



**FINAL REPORT**

**AIC 18-1004**

**AIR NIUGINI LIMITED**

**P2-PXE**

**Boeing 737-8BK**

**Chuuk Lagoon, 1,500 ft (460 m) before the runway 04 threshold**

**Chuuk State**

**FEDERATED STATES OF MICRONESIA**

**28 September, 2018**



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## ABOUT THE AIC

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The Papua New Guinea Accident Investigation Commission (AIC) was informed by Air Niugini Limited on 28 September 2018, of an accident involving a Boeing 737-8BK aircraft, registered P2-PXE, operated by Air Niugini Limited. The aircraft was on a scheduled passenger flight, number PX073, from Pohnpei to Chuuk, Federated States of Micronesia (FSM).

At 23:24:19 UTC<sup>1</sup> (09:24 local time) the aircraft impacted the water of the Chuuk Lagoon about 1,500 ft (460 m) short of the runway 04 threshold, during its final approach to land on runway 04 at Chuuk International Airport.

The AIC immediately contacted the Division of Civil Aviation, FSM and appointed an Accredited Representative and Adviser from the PNG Accident Investigation Commission in accordance with *Annex 13* to the *Convention on International Civil Aviation*. The AIC team arrived at Chuuk at 08:00 local time on 29 September, and immediately commenced interviewing surviving passengers and the crew under delegation of the FSM investigator in charge. The AIC played a pivotal role in the investigation and conducted the download, replay and analysis of Flight Data and Cockpit Voice recorder data and information in the AIC's Flight Recorder Laboratory in Port Moresby, PNG. The US National Transportation Safety Board also appointed an Accredited Representative and Advisers from the US Federal Aviation Administration and Boeing. The NTSB team assisted with the download of data from the Enhanced Ground Proximity Warning System. The readout of the damaged AFIRS system was conducted by the Transportation Safety Board of Canada.

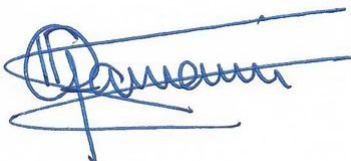
On 14 February 2019, the FSM Government delegated the whole of the investigation to the PNG AIC in accordance with *Para 5.1* of *ICAO Annex 13*, which obligates the State accepting the delegation to conduct the investigation including the issuance of the *Final Report* and the *Accident and Serious Incident Reporting (ADREP)* data.

This *Final Aircraft Accident Investigation Report* was produced by the AIC, PO Box 1709, Boroko 111, NCD, Papua New Guinea. It is publicly released by the Commission in accordance with *Para 6.5* of *ICAO Annex 13*. The report is published on the AIC website: [www.aic.gov.pg](http://www.aic.gov.pg).

The report is based on the 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.

The sole objective of the investigation and the *Final Report* is the prevention of accidents and incidents, and thereby promote aviation safety. (Reference: *ICAO Annex 13, Chapter 3, paragraph 3.1.*). Readers are advised that in accordance with *Section 219* of the *Civil Aviation Act 2000 (as amended)* and *Annex 13*, it is not the purpose of the Commission's aircraft accident investigation to apportion blame or liability. Fact based statements in the report should not be interpreted as apportioning blame.

Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose. When the AIC makes recommendations as a result of its investigations or research, safety is its primary consideration.



**Hubert Namani, LLB**  
**Chief Commissioner**

**15<sup>th</sup> July 2019**

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<sup>1</sup> 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/Chuuk Time is UTC + 10 hours.



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# TABLE OF CONTENTS

---

SYNOPSIS.....	xiii
<b>1 Factual Information .....</b>	<b>1</b>
1.1 History of the flight.....	1
1.1.1 Actual flight profile .....	4
1.1.2 Use of Electronic Flight Bag .....	5
1.2 Injuries to persons .....	5
1.3 Damage to aircraft.....	6
1.4 Other damage ... ..	7
1.5 Personnel information .....	7
1.5.1 Pilot in command ... ..	7
1.5.1.1 Route currency .....	7
1.5.2 Copilot .....	7
1.5.3 Cabin crew (CC1) Purser.....	8
1.5.4 Crew duty rest .....	8
1.6 Aircraft information .....	9
1.6.1 Aircraft data .....	9
1.6.2 Engine data .....	9
1.6.3 Weight and balance .....	10
1.6.4 Fuel .....	10
1.6.5 Aircraft serviceability .....	10
1.7 Meteorological information .....	10
1.7.1 Chuuk Terminal Aerodrome Forecast .....	10
1.7.2 Chuuk Airport Radio broadcast weather information.....	10
1.8 Aids to navigation .....	11
1.8.1 Published (Approved) Instrument Approaches.....	11
1.8.1.1 Route Guide briefing .....	12
1.8.2 TKK(CHUUK) Navigation aid serviceability .....	13
1.9 Communications .....	13
1.10 Aerodrome information.....	13
1.10.1 Runway End Safety Area (RESA).....	14
1.10.2 Precision Approach Path Indicator (PAPI).....	15
1.10.3 Airport Emergency Plan Manual .....	15
1.10.4 Rescue and fire fighting.....	17
1.11 Flight recorders .....	17
1.11.1 Solid State Flight Data Recorder (SSFDR) .....	18
1.11.2 Solid State Cockpit Voice Recorder (SSCVR).....	20
1.11.3 Other electronic components providing recorded data .....	21
1.11.4 Enhanced Ground Proximity Warning System (EGPWS).....	21

1.11.5	EGPWS Glideslope alerts during the previous sector Chuuk to Pohnpei flight PX 072 on 27 September 2018 .	25
1.12	Wreckage and impact information	25
1.13	Medical and pathological information	27
1.14	Fire	28
1.15	Survival aspects	28
1.15.1	The occupants	28
1.15.2	Life rafts	30
1.15.3	On-board passenger safety briefing	31
1.15.4	Life raft locations in P2-PXE	31
1.15.5	Procedures for egress after ditching	33
1.15.6	Passenger and crew egress	33
1.15.6.1	Cabin Crew evacuation commands	35
1.15.7	Exits and passengers in exit row	35
1.15.8	Emergency Exit Lights	35
1.15.9	Rescue coordination centre (RCC)	37
1.16	Tests and research	37
1.17	Organisational and management information	37
1.17.1	Aircraft Owner : Loftlieder / Icelandic	37
1.17.2	Aircraft Operator : Air Niugini Limited	37
1.17.3	Runway End Safety Area	40
1.17.4	Civil Aviation Safety Authority of PNG	40
1.18	Additional Information	41
1.18.1	Flight Operations	41
1.18.1.1	Crew use of unapproved Electronic Flight Bag	41
1.18.1.2	Challenge and response	42
1.18.1.3	Crew Simulator Training	43
1.18.1.4	Integrated Augmented Navigation System	44
1.18.2	Cabin Safety	44
1.18.2.1	Cabin Crew Requirements	44
1.18.2.2	Life Jackets (Cabin Crew & Passenger)	45
1.18.2.3	Fasten seatbelt sign and announcement	46
1.19	Useful or effective investigation technique	46
<b>2</b>	<b>ANALYSIS</b>	<b>47</b>
2.1	General	47
2.2	Use of an unapproved EFB OPT	47
2.3	Flight crew actions	48
2.3.1	Human Factors and medical	49
2.4	Enhanced Ground Proximity Warning System (EGPWS)	50
2.4.1	Previous sector Chuuk to Pohnpei flight PX 072	51
2.5	Survival	51

2.6	Fuel requirements.....	52
2.7	Operational risk assessments – Air Niugini Limited .....	52
2.8	Cockpit image recording .....	52
2.9	Civil Aviation Safety Authority of PNG.....	53
<b>3</b>	<b>CONCLUSIONS .....</b>	<b>55</b>
3.1	FINDINGS .....	55
3.2	CAUSES [CONTRIBUTING FACTORS].....	58
3.3	OTHER FACTORS .....	58
3.4	US NTSB STATE OF MANUFACTURE CONCLUSIONS.....	58
<b>4</b>	<b>SAFETY ACTIONS AND RECOMMENDATIONS.....</b>	<b>61</b>
4.1	SAFETY ACTION .....	61
4.2	Recommendations.....	63
4.2.1	Recommendation AIC 18-R04/18-1004 to Air Niugini Limited.....	63
4.2.2	Recommendation number AIC 19-R01/18-1004 to Air Niugini Limited.....	65
4.2.3	Recommendation number AIC 19-R02/18-1004 to Honeywell Aerospace .....	65
4.2.4	Recommendation number AIC 19-R03/18-1004 to Air Niugini Limited.....	67
4.2.5	Recommendation number AIC 19-R04/18-1004 to Air Niugini Limited.....	67
4.2.6	Recommendation number AIC 19-R05/18-1004 to Air Niugini Limited.....	68
4.2.7	Recommendation number AIC 19-R06/18-1004 to Air Niugini Limited.....	69
4.2.8	Recommendation number AIC 19-R07/18-1004 to Air Niugini Limited.....	70
4.2.9	Recommendation number AIC 19-R08/18-1004 to Federated States of Micronesia, Division of Civil Aviation. ....	71
4.2.10	Recommendation number AIC 19-R09/18-1004 to Air Niugini Limited.....	72
4.2.11	Recommendation number AIC 19-R10/18-1004 to Air Niugini Limited.....	73
4.2.12	Recommendation number AIC 19-R11/18-1004 to Air Niugini Limited.....	74
4.2.13	Recommendation number AIC 19-R12/18-1004 to Air Niugini Limited.....	74
4.2.14	Recommendation number AIC 19-R13/18-1004 to Civil Aviation Safety Authority of PNG .....	75
4.2.15	Recommendation number AIC 19-R14/18-1004 to Air Niugini Limited.....	76
4.2.16	Recommendation number AIC 18-R17/18-1004 to US Federal Aviation Administration (FAA) .....	77
4.2.17	Recommendation number AIC 19-R18/18-1004 to Jeppesen .....	78
<b>5</b>	<b>APPENDICES.....</b>	<b>79</b>
5.1	APPENDIX A: Air Niugini Standard Operating Procedures.....	79
5.1.1	Operation below MDH, or MDA.....	79
5.1.2	Air Niugini stabilised approach procedure .....	79
5.1.3	Missed approach procedure .....	79
5.1.4	Go Around Policy .....	80
5.1.5	Stabilised Constant Descent Profile.....	80
5.1.6	Stabilised Approach (Improved Procedure).....	80

5.1.7	Aviation industry stabilised approach recommendations .....	81
5.1.8	Monitoring and Crosschecking.....	82
5.2	APPENDIX B: Crew Resource Management.....	83
5.2.1	Air Niugini's Crew Resource Management (CRM) .....	83
5.3	APPENDIX C: Cabin Crew information .....	84
5.3.1	Cabin crew (CC2) Senior Economy Cabin.....	84
5.3.2	Cabin crew (CC3) ... ..	84
5.3.3	Cabin crew (CC4) Under training.....	85
5.3.4	Cabin crew (CC5) ... ..	85
5.3.5	Cabin crew (CC6) Trainer .....	86
5.3.6	Cabin crew (CC7) Check staff.....	86
5.3.7	Cabin crew (CC8) Observing check staff .....	87
5.4	APPENDIX D: Cabin Safety .....	88
5.4.1	Emergency Exit Lights .....	88
5.4.2	Over wing Exit Passenger briefing Card .....	89
5.4.3	Air Niugini <i>SEPM Vol 6, Section 2.14.4.2 – Evacuation drills – Ditch with life raft.</i> .....	90
5.5	APPENDIX E: RNAV (GPS) Approach chart briefings .....	91
5.5.1	PTKK RNAV (GPS) Rwy 4.....	91
5.5.2	PTPN RNAV (GPS) Rwy 9.....	93
5.5.3	Jeppesen chart briefing (Air Niugini SOPM – Section 11.9) .....	95
5.6	APPENDIX F: Precision Approach Path Indicator (PAPI) .....	97
5.7	APPENDIX G: FDR/AFIRS Derived Data .....	98
5.8	APPENDIX H: TSO-151b, Alert Prioritisation Scheme .....	101
5.9	APPENDIX I: Data retrieval and flight animation .....	102

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## FIGURES

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Figure 1: Depiction of aircraft in relation to Chuuk International Airport runway 04 threshold. ....	1
Figure 2: Passenger seating allocation showing injury status.....	6
Figure 3: RNAV Chart placed between the Flight Management Computer (FMC) screens.....	11
Figure 4: <i>PTKK RNAV (GPS) Runway 04</i> .....	12
Figure 5: <i>PTKK/TKK (CHUUK) Aerodrome Chart</i> .....	14
Figure 6: FDR data plot.....	18
Figure 7: Diagram showing glidepath deviation .....	19
Figure 8: EGPWS recorder being brought to the surface by the diver .....	22
Figure 9: PFD and NAV display showing weather and missed approach track.....	22
Figure 10: Passing 370 ft on descent. Showing <b>PULL UP</b> on <i>PFD</i> display.....	23
Figure 11: PFD display showing location of aircraft with reference to the localiser (Loc) and glideslope (GS) indicators. ....	23
Figure 12: One second before impact. Showing <b>PULL UP</b> on <i>PFD</i> display .....	24
Figure 13: Glideslope and Sink Rate aural alerts graphic plotted using Derived Data .....	24
Figure 14: In the area of seat row 22. <b>A</b> Fuselage fracture left side and behind the wing. <b>B</b> Upper fuselage fracture behind wing. <b>C</b> Rear fuselage fracture behind wings.....	25
Figure 15: Fuselage fracture right side behind the wing at wing root, in the area of seat row 22.....	26
Figure 16: Fuselage fracture right side behind the wing showing wing flap separation .....	26
Figure 17: Nose landing gear assembly.....	26
Figure 18: Nose landing gear assembly looking into the landing gear bay .....	26
Figure 19: Right engine attached to wing pylon.....	27
Figure 20: Left engine attached to wing pylon.....	27
Figure 21: Passenger and crew evacuation diagram.....	29
Figure 22: 56-person life raft cover on the floor in front of Business Class Seats 1A and 1B.....	31
Figure 23: Safety on Board Card (Version PX3-11009 Rev.A) Incorrect depiction.....	31
Figure 24: Diagram modified from Air Niugini SEPM – Volume 6 (B737) Section 3.2.2.....	32
Figure 25: Load master getting into a rescue boat with baggage taken from the aircraft, both hands full.....	33
Figure 26: The first passenger exiting via the right aft over-wing exit after passing a bag to US Navy diver who threw it to divers in the boat. ....	34

Figure 27: US Navy diver cautioning not to go aft due unknown water depth .....	34
Figure 28: Cockpit Overhead Panel Emergency Light switch .....	36
Figure 29: P2-PXE Cockpit Overhead Panel Emergency Light switch during the approach.....	36
Figure 30: Aft Attendant Panel Emergency Light switch.....	36
Figure 31: Cabin crew seating configuration Air Niugini Boeing 737-800 aircraft.....	45
Figure 32: Derived Data plotted against Honeywell EGPWS MK V Mode 1 Graph .....	51
Figure 33: Boeing 737-800 Safety on Board card (Version <i>PX3-11009 Rev.B</i> ) .....	64
Figure 34: Boeing 737-700 Safety on Board card (Version <i>PX3-11001 Rev. D</i> ).....	64
Figure 35: Air Niugini's Boeing B737, P2-PXE Emergency exit lighting.....	88
Figure 36: A scanned copy of the Passenger Safety Briefing Card.....	89
Figure 37: <i>Air Niugini Safety and Emergency Procedures Manual (SEPM) volume 6, section 1.14.4.2</i> .....	90
Figure 38: PIC's brief on the <i>PTKK RNAV (GPS) Rwy 4</i> approach chart.....	91
Figure 39: Required approach chart briefing as per <i>Air Niugini SOPM</i> .....	92
Figure 40: PIC's brief on the <i>PTPN RNAV (GPS) Rwy 9</i> approach chart .....	93
Figure 41: Required approach chart briefing as per <i>Air Niugini SOPM</i> .....	94
Figure 42: Excerpt from <i>Air Niugini SOPM, Section 11.9</i> .....	95
Figure 43: PAPI lights indicating profile if flown against 3-deg flightpath. ....	97
Figure 44: PXE flight profile at the MDA on approach to land .....	97
Figure 45: FDR Data plot .....	98
Figure 46: Glideslope and Sink Rate aural alerts graphic using derive data .....	99
Figure 47: Pohnpei approach flight path .....	100
Figure 48: TSO-151b, Alert Prioritisation Scheme .....	101
Figure 49: SSFDR memory chip board connected to Memory Access Retrieval System (MARS).....	102
Figure 50: Flight animation from recorded data and cockpit image recording (video) lower right .....	102

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## TABLES

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Table 1: Injuries to persons .....	5
Table 2: Excerpts of the transcript from the CVR, 19 seconds prior to impact.....	21
Table 3: Description of the PFD displays in Figure 11.....	23
Table 4: TSO-151b, Alert Prioritisation Scheme .....	103



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## SYNOPSIS

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On 28 September 2018, at 23:24:19 UTC<sup>2</sup> (09:24 local time), a Boeing 737-8BK aircraft, registered P2-PXE (PXE), operated by Air Niugini Limited, was on a scheduled passenger flight number PX073, from Pohnpei to Chuuk, in the Federated States of Micronesia (FSM) when, during its final approach, the aircraft impacted the water of the Chuuk Lagoon, about 1,500 ft (460 m) short of the runway 04 threshold.

The aircraft deflected across the water several times before it settled in the water and turned clockwise through 210 deg and drifted 460 ft (140 m) south east of the runway 04 extended centreline, with the nose of the aircraft pointing about 265 deg.

The pilot in command (PIC) was the pilot flying, and the copilot was the support/monitoring pilot. An Aircraft Maintenance Engineer<sup>3</sup> occupied the cockpit jump seat. The engineer videoed the final approach on his iPhone, which predominantly showed the cockpit instruments.

Local boaters rescued 28 passengers and two cabin crew from the left over-wing exits. Two cabin crew, the two pilots and the engineer were rescued by local boaters from the forward door 1L. One life raft was launched from the left aft over-wing exit by cabin crew CC5 with the assistance of a passenger. The US Navy divers rescued six passengers and four cabin crew and the Load Master from the right aft over-wing exit. All injured passengers were evacuated from the left over-wing exits. One passenger was fatally injured, and local divers located his body in the aircraft three days after the accident.

The Government of the Federated States of Micronesia commenced the investigation and on 14<sup>th</sup> February 2019 delegated the whole of the investigation to the PNG Accident Investigation Commission.

The investigation determined that the flight crew's level of compliance with *Air Niugini Standard Operating Procedures Manual (SOPM)* was not at a standard that would promote safe aircraft operations.

The PIC intended to conduct an RNAV GPS approach to runway 04 at Chuuk International Airport and briefed the copilot accordingly. The descent and approach were initially conducted in Visual Meteorological Conditions (VMC), but from 546 ft (**600 ft**)<sup>4</sup> the aircraft was flown in Instrument Meteorological Conditions (IMC).

The flight crew did not adhere to *Air Niugini SOPM* and the approach and pre-landing checklists. The *RNAV (GPS) Rwy 04 Approach chart* procedure was not adequately briefed.

The RNAV approach specified a flight path descent angle guide of 3°. The aircraft was flown at a high rate of descent and a steep variable flight path angle averaging 4.5° during the approach, with lateral over-controlling; the approach was unstabilised.

The Flight Data Recorder (FDR) recorded a total of 17 Enhanced Ground Proximity Warning System (EGPWS) alerts, specifically eight “Sink Rate” and nine “Glideslope”. The recorded information from the Cockpit Voice Recorder (CVR) showed that a total of 14 EGPWS aural alerts sounded after passing the Minimum Descent Altitude (MDA), between 307 ft (**364 ft**) and the impact point. A “100 ft” advisory was annunciated, in accordance with design standards, overriding<sup>5</sup> one of the “Glideslope” aural alert. The other aural alerts were seven “Glideslope” and six “Sink Rate”.

The investigation observed that the flight crew disregarded the alerts, and did not acknowledge the “minimums” and 100 ft alerts; a symptom of fixation and channelised attention. The crew were fixated on cues associated with the landing and control inputs due to the extension of 40° flap.

Both pilots were not situationally aware and did not recognise the developing significant unsafe condition during the approach after passing the Missed Approach Point (MAP) when the aircraft entered a storm cell and heavy rain. The weather radar on the PIC's Navigation Display showed a large red area indicating a storm cell immediately after the MAP, between the MAP and the runway.

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<sup>2</sup> 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/Chuuk Time is UTC + 10 hours.

<sup>3</sup> The aircraft was leased from Loftliedier / Icelandic. The leasing company employed an engineer to be on each flight for maintenance support at ports outside PNG.

<sup>4</sup> First reference is Pressure altitude with corresponding reference to Radio Altitude in *italics* and **bolded** brackets.

<sup>5</sup> Altitude callouts have priority over Glideslope.

The copilot as the support/monitoring pilot was ineffective and was oblivious to the rapidly unfolding unsafe situation. He did not recognise the significant unsafe condition and therefore did not realise the need to challenge the PIC and take control of the aircraft, as required by the *Air Niugini SOPM*<sup>6</sup>.

The *Air Niugini SOPM* instructs a non-flying pilot to take control of the aircraft from the flying pilot, and restore a safe flight condition, when an unsafe condition continues to be uncorrected.

The records showed that the copilot had been checked in the Simulator for EGPWS Alert (Terrain) however there was no evidence of simulator check sessions covering the vital actions and responses required to retrieve a perceived or real situation that might compromise the safe operation of the aircraft. Specifically sustained unstabilised approach below 1,000 ft amsl in IMC.

The PIC did not conduct the missed approach at the MAP despite the criteria required for visually continuing the approach not being met, including visually acquiring the runway or the PAPI.

The PIC did not conduct a go around after passing the MAP and subsequently the MDA although:

- The aircraft had entered IMC;
- the approach was unstable;
- the *glideslope indicator* on the *Primary Flight Display (PFD)* was showing a rapid glideslope deviation from a half-dot low to 2-dots high within 9 seconds after passing the MDA;
- the rate of descent high (more than 1,000 ft/min) and increasing;
- there were EGPWS *Sink Rate* and *Glideslope* aural alerts; and
- the EGPWS visual **PULL UP** warning message was displayed on the *PFD*.

The report highlights that deviations from recommended practice and *SOPs* are a potential hazard, particularly during the approach and landing phase of flight, and increase the risk of approach and landing accidents. It also highlights that crew coordination is less than effective if crew members do not work together as an integrated team. Support crew members have a duty and responsibility to ensure that the safety of a flight is not compromised by non-compliance with *SOPs*, standard phraseology and recommended practices.

The investigation found that the Civil Aviation Safety Authority of PNG (CASA PNG) policy and procedures of *accepting* manuals rather than *approving* manuals, while in accordance with the *Civil Aviation Rules* requirements, placed a burden of responsibility on CASA PNG as the State Regulator to ensure accuracy and that safety standards are met.

In *accepting* the Air Niugini manuals, CASA PNG did not meet the high standard of evidence-based assessment required for safety assurance, resulting in numerous deficiencies and errors in the Air Niugini Operational, Technical, and Safety manuals as noted in this report and the associated Safety Recommendations.

The report includes a number of recommendations made by the AIC, with the intention of enhancing the safety of flight (See *Part 4* of this report). It is important to note that none of the safety deficiencies brought to the attention of Air Niugini caused the accident. However, in accordance with *Annex 13 Standards*, identified safety deficiencies and concerns must be raised with the persons or organisations best placed to take safety action. Unless safety action is taken to address the identified safety deficiencies, death or injury might result in a future accident.

The AIC notes that Air Niugini Limited took prompt action to address all safety deficiencies identified by the AIC in the 12 *Safety Recommendations* issued to Air Niugini, in an average time of 23 days. The quickest safety action being taken by Air Niugini was in 6 days. The AIC has closed all 12 *Safety Recommendations* issued to Air Niugini Limited.

One safety concern prompting an *AIC Safety Recommendation* was issued to Honeywell Aerospace and the US FAA. The safety deficiency/concern that prompted this *Safety Recommendation* may have been a contributing factor in this accident. The PNG AIC is in continued discussion with the US NTSB, Honeywell, Boeing and US FAA. This recommendation is the subject of ongoing research and the *AIC Recommendation* will remain ACTIVE pending the results of that research.

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6 *SOPM: Standard Operating Procedures Manual*

# 1 FACTUAL INFORMATION

## 1.1 History of the flight

On 28 September 2018, at 23:24:19 UTC<sup>7</sup> (09:24 local time), a Boeing 737-8BK aircraft, registered P2-PXE (PXE), operated by Air Niugini Limited, was on a scheduled passenger flight (number PX073), from Pohnpei to Chuuk, in the Federated States of Micronesia (FSM) when, during its final approach, the aircraft impacted the water of the Chuuk Lagoon, about 1,500 ft (460 m) short of the runway 04 threshold.

The aircraft deflected across the water several times before it settled in the water and turned clockwise through 210 deg and drifted 460 ft (140 m) south east of the runway 04 extended centreline, with the nose of the aircraft pointing about 265 deg.



**Figure 1: Depiction of aircraft in relation to Chuuk International Airport runway 04 threshold.**

There were 12 crew members and 35 passengers on board. Six passengers were seriously injured, and one passenger, initially unaccounted for, was fatally injured.

The crew members and surviving 34 passengers exited the aircraft and were promptly rescued and brought to shore by Chuuk State Government boats, Red Cross, Transco, more than 20 privately-owned boats, and US Navy divers, who were first on scene after the accident.

The search for, and recovery of, the deceased passenger and aircraft on-board recorders was coordinated by the PNG Accident Investigation Commission at the request of the FSM Government. Local divers located the fatally injured passenger in the aircraft 3 days after the accident. US Navy divers, subsequently recovered the body from the aircraft.

