ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 19 - 1002

Ramu Agriculture Industries Limited

P2-SET

Air Tractor 502B

Controlled Flight into terrain

Kikori, Gulf province

Papua New Guinea

29 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 THE REPORT

At 16:57 local time (06:57 UTC), on the 29th August 2019, Papua New Guinea Air Services Limited (ASL) notified the Papua New Guinea Accident Investigation Commission (AIC) of the unreported arrival at Gusap, Madang Province of Air Tractor AT-502B aircraft, registered P2-SET, operated by Ramu Agri Industries Limited.

Information received from the Karaulti area in the Gulf Province later in the evening indicated that the aircraft had crashed in that area, but had not been located. The AIC dispatched a team of investigators to the area on the morning of 30th August 2019 and immediately commenced an on-site investigation and interviewing of the locals.

This *Final Aircraft Accident Investigation Report* was produced by the AIC, PO Box 1709, Boroko 111, NCD, Papua New Guinea.

The report is based on the initial investigation carried out by the AIC in accordance with Papua New Guinea *Civil Aviation Act 2000 (as amended), Chapter 31 of the Commissions of Inquiry Act, Annex 13* to the *Convention on International Civil Aviation*, and the *PNG AIC Investigation Policy and Procedures Manual*. It contains factual information. Analysis of that information, findings and contributing (causal) factors, other factors, safety actions, and safety recommendations.

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

16th October 2020

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SYNOPSIS

On 29 August 2019, around midday, an Air Tractor AT-502B aircraft, registered P2-SET, owned by Liddle Holdings Trust and operated by Ramu Agri Industries Limited (RAIL) was conducting a Visual Flight Rules (VFR) ferry flight from Daru, Western Province to Gusap, Madang Province, when it impacted trees near Era River about 6.8 nautical miles North-West of Baimuru Airstrip, Gulf Province.

The aircraft initially impacted a single protruding palm tree, clipping the outboard section of the right wing. The aircraft continued another 1.3 nautical miles towards the South-East before penetrating the canopy layer of the swamp forest, impacting a tall thick tree. The forward fuselage section with the hopper, main landing gear, engine and propeller still attached to it, separated on impact and projected further for another 290 meters before impacting and becoming embedded in mud. Both wings separated from the aircraft on impact and came to rest about 10 meters away from the main wreckage.

According to the PNG National Weather Services, there was rain, cloud and fog in the area of the accident. The weather conditions in the area were determined to be below the minimums specified for conducting flights under VFR. Locals confirmed that there was heavy fog in the area.

The investigation determined that the pilot encountered adverse weather conditions during the flight, descended and circled in the Kikori Delta area for almost an hour, to maintain or regain visual references. The aircraft subsequently impacted a tree at 43 feet above ground level. However, the pilot was unable to maintain separation from ground obstacles (trees).

The last known call from the pilot to the ATS was recorded at 10:42 local time (00:42 UTC).

The next day, the aircraft wreckage was located by nearby local villagers who later assisted the investigators to get to the site.

The pilot, the sole occupant of the aircraft, suffered fatal injuries. The aircraft was destroyed.

1 FACTUAL INFORMATION

1.1 History of the flight

On 29 August 2019, around midday, an Air Tractor AT-502B aircraft, registered P2-SET, owned by Liddle Holdings Trust and operated by Ramu Agri Industries Limited (RAIL), was conducting a VFR[1] ferry flight from Daru, Western Province to Gusap, Madang Province, when it impacted trees near the Era River, about 6.8 nm north west of Baimuru Airstrip, Gulf Province.

The aircraft initially departed Horn Island, Australia at 07:35 Local time (21:35 UTC[2]) and landed at Daru Airport, Western Province at 08:35 for customs clearance. The aircraft then departed Daru at 09:45 for Gusap with an estimated time of arrival (ETA) of 11:45.

Figure 1: P2-SET flight planned track from Daru, Western province to Gusap, Madang province

At 10:11, the pilot reported normal operations to Air Traffic Services (ATS), indicating that he was in the cruise phase at 9000 ft. he was then instructed by ATS to report at 30-minute intervals thereafter.

According to the ATS audio recordings, there was a transmission made by the pilot at 10:42. However, there was no response heard on the audio recording. There was no further communication from the pilot, recorded after that.

At 10:48, ATS began radio communication checks with P2-SET but did not receive any response from the pilot. At 11:10, after numerous attempts to re-establish communication with P2-SET were unsuccessful, ATS declared an Uncertainty phase. At 13:10, it was upgraded to a Distress phase (refer *Section 1.9* of this report).

1 V**isual Flight Rules**: Those rules as prescribed by national authority for visual flight, with corresponding relaxed requirements for flight instruments (Source: *The Cambridge Aerospace Dictionary*)

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

Local villagers, who sighted the aircraft, indicated that the aircraft was predominantly flying not too far above the treetops in rain and fog, for almost an hour, in the Kikori Delta area. They further stated that due to heavy fog, they weren't able to maintain sight of the aircraft. However, they could still hear the loud engine noise as the aircraft continued to circle in the area. The villagers stated that there was a sudden loud bang followed by a stop in engine noise.

At about 12:30 on 30 August, the main wreckage was located by nearby villagers. The pilot, the sole occupant, was found deceased in the aircraft.

The investigation team found that the aircraft initially clipped a protruding palm tree, separating the outboard section of the right wing. The aircraft continued for another 1.3 nm before it impacted a tall thick tree 43 feet AGL. The forward fuselage and engine section separated from the airframe at the bulkhead between the cockpit and the hopper. The forward fuselage including the hopper, main landing gear, engine and propeller continued another 290 metres along the direction of the flight path before becoming deeply embedded in mud.

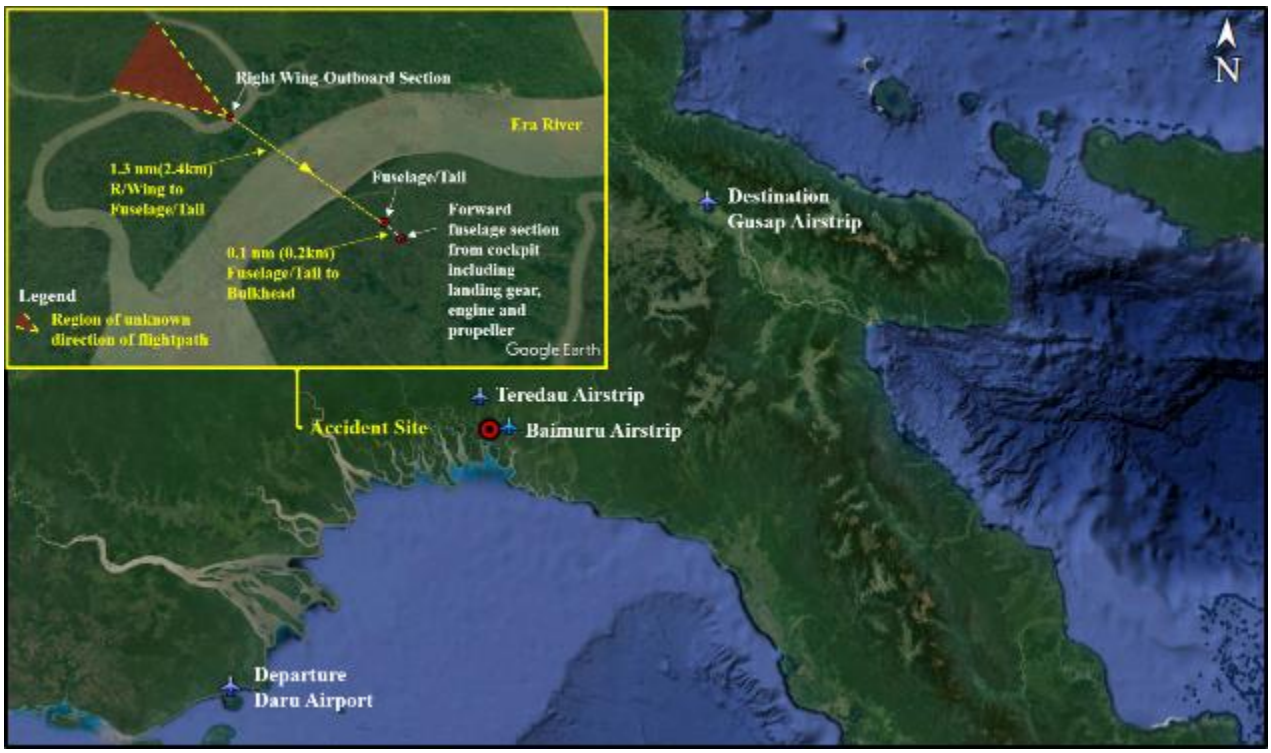


Figure 2: Depiction of accident location in relation to Baimuru Airstrip

1.2 Injuries to persons

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

Table 1: Injuries to persons

1.3 Damage to aircraft

The aircraft was destroyed by impact forces (see *Section 1.12*).

1.4 Other damage

The vegetation around the area of impact sustained minimal damage.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 68 years
Gender	: Male
Nationality	: Australian
Type of licences	: PNG CPL (A) (H)
Type ratings	: Single Engine Advanced, Aerial Application, Low-level
Total flying time	: ~ 24,000 hours
Total time in command	: 24,000 hours
Total on Air Tractor AT-502B	: ~ 2,500 hours
Total time in command AT-502B	: ~ 2,500 hours
Total hours last 30 days	: 21 hours
Total hours last 7 days	: 21 hours
Last Competency Check	: 03 October 2018
Medical class	: One
Valid to	: 02 October 2020
Medical limitation	: Spectacles to be worn
Time off duty prior to the flight	: 10.3 hours
Time on duty prior to the flight	: 0.75 hour
Duration of sleep prior to duty period	: 8 hours.

The pilot was employed by Liddle Holdings Trust (aircraft owner) in 2014. During his time of employment, he was also in charge of Aerial Agricultural Operations (under contract with RAIL) in PNG. Liddle Holdings Trust stated to the AIC that they considered the pilot to be highly experienced and proficient in agricultural operations.

The pilot had done numerous ferry flights along the route and was reported by Liddles Holdings Trust to be familiar with that route.

The Operator reported that proficiency checks were normally conducted yearly with the company pilots. The pilot's last proficiency check records showed that he had no difficulty operating the AT-502B. His last Annual Proficiency check was done on 24 August 2019.

1.6 Aircraft information

The AT-502B is a specialised aircraft designed for agricultural operations. Liquid or granular chemical for aerial spraying or spreading can be carried in the aircraft's hopper. With a load in the hopper, a pilot can use the performance benefits of flying the aircraft close to the ground (in ground effect) while it accelerates to a safe airspeed prior to climbing. If the pilot assesses the aircraft's power to be inadequate, particularly during the take-off, a jettison system enables them to dump the load, which quickly reduces the aircraft's weight and increases performance[3].

3 Source: Manufacturer's aircraft performance specifications.

1.6.1 Aircraft data[4]

Aircraft manufacturer	: Air Tractor
Model	: AT-502B
Serial number	: 502B-0255
Date of manufacture	: 1994
State of Registry	: Papua New Guinea
Registration	: P2-SET
Name of the owner	: Liddles Holdings Trust
Name of the operator	: Ramu Agri Industries Limited
Certificate of Airworthiness number	: 122
Certificate of Airworthiness issued	: 08 July 2015
Valid to	: non-terminating
Certificate of Registration number	: 122
Certificate of Registration issued	: 08 July 2015
Valid to	: non-terminating
Total airframe hours	: 7598.5
Total airframe cycles	: 16107
Approved Flight Manual Number	: AIR – 122

Certificate of Insurance expired on the 31 May 2016.

There were no records or evidence provided to the AIC to state the renewal of Certificate of Insurance.

