilot.

b) Toxicological tests for alcohol, narcotics, common drugs, carbon monoxide, hydrogen cyanide were not possible due to the impact and fire injuries.

3.1.8. Survivability

a) The accident was not survivable due to the magnitude of the deceleration (impact) forces and the severity of the fuel-fed post-impact fire.

b) The occupants succumbed to the effects of the impact and the post-impact fire.

3.1.9. Safety Oversight

a) The Civil Aviation Safety Authority's safety oversight of the operator's procedures and operations was adequate.

3.2 Causes [Contributing factors]

In an area of rising terrain, the pilot either flew the track in cloud or in markedly reduced visibility, with no reference to terrain, towards steeply rising terrain at an indicated airspeed that was 35 kts above the manufacturer's (flight tested) promulgated best angle of climb speed to avoid obstacles. There was no evidence of a manoeuvre to avoid the terrain.

Furthermore, investigation determined that the aircraft was flown in cloud or in reduced visibility at a cruise climb speed and struck vegetation and the face of a steep ridge resulting in controlled flight into terrain.

The aircraft was fitted with a Global Navigation System receiver capable of providing visual terrain awareness warnings. It was not fitted with a terrain aural warning interface. Incorporation of an aural warning in conjunction with the visual terrain warning, may have prevented the accident.

3.3 Other factors

Other factors is used for safety deficiencies or concerns that are identified during the course of the investigation, that while not causal to the accident, nevertheless should be addressed with the aim of accident and serious incident prevention, and the safety of the travelling public.

3.3.1 Route Guide

The investigation noted that the NCA Route Guide Area 3 Routes 1 and 2 and 3 and 4 differed from the NCA *Oz Runways Electronic Flight Bag (EFB)* app in the IT tablets located in each aircraft of the operator's fleet. The *EFB* app used by NCA was not approved by CASA PNG for use by NCA

Furthermore, the Route Guide did not cover an alternate route from Wasu to Nadzab the 20 Mile Gap or Landslide Gap (NE of Lae) for use in the event of the tracks southwest of Wasu and the Saidor Gap being impassable.

The AIC understands that due to environmental and visual conditions it may be prudent or expedient for a pilot to take different tracks in the general area specified in the Route Guide.

However, the guide must ensure no confusion and also should provide guidance for alternate routes for example east and south of Wasu as distinct from the NCA preferred routes west and south of Wasu.

4 RECOMMENDATIONS AND SAFETY ACTIONS

4.1 Recommendations

As a result of the investigation into the accident involving the Pilatus Britten-Norman BN2B-26 aircraft registered P2-SAM, about 32 nm north of Nadzab, Morobe Province, Papua New Guinea on 22 December 2024, the Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.1.1 Recommendation AIC 25-R06/24-1003 to North Coast Aviation Limited

Date Issued: 16 May 2025

The PNG Accident Investigation Commission (AIC) recommends that North Coast Aviation Limited (NCA) should ensure effective operational control measures and quality controls are in place to ensure pilot's records and company documents, especially operational documents including training records, are maintained and records kept up to date. Specifically covering route and airstrip training competency and recency and record keeping.

Action requested

The AIC requests that North Coast Aviation Limited (NCA) note recommendation *AIC 25-R06/24-1003* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how NCA has addressed the safety deficiency identified in the safety recommendation.

STATUS: ISSUED.

4.1.2 Recommendation AIC 25-R07/24-1003 to North Coast Aviation Limited

Date Issued: 16 May 2025

The PNG Accident Investigation Commission (AIC) recommends that North Coast Aviation Limited (NCA) should ensure that there is no possibility of route guidance confusion between the *NCA Route Guide* and the NCA *Oz Runways Electronic Flight Bag app Route Guide* in the IT tablets located in each of the operator's aircraft for flight operations and provide route guidance for alternate routes. For example, a route east and southeast of Wasu as distinct from the NCA preferred routes west and south of Wasu for use in the event of the tracks southwest of Wasu and the Saidor Gap being impassable.

Action requested

The AIC requests that North Coast Aviation Limited (NCA) note recommendation *AIC 25-R07/24-1003* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how NCA has addressed the safety deficiency identified in the safety recommendation.

STATUS: ISSUED.

4.1.3 Recommendation AIC 25-R08/24-1003 to North Coast Aviation Limited

Date Issued: 16 May 2025

The PNG Accident Investigation Commission (AIC) recommends that North Coast Aviation Limited (NCA) should ensure that aircraft in its fleet fitted with Global Navigation System receivers with terrain warning functionality to have the capability of displaying colour coded warnings and issuing aural alerts and that the serviceability of those systems is maintained.

Action requested

The AIC requests that North Coast Aviation Limited (NCA) note recommendation *AIC 25-R08/24-1003* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how NCA has addressed the safety deficiency identified in the safety recommendation.

STATUS: ISSUED.

4.1.4 Recommendation AIC 25-R09/24-1003 to the Civil Aviation Safety Authority of Papua New Guinea

Date Issued: 16 May 2025

The PNG Accident Investigation Commission (AIC) recommends that the Civil Aviation Safety Authority of Papua New Guinea should require that operators of PNG registered aircraft fitted with Global Navigation System receivers with terrain warning functionality to activate the capability of displaying colour coded warnings and issuing aural alerts and that the serviceability of those systems is maintained.

Action requested

The AIC requests that the Civil Aviation Safety Authority of Papua New Guinea (CASA PNG) note recommendation *AIC 25-R09/24-1003* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how CASA PNG has addressed the safety deficiency identified in the safety recommendation.

STATUS: ISSUED.

4.1.5 Recommendation AIC 25-R10/24-1003 to the Civil Aviation Safety Authority of Papua New Guinea

Date Issued: 16 May 2025

The PNG Accident Investigation Commission (AIC) recommends that the Civil Aviation Safety Authority of Papua New Guinea, when conducting audits of operators, should ensure that effective operational control measures and quality controls are in place to ensure pilot's records and company documents, especially operational documents including training records, are maintained. CASA PNG audits should verify that operator's records covering route and airstrip training competency and recency are kept up to date.

Action requested

The AIC requests that Civil Aviation Safety Authority of Papua New Guinea note recommendation *AIC 25-R10/24-1003* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how NCA has addressed the safety deficiency identified in the safety recommendation.

STATUS: ISSUED.