The pilot in command (PIC) and copilot commenced duty in Pohnpei at about 21:05 UTC<sup>8</sup> for the flight to Port Moresby, Papua New Guinea via Chuuk.

The scheduled departure time was 21:50. The aircraft took off from Pohnpei at 22:22, and the PIC was the pilot flying for the sector to Chuuk. The copilot was the support/monitoring pilot.

<sup>7</sup> 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/Chuuk Time is UTC + 10 hours.

<sup>8</sup> Pohnpei Standard Time (PONT) is UTC + 11 hours.

The engineer<sup>9</sup> for the flight was seated in the cockpit jump seat during the approach. He video recorded the approach from about 3000 ft for recreation purposes, using his smart phone. The video abruptly ended upon impact. The phone survived the accident and provided clear imagery of the cockpit environment and instruments.

Prior to top of descent (TOD) the crew briefly discussed brake setting for the landing.

The pilots then commenced a discussion about the approach and landing flap setting. The copilot asked the PIC if they should use Flap 30 and the PIC replying “Yeah, Flaps 30 would do. 141 plus 5 ah”. The discussion continued around whether to use Flap 30 or 40. The copilot entered the relevant conditional data into the *electronic flight bag (EFB) Boeing OPT*<sup>10</sup> and determined that the use of Flap 40 would reduce the landing distance required by about 150 meters. He informed the PIC and the PIC agreed to select Flap 40.

They then discussed the approach and missed approach procedure they would conduct at *HAMAX*<sup>11</sup> if they found themselves not visual by that point. However, the approach and landing checklist and the briefing on the *RNAV*<sup>12</sup> *approach chart* briefings were not conducted in accordance with the *SOPs* and not using standard phraseology. The missed approach was just a cursory mention of *DAMAY* and did not cover the procedure, nor the flight path to be followed.

At 22:54:36, San Francisco radio contacted the crew with the following decent clearance:

*ATC clearance. Niugini 73, descend to reach FL340 by time 23:05Z*<sup>13</sup>, *requirement to reach FL340 by time 23:05Z, and report level, FL340. Cruise, FL340, to Chuuk airport, report arrival. Report leaving FL280, flight level 180 and flight level 080, time, time check, 254 and a quarter.*

At top of descent, the PIC stated to the copilot that they were already high and needed to immediately initiate their descent. The crew commenced their descent leaving FL400<sup>14</sup> at 22:56:18, at a descent rate of 944 ft/pm. At FL340, the copilot contacted San Francisco radio and reported that they were maintaining FL340. Both pilots discussed the descent clearance for about two minutes, trying to recall and clarify the instructions that they were given.

At 23:05:14, while maintaining FL340, the PIC stated to the copilot that they were high on profile and needed to descend to get back on the required descent profile.

At 23:08:16, the PIC said “*alright, we catching back on profile, so just keep the speed up*”.

The copilot contacted Chuuk radio at 23:08:54 and requested a weather update. Chuuk radio acknowledged and asked the crew to standby for the weather update. The PIC, realising that they were still high on profile, instructed the copilot to go on *VNAV*<sup>15</sup>.

At 23:11:00, Chuuk radio contacted the crew with the weather update for Chuuk stating:

*“wind variable at 5, visibility 14 scattered 012 charlie bravo, broken 120 overcast 280, temperature 26 dep point 25, altimeter 2973”.*

At 23:11:25, the copilot reported passing FL180 to San Francisco radio.

At 23:15:59, at about 15 nm from Chuuk while passing 8,600 ft, the copilot made an inbound broadcast call stating their intention to track for the *RNAV (GPS) runway 04*, from the east south-east. Shortly after the broadcast the copilot contacted San Francisco Radio, and reported passing 8,000 ft on descent.

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9 The aircraft was leased from Loftliedier / Icelandic. The leasing company employed an engineer to be on each flight for maintenance support at ports outside PNG.

10 The *Boeing OPT (Operational Performance Tool)* was designed to assist pilots with takeoff and landing performance calculations by taking inputs for aircraft, runway, and weather data and calculating expected airplane behaviour.

11 *HAMAX* is the Missed Approach Point (MAP) prescribed in the *RNAV GPS Runway 4* instrument approach chart at which a missed approach procedure shall be executed if the required visual reference does not exist.

12 *RNAV* is a method of navigation which permits the operation of an aircraft on any desired flight path; it allows its position to be continuously determined wherever it is rather than only along tracks between individual ground navigation aids.

13 Zulu time = UTC time

14 Level of surface of constant atmospheric pressure related to datum of 1013.25 mb (29.92 in mercury), expressed in hundreds of feet; thus FL400 indicates 40,000 ft

15 Guidance of flight trajectory in vertical plane, e.g. to minimize pilot workload in letdowns, holding patterns and during climb or descent to ATC cleared FLs along particular routes or on early stages of approach; provided by modern transport navigation systems, especially those of energy-management type.

Prior to commencing the approach, while on descent through 4,000 ft, the PIC stated “*Alright, the missed approach is*” but he did not continue and the copilot did not respond. The PIC did not continue his statement/question with respect to the missed approach briefing.

23:20:53 The PIC stated to the copilot: “*okay, we on RNAV at 041 and I’ll go 1,000.*” Shortly afterwards at 23:21:07, the copilot made a general broadcast, stating that they were established on 041 inbound via the RNAV (GPS) runway 04.

23:21:27 The PIC called for gear down and flaps 15 and stated: “*we just configure as we can ah.*” The PIC did not complete his instructions to the copilot.

23:22:33 The copilot mentioned to the PIC that there were some showers in the area and the PIC acknowledged by stating: “*That must be some storm, but it’ll be out soon.*”

The PIC called for the landing checklist, but the only readout made by the copilot was landing gear, flaps and lights and runway in sight.

23:22:42 The PIC said to the copilot: “*ah we’ll probably just go down on the PAPI’s<sup>16</sup>.*” Seven seconds later the PIC said: “*alright flaps 30, flaps 40*”.

23:22:54 The PIC said: “*landing checks.*”

At the EGPWS 1,000 ft altitude call-out, the copilot told the PIC: “*OK, stable.*” Four seconds later the PIC said “*continue.*” The copilot then said: “*and visual, 900 cloud base.*”

23:23:41 The copilot set the missed approach altitude on the *Mode Control* and shortly afterwards, when passing 625 ft (**677 ft**)<sup>17</sup>, with the aircraft above the 3° glideslope, the PIC disconnected the auto-pilot and stated: “*I’m going back on profile.*”

23:23:43 When passing 548 ft (**602 ft**) on descent, the aircraft entered the storm cell and heavy rain and the PIC called for the wipers to be switched on.

The PIC stated during the investigation interview that he had already made the decision that it was visual up ahead with the runway edge lighting to continue for landing at that stage.

23:23:49 The PIC said: “*okay, landing.*”

23:23:52 The copilot said “*visual, one red,*” [pause] “*three whites.*”

23:23:53 EGPWS *MINIMUMS* call-out.

23:24:00 As the EGPWS call-out was repeating “*Sink Rate, Sink Rate,*” the PIC said: “*I just wanna get on profile*” (over the top of the last “*Sink Rate.*”)

23:24:03 EGPWS call-out repeated “*Glideslope, Glideslope, Glideslope.*”

23:24:06 EGPWS call-out repeated “*Sink Rate, Sink Rate.*” and the PIC said to the copilot: “*that’s fine, I’ll just go a little bit more.*”

23:24:09 EGPWS call-out repeated “*Glideslope, Glideslope.*”

23:24:11 The copilot rapidly asked, “*See the runway?*”

23:24:12 EGPWS call-out “*100, Glideslope*” and the PIC said “*Monitor airspeed. Okay, got it.*” (The FDR recorded a *Glideslope* alert but it was over-ridden by the EGPWS “*100 ft*” call and was not recorded on the CVR.)

23:24:13 EGPWS call-out repeated “*Glideslope.*”

23:24:17 (EGPWS call-out “*SINK RATE, SINK RATE*”). Copilot called rapidly with high intonation: “*Too low! We’re too low! We’re too low! We’re too low!*”

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<sup>16</sup> The PAPI provides visual guidance to pilots on final approaches to land on the recommended 3-deg flight-path profile to the runway threshold.

<sup>17</sup> First reference is Pressure altitude with corresponding reference to Radio Altitude in *italics* and **bolded** brackets.

### 1.1.1 Actual flight profile

The aircraft was being flown on a RNAV (GPS)<sup>18</sup> approach to runway 04. While the auto-pilot system was engaged, the approach was stabilised, tracking 041° from FIGBI 2,500 ft, passing FASPO at 1,700 ft. The PIC disconnected the auto-pilot at 625 ft (**677 ft**) and flew the aircraft manually.

The missed approach required a left turn to track 306° with a minimum rate of climb of 375 ft / NM tracking to 960 ft to the Missed Approach Fix *DAMAY*. (See RNAV Chart Figure 4)

From 548 ft (**602 ft**) the approach became unstabilised with an excessively high rate of descent and lateral over controlling. During the investigation interviews the PIC explained that from experience, he found the Boeing 737-800 aircraft laterally less stable with Flap 40 compared with the Flap 30 setting.

During the approach at 23:23:53, when the EGPWS<sup>19</sup> Advisory alert (altitude callout) “*Minimums*” sounded, the aircraft was passing through the published MDA at 420 ft (**477 ft**) with a rate of descent of 1,490 ft per min. The descent was not arrested by either pilot.

After passing the MAP, the aircraft was progressively flown below the glideslope on an approach path from 411 ft (**466 ft**) to the point of impact that averaged 4.5° (See figure 7). Between the MDA and the impact point, the aircraft flew for another 22 seconds; the EGPWS issued seven *Glideslope*<sup>20</sup> and six *Sink Rate*<sup>21</sup> aural alerts.

The first *Sink Rate* Alert was annunciated at 23:24:00 when the aircraft was at 307 ft (**364 ft**)<sup>22</sup> with a descent rate of 1,530 ft per min. The last *Sink Rate* Alert annunciated 2 seconds before impact at -13 ft (**30 ft**) and a rate of descent of 1,200 ft per min. The crew disregarded all these EGPWS alerts and continued the unstable approach at an excessive rate of descent in IMC from 23:24:00 to the time of impact at 23:24:19.

A storm cell situated immediately after HAMAX, the MAP, was *painted*<sup>23</sup> on the weather radar on the PIC’s EFIS<sup>24</sup> Navigation Display. The crew continued past the MAP and flew into IMC, through light and subsequently heavy rain. The copilot activated the windscreen wipers.

About 3 seconds prior to impact the aircraft was descending through -13 ft (**30 ft**) at a rate of 1,200 ft/min. Two seconds before impact the copilot rapidly stated with high intonation: “*Too low! We’re too low! We’re too low! We’re too low!*” and the EGPWS sounded: “*Sink Rate, Sink Rate*” as the aircraft impacted the water.

During his interview with the investigators, the PIC stated that he believed he was arresting the descent and also that the aircraft was sluggish. However, the recorded data and the video revealed that the PIC was over controlling the aircraft laterally. There was no evidence to indicate that the sink rate was being arrested. There was also no evidence on the recorded data to suggest that environmental forces, such as downdrafts, updrafts, etc, influenced aircraft movement against pilot control inputs (*Refer to section 1.11.4*).

The recorded information showed that the PIC had lost situational awareness and that he was fixated on the task of completing the approach and landing the aircraft. He continued the approach despite the excessive rate of descent while in IMC, and below the MDA.

During the investigation interviews, the copilot said that he believed they were “*pretty much stable in approach all the way down*”. The copilot was not aware that the aircraft was deviating from the intended flight path and projecting towards the water. The copilot did not proactively monitor the instruments in response to the EGPWS aural call outs of an unsafe situation throughout the approach.

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18 WENO 1, Federated States of Micronesia RNAV (GPS) Rwy 4 Jeppesen chart dated 26 January 2018 and current at the time of the accident.

19 EGPWS: Enhanced Ground Proximity Warning System. Uses forward-looking radar and sensitive altimeter[s] to give aural and/or visual warning, and in most systems, if ignored, to command. violent pull-up to [typically] 30° climb. See EGPWS.

20 *Glideslope* Caution Alert is issued by the EGPWS when the aircraft deviates below the 3° Glideslope.

21 *Sink Rate* Caution Alert is issued when the aircraft penetrates the zone shown on the Honeywell EGPWS MK V Mode 1 Graph (See Figure 32)

22 Radio Altitude is the altitude above the terrain beneath an aircraft by timing how long it takes a beam of radio waves to reflect from the ground and return to the aircraft. The radio altimeter provides the distance between the antenna and the ground directly below it, in contrast to a barometric altimeter which provides the distance above a defined datum, usually mean sea level.

23 To create blip on radar display, esp. one giving position of aircraft or object. (Source Cambridge Aerospace Dictionary.)

24 *Electronic Flight Instrument System*: Replaces traditional flight instruments by full-colour CRT displays (typically three 200 × 200 nm, 8 × 8 in, for each pilot) each reprogrammable to operate in different modes and giving high redundancy. (Source Cambridge Aerospace Dictionary.)

The NAV display showed the storm cell ahead of the MAP on the approach path. However, the CVR and video revealed that the crew did not discuss avoidance actions. During the interview the copilot stated: “*The showers came out of nowhere. That caught us by surprise*”.

### 1.1.2 Use of Electronic Flight Bag

The copilot had an iPad which he used as his Electronic Flight Bag (EFB)<sup>25</sup> with the *Boeing Operation Performance Tool (OPT)*<sup>26</sup> installed. Air Niugini had purchased and registered to use the software developed by Boeing. The OPT was issued to 65 pilots across the Boeing fleet to be used for training purposes pending CASA PNG approval for use in line operations.

Prior to TOD the copilot used the OPT to calculate the approach and landing performance. The recorded information from the CVR revealed that the crew discussed the calculations from the OPT, which indicated an available buffer of 150 m for the landing distance if they would use Flap 40. The PIC said: “*we better do a flaps 40.*”

Both pilots subsequently agreed that they would use the Flap 40 configuration for the approach and landing. The pilots did not cross check with, or refer to, the Air Niugini performance documents available in the cockpit.

## 1.2 Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	1	1	-
Serious	-	6	6	-
Minor	-	-	-	Not applicable
Nil Injuries	12	28	40	Not applicable
TOTAL	12	35	47	-

**Table 1: Injuries to persons**

The nationalities of the seriously injured passengers were: two Chinese, three Vietnamese, and one from the Philippines (See Figure 2 for seat positions).

The fatally injured passenger was an Indonesian citizen, seated in 23A<sup>27</sup>.

His travelling companions, also Indonesian citizens, reported seeing him stand as they were making their way forward, towards the over-wing exit.

The local divers subsequently found the passenger deceased, lying on his back on the floor between seat rows 22 and 23. One of his legs was around a seat frame of seat 23, and the other leg was out-stretched towards the left side of the fuselage at the fuselage fracture. (See also *Section 1.15.1*.)

The autopsy report concluded that the passenger succumbed to his injuries a within a few minutes after impact.

<sup>25</sup> An *electronic flight bag (EFB)* is an electronic information management device that helps flight crews perform flight management tasks more easily and efficiently with less paper. It is a general-purpose computing platform intended to reduce, or replace, paper-based reference material often found in the pilot's carry-on flight bag, including the *Aircraft Operating Manual*, *Flight-crew Operating Manual*, and navigational charts (including moving map for air and ground operations).

<sup>26</sup> Boeing OPT: Boeing Operation Performance Tool.

<sup>27</sup> Passenger was listed on the flight manifest as allocated seat 23A.

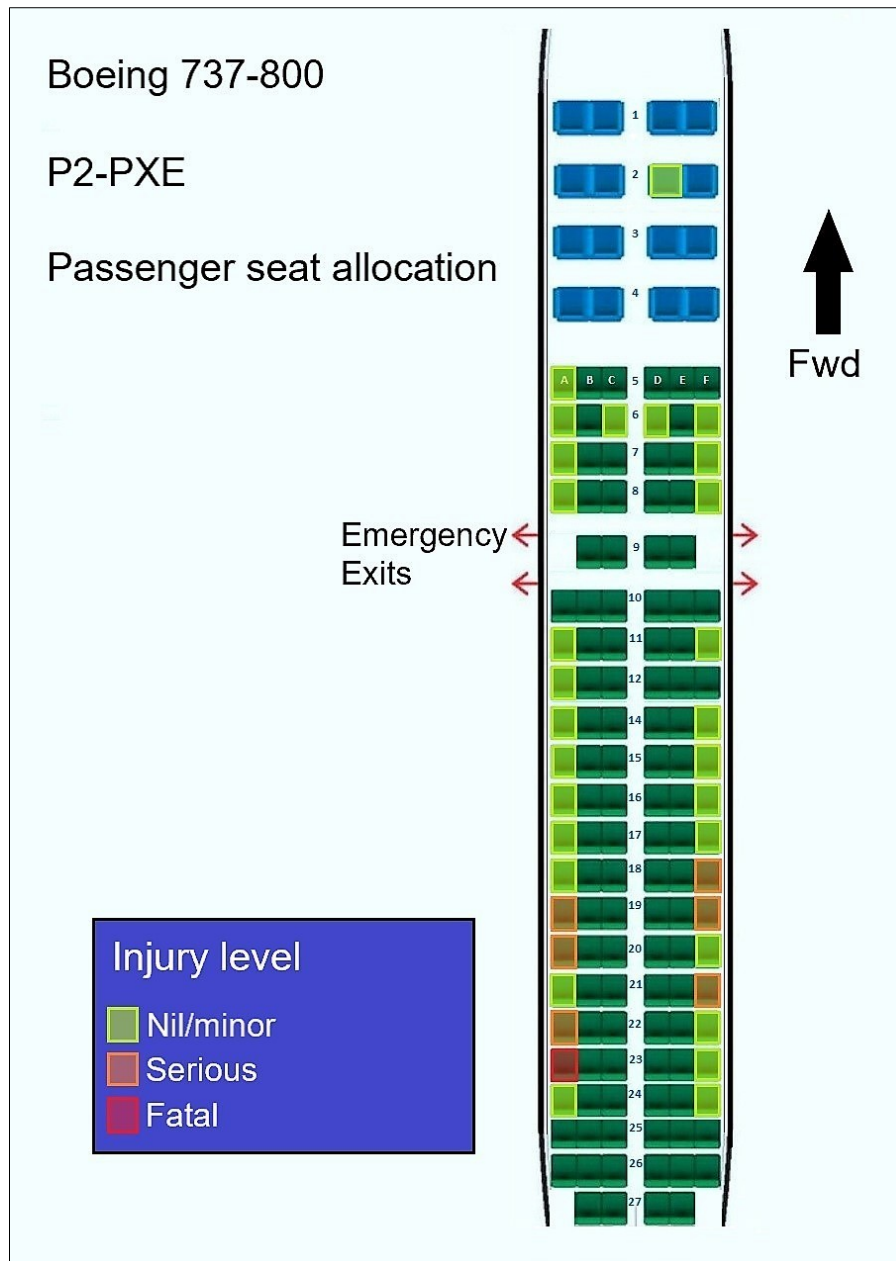


Figure 2: Passenger seating allocation showing injury status.

### 1.3 Damage to aircraft

The aircraft was destroyed by impact forces and submersion into the lagoon.

The main landing gear separated from the wings during impact with the water.

The fuselage behind the wings at seat rows 17 and 22 was ruptured around the circumference of the lower section below the window line on impact with the water and was largely held in place by plumbing and cables and the upper fuselage structure.

Some small components including the Cockpit Voice Recorder were ejected from the aft cargo compartment during the impact.

The photos taken by divers showed that the aircraft sustained further major fracturing and opening of the fractured areas, extending around the circumference of the fuselage, when it sank and impacted the sea floor.

## 1.4 Other damage

The water of the Chuuk Lagoon was contaminated with tonnes of fuel that leaked from the aircraft for days after the accident.

## 1.5 Personnel information

### 1.5.1 Pilot in command

Age	: 52 years
Gender	: Male
Nationality	: Papua New Guinea
Type of licences	: PNG ATPL
Type ratings	: Boeing 737-800 series
Total flying time	: 19,780.7 hours
Total time in command	: 4,987.0 hours
Total on Boeing 737	: 2,276.4 hours
Total time in command Boeing 737	: 2,276.4 hours
Total hours last 30 days	: 44.3 hours
Total hours last 7 days	: 18.5 hours
Last Competency Check (Simulator)	: 23 May 2018
Medical class	: One
Valid to	: 23 February 2019
Medical limitation	: Nil
Time off duty prior to the flight	: 10.3 hours
Time on duty prior to the flight	: 0.75 hour
Time awake prior to the flight	: 1.3 hours
Duration of sleep prior to duty period	: 5.5 hours approx.

#### 1.5.1.1 Route currency

The PIC's specific route and aerodrome training in which he observed from the jump seat was conducted several months prior to the accident flight. He had not been route and aerodrome checked through hands-on flying and execution of procedures. The Air Niugini Limited SOP's did not require hands-on flying and execution procedures for pilots to qualify for specific route and aerodrome operations.

### 1.5.2 Copilot

Age	: 35 years
Gender	: Male
Nationality	: Australian
Type of licences	: PNG ATPL
Type ratings	: Boeing 737-800 series
Total flying time	: 4,618.0 hours
Total time in command	: 1,820.0 hours
Total on Boeing 737 copilot	: 368.0 hours
Total hours last 30 days	: 43.3 hours

Total hours last 7 days	: 9.4 hours
Last Competency Check (Simulator)	: 25 May 2018
Medical class	: One
Valid to	: 11 January 2019
Medical limitation	: Nil
Time off duty prior to the flight	: 10.2 hours
Time on duty prior to the flight	: 1.0 hour
Time awake prior to the flight	: 3.0 hours
Duration of sleep prior to duty period	: 6.6 hours approx.
Spectacles	: Non-prescription sunglasses were worn.

### 1.5.3 Cabin crew<sup>28</sup> (CC1) Purser<sup>29</sup>

Age	: 49 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 26 April 2019
Total flying time	: 14,495.0 hours
Total time last 30 days	: 51.7 hours
Total on B737 last 30 days	: 24.9 hours
Total time last 7 days	: 12.1 hours
Total on B737 last 7 days	: 5.5 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.0 hour
Time awake prior to the flight	: 1.5 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

*(For other cabin crew information, refer Chapter 5 – Appendices, Section 5.3.)*

### 1.5.4 Crew duty rest

The pilots provided written statements<sup>30</sup> to the FSM investigator in charge (IIC) and copies were supplied to the PNG and USA Accredited Representatives<sup>31</sup>. The first statements listed their flight and duty times (See *Section 1.5* tables).

A subsequent unsigned report supplied by Air Niugini Limited, dated 10 October 2018, on behalf of the pilot, was received by the PNG AIC on 14 June 2019.

<sup>28</sup> Refer to Figure 31 for the location of the cabin crew members.

<sup>29</sup> ICAO Doc. 10002 definition **Purser: In-charge cabin crew member**. Cabin Crew who has overall responsibility for the conduct and coordination of cabin crew procedures during normal operations and during abnormal and emergency situations for flights operated with more than one cabin crew member.

<sup>30</sup> Prior to 14th February 2019, the FSM IIC delegated parts of the investigation to the AIC Accredited Representative. This provided for all interviews, including requested statements to be under the *Powers of the Commissions of Inquiry Act, Ch 31, Sections 9 to 13*.

<sup>31</sup> On 14 February 2019, the FSM Government delegated the whole of the investigation to the PNG AIC in accordance with *Para 5.1 of ICAO Annex 13. An investigator in charge was appointed by the PNG AIC to conduct the ongoing investigation*.

In that PIC's report, it lists:

- Sign off at Pohnpei at 11 pm
- Sign on at Pohnpei at 07:50 am

The AIC notes that *Section 4.10* of the *Air Niugini Limited Flight Administration Manual (FAM)* complies with the *Flight and Duty Limitations* of the *PNG Civil Aviation Rules* and requires pilots to be free of duty for 9 hours including the hours of 10 pm to 6 am. If that is not possible the duty-free period required is 10 hours.

Therefore, the PIC did not meet the duty-free requirements of the *CARs* or the *Air Niugini Limited FAM*.

The same duty requirements apply to the copilot and the cabin crew.

See also *Section 2.3.1 Analysis of Human Factors*.

## 1.6 Aircraft information

### 1.6.1 Aircraft data

Aircraft manufacturer	: The Boeing Company
Model	: 737-8BK
Serial number	: 33024
Date of manufacture	: April 19, 2005
Nationality	: Papua New Guinea
Registration	: P2-PXE
Name of the owner	: Loftlieder / Icelandic
Name of the operator	: Air Niugini Limited
Certificate of Airworthiness number	: 313
Certificate of Airworthiness issued	: 24 September 2013
Valid to	: non-terminating
Certificate of Registration number	: 313
Certificate of Registration issued	: 13 September 2013
Valid to	: non-terminating
Total airframe hours	: 37,160.36
Total airframe cycles	: 14,788

### 1.6.2 Engine data

Engine type	: Turbo-fan
Manufacturer	: CFM
Model	: CFM 56-7B26

#### **Engine number-one (Left)**

Serial number	: 8923
Total Time since new	: 32,336.36 hours
Cycles since new	: 12,922

### Engine number-two (Right)

Serial Number : 894605  
Total Time since new : 11,782.20 hours  
Cycles since new : 9,764

## 1.6.3 Weight and balance

Weight and balance was not a factor in this accident.

