ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 23-1006

Heli Solutions Limited

P2-HSN

Bell 407

Loss of visibility and collision with a tree during landing

Gebrau Village

Madang Province

Papua New Guinea

22 September 2023

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ABOUT THE AIC

The Accident Investigation Commission (AIC) is an independent statutory agency within Papua New Guinea (PNG). The AIC is governed by a Commission and is entirely separate from the judiciary, transport regulators, policy makers and service providers. The AIC's function is to improve safety and public confidence in the aviation mode of transport through excellence in: independent investigation of aviation accidents and other safety occurrences within the aviation system; safety data recording and analysis; and fostering safety awareness, knowledge and action.

The AIC is responsible for investigating accidents and other transport safety matters involving civil aviation in PNG, as well as participating in overseas investigations involving PNG registered aircraft. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The AIC performs its functions in accordance with the provisions of the *PNG Civil Aviation Act 2000* , and the *Commissions of Inquiry Act 1951*, and in accordance with *Annex 13* to the *Convention on International Civil Aviation.*

The objective of a safety investigation is to identify and reduce safety-related risk. AIC investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the AIC to apportion blame or determine liability. At the same time, an investigation report must include relevant factual material of sufficient weight to support the analysis and findings. At all times the AIC endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why it happened, in a fair and unbiased manner.

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ABOUT THIS REPORT

On 22 September 2023 at 16:50 local time (06:50 UTC), the AIC was notified by Niusky Pacific via a phone call of an accident involving a Bell 407 helicopter, registered P2-HSN, owned and operated by Heli Solutions, when during hover to land, the rotor blades struck a tree at Gebrau Village, Madang Province. The AIC immediately commenced an investigation and a team was deployed to the accident site on 23 September 2023.

This accident investigation *Final Report* has been produced by the AIC, P O Box 1709, Boroko 121, NCD Papua New Guinea. It has been approved for public release by the Commission in accordance with *Para 6.5* of *ICAO Annex 13*. The report is published on the AIC website www.aic.gov.pg.

The report is based on the investigation carried out by the AIC under the Papua New Guinea *Civil Aviation Act 2000 (As Amended),* 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 and safety recommendations.

Although AIC investigations explore the areas surrounding an occurrence, only those facts that are 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.

Readers are advised that in accordance with *Annex 13* to the *Convention on International Civil Aviation*, it is not the purpose of an AIC 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 (Reference: *ICAO Annex 13, Chapter 3, paragraph 3.1*). Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose.

Maryanne J. Wal

Chief Commissioner
10 September 2024

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TABLE OF CONTENTS

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FIGURES

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TABLES

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GLOSSARY OF ABBREVIATIONS

AAR	:	Certificate of Annual Airworthiness Review
AGL	:	Above Ground Level
AIC	:	Accident Investigation Commission (PNG)
AMSL	:	Above Mean Sea Level
AOC	:	Air Operator Certificate
ATC	:	Air Traffic Control
ATS	:	Air Traffic Service
CAR	:	Civil Aviation Rule
CASA	:	Civil Aviation Safety Authority
CoR	:	Certificate of Registration
CoA	:	Certificate of Airworthiness
CPL	:	Commercial Pilot License
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
ETA	:	Estimated Time of Arrival
FDR	:	Flight Data Recorder
GPS	:	Global Positioning System
HF	:	High Frequency
Hrs	:	Hours
ICAO	:	International Civil Aviation Organization
IIC	:	Investigator in Charge
Kts	:	Knots (nm/hours)
LLG	:	Local Level Government
MEL	:	Minimum Equipment List
MRB	:	Main Rotor Blades
MOC	:	Maintenance Organisation Certificate
MTOW	:	Maximum Take-off Weight
NM	:	Nautical mile(s)
PIC	:	Pilot in Command
SLA	:	Service Level Agreement
SMS	:	Safety Management System
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
SSFDR	:	Solid State Flight Data Recorder
TRGB	:	Tail Rotor Gearbox
TSN	:	Time Since New
TT/TD	:	Ambient Temperature/Dew Point
TTIS	:	Total Time in Service
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rules
VHF	:	Very High Frequency
VMC	:	Visual Meteorological Conditions

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INTRODUCTION

SYNOPSIS

On 22 September 2023, at 15:15 local time (05:15 UTC), a Bell 407 helicopter registered P2-HSN, owned and operated by Heli Solutions Limited was conducting a Visual Flight Rules passenger charter flight from Simbai to Kovon, Madang Province, when during its hover to land on a field at Gebrau Village in the Kovon LLG, the helicopter's rotor blades struck a tree.

There were six persons on board the helicopter: the pilot, a loadmaster and four adult passengers.

The pilot sustained minor injuries while the loadmaster and passengers sustained serious injuries. A local bystander at Gebrau Village who was injured by a helicopter part hurled into the air when the helicopter impacted the tree, succumbed to his injuries early the next morning.

The helicopter departed Mt. Hagen for Simbai with five persons on board. On arrival at Simbai, the passengers directed the pilot to Mamai Village about 4.5 NM Northeast of Simbai where they landed on a field. The next stop was Gebrau Village in the Kovon LLG, approximately 15 NM Northwest of Mamai Village. The pilot, therefore, entered the GPS coordinate of the nearby airstrip, which was Sengapi and relied on the local knowledge of the passengers to visually guide him to the specific landing areas. About 6 NM Northeast of Sengapi, the passenger pointed out Gebrau Airstrip, right of their position and the pilot turned and tracked towards Gebrau. According to the pilot, upon arrival at Gebrau Airstrip, he observed low cloud over the Airstrip, therefore, he manoeuvred the helicopter to identify and assess the client's preferred landing area, which was an open field almost a kilometre North of Gebrau Airstrip.

As soon as he was visual with the preferred landing area, the pilot did a left turn and orbited around the intended landing area. The pilot also stated that because it was a big field, there was no need for further orbits to check obstacles, so he continued with an approach to land.

Recorded data showed that from overhead the Gebrau Airstrip, the helicopter tracked towards the preferred landing area. The helicopter then made a right turn onto a Southeasterly heading before turning left and continued with the left turn towards the preferred landing area. The helicopter tracked over Gebrau Airstrip for a left base and a long approach from the East to land. He then continued with a low shallow approach from the east straight into landing.

As soon as the helicopter entered the hover at about 3-4 ft above ground level, as expected, the helicopters rotor downwash stirred up dust from the landing area surface. The effect of the rotor downwash dramatically stirred up dust that increased in volume and size, resulting in the helicopter being engulfed and entering the cockpit and cabin. The dust was so thick that the pilot lost visual reference and experienced disorientation. The pilot attempted to maneuver out of the dust but was unsuccessful. While maintaining hover and waiting for the dust to clear, the helicopter drifted backwards for 50 m from the helicopter landing area and its rotor blades struck a tree and impacted the ground, coming to rest on its left side at the base of the tree and the helicopter was destroyed.

The report includes recommendations made by the AIC to the operator, with the intention of enhancing the safety of operating ad-hoc or non-scheduled flights to unfamiliar airstrips/HLS and ensuring the operator's systems are monitored to ensure conformance and compliance. According to *ICAO Annex 13 Standards*, identified safety deficiencies and concerns must be raised with the persons or organizations best placed to take safety action. Unless safety action is taken to address the identified safety deficiencies, death or injury might result in a future accident.

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1. FACTUAL INFORMATION

1.1 History of the flight

On 22 September 2023, at 15:15 local time (05:15 UTC[1]), a Bell 407 helicopter, registered P2-HSN (HSN), owned and operated by Heli Solutions Limited was conducting a VFR[2] passenger charter flight from Simbai to Kovon, Madang Province, when during its hover to land on a field at Gebrau village in the Kovon LLG[3], the helicopter's rotor blades struck a tree.

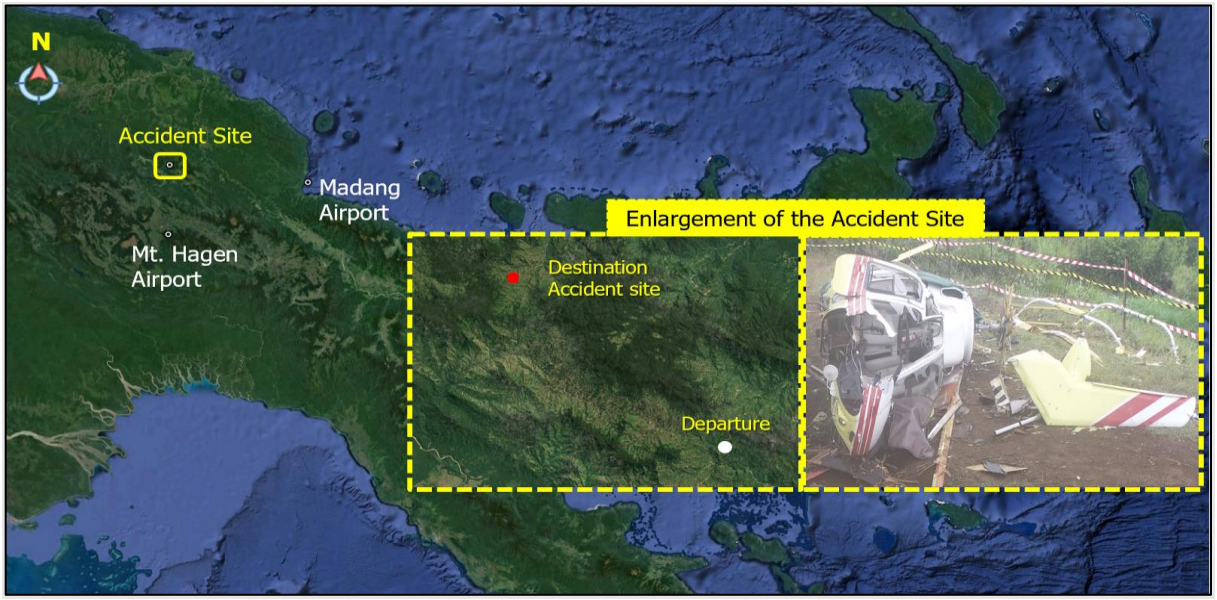

Figure 1:Overview of the P2-HSN accident site

There were six persons on board the helicopter: the pilot, a loadmaster and four adult passengers.

The planned route to be flown were Mt.Hagen-Simbai-Kovon-Aiome-Wanuma-Mt.Hagen. According to the operator, these flights were scheduled to be operated a week earlier, however, due to operational requirements, the operator had postponed the flights to 22 September 2023.

The flights were initially scheduled to depart earlier in the morning, however, the scheduled helicopter (P2-HSL) to operate the flights had a maintenance issue and was in service and therefore was swapped with P2-HSN, which was used to operate the flights in the afternoon. According to the pilot, because of the late departure (time factor) and reported weather, the pilot decided to operate Mt.Hagen-Simbai-Kovon then proceed to Madang for an overnight and complete the remaining flights the next day or return to Mt.Hagen depending on weather.

According to the pilot, the helicopter departed Mt.Hagen at about 13:40 with five persons on board. The pilot stated that due to not being familiar with the clients preferred specific landing areas, he referenced known GPS[4] coordinates of the nearby airstrips and relied on the local knowledge of the passengers to visually guide him to the specific landing areas.

On arrival at Simbai LLG, the pilot was directed by the passengers to the landing area in Mamai Village, about 4.5 nautical miles (NM) Northeast of the Simbai Airstrip, where they landed at about 14:05. The next stop was Gebrau Village in the Kovon LLG, approximately 15 NM Northwest of Mamai Village.

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[1] 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 serious incident, Papua New Guinea Time (Pacific/Port Moresby) is UTC + 10 hours.