This Final Report is released by;

Accident Investigation Commission

Ministry of Civil Aviation

Papua New Guinea

30 July 2025

ACCIDENT INVESTIGATION COMMISSION
The Common Seal of
PAPUA NEW GUINEA

MARYANNE J. WAL
CHIEF COMMISSIONER / CHAIRMAN

CAPTAIN ARIA BOURAGA
COMMISSIONER / DEPUTY CHAIRMAN

5 APPENDIXES

5.1 V2 Track data table and P2-SAM track overlaid on terrain graphic[30]

V2 Track GPS cellular / Satellite interrogations and AIC GPS Information

Map Reference	V2 Track Recorded data							Calculated by AIC using V2 Track data and AIC GPS information					Positions / Events
	Time	Latitude (° ′ ″)	Longitude (° ′ ″)	Altitude (ft)	GND Speed (kts)	Bearing between each position (°)	Data Source	Bearing between each position (°)	Distance between each position (NM)	Rate Of Climb Ft/min	Latitude (° ′ ″)	Longitude (° ′ ″)	
A	10:21:43	5° 57′ 41″ S	146° 59′ 56″ E	5574	91	240	Cellular	243	0.37				Made left turn
B	10:21:58	5° 57′ 52″ S	146° 59′ 37″ E	5745	84	238	Cellular	239	0.36	684			Track Southwest
C	10:22:13	5° 58′ 03″ S	146° 59′ 19″ E	5879	84	236	Cellular	237	0.35	536			
D	10:22:28	5° 58′ 15″ S	146° 59′ 02″ E	6004	84	235	Cellular	238	0.35	500			
E	10:22:43	5° 58′ 27″ S	146° 58′ 44″ E	6132	84	234	Cellular	237	0.35	512			
F	10:22:58	5° 58′ 40″ S	146° 58′ 27″ E	6247	85	233	Satellite	237	0.35	496			
G	10:23:14	5° 58′ 53″ S	146° 58′ 11″ E	6391	82	232	Cellular	234	0.35	576			
H	10:23:29	5° 59′ 05″ S	146° 57′ 54″ E	6512	82	233	Cellular	233	0.34	484			
I	10:23:44	5° 59′ 18″ S	146° 57′ 37″ E	6604	86	235	Cellular	232	0.35	360			
J	10:23:59	5° 59′ 30″ S	146° 57′ 19″ E	6716	86	235	Cellular	234	0.36	448			
K	10:24:14	5° 59′ 43″ S	146° 57′ 02″ E	6808	86	229	Cellular	236	0.35	368			
L	10:24:29	5° 59′ 58″ S	146° 56′ 46″ E	6916	86	228	Cellular	241	0.36	432			
M	10:24:44	6° 00′ 12″ S	146° 56′ 29″ E	7024	87	228	Cellular	236	0.36	432			
N	10:24:59	6° 00′ 27″ S	146° 56′ 12″ E	7113	88	233	Cellular	233	0.37	356			
O	10:25:14	6° 00′ 40″ S	146° 55′ 54″ E	7260	84	233	Cellular	238	0.38	588			
P	10:25:29	6° 00′ 54″ S	146° 55′ 37″ E	7352	88	231	Cellular	235	0.36	368			Last of V2 Track 15 sec
Q	10:26:59	6° 02′ 10″ S	146° 53′ 51″ E	8002	85	220	Cellular	235	2.17	433			Last interrogation point by V2 Track
R	10:28:10				85			240	1.68		6° 03′ 00.21″ S Source: AIC onsite Team GPS coordinates	146° 52′ 22.68″ E	Impact Point

Figure 21: Track data table and P2-SAM track overlaid on terrain graphic

30 The data calibrated by the AIC was from V2 Track recorded data to calculate time, bearing and distance and used the GPS coordinates of the impact point taken by the AIC on-site investigator to establish the track of the last 1.68 nm.