## 1.6.4 Fuel

The aircraft was refuelled at Pohnpei and the total fuel on board was 13,800 kg. The planned taxi fuel burn was 300 kg, and the fuel for the sector from Pohnpei to Chuuk was 3,100 kg. The estimated fuel on board on arrival at Chuuk was 10,400 kg.

Flight planned fuel required from Chuuk to Port Moresby was 200 kg taxi, 6,227 kg for the sector. The flight planned fuel on board for takeoff at Chuuk was 9,256 kg. After passing 5,500 ft on descent, the Chuuk Air Niugini agent asked the crew if fuel was required at Chuuk. Fuel was available at Chuuk.

The PIC replied: *“Ah negative fuel at this stage. Take-off fuel will be 10.2 and for 200 ah taxi.”*

About 4 minutes later, just after briefly mentioning the missed approach and the observed low cloud, the PIC said to the copilot: “we’ve got plenty of fuel anyway”.

## 1.6.5 Aircraft serviceability

The aircraft was certified as airworthy when it was dispatched from Pohnpei.

There was no evidence of any defect or malfunction with the aircraft or its systems that could have contributed to the accident.

# 1.7 Meteorological information

## 1.7.1 Chuuk Terminal Aerodrome Forecast

The Chuuk Terminal Aerodrome Forecast (TAF) issued by Met Service, Wellington, New Zealand, that was in effect at 22:00 on 27 September 2018 was as follows:

*Wind, 100 deg at 14 kts with gusts up to 25 kts. The visibility was 5 statute miles. Showers of rain to be expected with cloud Scattered at 800 ft and Overcast at 5,000 ft.*

## 1.7.2 Chuuk Airport Radio broadcast weather information

The Chuuk radio operator provided the following weather information to the aircraft as it approached Chuuk.

Chuuk Radio	ANG073	Okay, Chuuk weather report, wind variable at 5, visibility 14 scattered 012 charlie bravo, broken 120 overcast 280, temperature 26 dew point 25, altimeter 2973.
-------------	--------	--

The meaning of the report issued in aviation terminology was:

*Wind direction variable at 5 kts, visibility 14 statute miles, Scattered Cumulonimbus cloud at 1,200 ft, Broken-cloud at 12,000 ft, Overcast-cloud at 28,000 ft, temperature 26 deg C, Dewpoint 25, altimeter setting for QNH<sup>32</sup> 2973.*

<sup>32</sup> QNH is the term used when requesting the atmospheric pressure at sea level.

## 1.8 Aids to navigation

### 1.8.1 Published (Approved) Instrument Approaches

The Chuuk International Airport (TKK) had four approved instrument approaches:

- RNAV<sup>33</sup> (GPS<sup>34</sup>) Rwy 04;
- RNAV (GPS) Rwy 22;
- NDB<sup>35</sup> Rwy 04 to be used for daylight operations only; and
- NDB Rwy 22 to be used for daylight operations only.

At the time of the accident, the crew were using the RNAV (GPS) Runway 04 approach.

The investigation revealed that the pilots had only one RNAV 04 approach chart on board when departing Port Moresby, and did not obtain a second chart at Chuuk or Pohnpei.



*Section 20.2 of the Air Niugini SOPM provides a list of documents to be carried in accordance with CAR 91.111 and CAR 121.855. Section 20.2 dot point 12 states:*

*Copies of the relevant flight guide charts and plates, with a complete set of Jeppesen Airways Manuals for use by **each** operating flight crew member.*

*Section 20.12.5 of the Air Niugini SOPM states that the First Officer is responsible for ensuring relevant documents for the conduct of the flight are on board.*

The PXE crew did not comply with these requirements to ensure that all documents necessary for the operation of the flight were onboard.

#### **Figure 3: RNAV Chart placed between the Flight Management Computer (FMC) screens**

During the approach the crew positioned the RNAV Chart on the centre pedestal between the PIC and the copilot on the *Flight Management Computers (FMC)*.

The investigation determined that prior to top of descent, the PIC entered the *Chuuk PTKK RNAV (GPS) runway 04* approach via *MICNO*, into the FMC.

The recorded information from the CVR revealed that the briefing of the RNAV (GPS) runway 04 chart was not completed in accordance with the *Air Niugini SOPM*.

Actual briefing done by PIC:

- See *Appendix D, Section 5.5.1*

Required briefing:

- See *Appendix D, Section 5.5.1.1*
- See *Appendix D, Section 5.5.3, Jeppesen chart briefing as per Air Niugini SOPM.*

The CVR recorded information also revealed that during the approach, on the previous flight into Pohnpei on 27 September, the crew did not brief the *Pohnpei RNAV (GPS) X Rwy 9* approach chart in accordance with *Air Niugini SOPM*.

Actual briefing done by PIC:

- See *Appendix D, Section 5.5.2*

Required briefing:

- See *Appendix D, Section 5.5.2.1*
- See *Appendix D, Section 5.5.3, Jeppesen chart briefing as per Air Niugini SOPM.*

<sup>33</sup> Navaid that permits aircraft operations on any desired course within coverage of station-referenced navigation signals or within limits of self-contained system capability (FAA); thus, does not constrain aircraft to pre-set pathways. (Source *Cambridge Aerospace Dictionary*.)

<sup>34</sup> Worldwide system in which users derive their location by interrogating four satellites from total net of 24. Originally US military, which reserves to itself the greatest [centimetric] accuracy. (Source *Cambridge Aerospace Dictionary*.)

<sup>35</sup> ADF ground station sending in 190–550 kHz range with keyed identification carrier. (Source *Cambridge Aerospace Dictionary*.)



## 1.8.2 TKK(CHUUK) Navigation aid serviceability

The most recent calibration checks of the PTKK (Chuuk) Nav aids prior to the date of the accident were as follows:

IDENT	INSPECTION DATE	RUNWAY	ARINC <sup>36</sup> coding	SIAP <sup>37</sup> Inspection
PTKK04	20/10/2017	04	Gold Standard <sup>38</sup>	Sat ( <i>all waypoints</i> )
PTKK22	20/10/2017	22	Gold Standard	Sat ( <i>all waypoints</i> )

The inspection report showed an ARINC coding meeting *Gold Standard* for both RNAV (GPS) runway 04 and 22 instrument approach procedures respectively, and the SIAP/SIAP(s) were verified in accordance with Order 8200.1, USSFIM (*United States Standard Flight Inspection Manual*), Chapter 6 (*Flight Inspection and Flight Validation of Instrument Flight Procedures*).

## 1.9 Communications

All communications between Air Traffic Services (ATS) and the flight crew were normal.

## 1.10 Aerodrome information

The Chuuk runway is aligned 041 deg M / 221 deg M at an elevation of 10 ft (3m). The runway surface was grooved asphalt. Both runways had a 4-light PAPI visual slope indicator to the left of the runway providing 3-deg glideslope guidance. *See Aerodrome Chart figure 5*

Airport name	: Chuuk International Airport
Airport identification	: WENO I / TKK
Airport operator	: Division of Civil Aviation
Latitude	: 07°27'42.81"N
Longitude	: 151°50'34.86"E
Elevation	: 10 ft (3 m)
Runway 04 elevation	: 10 ft
Runway direction	: 04 - 22 / 041° - 221°
Runway length	: 6,006 ft (1,831 m)
Runway width	: 150 ft (46 m)
Surface	: Asphalt / grooved
Visual slope indicator	: 4-light PAPI providing a 3-deg glideslope guidance
Location of PAPI	: Left side of both runway, 04/22 respectively
RFFS category	: CAT 5

<sup>36</sup> ARINC 424 or ARINC 424 Navigation System Data Base Standard is an international standard file format for aircraft navigation data maintained by Airlines Electronic Engineering Committee and published by Aeronautical Radio, Inc. The ARINC 424 specifications are not a database, but a "standard for the preparation and transmission of data for assembly of airborne navigation system data bases".

<sup>37</sup> Standard Instrument Approach Procedure(s) is/are a series of predetermined manoeuvres for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

<sup>38</sup> The "Gold Standard" is a process of automation in developing a flight procedure, validating the procedure, ARINC 424 coding the procedure, and electronically packing the coded procedure into a navigation data base for use in the Flight Management System (FMS) on the flight inspection aircraft.

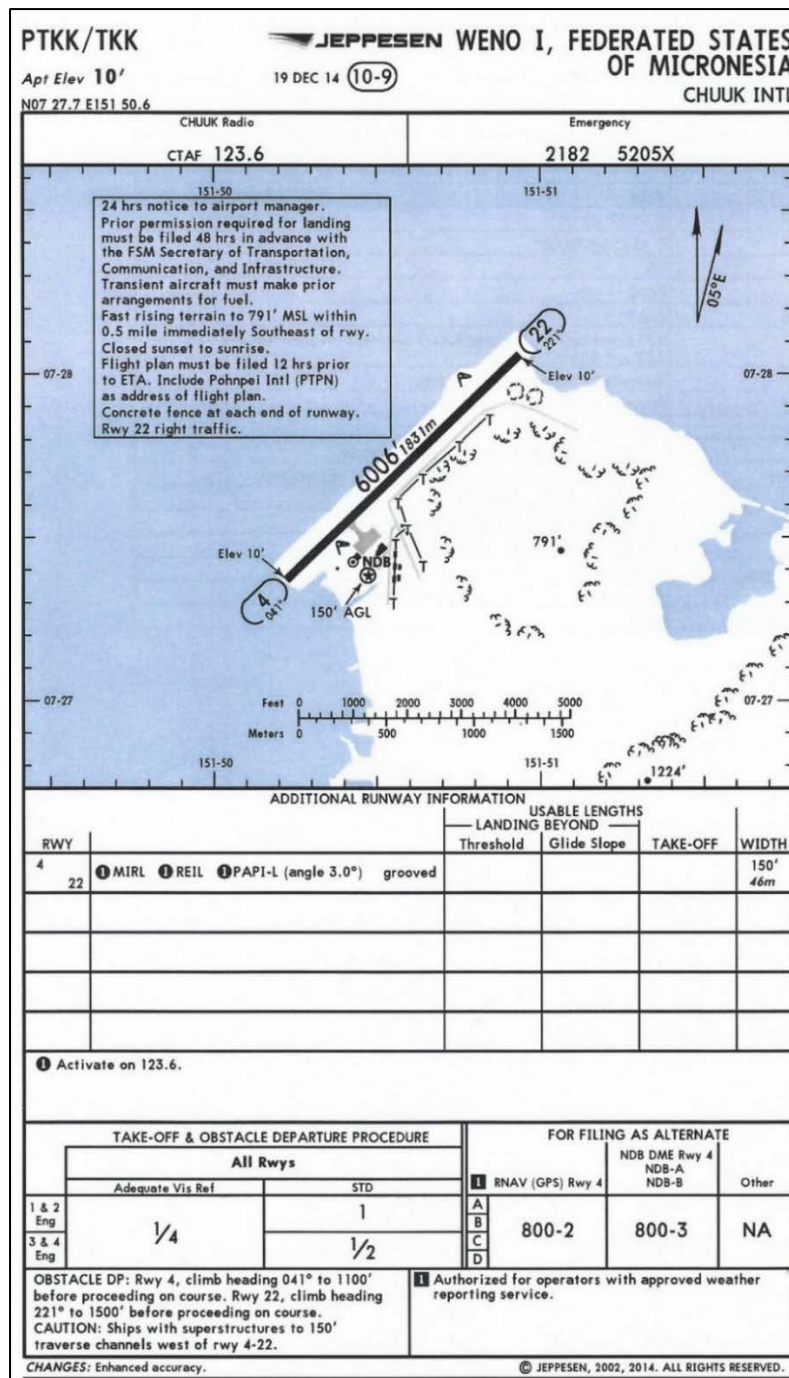


Figure 5: PTKK/TKK (CHUUK) Aerodrome Chart

### 1.10.1 Runway End Safety Area (RESA)

The Chuuk International Airport runways 04 and 22 do not have a runway end safety area (RESA) as required by ICAO<sup>39</sup> Annex 14, Volume 1, Paragraph 3.5 Standard.

At the time of the accident, the FSM Division of Civil Aviation (DCA) had not notified ICAO of a difference between the FSM national regulations and practices and Annex 14, nor had the DCA published information about the unavailability of a RESA in the FSM Division of Civil Aviation Aeronautical Information Service and NOTAMs<sup>40</sup>. Generally, notifying and publishing differences from ICAO standards, especially those that could present a significant safety risk to operators, is an important exercise to promote aviation safety.

<sup>39</sup> ICAO: International Civil Aviation Organization

<sup>40</sup> NOTAM Notice[s] to Airmen, identified as notice or as Airmen Advisory, disseminated by all means to give information on establishment, condition or change in any aeronautical facility, service, procedure or hazard.

### 1.10.2 Precision Approach Path Indicator (PAPI)<sup>41</sup>

The PAPI's at Chuuk International Airport, are located to the left side of runways 04/22.

The PAPI lights were serviceable and were operational during the approach.

During the investigation interview, the copilot said: “*Yes, I saw the PAPI too, three (3) reds, one (1) white at the beginning all the way up until probably the last point, I can see like what I said from my perspective I can see the runway I can see the PAPI...*”

He (copilot) then stated: “*oh yeah the night before we were surprised how the PAPI was always showing three (3) reds or three (3) whites, one red.*”

The accuracy of the copilot's recall of the PAPI was varying and contradictory during the investigation interview.

The CVR revealed that during final approach, one second after the EGPWS *MINIMUMS* call-out, the copilot said “*visual, one red,*” [pause] “*three whites.*”

At 04:45 (14:45 local time) on the day of the accident (5 hours after the accident), both PAPIs were taken out of service for routine post-accident inspection and calibration checks. A *NOTAM* was issued informing pilots that the PAPI was not available. The certifications were completed and both PAPI's were “returned to service” on 30 September, 2018. The inspection report indicated that the PAPIs for runways 04 and 22 were within the specified tolerance, and therefore were serviceable.

(See Chapter 5, Appendices, Appendix F, Section 5.6 for PAPI light indications and illustration)

### 1.10.3 Airport Emergency Plan Manual

The investigation found that the Chuuk International Airport, *Airport Emergency Plan (AEP)* and rescue and fire-fighting resources did not meet the *ICAO Annex 14 Volume 1, Standards* with respect to responding to accidents occurring in water adjacent to the aerodrome.

The *AEP* that was current at the time of the accident was dated 9/11/2011. (11 September 2011)

The *AEP* did not meet documentation convention (Standards) as required by ICAO:

- it was not a controlled copy;
- it did not have a version number and issue date on each page; and
- there was no amendment sheet for listing amendments.

The *AEP* procedures were inadequate for use in an emergency operation, especially during a rescue operation involving an aircraft accident in water.

The last emergency exercise conducted prior to the accident was in August 2017. It was conducted on land and within the airport perimeter. The post-exercise report did not provide evidence that the airport emergency response equipment and personnel would be effective in handling an actual emergency situation that might occur outside the airport perimeter “in water”. The report mentioned the Pohnpei and Kosrae airports, but also did not address the exercising of the *AEP* outside the airport perimeter of those airports.

*Article 38* to the *Convention on International Civil Aviation* imposes an obligation on Contracting States to notify ICAO of differences between their national regulations and practices and the *International Standards* contained in the *Annex* and any amendments thereto if the State cannot comply with a *Standard*.

Furthermore, the provisions of *Annex 15* require the publication of differences between a State's national regulations and practices and the related *ICAO Standards and Recommended Practices* through the *Aeronautical Information Service*, in addition to the obligation of States under *Article 38* of the *Convention*.

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<sup>41</sup> The PAPI provides visual guidance to pilots on final approaches to land on the recommended 3-deg flight-path profile to the touchdown point. The PAPI is usually located on the left side of the runway. If required, the PAPI can be installed on the right side of the runway.

At the time of the accident, there was no appropriate coordination and communication for the *AEP* to be effective. There were no specialist rescue personnel and equipment available to respond to an aircraft accident occurring in water adjacent to the aerodrome in accordance with the *Standards* (obligations) of *ICAO Annex 14* obligations.

The investigation found that as a result of the presence of more than 20 local, mostly privately-owned boats, and the US Navy personnel on assignment nearby at the time of the accident who used an inflatable boat, rescue was achieved without delay.

However, these responders cannot be considered to be a substitute to meet the requirements of specialist rescue equipment and trained personnel, and in any event cannot be relied upon 24 hours a day, 7 days a week.

The lack of specialist rescue personnel and equipment may seriously compromise the effective rescue from any future aircraft accident in water due to:

- the lack of an appropriate *Airport Emergency Plan*;
- the lack of specialist rescue services (personnel and equipment); and
- the lack of exercising of the full *AEP* plan, including the specialist rescue services.

*ICAO Annex 14* contains *Standards and Recommended Practices* with respect to *Airport Emergency Planning (AEP)*.

9.1.1 - An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 - The aerodrome emergency plan shall provide for the coordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

9.1.3 - The plan shall coordinate the response or participation of all existing agencies which, in the opinion of the appropriate authority, could be of assistance in responding to an emergency.

9.1.12 - The plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

9.1.13 - The plan shall be tested by conducting:

a) a full-scale aerodrome emergency exercise at intervals not exceeding two years and partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; or

b) a series of modular tests commencing in the first year and concluding in a full-scale aerodrome emergency exercise at intervals not exceeding three years; and reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

Note 1. — The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system. The purpose of modular tests is to enable concentrated effort on specific components of established emergency plans.

Emergencies in difficult environments:

Paragraph 9.1.14 - The plan shall include the ready availability of, and coordination with, appropriate specialist rescue services to be able to respond to emergencies where an aerodrome is located close to water and/or swampy areas and where a significant portion of approach or departure operations takes place over these areas.

Paragraph 9.1.15 Recommendation. — At those aerodromes located close to water and/or swampy areas, or difficult terrain, the aerodrome emergency plan should include the establishment, testing and assessment at regular intervals of a predetermined response for the specialist rescue services.

## 1.10.4 Rescue and fire fighting

The *Chuuk International Airport Emergency Plan (AEP)* with respect to Airport Rescue and Fire Fighting service (ARFF) in accordance with the international obligations for water rescue was not available. Specialist water rescue personnel and equipment were not available.

The airport operator did not establish a collecting area, care area, or holding area at or near the airport, and there was no specific area near the accident site to facilitate victims' triage.

Due to the lack of airport personnel at the crash site, the many boats used, and the various locations to which the survivors were taken, there was no proper coordination and coordinated tally of the survivors respectively until they were taken to the Chuuk State Hospital and triaged.

At *Part 1, Section 2 (ii)* the *AEP* calls for a public radio announcement to request boat owner assistance. The plan for such a broadcast assumes boat owners will be listening to the radio and will be in the vicinity of the airport. The reference to the boats is general and does not appear to be in any way related to specialist rescue vessels as required by *ICAO Annex 14 Standards*, and there is no reference in the *AEP* for **specialist rescue services** and fire-fighting equipment appropriate to the hazards and risks that *Annex 14* states "*shall be available.*"

At *Part 1, Section 8 (b)* the *AEP* lists one 24 ft boat and *(d)* 3 outboard motor boats, and *(e)* a multi-purpose vessel. After point *(g)* it lists private boat owner's boats by type and size.

*ICAO Annex 14* contains *Standards and Recommended Practices* with respect to *Rescue and Fire Fighting*.

The full wording of the *Annex* is crucial to understanding the *ICAO Annex 14 Standards*.

Paragraph 9.2.1 - Rescue and firefighting equipment and services shall be provided at an aerodrome.

Paragraph 9.2.2 states that:

Where an aerodrome is located close to water/or swampy areas and where a significant portion of approach or departure operations takes place over these areas, specialist rescue services and fire-fighting equipment appropriate to the hazards and risks shall be available.

*Note 1. — Special firefighting equipment need not be provided for water areas; this does not prevent the provision of such equipment if it would be of practical use, such as when the areas concerned include reefs or islands.*

*Note 2. — The objective is to plan and deploy the necessary life-saving flotation equipment as expeditiously as possible in a number commensurate with the largest aeroplane normally using the aerodrome.*

*Note 3.— Additional guidance is available in Chapter 13 of the Airport Services Manual (Doc 9137), Part 1.*

## 1.11 Flight recorders

The aircraft was fitted with a solid-state Cockpit Voice Recorder (SSCVR) and a separate solid-state Flight Data Recorder (SSFDR), both manufactured by Honeywell Aerospace. These were first generation solid-state recorders developed in the early 1990's.

The SSCVR was installed in a rack in the cargo compartment under the cabin floor of the rear fuselage of the aircraft. The SSFDR was installed in the ceiling at the rear of the passenger cabin.

The SSFDR system was comprised of:

- the SSFDR itself;
- a flight data acquisition unit (FDAU); and
- aircraft sensors.

The aircraft was equipped with a Honeywell Aerospace FDAU (P/N: 9670212-002 & S/N:1477) which transmitted data to the Flight Data Recorder at a data rate of 256 words per second.

The SSCVR system was comprised of four audio input channels: PIC headset, copilot headset, first observer headset, and cockpit area microphone. The SSCVR had a recording duration of about 2 hours.

In accordance with PNG AIC salt water recovery procedures, both recorders were washed with distilled water and transported while immersed in distilled water to the PNG AIC Flight Recorder Laboratory in Port Moresby for data recovery and readout.

PNG AIC recorder investigators carefully disassembled the recorders while keeping them in distilled water to avoid oxidation. Once disassembled, the memory boards were thoroughly cleaned in distilled water and silicate was removed (while keeping the memory boards underwater) to facilitate physical examination of the chips. The memory boards were then dried in a special fan-forced oven for approximately 15 hours at 40°C. The memory boards were then connected directly to the *Memory Access Retrieval System (MARS)* where the specially developed software and firmware read the memory chips one by one. *MARS* created a file for each memory chip rather than the single file that is produced by the Golden Chassis<sup>42</sup> method.

An examination of the data showed that the SSFDR data and the SSCVR audio from the accident flight had been successfully recorded. The data was good quality. Refer to Chapter 5 – Appendices, Section 5.9, Appendix H. Shows screen-shot of animation incorporating FDR, CVR, cockpit imagery.

### 1.11.1 Solid State Flight Data Recorder (SSFDR)

#### SSFDR details:

Manufacturer: Honeywell Aerospace  
 Type/Model: SSFDR  
 Part number: 980-4700-043  
 Serial Number: 17869

The SSFDR was recovered from its rack within the aircraft by local civilian divers.

The SSFDR data revealed that during the approach from 1,000 ft amsl, with the auto-pilot engaged, the aircraft flight path was relatively constant and consistent with the RNAV profile. The rate of descent was around 600 to 800 ft/min and the groundspeed remained between 149 and 151 kts. The approach was stable.

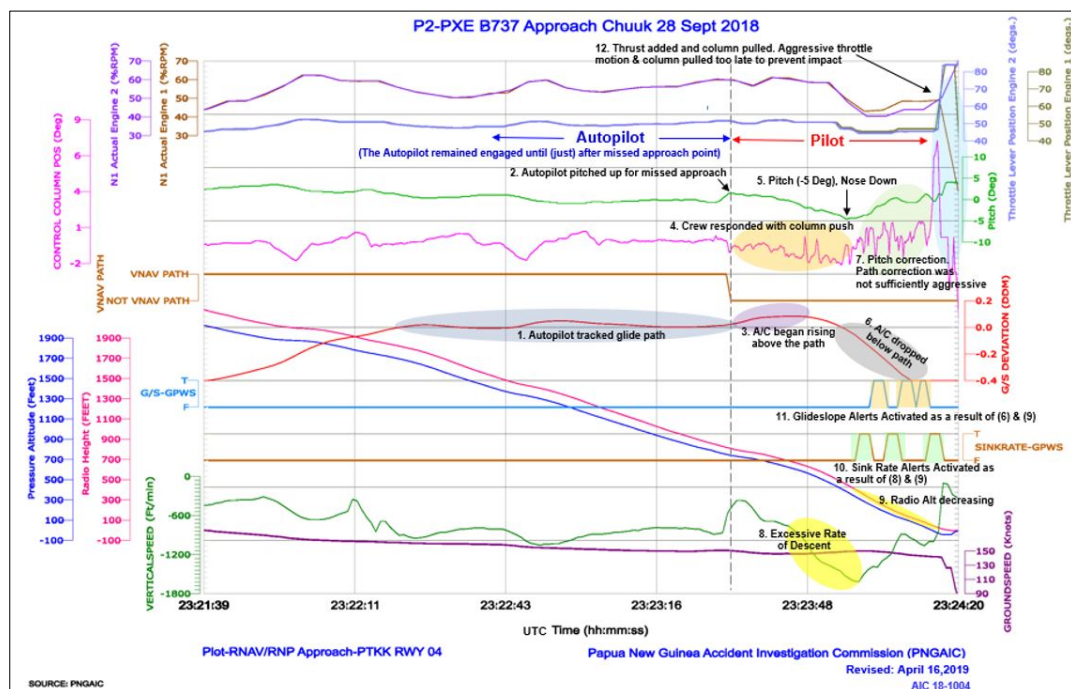


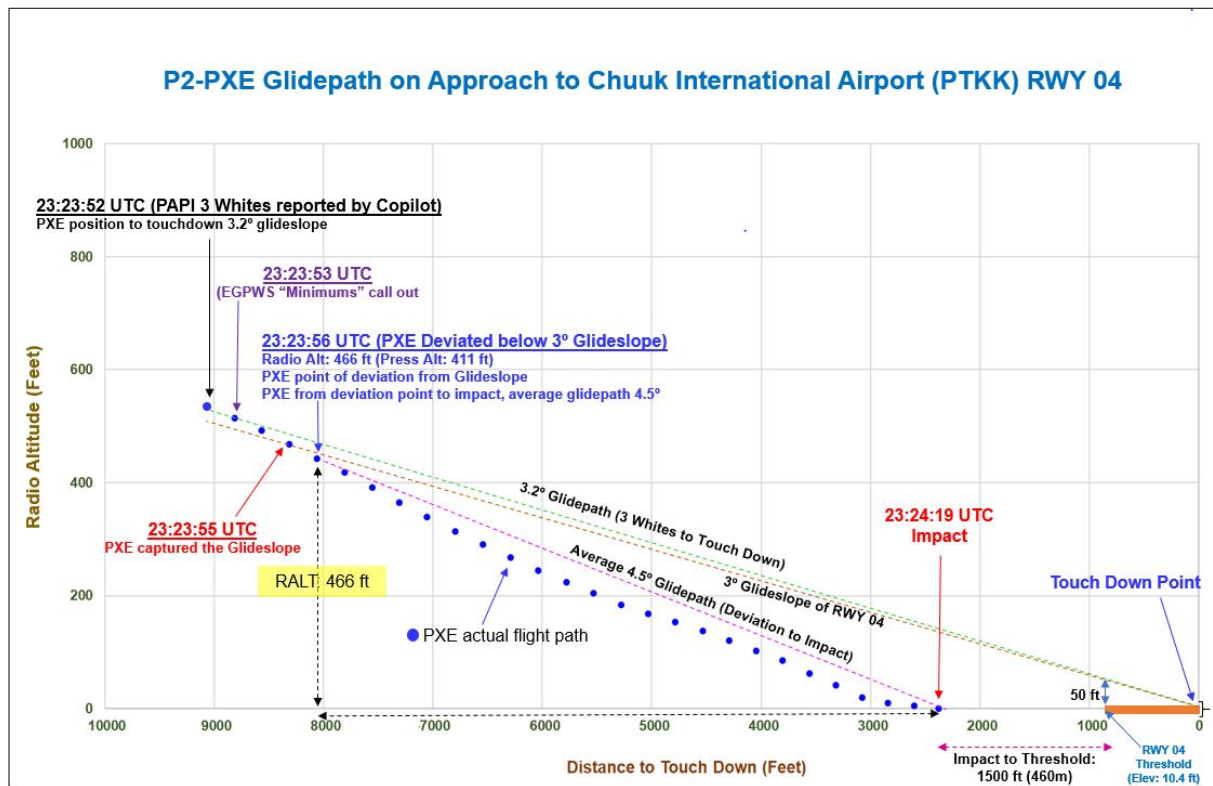
Figure 6: FDR data plot

(Refer to Chapter 5 Appendices, Section 5.7 Appendix F for larger version)

<sup>42</sup> The method of downloading crash-damaged solid state recorders by substituting the crash-damaged memory into a working recorder of the same make and model, and using the standard maintenance download equipment for downloading the data.