[2] Visual Flight Rules: Those rules as prescribed by national authority for visual flight, with corresponding relaxed requirements for flight instruments (Source: The Cambridge Aerospace Dictionary)

3 Local Level Government

4 Global Positioning System

According to Air Traffic Services (ATS) audio recordings, the pilot transmitted on HF[5] 6598 Kilohertz (KHz) a departure out of Simbai at time 15:02 with six persons on board (POB) and was on climb to cruising altitude not above 8,000 ft with an estimated arrival time to Sengapi at 15:11.

Approaching Sengapi, the passengers directed the pilot towards Gebrau Village, which was about 6 NM East of Sengapi Airstrip in the Kovon LLG (See Figure 2). The passenger pointed out Gebrau Airstrip, right of their position and the pilot turned and tracked towards Gebrau.

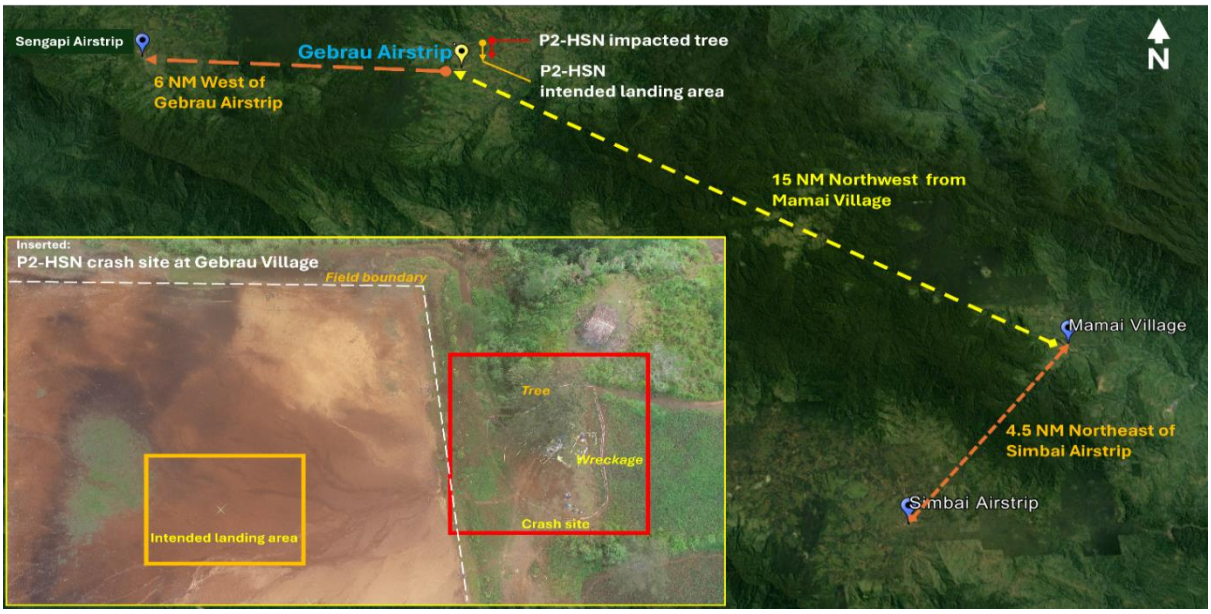

Figure 2:Overview of the flight route from Mamai Village to Gebrau

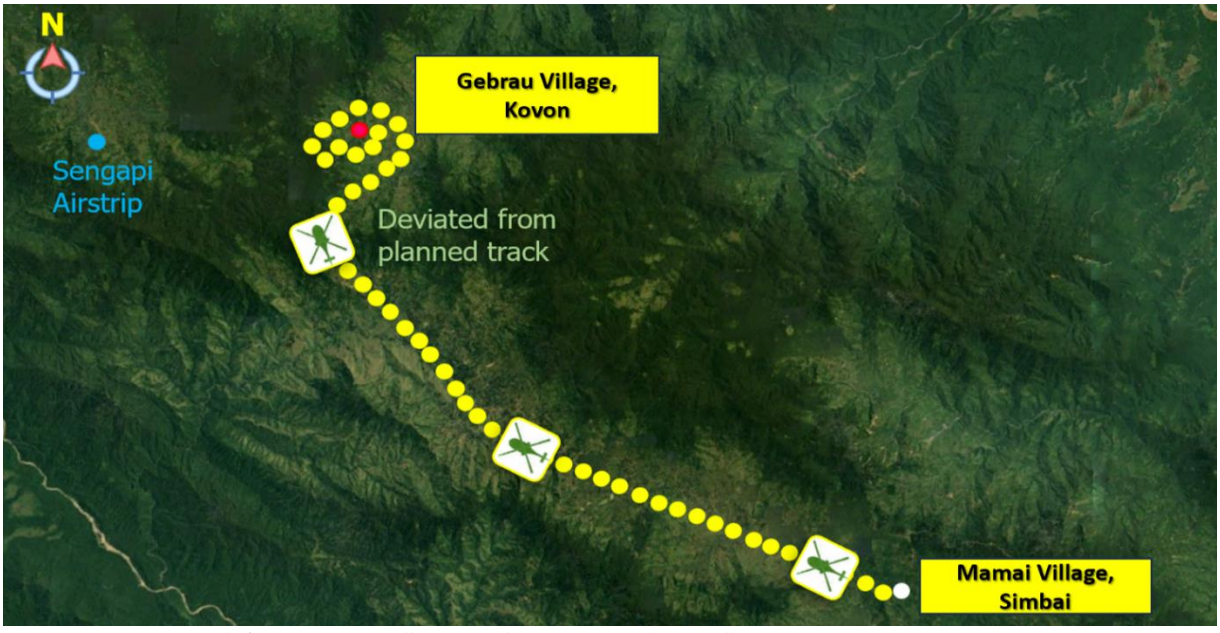

Figure 3:P2-HSN track from Mamai Village, Simbai LLG to Gebrau Village, Kovon LLG

According to the pilot, there was low cloud in the area at the time of arrival over Gebrau Airstrip, so the pilot manoeuvred around to identify and assess the client's preferred landing area, which was an open field almost kilometre North of Gebrau Airstrip. As soon as he was visual with the preferred landing area, the pilot did a left turn and orbited around the landing area. The pilot also stated that

[5] High Frequency

because it was a big field, there was no need for further orbits to check obstacles, so he continued with an approach to land.

The pilot also stated that because it was a big field, there was no need for further orbits to check obstacles, so he continued with an approach to land.

The Spidertracks recorded[6] data showed that from overhead the Gebrau Airstrip, the helicopter tracked towards the landing area. The helicopter then made a right turn onto a southeasterly heading before turning left and continued with the turn towards the landing area with a low shallow approach.

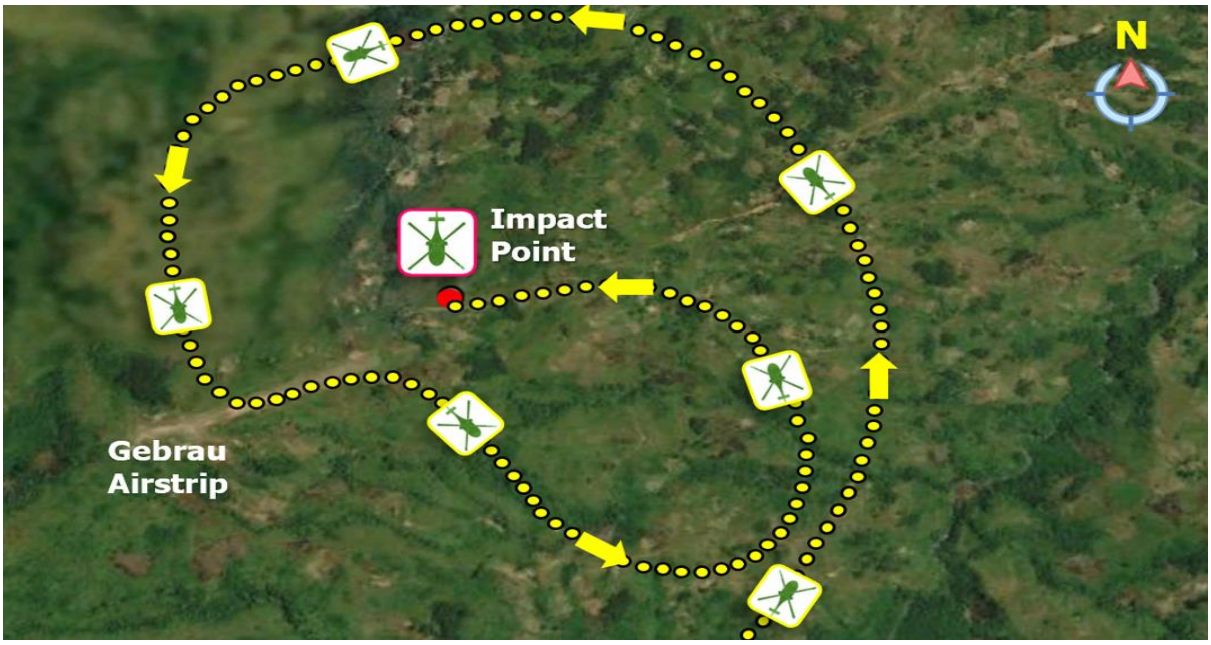

Figure 4:P2-HSN Flight Path at Gebrau Airstrip Circuit Area

The pilot stated that on finals he observed a crowd on the field pointing to the middle part of the field, which to him indicated the allocated landing area. As soon as the helicopter entered the hover at about 3 to 4 feet (ft) above ground level, as expected, the helicopter's rotor downwash stirred up dust from the landing area surface.

The dust significantly reduced visibility resulting in loss of visual reference with the surroundings. The pilot therefore held the position in anticipation for the dust to clear before executing the touchdown. However, the upward streaming of dust increased dramatically in volume and size, completely engulfing the helicopter both inside the cabin and outside. Interviews with the pilot and passengers revealed that the window in the cabin and cockpit of the helicopter were open during the landing and hovering phase. The pilot described the dust as being very thick that it became dark inside the cabin, and he lost complete visual reference as a result. While in hover and with nil visibility, the pilot stated that he attempted to manoeuvre out of the dust but was unsuccessful and therefore he maintained the hover. While in hover, the helicopter drifted backwards for about 50 m towards the northern end of the field, where it struck a tree and impacted the ground, coming to rest on its left side at the base of the tree.

According to the pilot, after the helicopter came to rest on the ground, he tried to shut down the engine, however, it would not shut down. He added that the engine kept on running and the rotor head kept on spinning, so he placed the fuel valve to off position to shut down the engine, but the engine remained running for another 15 to 20 minutes before it shut down on its own due to fuel starvation.

6 Spidertracks is used for real-time flight tracking and monitoring the aircraft's flight route, and receive specific flight information such as location, speed, altitude, and precise GPS position from anywhere, any time.

The pilot further reported that the loadmaster was the first to exit the helicopter. He subsequently assisted the other passengers out of the helicopter, with the pilot being the last to be pulled out through the broken windscreen. All the passengers and the pilot disembarked from the helicopter.