5.2 Aircraft track sourced from V2 Track data overlaid on terrain mapping

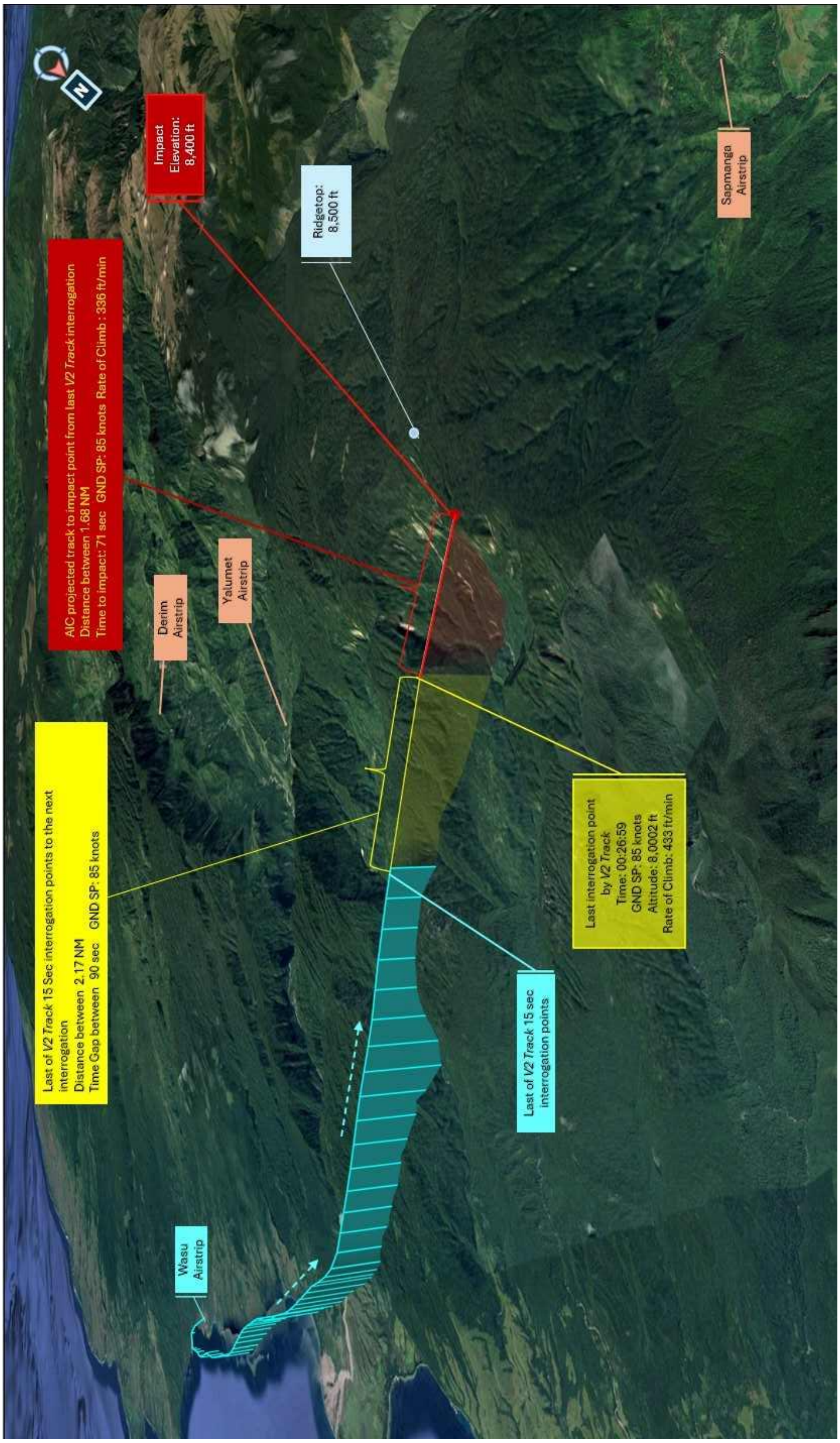


Figure 22:Aircraft track sourced from V2 Track data overlaid on terrain mapping

5.3 Auditory and visual alerts for Terrain Awareness and Warning Systems

Aircraft terrain warning systems (like *TAWS/EGPWS*) use both visual and auditory alerts to warn pilots about potential hazards, with aural alerts prioritized for immediate attention, and visual alerts providing supplementary information and context.

***TAWS/EGPWS*:**

- **Data Inputs:** *TAWS/EGPWS* systems use data from various sources, including:
  - **Digital terrain databases:** Maps of the Earth's terrain.
  - **Radar altimeters:** Measure the aircraft's altitude relative to the ground.
  - **GPS:** Determine the aircraft's position.
- **Alerts:**
  - **Excessive closure rates to terrain:** If the aircraft is approaching the ground at a dangerous speed.
  - **Proximity to the ground:** If the aircraft is flying too close to the ground.
  - **Descent or flight path below safe altitudes:** If the aircraft is descending below safe altitudes, such as during non-landing configurations.
  - **Excessive sink rate:** If the aircraft is descending too quickly.
  - **Loss of altitude after takeoff or go-around:** If the aircraft is losing altitude after takeoff or a go-around.
  - **Deviation from the ILS glideslope:** If the aircraft is deviating from the ILS glideslope.

Visual Alerts:

Purpose: To provide context and additional information about the nature and severity of the hazard.

Examples:

- **Color-coded displays:** Red for warnings, amber/yellow for cautions, and other colours for advisories.
- **Terrain displays:** Show the aircraft's position relative to terrain and obstacles.
- **Obstacle displays:** Highlight potential obstacles on the flight path.

Importance:

- Visual alerts allow pilots to assess the situation and make informed decisions.

Auditory Alerts:

Purpose: To immediately grab the pilot's attention and signal an imminent danger.

Examples include:

- Voice callout "Terrain, Terrain, Pull Up!"
- Voice callout "Ground Proximity"
- Bells, chimes, horn

Importance: Aural warnings are crucial in situations where pilots might be distracted or have their attention elsewhere.

- **Voice Warning Systems:** Some aircraft use voice warning or tone systems to enunciate warnings.

