ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 19 - 1001

Niugini Helicopters

P2-HSG

Bell 427

Helicopter impact with water

Kimbe, West New Britain province

Papua New Guinea

11 August 2019

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 (As amended)*, 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.

About this report

The AIC was informed at 17:45 local time (07:45 UTC) on 11 August 2019, by Papua New Guinea Air Services Limited (ASL) of an accident involving a Bell 427 helicopter, registered P2-HSG, owned and operated by Niugini Helicopters.

The AIC immediately commenced an investigation. Due to volcanic activity in the Bialla area, West New Britain Province, the AIC was unable to get its investigators to the site until the 14th August 2019. The day after the accident, the helicopter wreckage was salvaged and stored at the Operator's hangar where the investigators conducted the initial examinations.

This *Final Report h*as been produced by the AIC pursuant to *ICAO Annex 13* and has been approved for public release.

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, safety actions, 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.

Hubert Namani, LLB

Chief Commissioner

29 December 2020

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GLOSSARY OF ABBREVIATION

AFTN	: Aeronautical Fixed Telecommunication Network
AOC	: Air operator certificate
ARCC	: Aviation rescue coordination centre
ASL	: Air services limited
ATC	: Air traffic control
ATS	: Air traffic services
CAR	: Civil aviation rules
CASA	: Civil aviation safety authority
CPL H	: Commercial pilot licence Helicopter
CS	: Centre supervisor
CVR	: Cockpit voice recorder
DCU	: Data collection unit
ECU	: Engine control unit
ELT	: Emergency locator transmitter
ERP	: Emergency response plan
ETA	: Estimated time of arrival/Estimating arrival
FDR	: Flight data recorder
FIS	: Flight information service
FM	: Flight Manual
Ft	: Foot (feet)
GPS	: Global positioning system
H	: Hour(s)
HF	: High frequency (3 000 to 30 000 kHz)
hPa	: Hectopascal
IFR	: Instrument flight rules
JRCC	: Joint rescue coordination centre
KBSA	: Kimbe Bay Shipping Agency
Kt	: Knot(s)
M	: Metre(s)
MEL	: Minimum equipment list
MH_z	: Megahertz
min	: Minute(s)
MRCC	: Marine rescue coordination centre
Mt	: Mount
nm	: Nautical miles
NMSA	: National Maritime Safety Authority
NW	: North west
OEI	: One engine inoperative
PLB	: Portable locator beacon
P&W C	: Pratt & whitney Canada
RCC	: Rescue coordination centre
RPM	: Revolutions per minute
RVO	: Rabaul volcanological observatory
SAR	: Search and rescue
SE	: South east

SMS	: Safety management system
SOP	: Standard operating procedure(s)
SOS	: Save Our Souls (International code for rescue)
SPOC	: Search and rescue point of contact
SW	: South west
TAF	: Terminal Aerodrome Forecast
TSBC	: Transportation Safety Board of Canada
UTC	: Coordinated Universal Time
VAAC	: Volcanic ash advisory centre
VFR	: Visual flight rules
VHF	: Very high frequency (30 to 300 MHz)

INTRODUCTION

SYNOPSIS

On 11 August 2019, at 11:25 local time (01:25 UTC), a Bell 427 helicopter, registered P2-HSG, owned and operated by Niugini Helicopters, was reported to have impacted a reef 3.1 nm of North West of Buluma township while conducting a VFR ferry flight from Kokopo, East New Britain Province to Kimbe, West New Britain Province.

After completing a passenger flight from Kimbe to Kokopo, the pilot of the helicopter departed back to Kimbe at 10:02.

About 30 nm from Kimbe, the pilot made a radio broadcast reporting that he had commenced his descent from 8,000 ft into Kimbe. The helicopter was estimated to arrive in Kimbe at 11:09. The helicopter descended to 3,000 ft, where the pilot, according to his statement, decided to conduct an autorotation descent exercise to check the autorotation RPM which had been adjusted by the engineers during an unscheduled maintenance activity the day before.

The pilot reported that everything seemed normal until he commenced action to transition back to powered flight (recover), from simulation at around 1,000 ft, where he received the low rotor *RPM* warning. He then momentarily glanced at the torque gauge, and recalls sighting an abnormal reading which prompted him to think that one of the helicopter's engine had failed.

The pilot stated that he immediately lowered the collective and rolled the throttles to idle allowing the helicopter to enter an emergency autorotation descent straight ahead along its planned track. He subsequently pressed the SOS button on the installed company tracking system and later transmitted a Mayday.

The pilot further stated that at some stage, as he was getting closer to the water, he realised that the engine power was available. However, he concluded that it was already too late to recover and he had also not determined the cause of the warning and abnormal reading. He therefore continued on and ditched the helicopter on the water.

After the helicopter ditched, it continued tracking towards the South West for about 20 minutes before it reached a shallow reef which was reported to be generally less than a meter deep at the time. The pilot tried to lift the helicopter onto the reef, but it spun out of control and impacted the reef then came to rest on its left side.

The tail boom was torn off as it impacted the reef with momentum. The main rotor gearbox separated from its mount, only being held by springs, during the impact sequence and lodged itself into the forward lower section where the pilot's foot pedals were located. This injured the pilot's right foot.

The pilot managed to climb out of the helicopter during the low tide and wait for rescue. Rescuers arrived on scene about 40 - 45 minutes after the accident and rescued the pilot.

The Operator stated that they received the 'SOS' on their monitoring screen but thought that the pilot had inadvertently pressed the button. They reported that the 'SOS' button was sometimes accidently activated in past flights, thus they did not activate an emergency response but rather monitored that helicopter on screen to determine whether it was actually in distress or that it was just a false alarm.

The Operator reported that the CEO who was at home received a 'SOS' alert on his phone within 10 minutes of the pilot activating it. He immediately commenced coordination of the rescue operation, in liaison with Kimbe Bay Shipping Agency (KBSA), boarded a fishing boat at the KBSA marina and headed to the accident site.

The wreckage was salvaged on 12 August 2019 by the Operator and stored in their maintenance Hanger where the AIC wreckage inspection was conducted.

1 FACTUAL INFORMATION

1.1 History of the flight

On 11 August 2019, at 11:25 local time (01:25 UTC[1]), a Bell 427 helicopter, registered P2-HSG, owned and operated by Niugini Helicopters, was reported to have impacted a reef 3.1 nm North West of Buluma township while conducting a VFR[2] flight from Kokopo, East New Britain Province to Kimbe, West New Britain Province.

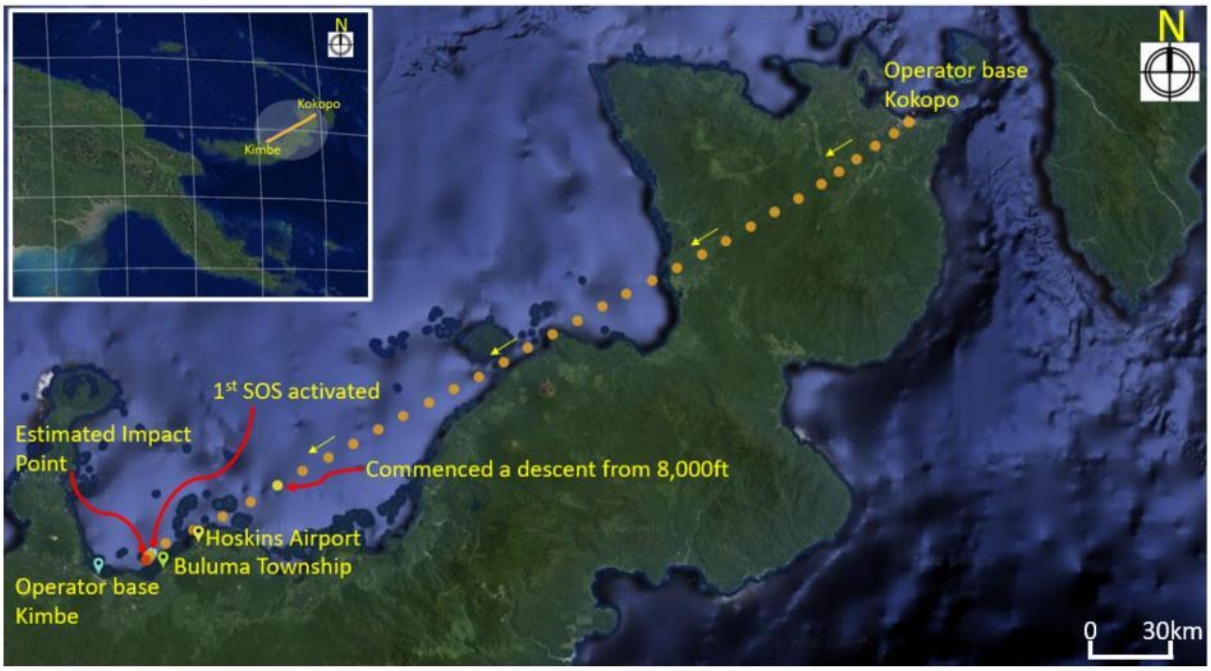

Figure 1: Depiction of P2-HSG flight path and accident location in relation to Buluma township

The pilot had, earlier that day, flown from Kimbe to Kokopo to drop off a passenger. The pilot stated during interview that he refuelled the helicopter and while preparing to return to Kimbe, he received a call from some local customers requesting for a charter, however, the customers did not turn up. He then decided to ferry the helicopter back to their Kimbe base.

The helicopter departed Kokopo at 10:02, climbed to an altitude of 8,000 ft with a planned track over water direct to Kimbe.

The pilot stated that during the cruise, he decided to conduct an autorotation[3] exercise to check the autorotation RPM because the helicopter had undergone maintenance the previous day where an adjustment of the main rotor RPM was made. He stated that he checked the fuel level and estimated the helicopters weight to be within the desired weight range for the exercise.

1 The 24-houl 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.

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

3 A state of flight where the main rotor disk of a helicopter is being turned by the action of air moving up through the rotor rather than engine power driving the rotor.

At 10:56, the pilot made a very high frequency (VHF) radio broadcast, reporting that he had commenced descent from 8,000 ft and was estimated to arrive in Kimbe at 11:09. At 3,000 ft, about 12 nm from Kimbe, the pilot lowered the collective and rolled the throttles to idle, allowing the helicopter to enter the autorotation. As the helicopter descended in this configuration, the pilot observed the RPM, which he recalled was about 99-100%.

The pilot stated that at about 1,000 ft, he rolled the throttles back to 'FLY' position and raised the collective to recover[4] from the autorotation. However, at that moment, the low rotor *RPM* warning activated. He added that when he momentarily glanced at the torque, it seemed to read *'1'* (one). He, therefore, concluded that the helicopter had experienced an engine failure. He immediately lowered the collective, rolled the throttles to idle and entered an emergency autorotation descent. The pilot subsequently pressed the Spidertracks[5] SOS button to alert the Operator about the emergency.

The pilot pointed out during interview that he broadcast a *Mayday*[6] on the HF radio during the emergency descent, but could not recall the altitude at which he made the call. He added that he did not make another call or pursue a response from Air Traffic Services (ATS) because he was more focused on handling the emergency event.

The pilot stated that at some stage, as he was getting closer to the water, he realised that engine power was available. However, by then the helicopter was too low and he had already committed to the autorotation landing. Furthermore, he had not identified the cause of the warning. He therefore, continued and ditched the helicopter in the sea.

After settling on the water, the helicopter remained partially afloat with its engines operating and the pilot was able to maintain the upright position and commenced tracking towards a reef situated approximately 0.9 nm South West of its position.

According to the Spidertracks recorded data, at 11:05, the helicopter was at 148 ft and had a groundspeed of 63 kts. The next point registered a minute later showed that the aircraft was at 40 ft. All data points recorded from 11:06 onwards, over about 20 minutes until the accident, read altitudes ranging between 37 – 46 ft, while the groundspeed remained under 5 kts *(see Figure 2).* The investigation determined that the altitude recordings were in error and that the helicopter was already in the water by 11:06 *(see Figure 3)*.