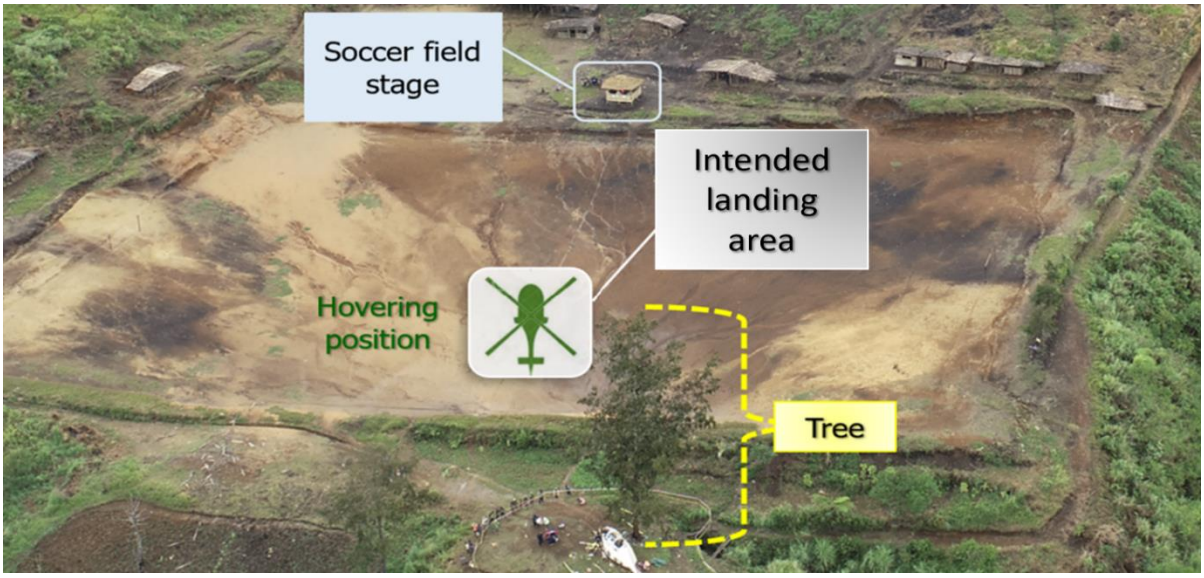

Figure 5:Intended Landing Area and Main Wreckage

1.2 Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	1
Serious	-	5	-	-
Minor	1	-	-	Not applicable
Nil Injuries	-	-		Not applicable
TOTAL	1	5	6	1

Table 1: Injuries to Persons

1.2.1.1 Pilot

The pilot was taken to the Nazarene Hospital in Jiwaka Province the following day on 23 September 2023 for medical evaluation and further treatment. *Refer to Section 1.13 for pilot medical results.*

1.2.1.2 Loadmaster

The loadmaster sustained serious injuries and was taken to Nazarene Hospital the next day to be treated.

1.2.1.3 Passengers

The four passengers sustained serious injuries and were taken to the Family Medical Centre Ltd in Mt.Hagen a day after the accident. Medical reports showed that they received severe injuries. Two passengers received soft tissue injuries and one passenger sustained severe tissue injury. Another passenger received multiple deep cuts to his head with concussion injury, deep laceration to left back of elbow and a dislocated right ankle joint.

1.2.1.4 Others (Persons outside the Helicopter)

Few villagers watching the helicopter from the ground also sustained injuries from the detached helicopter parts hurled into the air during the accident. One of the locals on the ground who was injured by a helicopter part hurled into the air succumbed to his injuries early the next morning.

1.3 Damage to aircraft

The helicopter was destroyed. Refer to section 1.12 for a detailed description of the damage to the helicopter.

1.4 Other damage

There was significant damage to the surrounding environment.

1.5 Personnel information

Pilot

Age	: 55 years
Gender	: Male
Nationality	: Papua New Guinean
Position	: Line Pilot
Type of licence	: CPL (Helicopter)
Rating	: SE Helicopter (Land):<2750kg MTOW; AS350; Bell 204/205/206/407; ME Helicopter (Land):BK 117
Total flying hours	: 11,670.1
Total hours in Command	: 9,093.2
Total hours on type	: 800.0
Total hours last 90 days	: 74.5
Total last 7 days	: 13.3
Total last 24 hours	: 3.5
Total on duty last 48 hours	: 6.3
Total rest period(s) last 48 hours	: 20.0
Last recurrent training	: 18 August 2023
Last proficiency check	: 18 August 2023
Route and Aerodrome currency	: 18 August 2023
Medical class	: One
Valid to	: 30 November 2023
Medical limitation	: Nil

Records provided by the operator indicated that at the time of the accident, the pilot was engaged on a contract basis as a casual Line Pilot under a Service Level Agreement (SLA). The contract was for the period 1 June 2022 to 31 July 2022. The effective date of the contract was 28 May 2022. At the time of the accident, the contract had already expired.

The pilot was also issued a company authorization (*Authorization number HSO24*) by the operator in accordance with *Section 6.1* of the operator's *Quality Assurance Manual (QAM), 'Issue of Authorizations'* and in accordance with *CAR Part 119.53*. The authorization was issued for the pilot to perform flying duties and pilot maintenance.

Section 4.4 of the QAM states that Requests for authorizations will be initiated and be renewed at 2-year intervals by submitting a *Form HSE 001* accompanied by documentation verifying experience and the initial & refresher competency assessment training relative to the request, unless otherwise stated in this Manual. *Section 4.9* to *4.12* states that to mark the authorization, a certificate will be issued on *Form HSQ 014 Authorisation Sheet* (*Refer to Section 5.1, Appendix A*) showing the scope and limitations of that authority. The Quality Authorisation and associated privileges are only valid while the holders' name is listed in the Quality Department database and within the expiry date. It is also the responsibility of the authority holder to ensure that the authorization, and any related CAA[7] document, is always current. Each department manager will keep track of authorizations in their department. Records showed that the pilot's authorization was last issued on 31 December 2013.

AIC also found that the pilot was a Tour duty pilot[8], specifically a Tour Type A, which means that he has a maximum of 28 days availability for duty followed by at least 21 days free of all duties as per *Civil Aviation Rules (CAR) Part 122.*

According to the pilot, he had just completed his tour with another operator and was on his 21 days free of all duties period. He further added that since he was given 28 days off by the other operator, he had rested the required 21 days and had one week (7 days) before the next tour duty. This indicates that the pilot was well rested at the time he was engaged by Heli Solutions to operate the charter.

1.6 Aircraft information

1.6.1 P2-HSN Data

Aircraft manufacturer	: Bell Helicopter
Model	: Bell 407
Serial number	: 53822
Year of manufacture	: 2008
Total airframe hours	: 3,262.0
Total airframe cycles	: 6,283.0
Registration	: P2-HSN
Certificate of Registration number	: 269
Certificate of Registration issued	: 17 January 2013
Certificate of Registration valid to	: Perpetual
Name of the Owner	: Heli Solutions Limited
Name of the Operator	: Heli Solutions Limited
Certificate of Airworthiness number	: 269
Certificate of Airworthiness issued	: 17 January 2013
Certificate of Airworthiness valid to	: Non-terminating

7 Civil Aviation Authority

8 Tour duty pilot means a pilot employed by the certificate holder for duty as a pilot of a flight crew consisting of not more than 2 pilots on the basis of a fixed time available for duties followed by a fixed time free of all duties.

1.6.2 Engine data

Manufacturer : Rolls Royce

Year of manufacture : 2007

Model : 250 - C47B

Serial Number : CAE-848098

Total time since new : 2,597.2

Time since overhaul : 0.0

1.6.3 Airworthiness and Maintenance

At the time of the accident, the helicopter had a current Certificate of Airworthiness (CoA), Certificate of Annual Airworthiness Review (AAR), Certificate of Registration (CoR), and was certified as being airworthy.

The maintenance records were reviewed during the investigation and identified that there were no outstanding scheduled maintenance, defects, and Minimum Equipment List (MEL) item at the time of the accident.

Therefore, the helicopter was airworthy and serviceable at the time of the accident.

1.7 Meteorological information

1.7.1 Area Forecast - PNG National Weather Service

The Area Forecast for Gebrau, which is in area seven, Madang Province, Papua New Guinea was issued on 21 September 2023 at 15:40 and was valid between 23:00 on 21 September 2023 to 11:00 on 22 September 2023 as follows:

Overview	**Scattered showers and thunderstorms with rain areas.**		
Upper Winds	2000ft 170 degrees at 35kts	5000ft 170 degrees at 25kts	7000ft 160 degrees at 20kts
	10,000ft 150 degrees at 20kts	14,000ft 100 degrees at 15kts	18,500ft 100 degrees at 20kts
Cloud below 20,000ft	Isolated cumulonimbus at 1800ft Broken Stratos at 500ft Scattered Cumulous at 1500ft Broken at 10,000ft with showers Scattered Stratocumulus 3000ft, Broken at 8000ft with rain and drizzle. Scattered Altocumulus Altostratus at 10,000ft.		
Visibility	500m in fog 3000m in thunderstorms 4000m in showers of rain and drizzle.		
Weather	Fog and Thunderstorms and rain, Showers of rain and rain drizzle.		
Freezing levels and icing	Freezing: at 15,000ft Ice: Severe cumulonimbus moderate including above freezing level.		
Turbulence	Severe in vicinity of Cirrus and Cumulonimbus. Moderate adjacent mountains associated with cumulus.		

Table 2:Area Forecast for Area 7 (Gebrau, Madang Province)

1.7.2 Reported Weather at Gebrau Area

The pilot reported that weather on the day was scattered low clouds with visibility greater than 10 km and light Northeasterly breeze[9]. The Loadmaster stated that the weather was closing in fast during approach into Gebrau. He observed that as they approached the landing area, it was clear, however due to wind, the clouds moved in.

9 A light breeze is a wind force on the Beaufort scale (4-6 kts or 7-12 km p/h)

1.8 Aids to navigation

Ground-based navigation aids / onboard navigation aids / aerodrome visual ground aids and their serviceability were not a factor in this accident.

1.9 Communication

The aircraft was equipped with a HF and VHF two-way communication radio. Both communication systems were determined to have been serviceable and not a contributing factor to the accident.

1.10 Aerodrome

1.10.1 Helicopter landing area information

1.10.1.1 Operator

There was no specific information for the helicopter landing area (field). The operator advised that other operators' aircraft or helicopter have landed at Gebrau Airstrip and use the field as a helicopter landing area.

1.10.1.2 Pilot and passengers' statement

The helicopter landing area at Gebrau was a playing field, bare open earth on top of a mountain, surrounded with green vegetation with a few houses adjacent to it. According to the pilot, the landing area has an elevation of about 6000 ft above mean sea level (AMSL).

According to the pilot, the landing site was newly built, and its surface was basically loose dust and gravel due to continuous erosion during rainy season. The landing site is also subject to dust if the surface is disturbed during the dry season.

The passengers stated that the area had been experiencing dry weather for the last two weeks and the field had built up dust.

1.10.1.3 Topography Data

The investigation plotted the location of the accident area on the topographic map and identified that the landing area is about 6,500 ft AMSL and situated on the side of a mountain. The accident area was at a location that was considered as high elevation.

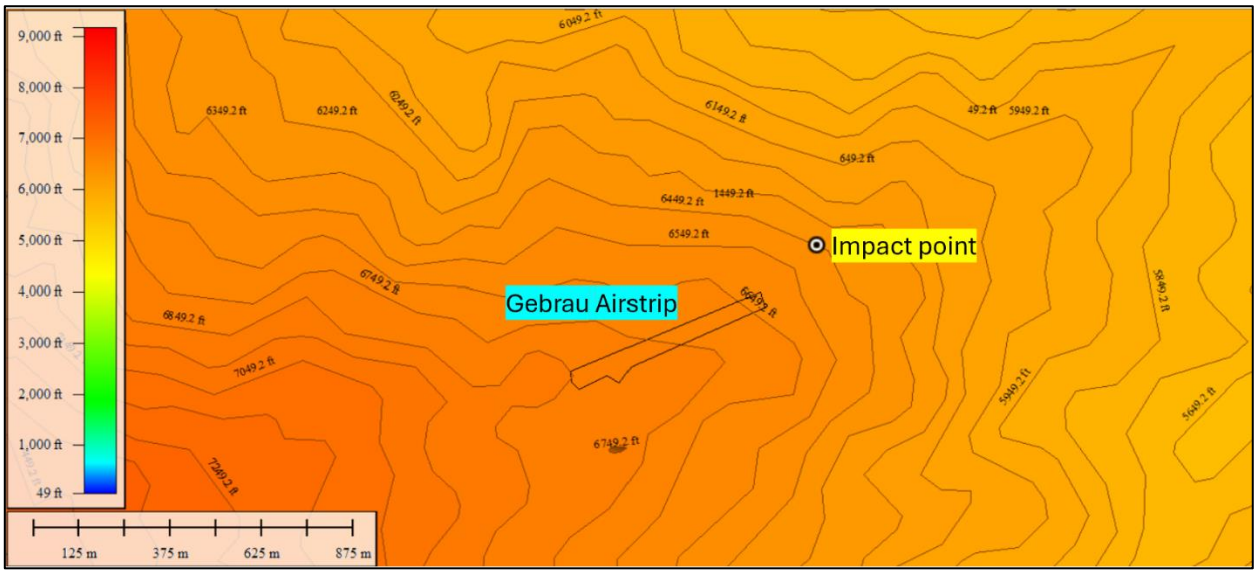

Figure 6:Topography Data

1.11 Flight Recorders

The helicopter was not equipped with a Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR), neither were required under the PNG Civil Aviation Rules current at the time of the accident.