***TAWS* alerts are based on estimated time to impact**.

5.4 Graphic of accident site slope and tree impacts

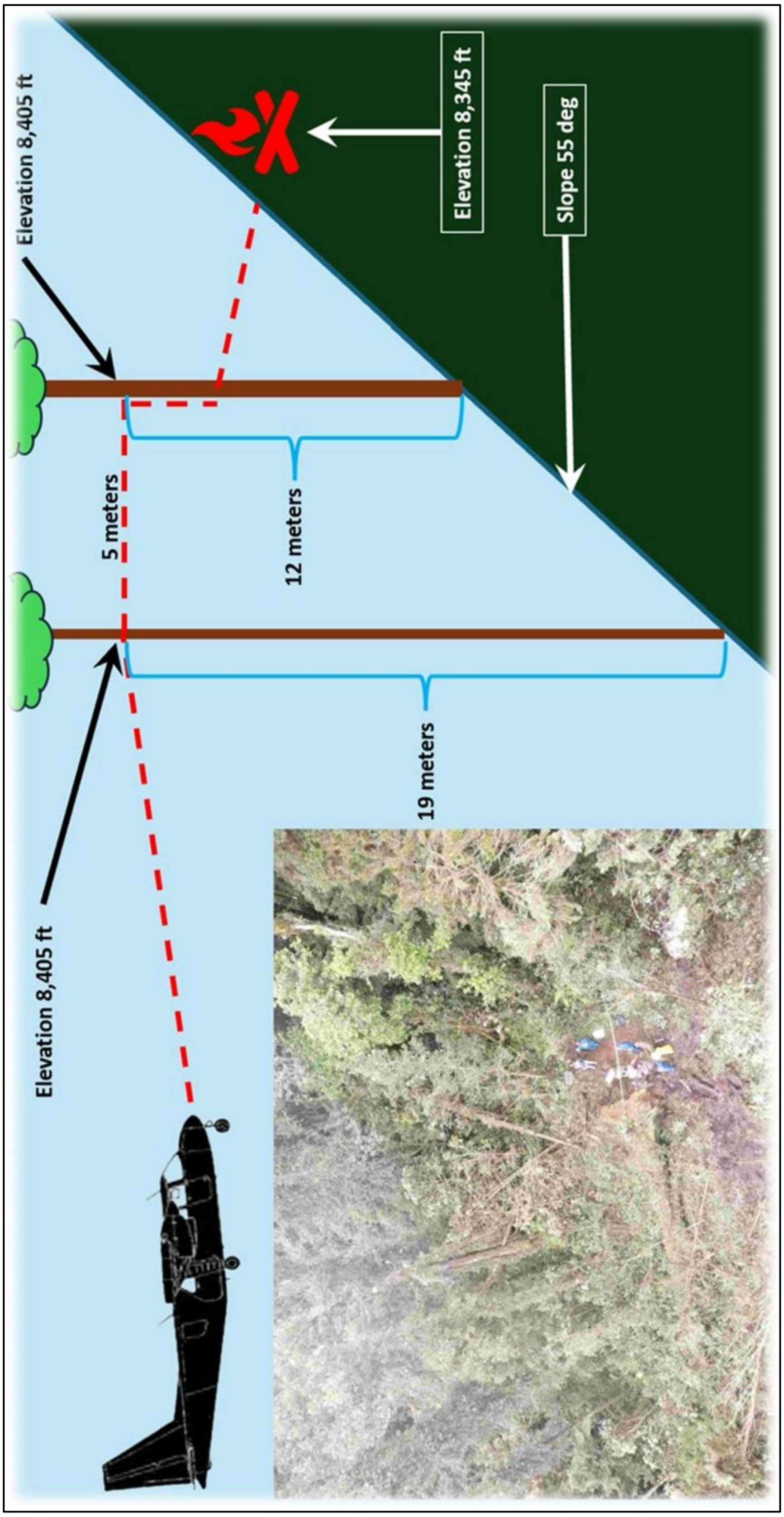


Figure 23: Graphic interpretation of accident site slope and tree impact (Created by AIC)

5.5 Search helicopter track by V2 Track app

The Manalos Aviation search helicopter was tracked using the V2 Track system. Enroute to the accident site the Digicel Cellular Tower PG3112 automatically interrogated the search helicopter. The cell tower is located 12.08 NM bearing 115 deg from the accident site. PG3112 is 3.35 NM on a bearing of 105.24 deg to Derim airstrip.

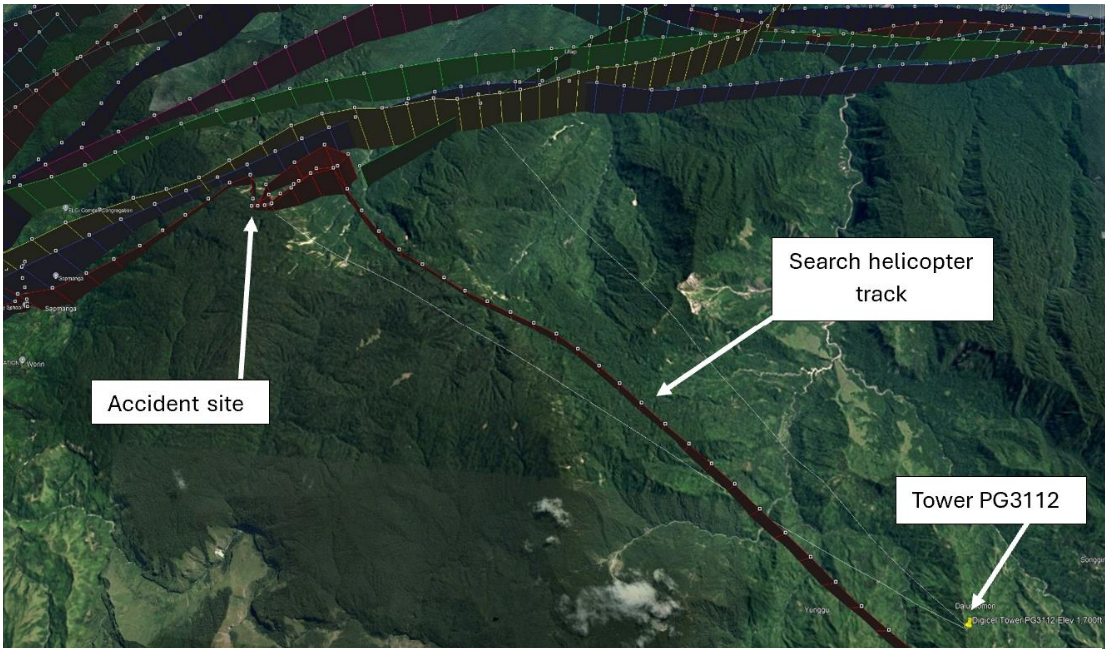


Figure 24: Search helicopter track and Digicel Cellular Tower

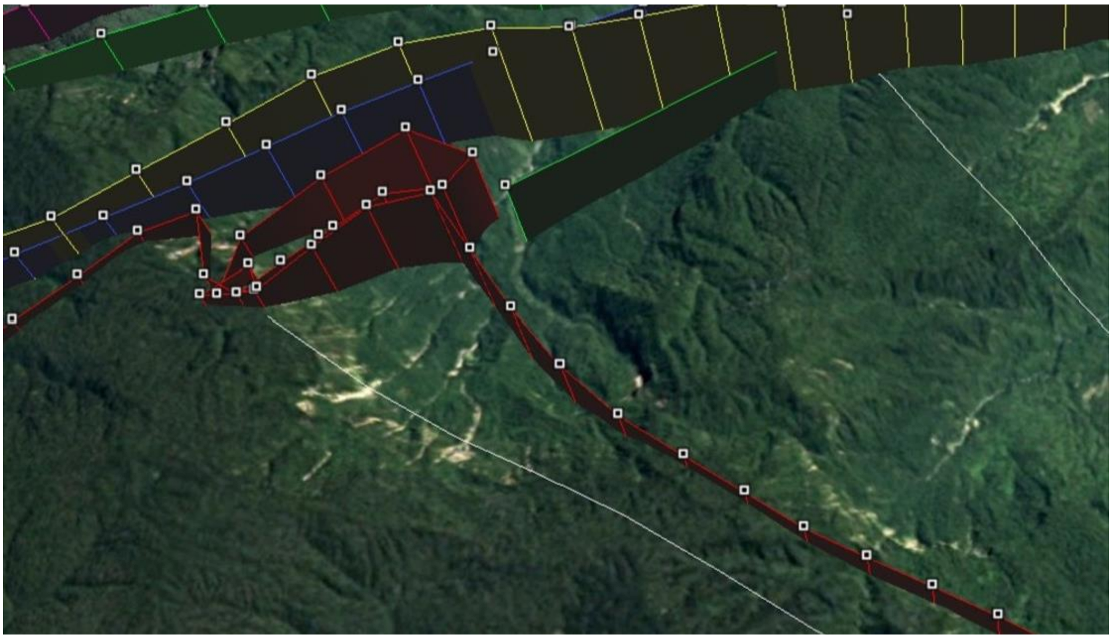
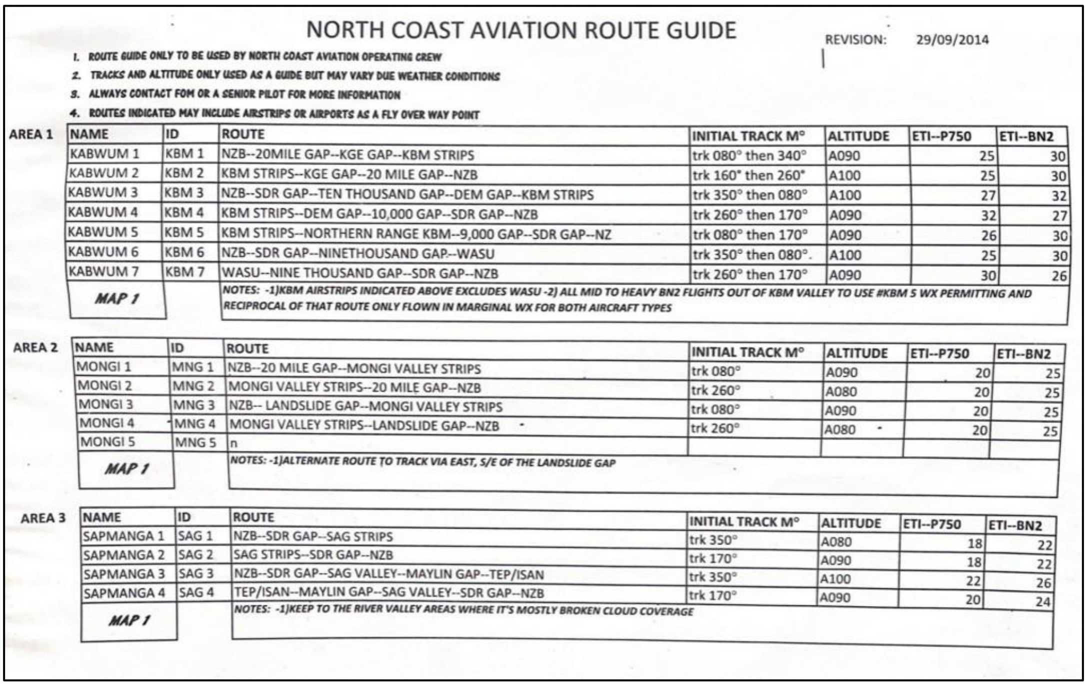