After the auto-pilot was disengaged at 625 ft (**677 ft**), the aircraft's descent rate increased from 750 ft/min and a groundspeed of 146 kts to 1,380 ft/min and a groundspeed of 149 kts, at 420 ft.

The FDR data showed an unstable approach from 625 ft (**677 ft**) and a flight path deviation from the 3° glideslope to an approach path profile averaging 4.5°.



**Figure 7: Diagram showing glidepath deviation**

Heavy rain and IMC were encountered at the minimums and the crew activated the windscreen wipers.

At 152 ft (**189 ft**) the rate of descent increased to 1,080 ft per min and the groundspeed was 147 kts.

At 121 ft (**150 ft**) with a ground speed of 146 kts, the rate of descent was 900 ft/min.

At 70 ft (**100 ft**) with a ground speed of 144 kts, the rate of descent was 1,080 ft/min.

At 53ft (**84 ft**) the rate of descent was 1,200 ft/min and the groundspeed was 143 kts.

At 30 ft (**65 ft**) and ground speed of 142 kts, the rate of descent was 1,290 ft per min.

From the first “Sink Rate” alert at 307 ft (**364 ft**) to the last “Sink Rate” alert before impact, there was also a red **PULL UP** warning displayed at the bottom of the PFD.

**Note:** The RNAV approach specified a descent rate of 743 ft/min at a ground speed of 140 kts to maintain a constant 3° descent angle (glideslope) to 50 ft over the threshold. The actual flight path (glideslope) flown from the point of glideslope deviation to impact gave an average angle<sup>43</sup> of 4.5°.

The AIC produced a flight animation from the recorded data from the SSFDR, SSCVR, and EGPWS using the latest Flight Animation Software (FAS-INV). Refer to Chapter 5 – Appendices, Section 5.9, Appendix H.

<sup>43</sup> The 4.5° is the average of the variable approach path angle flown.

### 1.11.2 Solid State Cockpit Voice Recorder (SSCVR)

#### SSCVR details:

Manufacturer: Honeywell Aerospace

Type/Model: SSCVR

Part number: 980 6022-001

Serial Number: 04448

The SSCVR was designed to record 30 minutes of audio on four channels (P/A, Co-pilot, Pilot, Cockpit Area Microphone/CAM) and 120 minutes of audio on 2 channels (combined crew audio & CAM).

Five days after the accident, at the request of the PNG AIC team, a Dukane Beacon receiver was brought from Guam by the US navy to locate the SSCVR. The SSCVR was recovered from the seabed by US Navy divers about 440 ft (135 m) back along the flight path from the 04 threshold, in the area ahead of the first point of water impact.

The SSCVR was downloaded and the data decompressed on 11 October 2018 at the PNG AIC Flight Recorder Laboratory in Port Moresby. The CVR captured 120 minutes of good quality recording from the PIC microphone, the copilot microphone and the cockpit microphone. The audio files were examined and the information was transcribed in the AIC Flight Recorder Laboratory.

Up to the time of the top of descent briefing, the oral communications between the PIC and the copilot and Air Traffic Control were in normal tones and in an orderly manner. Subsequently, during the approach below 10,000 ft, communication between the crew was minimal and was disjointed and not in accordance with standard operating procedures and standard phraseology.

The EGPWS sounded: ‘*Sink Rate*’ and ‘*Glideslope*’ alerts, continuously from shortly after passing the MDA until the aircraft impacted the water. There was a total of 13 loud EGPWS alerts (hard alerts) during the approach; six ‘*Sink Rate*’ and seven ‘*Glideslope*’ loud aural alerts. A 14<sup>th</sup> aural alert, ‘*Glideslope*’ registered on the FDR data, but was not heard on the CVR because it was over-ridden<sup>44</sup> by the EGPWS “100 ft” call.

Significant excerpts taken from the CVR are as follows:

At the “*approaching minimums*” EGPWS call, the copilot said: “visual one red [pause] three whites”

From the EGPWS “*minimums*” call to the “100 ft” EGPWS call there were four “*Sink Rate*” warnings and five “*Glideslope*” warnings.

From the “100 ft” EGPWS call to impact with the water there were two “*Glideslope*” calls and two “*Sink rate*” calls. The pilots talked over many of the alerts until impact.

Time	From	To	Transcript
23:24:00	PIC	Copilot	At the same time the EGPWS call-out was repeating “ <i>SINK RATE, SINK RATE.</i> ” PIC said: “ <i>Okay, I just wanna get on profile.</i> ”
23:24:03	Copilot	PIC	“ <i>Check.</i> ” (EGPWS call-out “ <i>GLIDESLOPE, GLIDESLOPE, GLIDESLOPE.</i> ”)
23:24:06	PIC	Copilot	(EGPWS call-out, “ <i>SINK RATE, SINK RATE,</i> ”) While PIC talking in the background, said: “ <i>that’s fine.</i> ” “ <i>I’ll just go a little bit more.</i> ”
23:24:09	Copilot	PIC	(EGPWS call-out, “ <i>GLIDESLOPE, GLIDESLOPE,</i> ”) The copilot rapidly asked, “ <i>see the runway?</i> ”

<sup>44</sup> Altitude callouts have priority over Glideslope.

23:24:12	PIC	Copilot	EGPWS call-out “100, Glideslope” and the PIC said “Monitor airspeed. Okay, got it.” (The FDR recorded a <i>Glideslope</i> alert but it was overridden by the EGPWS “100 ft” call and was not recorded on the CVR.)
23:24:13	EGPWS		(EGPWS call-out “GLIDESLOPE”
23:24:17	Copilot	PIC	(EGPWS call-out “SINK RATE, SINK RATE”). Copilot called rapidly with high intonation: “too low! We’re too low! We’re too low! We’re too low!”
23:24:19			Impact...End of recording.

**Table 2: Excerpts of the transcript from the CVR, 19 seconds prior to impact.**

Until 2 seconds before impact, the copilot did not give the PIC any oral cautions throughout the approach despite the excessively high rate of descent and the aircraft increasingly being flown below the glideslope in an unstabilised manner and in IMC. As the pilot monitoring, the copilot did not challenge the PIC (the flying pilot) as required in the *Air Niugini Limited Crew Resource Management (CRM)* procedures.

### 1.11.3 Other electronic components providing recorded data

Other electronic components of the aircraft were recovered by the local divers. They included: the Automatic Flight Information Recording System (AFIRS), Flight Management Computer (FMC), and the Enhanced Ground Proximity Warning System (EGPWS).

The EGPWS and the FMC were sent to the respective Manufacturers’ facilities in the US where specialised equipment was used to recover the data under the supervision of Technical Advisers from the US NTSB.

The AFIRS unit was sent to the Transportation Safety Board of Canada (TSBC) where the data was retrieved at the TSBC Recorder Laboratory. The AFIRS data was consistent with the data from the SSFDR.

### 1.11.4 Enhanced Ground Proximity Warning System (EGPWS)

The EGPWS was recovered from the aircraft’s avionics bay by a local civilian diver. It was sent to the manufacturer Honeywell Aerospace for data download.

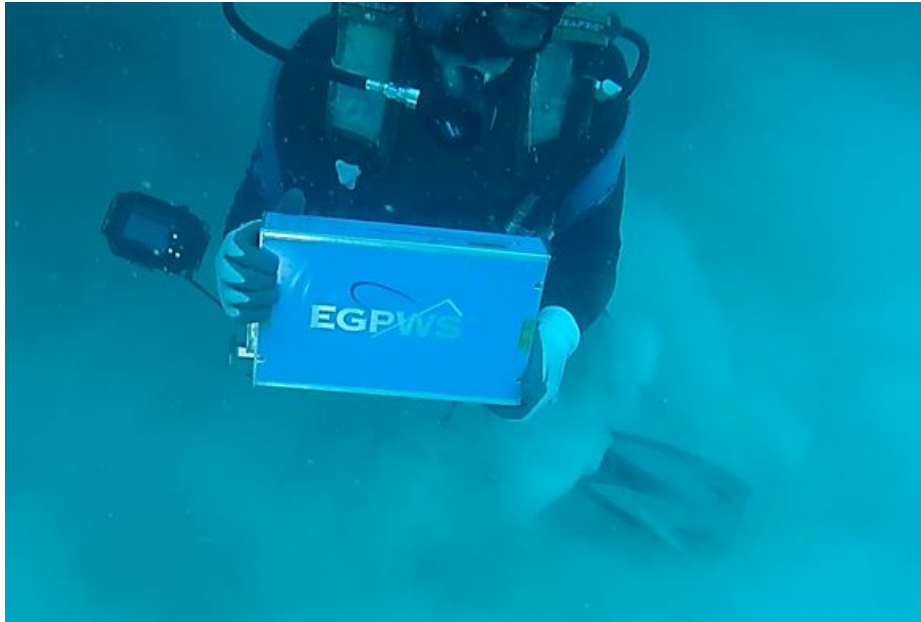
During the approach at 23:24:00, while the aircraft was passing through 307 ft (**364 ft**) with a rate of descent of 1,530 ft per min and the first EGPWS “Sink Rate” caution alert sounded.

The MDA was 420 ft (**477 ft**). The missed approach required a left turn to track 306° with a minimum climb of 375 ft / NM to 960 ft to the Missed Approach Fix *DAMAY*.

The aircraft was progressively flown below the glideslope, and from 23:24:00 to the time of impact at 23:24:19, the EGPWS issued seven *Glideslope* aural alerts, and six *Sink Rate* aural alerts.

The first *Sink Rate* alert annunciated at 23:24:00 when the aircraft was at 307 ft (**364 ft**) with a descent rate of 1,530 ft/min at a groundspeed of 150 kt. The last two *Sink Rate* aural alerts annunciated 2 seconds before impact at a Radio Altitude of **30 ft** and a descent rate of 1,200 ft/min.

From the analysis of the FDR data, the crew seemed to have disregarded and talked over all the Caution annunciations. The crew had experienced those type of cautions on previous flights and perceived them as nuisance alerts with no resultant consequence.



**Figure 8: EGPWS recorder being brought to the surface by the diver**

A storm cell situated immediately after the missed approach point was *painted*<sup>45</sup> on the weather radar on the PIC's Navigation Display.

The crew continued past the missed approach point and entered into IMC and subsequently into heavy rain.



**Figure 9: PFD and NAV display<sup>46</sup> showing weather and missed approach track.**

**NOTE:** In Figure 9, the windscreen wipers are ON (activated). The Triangle circled on the NAV display represents the aircraft.

<sup>45</sup> To create blip on radar display, especially one giving position of aircraft or other object. (Source Cambridge Aerospace Dictionary.)

<sup>46</sup> Photo from the cockpit video



Figure 10: Passing 370 ft on descent. Showing **PULL UP** on PFD display<sup>47</sup>

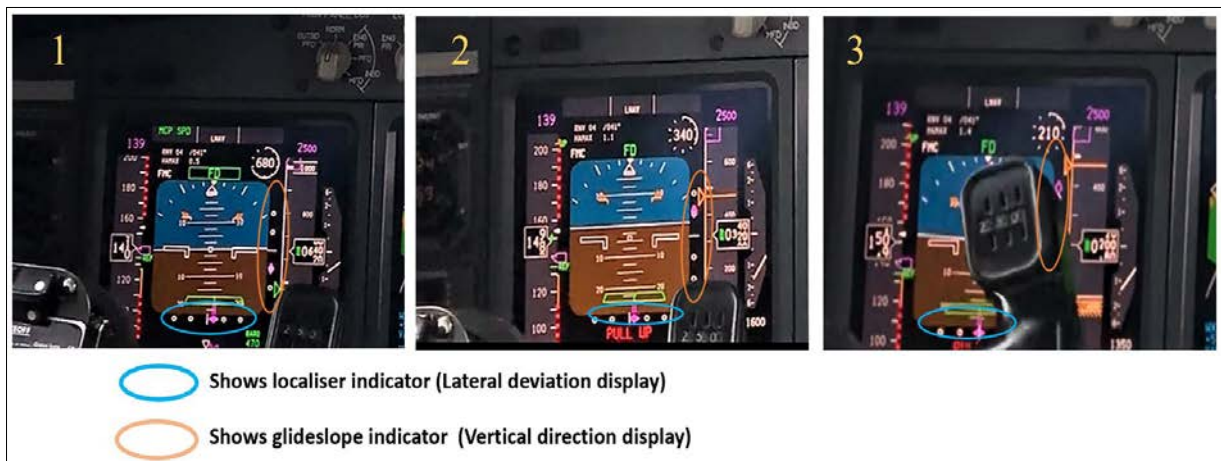


Figure 11: PFD display<sup>48</sup> showing location of aircraft with reference to the localiser (Loc) and glideslope (GS) indicators.<sup>49</sup>

Picture	Pressure Alt	Radio Alt	GS Indicator	Loc Indicator	Remarks
1	625 ft	677 ft	1 dot low	Half dot right	Autopilot disengaged
2	333 ft	392 ft	1 dot high	Slightly half right	“Sink Rate” aural alert Visual “ <b>PULL UP</b> ” on PFD
3	210 ft	259 ft	Above 2 dots	On the Localiser	Visual “ <b>PULL UP</b> ” on PFD
<b>Note:</b>	The GS and localiser indicators showed that the aircraft rapidly deviated from the glideslope. However, the aircraft was manually flown back on the localiser as shown on picture 3 above. Furthermore, the localiser indicator provided lateral navigation assistance to the PIC and the words “ <b>PULL UP</b> ” were displayed in bold red print directly below the localiser indicator.				

Table 3: Description of the PFD displays in Figure 11.

<sup>47</sup> Photo from the cockpit video.

<sup>48</sup> Photo from the cockpit video

<sup>49</sup> Refer to Section 1.18.8



Figure 12: One second before impact. Showing **PULL UP** on PFD display<sup>50</sup>

There was no evidence that the high rate of descent (ROD) was caused by environmental forces. The CVR data and video synchronizations do not show any sign of the crew noticing any unusual aircraft displacements against control inputs, nor a notion of a subtle recovery. There was evidence, though, that aircraft movements during the approach were in response to positive control inputs by the PIC.

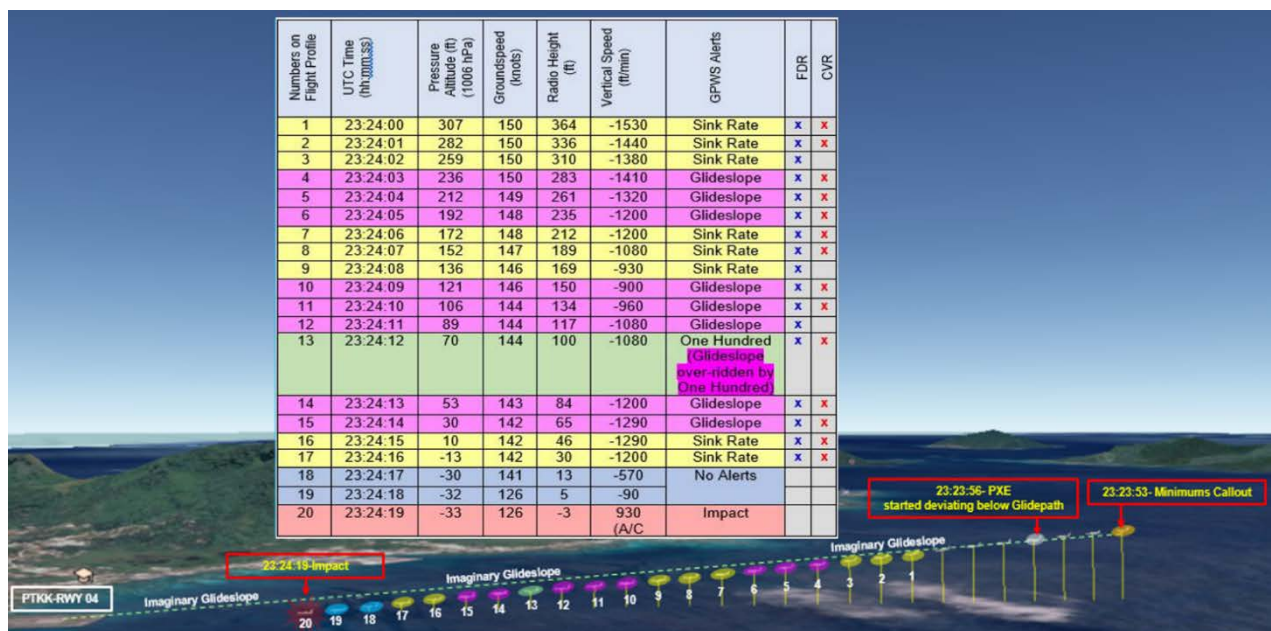


Figure 13: Glideslope and Sink Rate aural alerts graphic plotted using Derived Data

(Refer to Chapter 5 Appendices, Section 5.7 Appendix F for larger version)

The investigation determined that the crew of PXE were fixated on the task of landing the aircraft and did not notice the visual **PULL UP** caution alert at the bottom of their PFD. Therefore, they (crew) did not recognise the need and urgency take any positive action to arrest the high rate of descent and avoid landing in the lagoon.

<sup>50</sup> Photo from the cockpit video.

### 1.11.5 EGPWS Glideslope alerts during the previous sector Chuuk to Pohnpei flight PX 072 on 27 September 2018

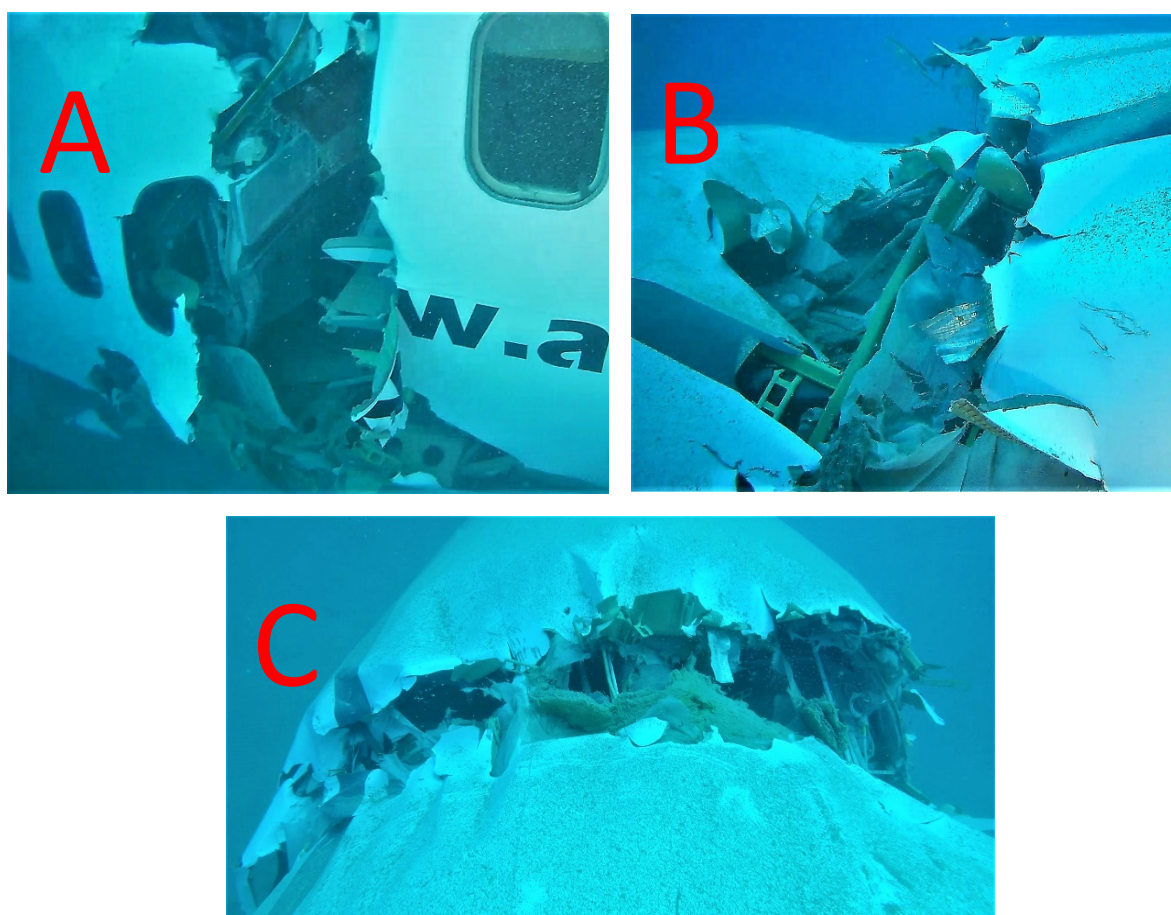
The investigation also found that on the previous flight flown by the same pilots, Air Niugini flight PX072 into Pohnpei on 27 September 2018, the EGPWS issued a total of twenty-eight (28) “*Glideslope*” aural alerts during final approach to land on runway 09 (see *Appendix F, Section 5.7.3 - Pohnpei Approach Runway 09 (EGPWS – 28 Glideslope aural alerts)*).

The flightpath into Pohnpei was significantly below the 3-deg flightpath (glideslope) thus prompting the EGPWS to issue the “*Glideslope*” aural alerts. The flight crew did not take corrective action to bring the aircraft back onto the required flightpath.

During that approach while the EGPWS alerts were annunciating, the flight crew disregarded and continuously talked over the aural alerts.

## 1.12 Wreckage and impact information

Prior to the wreckage sinking to the seabed of the Chuuk Lagoon, the rear fuselage had fractured around the lower fuselage behind the wings adjacent to seat rows 17 and 22. The aircraft sank in 90 ft of water to the Lagoon before impacting and coming to rest on the seabed. The impact with the seabed caused the fracture to extend across the upper fuselage (See Figure 14).



**Figure 14: In the area of seat row 22. A Fuselage fracture left side and behind the wing. B Upper fuselage fracture behind wing. C Rear fuselage fracture behind wings**

To a large extent the rear fuselage remained connected to the forward fuselage by plumbing, cabling, and some minor structural components.

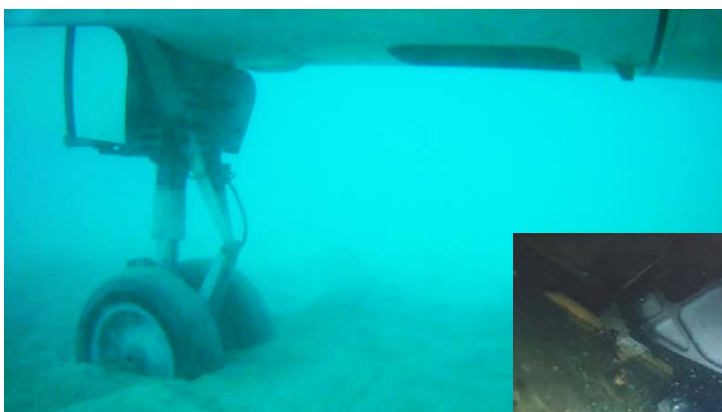


**Figure 15: Fuselage fracture right side behind the wing at wing root, in the area of seat row 22**



**Figure 16: Fuselage fracture right side behind the wing showing wing flap separation**

The main landing gear separated from the aircraft during the water impact, but the nose landing did not appear to have sustained impact damage.