1.6.2 Engine data

Engine type	: Turbo Propeller
Manufacturer	: Pratt & Whitney
Model	: PT6A-34AG
Serial number	: PCE-PH0383
Total Time since new	: 2084.5
Cycles since new	: 3593

1.6.3 Propeller data

Make	: Hartzell Propellers
Model	: HC-B3TN-3D
Serial number	: BUA21376
Total time since new	: 445.6
Cycles since new	: NA

4 Source: Aircraft owner (Liddles Holdings Trust)

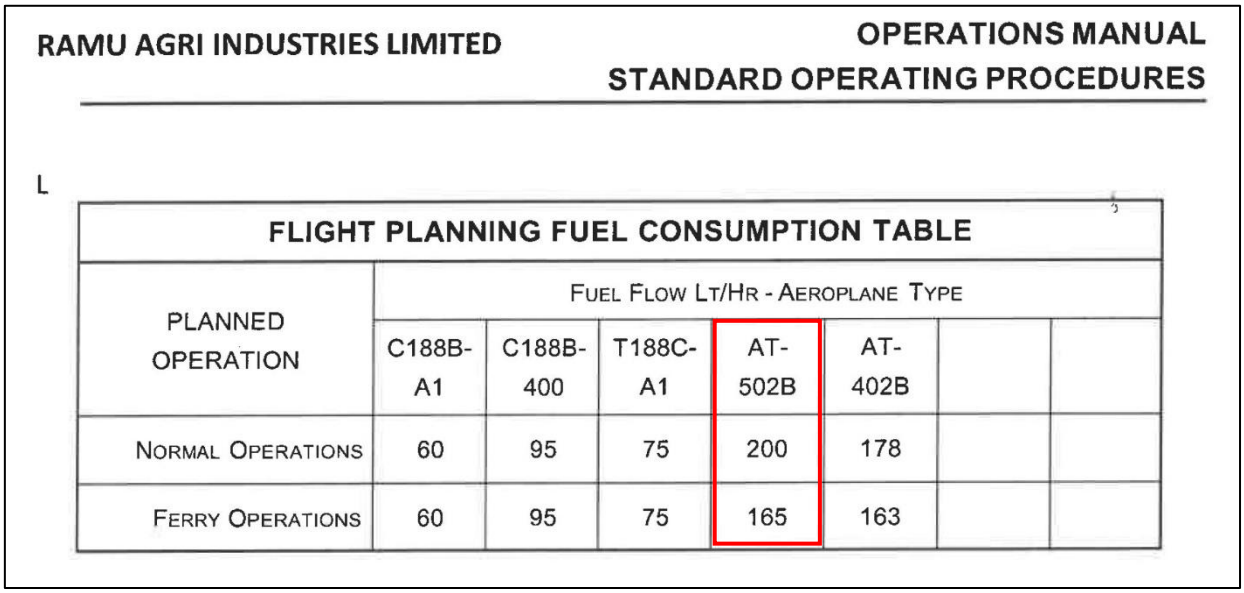
1.6.4 Weight and balance

Weight and balance was not a factor in this accident.

1.6.5 Fuel

The pilot refuelled the aircraft in Horn Island prior to departing for Daru. The quantity of fuel purchased was 465 litres. After refuelling, P2-SET had a full fuel capacity of 795 litres. As per the *RAIL Standard Operating Procedures Manual, Section 3, Appendix 4*, fuel consumption rate for ferry operations is 165 litres/hour. At this rate, the aircraft would have had a flight time of about 4.8 hours (4 hours and 48 minutes). The aircraft departed Horn Island at 07:35 and landed in Daru at 08:35. The aircraft would have had about 3.8 hours (3 hours and 48 minutes) of available fuel for flight at Daru.

The aircraft departed Daru at 09:45 for Gusap, locals reporting seeing and hearing the aircraft flying for almost an hour and his last reporting time to FIS at 10:11, he would have been flying for an hour and 26 minutes. At that point, the aircraft would have had about 2 hours and 22 minutes of fuel available for flight. This indicated that the aircraft had enough fuel onboard to conduct the flight.



RAMU AGRI INDUSTRIES LIMITED

OPERATIONS MANUAL
STANDARD OPERATING PROCEDURES

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FLIGHT PLANNING FUEL CONSUMPTION TABLE

PLANNED OPERATION	FUEL FLOW LT/HR - AEROPLANE TYPE						
	C188B-A1	C188B-400	T188C-A1	AT-502B	AT-402B		
NORMAL OPERATIONS	60	95	75	200	178		
FERRY OPERATIONS	60	95	75	165	163		

Figure 3: Fuel consumption rates (Source: RAIL company exposition)

When the aircraft wings were found at the accident site, both the right and left fuel tanks were empty. Local villagers reported smelling fuel around the vicinity where the wings were located. Investigators found that both fuel tanks were punctured during the accident sequence, as the wings separated from the main fuselage resulting in the loss of fuel.

1.6.6 Aircraft serviceability

The last schedule maintenance on the P2-SET was carried out by Skytek[5] on 16 August 2019. The aircraft was certified serviceable and released to service by an authorised licensed aircraft maintenance engineer (LAME).

The annual airworthiness review was carried out on 22 August 2019 by Skytek and was in compliance with the requirements of Civil Aviation Rule (CAR) *Part 43.153(a).*

The aircraft was deemed to be airworthy before it was dispatched on the ferry[6] flight back to Gusap, Madang Province.

5 An approved maintenance part 145 certified organisation in Queensland Australia

6 **Ferry Flight:** whose purpose is to reposition aircraft at a different place *(Source: The Cambridge Aerospace dictionary).*

1.7 Meteorological information

1.7.1 Papua New Guinea National Weather Service

Climate of Baimuru-Kikori, Gulf Province

According to the weather summary provided by the National Weather Services (NWS), Baimuru-Kikori has the tropical rainforest climate prevailing. The average annual temperature for the area is 24° degrees and there is about 1825 mm of rain in a year. It is dry for 10 days a year with an average humidity of 83% and an UV-index[7] of 5. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

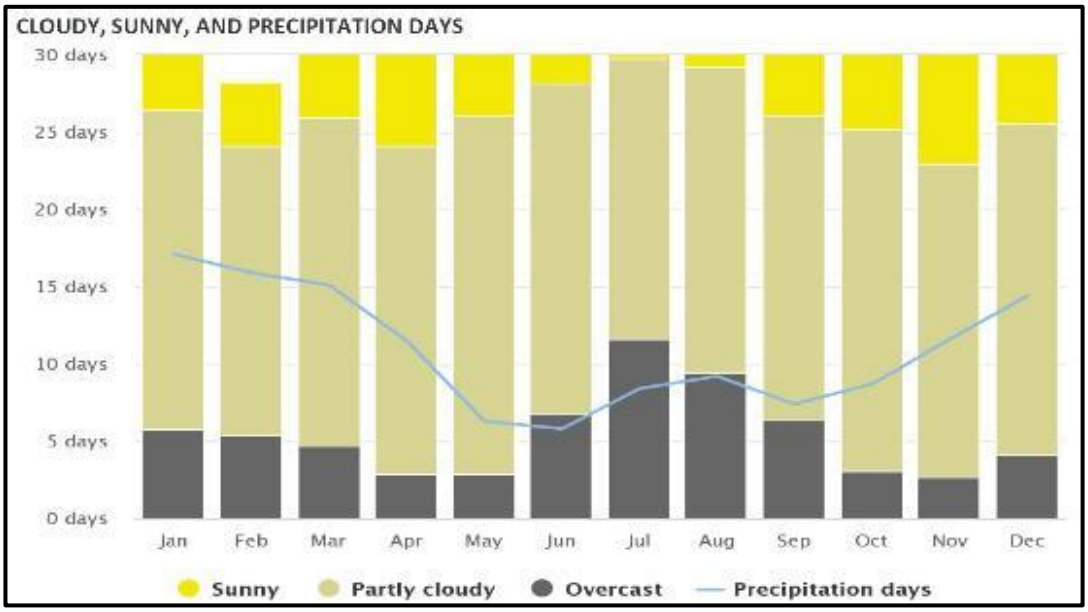


Figure 4: The graph shows the monthly number of sunny, partly cloudy, overcast and precipitation days.

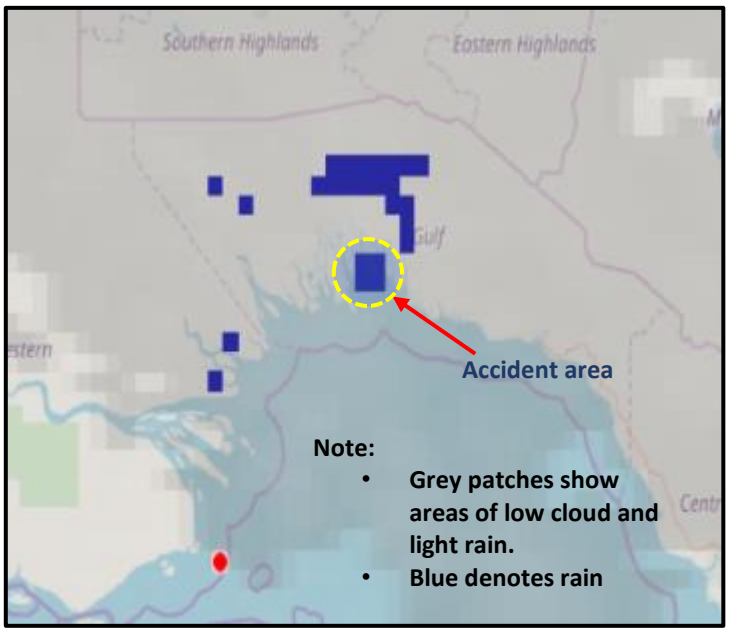


Figure 5: Weather in the area of accident on the day of the accident *(Source: NWS)*

7 The **UV index** is a measure to help you determine the effects of the sun on outdoor activities. It is computed using forecast ozone levels, cloudiness, and elevation. Values are effective at solar noon, which is when the sun is at its highest point of the day.

According to the NWS, the dark blue shadings shown in Figure 5 indicate rainfall of at least 0.1-0.5 mm/hr.

On 30 August, investigators arrived at the accident site and reported observing showers and drizzle with overcast clouds lasting for several hours. The visibility was very poor.

During the investigation interviews, the locals from around the accident site reported that the weather on the day of the accident was more adverse than the day the investigators had arrived on site.

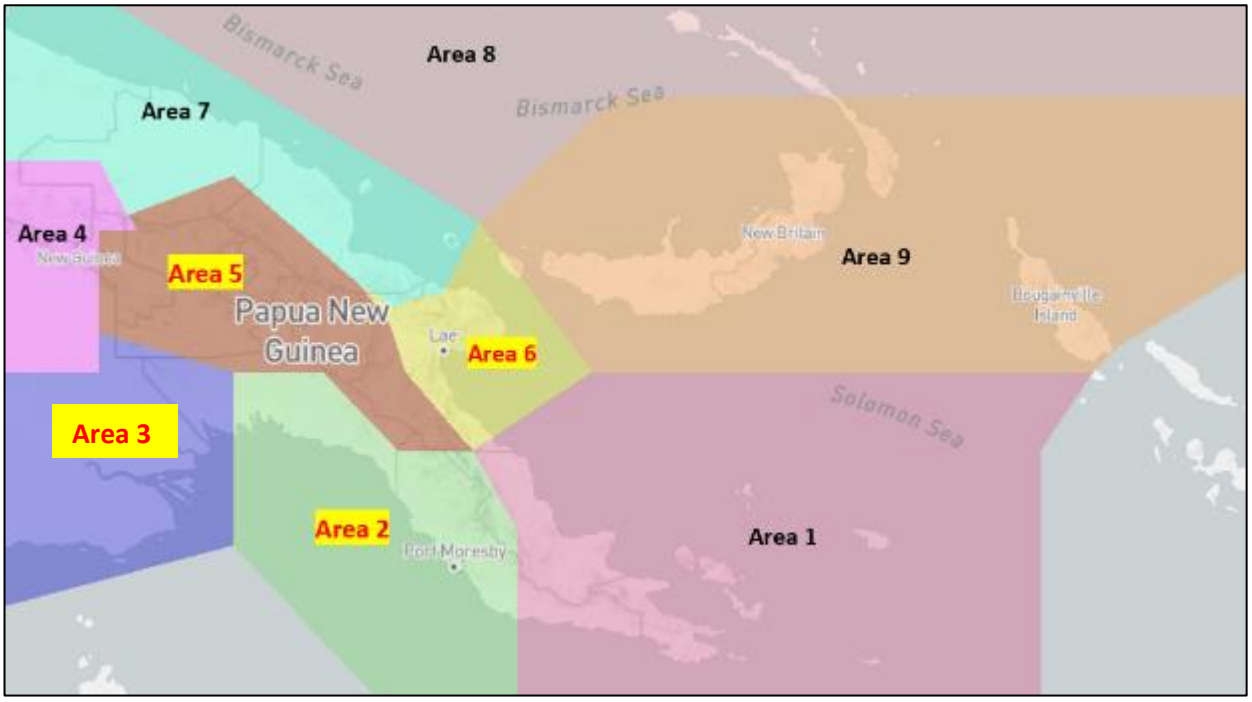


Figure 6: Allocated areas for Weather Forecasts *(Source: NWS)*

The area forecast for Areas 1, 2 and 3 (See Figure 6 - Gulf Province located at the border of Areas 2 & 3) provided by NWS and in effect on the day of the accident are as depicted in Table 2.