Figure 25: Search helicopter track approaching the accident site as described in Section 1.15.2

5.6 North Coast Aviation Route Guide



NORTH COAST AVIATION ROUTE GUIDE

REVISION: 29/09/2014

1. ROUTE GUIDE ONLY TO BE USED BY NORTH COAST AVIATION OPERATING CREW
2. TRACKS AND ALTITUDE ONLY USED AS A GUIDE BUT MAY VARY DUE WEATHER CONDITIONS
3. ALWAYS CONTACT FOM OR A SENIOR PILOT FOR MORE INFORMATION
4. ROUTES INDICATED MAY INCLUDE AIRSTRIPS OR AIRPORTS AS A FLY OVER WAY POINT

AREA 1

NAME	ID	ROUTE	INITIAL TRACK M°	ALTITUDE	ETI--P750	ETI--BN2
KABWUM 1	KBM 1	NZB--20MILE GAP--KGE GAP--KBM STRIPS	trk 080° then 340°	A090	25	30
KABWUM 2	KBM 2	KBM STRIPS--KGE GAP--20 MILE GAP--NZB	trk 160° then 260°	A100	25	30
KABWUM 3	KBM 3	NZB--SDR GAP--TEN THOUSAND GAP--DEM GAP--KBM STRIPS	trk 350° then 080°	A100	27	32
KABWUM 4	KBM 4	KBM STRIPS--DEM GAP--10,000 GAP--SDR GAP--NZB	trk 260° then 170°	A090	32	27
KABWUM 5	KBM 5	KBM STRIPS--NORTHERN RANGE KBM--9,000 GAP--SDR GAP--NZ	trk 080° then 170°	A090	26	30
KABWUM 6	KBM 6	NZB--SDR GAP--NINETHOUSAND GAP--WASU	trk 350° then 080°.	A100	25	30
KABWUM 7	KBM 7	WASU--NINE THOUSAND GAP--SDR GAP--NZB	trk 260° then 170°	A090	30	26
MAP 1		NOTES: -1)KBM AIRSTRIPS INDICATED ABOVE EXCLUDES WASU -2) ALL MID TO HEAVY BN2 FLIGHTS OUT OF KBM VALLEY TO USE #KBM 5 WX PERMITTING AND RECIPROCAL OF THAT ROUTE ONLY FLOWN IN MARGINAL WX FOR BOTH AIRCRAFT TYPES				

AREA 2

NAME	ID	ROUTE	INITIAL TRACK M°	ALTITUDE	ETI--P750	ETI--BN2
MONGI 1	MNG 1	NZB--20 MILE GAP--MONGI VALLEY STRIPS	trk 080°	A090	20	25
MONGI 2	MNG 2	MONGI VALLEY STRIPS--20 MILE GAP--NZB	trk 260°	A080	20	25
MONGI 3	MNG 3	NZB-- LANDSLIDE GAP--MONGI VALLEY STRIPS	trk 080°	A090	20	25
MONGI 4	MNG 4	MONGI VALLEY STRIPS--LANDSLIDE GAP--NZB	trk 260°	A080	20	25
MONGI 5	MNG 5	n				
MAP 1		NOTES: -1)ALTERNATE ROUTE TO TRACK VIA EAST, S/E OF THE LANDSLIDE GAP				

AREA 3

NAME	ID	ROUTE	INITIAL TRACK M°	ALTITUDE	ETI--P750	ETI--BN2
SAPMANGA 1	SAG 1	NZB--SDR GAP--SAG STRIPS	trk 350°	A080	18	22
SAPMANGA 2	SAG 2	SAG STRIPS--SDR GAP--NZB	trk 170°	A090	18	22
SAPMANGA 3	SAG 3	NZB--SDR GAP--SAG VALLEY--MAYLIN GAP--TEP/ISAN	trk 350°	A100	22	26
SAPMANGA 4	SAG 4	TEP/ISAN--MAYLIN GAP--SAG VALLEY--SDR GAP--NZB	trk 170°	A090	20	24
MAP 1		NOTES: -1)KEEP TO THE RIVER VALLEY AREAS WHERE IT'S MOSTLY BROKEN CLOUD COVERAGE				

Figure 26:North Coast Aviation Route Guide

The following Figures 27 and 28 are sourced from the NCA Route Guide in the NCA Oz Runways Electronic Flight Bag app with the track flown by SAM on 22 December.