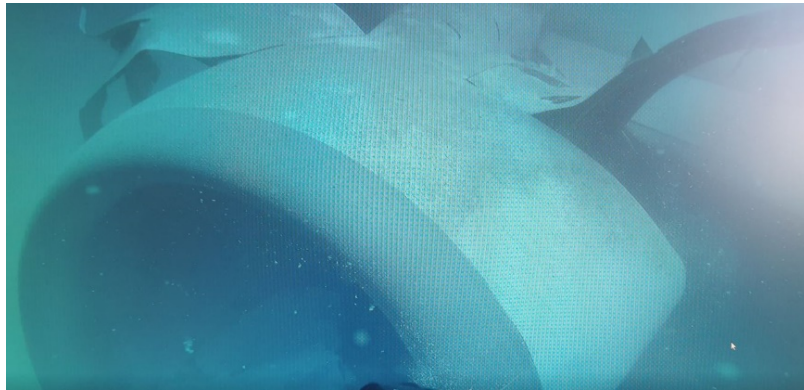


**Figure 17: Nose landing gear assembly**  
(Avionics bay in belly behind landing gear)



**Figure 18: Nose landing gear assembly looking into the landing gear bay**

The engines remained attached to the wings' pylons, but sustained major impact damage.



**Figure 19: Right engine attached to wing pylon**



**Figure 20: Left engine attached to wing pylon**

The underwater photographs revealed that the vertical stabiliser, horizontal stabilisers, outboard wings and control surfaces sustained minor or no impact damage.

The main cabin doors and over-wing exit doors were all present.

### **1.13 Medical and pathological information**

According to a statement provided by the Chuuk State Hospital Doctor who examined both pilots after the accident, neither of them were found to have been affected by drugs or alcohol.

A post mortem was conducted on the deceased passenger by the FSM State Pathologist. At the request of the FSM Investigator, a confirmation Post Mortem was conducted in Chuuk by the PNG State Pathologist.

The Pathologists' reports stated: *"the deceased passenger received blunt force trauma injuries to the skull and face."* The pathologists concluded that the passenger was not wearing a seat belt at the time of the impact, which allowed his body to become a projectile sustaining traumatic head and facial injuries.

There was no evidence of drowning and the Pathologists concluded that the passenger would have been severely concussed and died within the first 3 minutes of receiving the traumatic head injuries.

## 1.14 Fire

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

## 1.15 Survival aspects

### 1.15.1 The occupants

Most of surviving occupants egressed the aircraft unaided. The six seriously injured passengers were assisted from the aircraft via the left aft over-wing exit, by cabin crew and passengers.

The surviving occupants were rescued by local boaters and US Navy divers on assignment nearby, using small boats.

After the aircraft stopped, water rapidly entered the aircraft cabin from the fuselage fracture behind the wings in the areas of seat rows 17 and 22.

There were 12 crew and 35 passengers on board.

- The local boaters rescued 28 passengers and two cabin crew (CC5 and CC6) from the left over-wing exits. Two cabin crew (CC1 and CC3), the two pilots and the engineer were rescued by local boaters from the forward door 1L. All injured passengers were evacuated from the left over-wing exits.
- The US Navy divers rescued six passengers and four cabin crew (CC2, CC4, CC7 and CC8) and the Load Master from the right aft over-wing exit.
- One deceased passenger was found in the aircraft by Japanese divers seconded by the FSM government divers. The deceased was subsequently recovered by US Navy divers.

On the day after the accident, the US Navy divers reported to the Chuuk Airport Rescue Coordination meeting, attended by investigators from the FSM Government, PNG AIC and Air Niugini personnel that they had searched the aircraft from front to back and back to front and that the cabin was clear.

The search parties, therefore, concentrated their search away from the aircraft. After 3 days of searching away from the water. The AIC requested that the FSM IIC approve a verification search of the aircraft. A team of certified and highly experienced Japanese divers, seconded by the FSM government, were taken to the accident site to dive and search the aircraft. The search was coordinated by the AIC on behalf of the FSM IIC. The sea was heavily contaminated by fuel and the fuel could be seen across the surface. The fuel leak continued for days.

The divers located the deceased passenger lying on his back on the floor between seat 22 and 23 aircraft; the location of the fuselage fracture.

The US Navy dive team volunteered their specially designed equipment and personnel to extract and recover the deceased. The body was recovered by the US Navy divers on the same day and transported to the Chuuk State Hospital.

Cabin crew member CC2 found a passenger under water in the aisle and lifted him above water level, and with the assistance of cabin crew CC4 pulled him forward towards the left aft over-wing exit. He was from seat 22A and was seriously injured. On reaching the exit area they rolled the passenger onto his stomach over a seat arm rest and by that action were able to have the water ingested by the passenger expelled through his mouth and nose. They were then joined by CC6 and together they lifted the passenger through the exit and into a rescue boat.

One passenger was found by CC6 still strapped in his seat 17F. CC6 unfastened his seat belt and dragged the passenger to the left aft over-wing exit where passengers on the wing assisted his removal from the aircraft.

The Pathologist reported that the deceased passenger succumbed to injuries within 3 minutes of the accident and there was no evidence of drowning.

He also reported that the lack of bodily trauma around the waist and hips indicated that the deceased was not wearing a seatbelt at the time of impact which allowed his body to become a projectile resulting massive head trauma injuries.

By the time the water had reached the Business Class cabin the pilots and engineer were still in the cockpit and the door was locked. CC1 banged on the cockpit door and yelled for the pilots to come out. The engineer left the cockpit first, followed by the copilot who both boarded a boat at door 1L.

Cabin crew CC1 and the PIC yelled commands for the US Navy divers to leave the aircraft, which they then did via the right aft over-wing exit. Cabin crew CC1 then boarded a boat at door 1L followed by the PIC who was the last survivor to leave the aircraft.

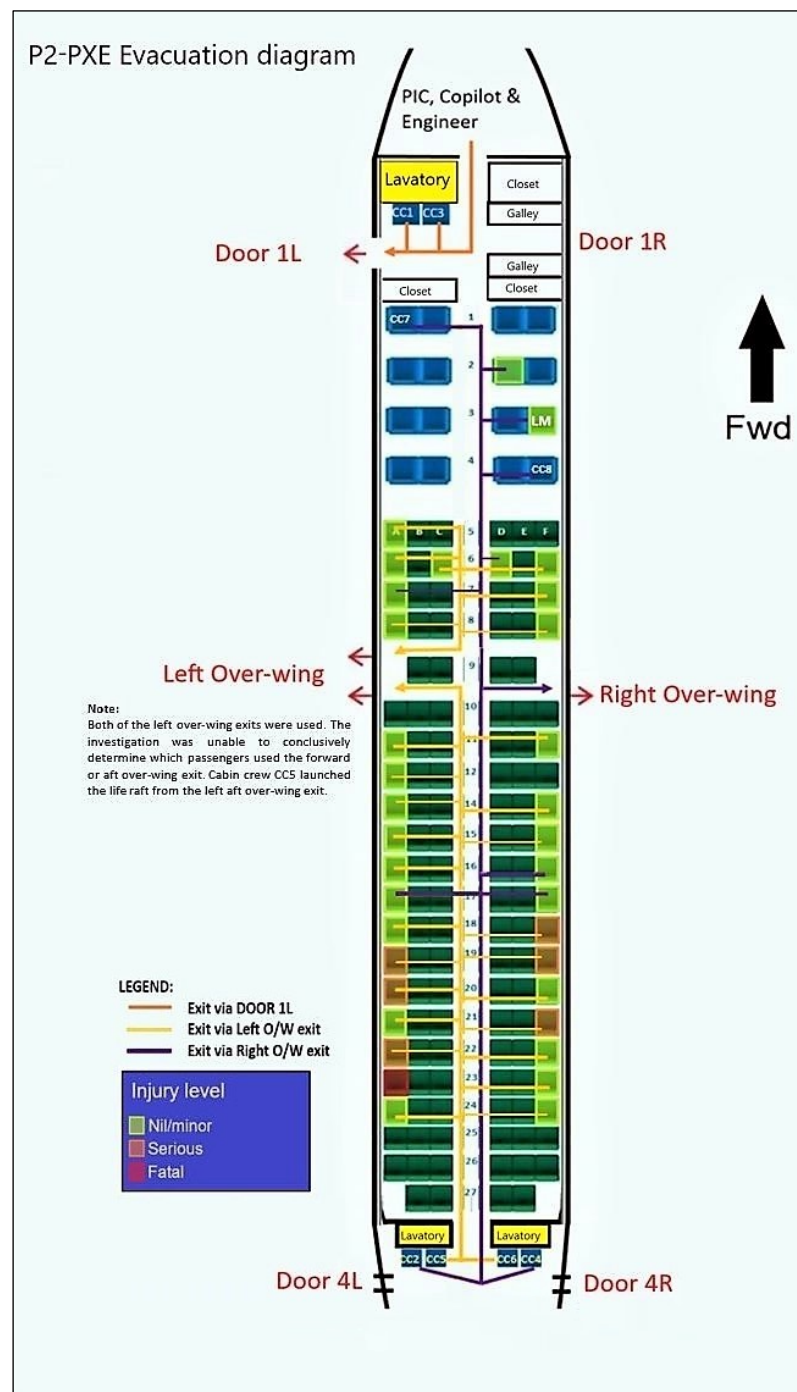


Figure 21: Passenger and crew evacuation diagram

## 1.15.2 Life rafts

The forward left passenger door 1L was opened by CC1.

The 56-person life raft stowed in the ceiling between Business Class Rows 1 and 2 reportedly partially inflated while being brought to door 1L. CC1 said: “...tugged the Lanyard, but only one chamber inflated.” She said: “I did it twice more. CC3 came and gave two pulls [the lanyard], but nothing happened.” At interview one of the cabin crew said that she kicked it out of the way so it would not obstruct the evacuation. The rescue boats arrived at the aircraft so the life raft was pushed out of the way.

CC1 advised that she declared the Door 1L exit blocked, but by that stage most of the passengers were out in the boats having left the aircraft via the over-wing exits. Door 1R was not opened for the evacuation of the crew.

During the investigation interview, CC1 stated that she inadvertently bumped the flight engineer who fell into the half-inflated life raft as he was moving from the cockpit to Door 1L.

The investigation examined photographic evidence and found that two life rafts were in the water and one was on a seat in the over-wing exit row and had not been used because of the abundance of small rescue craft that came to the crash site. There was a life raft container/cover on the floor at seats 1A and 1B.

The local divers recovered the unused life raft and it was brought to Port Moresby for examination. It still had a 3,000 psi charge in the carbon dioxide pressure bottle. Initially it could not be inflated, despite at least nine forceful tugs on the inflation lanyard.

Subsequently, one of the Lessor’s engineers opened the cover and freed the tube between the pressure bottle and the gas release cable. It then inflated on the second tug of the lanyard.

One of the three life rafts did not inflate as designed, and one raft was not deployed.

The investigation examined the *Air Niugini Training Reference Manual*<sup>51</sup> (TRM) with respect to emergency evacuations.

Section 7.11.19.3 of the TRM had diagrams of an inflated life raft (a side view and a plan view), but the captions describing the various parts of the life raft had very small blurred fonts and therefore were unreadable.

The description in Section 7.11.19.3 stated that the life raft:

*Should be tied to the aeroplane before launched with the mooring line which is located under a flap at one end of the life raft.*

*NOTE: When the life raft is carried to an exit, care must be taken to keep the mooring line folded under the flap to prevent inflation inside the aeroplane. If the life raft should accidentally inflate it must be punctured immediately.*

Section 7.11.19.3, *Equipment attached to the life raft*. The first point states:

### *Mooring line*

*This line should be used to tie the life raft to the aeroplane to prevent them to drift away. After the line has been attached to a seat leg and the life raft has been launched the line is pulled until the inflation bottles open and inflate the life raft.*

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<sup>51</sup> CASA PNG does not approve the Air Niugini Manuals, rather it accepts the Air Niugini Manuals.



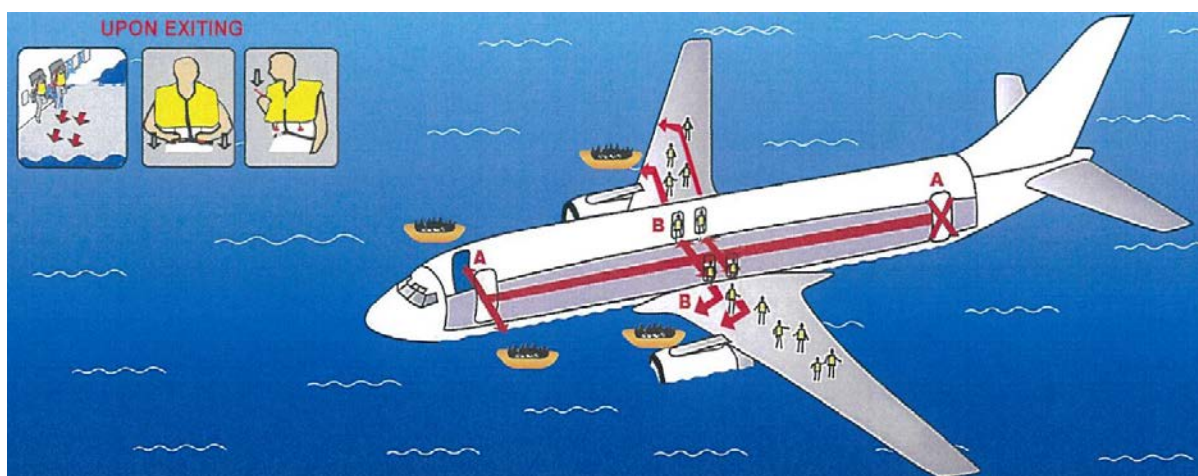
**Figure 22: 56-person life raft cover on the floor in front of Business Class Seats 1A and 1B.**  
(Photo taken by FSM diver)

### 1.15.3 On-board passenger safety briefing

PXE, was equipped with one life raft for deployment from the forward left door (door 1L), one life raft for deployment from the left over-wing exits, and one raft for deployment from the right over-wing exits. The other Boeing 737-800 in the Air Niugini fleet, P2-PXC has the same level of equipment.

Section 2.14.4.1 of the *Air Niugini Limited Safety and Emergency Procedures Manual*<sup>52</sup> (SEP)–Volume 6 (B737) specifies that only door 1L is to be opened when employing the *B737-800 Ditching Drills (with life raft)*. Door 1R is to be disarmed, but is not to be opened. The raft is to be deployed through Door 1L.

The investigation determined that the *Safety on Board Card* (passenger briefing card) for P2-PXC and P2-PXE incorrectly showed a path to the doors 1L and 1R with a life raft deployed from each door.



**Figure 23: Safety on Board Card (Version PX3-11009 Rev.A) Incorrect depiction.**

### 1.15.4 Life raft locations in P2-PXE

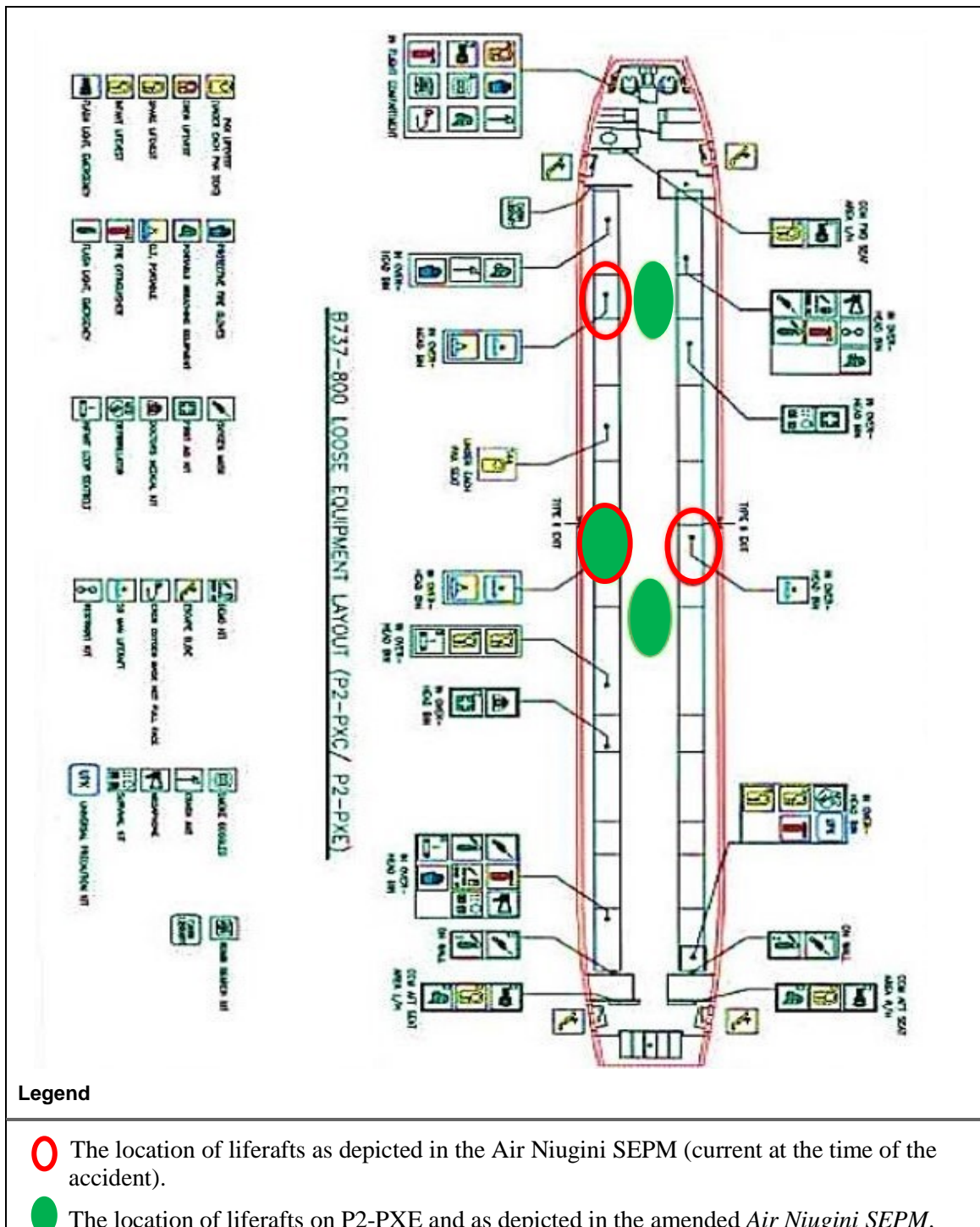
The investigation determined that the actual stowage locations of two life rafts on PXE were incorrectly depicted in the *Air Niugini SEPM – Volume 6 (B737) Section 3.2.2 titled P2-PXC / P2-PXE – location of Emergency Equipment*.

<sup>52</sup> CASA PNG does not approve the Air Niugini Manuals, rather it accepts the Air Niugini Manuals.

The life raft in the Business Class area was depicted as being stowed in the second left overhead locker (Row 2). The Economy Class life rafts were depicted as being stowed in the left and right overhead lockers above the over-wing emergency exit rows 9 and 10.

The actual life raft stowage locations on Air Niugini's Boeing 737's PXE and PXC are as follows:

- The Business Class life raft is stowed in the cabin ceiling between seat rows 1 and 2.
- One Economy Class life raft is stowed in the ceiling between rows 12 and 14, behind the over wing exit row; and the other life raft is stowed in the left overhead locker above the exit rows 9 and 10.



**Figure 24: Diagram modified from Air Niugini SEPM – Volume 6 (B737) Section 3.2.2.**

*Note: Coloured circles added by AIC for emphasis*

### 1.15.5 Procedures for egress after ditching

The Air Niugini *SEPM* ditching procedures from the front doors differ depending if there is a life raft deployed. *SEPM, Vol 6, 2.14.4.1* with a life raft and *SEPM, Vol 6, 2.14.4.2* without a life raft.

If a life raft is available it is required to be deployed from door 1L. Door 1R is to be disarmed, but not opened.

If no life raft is available, both doors 1L and 1R are to be opened and evacuation is to be made through both 1L and 1R using life jackets.

Door 1R was not opened and used in accordance with the procedures when no life raft is available at Door 1L in compliance with *SEPM, Vol 6, Sect 2.14.4.2*.

### 1.15.6 Passenger and crew egress

Some passengers reported that the cabin crew panicked and were yelling or shouting commands. However, the investigation determined that such voice projections were necessary to ensure instructions were heard by all passengers in the aircraft. The cabin crew stated during their interviews that during the evacuation they shouted the word “*evacuate*”, but it appeared that some of the passengers did not understand what it meant. They then shouted the phrase “*Get Out*” repeatedly which the passengers seemed to understand and followed.

The AIC investigation found that the CC5 who was responsible for the over-wing exit doors, experienced difficulty moving from the aft cabin crew station to the over-wing exits due to passenger congestion in the aisle. Her assigned duty in the event of an emergency evacuation was to reach and open the over-wing emergency exit. To get to the over-wing exits, in compliance with her assigned duty and in accordance with the Air Niugini *SEPM*, in addition to yelling her commands she had to use mild force and shove passengers out of her way.

The AIC’s investigation team reviewed video footage taken during the evacuation of PXE at Chuuk and noted with concern that there were many instances of non-compliance with evacuation directives prohibiting baggage, including hand baggage, being removed from the aircraft during the evacuation.

A couple of passengers stated in their response to the written questionnaire that they were annoyed that a cabin crew member at the over-wing exit forced them to leave cabin baggage in the aircraft. However, despite the instruction, several passengers still egressed the aircraft with their bags.

One of the cabin crew members took a uniform issued hand-bag from the front of the aircraft, through the cabin to the right over wing exit. Likewise, the load master carried a backpack, a clipboard and shoes off the aircraft. Both of his hands were full.



**Figure 25: Load master getting into a rescue boat with baggage taken from the aircraft, both hands full.**

There were two notable instances where the removal of baggage by passengers slowed the egress.

One passenger stopped inside the aircraft and leaned out the right aft over-wing exit to pass a carry-on bag to a US Navy diver standing on the wing assisting the evacuation. That diver first threw the bag to the divers in the rubber inflatable boat before assisting the passenger from the aircraft.

When the passenger was on the wing, he removed his life jacket and he was then observed to be wearing a shirt with US NAVY printed on it. He remained on the wing for a short time trying to assist the US Navy divers evacuate passengers, cabin crew and the Load Master egressing via the same over-wing exit, which gave the appearance that he was part of the US Navy rescue group.

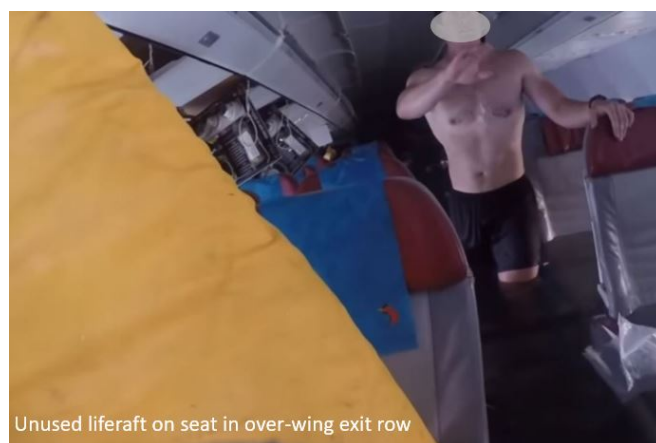


**Figure 26: The first passenger exiting via the right aft over-wing exit after passing a bag to US Navy diver who threw it to divers in the boat.**

(See paragraph 1.15.6 for details of the evacuation)

Another instance was where a passenger who had egressed the aircraft with cabin baggage (a backpack) was assisted by the US Navy divers to re-enter the aircraft and move forward to retrieve his shoes.

Video footage also showed a US Navy diver standing in thigh deep water two rows behind the over-wing exit in the cabin cautioning fellow rescuers and aircraft crew standing at the exit not to go further aft. He also exclaimed for them all to be careful as he did not know the depth of the water.



**Figure 27: US Navy diver cautioning not to go aft due unknown water depth**

### 1.15.6.1 Cabin Crew evacuation commands

During the interview, the cabin crew stated that because some passengers with lingual diversity on Air Niugini flight PX073 did not respond to the command “*Evacuate*”, they used the evacuation command “*Get out*”. Passengers quickly reacted to “*Get out*”, instead of “*Evacuate, Evacuate .....*”, as stipulated in the *Air Niugini SEPM volume 6, section 2.14.4.2 Evacuation commands with life rafts*<sup>53</sup> (see Chapter 5 Appendices, section 5.4.3, figure 37).

### 1.15.7 Exits and passengers in exit row

A review of *US Federal Aviation Regulations (FAR)* and *PNG CASA Rule Parts* regarding exit row seating requirements determined that there are no regulations or rules on over-wing exit row requirements.

The relevant Air Niugini manuals were reviewed to ascertain if procedures for over wing exit requirements were documented. There was no documented procedure in the Air Niugini manuals regarding over-wing exit procedural requirements.

In the case of the PXE ditching accident at Chuuk, a safety briefing card for passengers seated in an over wing exit row was available (refer Chapter 5 Appendices, Section 5.4.2 of this report), but because there were no passengers seated in the exit rows, no extra over-wing specific verbal briefing by the cabin crew was given to any passenger.

No one was seated in the over wing exit rows, and so no passenger was given the briefing titled “*Important information for passengers seated in an over wing exit row*”. (refer Chapter 3 – Appendices, Appendix C – Cabin Safety section 5.4.2)

Immediately after the ditching, cabin crew CC5 moved forward from her cabin crew station at the rear of the cabin to the over wing emergency exit row. Due to the congestion caused by passengers standing in the aisles, her attempt to reach the over wing exits was slowed.