1.11.1 Engine Control Unit (ECU)

The Engine Control Unit (ECU) was recovered from the accident site by the AIC and sent to Asia Pacific Aerospace (APA), an approved and authorised Rolls Royce maintenance, repair and overhaul centre in Brisbane, Australia. Provided below is the ECU description.

- Model Number: EMC-35R
- Manufacturer's Part Number: 11599ASSY115220-2A5-24
- Rolls-Royce Part Number: M250-10696
- Serial Number: JG6ALK0970

At APA, ECU data was downloaded by a Rolls-Royce Deployed Services Engineer, under the supervision of an Accredited Representative from the Australian Transport Safety Bureau present to oversee the process.

The ECU data was then sent to the Rolls-Royce Air Safety in United States for analysis and interpretation, and a summary report was provided to the AIC. According to the summary report, there were exceedances that triggered the Incident Recorder (IR) function of the ECU, capturing three snapshots. It was established that these exceedances were associated with the accident and occurred when the helicopter impacted terrain.

The engine performance was operating within the required parameters. See *Section 5.2, Appendix B* for an extract of the ECU report.

1.12 Wreckage and impact information

1.12.1 General Description of the accident site.

The accident site was located about 800 m Northeast of Gebrau Airstrip, Madang Province. The intended landing area (field) is sloped and located in between mountains ranges.

Figure 7:Overview of Helicopter Landing Area and Final Resting Position of P2-HSN

1.12.2 Impact Sequence and Distribution of the Wreckage

Evidence gathered by the investigation team onsite showed that the helicopter had drifted backwards for 50 m towards the northern end of the field, where it struck a tree and impacted the ground, coming to rest on its left side at the base of the tree. The blade markings on the tree indicated that all four Main Rotor Blades (MRB) struck the tree at once and one of the MRB struck it twice.

As a result, all four of the MRBs sheared off from the main attachment. Consequently, the helicopter lost its lift and spun out of control and the Tail Rotor Blades (TRB) struck the ground. Subsequently, the Tail Rotor Gearbox (TRGB) assembly snapped off from the 4th drive shaft segment. Following this, the helicopter impacted the ground.

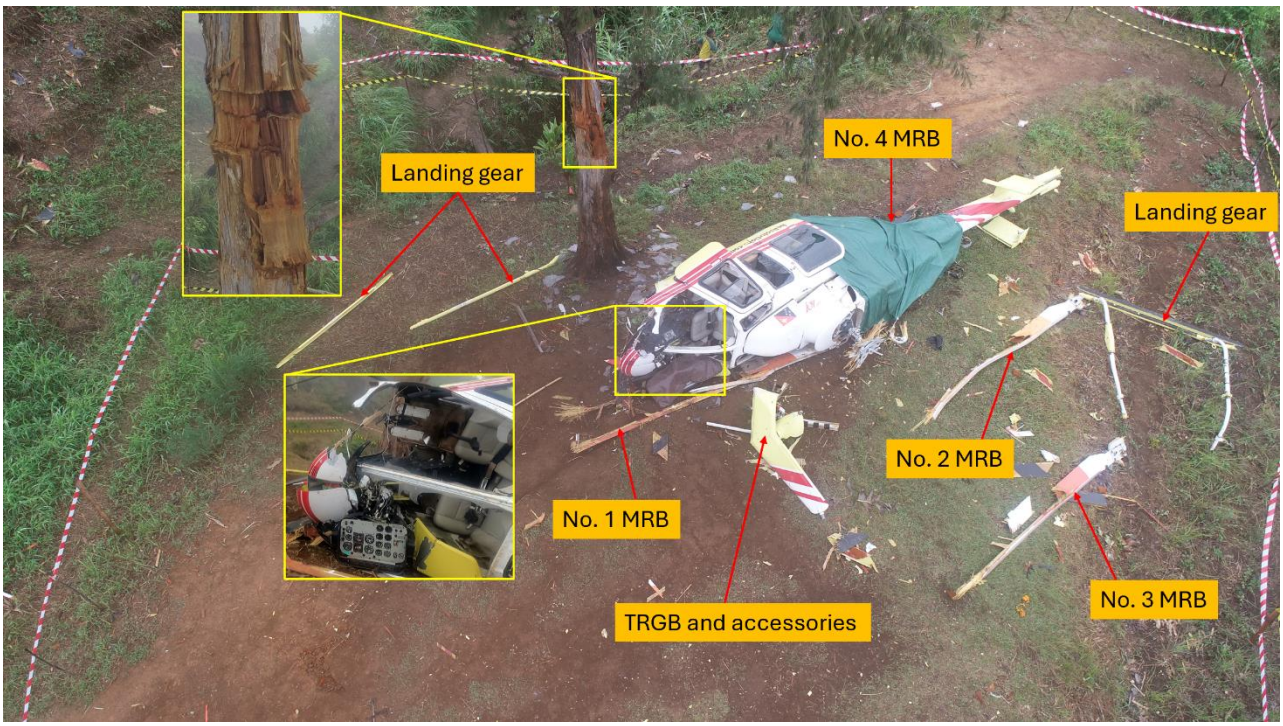

Figure 8:P2-HSN Wreckage Distribution and tree showing evidence of impact

The following damages were observed:

1. The cockpit and cabin sustained significant damage
2. The landing skids were snapped off from the main landing gear attachment.
3. TRGB snapped off from 4th drive segment and separated from the tail boom.
4. The instrument panel was separated from its mounting upon impact on the ground.
5. All four main rotor blades (MRB) were sheared off from its mounting mast and were destroyed
6. The exhaust cover of the engine sustained substantial damage.

The Main Rotor Blades, the skids and the tail rotor assembly detached and separated from the main wreckage upon impact.

1.13 Medical and pathological information

According to a statement provided on 4 October 2023 by a Specialist Emergency Physician at the Nazarene Hospital, the pilot sustained minor injuries and was treated for soft tissue injuries and no further significant findings. The specialist report provided two weeks later concluded that there were no further tests such as x-rays, scans or blood tests required.

There was no evidence that physiological factors or incapacitation affected the performance of the pilot.

1.14 Fire

There was no report of pre- or post- impact fire.

1.15 Survival aspects

According to NiuSky Pacific Limited (NSPL) Initial Notification of Incidents (INI), at 15:15 an unreported arrival normal communication check was carried out with HSN and also by other operating aircrafts within the area, however no response was received from the pilot of P2-HSN by NSPL.

The ATS audio recordings also revealed that at time 15:17, the Flight Information Service (FIS) attempted to call P2-HSN on HF 6598 KHz without any response.

At time 15:24, FIS mentioned that HSN did not cancel SARWATCH[10] at the nominated time. The recordings further revealed that at time 15:41 an INCERFA[11] was declared on HSN, due to unreported arrival at Sengapi.

The investigation found that the ELT[12] did not activate upon impact. Once all t persons onboard the aircraft disembarked the accident helicopter, the pilot and loadmaster were able to contact the base at Mt.Hagen to report the accident and initiate the operator's Emergency Response Plan.

At 15:46, the operator called ATS via phone and advised that HSN had crashed at location S05 13.59, E144 23.43 within close proximity of Sengapi Airstrip at Gebrau and there were reported injuries.

The operator attempted a rescue mission in coordination with the ATS that same afternoon by deploying a company helicopter (P2-HSL) to the area, however, the rescue helicopter was unable to access the accident site due to deteriorating weather and subsequently returned to base. The rescue helicopter returned to the accident site the next day and successfully rescued the crew and passengers of HSN.

1.16 Test and Research

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

1.17 Organisational and management information

1.17.1 Owner and Operator: Heli Solutions Limited (HSL)

HSL is a helicopter operator which conducts charter and regular Fares & Freight operations under the VFR category within PNG. Most of its operations are into remote areas, servicing rural communities.

HSL holds an Air Operator Certificate (AOC) number 119/061 issued on 16 August 2021 and effective from 31 August 2021, pursuant to *Section 47 (3) and 49 of the Civil Aviation Act 2000* , and *Part 119.9* that authorises the operator to perform commercial air operations in accordance with its exposition and *CAR Part 136.* The certificate expires on 31 August 2025.

The operator also holds a Maintenance Organization Certificate (MOC) number 145/061, issued on 1 September 2021 and expires on 31 August 2025. This certificate certifies that the operator is authorized to engage in activities in compliance with CARs and *Civil Aviation Act 2000* and the latest maintenance organization exposition (Part 145 Exposition). The HSL Maintenance Organization is based at Mt. Hagen (Kagamuga) Airport, Western Highlands Province.

1.17.2 Operational

1.17.2.1 Use of Heliports

CAR 136.77 'Use of heliports' states;

A holder of an air operator certificate must ensure that any heliport to be used in the certificate holder's operations meets the requirements of *91.127.*

CAR 91.127 (a), (b)(1), (e)(1) and *(e)(2)* under *'Use of aerodrome'* states;

> *(a) No person may use any place as an aerodrome unless that place is suitable for the purpose of taking-off or landing of the aircraft concerned.*
>
> *(b) No person may operate an aircraft at an aerodrome unless-*

10 Search and Rescue Watch
11 An Uncertainty SAR Phase
12 Emergency Locator Transmitter

(1) that person compiles with any limitations and operational conditions on the use of the aerodrome notified by the aerodrome operator;

(e) any place used as a heliport or as a place to hover that is outside a congested area of a city, town, or settlement; and

(1) is suitable for the helicopter to hover clear of obstructions; and

(2) for a heliport, has a surface area suitable for touchdown and lift-off;

The operator's *Operations Manual, section 1.25 'Use of Aerodromes'* states that no pilot shall operate a helicopter unless any place used as an aerodrome is suitable for its operations and has the physical characteristics, obstacle limitation surfaces, and visual aids that meet the requirements for the characteristics of the helicopter being used and the lowest meteorological minima to be used.

The investigation found that the surface of the landing area (field at Gebrau) was not suitable for landing. The field was newly built and is sloped, and its surface was basically loose gravel due to continuous erosion during the wet season and dust buildup during the dry season. Refer to Section 1.10 and 1.12 for Landing site information.

1.17.2.2 Pilot Responsibility in Respect of the Use of Helicopter Landing Sites (HLS)

The operator's *Operations Manual, Section 1.42.1* states that before commencing any flight, the PIC shall ensure that he/she has adequate knowledge of the HLS's to be used and their characteristics including the designated alternates.

The investigation determined that the pilot was not familiar with the Gebrau area and the landing area (Field). Therefore, he did not have adequate knowledge of the characteristics before commencing the flight.

1.17.2.3 Helicopter Landing Site/Aerodrome Register

Section 1.41.5 of the operator's *Operations Manual* also states that the Flight Operations Manager (FOM) shall maintain a register of HLS's which are not promulgated in the AIP[13] and have such information available to operating crews as required.

This register will contain as a minimum the following information:

- *the aerodrome data, and*
- *procedures for ensuring that the condition of the aerodrome is safe for that operation, and*
- *procedures for ensuring that the condition of any required equipment, including safety equipment, is safe for that operation, and*
- *any limitations on the use of the aerodrome*

There was no information of the helicopter landing area (field). The information provided by the operator was for Gebrau Airstrip, which is less than a mile from the field.