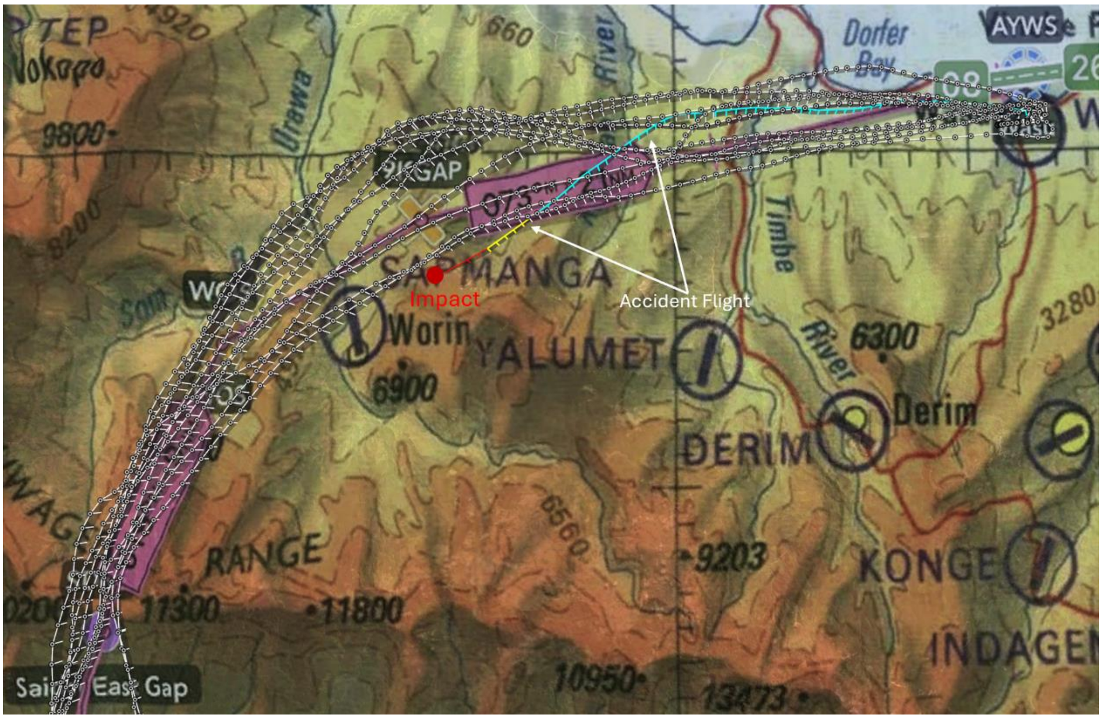


Figure 27:NCA Route Guide Chart for Area 3 Sapmanga 1 and 2 with SAM and previous flight tracks depicted

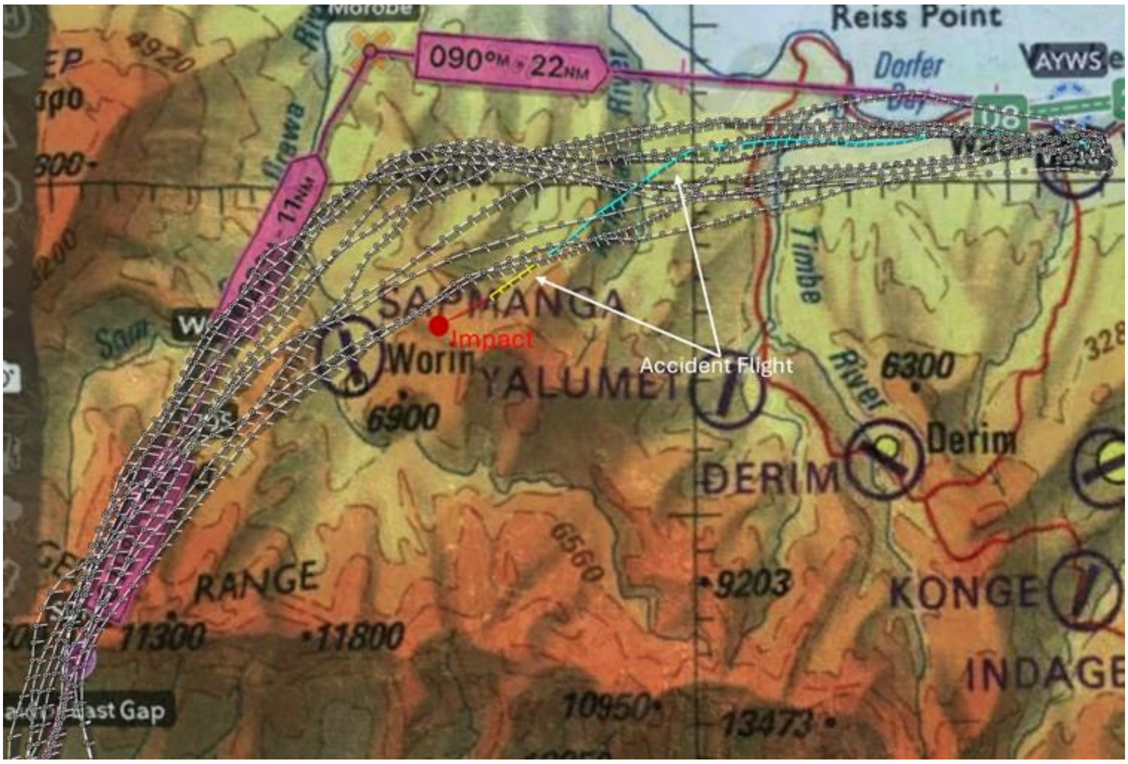


Figure 28:NCA Route Guide Chart for Area 3 Sapmanga 3 and 4 with SAM and previous flight tracks depicted

5.7 CASA PNG Safety Alert Bulletin SAB NO:02/2022

CIVIL AVIATION SAFETY AUTHORITY OF PAPUA NEW GUINEA

SAFETY ALERT BULLETIN

SAB NO: 02/2022

DATE 09/11/2022

A SAB contains important safety information and may include recommended action. SAB content should be especially valuable to air operators in meeting their statutory duty to provide service with the highest degree of safety in the public interest. Besides specific action(s) recommended in a SAB, an alternative action may be as effective in addressing the safety issue named in the SAB.