The tide was low at that time. The helicopter tracked on water before it arrived at a reef 3.1 nm North West of Buluma Township *(see Figure 1).* In accordance with the salvage report, the reef was less than a meter deep. As the pilot tried to lift the helicopter onto the reef, it spun out of control and impacted the reef then came to rest on its left side. The time of impact was confirmed to be at 11:25.

The pilot exited the helicopter and waited on the reef for rescuers. He reported that he was rescued about 40 – 45 minutes after the accident.

4 Transition from simulated autorotation to powered flight

5 A web-based global positioning tracking company.

6 International radio telephony distress signal.

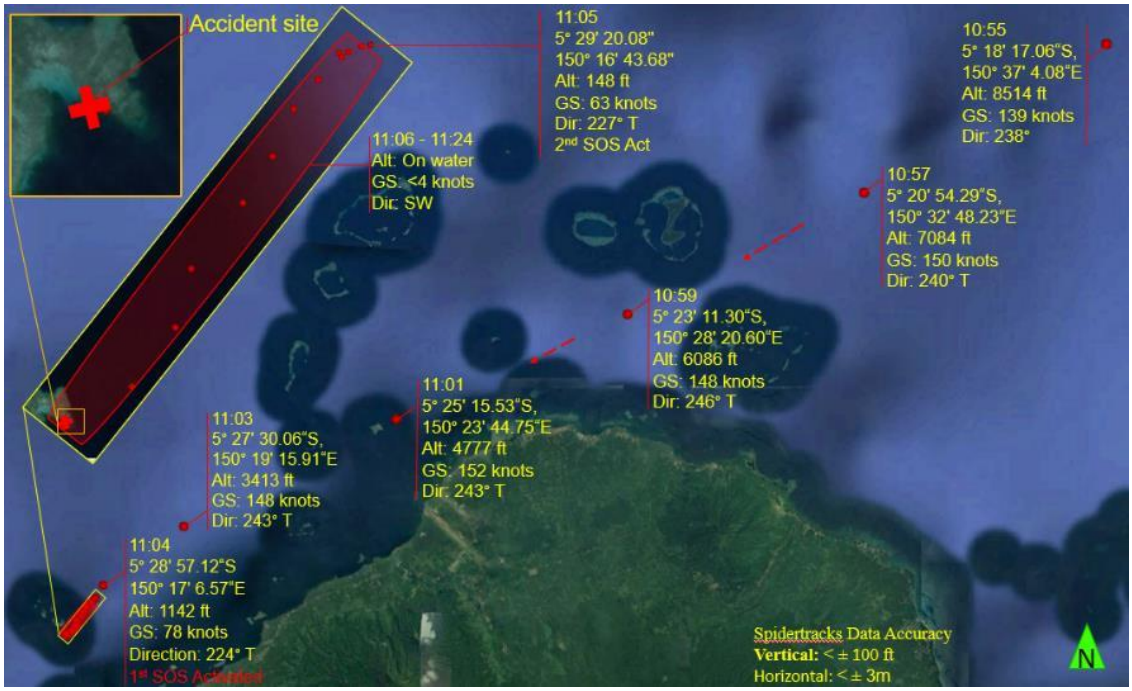

Figure 2: P2-HSG recorded data points for the descent and emergency **SOURCE:** *SPIDERTRACKS*

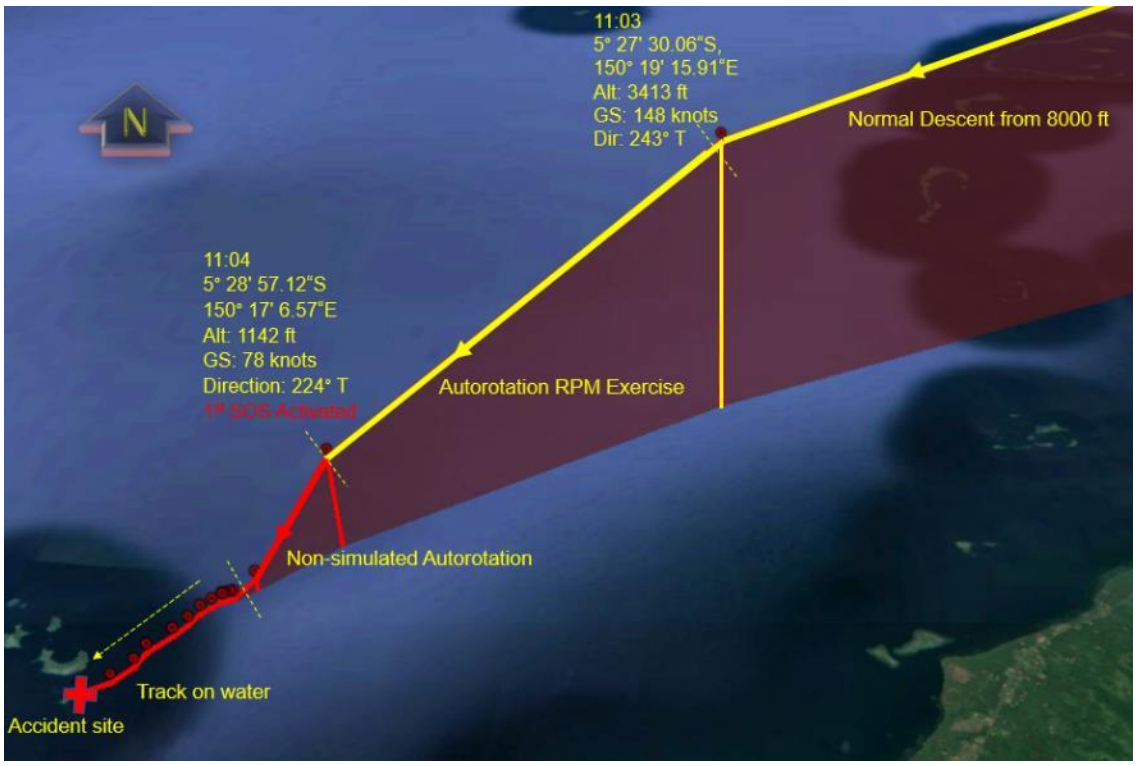

Figure 3: Depiction of the descent and emergency using P2-HSG recorded data **SOURCE:** ***SPIDERTRACKS***

1.2 Injuries to persons

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

Table 1: Injuries to persons

1.3 Damage to aircraft

The helicopter was destroyed. For description, refer to *section 1.12*.

1.4 Other damage

The environment around the area of impact sustained minimal damage.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 51
Gender	: Male
Nationality	: New Zealander
Position	: Pilot
Type of license	: PNG CPL H
Route competency check	: 10 April 2019
Type rating	: Bell 427
Total flying time	: 6,549.0 hours
Total hours in command	: 6,120.9 hours
Total hours on type	: 346.0 hours
Total hours last 90 days	: 87.0 hours
Total hours last 90 days on type	: 27.0 hours
Total hours last 7 days	: 22.6 hours
Total hours last 24 hours	: 2.6 hours
Total hours last 24 hours on type	: 2.6 hours
Medical class	: Class 1
Valid to	: 27 March 2020
Medical limitation	: Prescribed spectacles to be worn

The pilot was wearing the prescribed spectacles during the flight.

1.6 Aircraft Information

1.6.1 Aircraft data

Aircraft manufacturer	: Bell Helicopters Textron
Model	: Bell 427
Serial number	: 56066
Year of manufacture	: 2008
Total airframe hours	: 998.3 hours (including last flight)
Total airframe cycles	: 1,999 hours (not including last flight)
Registration	: P2-HSG
Certificate of Registration number	: 325
Certificate of Registration issued	: 12 July 2014
Certificate of Registration valid to	: Non terminating
Name of the owner	: Niugini Helicopters
Name of the operator	: Niugini Helicopters
Certificate of Airworthiness number	: 325
Certificate of Airworthiness issued	: 12 July 2014
Certificate of Airworthiness valid to	: Non terminating

The Bell 427 is an eight-place light helicopter with a standard configuration provided for one pilot and seven passengers. P2-HSG had this configuration. It is powered by two Pratt & Whitney Canada PW207D engines, which provide 400 SHP (Shaft Horsepower) each, in dual engine configuration.

1.6.1.1 *Engine data*

Engine type	: PW207
Year of Manufacture	: July 2007
Manufacturer	: Pratt and Whitney Canada
Model	: PW207D

No. 1 engine (Left)

Serial number	: PCE-BF0157
Total time since new	: 989.10 hours
Cycles since new	: 1073

No. 2 engine (Right)

Serial number	: PCE - BF0158
Total time since new	: 998.30 hours
Cycles since new	: 1074

Each engine was fitted with engine data recording devices; Data Collection Unit (DCU) and Electronic Engine Control (EEC). Both devices were removed and sent to Pratt & Whitney Canada (P&WC) for data download, readout and analysis *(see Section 1.11.1 and Appendix A, 5.1.1).*

1.6.1.2 *Rotor blades*

Tail rotor blades

Tail Rotor blades manufacturer : Bell Helicopters Textron

Tail Rotor blades 1-2 serial number : A-290 & A-280

Main rotor blades

Main Rotor blades manufacturer : Bell Helicopters Textron

Main Rotor blades 1-4 serial number : A-590, A-577, A-591 and A-585 respectively

Main rotor is a four-bladed, 37 foot (11 m) diameter, soft-in-plane design with a composite hub and individually interchangeable blades and tail rotor is a two-bladed teetering rotor with a 5.7 foot (1.7 m) diameter that provides directional control.

The P2-HSG *Daily Flight Record No: 15286* indicated that there was an autorotation RPM check conducted on 14 July 2019. This auto RPM flight check was conducted by the Chief Pilot (CP) and was done to verify that the autorotation RPM was within its specified nominal range. The FLIGHT DETAILS column read:

> *Auto RPM check x2*
> *Second one spot on @ 99%*
> *(Nominal Auto rpm Rev's).*

The Operator stated that the result observed during this check was within the nominal range and that no RPM adjustment was necessary.

1.6.1.3 *Fuel information*

All relevant documents containing fuel information were destroyed in the accident.

In accordance with the pilot's statement and the P&W C report in relation to the engine operations, the investigation determined that there was sufficient fuel on board the helicopter at the time of the accident.

1.6.1.4 *Minimum equipment list*

There was no outstanding *Minimum Equipment List (MEL)* item at the time of the accident.

1.6.1.5 *Maintenance information*

According to the Operator's *Maintenance Organisation Exposition, Section 5.8.3 Maintenance Process-Planned Maintenance Process, the MPS101 Initial Document Review* states that;

> *a) The CE[7], through consultation with Maintenance Controller (MC) and the Engineers will review and schedule all maintenance requests for work as described in this procedure.*

7 Chief Engineer.

On 10 August 2019, the day before the accident, an unscheduled maintenance action was carried out. It involved an adjustment of the autorotation RPM. According to the Operator, the adjustment was requested by the accident pilot and carried out by one of the engineers. The Operator also stated that the Chief Engineer (CE) was aware of the request, however he was not aware of the subsequent maintenance action at the time.

The maintenance was recorded in the maintenance log as follows:

In the *'Maintenance Arising'* column

M/R ROTOR AUTOROTATION RPM SET
TO LOW

In the *'Rectification or Deferral Action'* column

ADJUSTED RPM ONE FULL TURN
ON PITCH LINKS TO INCREASE BY
3 % IAW BHT-427-MM CHAPTER 18.

The defect entry rectification had a stamp with the inscription:

> *The maintenance recorded has been carried out in accordance with the requirements of Papua New Guinea Civil Aviation Rule Part 43 and in respect of that maintenance the aircraft is released to service, in pursuant to CAR Part 43.105*

The helicopter was released back to service on 10 August 2019 after the main rotor pitch link adjustment was completed *(see Appendix B, 5.2.1)*.

Investigators reviewed the *Bell Helicopters Textron 427 Maintenance Manual Chapter 18 (see Appendix B, 5.2.2)* and found that the manual specified instructions for an autorotation check to be conducted prior to the pitch link adjustment. The manual also instructed that an autorotation check be done following the adjustment. Investigators determined that autorotation RPM checks were not conducted as required by the manual. The only action carried out was the pitch link adjustment followed by the release of the aircraft back to service. The first flight conducted after the release to service was the passenger flight to Kokopo on 11 August. During the return flight, while conducting an autorotation verification, the accident occurred.