Cloud below 20,000 feet (amount, type bases and tops above MSL)	*CLD:*	*ISOL*	*CB*	*1800/*	*45000*		
		BKN	*ST*	*0500/*	*3000*	*IN*	*PCPN.*
		SCT	*CU*	*1500/*	*10000*	*BKN*	*SHRS*
		SCT	*SC*	*3000/*	*8000*	*BKN*	*RADZ*
		BKN	*ACAS*	*10000/*	*18000*		
Visibility	*VIS:*	*0500 FG- 3000M- TSRA- 4000M- SHRA/RADZ*					

Table 2: Area Forecast for areas 1, 2 and 3 (source: NWS)

According to the above, cloud cover and visibility reads:

Cloud: *Isolated (ISOL) cumulonimbus (CB) with base of 1800 feet and ceiling of 45,000 feet, broken (BKN) stratus (ST) with base of 500 feet and a ceiling of 3000 feet in precipitation (PCPN), scattered (SCT) cumulus (CU) with a base of 1500 feet to a ceiling of 10,000 feet broken with showers or rain showers, scattered stratocumulus (SC) with a base of 3000 feet and a ceiling of 8000 broken with rain and drizzles (RADZ), broken altocumulus and altostratus with base of 10,000 feet and a ceiling of 18,000 feet.*

Visibility: *Fog (FG) at 500 feet, visibility reducing to 3000m in thunderstorm (TS) and rain, visibility reducing to 4000m in showers and rain or rain and drizzles.*

Weather Summary for 29 August 2019

The weather summary provided by the NWS for the day of the accident as shown in Figure 7 indicated that there was torrential rain and fog. High humidity indicated the likelihood for precipitation, dew or fog to be present. The presence of fog[8] is, outlined in red as indicated in Figure 7. Given the conditions, the investigation suggested that the weather behavioural patterns forecasted in the accident area did not permit an ideal day to conduct a VFR flight (see *Section 2 Analysis*).

SUMMARY OF THE WEATHER ON THURSDAY 29TH AUG, 2019

Temperature: Max: 21°c
Min: 15°c

Rain: 45.10 mm

Sunrise: 06:23 AM

Sunset: 06:20 PM

Moonrise: 05:05 AM

Moonset: 05:13 PM

Time	00:00	03:00	06:00	09:00	12:00	15:00	18:00	21:00
Weather	Torrential Rain	Torrential Rain	Torrential Rain	Torrential Rain	Torrential Rain	Torrential Rain	Torrential Rain	Torrential Rain
Temp (°C)	16	16	16	18	20	20	17	16
Dew Point Temp (°C)	15.7	15.5	15.5	16.7	17.7	17.9	16.2	15.7
Wind (km/h)	3	4	4	3	3	4	3	3
Gust (km/h)	4	6	6	5	4	8	6	5
Cloud (%)	81	68	69	80	72	64	69	83
Humidity (%)	98	97	97	92	87	88	95	98
Precip (mm)	10.7	7.8	2.8	1.1	3.6	8.2	6.1	7.5
Presure (mb)	1014	1012	1013	1014	1012	1010	1011	1014

Figure 7: Summary of the weather on 29 August 2019. Source: NWS (Times in Local time)

1.8 Aids to navigation

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

1.9 Communications

P2-SET planned flight was superimposed with the *PNG ASL Aerodrome/Communication (ADCOM) Chart* (see Figure 8). The flight departed Daru (Sector 2), and was planned to transit through sectors 3 and 7 before reaching its destination, Gusap, located within sector 8.

The Very High Frequency (VHF) communication system is the primary communication frequency band for two-way communication between aircraft and Air Traffic Services (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.

8 When temperature and dewpoint are within 1 degree, there is likelihood of fog

All communication between ATS and the pilot was recorded by PNG ASL's ground based automatic voice recording equipment.

The Flight Information Region[9] (FIR) in Papua New Guinea airspace is separated and monitored by two ATS Units; Port Moresby (AYPY) FIS and Madang (AYMD) FIS. There is a total of nine sectors monitored by both AYPY and AYMD FIS. AYPY FIS monitors sectors 1, 2, 3, 7, 8 and 9, and AYMD FIS, sectors 4, 5 and 6. During a flight, aircraft are transferred from sector to sector as they pass through each boundary. The planned VFR flight path of P2-SET was through Sectors 2, 3, 5 and 6.

Figure 8: PNG ASL ADCOM Chart depicting the FIS sectors and mandated frequencies for P2-SET flight

The investigation found that the pilot initiated three radio calls on the High Frequency (HF) 6622, to Moresby Flight Information Service (FIS) personnel between the time of his departure from Daru, and the time of occurrence.

According to the FIS flight progress strip (see Figure 9), at 09:40, while on climb to 9,000 ft, out of Daru, the pilot made his departure call from within the sector 2 airspace. Although the Moresby FIS sector 2 operator was responsible for P2-SET at that time, the call was picked up by the FIS operator who was responsible for the combined sectors 1&7. The FIS sector 1&7 operator coordinated all departure flight details to the responsible sector, the FIS sector 2 operator.

During the investigation interview, the FIS sector 1&7 operator stated that it was normal for pilots to call on the secondary frequency (HF) or any contactable frequency when there is no contact on the primary frequency (VHF). In this case, the allocated primary VHF frequency 124.3 and HF frequencies for sector 2 were 5565 and 8861. There were no records to indicate that the pilot called on both HF frequencies for sector 2, however the pilot called on the HF 6622 which was shared by sector 3 and combined sectors 1&7. The FIS sector 3 operator told the AIC that the radio calls were not heard due to the poor reception of HF transmissions, at the FIS operator's workstation. The FIS sector 1&7 operator just assisted with monitoring of aircraft movements with information provided by other neighbouring FIS operators.

At 10:11, a minute after the scheduled time of call, the pilot made an operations normal call within the sector 3 airspace advising that he was maintaining 9,000 ft, tracking 034 degrees and was 175 miles from Gusap airstrip. This call was also coordinated by the FIS sector 1&7 operator.

9 In aviation, a flight information region (FIR) is a specified region of airspace in which a flight information service and an alerting service (ALRS) are provided.

According to the ATS radio communications audio recordings, the pilot made a call at 10:42 while he was still in sector 3. The AIC was advised by both FIS operators that they did not hear this call.

The FIS sector 1&7 operator stated that when the pilot of P2-SET made calls, she was busy monitoring other aircraft within her area of responsibility, however she ensured that she maintained communication with P2-SET when she realised that FIS sector 3 was unable to hear any calls or radio calls from her workstation.

1.9.1 Communication equipment

The aircraft was fitted with the following communication equipment[10]:

1. an ICOM IC-706 MkIIG HF/VHF/UHF Transceiver;
2. an Audio Unit Flightcell Version IV;
3. a VHF Comm Bendix King KY96A; and
4. a UHF Comm Uniden UH-011.

All air ground communications that FIS were operating on were recorded on four stand-alone radio sets. These HF radio antennas are located outside the Port Moresby control tower building. However, the investigation found that the communications were intermittent and filled with static interference.

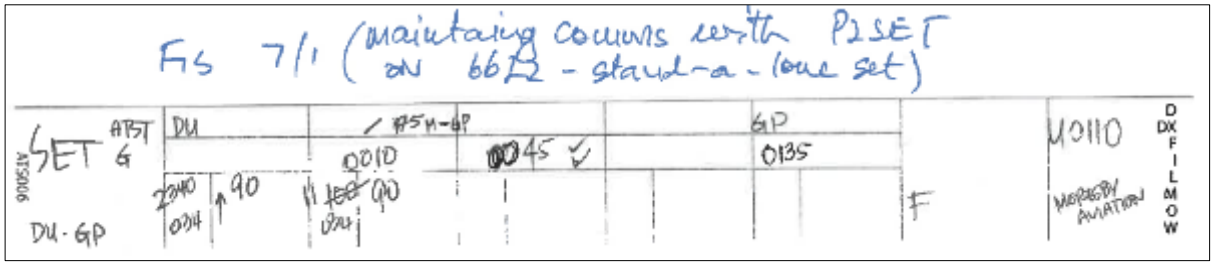


Figure 9: PNG ASL Flight Strip for Sector 1&7 with actual recorded information showing the progress of flight on P2-SET

1.10 Aerodrome information

Not relevant to this investigation.

1.11 Flight recorders

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

1.12 Wreckage and impact information

1.12.1 Accident Site

The accident site was located about 6.8 nautical miles North-West of Baimuru airstrip, Gulf province. The area has vegetation made up of tall dense palm trees. All year-round, the vegetation remains dense due to the climatic conditions (see *Section 1.7.1* for climate information). The accident site was located at a delta environment with muddy banks that made movement quite difficult. Investigators with the help of the locals gained access to the accident site by foot.

10 Source: CASA PNG (the scale of radio and navigation equipment required for various types of flight operations is prescribed in Civil Aviation Rule Parts 91, 121 and 135).

1.12.2 Wreckage distribution and inspection

The general spread of wreckage indicated that the aircraft had been tracking to the south-east prior to final impact. Aircraft components were found within a 1.3 nm radius from the main impact point (see *Section 1.1 and* Figure 5).