According to the operator, the field has been used before as a helicopter landing area and information is stored in the GPS in the helicopter.

The operator further stated that for flights into sites where it is the first time to operate into, the information is loaded into the GPS in the helicopter for future references and use. A review of the operator's relevant expositions showed that this procedure is not documented.

13 Aerodrome Information Publication

The passengers, pilot and loadmaster revealed that the passengers had directed the pilot to Gebrau and pointed out the landing area (field) because the pilot was either not familiar with Gebrau, or did not have information of the landing area.

1.17.2.4 Helicopter Landing Site Management

According to the Operator's *Operations Manual, Section 8.4, Appendix E,'Journey Plan'*, prior to commencement of any operation, the FOM must conduct a landing site assessment and incorporate the findings into the operational risk assessment (Refer to Section 5.1, Appendix A) and Journey Management Plan (*Refer to Section 5.3, Appendix C*).This assessment should include all likely landing areas including diversion landing points.

Section 8.4.4 'A*d hoc Landing Sites*' also states that for Ad hoc use of a helicopter landing site, the Accepted operator shall conduct a review of the site and ensure it meets the requirements of *CASA PNG AIP/AGA-5* and this Policy.

The investigation noted that the correct reference which contains the requirements of a Helicopter landing site in the PNG AIP would be '*AIP/AD-6*' and supersedes *AIP/AGA-5* which is still referenced in the operators Operations Manual.

The landing area (field) was an Ad hoc Landing site. The investigation found that there was no record of a landing site assessment conducted on Gebrau and incorporated in the operational risk assessment and Journey Plan, nor was there any record of a review of the landing site to ensure it met the requirements of *CASA PNG AIP/AD-6.*

1.17.2.5 Journey Plans for Contract Clients

According to the operator's *Operations Manual, Section 8.5, Appendix E 'Journey Plan for Contract Clients'* (Refer to Section 5.3 Appendix C of this report**),** Journey Plans must be prepared by the client for the intended flights in consultation with the HSL FOM or the Aircraft Captain on site.

A single Journey Plan may be adequate for identifying multiple routine flight routes and tasks. However, Individual Journey Management Plans must be established for all non-routine flights.

The scope and terms specified in the Journey Plan must be reviewed by the Clients responsible, Line Manager and HS&E[14] Manager to confirm that these are current and applicable for the intended flight activities.

Once the client charter request is received, the operator identifies the purpose and objective of the flight and conducts an operational risk/threat assessment and mitigate the risks.

The Journey Management Plan will take into consideration, but not limited to the following prior to the aircraft and crew being committed:

- *The purpose and objective of the flight*
- *Aircraft type*
- *Pilot qualifications and recent experience*
- *Pilot flight and duty time limitations*
- *Route details*
- *Sector flight times*

14 Health, Safety & Environment

- *Hazards, weather and available daylight*
- *Diversion airfields or landing sites*
- *Emergency response resources*

The operator advised that the Journey Plan was passed to the pilot, and he was informed of the locations to be visited on that day in order to plan for fuel, taking into consideration weather reports, before the flight commenced. However, there was no record of the operational risk assessment and threat assessment being prepared for the Journey Plan to ascertain if proper risk/threat assessment was carried out and risks mitigated before operating the flights.

1.17.3 Safety and Quality Management System

According to the operator's Safety Management System (SMS) Manual, a SMS is based on hazards and risks, especially in the aviation industry. The primary role of the SMS is to promote procedures that support operational excellence, prevent accidents and incidents, and manage corporate risk. SMS is proactive, predictive, and data-driven in nature. SMS components include the collection, analysis, and dissemination of safety information, the purpose of which is to raise safety awareness throughout the Company.

The Quality and Safety Manager serves as the primary liaison for implementation of the SMS and has direct access to the Chief Executive Officer (CEO) on all aspects of the program. This Part applies to all personnel and includes all activities, processes, and procedures within the Company.

The operator's *Quality Assurance Manual (QAM)* states that the size of HSL is such that the Quality & Safety Manager is the only full-time employee dedicated to the quality function.

The Quality & Safety Manager has a direct line of accountability to the CEO. The quality system ensures all activities conducted under the company's *Part 119* AOC complies with the relevant certificate.

The investigation identified the appropriate operational procedures (discussed in sub sections 1.16.2.4. to 1.16.2.5), required to be carried out by responsible persons in the company to mitigate the risks before operating the ad hoc charter was not carried out in compliance with the relevant CARs and in conformance with the operator's operational procedures. It was also found that some operational procedures were not effectively carried out to ensure risks were mitigated to as low as reasonably practicable before operating the charter.

1.18 Additional Information

1.18.1 Crew Resource Management (CRM)

1.18.1.1 CRM Training

According to *CAR Part 136.809 (a) (3), 'Flight crew training requirements*'

(a) A holder of an air operator certificate must ensure that each segment of the flight crew training programme required under rule 136.803 includes training applicable to the following:,

(3) crew member assignments, functions, and responsibilities, including crew resource management;

The operator's *Training and Competency Manual* states that the CRM and Human Factors Training is conducted every 24 months (about 2 years) through lectures/presentations by arranging with an external training organisation when a pilot is due for the CRM Training

The investigation reviewed the training records and found that at the time of the accident, there was no record of CRM training provided by the operator, however, the pilots CRM training was provided by another operator that also engaged the pilot as a Line Pilot through a Service Level Agreement (SLA). The pilot's CRM was valid till 5 November 2023. The CRM Training was conducted by an external Training organization.

There was no record of Human Factors Training, which according to the operator's Training and Competency Manual is conducted through lectures or presentations by an online training provider or CASA Approved Instructor upon arrangement every 24 months when a pilot is due for the training.

The investigation also noted that the operator's *Competency/Proficiency Checks Form HST 002* under the heading '*General'* for Human Factors is limited to the pilot's judgement and crew coordination.

The investigation also noted that the relevant manuals of the operator reviewed do not emphasize the importance of Crew Resource Management.

1.18.2 Crew Decision Making

CASA Australia, '*Safety Behaviours: human factors for pilots 2nd edition Resource booklet 7 'Decision making'* defines decision making as;

> *the act of choosing between alternatives under conditions of uncertainty. We consider the circumstances and reach a judgment or choose an option or action depending on the situation. It sounds easy, but in an operational environment, we're not just talking about one decision where we can consider the pros and cons at our leisure.*
>
> *The very nature of flying the aeronautical environment means that we're subject to a continuous cycle of monitoring and re-evaluating. Decisions may have to be made within a tight timeframe; just when we think we've settled on a course of action, circumstances may require us to review and change it.*
>
> *There is sometimes no one correct decision, but many decisions with different outcomes. It's our job to use good resource management to make the best decision in the circumstances. The key for any pilot is to monitor constantly and think ahead, maintaining a high level of situational awareness.*
>
> *To make successful decisions, we need to be aware of all the conditions, consider appropriate options and be able to make a sound evaluation often under time constraints and stressful situations. Awareness of all relevant conditions is important for good decision making. If we miss cues or don't understand their relevance and importance, we may end up making an inappropriate decision.*

The investigation revealed that both the pilot and loadmaster were not familiar with the Gebrau area and the landing site (field). The pilot was also not aware of the conditions of the landing site (field) to be able to make the decision to land at an alternate HLS, which is Gebrau Airstrip, less than a kilometre away.

The investigation also found that confirmation bias had influenced the pilot's decision making. Confirmation bias is the tendency to seek out and prefer information that supports our pre-existing beliefs. As a result, we tend to ignore information that contradicts those beliefs. It is a biased approach to decision making that is largely unintentional. It results in ignoring or undervaluing information that contradicts our beliefs. It can lead to poor decision making as it distorts the reality from which we draw evidence.

The pilot's previous experiences of nil adverse effects of the downwash on the helicopter and the flight influenced his decision to continue the hover to land.

1.18.3 Handling Techniques

1.18.3.1 Reconnaissance Procedures

According to the *Helicopter Flying Handbook (FAA-H-8083-218) 'Reconnaissance Procedures'* when planning to land or take off at an unfamiliar site, gather as much information as possible about the area. Reconnaissance techniques are ways of gathering this information.

The purpose of conducting a high reconnaissance is to determine direction and speed of the wind, a touchdown point, suitability of the landing area, approach and departure axes, and obstacles for both the approach and departure. The pilot should also consider forced landing areas in an emergency.

A low reconnaissance is accomplished during the approach to the landing area. When flying the approach, verify what was observed in the high reconnaissance, and check for anything new that may have been missed at a higher altitude, such as wires and their supporting structures (poles, towers, etc.), slopes, and small crevices. If the pilot determines that the area chosen is safe to land in, the approach can be continued.

However, the decision to land or go around must be made prior to decelerating below effective translational lift (ETL), or before descending below the barriers surrounding the confined area. If a decision is made to complete the approach, terminate the landing to a hover in order to check the landing point carefully before lowering the helicopter to the surface. Under certain conditions, it may be desirable to continue the approach to the surface.

The operator's *Operations Manual, section 7.5.6 (c)* '*Handling Techniques-Low Reconnaissance*' states that the low reconnaissance should take the form of a practice approach and overshoot using the path previously selected. Ample airspeed should be maintained with a minimum height of 20 feet above the Landing Zone (LZ). The low reconnaissance should be used to check the following points relevant to the LZ.

(i) Wind speed and direction in the vicinity of the landing point.

(ii) Ground obstructions in the immediate vicinity of the LZ, their size and positions relative to the approach path and touchdown point. These may determine the lowest hover height to which the approach can be flown and may have some effect on dissipating the ground cushions.

Interview with the pilot indicated that a high and low reconnaissance was accomplished during the approach to the landing area which permitted the approach to continue. The pilot stated during the interview that he had conducted an aerial assessment of the intended landing area before setting up for a long final approach from the East to the landing area.

Recorded data showed that on arrival over Gebrau Airstrip, the helicopter maintained altitude and conducted a high left orbit around the landing area before tracking back towards the airstrip. From over the airstrip, it then tracked towards the intended landing area before making a right 90 degrees turn towards the South of the landing area. From the South of the landing area, the helicopter then conducted a Left descending turn onto the Final Approach path from the East.

1.18.3.2 Low Shallow Approach and Running/Roll-On Landing

Helicopter Flying Handbook (FAA-H-8083-218) 'Low Shallow Approach and Running/Roll-On Landing' states;

Use a shallow approach and running landing when a high-density altitude, a high gross weight condition, or some combination thereof, is such that a normal or steep approach cannot be made because of insufficient power to hover. To compensate for this lack of power, a shallow approach and running landing makes use of translational lift until surface contact is made.

The glide angle for a shallow approach is approximately 3° to 5°. Since the helicopter is sliding or rolling to a stop during this manoeuvre, the landing area should be smooth, and the landing gear must be aligned with the direction of travel to prevent dynamic rollover and must be long enough to accomplish this task.