TITLE: PNG Helicopter Operations – Inadvertent Flights into Instrument Meteorological Conditions (IIMC) and Lost Procedures

OBJECTIVE:

This SAB provides safety guidance information to help helicopter pilots avoid accidents when:

- Encountering disorientation, flying over unfamiliar territory, or in visibility conditions that is low enough to render familiar terrain unfamiliar; and
- flying in unforecast weather conditions that may quickly deteriorate into degraded visibility conditions placing the pilot in a situation of increased risk of unintentional flight in Instrument Meteorological Conditions (UIMC).

APPLICABILITY: This SAB is applicable to PNG Helicopter pilots.

BACKGROUND:

Recent accidents within the PNG Helicopter operations were a result of inadvertent flight into Instrument Meteorological Conditions.

Helicopter pilots should always expect the worst hazards and possible aerodynamic effects and plan for a safe exit path or procedure to compensate for the hazard. Recovery needs to be quick and precise. By

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having a thorough knowledge of the helicopter, its systems, anticipation of possible malfunctions and failures, and methods of recovery will help a pilot avoid accidents and be a safer pilot.

Helicopter emergencies and the proper recovery procedures should be discussed and, when possible, practiced in flight. In addition, by knowing the conditions that can lead to an emergency, many potential accidents can be avoided.

Lost Procedures

Pilots may become lost while flying for a variety of reasons, such as disorientation, flying over unfamiliar territory, or visibility that is low enough to render familiar terrain unfamiliar. When a pilot becomes lost, the first order of business is to fly the helicopter; the second is to implement lost procedures. Keep in mind that the pilot workload will be high, and increased concentration will be necessary. If lost, always remember to look for the practically invisible hazards, such as wires, by searching for their support structures, such as poles or towers, which are almost always near roads.

If lost, follow common sense procedures:

- Try to locate any large landmarks, such as mountains, lakes, rivers, towers, railroad tracks, or Interstate highways. If a landmark is recognized, use it to find the helicopter's location on the sectional chart. If flying near a town or city, a pilot may be able to read the name of the town on a water tower or even land to ask for directions.
- If no town or city is nearby, the first thing a pilot should do is climb. An increase in altitude increases radio and navigation reception range as well as radar coverage.
- Navigation aids, dead reckoning, and pilotage are skills that can be used as well.
- Do not forget air traffic control (ATC)—controllers assist pilots in many ways, including finding a lost helicopter. Once communication with ATC has been established, follow their instructions.

These common-sense procedures can be easily remembered by using the 4 Cs: Climb, Communicate, Confess, and Comply:

- **Climb** for a better view, improved communication and navigation reception, and terrain avoidance.
- **Communicate** by calling the nearest flight service station (FSS) applicable to the area of operation. If the FSS does not respond, call the nearest control tower, center, or approach control. For frequencies, check the chart in the vicinity of the last known position. If that fails, switch to the emergency radio frequency (121.5 MHz) and transponder code (7700).
- **Confess.** Report the lost situation to ATC and request help.
- **Comply** with controller instructions.

Pilots should understand the services provided by ATC and the resources and options available. These services enable pilots to focus on aircraft control and help them make better decisions in a time of stress.

When contacting ATC, pilots should provide as much information as possible because ATC uses the information to determine what kind of assistance it can provide with available assets and capabilities. Information requirements vary depending on the existing situation, but at a minimum a pilot should provide the following information:

- Aircraft identification and type
- Nature of the emergency
- Aviator's desires

To reduce the chances of getting lost in the first place, use flight following through active contact with an aircraft during flight either by radio or through automated flight following systems when it is available, monitor checkpoints no more than 25 miles apart, keep navigation aids such as Very High-Frequency Omni-Directional Range (VOR) tuned in, and maintain good situational awareness. Flight following provides ongoing surveillance information to assist pilots in avoiding collisions with other aircraft.

Getting lost is a potentially dangerous situation for any aircraft, especially when low on fuel. Due to the helicopter's unique ability to land almost anywhere, pilots have more flexibility than other aircraft as to landing site. An inherent risk associated with being lost is waiting too long to land in a safe area. Helicopter pilots should land before fuel exhaustion occurs because maneuvering with low fuel levels could cause the engine to stop due to fuel starvation as fuel sloshes or flows away from the pickup port in the tank.

If lost and low on fuel, it is advisable to make a precautionary landing. Preferably, land near a road or in an area that would allow space for another helicopter to safely land and provide assistance. Having fuel delivered is a minor inconvenience when compared to having an accident. Once on the ground, pilots may seek assistance.

VFR Flight into Instrument Meteorological Conditions

Helicopters, unlike airplanes, generally operate under Visual Flight Rules (VFR) and require pilots to maintain aircraft control by visual cues. However, when unforecast weather leads to degraded visibility, the pilot may be at increased risk of Inadvertent flight into Instrument Meteorological Conditions (IIMC). During an IIMC encounter, the pilot may be unprepared for the loss of visual reference, resulting in a reduced ability to continue safe flight. IIMC is a life- threatening emergency for any pilot. To capture these IIMC events, the International Civil Aviation Organization (ICAO) Common Taxonomy Team (CICTT) categorizes this occurrence as Unintended flight in Instrument Meteorological Conditions (UIMC). This term is also recognized by CASA PNG to classify occurrences (accidents and incidents) at a high level to improve the capacity to focus on common safety issues and complete analysis of the data in support of safety initiatives.

The onset of IIMC may occur gradually or suddenly, has no simple procedural exit, and is unlike flight training by reference to while in Visual Meteorological Conditions (VMC). Most training helicopters are not equipped or certified to fly under Instrument Flight Rules (IFR). Therefore, helicopter pilots may not have the benefit of flight in actual Instrument Meteorological Conditions (IMC) during their flight training. Helicopter pilots that encounter IIMC may experience physiological illusions which can lead to spatial disorientation and loss of aircraft control. Even with some instrument training, many available and accessible helicopters are not equipped with the proper augmented safety systems or autopilots, which would significantly aid in helicopter control during an IIMC emergency. The need to use outside visual references is natural for helicopter pilots because much of their flight training is based upon visual cues, not on flight instruments. This primacy can only be overcome through significant instrument training. Additionally, instrument flight may be intimidating to some and too costly for others. As a result, many helicopter pilots choose not to seek an instrument rating.