Figure 10: Depiction of wreckage trail along final flightpath

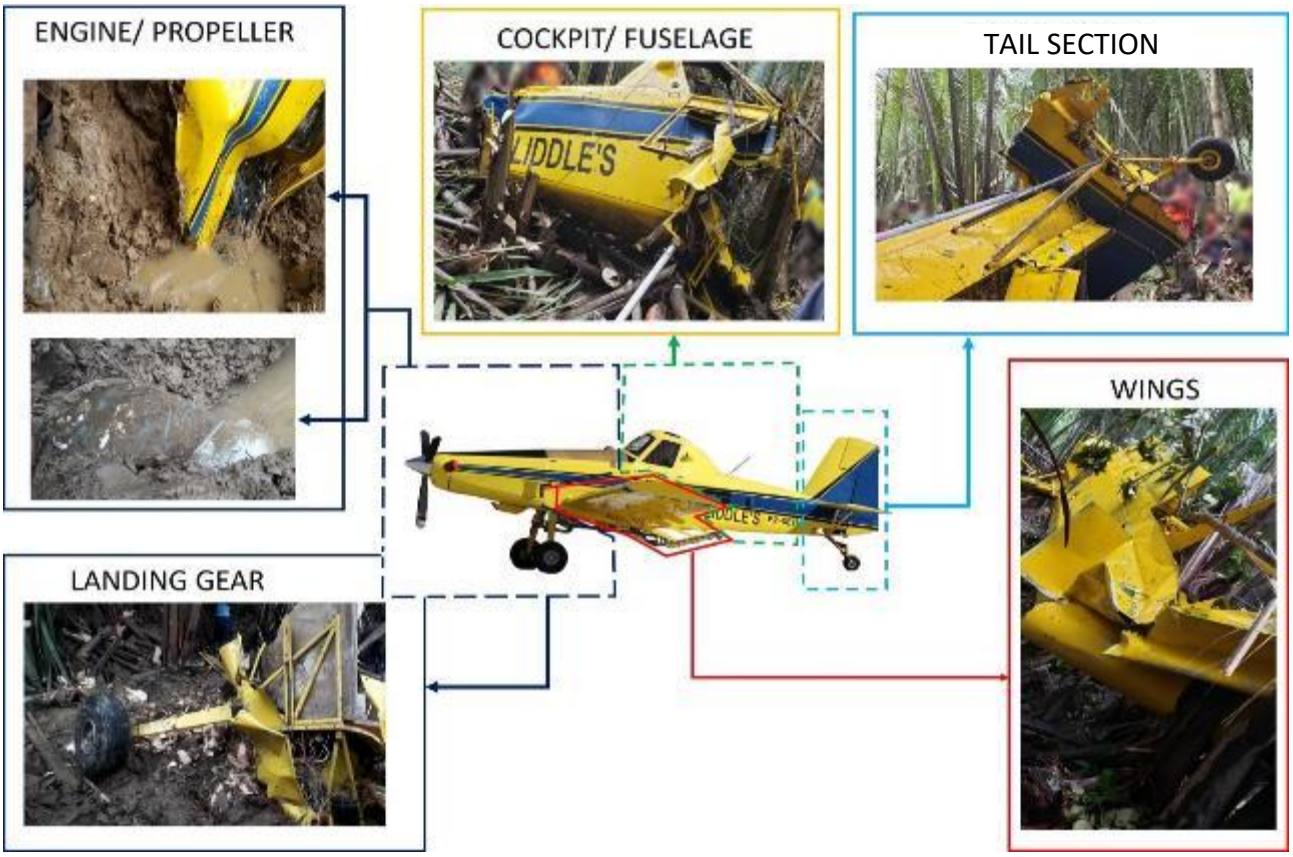


Figure 11: Wreckage distribution

Figure 12: Tree showing evidence of impact.

Figure 13: Tail section and cockpit with reference to the tree

Figure 14: Engine completely embedded in mud (Left) and propeller blade tip (Right).

Figure 15: Engine and propeller section embedded in mud

Figure 16: Left wing

The investigation team conducted an on-site examination of the aircraft, its engine and propeller. The investigators found that there was rearward bending of the propeller blade at the shank of the only visible blade. This rearward bending indicated that subsequent to final impact, the propeller stopped turning in flight before being deeply embedded in mud.

The investigation determined that after the initial impact, the flatter angle at which the aircraft flew for 1.3 nm (see Figure 10) until the final impact, required a significant amount of engine power to maintain level flight. Moreover, the distance (290 meters) between the engine, the main landing gear, the hopper and where the cockpit including the tail of the aircraft were found, was a result of the momentum produced by the high engine power present during the dynamics of the final impact.

1.12.3 Flight Controls[11]

Impact forces can determine the position of control surfaces due to the momentum and the angle at which the aircraft impacts a hard surface.

The aircraft's approximate attitude and angle of impact was calculated using the position of aircraft components and angle crush damage to the forward, cockpit, tail and wing sections respectively (see Figure 11).

Examination of the flight control surfaces, control cables and push rods was conducted and did not indicate any pre-impact defects.

11 Examinations of the flight controls were done on - site

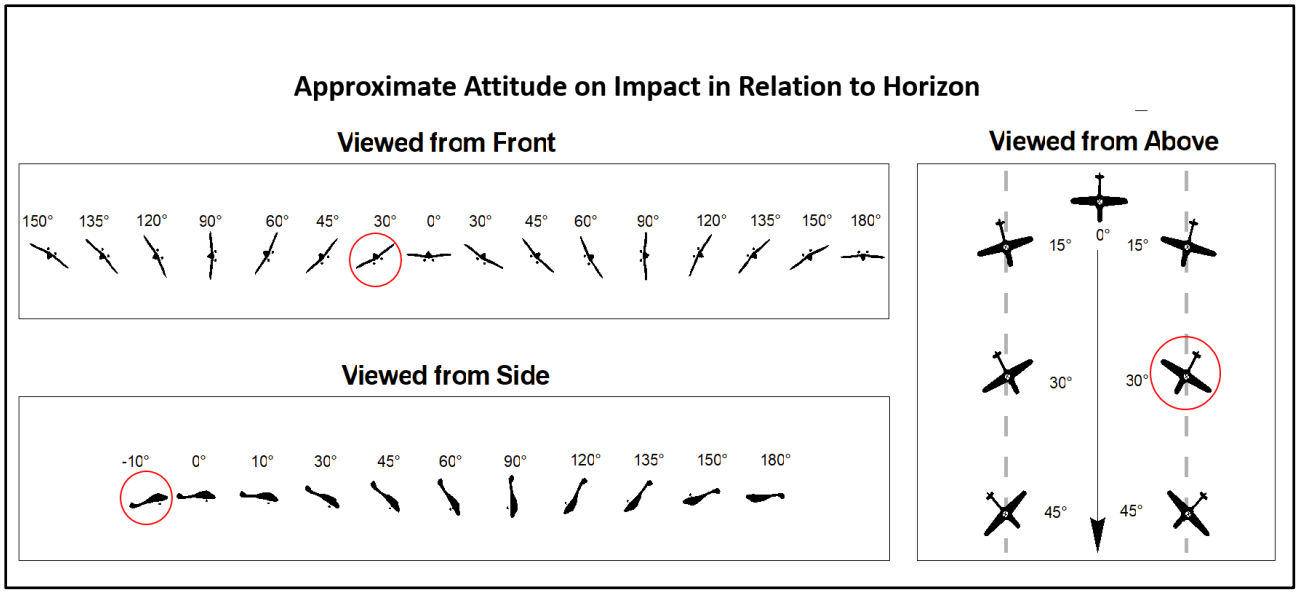


Figure 17: Depiction of approximate aircraft attitude on impact

A thorough examination of the position of aircraft components and damage observed showed that the aircraft impacted the tree at a right-wing low, nose up attitude at the point of impact.

1.13 Medical and pathological information

A post mortem forensics examination was conducted on the deceased pilot by the PNG State Pathologist.

The Pathologist's report stated: *"the incapacitation injuries included a fractured spinal column, bilateral collapsed lungs and received head injuries due to the blunt force trauma to body due to the crash"*

According to the Pathologist's report, the severity of the injuries sustained suggested that the pilot died upon impact. The time of death was estimated to be around midday (local time) on the day of the accident.

1.14 Fire

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

1.15 Survival aspects

1.15.1 Personal Locater Beacon (PLB)

PLBs are portable units that operate much the same as Emergency Position-Indication Radio Beacon (EPIRB) or Emergency Locator Transmitters (ELTs). These beacons are designed to be carried by an individual person instead of on a boat or an aircraft.

Unlike ELTs and some EPIRBs, they can only be activated manually and operate exclusively on 406 MHz

Like EPIRBs and ELTs, all PLBs also have a built-in, low-power homing beacon that transmits on 121.5 MHz. This allows rescue services to home-in on the distress beacon once the 406 MHz satellite system has provided the necessary position information. Some PLBs also allow GPS units to be integrated into the distress signal.

The aircraft owner reported that the pilot was wearing a PLB around his neck when he departed Horn Island for Daru. The PLB S/N: 1508343913 (registered with PNG Air Services Limited) was not located during the onsite investigation. According to ATS, there was no PLB distress signal received on the day of the accident. Furthermore, the pilots of an aircraft flying in the accident area at that time, reported that they did not receive any distress signal from P2-SET.

1.15.2 Search and Rescue

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

The Civil Aviation Authority (CAA) that existed in PNG prior to 1 January 2010 had coordinated Search and Rescue (SAR) services up until the formation of PNG Air Service Limited (PNGASL) in July 2007. Since its formation PNGASL coordinated SAR services and activated the Rescue Coordination Centre (RCC) on a need basis.

The responsibility of the establishment, function and maintenance of the PNG Aeronautical RCC was formally delegated to PNG Air Services Limited (PNG ASL) on 9 July 2018, by the Civil Aviation Minister in compliance with the *Civil Aviation Act 2000 (As Amended) Section 8A and 8B*, following a safety recommendation from PNGAIC.

1.15.2.1 Aeronautical Rescue Coordination Centre (ARCC)

ICAO Annex 12, Chapter 1 defines a Rescue Coordination Centre as:

A unit responsible for promoting efficient organisation of search and rescue services and for coordinating the conduct of search and rescue operations within a search and rescue region.

ICAO Annex 12, Section 2.3 Rescue *Coordination Centre and rescue subcentres states;*

2.3.1 Contracting States shall establish a rescue coordination centre in each search and rescue region.

2.3.3 Each Rescue Coordination Centre and, as appropriate, rescue subcentre, shall be staffed 24 hours a day by trained personnel proficient in the use of language used by radiotelephony communications.

According to the information provided to the AIC by PNGASL management, at the time of the accident the organisation was in the process of preparing an application for submission to the Civil Aviation Safety Authority (CASA PNG) for *CAR Part 176* certification. PNGASL also informed the AIC that at the time of the accident a RCC Coordinator had been appointed and the assigned RCC facilities were under renovation. The investigation found that the RCC was not staffed 24 hours a day, and the staff was not trained and proficient in the use of language used by radiotelephony communication.

Evidence before the AIC indicated that the PNGASL RCC had an RCC room which was under renovation at the time of the accident. Subsequently, the coordination of the search and rescue for P2-SET was conducted at the Centre Supervisor's (CS) work station.

The RCC Coordinator was appointed on 30 August 2018, accountable to the Managing Director.

1.15.2.2 Search and rescue relating to P2-SET

According to Audio recordings of the Air Traffic Services Radio Communications with P2-SET, the pilot made his last call at 10:42. According to the statements provided to the AIC by the two Moresby FIS operators who monitored P2-SET at that time, that last radio call was not heard by them (*Refer to Section 1.9 Communications for more information).*

At 10:48, the FIS operator commenced communication checks with P2-SET when she realised that the pilot did not report operations normal at 10:45. At 10:55, the FIS operator made contact with the pilot of P2-BJD, flying in the area and asked him to contact the pilot of P2-SET. At 11:08, the pilot of P2-BJD advised the FIS operator that he was unable to reach P2-SET. At 11:13, the FIS operator resumed communication checks with P2-SET and continued until 11:34.

The Moresby FIS also contacted the Madang FIS who confirmed no calls were received from P2-SET and attempts to make contact with P2-SET were unsuccessful.

At 11:10, the Moresby FIS declared an UNCERTAINTY Phase (INCERFA)[12] and advised the Centre Supervisor about the situation.

The CASA *Aircraft Registration Directory (ARD)* stated that the aircraft belonged to Moresby Aviation (see *Appendix 5.2*), however there were no listed contact numbers in the *ARD*, nor in the Centre Supervisor's directory. The FIS operator stated that although instructed by the Supervisor to contact CASA PNG to obtain contact details of the Operator, she was unable to do so as she was preoccupied with other tasks. She added that she was quite busy all morning with no relieve break until 11:54, which was six minutes before her shift ended, when the relief staff came to her sector. Therefore, she handed over all her tasks to the relief staff and the Centre Supervisor (CS) before signing off from duty.

According to the *PNG ASL Initial Notification of Incidents (INI)*, the ALERT phase (ALERFA)[13] was declared at 13:10, after continued attempts on coordination with relevant agencies and airline companies such as; Marine Rescue Coordination Centre (MRCC), Summer Institute of Linguistics (SIL), National Airports Corporation (NAC) – Daru and Kerema, resulting in the aircraft not being located.