According to the Operator's *Maintenance Organisation Exposition (MOE) Section 5.8.3 (see Appendix B, 5.2.3)*, upon completion of each requested maintenance task, which includes a test / operational check flight results, a final certification review must be completed to ensure that the task was completed satisfactorily.

The *MOE Section 5.11 (d) (see Appendix B, 5.2.4)* states that maintenance procedures including the operational flight check must be completed satisfactorily in accordance with the procedures specified in the MOE prior to releasing the helicopter to service pursuant to *CAR Part 43.105*.

The *PNG CAR Part 43.105 Certifying release-to-service* after maintenance states that:

> *(a) Except as required in paragraph (b), a person who certifies an aircraft or component for release to service after maintenance must record the following information in the appropriate maintenance logbook or worksheet, and the technical log as may be necessary, immediately adjacent to the details of the maintenance that is required to be recorded under rule 43.68—*
>
> *(5) the following statement of release-to-service if the maintenance logbook, worksheet, or technical log, as the case maybe, does not include a preformatted equivalent statement:*

"The maintenance recorded has been carried out in accordance with the requirements of Papua New Guinea Civil Aviation Rule Part 43 and in respect of that maintenance the (aircraft) (component)* is released to service".*

**delete as applicable*

PNG CAR Part 43.68 Maintenance records states that:

(a) Except as provided in paragraph (b), a person performing maintenance on an aircraft or component must, on completion of the maintenance, record the following information in the appropriate maintenance logbook:

(1) details of the maintenance including, where applicable,

(i) the identity of any inspection carried out; and

(ii) a description of the work performed; and

(iii) the technical data used; and

(iv) the requirement for an operational flight check if the maintenance requires a flight check under rule 43.103(a)(4):

PNG CAR Part 43.103 (a)(4) Requirements for certifying release-to-service states that:

(a) A person must not certify an aircraft or aircraft component for release to service after maintenance unless-

(4) if the aircraft has undergone maintenance that may have appreciably affected the flight characteristics or operation of the aircraft, -

(i) a satisfactory operational flight check has been carried out in accordance with rule 91.613 and the completion of the flight check is recorded in the aircraft maintenance logbook or worksheet, and the technical log; or

(ii) ground tests, inspections, or both, show conclusively that the maintenance has not appreciably changed the flight characteristics or substantially affected the flight operation of the aircraft and details of the ground tests and inspections, as the case may be, have been recorded in the aircraft maintenance logbook or worksheet; or

(iii) the release-to-service is for the purpose of performing the operational flight check required under paragraph(a)(4)(i).

PNG CAR Part 43.103(c)(1) states:

(c) The person responsible for certifying an aircraft for release-to-service under paragraph (a)(4)(iii) for the purpose of an operational flight check must record in the aircraft maintenance logbook or worksheet, and the technical log-

(1) the following statement of release-to-service:

In respect of the recorded work, the aircraft is released-to-service for an operational flight check only;

Information gathered revealed that the helicopter was released to service under *CAR 43.105*, without completing the final certification review which included the operational / test flight procedure. In addition, the Operator did not have a procedure pursuant to *CAR Part 43.103 (c)(1).*

1.6.2 Aircraft systems

1.6.2.1 *Low rotor RPM warning system*

According to the *Bell 427 Aircraft Flight Manual*, when the main rotor RPM drops below 95%, the low rotor RPM warning activates. The warning is in the form of a visual low rotor *RPM* warning and a loud horn. The manual provides a procedure to follow in the event that this warning is received. The procedure is:

> *RPM (with low RPM audio) N_R[8] below 95%*
> *1) Collective — Reduce.*
> *2) Throttles — FLY.*

This was the warning the pilot reported hearing. He reported that he initially thought that the helicopter had experienced an engine failure *(see Appendix C, 5.3.1)* so he immediately actioned the procedure for entering an emergency autorotation descent. He therefore, reduced the collective and rolled the throttles to idle.

1.6.3 Collision Avoidance Systems

The helicopter was equipped with Mode-S Transponder (GTX330) and a Traffic Advisory System (TAS605) and their serviceability were not a factor in this accident.

1.7 Meteorological information

1.7.1 PNG National Weather Service Forecast Data

The PNG National Weather Service Aerodrome Forecast for Hoskins Airport (8.5 nm South West of the accident site), issued at 10:01 on 11 August 2019 for Hoskins Airport was:

Wind	: 120 degrees at 8 knots
Weather	: Good visibility with light showers and rain, scattered clouds at 1,600 ft and 3,000 ft and broken at 12,000 feet
INTER	: Visibility reduced to 4km with showers and rain, broken clouds at 800 feet
QNH (TEMP)	: 1009hPa, 1007hPa and 1008 hPa respectively (three-hour interval from 11 August 02:00 – 11:00)

1.7.2 Satellite Weather Information

The satellite image provided by PNG National Weather Service indicated that there were scattered clouds towards the South East (SE), left of the helicopter's track. From the prominence of the clouds in the satellite image, it is identified that there was good visibility off the coast of mid New Britain's northern side along the helicopter's flight path. There was reduced visibility inland New Britain as there is evident topography weather of cloud build up along the mountain ranges.

8 Helicopter main rotor rpm.

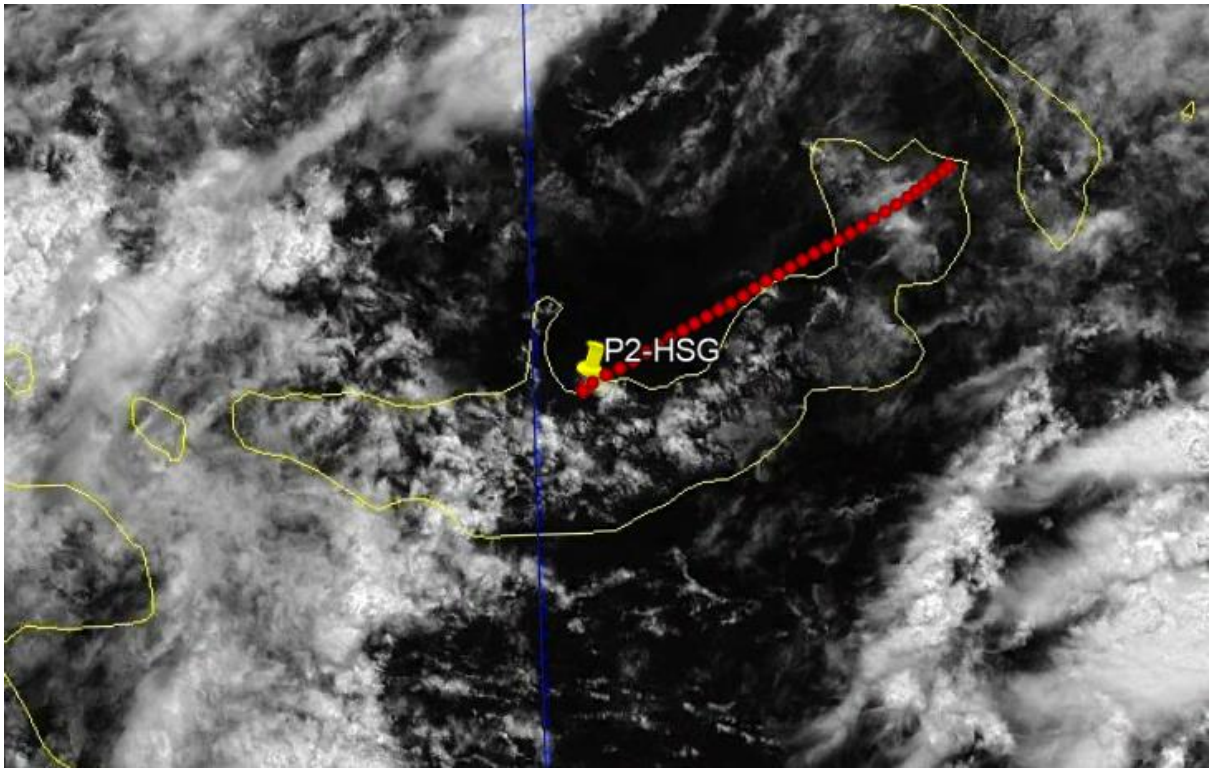

Figure 4: Satellite image of weather around New Britain area at 11:20 on 11 August 2019 SOURCE: JAXA GLOBAL WEATHER WATCH

1.7.3 Pilot Weather observations

The pilot indicated that there was light-off shore wind, and scattered clouds above 3,000 ft. He added that he was flying into wind.

1.8 Aids to navigation

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

1.9 Communication

The aircraft was fitted with the following communication equipment:

- two Garmin VHF *Communication Transceiver* (GNS430W and GNS530W); and
- an *ICOM IC-7000F HF Communication Transceiver*.

Both onboard systems were determined to be operating normally prior to the accident.

The VHF communication system is the primary communication frequency band for two-way communication between aircraft and ATS. The secondary communication system is the High Frequency (HF).

Communication on the VHF is limited to line of sight. VHF wave propagation is blocked by elevated terrain such as hills and mountains and has a limited coverage. When VHF communication becomes unavailable, communication can be maintained on the HF system. Radio waves in the HF band can be reflected by the ionosphere which allows the waves to travel over mountains and other obstructions to reach the receiver.

All communication between ATS and the crew on VHF was recorded by PNG ASL's ground based automatic voice recording equipment. The VHF communication between the pilot and Moresby Flight Information Services (FIS) officer[9] was loud and clear.

At 11:11, two minutes after the estimated arrival time of P2-HSG, the FIS commenced radio communication checks on P2-HSG because the pilot had not called back to cancel SAR WATCH[10]. These communication checks were all made on the VHF.

An aircraft in the vicinity was requested to make contact with P2-HSG, however to no avail. During his interview, the pilot stated that he heard a pilot of an aircraft trying to make contact with him when he was on water, before the helicopter spun out of control.

The pilot stated that in his experience operating helicopters in the Northern parts of the New Britain, the HF communication has not been reliable. He would usually cancel SAR WATCH on the ground after shutting down.

The pilot also stated that he had broadcast a *Mayday* call on HF after he had activated Spidertracks. However, there was no evidence of any HF communication available to the investigation. ATS staff also confirmed that they have been unable to communicate with pilots on HF because there has been continuous static interference making it impossible to maintain effective communication.

The AIC found that the HF quality deficiency was an ongoing issue which was first identified and highlighted by the AIC through a previous accident investigation reference *AIC 16-1002*, involving a Pilatus Britten Norman BN-2T aircraft, registered P2-SBC which occurred in Kiunga on 13 April 2016.

During the investigation, AIC issued a safety recommendation *AIC 16-R12-1002*, which was associated with ineffective HF communication system. The recommendation read:

> *The Accident Investigation Commission recommends that PNG Air Services Limited, should take action to improve High Frequency radio capability to ensure, as much as possible, that transmission are clear and readable so vital transmissions for the safety of aircraft operations are not missed.*

PNG ASL responded, acknowledging the deficiency and stated the following:

> *On July 11 2018, PNG Air Services Limited informed the Accident Investigation Commission that its program to deploy and commission duplicated Transmitter and Receiver systems located at Nadzab Airport, Lae had been delayed, but expected completion towards the end of 2018.*

During this helicopter accident investigation, the AIC retrieved audit records from CASA PNG to verify the status of the HF system. The audit records, along with pilot and ATS staff interviews confirmed that the upgrade of the HF system, up to the date of release of this report, has not been completed.

1.10 Aerodrome information

Not Applicable.

9 From here on the Moresby Flight Information Services Officer will be referred to as FIS.

10 Commences at the time of receipt of the first pilot call, and ends upon receipt of the last call from the pilot, usually upon arrival at the destination.

1.11 Flight recorders

The helicopter was not equipped with a flight data recorder (FDR) or cockpit voice recorder (CVR). Neither of the recorders were required under *PNG Civil Aviation Rules* current at the time of the accident.