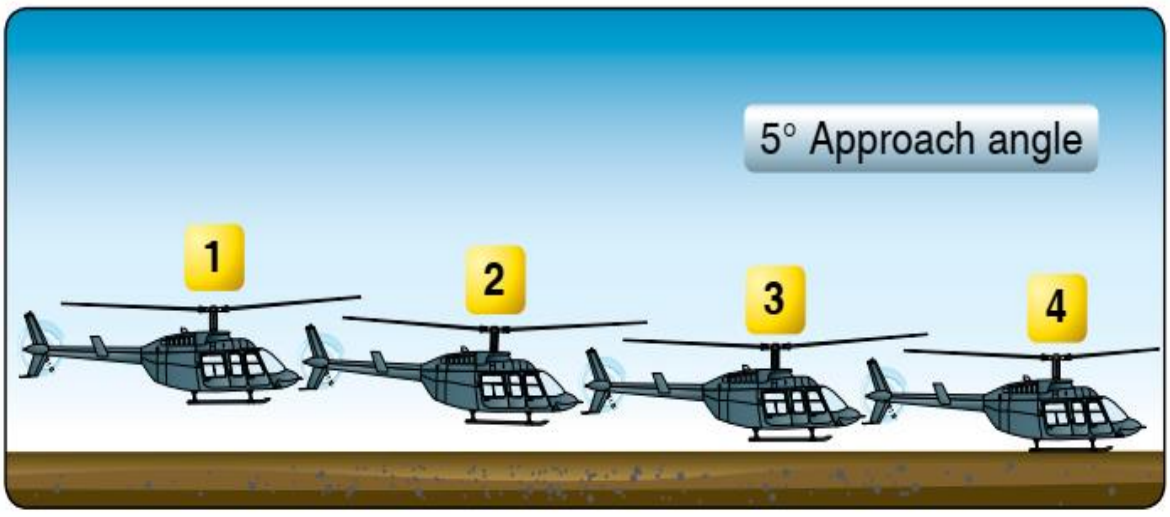

Figure 9:Shallow Approach and Running Landing

The investigation determined that the shallow approach was conducted due to the high gross weight conditions so a normal or steep approach could not be made because of insufficient power to hover. The landing area was not smooth so when the helicopter was sliding to a stop, during this manoeuvre, dust flowed upwards and engulfed the helicopter.

1.18.4 Ground Effect

Federal Aviation Administration Rotorcraft Flying Handbook (FAA-H-8083-218) states;

> *When hovering near the ground, a phenomenon known as ground effect takes place. This effect usually occurs less than one rotor diameter above the surface. As the induced airflow through the rotor disc is reduced by the surface friction, the lift vector increases. This allows a lower rotor blade angle for the same amount of lift, which reduces induced drag. Ground effect also restricts the generation of blade tip vortices due to the downward and outward airflow making a larger portion of the blade produce lift.*
>
> *When the helicopter gains altitude vertically, with no forward airspeed, induced airflow is no longer restricted, and the blade tip vortices increase with the decrease in outward airflow. As a result, drag increases which means a higher pitch angle, and more power is needed to move the air down through the rotor.*
>
> *Ground effect is at its maximum in a no-wind condition over a firm, smooth surface. Tall grass, rough terrain, revetments, and water surfaces alter the airflow pattern, causing an increase in rotor tip vortices.*

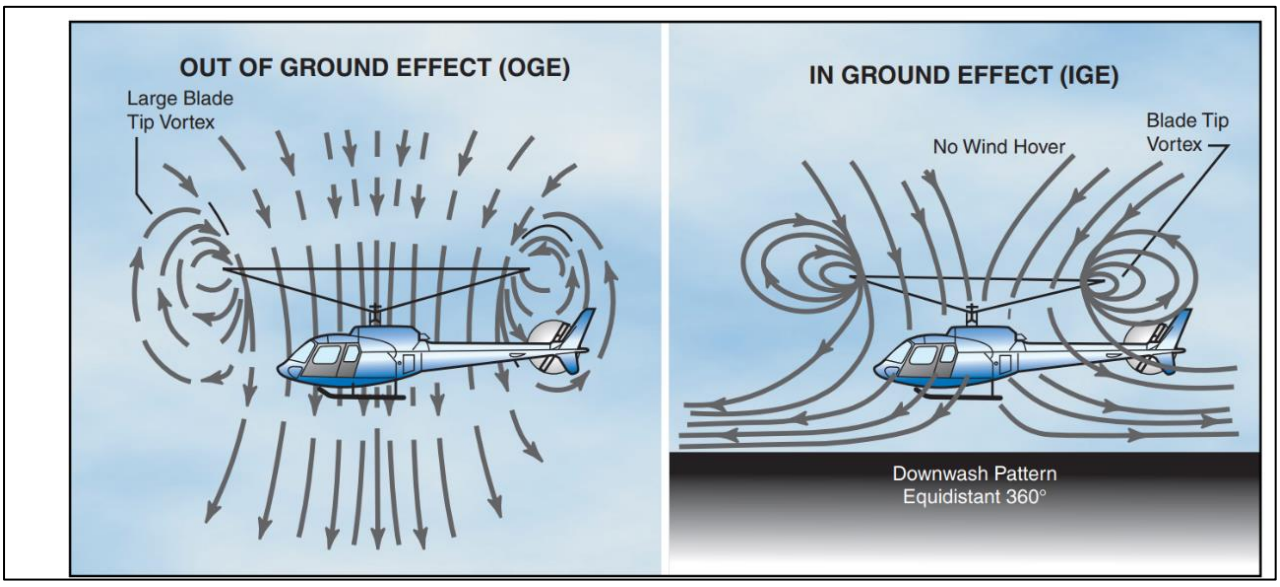

Figure 10:In Ground Effect (IGE) and Out of Ground Effect (OGE)

As the rotor blades rotate, they generate what is called rotational relative wind. This airflow is characterized as flowing parallel and opposite the rotor's plane of rotation and striking perpendicular to the rotor blade's leading edge.

This rotational relative wind is used to generate lift. As rotor blades produce lift, air is accelerated over the foil and projected downward. Anytime a helicopter is producing lift, it moves large masses of air vertically and down through the rotor system. This downwash or induced flow can significantly change the efficiency of the rotor system. Rotational relative wind combines with induced flow to form the resultant relative wind. As induced flow increases, resultant relative wind becomes less horizontal. Since angle of attack is determined by measuring the difference between the chord line and the resultant relative wind, as the resultant relative wind becomes less horizontal, angle of attack decreases.

1.18.4.1 Rotor Downwash Effect

ICAO Doc 9261 Heliport Manual, sub-section 2.1.4.3.1 states that when manoeuvring at slow speeds, especially during take-off and landing, helicopters generate significant rotor downwash extending out to a distance of 2 to 3 rotor diameters below the generating aircraft.

This downwash produces effects comparable to high and gusty wind conditions which may cause light or insecure cladding and other light objects and structures to become detached.

The investigation found that the effects of downwash stirred up the dust dramatically in volume and size. The pilot stated that when the dust was stirred up, he expected it to clear, however it continued to be stirred up dramatically in volume and size and he lost complete visibility and loss of visual reference. Without visual reference the pilot could not correct the drift during the hover to land.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the Papua New Guinea *Civil Aviation Act 2000,* and the Accident Investigation Commission's approved policies and procedures, and in accordance with the *Standards and Recommended Practices of Annex 13 to the Conventional on International Civil Aviation.*

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2. ANALYSIS

2.1 General

The analysis part of this Final Report will discuss the relevant issues resulting in the collision with a tree during hover to land involving a Bell 407 helicopter, registered P2-HSN at Gebrau Village, Madang Province on 22 September 2023.

The investigation determined that there was no evidence of a pre-existing defect in the helicopter that may have contributed to the occurrence, nor was there any evidence of a medical condition that could have affected the pilot's ability to control the helicopter. There were no issues with the helicopter and all systems were generally operating normally. The analysis will therefore focus on the following issues, but not necessarily under separate headings:

- Approach Technique
- Rotor Downwash effect
- Operational Procedures
- Pilot knowledge of the area and HLS
- Crew Decision Making
- Helicopter Landing Site

2.2 Approach Technique

The investigation found that the helicopter had a high gross weight therefore the pilot conducted a low shallow approach. With a high gross weight, a normal or steep approach cannot be done because of insufficient power to hover, therefore a shallow approach and running landing was conducted. Since the helicopter was sliding during this manoeuvre, the landing areas should be smooth. The investigation found that the surface of the intended landing area was sloped and not smooth. There was excessive loose dust on the surface of the landing site which was stirred up as the helicopter conducted a running or roll on landing.

During the shallow approach, the helicopter was manoeuvred at slow speeds which resulted in significant rotor downwash below the generating helicopter. This downwash effects are comparable to high and gusty wind conditions, hence, the dramatic upward streaming of dust which increased in volume and size, which then completely engulfed the helicopter and entered the cabin and cockpit. This resulted in the pilot experiencing complete loss of visual reference and disorientation due to the dense dust.

The investigation noted that the fine dust particles would take time to settle on the ground after being stirred up by the effects of the rotor downwash. Therefore, as the dust particles took time to settle, more dust was being stirred up.

2.3 Rotor Downwash Effect

When each individual blade of the helicopter starts generating lift when the rotor disc starts spinning, it creates rotor thrust, acting vertically upwards (perpendicular to the rotor disc). As a result, air goes through the disc. Downwash is the downward flow of air through the rotor disk and is the same as the induced flow through the rotor disk. This downward flow of air is called induced flow. It takes roughly

3 rotor diameters for the air to reach its highest velocity and lowest pressure. Rotor blade action changes the still air to a column of descending air.

Therefore, each blade has a decreased Angle of Attack (AOA) due to the downwash. Stronger downwash is produced at high gross weight conditions, at high-density altitude at a hover under no-wind conditions and at high gross weight and low air density (high density altitudes).

The investigation found from evidence gathered that the helicopter had a high gross weight and there was light breeze at Gebrau on the day of the accident. The field was located at a high altitude of 6,500 ft AMSL and situated on the side of a mountain. Therefore, there was low air density at that altitude. All these conditions contributed to the strong downwash effect.

2.4 Operational, Safety & Quality Procedures

The investigation identified that certain operational, safety and quality related procedures required to be carried out to mitigate the risks before operating the ad hoc charter was either not carried out or not effectively carried out to ensure risks were mitigated to as low as reasonably practicable before operating the charter.

There was no HLS assessment carried out and incorporated into the operational risk/threat assessment to mitigate the risks associated with operating the flight, specifically to Gebrau and no record of the Journey Plan to ascertain if the field was suitable for landing and lift off. The investigation determined from evidence gathered onsite and offsite that the landing area was not suitable for landing and lift off. It was also found that there was no specific or detailed information about the landing area (field) in the operator's Aerodrome/HLS Register.

It was also found that the pilot commenced the flight with inadequate information about the destination (Gebrau) and landing area (field). He had not operated to Gebrau Airstrip and the field before, therefore he was not aware of the surface conditions of the field which was not suitable for landing. The prevailing surface conditions due to prolonged dry weather and the field was also newly built and therefore had excessive dust on the surface.

The investigation also found that from the altitude that he assessed the intended landing area, the pilot would not have been able to properly assess the surface conditions of the field.

2.5 Crew Decision Making

To make effective decisions, the pilot needs to be aware of all the conditions, consider appropriate options and be able to make a sound evaluation often under time constraints and stressful situations. Awareness of all relevant conditions is important for good decision making.

The investigation found that apart from the field, the suitable landing area was the Gebrau Airstrip which was about 800m from the intended landing area. However, the field was the client's preferred landing area.

The investigation found that the field was an open area with a clear approach path. The pilot conducted his approach and determined that the landing area was suitable. The investigation observed that, from the overhead assessment of the field, the pilot could not have determined the excessive amount of dust on the landing area surface, and how much the visibility would have been affected by the dust when stirred up by the propeller wash on hovering.

3. CONCLUSIONS

3.1 FINDINGS

1. AIRCRAFT

a) The helicopter had a valid Certificate of Airworthiness, Certificate of Registration, Certificate of Annual Airworthiness Review and had been maintained in compliance with the regulations.

b) The maintenance records indicated that the helicopter was equipped and maintained in accordance with existing regulations and approved procedures.

c) The helicopter was certified as being airworthy when dispatched for flight.

d) The mass and the centre of gravity of the helicopter were within the prescribed limits.

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

f) There was no evidence of airframe failure or system malfunction prior to the accident.

g) The helicopter was structurally intact prior to impact.

h) All control surfaces were accounted for, and all damage to the helicopter was attributable to the impact forces.

i) The helicopter was destroyed.

j) The engine continued running for about 15-20 minutes after impact and stopped upon fuel starvation (usable fuel on board).