The *PNG ASL P2-SET Chronology of SAR Events* indicated that at 14:10, the aircraft owner in Cairns contacted PNGASL to check on status of the aircraft and advised that the aircraft was not carrying an ELT.

At 14:22 (SAR events) after continued failed attempts to contact personnel at Gusap and NAC Daru, to check on arrival or return of aircraft respectively, the DISTRESS phase (DETRESFA)[14] was declared. Subsequently, the RCC was activated.

At 14:30, the CS, with the RCC coordinator, plotted the aircraft's flight plan route to estimate the last known position. Several unsuccessful attempts were made to contact NAC, Daru, Kikori and RAIL at Gusap, who eventually confirmed that the aircraft had not arrived at its destination.

The MRCC duty officer was contacted at 15:38 and advised about the distress situation. He confirmed that he had prior knowledge/information of the situation, as advised by the CS, and an arrangement was in place with the Joint Rescue Coordination Centre (JRCC) of Australia, for assistance with search.

The aircraft owner also contacted the RCC coordinator to advise that they would fund the search and that they were in contact with Tropic Air. At 15:46, the RCC coordinator called Department of Transport (DoT) to obtain assurance on the funding aspect of possible Search and Rescue aircraft, but to no avail.

At 15:49, the RCC Team was updated on the JRCC arrangement, in which the rescue aircraft was due for arrival at the search area/Commence Search Point (CSP), in 2 hours. Considering the amount of remaining daylight against the arrival time, plans were made to seek approval from Tropic Air to arrange and commence a visual search along the aircraft's route, however the status of this concept could not be verified.

During this time, Tropic Air Staff informed RCC[15], on several reports from local villagers and Tropic Air Staff regarding the aircraft and weather.

The *PNGASL Initial Notification of Incident (INI)* was raised at 16:59.

A Police Commander (Water Police) was contacted at 17:22 and he stated that he would disseminate the information to all relevant Police personnel including the Airborne Unit.

An update was provided to the MRCC personnel at 17:36, and he advised that he was in contact with the RPNG Water Police personnel. During his interview, the Water Police personnel stated that he maintained communication with the MRCC personnel during the distress period as he was unaware of the PNG ASL RCC. He added that there was work underway for the expansion of Search and Rescue amongst relevant Police Units.

12 International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual, Volume 1 definition: A situation wherein doubt exists as to the safety of an aircraft or a marine vessel, and of the persons on board.

13 *IAMSAR Manual, Volume 1* definition: A situation wherein apprehension exists as to the safety of an aircraft or marine vessel and of the persons on board.

14 *IAMSAR Manual, Volume 1* definition: DISTRESS PHASE A situation wherein there is reasonable certainty that a vessel or other craft, including an aircraft or a person, is threatened by grave and imminent danger and requires immediate assistance.

15 RCC tasks were carried out by the Centre Supervisor

At 17:51, the RCC was advised that a former Member of Parliament (from Kikori) was organising a search party, and the possible crash site was near Era River, Gulf Province.

The Police Commander called the RCC at 17:56 and advised that arrangements were underway for police personnel to travel to the crash site with the Tropic Air team on 30 August 2019, the day after the accident.

The standing down of the RCC for the day's operation was logged as 19:00 and planned to resume the next day, 30 August 2019. The PNG ASL personnel advised the AIC that the RCC did not resume operations as planned.

On 30 August 2019, the AIC despatched a team of investigators, who with the assistance of local villagers located the crash site. The pilot was fatally injured and he was found in his seat, with his seatbelt still fastened. His body was repatriated to Port Moresby the following day, and received by Police personnel at Jacksons Airport.

1.16 Tests and research

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

1.17 Organisational and management information

1.17.1 Aircraft Owner : Liddle Holdings Trust

Liddle Holdings Trust was contracted to conduct Agricultural Aircraft operations under a MOA which was in effect from 01 October 2016 until 31 May 2019. The MOA provided for renewal under Duration of the Agreement. On 15 April 2019, RAIL sent a letter for extension of the MOA to Liddle Holdings Trust in which both parties agreed. The MOA was then extended for a further 2 years which was in effect on 01 June 2019

1.17.2 Aircraft Operator : Ramu Agri Industries Limited

Air Operator Certificate Number: 119/075

The Operator was approved to conduct Agricultural Aircraft Operations in accordance with an Air Operators Certificate (AOC) issued by the Civil Aviation Safety Authority (CASA). The AOC authorised the Operator to engage in aerial work operations, and the requirements of *PNG Civil Aviation Rule Part 137* were applicable.

1.17.2.1 Ramu Agri Industries Limited (RAIL) Standard Operating Procedures manual

RAIL SOP did not contain specific information pertaining to weather minima as set out in the *PNG CAR Part 91* to equip pilots with the necessary information when planning for a flight. The investigation found that RAMU SOP lacked guidelines pertaining to weather for pilots during flight planning.

1.17.3 Safety Management Systems

CASA PNG Advisory Circular AC100-1, Issue 2,01 July 2014 states;

> *The PNG Civil Aviation Act 2000 requires organisations entering the civil aviation system to have a safety management system in place.*
>
> *The new PNG Civil Aviation Rules related to certification of organisations contain requirements which taken collectively cover all the elements of a safety management system. In developing, implementing and maintaining systems to ensure compliance with Part 119, the organisation concerned will put in place a safety management system meeting the requirements of Civil Aviation Rule Part 100.*
>
> *While the safety management system standards embedded in the Rules are structured around elements of ISO 9000, Quality Management and Quality Assurance Standards, the Rules do not address all elements of the ISO standard and organisations certificated under the new rules do not automatically qualify for ISO certification. Conversely, an organisation with ISO certification does not necessarily show compliance with the requirements of the applicable Civil Aviation Rules*.

The investigation identified that the operator had an Operational Sustainability Plan that introduces aspects of the RAILS Sustainability Management System (SMS).

The Sustainability Management System draws together and integrates three systems that deliver sustainable performance and continuous improvement in the fields of Environment, OHS, and Social responsibility.

These three Systems are;

- Occupational Health and Safety Management System
- Environment Management System
- Social / Employee Welfare Management System

The investigation also identified that RAIL was certified under RSPO and SAN. Roundtable and Sustainable Palm Oil and Sustainable Agriculture Network both have ISO components embedded into their standard requirements, inclusive of ISO 45001-Occupational Health and Safety Management System.

The Operator stated that there is no separate system dedicated for the agricultural spraying operations because the agricultural spraying operations made up only a small part of the whole operations at RAIL. They had integrated the aircraft operations within the whole system (Sustainability Management System or SMS).

The Operator further stated that the safety concerns of the aircraft operations are assessed within standard registers. The workplace assessments have generated 4 Registers that form the basis of data collection, and continuous improvement;

- Environmental Aspects and Impacts Register
- Occupational Health and Safety Hazard and Risk Register
- Employees and Grievances and Issues Register
- External Stakeholder Issues Register

The investigation identified that there is no SMS Manual giving full details of the operator's relevant SMS procedures and processes. Although, Section 3.10 of the Sustainability Management Plan clearly states that there is a SMS Manual and procedures that gives full details of the SMS processes and procedures

The investigation reviewed the compliance matrix, however did not include compliance with PNG Rule Parts 119.71,119.73 and Part 100.

1.17.4 Emergency Response

PNG CAR Part 100.71(a) (b) (c)- 'Emergency response procedures' states;

(*a) An applicant for the grant of a certificate under Part 119, Part 139 or Part 140 must establish and maintain documented procedures to:*

(1) identify potential accident, incident and emergency situations arising from the operation authorised by the scope of the certificate; and

(2) respond to those accidents, incidents and emergencies.

(3) for international operations, provide for the due response from appropriate authorities in sovereign States.

The investigation reviewed the Operator's Emergency Response Procedures (ERP) in the Operations Manual, the *Sustainability Management Plan, SOP AIR Form 010* and the *SOP ERP Form 002.*

The investigation identified that the Operator had an established ERP; however, the ERP was not fully established in accordance with *Appendix 6* of *CASA PNG Advisory Circular 100-1, Issue 2,1 July 2014* that provides information and guidance relating to Emergency Response Procedures.

There are no emergency services contact details and Emergency Coordination centre from which to coordinate the emergency response and no documented duties and responsibilities for the Emergency Response Team. There was also no record of ERP Training conducted.

1.17.4.1 Civil Aviation Safety Authority (CASA PNG) Safety Oversight

The CASA PNG has regulatory oversight of aircraft operations in PNG.

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

While the safety regulation of civil aviation remains its primary role, CASA PNG also provides aviation security, safety education and training programs including responsibilities for airspace regulation.

As a signatory to the *Convention on International Civil Aviation*, Papua New Guinea is responsible for maintaining ongoing compliance with its international obligations. CASA PNG provides for this in its management of the civil aviation sector.

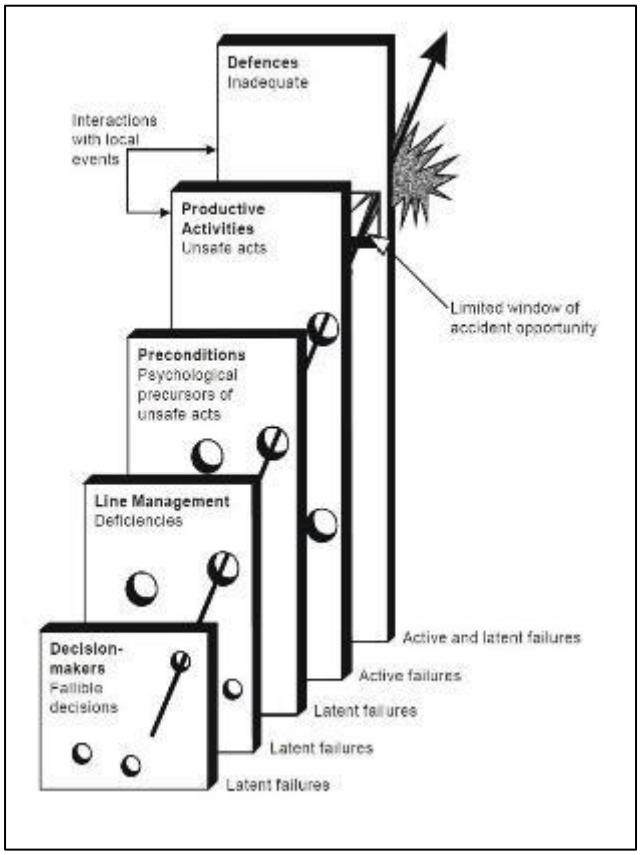
The investigation found safety deficiencies in the operators *Standard Operating Procedures Manual*. Lack of appropriate SOP's pertaining to weather minima, inadequate processes and procedures for maintaining records of flight/operational documents, that were accepted by CASA PNG on 27 January 2015. The CASA PNG also did not have records of the pilot from 2013 thereafter.