1.11.1 Other electronic data recording device

1.11.1.1 *Engine Data Recording Units*

The DCU is a unit mounted on the side of the engine and is connected to the EEC through the engine wiring harness.

The DCU was designed purposely as a repository for recording data of various engine trim parameters, accumulated operation time, accumulated part cycles and specific operational exceedance/excursion data when detected by the EEC. The EEC also has the non-volatile capability for recording the detected data. The DCU recording consists of 16 standard parameters for exceedance and event recording while a fault recording consists of 4 parameters.

No.1 Engine (SN: BF0157) DCU and EEC

DCU
Part Number: 3059185-03
Serial Number: DP06-4235

EEC
Part Number: 824165-8-003
Serial Number: 06060840

No.2 Engine (SN: BF0158) DCU and EEC

DCU
Part Number: 3059185-03
Serial Number: DP07-4675

EEC
Part Number: 824165-8-003
Serial Number: 060687018

The helicopter wreckage was salvaged on 12 August 2019 by the Operator in coordination with the AIC. When investigators arrived in Kimbe, the data recording units were retrieved and sent to the Canadian Accredited Representative to the investigation, the Transportation Safety Board of Canada (TSBC), where they were processed. TSBC subsequently sent the components to their Advisor, Pratt & Whitney Canada (P&W C) for the download attempt. This download and readout was conducted under the supervision of the Accredited Representative.

The advisor stated that the DCUs were able to record faults and exceedances and had a more complete fault history than the EECs. Therefore, the DCU data was considered for use in the investigation.

A report was provided to the AIC on 19 November 2019 which contained the DCU data readout and its analysis *(see Appendix A, Section 5.1.1).*

1.11.2 Spidertracks Real-time Tracking System

The Spidertracks tracking system is a web-based system which allows subscribed operators to track and monitor their aircraft using an internet connected device. A Spidertracks device, called the 'Spider' is installed on the aircraft to transmit GPS[11] information in real-time.

It also has a function which allows pilots to manually transmit a SOS when in an emergency. This is achieved by pressing the SOS button which is installed with the Spider.

P2-HSG had a Spider mounted on top of the dashboard. It transmitted GPS coordinates, altitude, groundspeed in real-time at 2-minute intervals. When the SOS button was activated the data transmission frequency increased and started transmitting at 15 seconds intervals twice before returning to 2 minutes.

According to Spidertracks, the recorded data would have altitude error, approximately plus or minus 100 ft of the actual altitude, while lateral position error, approximately plus or minus 10 ft of the actual position.

1.12 Wreckage and impact information

The helicopter wreckage was found on a reef located in the Satin Bay Area about 3.1 nm North West of Buluma township, partially submerged in the saltwater less than a meter deep, when rescuers arrived *(see Figure 5).*

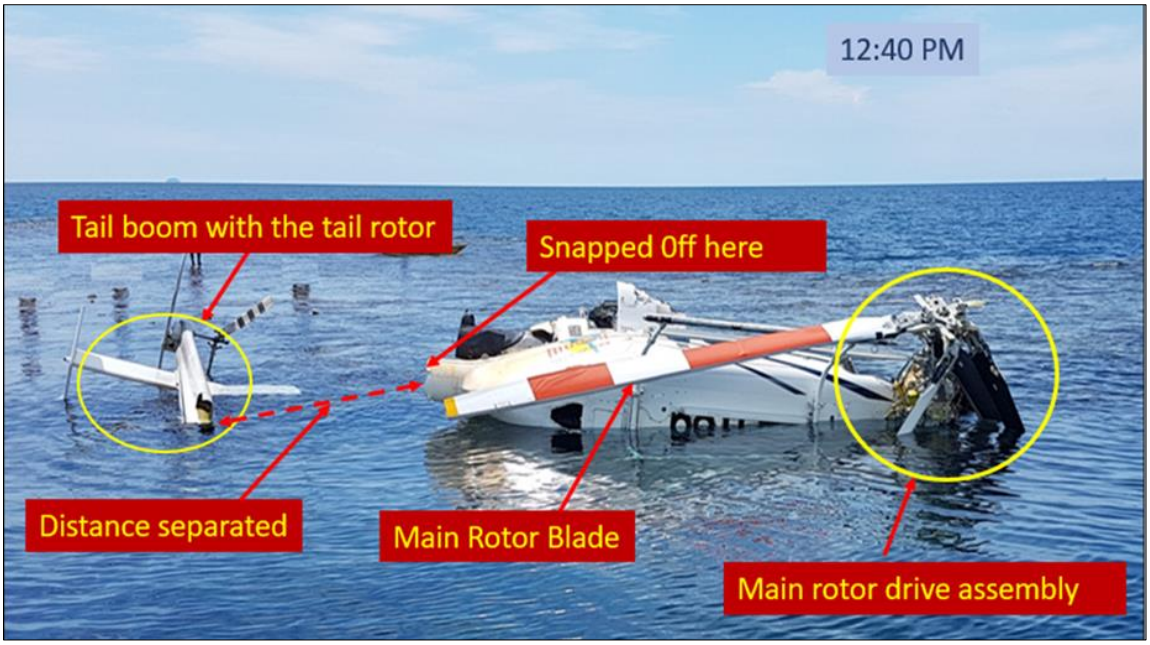

Figure 5: P2-HSG final resting position ***(Picture taken about an hour after the accident by Operators rescue team)***

The Operator obtained authorisation from the AIC to salvage the wreckage because the main wreckage was sitting on the edge of the reef and was at risk of being pushed off the reef by ocean currents. The Operator hired and used salvage equipment from local businesses and commenced the salvage operation on 12 August 2020, the next day. The wreckage was transported to the Niugini Helicopters Kimbe base hanger. A salvage report was provided to the AIC for the investigation.

11 Global positioning system.

The main rotor blades with the main rotor drive assembly were separated from the fuselage and rested adjacent to the helicopter main wreckage *(see Figure 5)*. The damage of the main rotor blades suggests that they impacted the reef with significant engine power *(see Figure 6)*.

Figure 6: P2-HSG main rotor blades

The main rotor drive assembly separated from the helicopter, remaining attached to two elongated springs which swung it around into the pilot's foot area *(see Figure 7)*.

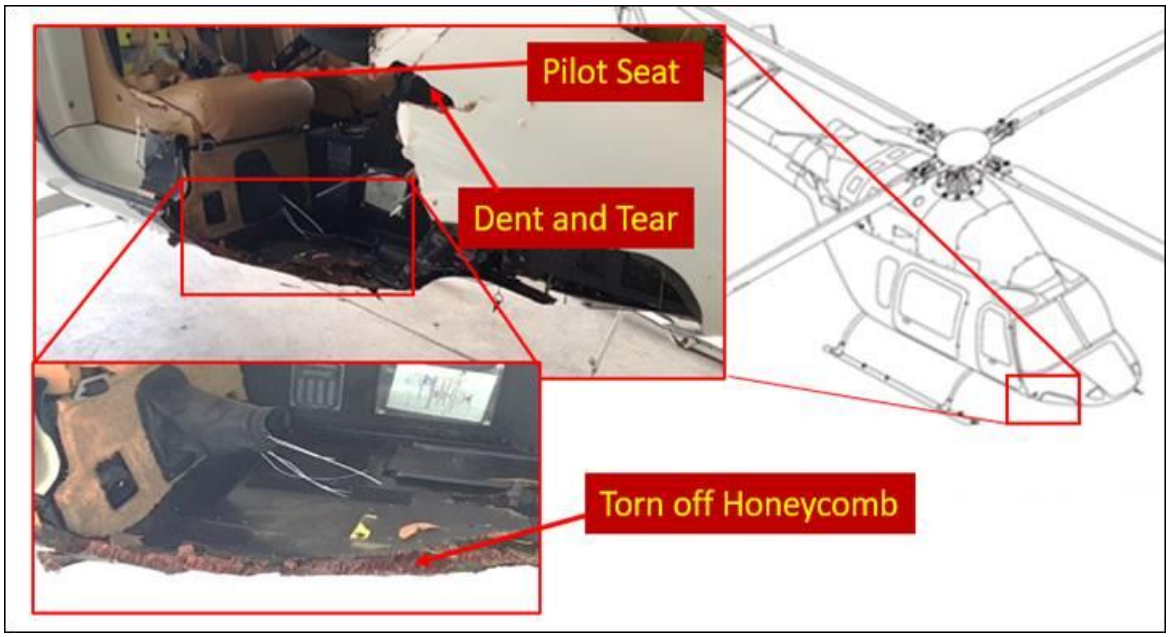

Figure: 7 Damage caused by the main rotor drive at the right side of the helicopter

There was no chordwise damage observed on the tail rotor blades which suggests that the tail rotor stopped turning prior to the helicopter's impact with the reef *(see Figure 8)*.

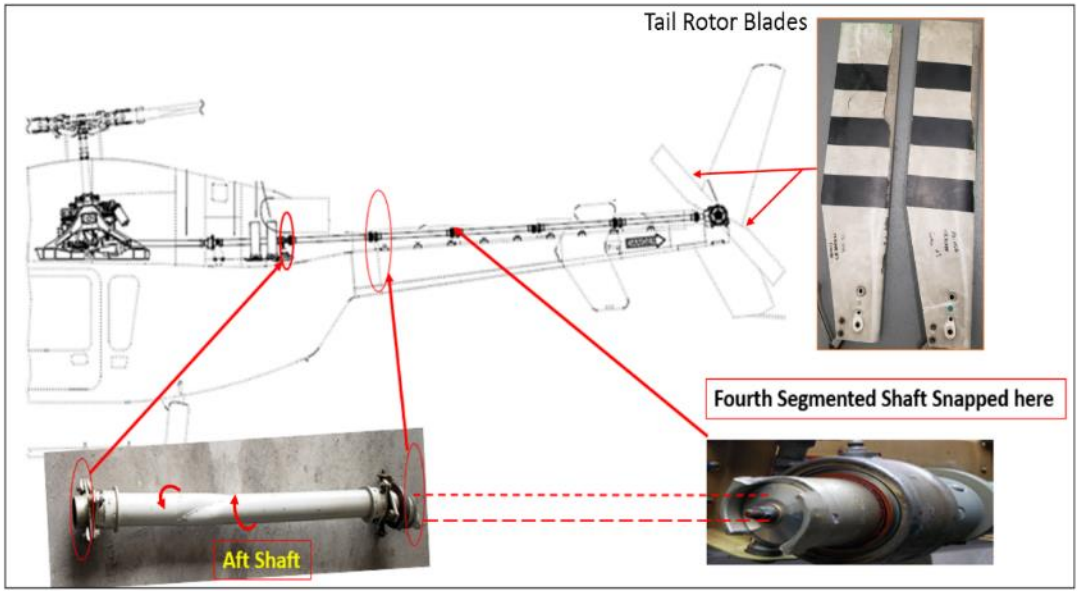

Figure 8: Tail rotor blades.

The damage observed on the tail boom indicates that the helicopter impacted the reef on its left side. It protruded from the water adjacent to the fuselage *(see Figure 5)*.

The damage observed to the torn-off tail boom suggests that the helicopter was steeply banked to the left when the tail impacted the reef *(see Figure 9)*. The fuselage was found at rest on its left side. Impact damage to the fuselage was limited to its left side. This suggested that the helicopter came to rest upon initial impact with the reef.