2. PILOT

a) The pilot was licensed and qualified for the flight in accordance with existing regulations.

b) The pilot was properly licensed, medically fit and adequately rested to operate the flight.

c) Proficiency and Recency requirements were met by the pilot.

d) The pilot flight and duty time regulations was in compliance with the requirements.

e) The pilot was not familiar with the helicopter landing area.

f) The pilot was a casual employee with the operator.

g) The pilot operated under an expired SLA and company Authorisation.

3. FLIGHT OPERATIONS

a) The pilot made normal radio communications with the relevant ground units.

b) The pilot attempted landing while visual reference with outside surroundings was lost.

c) The pilot did not make a decision to divert towards a suitable alternate area which was an airstrip 800 m from the intended landing area due to the client requirements to land on the field at Gebrau.

d) The pilot did not have information on the conditions of the intended landing area before commencing the flight.

4. OPERATOR

a) The operator’s Quality Assurance system had not identified deviations from the requirements of operational procedures.\

b) The operator's procedures for operating non-routine/ad hoc flights were not implemented before commencing the flight to identify the risks and mitigate to as low as reasonably practicable.

c) There was no record of CRM training provided by the operator. The pilot's CRM training was provided by another operator that had also engaged the pilot as a Line pilot through a Service Level Agreement (SLA).

d) There was no record of Human Factors Training for the pilot.

e) Relevant manuals of the operator do not emphasize the importance of Crew Resource Management

5. HELICOPTER LANDING AREA

a) The landing area was not suitable for landing and lift off.

6. FLIGHT RECORDERS

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

7. MEDICAL

a) There was no evidence that incapacitation or physiological factors affected the pilot performance.
b) There was no evidence that the pilot suffered any sudden illness or incapacity which might have affected his ability to control the helicopter.

8. SURVIVABILITY

a) The accident was survivable.
b) The pilot sustained minor injuries while the loadmaster and passengers sustained severe injuries.
c) The ELT did not activate upon impact.

3.2 CAUSES (CONTRIBUTING FACTORS)

The investigation identified several factors that contributed to the accident.

The investigation identified that operational, safety and quality procedures required to be carried out for ad hoc charters for non-routine flights were not carried out to mitigate the risks associated with operating the flight, specifically to Gebrau before commencing the flight. The pilot commenced the flight with inadequate knowledge of the Gebrau area and the intended landing area (field).

The flight was from Mamai to Sengapi Airstrip, however, the flight changed its track, 6 NM East of Sengapi Airstrip and tracked Northwest towards Gebrau. To meet client requirements, the pilot had to change the aircraft's track.

The investigation found that on arrival in the Gebrau area, the helicopter tracked over Gebrau Airstrip for an assessment overhead of the intended landing area (field) less than a Kilometre from Gebrau Airstrip. The second assessment was done during hover to land before committing to land. However, the pilot could not determine the surface conditions of the field (excessive loose dust). Therefore, he assessed the landing area as being suitable for landing and continued hover to land. However, the surface condition of the field was not suitable due to prolonged dry weather resulting in excessive dust on the surface of the field. Also, the landing area on the field was down slope so when it rains, the soil washes down and overtime the soil accumulates on the surface of the landing area.

The pilot conducted a low shallow approach to land due to high gross weight conditions, high density altitude and no-wind conditions. The normal and steep approach could not be carried out due to the insufficient power to hover. To compensate for this lack of power, a shallow approach and running landing was conducted which made use of translational lift. The helicopter was manoeuvred at slow speeds because the approach was a shallow approach, which resulted in significant rotor downwash below the generating helicopter. Additionally, since the helicopter was sliding during this manoeuvre, the landing area should be smooth. However, the landing area was not smooth. The investigation also identified that high gross weight conditions, high density altitudes and no wind conditions on the day contributed to a stronger effect of the downwash.

During hovering to land, the pilot observed dust being stirred up, but from his previous experiences, the dust stirred up from the effects of rotor downwash would clear, so he therefore continued the hover to land and the excessive dust on the surface of the landing area was stirred up dramatically.The downwash effects are comparable to high and gusty wind conditions, hence, the dramatic upward streaming of dust which increased in volume and size, completely engulfing the helicopter and entered the cabin and cockpit. This resulted in the pilot experiencing complete loss of visual reference and disorientation due to the dense dust.

The pilot-maintained hover over the landing area while waiting for the dust to clear. He then attempted to manoeuvre out of the dust with nil visibility but was unsuccessful. The helicopter drifted backwards and impacted a tree 50 m from the intended landing area.

3.3 OTHER FACTORS

The investigation identified safety deficiencies or concerns during the investigation that while not causal to the accident, nevertheless, should be addressed with the aim of accident prevention. The investigation identified the following safety deficiencies or concerns:

- There was no information of the Intended Landing Area (Field at Gebrau) in the operator's aerodrome or HLS Register.
- At the time of the accident, the pilot's company Authorisation and contract had expired.

- The operator advised that information for initial non routine/ad-hoc flights are loaded into the GPS in the helicopter for future reference and use. A review of the operator's relevant expositions showed that this procedure is not documented.

4.1 SAFETY RECOMMENDATIONS

As a result of the investigation into the accident involving a Bell 407 helicopter registered P2-HSN at Gebrau Village, Kovon LLG, Madang Province on 22 September 2023, the PNG AIC issues the following recommendations to address safety issues identified in this report.

4.1.2 Safety Recommendation AIC 24-R05/23-1006 to Heli Solutions Limited

The PNG Accident Investigation Commission recommends that Heli Solutions Limited ensure that before commencing Ad hoc or non-routine flights to unfamiliar Aerodromes/Helicopter Landing Sites/areas, the following operational and safety procedures should be conducted.

- *Journey Management Plan*
- *Operational Risk Assessment*
- *Landing Site Assessment*

The procedures must be completed and recorded accordingly to ensure risks are mitigated to as low as reasonably practicable.

Action requested

The AIC requests that the Heli Solutions Limited note recommendation *AIC 24-R05/23-1006 and* provide a response to the AIC within 90 days of the issue date, but no later than 2 October 2024 and explain including with evidence how Heli Solutions Limited has addressed the safety deficiency identified in the safety recommendation.

4.1.3 Safety Recommendation AIC 24-R06/23-1006 to Heli Solutions Limited

The PNG Accident Investigation Commission recommends that Heli Solutions Limited should ensure Quality Assurance System procedures are effectively implemented to ensure company documented procedures are implemented and monitored according to the requirements to ensure conformance to company procedures and compliance with regulatory requirements.

Action requested

The AIC requests that the Heli Solutions Limited note recommendation *AIC 24-R06/23-1006* and provide a response to the AIC within 90 days of the issue date, but no later than 2 October 2024 and explain including with evidence how Heli Solutions Limited has addressed the safety deficiency identified in the safety recommendation.

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5. APPENDICES

5.1 Appendix A: Company Authorisation Certificate on Form HSQ 014

HELI SOLUTIONS LTD

HELI SOLUTIONS	Form No. HSQ 014
	Revision No. 00

COMPANY AUTHORISATION

Terms of Reference

1. This authorisation is issued in accordance with the applicable Papua New Guinea Civil Aviation Rules.
2. At all times when using this authority you are responsible to the Quality and Safety Manager of Heli Solutions Limited.

Scope of Company Authorisation

Area:

1 – Air Operations

2 – Aircraft Maintenance

System:

1 – XXXXXXXXXXXXXXXXXXXXXXXX
2 – XXXXXXXXXXXXXXXXXXXXXXXX
3 – XXXXXXXXXXXXXXXXXXXXXXXX

Rating:
A – Bell 407
B – BK117

HELI SOLUTIONS	Form No. HSQ 014
	Revision No. 00

COMPANY AUTHORISATION

Pursuant to the applicable PNG Civil Aviation Rules (Parts 119, 145) and Heli Solutions documented exposition procedures, the Quality and Safety Manager authorises the person named in this document to carry out and certify work functions as detailed here in.

Any person finding this document is requested to forward it to:

Quality and Safety Manager

Heli Solutions Limited

P. O. Box 337

Mt Hagen, WHP 281

Papua New Guinea

Postage will be paid by Heli Solutions.

HELI SOLUTIONS	Form No. HSQ0 14
	Revision No. 00

COMPANY AUTHORISATION

Name:	Stephen Anthony BUNTING	
Authority #	**Date of Issue**	**Expiry Date**
061- XXXXXX	XXXXXXXXXX	XXXXXXXXXXXX
Holders Signature:		Authorised by:

IMAGE

TEMPORARY AUTHORITY

NOTES

1. This authorisation remains valid provided the holder remains employed by Heli Solutions Limited, or as approved by the Quality and Safety Manager
2. This authorisation is conditional on maintaining regulators licences and instruments – i.e. Pilot medical, AME licences and AMS certificates, where applicable
2. This authorisation may be withdrawn at any time by the Quality and Safety Manager.
3. Whenever certifying work on aircraft or components you are required to use your Authorisation Number.

HELI SOLUTIONS	Form No. HSQ 014
	Revision No. 00

COMPANY AUTHORISATION

Scope of Company Authorisation

The holder is hereby authorised to carry out the following functions

FUNCTIONS

1 – XXXXXXXXXXXXXXXXXXXXXXXXXXXX
2 – XXXXXXXXXXXXXXXXXXXXXXXXXXXX
3 – XXXXXXXXXXXXXXXXXXXXXXXXXXXX
4 – XXXXXXXXXXXXXXXXXXXXXXXXXXXX
5 – XXXXXXXXXXXXXXXXXXXXXXXXXXXX
6 – XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7 – XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8 – XXXXXXXXXXXXXXXXXXXXXXXXXXXXX

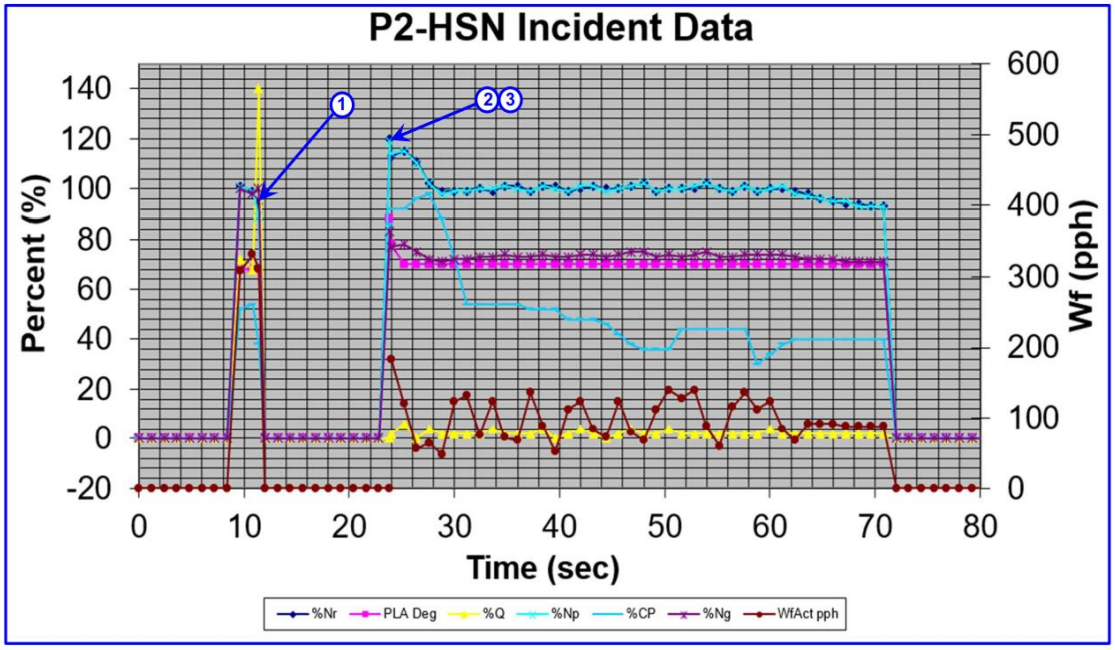
5.2 Appendix B: Extract of the ECU Data Summary

Incident Recorder Data

Data download was completed and a cursory review showed primary exceedance messages for Nr Droop (main rotor under-speed) followed immediately by loss of aircraft power & Np Exceedance (power turbine overspeed).