While commercial helicopter operators often prefer their pilots to be instrument rated, fatal accidents still occur as a result of IIMC. Many accidents can be traced back to the pilot's inability to recover the helicopter after IIMC is encountered, even with adequate equipment installed. Therefore, whether instrument rated or not, all pilots should understand that avoiding IIMC is critical.

A good practice for any flight is to set and use personal minimums, which should be more conservative than those required by regulations for VFR flight. In addition, a thorough preflight and understanding of weather conditions that may contribute to the risk of IMC developing along a planned route of flight is essential for safety. Pilots should recognize deteriorating weather conditions so the route of flight can be changed or a decision made to terminate the flight and safely land at a suitable area, well before IIMC occurs. If weather conditions deteriorate below the pilot's personal minimums during flight, a pilot who understands the risks of IIMC knows that he or she is at an en route decision point, where it is necessary to either turn back to the departure point or immediately land somewhere safe to wait until the weather has cleared. Pilots should recognize that descent below a predetermined minimum altitude above ground level (AGL) (for example, 500 feet AGL) to avoid clouds or, slowing the helicopter to a predetermined minimum airspeed (for example, slowing to 50 KIAS) to reduce the rate of closure from the deteriorating weather conditions, indicates the decision point had been reached. Ceilings that are lower than reported and/or deteriorating visibility along the route of flight should trigger the decision to discontinue and amend the current route to avoid IIMC.

If the helicopter pilot is instrument rated, it is advisable to maintain instrument currency and proficiency as this may aid the pilot in a safe recovery from IIMC. A consideration for instrument rated pilots when planning a VFR flight should include a review of published instrument charts for safe operating altitudes, e.g. minimum safe altitude (MSA), minimum obstruction clearance altitude (MOCA), minimum in VMC throughout a flight: off-route altitude (MORA), etc. If IIMC occurs, the pilot may consider a climb to a safe altitude. Once the helicopter is stabilized, the pilot should declare an emergency with air traffic control (ATC). It is imperative that the pilot commit to controlling the helicopter and remember to **aviate, navigate, and finally communicate.** Often communication is attempted first, as it is natural to look for help in stressful situations. This may distract the pilot from maintaining control of the helicopter.

If the pilot is not instrument rated, instrument current nor proficient, or is flying a non-IFR equipped helicopter, remaining in VMC is paramount. Pilots who are not trained or proficient in flight solely by reference to instruments have a tendency to attempt to maintain flight by visual ground reference, which tends to result in flying at lower altitudes, just above the trees or by following roads. The thought process is that, "as long as I can see what is below me, I can continue to my intended destination." Experience and statistical data indicate that attempting to continue VFR flight into IMC can often lead to a fatal outcome as pilots often fixate on what they see below them and are unable to see the hazards ahead of them (e.g., power lines, towers, rising terrain, etc.). By the time the pilot sees the hazard, it is either too late to avoid a collision, or while successfully maneuvering to avoid an obstacle, the pilot becomes disoriented.

Flying at night involves even more conservative personal minimums to ensure safety and avoidance of IIMC than daytime flying. At night, deteriorating weather conditions may be difficult to detect. Therefore, pilots should ensure that they not only receive a thorough weather briefing, but that they remain vigilant for unforecasted weather during their flight. The planned route should include preselected landing sites that will provide options to the pilot in the event a precautionary landing is

required to avoid adverse weather conditions. As a pilot gains night flight experience their ability to assess weather during a flight will improve.

Below are some basic guidelines to assist a pilot to remain in VMC throughout a flight:

1. Slowly turn around if threatened by deteriorating visual cues and proceed back to VMC or to the first safe landing area if the weather ahead becomes questionable. Remember that prevention is paramount.
2. Do not proceed further on a course when the terrain ahead is not clearly discernible.
3. Delay or consider cancelling the flight if weather conditions are already questionable, could deteriorate significantly based on forecasts, or if you are uncertain whether the flight can be conducted safely. Often, a "gut-feeling" can provide a warning that unreasonable risks are present.
4. Always have a safe landing area (such as large open areas or airports) in mind for every route of flight.

There are five basic steps that every pilot should be familiar with, and which should be executed immediately at the onset of IIMC, if applicable. However, remember that if you are not trained to execute the following maneuvers solely by reference to instruments, or your aircraft is not equipped with such instruments, this guidance may be less beneficial to you and loss of helicopter control may occur:

1. **Level the "wings"** – level the bank angle using the attitude indicator.
2. **Attitude** – set a climb attitude that achieves a safe climb speed appropriate to your type of helicopter. This is often no more than 10° of pitch up on the attitude indicator.
3. **Airspeed** – verify that the attitude selected has achieved the desired airspeed. It is critical to recognize that slower airspeeds, closer to effective translational lift, may require large control inputs and will decrease stability, making recover impossible while in UIMC.
4. **Power** – adjust to a climb power setting relative to the desired airspeed. This should be executed concurrent with steps 2 and 3.
5. **Heading and Trim** – pick a heading known to be free of obstacles and maintain it. This will likely be the heading you were already on, which was planned and briefed. Set the heading bug, if installed, to avoid over- controlling your bank. Maintain coordinated flight so that an unusual attitude will not develop.

Try to avoid immediately turning 180°. Turning around is not always the safest route and executing a turn immediately after UIMC may lead to spatial disorientation. If a 180° turn is the safest option, first note the heading you are on then begin the turn to the reciprocal heading, but only after stable flight is achieved (items 1 through 5 above) and maintain a constant rate of turn appropriate to the selected airspeed.

Each encounter with UIMC is unique, and no single procedure can ensure a safe outcome. Considerations in determining the best course of action upon encountering UIMC should include, at a minimum, terrain, obstructions, freezing levels, aircraft performance and limitations, and availability of ATC services.

There are new technologies being developed regarding aircraft design, enhanced and lower-cost technologies, and aircraft certification. Because of this promising future, much of the discussion and guidance in this chapter may one day become irrelevant. As helicopters integrate more into the National Airspace System, the IFR infrastructure and instrument training will become more prevalent. In the future, UIMC may no longer be the emergency that ends with a fatality but rather associated with proper prevention, skilled recovery techniques along with the aid of emerging new life saving avionics technology.

A helicopter instrument rating may be a life-saving addition to a pilot's level of certification.

When faced with deteriorating weather, planning and prevention, not recovery, are the best strategies to eliminate UIMC-related accidents and fatalities.

ENQUIRIES:

For any further enquiries regarding the contents of this Safety Information Bulletin (SIB), you may contact the CASA PNG Manager Flying Operations Branch:

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