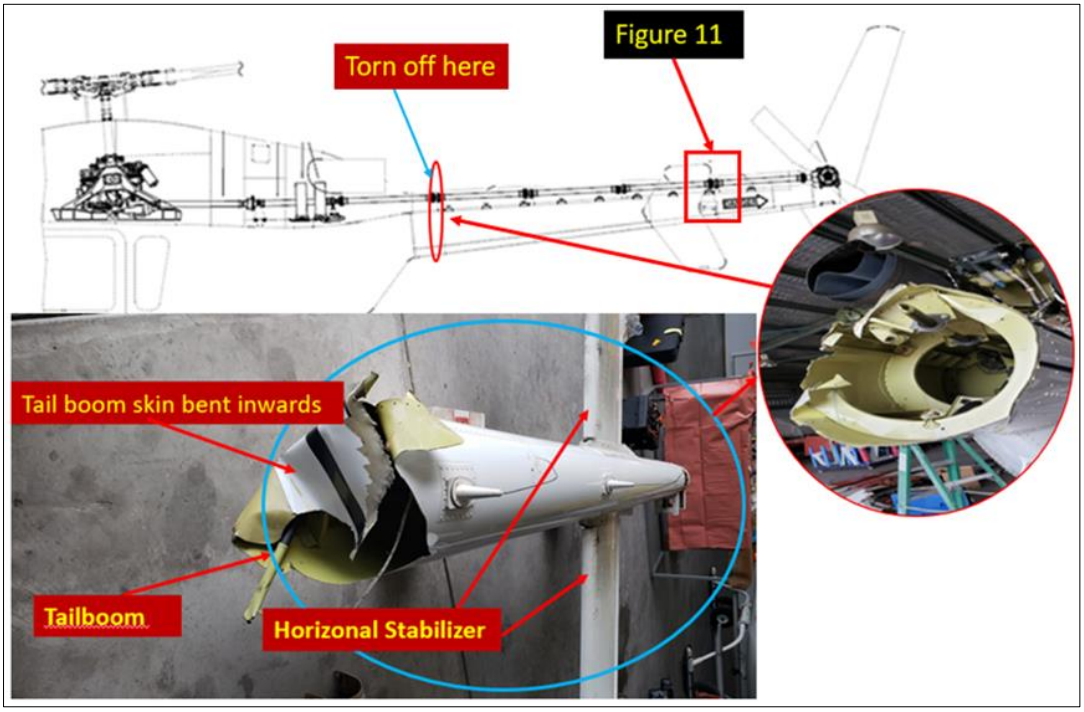

Figure 9: Snapped off tail boom

The 4th segmented shaft-hangar bearing joint rivets were missing. The aft section of the shaft, where it joins the hangar bearing, was discoloured and ground significantly due high temperature exposure *(see Figure 10)*. This suggests that the tail rotor disconnected from the engine while the engine power was still being transmitted through the drive line.

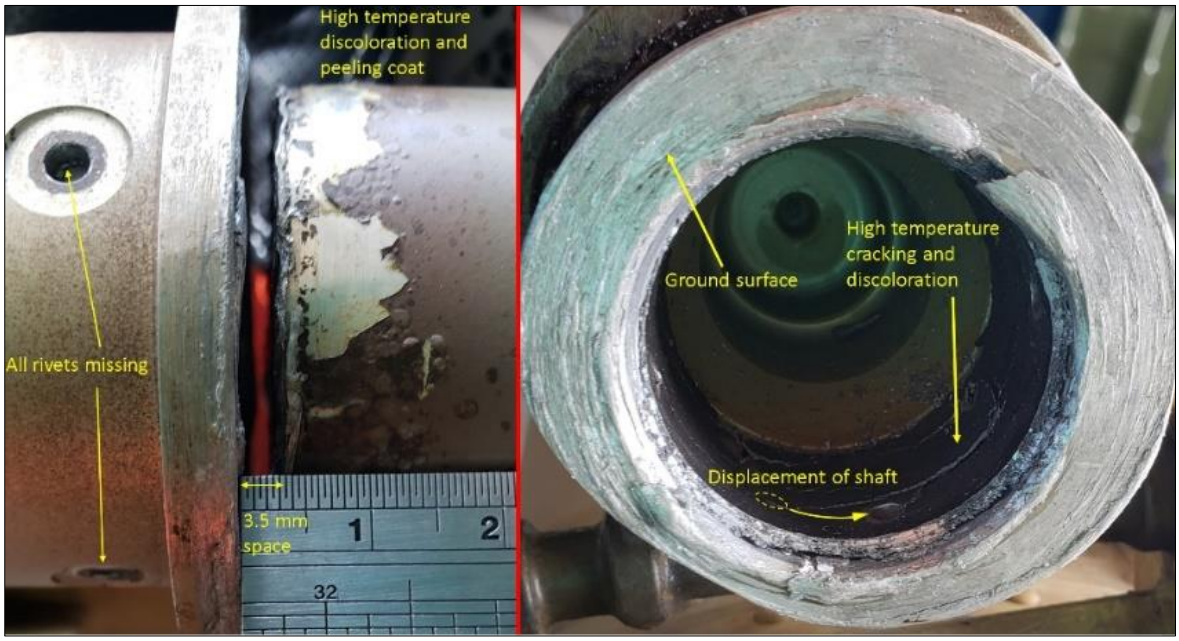

Figure 10: Failed tail rotor drive shaft

The tail rotor drive was removed for further examinations. When the tail rotor gearbox cap assembly was removed, extensive corrosion material was observed in the tail rotor gearbox housing *(see Figure 11)*.

Figure 11: Corroded inner tail rotor gearbox housing

The damage sequence was determined to be as follows:

- Upon contact with the sea, the tail rotor blades struck the water causing the drive shaft assembly failure resulting in the loss of tail rotor function. The fuselage and tail rotor were found on the reef about 2 m apart. The main wreckage was confined to Eastern edge of where it initially impacted. The nose of the helicopter was oriented towards the North West suggesting that the helicopter had spun around laterally.
- The main Rotor blades were destroyed during the impact with the reef. The main rotor gearbox subsequently separated from its mount and lodged itself into pilot's foot area.
- The tail boom was torn off the helicopter at the forward side. This occurred during the reef impact sequence.

The extensive damage to the fuselage suggests that the helicopter made an abrupt uncontrolled bank on its left side and came to rest.

1.13 Medical and pathological information

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

1.14 Fire

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

1.15 Survival aspects

ICAO Annex 13 requires the search and rescue activities to be addressed in an investigation of an aircraft accident. Search and rescue activities are covered in the later sections of this report.

1.15.1 Pilot

The pilot survived the impact and egressed the helicopter after it came to rest. About 40 - 45 minutes after the helicopter impacted water, six locals from Buluma village arrived at the accident site and rescued the pilot. Information provided by the Operator indicated that the villagers who facilitated the rescue reported that that they had witnessed the helicopter land on water then sail through the water like a boat, for about 20 minutes. They also reported that they saw the helicopter spinning around through the water many times, as it attempted to make its way to the reef. They climbed into their dinghy and headed out to the reef where the accident site was located.

About 5 minutes later, a team from the Operator arrived at the accident site in a fishing boat. The pilot was transferred over to the fishing boat and was taken to shore.

1.15.2 Emergency locator transmitter

The helicopter was fitted with an Artex C406-1HM Emergency Locator Transmitter (ELT). The Artex C406-1 HM transmits on all three nominated ELT frequencies (121.5/243.0 and 406 MHz). The ELT automatically activates when certain G-forces act on the aircraft and transmits the standard swept tone on 121.5 and 243.0 MHz *(refer to Appendix D, 5.4.1)*. It also transmits a 406 MHz encoded digital message to the COSPAS-SARSAT satellite system.

The PNG ASL Chronology of Search and Rescue (SAR) events *(refer to Appendix D, 5.4.2)*, indicated that the ELT Distress COSPAS-SARSAT message was received at ATS at 11:26. The message no: 02632, transmitted through the Australian Mission Control Centre (AUMCC) via Aeronautical Fixed Telecommunication Network (AFTN), indicated that P2-HSG's ELT beacon signal was detected at 11:25 (01:25 UTC), on frequency 406.0276 MHz.

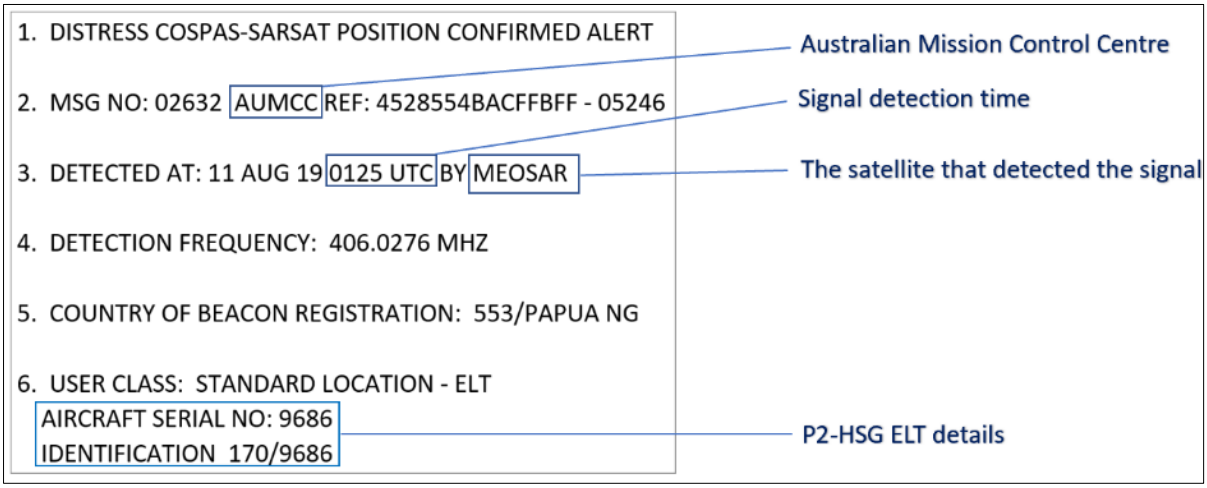

Figure 12: Extract of P2-HSG ELT activation COSPAS-SARSAT message

The pilot stated during his interview that as he exited the helicopter onto the reef, he could hear the sound of the activated ELT. Thus, he decided not to activate the Portable Locator Beacon (PLB).

1.15.3 COSPAS-SARSAT satellite system

The COSPAS-SARSAT[12] system only detects distress Emergency Locator Transmitters (ELTs), Emergency Position-Indicating Radio Beacons (EPIRBs), and Portable Locator Beacon (PLBs) operating on the 406 MHz frequency. Each 406 MHz beacon transmits a unique digital code that identifies the type of beacon and allows registration data to be associated with the beacon. The registration data provides information such as the beacon owner; the type of platform the beacon is associated with; emergency points of contact; and much more.

After the satellite receives a beacon signal, it relays the signal to earth stations referred to as Local User Terminals (LUT). The LUT processes the data, computes the location of the distress beacon, and transmits an alert message to its respective Mission Control Centre (MCC) via a data communication network.

The MCC performs matching and merging of alert messages with other received messages, geographically sorts the data, and transmits a distress message to another MCC or SAR Point of Contact (SPOC), an appropriate SAR authority such as Aviation Rescue Coordination Center (ARCC) or Maritime Rescue Coordination Centre (MRCC).

The *PNG Air Services Limited, Manual of Air Traffic Services (MATS) SAR 1-1, Para 3.3* states:

> *Port Moresby RCC is a designated search and rescue point of contact (SPOC) for the receipt of COSPAS-SARSAT distress data information which, emanates from ELT beacons that are activated.*

12 COSPAS (COsmicheskaya Sisteyama Poiska Avariynich Sudov) is a Russian acronym for Space System for Search of Distress Vessels, and SARSAT means Search and Rescue Satellite-Aided Tracking.

1.15.4 Search and rescue background

Papua New Guinea is a contracting state to the Convention on International Civil Aviation Organization (ICAO) and is responsible to provide the search and rescue services in accordance with *ICAO Annex 12.*

Provisions for Search and Rescue (SAR) were initially added to *Civil Aviation Act 2000, as amended in 2016*. These were sections 8A and 8B *(Refer to Appendix D, 5.4.3)*. Since the introduction of these provisions, the state of PNG did not have a designated Search and Rescue Coordination Centre (RCC). The AIC first identified this deficiency through a previous accident investigation reference *AIC 17-1004,* involving a Britten Norman BN-2A Islander aircraft, registered P2-ISM which occurred in Morobe Province on 23 December 2017.