The exceedances triggered the Incident Recorder (IR) function of the ECU, which captured 3 "snapshot" lines of data as well as an additional 40 complete IR lines of data. Power interruptions to the ECU due to airframe 28-volt power loss & a momentary loss of PMA (permanent magnet alternator) power from a brief Np under-speed resulted in several blank lines of IR data. Consistent electrical power to the ECU is required to satisfy the unit's ability to populate record lines from the running buffer memory.

NOTE: Snapshot data is recorded each time a given parameter is exceeded; IR data records 10 lines of data prior to an exceedance and continues recording data for at least 48 seconds following the last exceedance or until electrical power is lost to the ECU. In this event, the IR recorded measurable data for 43 seconds. Incident data is recorded at a rate of 1 line every 1.2 seconds. Snapshot data is continuously monitored and recorded instantaneously.



Event Synopsis

1. Trigger #1 was an Nr droop at the time the main rotor blades contacted the tree (rotor slowing down). Note the corresponding torque spike (%Q) yellow line consistent with the tree strike.
2. The lack of data from time 0 to 9.6 seconds & 12 to 22.8 seconds was due to lack of power to the ECU caused during the accident. These time gaps indicate the periods at which the incident recorder was attempting to capture the previous 10 records in its memory buffer following the triggers but was unable to do so due to the lack of power to the ECU. These time gaps are not reflective of "real time" during the accident sequence, rather they are essentially unfilled records holds in the buffer but was unable to fill.

3. Aircraft 28-volt power was lost likely from battery power being severed based on wreckage photos. At the same time, Np dropped below 85%, which is the point that the PMA goes off-line.

4. According to the AIC Preliminary Report: *"After the helicopter came to rest on the ground, the pilot tried to shut down the engine, however, it would not shut down. The engine continued running with all rotor blades detached."* It is unknown what actions the pilot took to shut down the engine. The IR data indicates that the PLA (power lever angle or throttle) was still in the FLY position while the aircraft was on the ground, the engine had adequate fuel being supplied, & the master fuel cut-off switch was not activated.

5. Triggers #2 and #3 occurred at the same time, which were Np & Nr exceedances. This is because the engine effectively had no load due to the loss of the main rotor blades while running on the ground.

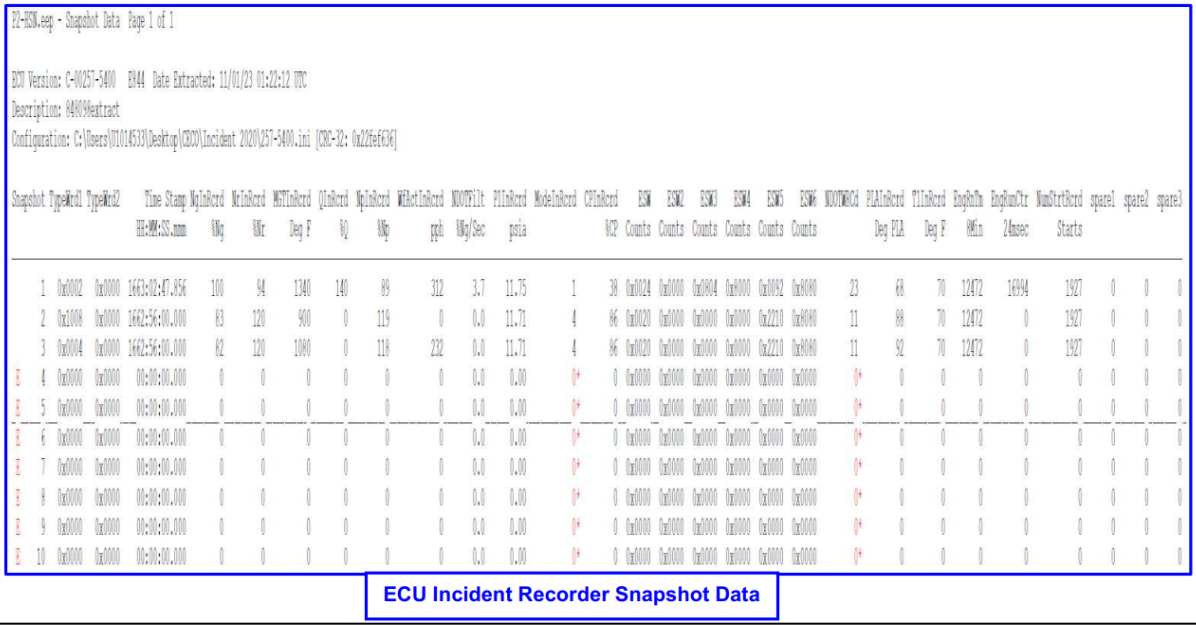
6. At the same time triggers #2 and #3 occurred, power turbine (Np) speed recovered to a level well above the point at which the PMA came back on-line (>85%) thereby restoring power to the ECU. Note the corresponding positions of fuel flow (Wf) & gas generator speed (Ng) at the same trigger point.

7. The ECU sensed the Np and Nr exceedances, which tripped the overspeed detection in the ECU thereby energizing the overspeed solenoid valve in the HMU (hydro-mechanical unit) & reducing fuel flow.

8. A corresponding drop in fuel flow (Wf) resulting in a lowering of power turbine speed (Np) & main rotor speed (Nr) to approximately 100% was observed in the IR data and is consistent with proper functionality & response of the overspeed solenoid valve in the HMU.

9. The ECU fulfilled its IR data capture requirement following the last exceedance capture indicating the final record being taken at approximately 72 seconds.

10. According to the AIC Preliminary Report: *"The engine ran for another 15-20 minutes before it shut down on its own."* This is likely due to the fuel level in the aircraft tank depleting to the point that the fuel pick-up in the tank, normally located on the bottom of the tank, was displaced 90° due to the aircraft being on its side. This likely resulted in the fuel tank pick-up becoming "unported" thereby starving the engine of fuel. The pilot stated in his interview with the AIC that the engine shut down due to fuel starvation.



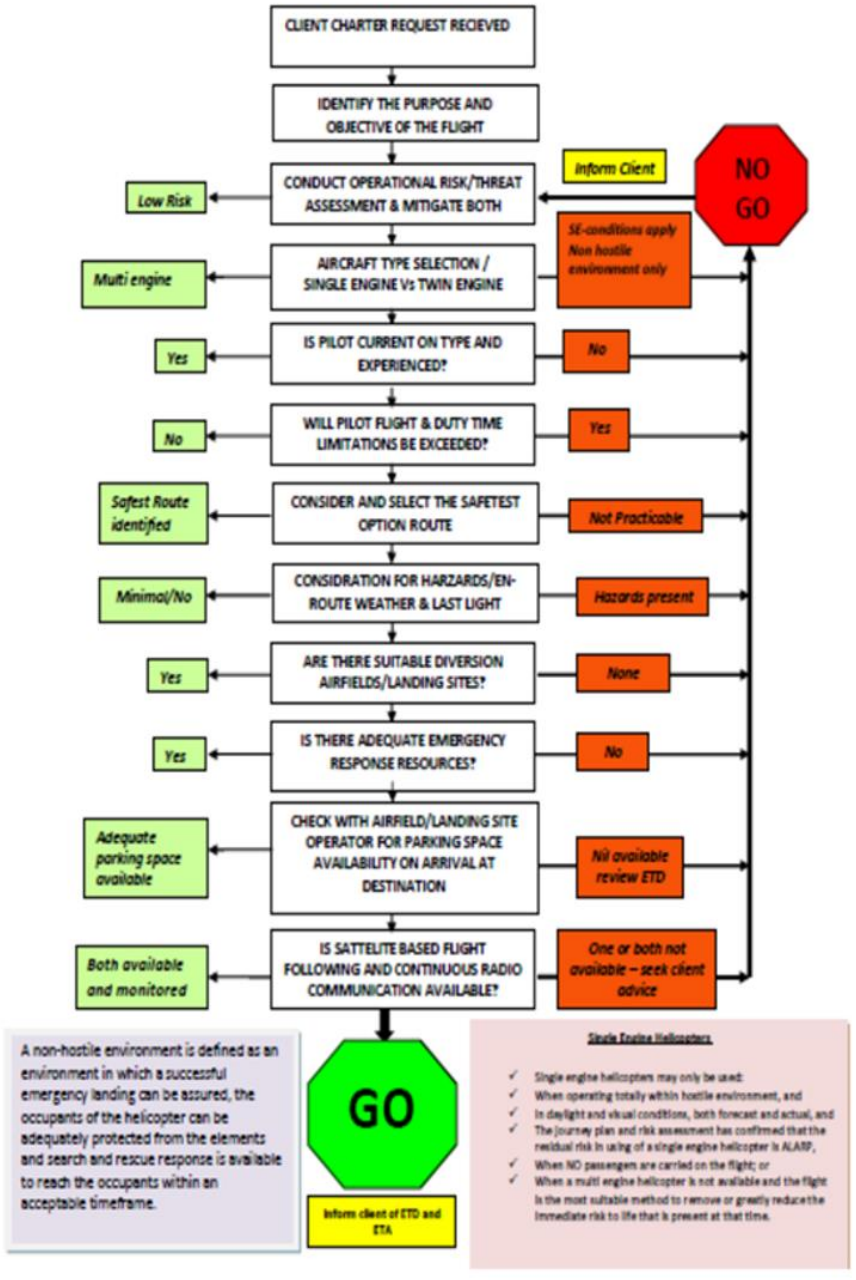
P2-H3N.eep - Snapshot Data Page 1 of 1

ECU Version: C-00257-5400 E044 Date Extracted: 11/01/23 01:22:12 UTC
Description: 04009extract
Configuration: C:\Users\U1014533\Desktop\CEDD\Incident 2020\257-5400.ini [CRC-32: 0x22fef636]

Snapshot	TypeWrd1	TypeWrd2	Time Stamp HH:MM:SS.mmm	NgLimRcrd %Ng	NrLimRcrd %Nr	MGTLimRcrd Deg F	QLimRcrd %Q	NpLimRcrd %Np	WfActLimRcrd pph	NDOTFilt %Ng/Sec	PLimRcrd psia	ModeLimRcrd	CPLimRcrd #CP	ESN Counts	ESN2 Counts	ESN3 Counts	ESN4 Counts	ESN5 Counts	ESN6 Counts	NDOTNRCA	PLALimRcrd Deg PLA	TLimRcrd Deg F	EngRnTm RMin	EngRunCtr 24msec	NumStrtRcrd Starts	spare1	spare2	spare3
1	0x0002	0x0000	1663:02:47.856	100	94	1340	140	89	312	3.7	11.75	1	38	0x0024	0x0000	0x0804	0x0000	0x0092	0x8080	23	68	70	12472	14394	1927	0	0	0
2	0x1008	0x0000	1662:56:00.000	83	120	900	0	119	0	0.0	11.71	4	86	0x0020	0x0000	0x0000	0x0000	0x2210	0x8040	11	88	70	12472	0	1927	0	0	0
3	0x0004	0x0000	1662:56:00.000	82	120	1080	0	118	232	0.0	11.71	4	86	0x0020	0x0000	0x0000	0x0000	0x2210	0x8040	11	92	70	12472	0	1927	0	0	0
E 4	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 5	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 6	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 7	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 8	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 9	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0
E 10	0x0000	0x0000	00:00:00.000	0	0	0	0	0	0	0.0	0.00	0*	0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0*	0	0	0	0	0	0	0	0

ECU Incident Recorder Snapshot Data

5.3 Appendix C: Journey Management Plan for Contract Clients



5.4 Appendix D: Operational Risk Assessment and Response Flow Chart