1.18 Additional Information

1.18.1 James Reason's Swiss Cheese model of Accident Causation

ICAO Doc 9683, paragraph 4.2.9 states:

James Reason views the aviation industry as a complex productive system. One of the basic elements of the system consists of the ***decision-makers*** *(upper management, the company's corporate body or the regulatory body), who are responsible for setting goals and for managing available resources to achieve and balance two distinct goals: the goal of safety, and the goal of on-time and cost-effective transportation of passengers and cargo. A second key element is* ***line management*** *— those who implement the decisions made by upper management. For upper management decisions and line management actions to result in effective and productive activities by the workforce involved, certain* ***preconditions*** *have to exist. For example, equipment must be available and reliable, the workforce has to be skilled, knowledgeable and motivated, and environmental conditions have to be safe. The final element —* ***defences*** *or safeguards — is usually in place to prevent foreseeable injury, damage or costly interruptions of service.*



Paragraph 4.2.11 states:

*Failures can be of two types, depending on the immediacy of their consequences. An **active failure** is an error or a violation which has an immediate adverse effect. Such errors are usually made by the front-line operator. A pilot raising the landing gear lever instead of the flap lever exemplifies this failure type. A **latent failure** is a result of a decision or an action made well before an accident, the consequences of which may lie dormant for a long time. Such failures usually originate at the decision-maker, regulator or line management level, that is, with people far removed in time and space from the event. A decision to merge two companies without providing training to standardize operating procedures illustrates the latent failure. These failures can also be introduced at any level of the system by the human condition — for example, through poor motivation or fatigue.*

Figure 18: James Reason's Swiss Cheese Model of Accident Causation (ICAO Doc. 9683)

Failures in the defences when holes in all of the slices momentarily align, 'permitting a trajectory of accident opportunity, so that a hazard passes through holes in all of the defences, results in accidents as shown in Figure 19. Some of the latent conditions identified are discussed in *organisational and management information* and active failures in *section 1.18.2.1* and further discussed in *section 2.1 – Analysis* of this report.

The weather summary provided by the National Weather Services indicated that there was fog in the area of the accident.

1.18.2 Visibility Impact of Fog

Fog is the most common visibility limiter in aviation. It has the ability to limit surface visibility; therefore, the operational impacts of fog can be significant. Fog conditions often reduce aircraft arrival/departure flow rates and can become dense enough to close an airfield. In terms of specific disruption potential, fog has the ability to cause operational delays or to even prevent an aircraft from arriving at the destination. When fog is anticipated, pilots will need to consider airport alternates, and or carry additional fuel due to the conditions generated by fog. Fog has potential to rapidly reduce visibility, from visual flight rules (VFR) to instrument flight rules (IFR) within minutes. This rapid reduction in visibility occurs, primarily, with advection types of fog – along coastlines or in upslope conditions. Advection fog is most prevalent along coastlines, especially when there are sharp temperature gradients. Time of day also influences occurrence of fog. Advection fog can impact aviation operations any time of the day. It is important for pilots to be aware of the particular fog type that may impact their operations. Fog conditions may be transient, with fog density varying rapidly within a particular airfield. Geography plays a significant role in fog development, making fog density and dissipation difficult to predict. It is always important that pilots be aware of geographic makeup of an airfield and local area. Flying into fog can create an illusion of pitching up. Pilots who do not recognize this illusion will often steepen the descent quite abruptly.

1.18.3 Flight Planning

Initial Pre-flight actions (Planning, Judgement and Aircraft handling)

Flight planning is the most important phase of any flight which sets the stage for the entire flight. Its purpose is to determine requirements, identify hazards, and determine airworthiness of the aircraft before flight. Pilots in command, before beginning a flight, become familiar with all available information concerning that flight. This information must include: weather reports and forecasts, fuel requirements, alternates available if planned flight cannot be completed and any known traffic delays in which the pilot in command may have been advised by ATS. Pilot weather briefings/planning prior to flight are significant in translation of weather observations and forecasts, including surface, upper air, radar, satellite, and PIREPs[16] into a form directly usable by the pilot or flight personnel to formulate plans and make decisions for the safe and efficient operation of the flight. The basic steps to use during pre-flight planning are:

1. **Perceive** (understanding information and hazards that could adversely affect the safe and efficient operation of the flight);
2. **Process** (analysing information to determine whether the hazards create risk, which is the potential impact of a hazard that is not controlled or eliminated); and
3. **Perform** (making a plan to eliminate the hazard or mitigate the risk).

Planning

RAIL SOP section 3.4, sub-section (2) states:

In addition to the Aircraft Library, the following documents shall be carried on all flights.

(a) Certificate of Registration;

(b) Airworthiness Certificate;

(c) Technical Log;

(d) NOTAMs applicable to the flight;

(e) Meteorological information for the flight;

(f) Current information on aerodromes/landing areas to be used;

(g) Aeronautical maps/charts pertinent to the flight.

RAIL SOP, Section 3.6 (3) (4) states;

(3) Before departing from an intermediate landing point, the pilot in command, where possible, shall obtain and study the latest actual or forecast weather reports for the next planned landing point.

(4) Company pilots shall not use any actual or forecast weather reports of meteorological conditions unless those reports were made with the authority of the Director of Meteorology, by a source approved by the CASA.

Liddle Holdings Trust informed AIC, that they had no records or copies of the flight documents mentioned in *RAIL SOP section 3.4 sub-section (2),* that were gathered by the pilot, prior to departing Horn Island on the day of the accident. The pilot submitted his flight planning via NAIPS[17]. Liddle Holdings Trust also stated that the pilot had many contacts from the vast experience he had and that is where he usually obtained his weather information from Liddle Holdings Trust also stated that the pilot organised weather information himself from local contacts.

PNG *CAR part 91.307* states:

(a) Except as provided in paragraph (d), a pilot-in-command of an aircraft must—

(1) where practical, submit a flight plan to an appropriate ATS unit before starting any flight conducted under VFR; or

16 A pilot report or PIREP is a report of actual weather conditions encountered by an aircraft in flight.

17 National Aeronautical Information Processing System

(2) otherwise, submit a flight plan by radio to the appropriate ATS unit as soon as practical after take-off.

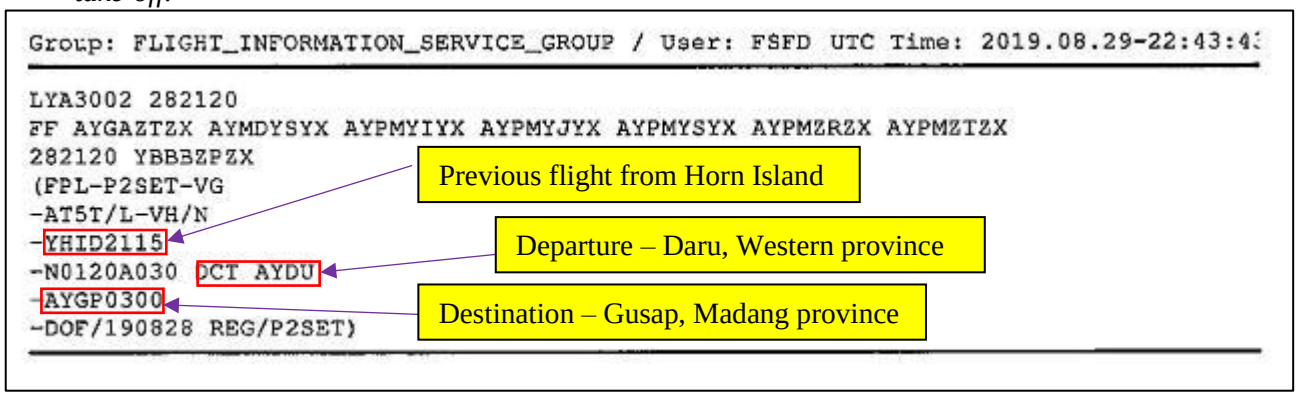


Figure 19: P2-SET Flight plan that was submitted to Air Traffic Services on the day of the accident (source: PNG Air Services Limited)

Liddle Holdings Trust stated that the pilot did his own flight planning.

1.19 Useful or effective investigation techniques

Evidence gathered at the accident site were contaminated (see Figure 21). They were transported to the PNG AIC Engineering Workshop and processed in the Biohazard Safety Cabinet.

The evidence included the Air Tractor AT-502B Aircraft Flight Manual and the belongings of the pilot; a wallet, a note book and a clipboard.

Figure 20: Condition of AFM when brought to the AIC engineering lab for processing

Figure 21: Lab technician placing the evidence in the Biohazard safety cabinet for processing

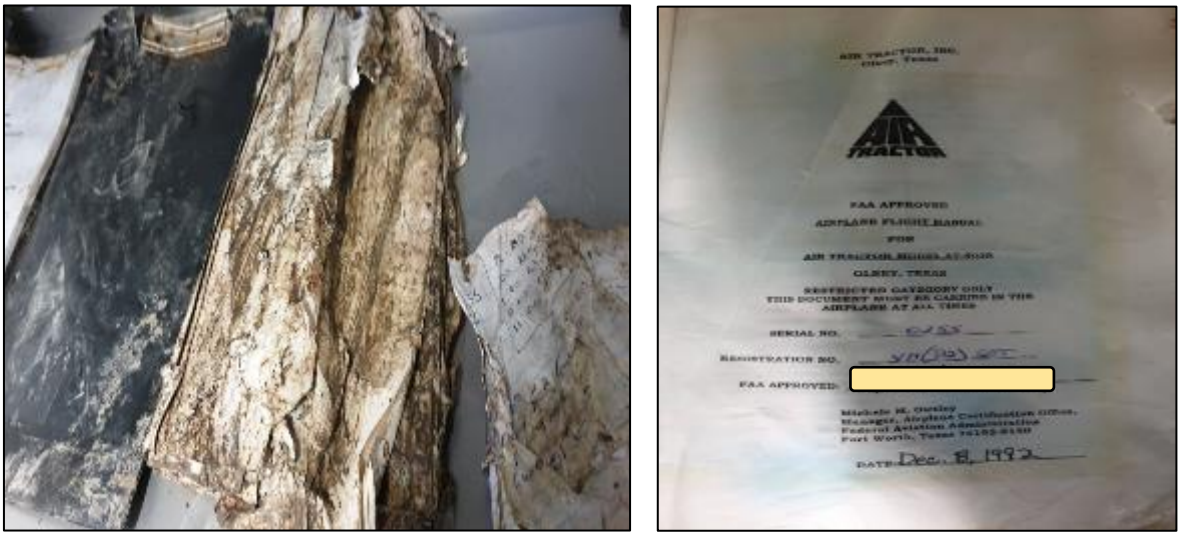


Figure 22: Before (left) and after the Biohazard treatment processing (right)

2 ANALYSIS

2.1 General

The analysis part of this Draft Report will discuss the relevant issues and other issues resulting in the impact with trees involving the Air Tractor AT-502B aircraft, P2-SET during its ferry flight to Gusap, Madang province from Daru, Western province on 29 August 2019. Other safety deficiencies although not directly related to the accident are also discussed in this section.

The investigation determined that there were no issues with the aircraft and all systems were generally operating normally. The analysis will therefore focus on the following issues but may not necessarily be under separate headings:

- Pilot Actions which include:
  - Planning;
  - Judgement; and
  - Aircraft Handling
- Weather Aspects
- Ramu Agri Industries Limited (RAIL) Standard Operating Procedures (SOP)
- Safety Management Systems Overview
- CASA Safety Oversight
- Search and Rescue

2.2 Flight Operations

2.2.1 Initial Pre-flight actions (Planning, Judgement and Aircraft handling)

2.2.1.1 Planning

The investigation determined that there was no evidence which showed that the pilot obtained viable and significant weather information during flight planning prior to departing Horn Island for Daru, Western province (previous flight).

The investigation also determined that there was no supplement document or "non-standard" operating procedural document to support pilot actions in obtaining weather information from local contacts.

It was evident that the Operator did not have adequate processes and procedures for maintaining records of flight/operational documents specifically weather forecasts.

2.2.1.2 Judgement

Decision making is fundamental to all aspects of flight operations. Lack of significant weather information and data results in poor planning and judgment during flight planning. Specifically, weather elements can:

1. Reduce visibility;
2. Create turbulence; and
3. Reduce aircraft performance.

The weather on the day of the accident as reported by the locals was adverse compared to the day (30 august 2019) when investigators arrived at the accident site (see *section 1.7 Meteorological Information*).
The likelihood of the pilot encountering marginal conditions, including torrential rain, fog and low visibility was overwhelming. According to the meteorological data provided by NWS for the day of the accident (see Table 2), there was so much cloud cover from 500 feet up to 18,000 feet with fog at 500 feet reducing the visibility to 3000 meters.