On 17 April 2018, AIC issued a safety recommendation *AIC 18-R03/17-1004*, to the then Minister for Civil Aviation, which stated:

> *The Accident Investigation Commission recommends that the Minister for Civil Aviation, in compliance with Sections 8A and 8B of the Civil Aviation Act 2000 (As Amended in 2016), should ensure that a rescue coordination center is established, maintained and operated, to coordinate and conduct aviation search and rescue operations in PNG. This will also ensure compliance with ICAO Annex 12, thereby specifically complying with Section 8A (1) (B) (ii) of the Act.*

On 9 July 2018, the Minister for Civil Aviation formally delegated the function of Rescue coordination Centre (RCC) to PNG ASL.

This investigation found that a RCC Coordinator was appointed on 30 July 2018, from within PNG ASL, from a non-aviation background, qualification and experience. Subsequently, the officer completed an *Introduction to Search and Rescue Operation* course with SAR Training Australia, on 21 February 2019, and an *Aeronautical Search and Rescue Operations* training course with the Singapore Aviation Academy between 17 June to 2 August 2019. Both training courses covered the operational aspects of the RCC and to date of this report, the officer is yet to attend a *SAR Administrative* course. At the time of the accident, the officer was yet to complete a Fit and Proper Person's assessment with the Civil Aviation Safety Authority, Papua New Guinea (CASAPNG). The ASL management informed the AIC that due to man power issues, they were unable to appoint a staff from the ATS section to assume the role.

The PNG ASL management informed the AIC that the assigned RCC room was under renovation at the time of the accident. There were no two-way radios installed to ensure rapid and reliable two-way communications, in accordance with *ICAO Annex 12*. Consequently, coordination of the search and rescue for P2-HSG was conducted at the Centre Supervisor's (CS) work station.

The PNG ASL *Search and Rescue Manual (SARM)* provided to the AIC was still in a draft format, and the SAR plan that was currently in use had not been amended since 13 June 2003. The *MATS SAR section* for SAR alerting services only, had not been amended since 25 July 2013. The investigation determined that the ASL did not have a tentative SAR plan specifically for use within ATS, pending the establishment of the RCC.

1.15.5 Search and rescue in relation to P2-HSG

Information gathered indicated that at 11:04, approximately 30 nm from Kimbe, the pilot pressed the Spidertracks SOS button, which activated the emergency alert at the Operator's base in Kimbe. The pilot stated that he made a *Mayday* call on HF after he had activated the tracker. The investigation determined that this call was made at approximately 11:05, and at an altitude of about 1,000 ft. This transmission was not recorded on the ATS audio recordings, nor was it heard by the FIS officer, as indicated in the officer's statement.

The *MATS SAR 4-2 (refer to Appendix D, 5.4.4)* where FIS initiates the communication checks within 3 minutes after ETA if the pilot does not call by then. In this case, there was an unreported arrival on P2-HSG and SAR WATCH had not been terminated. The ATS audio recordings confirmed that at 11:11, a minute after the original estimated time of arrival (ETA), the officer commenced radio communication checks on P2-HSG.

At 11:14, the FIS requested the pilots of an aircraft enroute to Tokua, ENB, to contact P2-HSG and they reported back at 11:16 that that no contact was established.

The ELT distress COSPAS-SARSAT message was received at 11:26, on the AFTN terminal. However, as reported by ATS, this message was mishandled and was not brought to the attention of the CS immediately.

The FIS contacted Tokua Tower at 11:37 and advised that she had lost contact with P2-HSG, and asked if they had copied him cancelling SAR on their frequency. Tokua Tower confirmed no contact with HSG, and provided telephone numbers of the operator as requested by the FIS.

At 11:39, the FIS eventually managed to make contact with the Operator and established that the number of persons on board and the location of the helicopter were unknown at that time.

At 11:43, the FIS declared the first SAR phase, Uncertainty (INCERFA)[13], due to unreported arrival of P2-HSG and advised the CS accordingly. Subsequently, the FIS contacted the Operator for any leading information, and was briefed that they had lost tracking of the helicopter on Spidertracks and which was believed to have ditched with one person on board.

At 11:44, the ELT distress COSPAS-SARSAT message was brought to the attention of the CS.

The SAR phase was upgraded to Distress phase (DETRESFA)[14] at 11:45. SAR event entries indicated activation of ARCC at 11:46. The CS informed the AIC that although not formally appointed as an RCC personnel, he coordinated all SAR activities as a duty of care. The appointed RCC Coordinator was called in to observe SAR operations and he assisted the CS, where necessary.

The Maritime Rescue Coordination Centre (MRCC) was alerted about the distress and advised to check and notify vessels within the vicinity of the last known position for possible sightings of wreckage or the pilot. Subsequently, the MRCC deployed a search asset, a 23 ft dinghy, from Kimbe to conduct the search.

At 11:50, the Operator reported that the helicopter had ditched with one person onboard, and the Operator had deployed a 23 ft dinghy to the accident site.

At 13:12, the Operator advised the FIS Officer that the pilot was rescued from the accident site, and that he had sustained minor injuries. This information was relayed to the CS.

An update regarding the SAR incident was provided to PNG ASL management and MRCC personnel at 13:21 and 13:24 respectively. The CS cautioned MRCC for any hazardous objects within the vicinity of the accident site, and terminated the SAR action.

13 INCERFA – The code word used to designate an uncertainty phase.

14 DETRESFA – the code word used to designate a distress phase.

1.16 Tests and research

1.16.1 Tail rotor gearbox

During the disassembling of the tail rotor gearbox which is made of Magnesium Alloy, the investigation found a grainy and white greyish corrosion material inside. To establish what caused this white greyish corrosion products, investigation conducted a simple simulation by putting the gearbox housing into salt water and putting the assembly cap into fresh water.

The tail rotor gearbox housing was dipped into a bucket of salt water after the removal of the existing corrosion product. As soon as it was dipped in and in less than a minute there were bubbles with milky colour coming out. After about 5 minutes, the reaction rate was more than was before turning the sea water milky and forming bubbles with a precipitate.

After the 5 minutes observation, the tail rotor gearbox was then taken out and left in a room for one day at room temperature. After that, it was noticed that corrosion products similar to the ones initially found appeared in the gearbox housing.

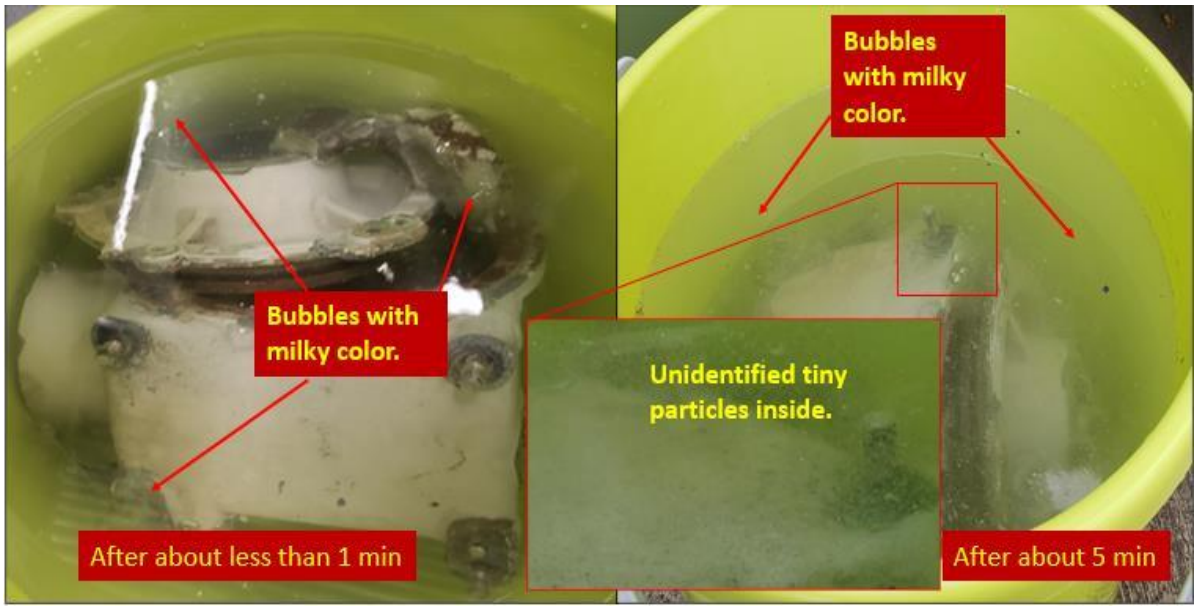

Figure: 13. Reaction of tail rotor gearbox housing with salt water at different times

Figure: 14. Magnesium products found at two different conditions

The assembly cap was removed from the saltwater and washed with pure water and put under normal temperature for a day to identify whether it can form corrosion. After the day of being kept in the room, it was noticed that there was no sign of corrosion formation on the component.

There was no evidence observed to suggest that the corrosion had occurred prior to the accident. The corrosion was formed by the housing material reacting with sea water. It is suspected that the water entered through the breather, a tube that allows air to and from the tail rotor gearbox for balanced atmospheric pressure.

Furthermore, the cap assembly was placed again in a bucket of fresh water and there was no form of reaction after the same time as above *(see Figure 15)*.

Figure: 15 Reaction of tail rotor gearbox cap assembly with fresh water at different times

There were no corrosion products on the surface of the cap assembly, apart from the previous pitting corrosion as shown in Figure 16.

Figure 16. Tail rotor gearbox cap assembly

The investigation confirmed that the result obtained after tail rotor gearbox housing reacting with sea water was found to be consistent with what was mentioned by the manufacturer in an email statement provided during the investigation, as follows:

> *The magnesium tail rotor gearbox case will begin to deteriorate and corrode from contact with salt water. You will note that white/grayish corrosion products will result very soon after contact, generally at edges where the salt water can infiltrate coatings and paint on the tail rotor gearbox case.*

1.17 Organisational and management information

1.17.1 Niugini Helicopters (The Operator)

Niugini Helicopters is a niche ad-hoc charter helicopter operator based in Kimbe, West New Britain (WNB) Province and conduct helicopter charter missions across Papua New Guinea.

The Operator's Head Office and Maintenance facility is at Kimbe in the WNB. Niugini Helicopters currently conducts operations from three bases in Kimbe WNB, Wewak (East Sepik) and Kokopo (East New Britain) as well as field and remote operating centres sited on demand out of Lae (Morobe) and Kiunga (Western Province) and as required.

The company operates only Bell turbine helicopters in its fleet.

Niugini Helicopters has an Air Operator Certificate, or AOC number: 119/017 issued on the 31st December 2017 and expires on the 31st March 2021.

Maintenance is done in-house at a registered maintenance facility at Kimbe, WNB. Niugini Helicopters Maintenance Organisation Certificate, or MOC number: 145/017 issued on the 31st January 2018, and expires on the 31st March 2021.

1.17.1.1 *Standard Operating Procedures (SOPs)*

The operational check flight is required to be carried out in accordance with *PNG CAR Part 91.613* and *Part 43.68 (a) (1) (iv).*

The Operator mentioned in an interview that they were not aware that the pilot would conduct the autorotation RPM exercise on his way back to Kimbe from Kokopo.

For that matter, the AIC examined the Operator's *exposition* for procedures on who authorises the check flights after the aircraft is released to service. It was found that although the Compliance Matrix under *'3. Maintenance requirements'*, referred to *Section 5.10* for a procedure pursuant to *CAR Part 91.613*, this section was non-existent *(see to Appendix C, 5.3.2)*.

The Operator's *Maintenance Operating Exposition (MOE) Sections 5.8.3 Maintenance Process – Planned Maintenance Procedures* and *Section 5.11* included the Operational check flights as part of the procedure, which, if applicable, is to be completed prior to the release of an aircraft to service. The MOE also included relevant release to service check sheets for use after maintenance has been carried out. This included *Form BL005-B427* for flight testing *(see Appendix C, 5.3.3)*.

The investigation found that the MOE did not include procedures for release to service for operational check flight in accordance with CAR Parts 43.103 and 91.613.

The Operator mentioned in an investigation interview that they did not have a procedure for the authorisation of maintenance / operational flight check.