This flight did not have a full passenger load. There were numerous empty seats. In the event of a full capacity flight, the cabin crew would have had significant difficulty reaching the over wing emergency exit.

### 1.15.8 Emergency Exit Lights

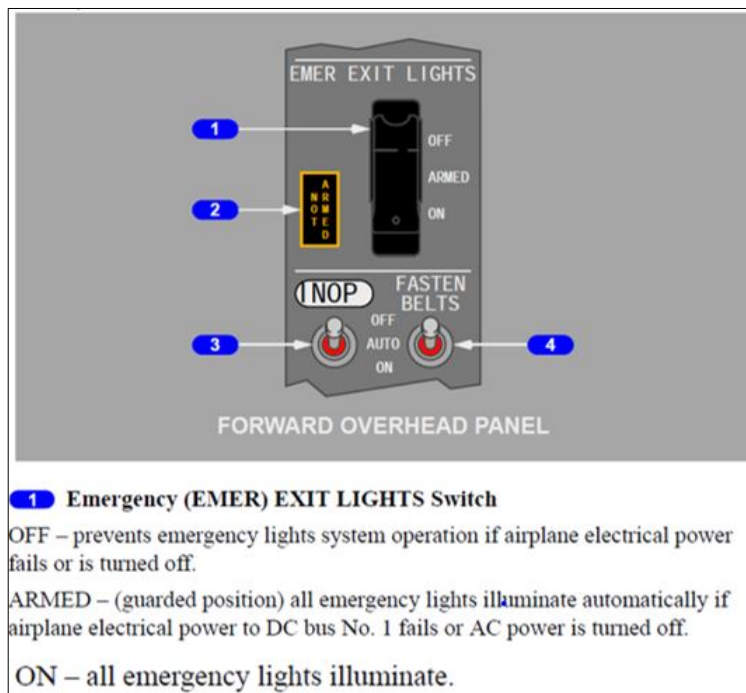
The investigation found that the internal and external emergency lighting did not illuminate following the impact. The reason(s) the armed emergency lights did not illuminate could not be determined.

There was no procedure in any Air Niugini manual or the *Quick Reference Handbook (QRH) Evacuation Checklist* that would require the pilots to activate the emergency lights for evacuation.

The investigation determined that it is essential for the emergency lights to be activated in the event of any occurrence requiring evacuation to assist with visibility in the aircraft during evacuation.

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<sup>53</sup> Refer to Chapter 5 Appendices, Section 5.4.3 - Air Niugini Safety and Emergency Procedures Manual (SEPM) volume 6, section 2.14.4.2.

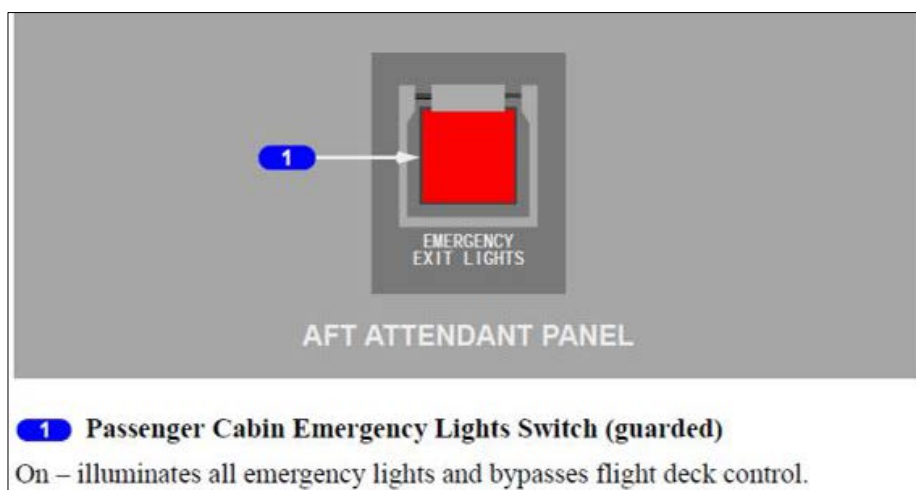


**Figure 28: Cockpit Overhead Panel Emergency Light switch**  
(Source: Air Niugini B 737-800 Flight Crew Operating Manual)



**Figure 29: P2-PXE Cockpit Overhead Panel Emergency Light switch during the approach**  
(Source: Snapshot taken from video taken by jump seat occupant from top of descent to impact.)

There is a *Passenger Cabin Emergency Lights Switch* at the *Aft Attendant Panel (Cabin crew station)*. When switched on (activated) that switch bypasses the flight deck (cockpit) emergency light switch and illuminates all emergency lights.



**Figure 30: Aft Attendant Panel Emergency Light switch**  
(Source: Air Niugini B 737-800 Flight Crew Operating Manual.)

The *Air Niugini Boeing B737 – 800 FCOM*<sup>54</sup> described the aircraft (PXE) as being fitted with exit lights located throughout the passenger cabin to indicate emergency exit routes.

<sup>54</sup> CASA PNG does not approve the Air Niugini Manuals, rather it accepts the Air Niugini Manuals.

The *Air Niugini TRM, Section 10.8.3* stated that:

*The emergency lighting system was controlled by a switch in the flight deck and was to be placed in the ARMED position prior to flight. In that position, all interior and exterior emergency lights illuminate automatically if there is a total loss of electrical power.*

Pilot(s) can illuminate the emergency lights at any time by placing the flight deck emergency lights switch to ON. The emergency lighting switch located on the Flight Attendant panel at the aft entry door can also be used to bypass the flight deck switch and illuminate the emergency lights, regardless of the position of the flight deck switch.

The flight deck aft DOME light contains a separate bulb that is powered by the emergency lighting system to provide illumination for the flight deck evacuation.

The investigation found that the relevant Air Niugini manuals including the *QRH* did not provide instructions or emergency procedure(s) for the manual operation of the emergency lighting switches located in the *cockpit overhead panel*, or on the *Aft Attendant's Panel*. Therefore, manual activation of these emergency lights by pilots and cabin crew was not required at the time of the accident.

The investigation determined that manually switching on the emergency lights, after engine shutdown, for aiding evacuation is an essential action, just in case the lights don't activate automatically. There have been occurrences in the past where engine shutdown could not be achieved which would mean individual generator shutdown or bus isolation in order for complete power loss.

On the basis of these safety concerns, Air Niugini Limited has acted on the *AIC Safety Recommendation* by including the requirement in the *SOPM*, and has undertaken to request Boeing to include the item in a revision to the *QRH Evacuation Checklist*. Refer to *Paragraph 4.2.12* of this Report, *AIC Safety Recommendation AIC 19-R11/18-1004*.

### **1.15.9 Rescue coordination centre (RCC)**

The Chuuk Airport Emergency Operation Committee facilitated the transport of all surviving passengers and crew to the Chuuk State Hospital for medical assessment and treatment.

## **1.16 Tests and research**

The investigation was unable to determine why some passengers and at least two cabin crew had difficulty in tearing open the lifejacket covering / packet to access the lifejacket.

The investigation obtained samples of life jackets for testing. The life jacket packets were immersed in salt water for 10 minutes. They were then opened without difficulty.

(See also *Section 1.18.2.2*)

## **1.17 Organisational and management information**

### **1.17.1 Aircraft Owner : Loftliedder / Icelfander**

Address : Reykjavikurflugvelli  
101 Reykjavik, Iceland

Loftliedder / Icelfander leased the Boeing 737-8BK, P2-PXE to Air Niugini Limited.

### **1.17.2 Aircraft Operator : Air Niugini Limited**

Address : Air Niugini Haus  
Jacksons International Airport,  
7 Mile, NCD

Air Operator Certificate Number: 119/010

Air Niugini Limited is the national airline of Papua New Guinea, with its headquarters office in Air Niugini Haus on the property of Jacksons International Airport, Port Moresby, PNG. Its main operational base and maintenance base is located at Jacksons International Airport at 7 Mile, Port Moresby. Air Niugini operates a domestic network from Port Moresby to all 12 major airports, and also operates international scheduled air services to Asia, Oceania, and Australia.

In accordance with its *Annex 13 and 19 Standards (obligations)*, the AIC team reviewed the *Risk Assessment Reports* conducted by Air Niugini in 2016 for the commencement of services to Chuuk, FSM, and for the re-commencement of services after the accident.

Documents obtained from Air Niugini were:

- Risk Assessment RA/003/16 Rev 01 had Review dates: 12/05/2016; 25/05/2016; and 27/05/2016.
- Risk Assessment RA/003/16 Rev 03 had Review dates: 25/05/2016; 07/07/2016; 30/08/2016; and 29/11/2016.
- Risk Assessment RA/018/18 dated 03/10/18.

The investigation determined that the content in the risk assessment table were, in most cases, listed in the wrong columns. General company guidance questions for the risk assessment were listed in the 'Hazards/risks' column, where actual identified hazards/risks were supposed to be listed.

The identified situations, hazards and risks were listed in the 'control methods and monitoring' column where the actions to eliminate or reduce the hazards were supposed to be listed. Company mitigation or control measures in almost all cases were not listed in the document. The few that had the operator's control measures/mitigation actions were, without distinction, listed with the identified hazards/risks in the 'control methods and monitoring' column. Although the hazards and risk mitigation action and control measures were not established and listed, they were accepted and closed.

The investigation found that the *Risk Assessments* did not meet the ICAO Standards for Safety Management Systems and in general were not in accordance with Risk Assessment audit standards and methodology.

*Annex 19, Framework for a Safety Management System lists:*

*2. Safety risk management*

*2.1 Hazard identification*

*2.2 Safety risk assessment and mitigation*

Safety deficiencies found during the investigation included that in the Air Niugini *Risk Assessment* documents there was little evidence of hazard identification being completed by Air Niugini during each of the risk assessment exercises. Detailed documents supporting the AIC's concerns were supplied to Air Niugini Limited.

The PNG AIC raised safety concerns of the inadequacy of the Risk Assessment conducted for the Chuuk operation to Air Niugini Limited's attention. These may be an indicator of similar inadequate Risk Assessments throughout the Air Niugini network.

The *Air Niugini Corporate Safety and Quality Manual*<sup>55</sup>, Chapter 8 (*Hazard Identification and Reporting Program*), Section 14, Sub-section 14.8 *Safety Risk Management Process* states:

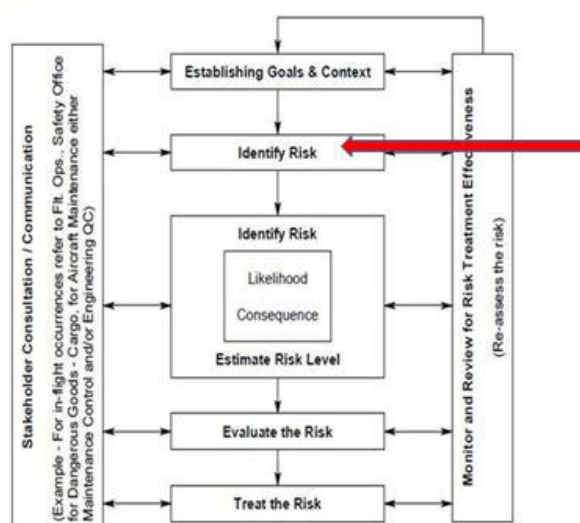
1. Establishment of the context
2. Hazard identification
3. Risk assessment
4. Risk treatment and monitoring.
5. Review / assessment of residual risk

Sub-section 14.9 does not show *Hazard identification*, but two *Identify Risk* boxes as indicated by the red arrow.

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<sup>55</sup> CASA PNG does not approve the Air Niugini manuals, rather it accepts the Air Niugini manuals.

## 14.9 Steps in Managing Risks



Also, between Sub-section 14.10, *Establishing the Context for Project Change Management*, and Sub-section 14.11 *Identifying Risk*, the *Hazard Identification* step is not included in the process.

The *Air Niugini Limited Risk Assessment* documents pre-Chuuk operations start up, and the post-accident *Risk Assessment* documents did not identify the following in order to ensure awareness and risk mitigation for flight operations into Chuuk:

- The *Chuuk International Airport Emergency Plan* did not meet *ICAO Annex 14 Standards*.
- The *Chuuk International Airport Emergency Plan* had not been exercised with respect to water emergency rescue services and therefore did not meet *ICAO Annex 14 Standards*.
- The Chuuk International Airport did not meet *ICAO Annex 14 Standards* for specialised emergency equipment and personnel for rescue in the event of an accident in water adjacent to the Chuuk International Airport that has water of three sides of the runway.
- The Chuuk International Airport runways did not meet *ICAO Annex 14 Standards*. There was no Runway End Safety Area (RESA).

Furthermore, the concerns raised in early 2019 by Air Niugini that the Chuuk *RNAV GPS Rwy 4 Approach Chart* design was in error and could induce confusion and approach path error were never brought to the attention of the AIC by the pilots of PXE, nor was it a *Risk Assessment* consideration pre-Chuuk operations start up, and in the post-accident *Risk Assessment*. There was no evidence that since Chuuk operations commenced that the risks were mitigated in flight operations procedures.

The Chuuk International Airport runways 04 and 22 do not have a runway end safety area (RESA) as required by ICAO56 Annex 14, Volume 1, Paragraph 3.5 Standard.

Following the accident, and in response to the AIC Safety Recommendation AIC 19-R08/18-1004, dated 8 February 2019, the FSM Division of Civil Aviation (DCA) notified ICAO of a difference between the FSM national regulations and practices and *Annex 14*, with respect to RESA and the requirement for specialised emergency equipment and personnel for rescue in the event of an accident in water, adjacent to the Chuuk International Airport.

At the time of issuing the Final Report the DCA had not published information about the lack of these facilities and services in the FSM Division of Civil Aviation *Aeronautical Information Service* and *NOTAMs*<sup>57</sup> in order for airlines to be aware of the safety deficiency and mitigate their operational risks.

<sup>56</sup> ICAO: International Civil Aviation Organization.

<sup>57</sup> **NOTAM** Notice[s] to Airmen, identified as notice or as Airmen Advisory, disseminated by all means to give information on establishment, condition or change in any aeronautical facility, service, procedure or hazard.

### 1.17.3 Runway End Safety Area

The absence of a Runway End Safety Area (RESA) at Chuuk International Airport is discussed in *Section 1.10, Aerodrome Information, Subsection 1.10.1 RESA*, and also in *Section 1.17.2, Aircraft Operator* in the area of *Risk Assessment*.

*Civil Aviation Rule 121.69 - Use of Aerodromes* specifies the requirements for PNG AOC holders (aircraft operators) flying to or from or outside Papua New Guinea.

#### 121.69 - Use of aerodromes

(a) A holder of an air operator certificate must ensure that an aeroplane performing an air operation under the authority of the holder's certificate does not use an aerodrome for landing or taking off unless—

(1) the aerodrome has physical characteristics, obstacle limitation surfaces, and visual aids that meet the requirements of—

(i) the characteristics of the aeroplane being used; and

(ii) the lowest meteorological minima to be used.

(2) if the operation is a regular air transport service operating to, from, or outside of Papua New Guinea after 1 January 2017—

(i) each runway at an aerodrome within Papua New Guinea that is used for the operation has a RESA at each end of the runway in accordance with the requirements of Part 139 Appendix A. or

(ii) if the runway does not have a RESA as required in paragraph (a)(2)(i), the certificate holder must ensure that the takeoff and landing performance calculations for the aeroplane are based on a reduction of the appropriate declared distances for the runway to provide the equivalent of a 90m RESA at the overrun end of the runway strip; and

(iii) each runway at an aerodrome outside of Papua New Guinea that is used for the operation has RESA that extends to at least 150m from the overrun end of the runway, or an engineered equivalent that is acceptable to the Director; or

(iv) if the runway does not have a RESA or an engineered equivalent as required in paragraph (a)(2)(iii), the certificate holder must ensure that the take-off and landing performance calculations for the aeroplane are based on a reduction of the appropriate declared distances for the runway to provide the equivalent of the RESA required in paragraph (a)(2)(iii) at the overrun of the runway.

The investigation determined that there was no evidence that Air Niugini Limited had considered the absence of RESA in its operational and performance risk assessment. It was not referenced in the *Route Guide* for Chuuk International Airport.

### 1.17.4 Civil Aviation Safety Authority of PNG

The Civil Aviation Safety Authority of 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 a number of obvious safety deficiencies and errors in the CASA PNG accepted<sup>58</sup> Air Niugini manuals and *Risk Assessment* documents, that were accepted by CASA PNG during the approval process.

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<sup>58</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals.

These did not cause the accident. However, in accordance with *ICAO Annex 13*, they were brought to the attention of CASA PNG and Air Niugini Limited through this report and associated *Safety Recommendations* with the aim of accident prevention.

## 1.18 Additional Information

### 1.18.1 Flight Operations

#### 1.18.1.1 Crew use of unapproved Electronic Flight Bag

The copilot used an unapproved electronic flight bag, which included the *Boeing Onboard Performance Tool (OPT)* that was not an Air Niugini Limited authorised operating procedure, and was not in accordance with the Air Niugini *FCOM* and *SOPM*. There was no mention in those manuals of the use of EFB as a substitute for the *Airplane Flight Manual* and other Air Niugini operational documents.

The investigation found that Air Niugini Limited had a formal Master Services Agreement with Jeppesen Sanderson Inc., for the provision of *OPSDATA SERVICES*, which included the *Airport Data Service*:

##### **Boeing Laptop Tool/On-Board Performance Tool (BLT/OPT)**

The Air Niugini Flight Performance Office had issued the *Boeing OPT* to 65 Air Niugini Boeing Captains and First Officers for training. The *OPT* was able to be applied to specific “tail numbers” of aircraft in the Air Niugini Boeing fleet, and therefore was deemed to be an accurate tool providing self-planning capability through fast and precise calculations. It also allows flight crews to calculate the takeoff analysis, landing analysis, (and weight and balance) information. Instant and accurate (performance) calculations save time by correcting for pressure variation, runway conditions, engine bleeds and *Minimum Equipment List (MEL)* items.

At the time of the accident Air Niugini Limited had not applied to the Civil Aviation Safety Authority of PNG (CASA PNG) for approval to use the *OPT* on the flight deck. Therefore, the use of the *OPT* on the Flight Deck was not approved.

The investigation determined that during the critical phase of the flight, that required analytical and methodological procedures, the copilot’s use of the electronic flight bag had the potential to overlook critical operational procedures that would require referencing the respective onboard performance charts and tables, and aircraft data available in the cockpit.

The copilot based his calculations from the EFB OPT on the use of flap 40, and did not cross check with, or refer to, the Air Niugini performance documents provided in the cockpit.

The investigation therefore, determined that the use of the *EFB* did not comply with the operator’s *SOPM*, *FCOM*, and the technical and information data contained in the specific aircraft’s *Aircraft Flight Manual (AFM)* and performance charts, and is not part of the primary flight crew duties.

*ICAO Annex 6* contains *Standards and Recommended Practices* with respect to the duties of the pilot in command (PIC). Annex 6 states;

#### **4.5 DUTIES OF PILOT-IN-COMMAND**

Paragraph 4.5.2 - The pilot-in-command shall ensure that the **checklists specified in 4.2.6** (refer below) are complied with in detail.

##### **4.2.6 Checklists**

**The checklists provided in accordance with 6.1.4** shall be used by flight crews prior to, during and after all phases of operations, and in emergency, to ensure compliance with the operating procedures contained in the aircraft operating manual and the aeroplane flight manual or other documents associated with the certificate of airworthiness and otherwise in the operations manual. The design and utilization of checklists shall observe Human Factors principles.

**Paragraph 6.1.4** - The operator shall provide operations staff and flight crew with an aircraft operating manual, for each aircraft type operated, containing the normal, abnormal and emergency procedures relating to the operation of the aircraft. The manual shall include details of the aircraft systems and of the checklists to be used. The design of the manual shall observe Human Factors principles.

The recorded information from the CVR revealed that the PIC's tolerance and non-questioning of the copilot's use of the *EFB*, and his subsequent adherence to the *EFB* data, was not in accordance with *ICAO Annex 6 Standards* and the operator's *SOPM*. Therefore, both pilots based their approach and landing performance assessment entirely on the calculations from the *Boeing OPT* contained in the *EFB*.

According to the *Annex 6 Standards*, it is the PIC's duty to ensure all procedures and checks done in the aircraft are in compliance with the procedures stated in the operator's *SOPM* and respective manuals.

Following the accident, Air Niugini acted on the AIC Safety Recommendation AIC 19-R01/18-1004 (See *Section 4.2.2* of this Report) and the AIC noted that Air Niugini Limited issued Flight Standing Orders to all company Boeing pilots that the use of Boeing OPT has not been approved and is therefore not authorised to be used for line operations.

Subsequently a further Flight Standing Order was issued to all Air Niugini Limited pilots that included the statement:

Pending the CASA PNG approval for the use of EFB and in light of the PNG Accident Investigation Commission safety recommendation, ALL flight crew shall comply with the Standard Operating Procedures Manual (SOPM) and the Flight Crew Operating Manual (FCOM) with respect to operational procedures and primary flight crew duties during flight operations.

The use of personal Electronic Flight Bag (EFB) is strictly prohibited.

For operational procedures, continue to use hard copy manuals and documents

These Flight Standing Orders are valid for 3 months pending promulgation of relevant amendments to the relevant Air Niugini Limited Manual.

### 1.18.1.2 Challenge and response

The investigation determined that the co-pilot was unaware of the quickly developing unsafe situation; tracking for the water. However, there were sufficient indications of the unsafe situation that were disregarded, which as the co-pilot, or the pilot monitoring, should have been verified and confirmed. The CVR showed that he did not question or suggest any of the actions or inactions of the pilot flying.

The *Air Niugini SOPM*<sup>59</sup>, *Section 2.5.1.4, Challenge and Response* states:

When a crew member notices a significant deviation from standard procedures during a normal flight regime, he should communicate this immediately to the crew member flying. If he does not receive a response to his challenge either verbally or by corrective action, he should immediately repeat the challenge.

If there is still no response to the second challenge, then he should take over control of the aircraft and restore safe flight condition while he obtains assistance to determine the cause of the problem.

All crew members are to be aware of this challenge and response philosophy. If they are challenged, they must be prepared to respond immediately, either verbally or by taking corrective action.

The uniform or standard used by the International Civil Aviation Organization (ICAO) when desirable or recommended for safety of flight, the operating verb is "should". When vital or necessary for safe flight the operating verb "shall" is always used.

The AIC investigation found that Air Niugini manuals tend to use the operating verb "should" instead of the imperative operating verb "shall" with respect to instructions for compliance with vital and essential safety of flight actions. The use of "shall" would ensure the importance of taking vital and immediate safety action is recognised.

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<sup>59</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals.

### 1.18.1.3 Crew Simulator Training

The PIC and copilot had attended crew resource management (*CRM*) classroom training in accordance with the Air Niugini *CRM* training program.

The stated aim of the *Air Niugini Training Policy and Procedures Manual*<sup>60</sup> (TPPM) with respect to *CRM* training is:

- Threat recognition and management;
- Error reduction; and
- Error recognition and management.

The *Air Niugini TPPM* states that the training is aimed at building crew performance required to reduce the number of errors, and building crew performance to effectively manage threats and errors.

Air Niugini provides guidance for pilots with respect to ***Challenge and Response*** requirements in *Section 2.5.1.4* of the *SOPM*.

*Section 8.21*, of the *TPPM* lists the classroom training, and states that *CRM* skills are practiced during simulator recurrent sessions and line operations.

The simulator instructor/check and training pilot who conducted the last simulator check with the copilot informed the investigation about the simulator training and checking syllabus and the results of the simulator check he conducted with the copilot.

Air Niugini pilots, including training and checking instructor pilots informed the AIC that simulator *threat and error recognition and management*, including checking during recurrent simulator training was not conducted by Air Niugini, resulting in it not being tested.

Air Niugini was unable to provide evidence of simulator *threat and error recognition and management* testing for the copilot of P2-PXE during his recurrency check prior to the accident.

The Training and Checking instructor stated that the simulator training and proficiency check did not cover this essential training, nor was it required by Air Niugini to be covered.

Evidence was provided showing that 2 years and 4 months prior to the accident, the PIC was tested for *GPWS*<sup>61</sup> *warning* during a Simulator recurrent training session. Ten months before the accident, the copilot was tested for *GPWS Alert (terrain)*.

There was no evidence that the simulator recurrency training and checking covered the vital actions and required responses to be taken by the non-flying (monitoring) pilot, in the event of a sustained unstabilised approach situation developing when below 1,000 feet amsl, and when in IMC.

During the final approach, a total of seven *Glideslope* and six *Sink Rate* aural alerts were issued. Although conditions around these aural alerts were obvious, no corrective action was taken by the pilot-in-command (flying pilot), nor was corrective action imposed by the copilot (supporting / monitoring pilot).

More broadly, across the aircraft fleet, the Air Niugini simulator training did not include training in the vital actions and responses to be taken by the non-flying pilot in the event of a sustained unstabilised approach situation developing when below 1,000 feet amsl, and when in IMC.

Following the accident, Air Niugini acted on the AIC Safety Recommendation AIC 19-R09/18-1004 (See *Section 4.2.10* of this Report) and the simulator checking is now conducted, and a CASA PNG accepted amendment has been included in the Air Niugini Training and Checking Manual (Vol 1) *Section 8.5*.

*(Excerpts of Air Niugini SOPM<sup>62</sup>, refer this Report Chapter 5 Appendices, Section 5.1, Appendix A)*

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<sup>60</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals.

<sup>61</sup> GPWS and EGPWS: Ground Proximity Warning System and Enhanced Ground Proximity Warning System.