The weather summary also showed that there was torrential rain in the accident area. The pilot was cruising at 9000 feet after departing Daru for Gusap. The forecasted cloud cover and ceiling did not allow for a VFR flight at 9000 feet. The pilot most likely entered cloud with poor visibility whilst in the cruise phase at 9000 feet. The pilot could have taken an alternate route or other alternative actions if he identified from the weather report the adverse weather conditions in Kikori. However, he continued with the flight.

2.2.1.3 Aircraft handling

The investigation determined that the pilot manoeuvred the aircraft for almost an hour. However, cloud base and fog within the Kikori delta area would not allow the pilot to continue to his intended destination maintaining visual references. The pilot continued descending to about 200 feet circling in the area, further descending below 100 feet. This type of low flying is a common practise for agricultural pilots. Agricultural flights are usually performed as low as 20 feet above ground level.

The investigation also determined that during the manoeuvre to obtain or maintain visual reference as he descended below 100 feet, the aircraft's outboard section of the right-wing clipped palm trees, separating from the wing. The adverse effect on the wings did not produce sufficient lift for the aircraft to climb back to a safe altitude. The aircraft then continued flying in the direction of flight and impacted a thick tall tree.

2.2.2 Weather aspects

The investigation determined that the pilot may have attempted to evade the deteriorating weather as he progressed along the flight path, with the intent to ensure the aircraft was well within safe parameters of its operation.

The nearest suitable airstrip (Baimuru) was about 6.8 nm away from the accident site. There was no recorded communication between the pilot and ATC stating that he may have considered diverting to an alternate due to weather.

The investigation determined that the pilot did not consider viable information with regard to the weather forecast pertinent to the flight path during the flight preparation phase as required by the Operator. In these circumstances, the flight should not have been conducted. Moreover, if weather conditions would have been properly considered by the pilot in his flight planning, the flight would have been cancelled or delayed until weather conditions improved. The investigation also found that *RAIL SOPM* did not contain specific information regarding meteorological minima for VFR flights that would have guided the pilot during flight planning. The pilot relied mostly on his flying experience and local contacts for the conduct of the flight.

2.2.2.1 Effects of fog

According to the weather summary provided by NWS, the preceding weather conditions up to the day of the accident were ideal for the formation of fog in the area of the accident as described. The obscurity and limitations in visibility were fallouts of foggy conditions. Witnesses' accounts of hearing the accident aircraft flying around at low altitude could possibly explain why the pilot flew too low in an attempt to evade cloud and fog and to maintain or regain visual reference.

The investigation determined that the effects of fog as described above would have restricted the pilot with reduced visibility to continue the flight on the nominated flightpath. The investigation suggested that during the manoeuvring phase to evade fog, the aircraft/pilot would have experienced the following:

- Reduced visibility and obscured line of sight.
- Restricted radio communications due to weather.

The effects of fog resulting in reduced visibility and obscurity, would have placed the aircraft in an unsafe situation causing the pilot to take evasive manoeuvres to keep the flight within safe parameters.

2.3 Survival

2.3.1 Personal Locater Beacon

The investigation could not conclusively determine whether the pilot was wearing a Personal Locator Beacon (PLB) as stated by Liddle Holdings Trust. However, if the pilot was wearing a PLB at the time of

the accident, the severity of the impact forces and the overwhelming injuries he sustained would have limited his chances of activating the PLB.

2.3.2 Search and Rescue

2.3.2.1 FIS Sector 1&7

The investigation determined that the FIS (Sector 1 & 7) operator had other tasks, which would have prevented her from being focused or attentive enough to hear the faintest audible sound of the pilot's last call.

In addition, she was not given a relief break until 6 minutes before her shift ended, when she was assigned a relief officer. She conducted a hand over, take over brief before signing off from duty.

The FIS operator had additional work load, due to the ineffective functioning of the HF equipment/facilities. She maintained all radio communications with P2-SET, although the aircraft was not in her area of responsibility, while monitoring aircrafts in her area of responsibility.

2.3.2.2 Times when the phases were declared

The INCERFA was declared at 11:10, 22 minutes after the pilots last operations normal call time. The ALERFA was declared at 13:10, two hours after INCERFA, followed by DETRESFA which was declared at 14:22, twelve minutes after ALERFA.

According to *MATS SAR-4-2 25 July 2013*, the INCERFA should have been declared within 15 minutes after the communication checks time, which would have been at 11:03 or earlier. ALERFA and DETRESFA should both be declared immediately when the condition was recognised (see *Appendix C*). The investigation determined that the SAR phase declarations were well outside of their required times.

2.3.2.3 Rescue Coordination Centre (RCC)

ICAO Annex 12 Chapter 2 Organisation, Section 2.1.1 states that Search and rescue services shall be provided on a 24-hour basis.

On the day of the accident, the standing down of the RCC was logged as 19:00, which was before the aircraft or crash site was located, and planned to resume the following day. However, the RCC did not resume operations as planned.

The investigation determined that the RCC did not comply with the requirements of *ICAO Annex 12, Section 2.1.1.*

Although not directly related to the cause/contributing factor of an accident, post-accident activities including search and rescue are important pertaining to survival aspects. Coordination of search and rescue may involve organisations like the police, defence force, maritime (although not directly involved in aviation activities) and aircraft operators to effectively conduct search and rescue. *ICAO Annex 12* states the minimum standards of establishing an RCC. However, service providers can improve or exceed these requirements by branching out to other *non-aviation* entities, to broaden the capabilities of search and rescue and have an efficient and effective RCC.

2.3.3 Communications

The investigation determined that the High Frequency (HF) system that was used to provide two-way communication was unreliable. Static interference, HF system coverage in the HF system made it difficult for calls to be transmitted between ATS and the aircraft.

2.4 Operational risk assessments

2.4.1 RAIL Safety Management

The investigation determined that RAILS's Safety and Quality Management System was not established and implemented in compliance with PNG CAR Part 119.71 and 119.73 to fully meet the requirements of Part 100.

Documented SMS procedures in an SMS Manual would have ensured safety and operational risks were identified and mitigated. Operational risks like lack of appropriate SOPs pertaining to weather minima, inadequate processes and procedures for maintaining records of flight/operational documents would have been avoided if the operator had appropriate documented procedures and processes.

Lack of documented procedures and processes results in unsafe acts. The fact that there was lack of fully detailed SMS procedures and the pilot making decisions on his own indicated a poor safety culture.

2.5 Regulatory and Safety oversight

Regulatory oversight is significant in keeping records of the pilot information and organisational compliance to regulations.

The investigations determined that regulatory oversight on the Operator was not conducted efficiently. Furthermore, CASA PNG was unable to provide the investigation, up to date records of pilot information and organisational safety oversight information.

The investigation also determined that the CASA PNG accepting RAILs SMS that did not have fully documented procedures in the SMS Manual, placed a burden of responsibility on CASA PNG as the State Regulator to ensure accuracy and that safety standards are met.

In *accepting* the the operators SMS manuals, CASA PNG did not meet the standard required by *ICAO Annex 19, Section 4.1.1 and 4.1.2*.

3 CONCLUSIONS

3.1 FINDINGS[18]

1. AIRCRAFT

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

b) The aircraft was certified as being airworthy when dispatched for the flight.

c) The mass and the centre of gravity of the aircraft were not factors in this accident.

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

e) All control surfaces were accounted for, and damage to the aircraft was attributable to the severe impact forces.

f) The aircraft was destroyed by impact forces.

g) The aircraft was not fitted with an Emergency Locator Transmitter.

h) The aircraft had enough fuel for the duration of the flight.

i) The aircraft was equipped with both VHF and HF radio transmitters.

2. CREW / PILOTS

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

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

3. FLIGHT OPERATIONS

a) During flight the pilot encountered adverse weather conditions (cloud, rain and fog).

b) The pilot continued visual flight in adverse weather conditions, descending from the cruise altitude to low altitude probably to maintain or regain visual reference.

c) Reduced visibility may have affected the pilot's ability to identify obstacles on the aircraft trajectory when flying low.

4. OPERATOR

a) RAIL's *Standard Operating Procedures Manual* did not contain specific information pertinent to weather.

b) RAIL did not have a *Safety Management Systems Manual* as per *CAR Part 100.*

5. FLIGHT RECORDERS

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

6. MEDICAL

18 Findings are not listed in an order of hierarchy or importance.

d) There was no evidence that incapacitation or physiological factors affected the pilot's performance.

e) There was no evidence that the pilot suffered any sudden illness or incapacity which might have affected his/her ability to control the aircraft.

f) Based on the autopsy, toxicology, and medical reports, there was no evidence to indicate that the pilot's performance was degraded by physiological factors.

7. SURVIVABILITY

a) The accident was not survivable due to the magnitude of the deceleration forces.

b) The fatally injured pilot was wearing a seatbelt at the time of the impact. He sustained traumatic head injuries.

8. SAFETY OVERSIGHT

a) CASA PNG did not detect safety deficiencies in the operator's *Standard Operating Procedures Manual*

b) CASA PNG did not have records of the pilot from 2013 thereafter.

3.2 CAUSES [CONTRIBUTING FACTORS]

The weather conditions in the accident area included torrential rain, cloud and fog. Visibility was poor.

The pilot obtained weather information from local contacts which was not an approved source as per RAIL *Standard Operating Procedures* (SOP). Furthermore, while enroute, the weather deteriorated and the pilot inadvertently flew into cloud, rain and fog.

The pilot flew at very low altitude in adverse weather conditions, likely to maintain or regain visual reference and subsequently impacted trees.

3.3 OTHER FACTORS

This is used for safety deficiencies or concerns that are identified during the course of the investigation that while not causal to the accident, nevertheless should be addressed with the aim of accident prevention.

The investigation found a number of non-contributory safety deficiencies. These are addressed in Part 1 *Factual* and Part 4 *Safety actions and recommendations*.

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 SAFETY ACTION

To the date of closure of this investigation, no information about safety actions developed by the parties has been reported to the AIC.

4.2 Recommendations

4.2.1 Safety recommendation: AIC 20-R6/19-1002 SOP inconsistencies with CAR Part 91

On **13/07/20**, the PNG AIC issued the following recommendation:
The PNG Accident Investigation Commission recommends that Ramu Agri Industries Limited, should ensure that:

Section 3 of the *Standards Operating Procedures Manual* is amended to include a sub-section that provides guidance to pilots pertaining to VFR meteorological minima to ensure pilots are provided with the standards as per *CAR Part 91.301* that will ensure ***essential flight crew actions during planning***.

Action requested

The Accident Investigation Commission requests that Ramu Agriculture Limited note recommendation *AIC 20-R6/19-1002*, and provide a response to the PNG AIC within 90 days, but no later than **11/10/20**, and explain including with evidence how Ramu Agriculture Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 20-R6/19-1002*

Status of the AIC Recommendation: Open

4.2.2 Safety recommendation: AIC 20-R7/19-1002 Establishment and implementation of Safety Management System

On **13/07/20**, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that CASA PNG, should ensure that RAIL establishes and implements a Safety Management System for its aircraft operations meets the requirements of *CAR Part 100* pursuant to *CAR Part 119*.