The Operator further stated that there was no engine off autorotation training on the Bell 427, they only conduct one engine inoperative training. This is in accordance with the *BHT-427-FM TC Approved paragraph 1-9 Maneuvering* which stated;

> *1-4 Rev.10 14 SEP 2011 ECCN EAR99*
>
> *1-9-A. PROHIBITED MANEUVERS*
>
> *Aerobatic maneuvers are prohibited*
>
> *Autorotation to ground, for training, is prohibited*

1.17.1.2 *Emergency Response Procedures*

The pilot, in an attempt to arrest the descent and recover from the autorotation exercise, noticed the low rotor *RPM* visual and aural warnings. The pilot immediately lowered the collective and rolled the throttles to idle to enter an emergency autorotation. He subsequently pressed the SOS button to alert the Operator on Spidertracks about the emergency and soon afterward he transmitted a *Mayday* on the HF radio during the emergency descent.

The Operator stated during investigation that because the SOS button was sometimes accidentally activated in past flights, the Operator had received the 'SOS' button on their monitoring screen at their Kimbe Base office, but thought that the pilot had inadvertently pressed the button.

The Operator also reported that the Chief Executive Officer (CEO), who was at home at that time, picked up the SOS message on his phone within 10 minutes of when it was activated by the pilot. He immediately discussed the situation with Kimbe Bay Shipping Agency (KBSA) Manager and planned an immediate rescue utilising a small fishing boat at the KBSA Marina, located next to the Kimbe Town heliport. The CEO was on his way to the office from his home when he was contacted by the Chief Engineer to advise him of the SOS alert. They tried contacting the pilot by HF radio and FM radio but there was no response. The CEO organised rescue items before boarding the fishing boat at KBSA marina and headed to the crash site. They were on their way to the accident site when FIS contacted them.

The pilot was rescued and the wreckage was salvaged and prevented from floating off the edge of the reef and sinking to the bottom of the sea.

The Operator conformed with their Flight Following procedures in the *Safety and Quality Management Manual, Appendix 7 (1-11) (see Appendix E, 5.5.1)* and the Search and Rescue procedures in the Operators Emergency Response Plan.

1.17.1.3 *Emergency response and flight procedures training*

The Operators *Operations Manual, Chapter 3, section 3.1.5* states that the Safety Manager will be accountable for all aspects of Safety Management and will ensure the *ERP* is monitored, reviewed and that all appropriate staff receive initial and recurrent training. However, there was only record of four staff trained on the 8/11/2017 and no record of ERP training conducted for the rest of the staff that require the training.

The Operator stated that they had been directed by the PNG Civil Aviation Safety Authority (CASA) in 2017 to commence conducting *ERP* Training in late 2017 and that they were working closely with CASA to develop a new *ERP* which was due in mid-2019, but it had since been delayed. To the date of this report, no progress evidence has been provided to the AIC.

The operator also stated in the investigation that there was no training program for ERP as it was workshop based in nature and at present there was no certificate provided upon completion for the ERP training and only key staff were targeted to attend the training. However, an audit conducted from July 17th to 18th 2019 by PNG Civil Aviation Safety Authority found that training courses such as Dangerous Goods Awareness, SMS, CFIT, CRM and ERP were conducted for Niugini Helicopters personnel and recorded for all staff, who attended the course.

The investigation also identified that there were no training records for Flight Following although *Appendix 7 (1)* in the company's *Operations Manual, Chapter 3*, clearly states that the company is to train staff in the Flight Following Procedures e.g. Spidertracks. Training records for Flight Following was also requested from the operator and they stated that there was no formal training for Flight Following, or Flight operations duties, as these were integral to all staff who are involved in operations, at head office and at each base and that they perform these duties daily.

1.17.1.4 *Safety management*

Niugini Helicopter's *Safety and Quality Management Systems Manual* in the *Company Exposition, Section 3.1.2* states the purpose of establishing the SMS. The SMS has been established to manage all aspects of safety through a continuing process of hazard identification, risk management and continuous improvement.

The investigation determined that the operator had not established a training programme to include relevant safety courses.

When a new member of staff is hired, the company *Form SMS 6, 'Understanding Safety'* is introduced to each staff member. The operator also uses the CASA SMS modules (10 modules) to deliver SMS training to the pilots and management.

1.17.1.5 *Quality management*

The Operator has established a Quality Management System to ensure compliance with the Rules and to provide a safe and efficient service, a good working environment for all company staff and to facilitate and provide a high standard of customer service, safety and satisfaction.

According to the Operators Safety and Quality Manual, the Safety and Quality Assurance Manager (SQAM) has the responsibility and authority to develop, and document the audit programme (SQAM). The audit programme was reviewed during the investigation in the Operator's Safety and Quality Manual. Company Audits are performed by the SQAM. The SQAM maintain a role independent of those operational and engineering sections being assessed.

The *SQAM* is responsible for developing, implementing, recording and reviewing procedures for*:*

(a)Conduct of audits

(b)Management review

(c)Continuous improvement, including analysis of error and non-compliance

(d)Document control

(e)Record control

(f)Communication of quality information to staff

The frequency and scope of audits take into account the nature of the operations to be audited and is undertaken at least yearly, or at most quarterly, based on the Audit Scope Schedule.

The AIC reviewed the last surveillance Audit conducted by CASA PNG on the 17th and 18th of July 2019. The findings for the last internal audit (3rd Quarter of 2018 to 1st Quarter of 2019) were also reviewed.

This investigation determined that there was lack of safety oversight by the operator to ensure full compliance with CASA PNG requirements for Maintenance procedures and that staff were fully conforming to the documented operational and maintenance procedures.

1.18 Additional information

1.18.1 Volcano

On 26 June 2019, Mt. Ulawun, a volcano located about 77 nm North West of Kimbe, erupted emitting plumes up to about 15,000 ft. This disrupted operations in the North Western region of West New Britain. The volcano erupted again on 3 August 2019. Significant amounts of ash were carried by Easterly and South Easterly winds during that time. The ash began to settle and within a week, general aviation operations were resumed.

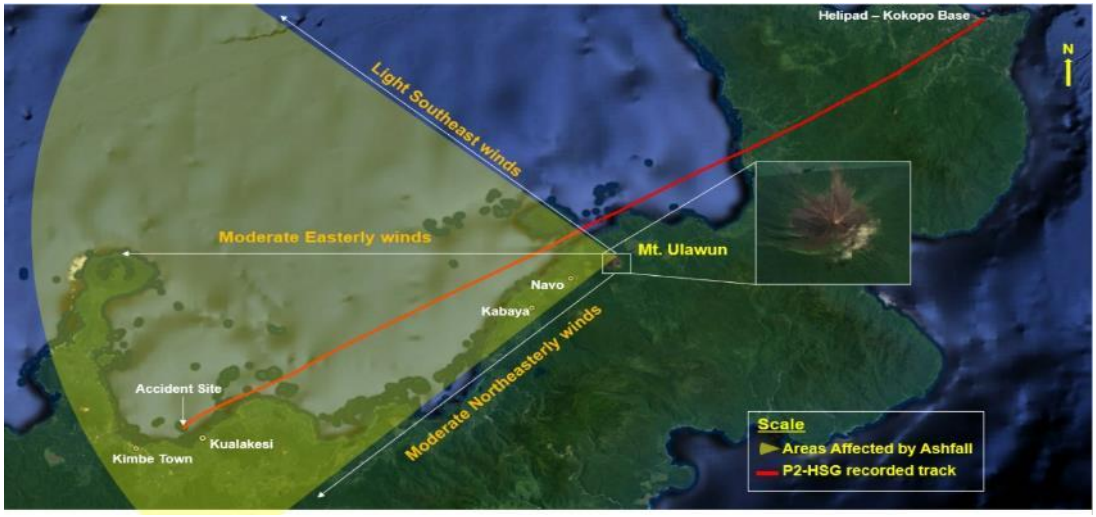

Figure 17: Depiction of areas affected by Mt. Ulawun's eruptions subject to wind movement

The investigators borescope[15] inspection of both engines revealed no sign of ash contamination. However, the accident site was under water. The helicopter remained under water for more than 24 hours. As a result, the investigation could not determine whether there had been any ash ingestion.

1.19 Useful or effective investigation techniques

1.19.1 Tail rotor gearbox component reaction with seawater

The tail rotor gearbox was disassembled and found a grainy white greyish product. The investigation did not have any knowledge about it and conducted a simulation between seawater and the components of the tail rotor gearbox. The result obtained in this simulation was consistent with what was noticed in the tail rotor gearbox and the same white greyish description that the manufacturer provided if the components undergo reacting with saltwater.

1.19.2 Borescope Inspection

An on-site borescope inspection was carried out by the investigation team at the Operators Hangar in Kimbe, West New Britain on 14 August 2019. The objective of the borescope was to inspect and verify if there was any foreign object damage (FOD) or contamination internally which would have subjected to several examination and testing to be performed by the manufacturer P&WC.

The areas of the engines inspected were the compressor turbine and power turbine blades sections. The inspection revealed that there was no evidence of abnormalities internally which could have determined the engines to be further examined and tested by the P&WC.

15 An optical tool with which a visual inspection can be made inside an area that otherwise impossible to see SORUCE JEPESSEN AVIATION DICTIONARY.

2 ANALYSIS

2.1 General

The analysis section of this report discusses relevant facts which contributed to the on-set of an emergency and subsequent accident.

2.2 Aircraft

2.2.1 Aircraft maintenance

Chapter 18 of the Bell 427 Maintenance Manual outlines three main steps for the completion of the rotor RPM adjustment. Firstly, verify and record the RPM, and specified conditions under which the pre-adjustment RPM verification was conducted. This is specified to be achieved through an autorotation flight check. Then carry out necessary adjustment for target RPM reference to data from the first step and finally, verify the RPM for the adjusted RPM. The operator only took the second step and then signed the maintenance log releasing the aircraft back to service.

The Maintenance log entries for 10 August 2019 stated that the maintenance had been conducted in accordance with the *BHT 427 Maintenance Manual* and that the requirements of *CAR Part 43* had been met. The maintenance practices on the day were not completed in accordance with the Bell 427 Manual and the Operator did not meet the general requirements of *CAR Part 43*.

When the main rotor autorotation RPM is adjusted, an autorotation verification follows to verify the autorotation RPM. If the yielded RPM readings are not at the target RPM, further adjustment is necessary, followed by further verification. When the RPM readings coincide with the desired values, within the manufacturers specified limits, the helicopter may then be released to service. Any verification/inspection to be conducted prior to and/or following an adjustment of a control surface is considered part of maintenance action and should be completed before releasing a helicopter to service.

The Chief Engineer was unaware of the maintenance request and the subsequent pitch link adjustment.

P2-HSG conducted a passenger flight to Kokopo on 11 August, the day after the RPM adjustments had been made and the release to service was signed. The helicopters maintenance log showed that the maintenance had been completed and that the helicopter was released to service. However, the investigation determined that the verification check required by *Bell 427 Maintenance Manual Chapter 18* had not yet been conducted. The AIC therefore concluded that the helicopter was released to service without proper completion of maintenance action.

2.2.2 Engines

The P&W C report provided for the investigation suggested that engine No.1 entered One Engine Inoperative (OEI) power ratings due to the torque reading passing.

Engine BF0157 showed indication of running in OEI. The faults that were recorded from the engines, believed to be related to the event, occurred when the engines were shut down and were all signal feedback faults with the exception of the ARINC input fault on engine BF0158 which was indicative of a problem with the ARINC being sent from the cockpit to the EEC.

There were no faults observed with the engines running during the last hour of fault recordings. P&W C concluded that the DCU data captured by the DCU's for both engines BF0157 and BF0158 showed normal peak value recordings during the last flight.

The data from the DCU's showed no sign of any abnormal operation of the engines. The data showed that the No.1 engine was operating in the One Engine Inoperative Mode for about 19 minutes before data stopped recording (the accident). The AIC determined from the Spidertracks that the helicopter was tracking on water during that time. The pilot got the low rotor *RPM* and entered the emergency descent 20 minutes before the accident. This allowed the investigation to conclude that the engines were running normally at the time the pilot got the low rotor *RPM* warning.