<sup>62</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

#### 1.18.1.4 Integrated Augmented Navigation System

P2-PXE was fitted with an Integrated Approach Navigation System (IANS) that provides a display similar to the Instrument Landing System (ILS) and allows flight crew to fly any published approach that exhibits a glide path within the navigational database of the Flight Management System (FMS). Flight path guidance is derived from the Central Control Unit (CDU), navigational radios (NAV1/2 & ADF 1/2), or combination of both.

The Navigation data used by the FMS is interpreted by the IANS for navigation guidance similar to the ILS.

IANS was not installed on the other Air Niugini B737 aircraft.

On 22<sup>nd</sup> December 2015, Air Niugini Limited issued a *Flight Standing Order B737 Operational Notice No: 017/2015* to all B737 pilots, to briefly advise the procedures for use of IAN on approach. That FSO also informed that a request would be made to Engineering to reconfigure PXE's avionics to standardise with the rest of the fleet.

The FSO expired on 22<sup>nd</sup> March 2016, before the details and instructions were incorporated in any Air Niugini manuals.

The Engineering Department did not act to reconfigure PXE to standardise the avionics with the rest of the B737 fleet.

The instruction embodied in the FSO was never incorporated in any Air Niugini manuals despite Engineering not removing the IAN capability. Therefore, it was still able to be used in PXE.

Furthermore, the aircraft was not placarded to alert crews not to use IAN, even though Engineering had not disabled or removed the IAN system.

The IAN system being available on the aircraft complemented navigation and because of its integration with other aircraft systems such as the FMS, CDU and EGPWS, the glideslope alerts were being generated during a non-Precision Approach (NPA).

The aircraft continued in service from 22<sup>nd</sup> December 2015 to the date of the accident 28<sup>th</sup> September 2018 with the IANS enabled. However, the integrity and accuracy of the IANS was not monitored by Air Niugini Limited throughout that period.

The investigation determined that Navigation guidance provided by the IANS was consistent with the aircraft profile and was accurate.

Evidence shows the IANS did not cause a hindrance or adverse distraction to the flight crew.

### 1.18.2 Cabin Safety

#### 1.18.2.1 Cabin Crew Requirements

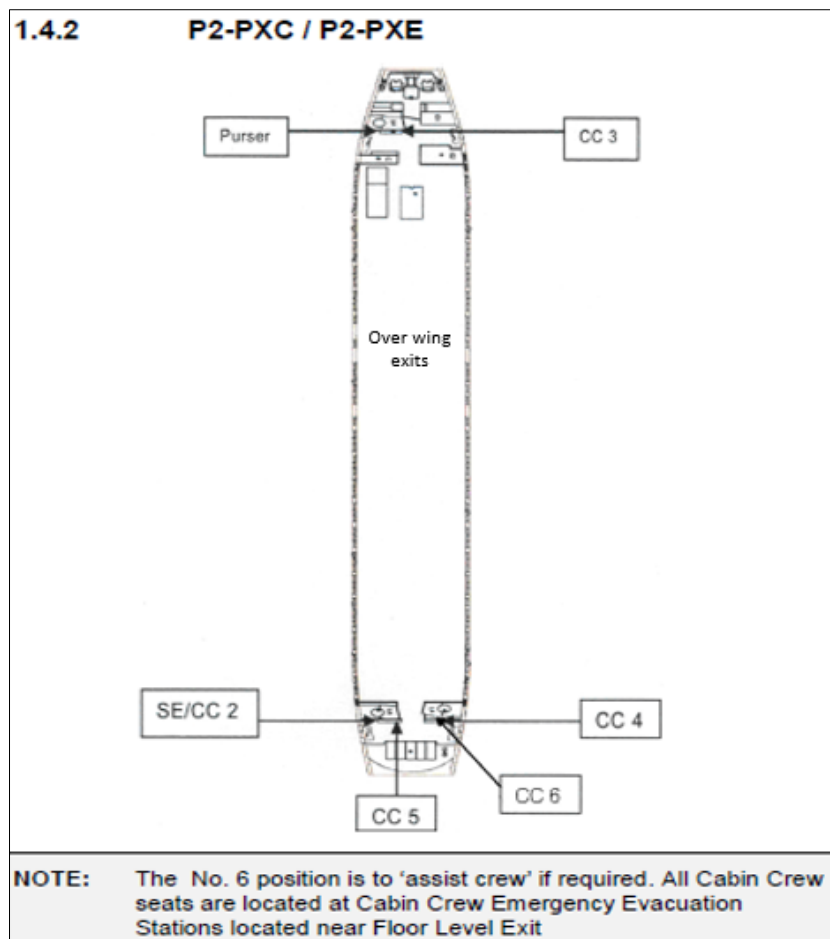
The investigation found that the seating requirements for extra crew (more than six) had not been documented in any of the Air Niugini expositions/manuals.

The accident aircraft, PXE had six (6) cabin crew seats. The flight from Pohnpei to Chuuk had a total of eight (8) cabin crew: CC1/Purser; CC2 (Senior Economy); CC3; CC4 (Trainee); CC5; CC6 (Trainer); CC7 (Check Staff); and CC8 (Observing Check Staff).

Cabin Crew 1, 2, 3, 4, 5 & 6 were seated as shown in the diagram below. CC7 and CC8 were seated in business class seats 1A and 4D respectively.

The investigation reviewed *Air Niugini SEPM Volume 6, Chapter 1, Section 1.4* and *Airport Services Manual (ASM) section 10.11.1*. The basic Cabin Crew complement on PXE was four and standard complement was six.

The *SEPM volume 6, chapter 1* and *ASM* did not contain seating allocations for the two additional Cabin Crew (CC7 and CC8).



**Figure 31: Cabin crew seating configuration Air Niugini Boeing 737-800 aircraft**

### 1.18.2.2 Life Jackets (Cabin Crew & Passenger)

The investigation revealed that four Cabin Crew who were seated at the rear bulkhead crew seats had difficulty in obtaining their lifejackets from the stowage under their seats that were submerged in the water by the time the aircraft had come to a complete stop after impact.

Some passengers also stated in their written questionnaire that they could not locate their life jacket under their seats and that they were given lifejackets either by a cabin crew or fellow passenger(s).

In addition, a couple of passengers stated that they retrieved their life jackets from under other seats, while one passenger stated that he evacuated without a life jacket and boarded the life raft, which he assisted the Cabin Crew and a fellow passenger to launch from the left over-wing exit.

Passengers and cabin crew reported that with the water in the rear cabin above knee height they had difficulty locating the life jackets under some seats. The Load Master assisted the cabin crew by going to the forward cabin and retrieving life jackets and handing them to passengers.

The investigation was unable to determine why some passengers and at least two cabin crew had difficulty in tearing open the lifejacket covering / packet to access the lifejacket.

The investigation obtained samples of life jackets for testing. The life jacket packets were immersed in salt water for 10 minutes. They were then opened without difficulty.

Furthermore, as stated by the cabin crew during the interviews, the cabin crew life jackets and torches may be better located above or adjacent to the cabin crew seat headrest within arm's length, to prevent difficulty in retrieval of these items of emergency equipment during a ditching/inadvertent water contact emergency.

### **1.18.2.3 Fasten seatbelt sign and announcement**

During the subsequent descent, after making the public address (PA), the PIC told the cabin crew:

*“prepare the cabin for arrival.”*

The cabin crew then made a PA stating:

*“Ladies and gentlemen the seat belt sign will shortly be illuminated, if you wish to use the lavatories, please do so at this time. As soon as the seat belt sign is switched on, movement in the cabin will be restricted, thank you”.*

There was no recorded information to confirm that cabin crew informed passengers to fasten their seatbelts as per Air Niugini *Safety Operational Procedures (SOP)*. However, in written answers to the investigation’s *Passenger Questionnaire*, passengers stated that the seatbelt signs were switched on and the fasten seatbelt announcement was made for landing.

## **1.19 Useful or effective investigation technique**

The investigation was conducted in accordance with the *PNG Civil Aviation Act 2000 (as amended)* and in accordance with the *Standards and Recommended Practices of Annex 13 to the Convention on International Civil Aviation*.

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## 2 ANALYSIS

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### 2.1 General

The analysis part of this Final Report will discuss the relevant issues resulting in the collision with water involving the B737-8BK aircraft, P2-PXE during its approach to Chuuk International Airport runway 04 on 28 September 2019.

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 not necessarily under separate headings:

- Use of unapproved EFB
- Flight crew actions
- Flight crew appreciation of external environment
- EGPWS
- Air Niugini Standard Operating Procedures
- Crew Resource Management
- Air Niugini manuals

### 2.2 Use of an unapproved EFB OPT

The *OPT* was designed to assist pilots with takeoff and landing performance calculations by taking inputs for aircraft, runway, and weather data and calculating expected airplane behavior. When Air Niugini purchased the *OPT*, Boeing provided unique, aircraft-specific configuration data for all of Air Niugini's Boeing fleet.

Prior to Top of Descent, the copilot used the *Boeing OPT* to calculate the approach and landing performance. The decision for the selection of Flap 40 was solely based on the *Boeing OPT* calculation done by the copilot on his EFB. The PIC did not query the source and method used to calculate and determine these operational figures. He agreed without verifying the data or instructing the copilot to verify the data using an approved onboard performance documents.

The Air Niugini Flight Performance Office had issued the *Boeing OPT* to 65 Boeing Captains and First Officers for training. The investigation determined that the copilot's use of the *OPT* was not in accordance with the Air Niugini Limited *FCOM* and *SOPM*.

The *OPT* was not approved by CASA PNG for operational use. It was therefore not to be used as primary performance calculation tool. The crew did not use any other approved means to calculate performance, except for the *OPT*.

The use of the *EFB* diverted the copilot's attention from his primary flight duties. The analytical and methodical procedures outlined in the *SOPM* and *FCOM* were overlooked during that time. The 150m landing distance buffer calculated from the *EFB* was not checked against the approved onboard charts and tables.

The investigation therefore, determined that the use of the *EFB* did not comply with the operator's *SOPM*, *FCOM*, and the technical and information data contained in the specific aircraft's *Aircraft Flight Manual (AFM)* and performance charts, and its use was not part of the primary flight operational tool or instrument.

The recorded information from the CVR revealed that the PIC's tolerance and non-questioning of the copilot's use of the *EFB*, and his subsequent adherence to the data derived from the *EFB*, was not in accordance with *ICAO Annex 6* and the operator's *SOPM*. Therefore, both pilots based their approach and landing performance assessment entirely on the calculations from the *Boeing OPT* contained in the *EFB*.

According to the *Annex 6<sup>63</sup> Standards*, it is the PIC's duty to ensure all procedures and checks done in the aircraft are in compliance with the procedures stated in the operator's *SOPM* and respective manuals.

## 2.3 Flight crew actions

During the flight, before the TOD briefing, the oral communications between the PIC, the copilot, and air traffic control were in a normal tones and in an orderly manner. However, during the approach below 10,000 feet, communication between the pilots was minimal and not in accordance with SOPs, and they were not using standard phraseology.

The PIC's intention to continue the landing was reinforced when he asked the copilot to continue the landing checklist immediately prior to the EGPWS 1,000 ft annunciation. However, the CVR indicated that the only items covered were landing gear, flaps and lights.

The copilot did not provide effective monitoring and operational support to the PIC, and did not recognise the unstable approach. The evidence showed that he was unaware of the developing unsafe conditions. Due to his lack of situational awareness and vigilance, he was unable to recognise the need to correct the ever-increasing dangerous rate of descent below the glideslope.

At the minimums call, the copilot stated *three whites* with reference to the PAPI indicating high above the glidepath. The aircraft was not on the correct flight path and the rate of descent significantly exceeded 1,000 ft per min with the *glideslope indicator* indicating a rapid deviation from *half dot* low at the MDA, to *two dots* high within nine seconds after passing the MDA in IMC.

The crew were not complying with *Air Niugini SOPs*, and demonstrated that they were not situationally aware, and that their attention was channelised. Their actions indicated that they were fixated on a particular aspect and did not address the alerts and take corrective action. The PIC said that he found the Boeing 737-800 aircraft laterally less stable with flap 40 compared with flap 30 setting, resulting in lateral overcorrections of the aircraft after he disconnected the auto-pilot.

Both pilots stated during interview that they disregarded the constant *Glideslope* and *Sink Rate* aural alerts.

Video footage of the cockpit NAV display taken by the cockpit jump seat occupant showed an area of heavy rain on the approach in front of the aircraft immediately after the MAP. The missed approach track was outside the boundary of the storm cell and rain. However, the storm cell was between the aircraft and its intended landing runway.

If the crew had made the missed approach at the MAP, they would have avoided the heavy rain.

The investigation determined that when the aircraft entered the rain, all visual reference, if established earlier, would have been lost. The PIC informed the AIC that *visual contact with the runway was lost in the final 30 seconds of the flight*.

It is inconceivable that the PAPI or the runway were visible to either pilot as the aircraft was descending further below the glideslope in the rain. From 307 ft (**364ft**), the PFD displayed a red warning; **PULL UP**. That warning was generated by the EGPWS when the rate of descent exceeded a specified limit.

However, under the circumstances where the PIC's attention was channelised, and the copilot was not effectively monitoring the displays and was lacking vigilance, that visual cue **PULL UP** was missed by both pilots. There was no aircraft generated aural **hard** warning to alert the crew to the approaching disaster.

There was ample information available to the flight crew from the EGPWS alerts and warnings to alert the pilots that the approach was unstable and therefore a hazard existed.

The *Air Niugini SOPM Vol 11.3, section 12.7* stated that:

*If a deviation exists at or below the stable approach gates (1,000 ft AGL in IMC or 500ft AGL in VMC) the PM shall make the relevant deviation call followed by the word "unstable". The PIC shall announce "Go-around" and an immediate go-around procedure shall be conducted.*

From the time the auto-pilot was disconnected at 625 ft (**677 ft**), the aircraft was never in a stabilised approach and so a go-around should have been conducted immediately.

The copilot was completely unaware of the hazardous situation unfolding and did not challenge the PIC and attempt to take control of the aircraft from the PIC and execute a go-around, in accordance with company instructions that require taking over when an unsafe condition exists.

The PIC's actions were consistent with him being trapped in the condition called 'fixated on one task' or 'one view of a situation even as evidence accumulates'. He intended to land the aircraft, and in doing so disregarded the alerts (EGPWS 'Sink Rate and Glideslope' indicating an unsafe condition).

The approach to Chuuk was unstabilised and not conducted in accordance with Air Niugini SOPs.

### 2.3.1 Human Factors and medical

The AIC obtained the services of an aviation investigation medical practitioner who has specialised in aircraft accident and serious incident medical and psychological investigations for more than 20 years. Under the provisions of the *Civil Aviation Act 2000 (as amended)* and the *Commissions of Inquiry Act*, this expert examined ALL relevant evidence and provided the AIC with assessment and findings. No evidence of fatigue was presented.

Inattention, or decreased vigilance has been a contributor to operational errors, incidents, and accidents worldwide. Decreased vigilance manifests itself in several ways, which can be referred to as hazardous states of awareness.

These include:

1. *Absorption*. A state of being so focused on a specific task that other tasks are disregarded.
2. *Fixation*: A state of being locked onto one task, or one view of a situation, even as evidence accumulates that attention is necessary elsewhere, or that the particular view is incorrect.
3. *Channelised attention*: A mental state which exists when a person's full attention is focused on one stimulus to the exclusion of all others. This becomes a problem when the person fails to perform a task or process information of a higher priority and thus fails to notice or has no time to respond to cues requiring immediate attention.
4. *Fascination*: An attention anomaly in which a person observes environmental cues, but fails to respond to them.
5. The '*tunnelling or channelizing*' that can occur during stressful situations, which is an example of fixation.

**Note:** The term 'fixation' has been chosen to describe the PIC's state of alertness, which provides a clearer idea of 'being locked onto one task', than 'absorption'. Several 'findings' support this 'tunneling or channelized' condition, for example:

- The PIC's attention became fixated on landing the aircraft.
- The crew did not respond to 13 EGPWS aural caution alerts and the **PULL UP** visual warning. The PIC did not change his plan to land the aircraft, although the aircraft was in unstabilised condition. The other tasks that needed the crew's attention were either not heard or disregarded. The auditory information about other important and hazardous things did not reach their conscious awareness.
- The PIC flew an unstabilised approach. The PIC's intention to continue to land the aircraft, from an excessively high rate of descent when in IMC and below the minimum descent altitude, was a sign that his attention was channelized during a stressful time.
- The PIC's decision to continue in IMC past the MAP and not conduct the missed approach was flawed. In choosing the landing option rather than the go around the PIC fixated on a dangerous option.

## 2.4 Enhanced Ground Proximity Warning System (EGPWS)

The investigation found that the crew did not take any remedial action in response to the *Glideslope* and *Sink Rate Caution*<sup>64</sup> alerts (aural alerts). The EGPWS additionally issued the red **PULL UP** visual alert on the PFD at 307 ft (**364 ft**) when the aircraft penetrated the *Sink Rate Envelope* of the *Honeywell EGPWS MK V Mode 1 Graph*. (See Figure 32).

During the approach the crew lost situational awareness, with their attention channelised, and the aircraft entered the storm cell with heavy rain after passing the *MAP*. The PIC did not arrest the excessive rate of descent, and flew the aircraft increasingly below the *Glideslope*.

The crew of P2-PXE were fixated on the task of landing the aircraft and did not notice the visual **PULL UP** caution alert at the bottom of their PFD. Therefore, they (crew) did not take any positive action to arrest the high rate of descent and avoid landing in the lagoon. In fact, neither of the pilots were aware of the rapidly unfolding unsafe situation.

The investigation found that the crew had received similar aural alerts on previous approaches in visual conditions where the aircraft was safely landed. This would have contributed to the perception that the alerts during the accident approach were nuisance alerts, and therefore disregarded them.

A visual display of the steady red **PULL UP** on the *PFD*, was not noticed by either of the pilots, and therefore was not sufficient to alert them to the imminent danger.

A steady message surrounded by lights during a critical phase of flight where the PIC is fixated on other displays may not be an effective means of alerting the crew that the unsafe situation has developed to the next level. The investigation determined that the light blended in with the displays and was not noticed by both pilots when it illuminated, nor did it have any features to effectively draw the attention of the crew after its illumination.

The AIC Human Factors investigation determined that it is likely that a hard aural ‘WARNING’ alert or a flashing visual **PULL UP** would have more effectively drawn the attention of the pilots during this critical phase of flight where workload was higher and attention fixated. It could be the last line of defence for any crew who may unknowingly or inadvertently get in a similar fixated situation.

The investigation found that it is important for aircraft alerting systems to be able to effectively draw attention and provide information to flight crew, to allow them (the crew), to distinguish between levels of unsafe situations as they develop. If an alert signifying an elevation of an unsafe condition is missed by crews, they may not be able to recognise that the unsafe condition has developed to the next level and requires urgent corrective action.

In January 2019, the AIC recommended to Honeywell that a continuous “WHOOP WHOOP PULL UP” hard aural warning, simultaneously with the visual display of **PULL UP** on the Primary Flight Display, should replace the *Sink Rate Caution* alerts (aural alerts) to alert a crew of imminent danger when the aircraft continues to descend below 500 ft Radio Altitude and below the glideslope.

However, during subsequent discussions with Honeywell and Boeing, the AIC was informed that such hard-aural warning might not be an option for older generation EGPWS.

From a Human Factors perspective, in the absence of a continuous “WHOOP WHOOP PULL UP” hard aural warning, changing the steady **PULL UP** visual display to a flashing visual display **PULL UP** on the PFD is desirable. That could be more effective than a steady **PULL UP** visual display to alert flight crews to imminent danger when the aircraft continues to descend below 500 ft Radio Altitude and below the glideslope. A hard-aural warning alert or flashing visual warning, demanding an immediate flight crew response would clearly be desirable in the interest of safety enhancement.

The AIC issued recommendations to Honeywell and the US Federal Aviation Administration in relation to EGPWS alerts and warnings.

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<sup>64</sup> Definitions excerpted from 14 CFR 25.1322:

- Warning: For conditions that require immediate flightcrew awareness and immediate flightcrew response;
- Caution: For conditions that require immediate flightcrew awareness and subsequent flightcrew response; and
- Advisory: For conditions that require flightcrew awareness and may require subsequent flightcrew response.

Much more research is required and the AIC is actively working with the US NTSB, FAA, Honeywell, and Boeing. The *Safety Recommendations AIC 19-R02/18-1004* and *AIC 19-R17/18-1004* addressed to Honeywell and FAA respectively will remain **Active** pending the results of the ongoing research.

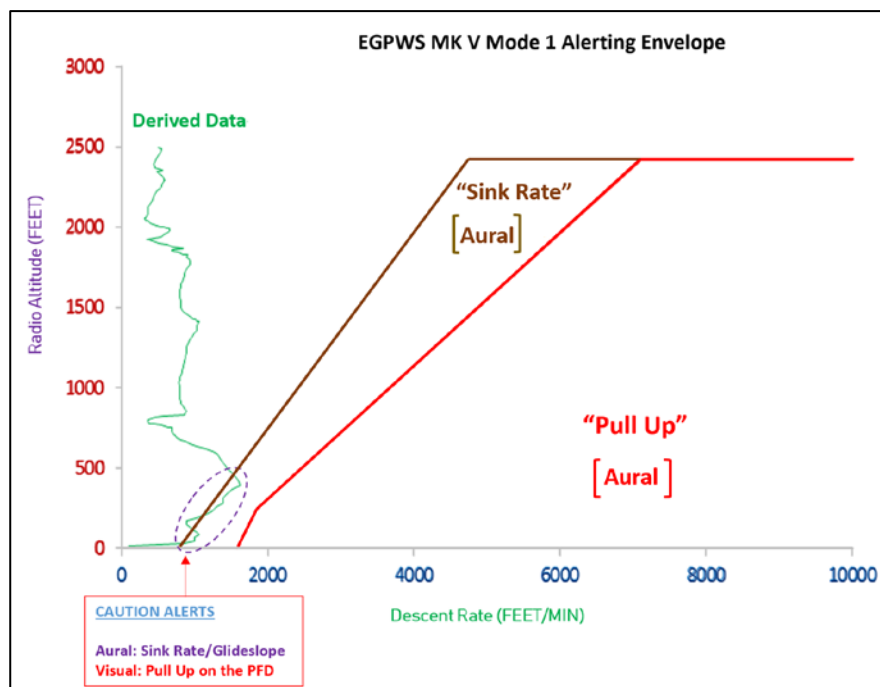


Figure 32: Derived Data plotted against Honeywell EGPWS MK V Mode 1 Graph

## 2.4.1 Previous sector Chuuk to Pohnpei flight PX 072

During the previous flight flown by the same pilots, Air Niugini flight PX72 into Pohnpei on 27 September 2018, the flightpath was significantly below the 3-deg flightpath (glideslope) thus prompting the EGPWS to issue 28 *Glideslope* aural alerts.

The pilots talked continuously about non-operational matters while the EGPWS alerts were sounding and they ignored the alerts. They did not take corrective action to bring the aircraft back onto the required flightpath to be considered a stabilised approach.

The investigation found that the approach was not stabilised and there was not a sterile cockpit environment as required by *Air Niugini SOPM*.

## 2.5 Survival

Other than the issue of the life raft partially inflating in the Business Class cabin and the attempts to inflate it while in the aircraft, and some cabin crew and Load Master leaving the aircraft with baggage, the investigation found no evidence that the cabin crew did not comply with *Air Niugini Standard Operating Procedures*.

Their actions resulted in a number of seriously injured passengers being evacuated from the aircraft.

Passenger's reports of cabin crew panic appear to be their perceptions, and in a number of cases were based on their being annoyed and frustrated at being ordered by cabin crew CC4 to leave cabin baggage and get out.

During the investigation interviews cabin crew reported that because some passengers with lingual diversity on Air Niugini flight PX073 did not respond to the command "*Evacuate*", they used the evacuation command "*Get out*". Passengers quickly reacted to "*Get out*", instead of "*Evacuate, Evacuate .....*", as stipulated in the *Air Niugini SEPM volume 6, section 2.14.4.2 Evacuation commands with life rafts*.

The majority of passengers egressed the aircraft from the left over-wing exits where the flotilla of more than 20 local boats were located. Five cabin crew and four passengers egressed via the right aft over-wing exit where the US Navy inflatable boat was located.

In this accident the pilots and engineer in the cockpit were uninjured and survived.

One passenger was fatally injured. There was no evidence of drowning, and the Pathologist concluded that the passenger died within the first 3 minutes of receiving the traumatic head injuries. The autopsy report found that this passenger, who was believed to have been in seat 23A, was not wearing a seatbelt at the time of impact.

In written answers to the investigation's *Passenger Questionnaire*, passengers stated that the seatbelt signs were switched on and the fasten seatbelt announcement was made for landing.

## 2.6 Fuel requirements

The flight planned estimated fuel on board on arrival at Chuuk was 10,400 kg. Therefore, on arrival at the MAP, the aircraft would have had an estimated minimum fuel quantity of 10,400 kg. Flight planned fuel required from Chuuk to Port Moresby was 6,227 kg.

Therefore, there was sufficient fuel for at least two missed approaches at Chuuk before diverting to Guam or Port Moresby.

## 2.7 Operational risk assessments – Air Niugini Limited

The investigation team reviewed the most recent Air Niugini Risk assessment reports conducted by Air Niugini prior to commencement of Chuuk, FSM operations, and for the recommencement of the operation into Chuuk after the accident.

The investigation found that the Risk Assessments did not meet the *ICAO Annex 19 Standards for Safety Management Systems* and in general were not in accordance with Risk Assessment audit standards and methodology.