Action requested

The Accident Investigation Commission requests that CASA PNG note recommendation *AIC 20-R7/19-1002*, and provide a response to the PNG AIC within 90 days, but no later than **11/10/20**, and explain including with evidence how Ramu Agriculture Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 20-R7/19-1002*

Status of the AIC Recommendation: Open

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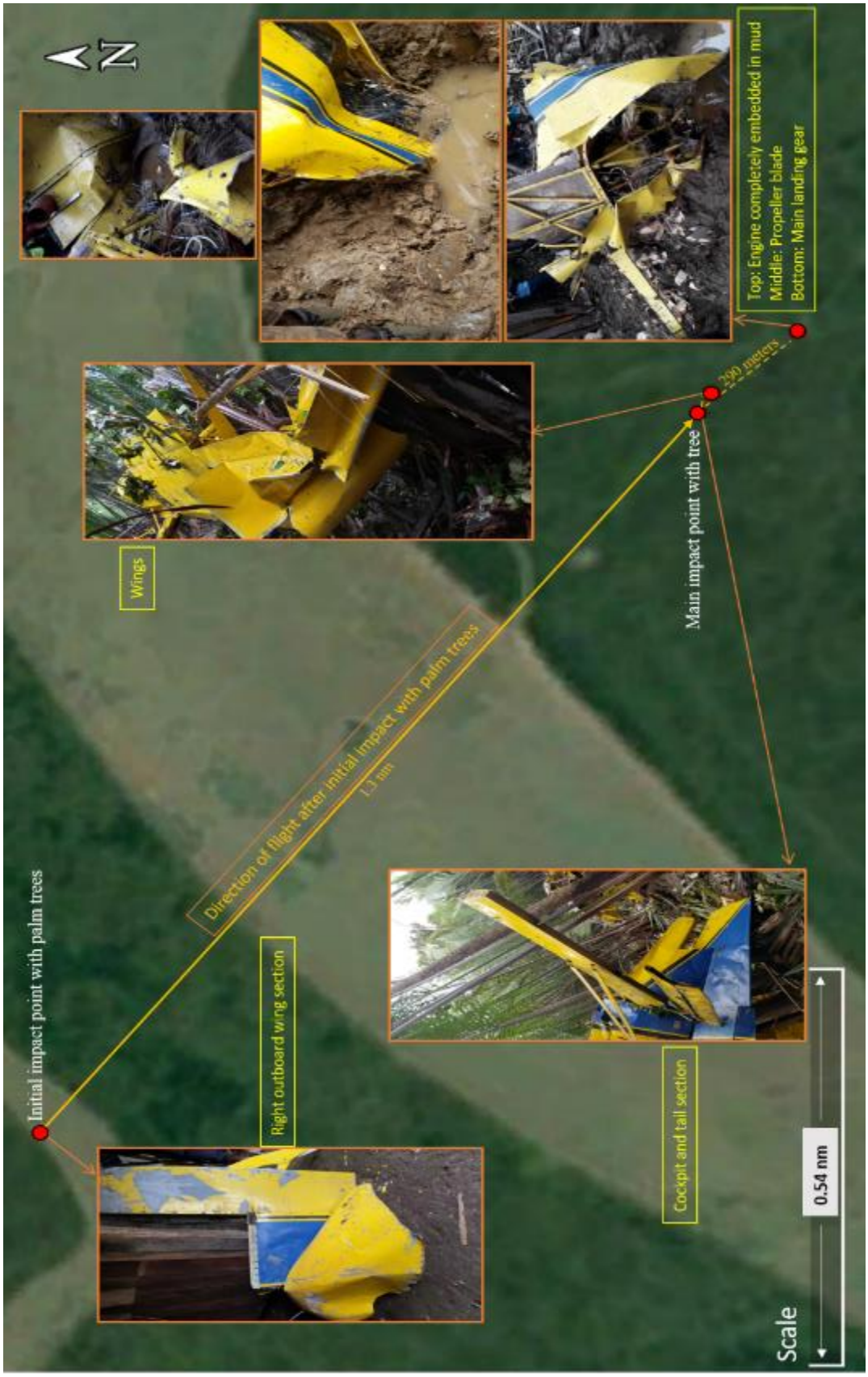
5 APPENDICES

5.1 Appendix B: Wreckage diagram



5.2 Aircraft Registry Directory (current at the time of accident)

REG	MAKE	MODEL	SERIES	MSN	OPERATOR_NAME	OPERATOR_ADDRESS
P2-SBB	BRITTEN NORMAN	BN2T	T	880	SUNBIRD AVIATION LTD	PO BOX 205, VANIMO, SANDAUN PROVINCE
P2-SBC	BRITTEN NORMAN	BN2T	T	3010	SUNBIRD AVIATION LTD	P.O.BOX 205, VANIMO, SANDAUN PROVINCE, PAPUA NEW GUINEA
P2-SDC	PAC	750XL	750	177	ADVENTIST AVIATION SERVICES	PO BOX 301, GOROKA 441 EASTERN HIGHLANDS PROVINCE
P2-SDF	PAC	750XL	750	188	ADVENTIST AVIATION SERVICES	PO BOX 301, GOROKA 441 EASTERN HIGHLANDS PROVINCE
P2-SEQ	CESSNA	185	100	185-0429	JAMES E BLUME	PO BOX 73 WAU 422 MOROBE PROVINCE
P2-SET	AIR TRACTOR	AT502	B50	502B-0255	MORESBY AVIATION	PO BOX 633 PORT MORESBY NATIONAL CAPITAL DISTRICT
P2-HCO	BELL	206	400	51178	HEVILIFT AVIATION LTD	P.O.BOX 1197, MT HAGEN WHP 281, PAPUA NEW GUINEA
P2-SIB	QUEST	KODIAK100	100	100-0008	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP,PNG
P2-SID	QUEST	KODIAK100	100	100-0048	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP,PNG
P2-SIH	BELL	206	206	51156	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP,PNG
P2-SIL	Bell	206	L3	51511	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP 444,PNG
P2-SIR	QUEST	KODIAK100	100	100-0038	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP,PNG
P2-SIT	QUEST	KODIAK100	100	100-0077	SUMMER INSTITUTE OF LINGUISTICS AVIATION	PO BOX 1(402), UKARUMPA, EHP,PNG
P2-SJC	KAWASAKI	BK117	B1	1027	PACIFIC RIM AIR SERVICES	P.O.BOX 5925 BOROKO NCD,PNG

5.3 Appendix C: SAR events

Time (LMT)	PNGASL FIS/ARCC	NMSA MRCC
09:40	P2-SET departed DARU for GUSAP on HF radio and on Ops normal calls (every 30 mins) cruising altitude 9000ft AMSL.	
10:11	P2-SET reported Ops normal cruising altitude 9000ft – next ops normal call 10:45am.	
10:45	P2-SET failed to report ops normal. Moresby FIS unit carried normal radio communication checks and with adjacent ATS units.	
11:10	UNCERTAINTY PHASE declared.	
13:10	Phase upgraded to ALERT PHASE before upgraded to the DISTRESS PHASE. Aviation RCC activated. Continuing attempts on coordination with relevant agencies and airlines companies to assist in locating aircraft: Marine RCC (NMSA), Summer Institute of Linguistics (SIL), Airport Cooperation Daru, Kerema.	
14:10	Advised of overdue aircraft P2-SET enroute Daru – Gusap. Failure to report operations normal at 10:45 am. ALERFA current. Contact from aircraft owner in Cairns enquiring on status of the aircraft. Advised that the aircraft was not carrying an ELT.	
14:13	Unable to contact anyone at Gusap to check on arrival to check on aircraft arrival. Continuing attempts.	
14:15	Attempting to contact NAC personnel at Daru to check on aircraft return.	
14:22	DETRESFA declared. RCC Activated.	
14:30	Plotted aircrafts flight plan route and estimated last known position.	
14:41	Called NAC personnel for Daru NAC updated contacts – contacts provided.	
14:49	Checking with personnel at Kikori to establish if the aircraft diverted.	
15:05	Called Ramu again to confirm the arrival of the aircraft-Nil response.	Called for JRCC Aus & asked – MRCC was aware of an aircraft crash whilst enroute Daru for Gusap in the Morobe Province. Informed JRCC was not aware & will follow up with Center Supervisor ATS, Jax. JRCC informed

		that aircraft failed 2nd radio attempt and that Distress Phase was declared. JRCC asked who had coordination and was informed ARCC or ARS had coordination. JRCC asked whether they should deploy a Search aircraft & was fully supported by PNGMRCC.
15:10	Called Ramu again to confirm the arrival of the aircraft – Nil response.	
15:15	Contacted Ramu Agri Industries and established that the aircraft had not arrived.	
15:25		Called Centre Supervisor ATS for info and only confirmed info received from JRCC. Thus, informed Centre Supervisor that spoke to JRCC Aus and that they were in the process of activating a Rescue a/c to assist in search.
15:26	Called Kikori District office – Nil response. Called Baimuru Contacts – Nil response.	
15:38	Called NMSA and advised of the distress situation. MRCC personnel had prior knowledge/information as advised by Centre Supervisor (CS), and further mentioned that the arrangement was in place for JRCC's assistance to conduct search (JRCC's contact).	
15:40	Contact from aircraft owner – will fund search aircraft. In contact with Tropic Air.	
15:46	Called DoT to obtain the assurance on funding aspect of possible Search and Rescue aircraft – Nil response.	
15:49	Provided an update to the ARCC team on the JRCC arrangement – 2 hours arrival time at the search area/commence search point (CSP). The possibility in conducting visual search along the aircraft's route.	
15:51	Considering the amount of remaining sunlight, and the arrival time (2hrs) of JRCC's search aircraft, the plan was underway to seek approval from Tropic Air to arrange and commence a visual search along the aircraft's route.	
16:00	Call Summer Institute of Linguistics (SIL) Aviation enquiring on the possible contacts for Kikori and nearby locations and also for aircraft hearing/sighting reports etc.	Inform by CC that a possible crash had occur. Called GFM Marine to ask them to ask them to advice swift No 1+ 9 & report back on possible slightly of the describe aircraft in their vicinity.
16:05	Call Gulf Provincial Administration – Nil response.	
16:08	Called Airport Safety Officer -Kerema – Nil response.	

16:21	Called Airport safety Officer, Kerema again – responded and advised of the weather condition (heavy rain within Kikori) and also provided distorted Information (from Kikori locals) on the sighting of aircraft descending in Sago Palms.	
16:30		RPNG water Police called to seek information whether MRCC was in the area of the SAR incident of the missing aircraft. Also informed MRCC that Police had communicated in the process of communicating with their field officers. Updated each other on possible crash site & agreed to await further & more updated info for CC ATS. Water police called to touch base. JRCC Aus also advised of Rescue R550 to be in the AO in 2 hours.
16:34	Information from Tropic Air that their agent in Kikori heard aircraft having faulty engine and landed at the nearby airstrip.	
16:46	Tropic Air mentioned that the crash of the aircraft was near Teradau, as per information from their agent in Kikori.	
16:52	Tropic Air advised that the pilot was still alive-Teradau.	
16:59	Initial Notification of Incidents (INI) raised.	Emailed JRCC & informed them of latest development of possible crash location at Tetehim, approx. 24 km NW of Baimuru. More info to follow.
17:02	Tropic Air confirmed the crash site near Ketati, pilot's condition was unknown and that the Health Centre from within deployed a team to crash site.	
17:12	Tropic Air advised that the locals had located the aircraft's wing and the pilot's shirt within Karauti station area.	
17:15		Msge by CC ATS that information received that ground party are proceeding to possible crash site.
17:16	AIC personnel called for update	
17:22	Called police hierarchy. He mentioned that he will relay messages to appropriate Police personnel including Airborne Unit.	
17:36	Provided update to NMSA and also advised him to further relay same update to JRCC considering the initial arrangement in place.	
17:39		Informed by JRCC Aus through email of ground party heading to locate possible crash

		site. JRCC called to inform MRCC that R550 was diverted to possible crash site to try & pinpoint impact location or main wreckage location.
17:51	Tropic Air called advising on former Member of Parliament (from Kikori) organising search party. Possible crash site was near Era River.	
17:56	Police Hierarchy called and advised the ARCC Team that the arrangement was underway for the police personnel travel to the crash site with the Tropic Air Team (ETD 30/08/2019).	
17:59	AIC personnel called for further clarification/information on the distress situation and location.	
18:00		Called center Supervisor to check for updates. No updates given. Briefed incoming night shift and dismounted.
18:14	the RPNGC called and advised that Police Personnel have planned to travel to crash site (ETD 30/08/19)	
18:55	Called Tropic Air for further updates, no updates.	
19:00	Standing down of ARCC for the day's operation. To be resumed the next day 30/08/2019.	