The investigation deduced from DCU times, ELT activation time and Spidertracks that the helicopter entered the OEI mode while it was on the water. The inadvertent shutdown of an engine may have occurred upon contact with the water or a few seconds after that.

2.3 Flight Operations

2.3.1 The Autorotation exercise

The verification before and after maintenance were not conducted, which meant that the helicopter was unserviceable when the flight was conducted on 11 August with an unverified RPM rating.

The investigation found that the Chief Pilot was unaware that the pilot was planning on doing an autorotation RPM check. The investigation also found that although considered normal practice, the Operator did not have any procedure documented to prohibit such operations without authorisation from the Chief Pilot.

The investigation concluded that the autorotation exercise was solely decided and conducted because the pilot just happened to be flying solo, ferrying the helicopter back to its Kimbe base. There was no check flight scheduled specifically to verify the autorotation RPM adjustment.

The pilot did not consider the position and distance from land when he planned and conducted the autorotation exercise. This was evident because he commenced the autorotation along his normal flight track when the aircraft reached nominated entry altitude 3,000 ft. In accordance with the *FAA Advisory Circular(AC) No: 61-140A on Autorotation Training,* most recorded autorotation exercise related accidents have been attributed to their recovery phase (transition back to powered flight), at the position, at 1,000 ft, where the pilot attempted his recovery, there was no land close enough for the pilot to land the helicopter in any emergency descent.

2.3.2 Psychological and physiological factors

The investigation determined that the decision made by the pilot to conduct the autorotation greatly influenced the outcome of the flight. The decision was made without having full situational awareness. Had the pilot conducted the autorotation exercise at a location where the helicopter could be safely settled onto a solid, even surface, an accident would likely have been avoided.
At the time the pilot attempted to recover from the simulated autorotation, he did not observe the change he expected. Instead, he received a warning that his rotor RPM was low. These events occurred at a low altitude which did not give him enough time to properly assess the situation. What he reported was that he thought that the helicopter had experienced an engine failure. He immediately entered an emergency autorotation.

The pilot's desired altitude for conducting the autorotation exercise was 3,000 ft and he had planned to conduct the exercise when he reached the 3,000 ft during his normal approach descent. At the time he reached 3,000 ft, the helicopter was too far from any safe landing area, however, the pilot proceeded with the exercise anyway. This was likely due to a condition known as channelized attention. This condition deteriorates situational awareness. The pilot was so focused on his planned activity that he did not consider his lateral position in relation to the nearest coast.

2.3.3 Communications

Communication between the pilot commenced with Tokua tower on VHF and the pilot was instructed to contact FIS on VHF as the primary frequency, and HF frequencies as back up. The quality of the VHF recorded data was good and the pilot made his last transmission on VHF, which was a broadcast call.

Although back up HF frequencies were nominated by the ATS, the pilot stated that the Mayday call was transmitted on HF, however there was no evidence of recorded data by ATS to confirm this statement. The pilot further stated that, during his experience, flying in this part of New Britain, it is quite difficult to contact FIS on HF.

When ATS receive a Mayday, they immediately declare an emergency and notify the appropriate authorities to commence search and rescue activities. During the P2-HSG emergency phase, the alleged Mayday call made by the pilot was not received by ATS. Therefore, ATS could not carry out appropriate actions at that time.

The AIC attributed this communication and transmission issues to deficiency communication issues, particularly, HF.

2.4 The Operator

Although the Operator had procedures that required each maintenance requests to be reviewed and approved by the CE before maintenance actions were carried out, the CE was unaware of the maintenance request and the adjustment made.

The helicopter was released back to service without the fully complying with PNG CAR Part 43.103 requirements.

According to the Operator, they were not aware that the pilot was conducting an autorotation. The pilot had not requested and was not given any form of authorisation to conduct the autorotation exercise. The Operator lack procedures in relation PNG CAR Part 91.613.

The AIC determined that the Operator's Quality and Safety oversight systems, procedures and processes was inadequate. The pilot did not know that he needed authorisation to conduct the autorotation. This is because there is no documented procedure or other such evidence that would prohibit such operations to be carried out without authorisation.

2.5 Survivability

2.5.1 Rescue services response

When ATS receives a COSPAS-SARSAT message, they immediately declare an emergency, and notify relevant authorities to commence search and rescue activities. Although the Distress COSPAS-SARSAT message was received at 11:26, about a minute after the ELT activated, this message was mishandled and did not get delivered to the Centre Supervisor until 11:45, about 19 minutes after it was received. Upon receipt of the message, the Alert Phase was immediately upgraded to the Distress Phase which was about 19 minutes after the ELT activated.

The Operator was already on their way to the crash site when FIS contacted them. The pilot had already been rescued by six Buluma villagers before the Operator arrived at the crash site. The pilot was later taken to shore by the Operator.

The investigation determined that the Emergency Response and SAR activities led to rescue the pilot approximately 40 – 45 minutes after the accident. Due to following circumstances; the aircraft had landed on the reef, the tide was low at that time, and the six Buluma villagers who witnessed the aircraft impact water and rescued the pilot, the time (40 – 45 minutes) in which the pilot was rescued, was reasonable.

3 CONCLUSIONS

3.1 Findings

3.1.1 Aircraft

a) The aircraft was certified and equipped in accordance with existing regulations and approved procedures.

b) The aircraft was not maintained in accordance with existing regulations and approved procedures; particularly release of aircraft under *CAR Part 43.103* were not met.

c) There was no evidence of any defect or malfunction in the helicopter's engines.

d) The aircraft was structurally intact prior to impact.

e) All control surfaces were accounted for, and all damage, apart from the tail rotor drive, was attributable to the severe impact forces.

f) The aircraft was destroyed by the different forces involved in the accident.

g) The significant amount of corrosion observed within the tail rotor gearbox was due to sea water contamination after the accident.

h) The pilot statement indicated that there was sufficient fuel on board for the flight.

i) Main rotor system damage was consistent with powered operation at impact.

j) Tail rotor drive shaft severed when the helicopter ditched.

3.1.2 Crew / pilot

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

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

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

d) The pilot's actions and statements indicated that his knowledge and understanding of the aircraft systems was inadequate.

3.1.3 Flight operations

a) The pilots operating limitations were not clearly defined in the Operator's Operating Manuals.

b) The pilot carried out normal radio communications with the Tokua Tower and Moresby ATC units.

c) The pilot decided and conducted the autorotation to check the autorotation RPM during a normal flight.

3.1.4 Operator

a) The Chief Engineer was aware of the pilot's maintenance request, however he was not aware of the subsequent maintenance conducted at the time they happened.

b) The Chief Pilot was not aware that the pilot was conducting an autorotation exercise on the day of the accident.

c) The Operator's Quality Assurance systems oversight of its procedures in accordance with *CAR Part 43.103* and *Part 91.613* did not adequately meet the requirements of these rules.

3.1.5 Communication

a) All communication between ATS and the pilot were made on VHF.

b) The alleged Mayday call made by the pilot on HF was not received by ATS.

c) The HF transmissions were convoluted with static interference.

3.1.6 Medical

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

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

3.1.7 Survivability

a) The accident was survivable.

b) The pilot activated the Spidertracks SOS button at 11:04.

c) The ELT activated at 11:25 on frequency 406 MHz.

d) The pilot did not activate the Portable Locator Beacon.

e) The pilot egressed the helicopter with minor injuries.

f) The pilot was rescued by six Buluma villagers at approximately 40-45 minutes after the accident.

3.1.8 Safety Oversight

a) The Civil Aviation Safety Authority's safety oversight of the Operator's procedure implementation specifically for *CAR Part 43.103 and Part 91.613* were inadequate.

3.2 Causes [Contributing factors]

The decision of the pilot to conduct the autorotation RPM check over water, far away from a safe landing area, although not directly casual to the accident, contributed to the severity of the accident and the damage caused as a result of the impact.

The pilot's initial misdiagnosis of low rotor RPM warning associated, with the alleged abnormal torque reading led the pilot to enter into the emergency descent instead of actioning the low rotor RPM emergency procedure.

The late recognition of engine status resulted in the pilot being unable to recover from the emergency descent as the helicopter was quite low at that time.

3.3 Other factors

The Chief Engineer was unaware of the of the Pitch Link adjustment at the time it was being conducted.

Release of aircraft to service with incomplete maintenance procedures in relation to *CAR Part 43.103* requirements.

The Chief Pilot was not made aware by the pilot of his intentions to conduct an autorotation RPM check.

The Operator's lack of procedures for authorisation of operational flight check.

4 RECOMMENDATIONS

4.1 Recommendations

As a result of the investigation into the accident involving the Bell 427 helicopter registered P2-HSG 3 nm miles from Buluma Township, West New Britain Province, Papua New Guinea on the 11th August 2019, the Papua New Guinea Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.1.1 Recommendation number AIC 20-R08/19-1001 to Niugini Helicopters

Date Issued: 12 August 2020

'Release-to-service for operational flight checks'

The PNG Accident Investigation Commission recommends that Niugini Helicopters should ensure that a procedure for *'Release-to-service for operational flight checks'* pursuant to *CAR Part 43.103*, is developed and documented in the Operator's expositions and implemented as required.

Action requested

The AIC requests that Niugini Helicopters note recommendation *AIC 20-R08/19-1001*, and provide a response to the AIC within 90 days of the issue date, and explain (including evidence) how Niugini Helicopters has addressed the safety deficiency identified in the safety recommendation. **STATUS: ACTIVE.**

4.1.2 Recommendation number AIC 20-R09/19-1001 to Niugini Helicopters

Date Issued: 12 August 2020

'Operational flight checks'

The PNG Accident Investigation Commission recommends that Niugini Helicopters should ensure that a procedure for operational flight check pursuant to *PNG CAR Part 91.613*, is developed and documented in the Operator's exposition and that the pilots fully understand it.

Action requested

The AIC requests that Niugini Helicopters note recommendation *AIC 20-R09/19-1001*, and provide a response to the AIC within 90 days of the issue date, and explain (including evidence) how Niugini Helicopters has addressed the safety deficiency identified in the safety recommendation. **STATUS: ACTIVE.**

4.1.3 Recommendation number AIC 20-R10/19-1001 to Niugini Helicopters

Date Issued: 12 August 2020

'Quality Assurance System'

The PNG Accident Investigation Commission recommends that Niugini Helicopters should ensure that its *'Quality Assurance System'* and any other relevant organisational systems, processes and procedures identify deviations from the requirements of the Aircraft Maintenance Manual and management.

Action requested

The AIC requests that Niugini Helicopters note recommendation *AIC 20-R10/19-1001*, and provide a response to the AIC within 90 days of the issue date, and explain (including evidence) how Niugini Helicopters has addressed the safety deficiency identified in the safety recommendation. **STATUS: ACTIVE.**

4.1.4 Recommendation number AIC 20-R11/19-1001 to Papua New Guinea Air Services Limited

Date Issued: 12 August 2020

'Rescue Coordination Centre'

The PNG Accident Investigation Commission recommends that PNG Air Services Limited should ensure that the RCC is fully compliant with CAR Part 176, and it is staffed 24 hours a day by trained personnel proficient in the use of radiotelephony communication.

Action requested

The AIC requests that PNG Air Services Limited note recommendation *AIC 20-R11/19-1001*, and provide a response to the AIC within 90 days of the issue date and explain including evidence, how PNG Air Services Limited has addressed the safety deficiency in the safety recommendation. **STATUS: ACTIVE.**

4.1.5 Recommendation number AIC 20-R12/19-1001 to Papua New Guinea Air Traffic Services

Date Issued: 12 August 2020

'High Frequency (HF) radio capability'

The PNG Accident Investigation Commission recommends that PNG Air Services Limited should take action to improve High Frequency radio capability to ensure, as much as possible, that transmissions are clear and readable so vital transmissions for the safety of aircraft operations are not missed.

Action requested

The AIC requests that PNG Air Services Limited note recommendation *AIC 20-R12/19-1001*, and provide a response to the AIC within 90 days of the issue date and explain including evidence, how PNG Air Services Limited has addressed the safety deficiency in the safety recommendation. **STATUS: ACTIVE.**