These may be an indicator of similar inadequate Risk Assessments throughout the Air Niugini network.

## 2.8 Cockpit image recording

A cockpit jump-seat occupant videoed the approach from 3,000 ft on approach to impact using a smart phone camera. The video was of high quality. This video was an invaluable source of vital information to complement and enhance the data from the FDR, CVR, AFIRS, and EGPWS.

Video footage of the cockpit NAV display taken by the cockpit jump seat occupant showed an area of heavy rain on the approach in front of the aircraft immediately after the MAP. The missed approach track was outside the boundary of the heavy rain.

If the crew had made the missed approach at the MAP, they would have avoided the heavy rain. The video and FDR data also showed that the PIC was over-controlling the aircraft laterally.

The image recording taken from the jump seat of the Boeing 737 during the approach to Chuuk was invaluable to the investigation process and enabled the PNG AIC to develop an extremely accurate and thorough sequence of events like never seen before and in a very short time. Knowing 'what' happened almost immediately and in exquisite detail using the flight data and cockpit voice recorders and the 'image recording' sets a new standard of investigation information that, while controversial<sup>65</sup>, is long overdue.

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<sup>65</sup> The statement in *Section 2.8* about *controversy* is in relation to industry perceptions that a cockpit is private and cockpit imagery presents an invasion of privacy. A cockpit is a workplace and not a private space. Safety is paramount and perceptions of privacy provisions must never over-ride safety. It must be noted that the use of the disseminated imagery by the AIC masks the identity of the pilots and is used solely for cockpit imagery evidence for the no-blame investigation in accordance with the CAACT and *ICAO Annex 13 Para 5.12*. All evidence-based materials are vital to the investigation and are used in accordance with *Annex 13* for evidence gathering and finding the causes (contributing factors) of the accident.

Safety action is significantly compromised when there is controversy over the facts, which is often the case even with good quality FDR, CVR and EGPWS data. The imagery from the recording brought everything together in crystal clarity with irrefutable evidence.

Image recording has been readily available for many years and a Minimum Operational Performance Specification was developed by the international flight recording community through Euroace almost 20 years ago.

Despite relatively inexpensive video technology and the fact that it is now used in many professions, including police, ambulance, public road and rail transport in many countries, image recording remains elusive as a tool for aircraft accident investigators.

*Section 8(1) (b) of the Civil Aviation Act 2000 (as amended) states:*

*The principal function of the Minister under this Act is to ensure that Papua New Guinea's obligations under international civil aviation agreements are implemented.*

*ICAO Annex 13 Paragraph 5.12 (Standard)* calls for the protection of airborne image recordings and transcripts from such recordings.

The introduction of a requirement for PNG registered aircraft to be equipped with a functioning cockpit image recorder should therefore come under the protection of PNG legislation as is the case for cockpit voice recordings.

## **2.9 Civil Aviation Safety Authority of PNG**

The investigation found that the CASA PNG policy and procedures of *accepting* manuals rather than *approving* manuals, while in accordance with the Civil Aviation Rules requirements, placed a burden of responsibility on CASA PNG as the State Regulator to ensure accuracy and that safety standards are met.

In *accepting* the Air Niugini manuals, CASA PNG did not meet the high standard of evidence-based assessment required for safety assurance, resulting in numerous deficiencies and errors in the Air Niugini Operational, Technical, and Safety manuals as noted in this report and the associated Safety Recommendations.



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## 3 CONCLUSIONS

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### 3.1 FINDINGS<sup>66</sup>

#### 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 and submersion in salt water.
- g) The emergency lighting did not illuminate despite the system being armed.

#### 2. CREW / PILOTS

- a) Both pilots were licensed and qualified for the flight in accordance with existing regulations.
- b) Both pilots were in compliance with the flight and duty time regulations.
- c) The pilots did not ensure they had the required flight documents prior to departure from Port Moresby. They only had one *RNAV (GPS) Rwy 04* chart for Chuuk.
- d) The pilots' actions and statements indicated that they had lost situational awareness from 625 ft on the approach and their attention had become channelised and fixated on completing the approach and landing the aircraft.
- e) Cabin crew were not able to prevent some passengers from taking cabin baggage from the aircraft during the evacuation. However, some passengers were annoyed that a cabin crew member prevented them from taking their bags.
- f) One cabin crew member and the Load Master took cabin baggage from the aircraft during the evacuation.
- g) Other than e) and f), above, the investigation found no evidence that the cabin crew did not comply with *Air Niugini Standard Operating Procedures*.
- h) The cabin crew's actions resulted in a number of seriously injured passengers being evacuated from the aircraft.

#### 3. FLIGHT OPERATIONS

- a) The flight was not conducted in accordance with the procedures in the *Air Niugini SOPM*.
- b) The flight crew carried out normal radio communications with the relevant ATC units. However, the phraseology used was not standard and was not in accordance with Air Niugini standards.
- c) Prior to entering the area of heavy rain, the copilot called *three whites* showing on the Chuuk runway 04 PAPI at the Minima indicating slightly high on the glideslope. The aircraft flightpath to impact was an average of 4.5° average and flown in excess of 1,000 ft per min in IMC.

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<sup>66</sup> Findings are not listed in an order of hierarchy or importance.

- d) The continuation of the approach at an excessively high rate of descent, in IMC<sup>67</sup> and below the MDA<sup>68</sup>, resulted in the aircraft continuing descent below the glideslope and impacting the water 1,500 ft (460) short of the runway 04 threshold.
- e) The pilots did not respond to the 16 EGPWS aural caution alerts, and the **PULL UP** visual warning displayed at the bottom of the Primary Flight Display (PFD).
- f) The PIC did not change his plan to land the aircraft, although the aircraft was in an unstabilised condition in IMC.
- g) Both pilots ignored the alerts and warnings and were unaware of the unsafe situation developing.
- h) The pilots ignored the 28 EGPWS “*Glideslope*” aural caution alerts during the approach to Pohnpei during the previous sector on 27 September 2018.

#### 4. OPERATOR

- a) The Air Niugini *Crew Resource Management Challenge and Response Instructions* used the operative verb “*should*” instead of the imperative operative verb “*shall*” when directing responses to unsafe situations to be urgently addressed.
- b) The Air Niugini Simulator training and checking policies and procedures did not require training and testing in the practical application of the challenge and response requirement for the monitoring pilot to take control of the aircraft if a challenge to an unsafe situation, including EGPWS aural alerts went unresolved.
- c) The Air Niugini *SEPM* was inaccurate in describing the stowage location of life rafts.
- d) The Air Niugini manuals did not include a requirement for cabin baggage to be left on board by both crew and passengers in the event of an emergency evacuation.
- e) There was no requirement or procedure in any Air Niugini manual or the Quick Reference Handbook (QRH) Evacuation Checklist to instruct or guide the pilots and cabin crew in the operation of the emergency lights.
- f) The *Safety on Board* cards were inaccurate in their description of the exits to be used in the event of a ditching evacuation when life rafts were deployed, and also when life rafts were not deployed.
- g) The investigation found that the Operational Risk Assessments conducted by Air Niugini Limited for the Chuuk operation did not meet the *ICAO Annex 19 Standards for Safety Management Systems* and in general were not in accordance with *Risk Assessment* audit standards and methodology.
- h) The life raft located in the ceiling between seat rows 1 and 2 partially inflated while being moved to the forward door.

#### 5. AIRPORT FACILITIES

- a) The *Chuuk International Airport Emergency Plan* did not meet *ICAO Annex 14 Standards*.
- b) The *Chuuk International Airport Emergency Plan* had not been exercised with respect to water emergency rescue services and therefore did not meet *ICAO Annex 14 Standards*.
- c) The Chuuk International Airport did not meet *ICAO Annex 14 Standards* for specialised emergency equipment and personnel for rescue in the event of an accident in water adjacent to the Chuuk International Airport that has water on three sides of the runway.
- d) The Chuuk International Airport runways did not meet *ICAO Annex 14 Standards*. There was no Runway End Safety Area.

<sup>67</sup> IMC: Instrument Meteorological Conditions

<sup>68</sup> MDA(H): Minimum descent altitude; sometimes termed minimum decision altitude. (Source Cambridge Aerospace Dictionary.)

- e) The Federated States of Micronesia (FSM), Division of Civil Aviation had not notified the International Civil Aviation Organization of their inability to comply with the *ICAO Annex 14 Standards* in regard to points (c) and (d) above, and had not published notices in the FSM Aeronautical Information Service as required by ICAO.

## 6. FLIGHT RECORDERS

- a) The aircraft was equipped with a solid-state flight data recorder (SSFDR) and a solid-state cockpit voice recorder (SSCVR); both recorded good quality data.
- b) A cockpit jump-seat occupant videoed the approach from 3,000 ft on approach to impact. The video was of high quality. This video was an invaluable source of vital information to complement and enhance the data from the FDR, CVR, AFIRS, and EGPWS.
- c) The Honeywell EGPWS gave continuous aural alerts of *Glideslope* and *Sink Rate* when the aircraft was at an excessively high rate of descent at a low altitude.
- d) The Honeywell EGPWS gave continuous visual display of **PULL UP** on the PFD when the aircraft was at an excessively high rate of descent at a low altitude.
- e) The Honeywell EGPWS did not give a continuous aural **hard warning** of **PULL UP** when the aircraft was at an excessively high rate of descent at a low altitude.

## 7. MEDICAL

- a) There was no evidence that incapacitation or physiological factors affected the flight crew performance.
- b) The Chuuk State Hospital medical examiner stated that the pilots were not affected by drugs or alcohol.

## 8. SURVIVABILITY

- a) The accident was survivable.
- b) The fatally injured passenger was not wearing a seatbelt at the time of the impact. He sustained traumatic head injuries.

## 9. SAFETY OVERSIGHT

- a) The Civil Aviation Safety Authority of PNG (CASA PNG) *accepted* Air Niugini Operational, Technical, and Safety manuals, rather than *approving* the manuals.
- b) The CASA PNG did not detect safety deficiencies and errors in a number of the Air Niugini manuals and the *Risk Assessment* documents that CASA PNG had accepted<sup>69</sup>.
- c) CASA PNG did not meet the high standard of evidence-based assessment required for safety assurance, resulting in numerous deficiencies and errors in the Air Niugini Operational, Technical, and Safety manuals.

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<sup>69</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals.

## 3.2 CAUSES [CONTRIBUTING FACTORS]

The flight crew did not comply with *Air Niugini Standard Operating Procedures Manual (SOPM)* and the approach and pre-landing checklists. The *RNAV (GPS) Rwy 04 Approach chart* procedure was not adequately briefed.

The aircraft's flight path became unstable with lateral over-controlling commencing shortly after auto-pilot disconnect at 625 ft (**677 ft**). From 546 ft (**600 ft**) the aircraft was flown in Instrument Meteorological Conditions (IMC) and the rate of descent significantly exceeded 1,000 feet/min in Instrument Meteorological Conditions (IMC) from 420 ft (**477 ft**).

The flight crew heard, but disregarded, 13 EGPWS aural alerts (*Glideslope and Sink Rate*), and flew a 4.5° average flight path (glideslope).

The pilots lost situational awareness and their attention was channelised or fixated on completing the landing.

The PIC did not execute the missed approach at the MAP despite: PAPI showing 3 whites just before entering IMC; the unstabilised approach; the *glideslope indicator* on the PFD showing a rapid glideslope deviation from half-dot low to 2-dots high within 9 seconds after passing the MDA; the excessive rate of descent; the EGPWS aural alerts; and the EGPWS visual **PULL UP** warning on the PFD.

The copilot (support/monitoring pilot) was ineffective and was oblivious to the rapidly unfolding unsafe situation.

It is likely that a continuous “*WHOOP WHOOP PULL UP*”<sup>70</sup> hard aural warning, simultaneously with the visual display of **PULL UP** on the PFD (desirably a flashing visual display **PULL UP** on the PFD), could have been effective in alerting the crew of the imminent danger, prompting a pull up and execution of a missed approach, that may have prevented the accident.

## 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*.

## 3.4 US NTSB STATE OF MANUFACTURE CONCLUSIONS

The US National Transportation Safety Board's Accredited Representative and Technical Advisers representing the State of Manufacture, had full access to the evidence, including all recorded data and the cockpit imagery (video), in accordance with *Annex 13* international obligations.

The NTSB team provided their conclusions, which have been duly considered during the drafting of the *Final Report*.

With respect to the last paragraph of *Section 3.2* above, the NTSB Team requested that the substance of their comments be appended to the *Final Report*, in accordance with *Paragraph 6.3 of Annex 13, Standard*.

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<sup>70</sup> Honeywell and Boeing, informed the AIC that such hard-aural warning might not be an option for older generation EGPWS.

The AIC agreed to publish the NTSB Team's findings and conclusion, which states:

*NTSB staff disagrees that an additional warning would have been effective in alerting the crew. The conclusions and the supporting information in the draft report effectively demonstrate that the pilots:*

- *Lost situational awareness.*
- *Disregarded 16 EGPWS alerts that had occurred in the 19 seconds preceding impact with the water.*
- *Disregarded vertical guidance being displayed on the Primary Flight Display (PFD).*
- *Did not comply with the Air Niugini go-around policy after the first and subsequent EGPWS alerts.*
- *Did not comply with the Air Niugini go-around policy after the approach had become unstable with the descent rate exceeding 1000 feet per minute.*

*NTSB staff believes that the actions of the pilots to disregard the 16 EGPWS alerts and to not comply with Air Niugini policy clearly demonstrate that the crew was unresponsive to guidance that should have prompted a clear and decisive action to initiate a missed approach.*

*NTSB staff believes the disregard of the alerts, disregard of the PFD display guidance, and the continuation of an unstable approach demonstrate that any additional guidance, alert, or warning would be similarly disregarded by the flight crew and ineffective in preventing the accident.*



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## 4 SAFETY ACTIONS AND RECOMMENDATIONS

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### 4.1 SAFETY ACTION

On 23 October, 2018, Air Niugini Limited informed the investigation of the following Safety Actions taken and proposed following the accident and stated:

*Following the recent landing accident involving Air Niugini's B737-800, P2-PXE at Chuuk, Weno Airport, FSM, the following Safety Actions have been taken or are proposed:*

#### **Organizational**

##### ***Safety Action taken:***

*Air Niugini Limited has replaced the Boeing 737 on these routes [Chuuk and Pohnpei] with Fokker28-70 series aircraft.*

#### **Procedural**

##### ***Safety Action taken:***

*Chuuk (TKK) and Pohnpei (PNI) Airport categories have been changed from CAT B to CAT X (CAT X being more restrictive) operations by Air Niugini Limited.*

##### ***Safety Action proposed:***

*Other similar airports in the Air Niugini Boeing network are being reviewed and may be re-categorized accordingly.*

#### **Additional training and qualifications required.**

##### ***Safety Action proposed:***

*Category X training requirements for Flight Crew to be initiated.*

On 11 April, 2019, Air Niugini Limited informed the AIC of the following safety actions taken and proposed, and provided supporting evidence:

#### **Operational**

##### ***Safety action taken:***

*Chuuk can only be nominated as a destination airport for arrival during daylight hours;*

*Tailwind component for landing in Chuuk reviewed and amendments made in the Air Niugini Boeing Route Guide Section 6;*

*Fuel tankering policy reviewed and amendments made in the Air Niugini Boeing Route Guide;*

*Destination holding fuel for airports with weather issues reviewed; and*

*Aircraft with any open braking aid MELs shall not be operated into Chuuk.*

#### **Training**

##### ***Safety action taken:***

*Inclusion of more approach and landing exercises with the sudden loss of visibility, approach with flap 40 with limited runway available in current SIM recurrent cyclic;*

*Go around policy as per Air Niugini SOP section 12.5 reviewed and amended;*

##### ***Safety action proposed:***

*Route check discussions on unprepared landing or ditching to be implemented;*

##### ***Additional Safety actions taken:***

*Procedures to define categories of airports along with additional training requirements;*

*Tech crew Airport qualifications Expiry triggers on GENEVA<sup>71</sup>;*

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<sup>71</sup> Air Niugini crewnet, crew rostering software

### **Air Niugini *FLIGHT STANDING ORDER***

On 14<sup>th</sup> June 2019, Air Niugini notified the AIC that on 14<sup>th</sup> February 2019 Air Niugini Limited issued *Flight Standing Order, B737 Operational Notice No: 006/2019*.

#### **SUBJECT: SAFETY RECOMMENDATIONS – B737 CHUUK OPERATIONS.**

The following recommendations have been inserted into Section 6 of the Boeing Route Guide:

1. Operations into Chuuk are restricted to PIC ONLY landing.
2. Chuuk can only be nominated as a destination airport for arrival during daylight hours.
3. Chuuk may be planned as an EDTO en-route alternate for day/night when no other options exist.
4. Aircraft shall not be dispatched from POM to Chuuk with any open MEL items for braking systems (Brakes and anti-skid systems, Thrust Reversers and Flight and Ground Spoilers).
5. Consideration should be given for using Flaps 40 landing.
6. Landing with a known tailwind component is NOT permitted.
7. Due to the risk of higher than expected ZFW ex TTK plus the TTK and PNI runway lengths the plan supplied for these airports will be a min fuel plan. The PIC has the final authority on the total fuel uplift.

### **Air Niugini *FLIGHT STANDING ORDER***

On 14<sup>th</sup> June 2019, Air Niugini notified the AIC that on 12<sup>th</sup> June 2019 Air Niugini Limited issued *Flight Standing Order, B737 Operational Notice No: 016/2019*.

#### **SUBJECT: CHUUK / WENO AIRPORT PTKK/TKK RNAV (GPS) RWY 4 APPROACH.**

Following a review of the RNAV (GPS) RWY 4 approach, the company minimum altitude will be set higher than the published chart MDA (H).

The minimum visibility remains as published.

The MDA (H) to be used when flying the RNAV (GPS) RWY 4 approach is 860' (850').

This will allow the aircraft to reach the MDA prior to the MAP at HAMAX.

The FSO will expire following publication of the FSO in the relevant Air Niugini Manual or on 12 date is listed as 12<sup>th</sup> September 2019.

## 4.2 Recommendations

### 4.2.1 Recommendation AIC 18-R04/18-1004<sup>72</sup> to Air Niugini Limited

On 24 November 2018, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited should ensure that the *Safety on Board Card* (passenger briefing cards) for the Boeing 737-700 and -800 fleet accurately show the exits to be used in a water ditching accident, and the accurate depiction of which exits have life rafts deployed.

#### Action requested

The AIC requests that Air Niugini Limited note recommendation AIC 18-R04/18-1004, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

#### 4.2.1.1 Air Niugini Limited response

On 28 November 2018, Air Niugini Limited informed the AIC that they had completed an action plan to address the safety deficiency identified in this *Safety Recommendation AIC 18-R04/18-1004*. The safety action plan provided to the AIC included amending the *Safety on Board Card* to depict the path to Door 1L for raft deployment.

Air Niugini Limited stated:

*The Safety on Board Card (Passenger Briefing Card) contains only primary information and other information is given in SEP manual for cabin crew reference purpose. Therefore, Air Niugini will amend Safety on Board Card to remove 1R life raft and evacuation path. Additionally, a foot note will be included stating that “Door 1R will only be used if door 1L is unusable during launching of Life rafts”. It will address the scenario where the entire cabin crew is unavailable and passengers will have to evacuate themselves.*

#### PNG Accident Investigation Commission (AIC) assessment of the Air Niugini Limited response

On 28 November 2018 the AIC reviewed the Air Niugini Limited response addressing the recommendation AIC 18-R04/18-1004. The AIC assigned this response a *satisfactory intent* rating, and recorded the **Status of the AIC Recommendation: MONITOR**.

#### 4.2.1.2 Air Niugini Limited further response

On 30 November 2018, the PNG AIC received an updated response from Air Niugini Limited providing copies of the Boeing 737-800 and 737-700 Safety on Board cards. The cards clearly depict the correct door and raft deployment from door 1L, and a footnote has been added to the diagram stating:

NOTE: FORWARD RIGHT EXIT ALTERNATIVELY MAY BE USED IF FORWARD LEFT EXIT IS UNUSABLE.

The card also has a “No bags, No shoes” symbol in the *Upon Exiting* section of the card.

Air Niugini Limited also provided a copy of the new Cabin Standing Order Boeing Operational Notice No: 007/2018 that informs Cabin Crew of the changes to the Safety on Board cards.

Air Niugini Limited informed the PNG AIC that the new Safety on Board cards will be in the aircraft on Wednesday 5 December 2018.

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<sup>72</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.



Figure 33: Boeing 737-800 Safety on Board card (Version PX3-11009 Rev.B)



Figure 34: Boeing 737-700 Safety on Board card (Version PX3-11001 Rev. D)

### PNG Accident Investigation Commission (AIC) assessment of the Air Niugini Limited response

On 30 November 2018 the AIC reviewed the Air Niugini Limited response dated 30 November 2018 addressing the recommendation AIC 18-R04/18-1004. The AIC assigned this response a *satisfactory intent* rating, and recorded the **Status of the AIC Recommendation: MONITOR** pending evidence of implementation in the affected aircraft scheduled for 5 December 2018.

#### 4.2.1.3 Air Niugini Limited further response

On 5 December 2018, the PNG AIC received an updated response from the Air Niugini Limited, Executive Manager Corporate Quality and Safety, advising that the revised Safety on Board Cards had been installed in the Boeing 737-700 (P2-PXD) and -800 (P2-PXC) aircraft.

### PNG Accident Investigation Commission (AIC) assessment of the Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited response dated 5 December 2018 addressing the recommendation AIC 18-R04/18-1004. The AIC assigned this response a *satisfactory intent* rating, and records the **Status of the AIC Recommendation: CLOSED, RESPONSE ACCEPTED.**

#### 4.2.2 Recommendation number AIC 19-R01/18-1004<sup>73</sup> to Air Niugini Limited

On 7 February 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure that all flight crew comply with the *Air Niugini Limited Standard Operating Procedures Manual (SOPM)* and the *Flight Crew Operating Manual (FCOM)* with respect to operational procedures and primary flight crew duties, and do not use personal *Electronic Flight Bag (EFB)*, and specifically do not use the *Boeing OPT* data during flight operations until approved by Air Niugini Limited.

##### Action requested

The Accident Investigation Commission requests that Air Niugini Limited note recommendation AIC 19-R01/18-1004, and provide a response to the AIC as soon as possible, but no later than 5 May 2019 (within 90 days of the issue date), and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

##### 4.2.2.1 Air Niugini Limited Safety Action

On 6 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of the safety actions taken to address the safety deficiencies identified in *Safety Recommendation AIC 19-R01/18-1004* and stated:

*Air Niugini has not approved the use of the Boeing OPT. Therefore, it has been again re-enforced to B737 & B767 crew not to use unauthorised Boeing OPT. Secondly, FSOs [Flight Standing Orders] have been issued to B737, B767 & Fokker 70/100 crew not to use electronic flight bag until approved<sup>74</sup> by CASA PNG.*

Air Niugini provided evidence in support of their Safety Action Statement.

##### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken. The AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the AIC *Safety Recommendation AIC 19-R01/18-1004*.

The AIC has assigned the Air Niugini Limited response a *fully satisfactory rating*, and records the **Status of the AIC Recommendation: CLOSED, RESPONSE ACCEPTED.**

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#### 4.2.3 Recommendation number AIC 19-R02/18-1004<sup>75</sup> to Honeywell Aerospace

On 31 January 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Honeywell Aerospace should ensure that the Honeywell EGPWS MK V Computer should provide timely and continuous hard aural warning “*WHOO PULL UP*”, simultaneously with the Visual Display of **PULL UP** on the Primary Flight Display, which requires immediate action from the crew, when encountering an excessive Rate of Descent at very low Radio Altitude similar to that flown by the crew of P2-PXE as shown in Figure 1 (*In the stand-alone recommendation AIC 91-R02/18-1004, and Figure 32 of this report*).

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<sup>73</sup> The safety deficiency/concern that that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

<sup>74</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

<sup>75</sup> The safety deficiency/concern that prompted this Safety Recommendation may have been a contributing factor in this accident. The PNG AIC is in continued discussion with the US NTSB, Honeywell, Boeing and US FAA. This recommendation is the subject of ongoing research and the AIC Recommendation will remain ACTIVE pending the results of that research.

### Action requested

The AIC requests that Honeywell Aerospace note recommendation *AIC 19-R02/18-1004*, and provide a response to the AIC no later than 1 May 2019 (within 90 days of the issue date), and explain (including with evidence) how Honeywell Aerospace has addressed the safety deficiency identified in the safety recommendation.

#### 4.2.3.1 Honeywell Aerospace response

On 30<sup>th</sup> April 2019, Honeywell Aerospace informed the AIC in response to recommendation *AIC 19-R02/18-1004* that the requested recommendation *AIC 19-R02/18-1004* was not achievable for two reasons:

1. *Boeing and/or operator has chosen to drive a red “**PULL UP**” annunciation on the PFD when the EGPWS triggers a Mode 1 “Sink Rate” caution alert level when another option is available which would not generate the red “**PULL UP**” annunciation with the same caution level alert; and*
2. *If Honeywell were to change the EGPWS Mode 1 Warning curves to generate a “**PULL UP**” aural when a flight profile were to be flown as P2-PXE performed, it would be in violation of TSO-151d (MOPS DO-367) and would be unable to certify the product with the FAA.*

Given the points of this response, Honeywell Aerospace requested that the recommendation be removed from consideration and stated that it would not be feasible nor within Honeywell’s control to accomplish.

#### **PNG Accident investigation Commission Recommendation number *AIC 18-R02/18-1004* to Honeywell Aerospace (revised/re-issued)**

On 20<sup>th</sup> May 2019, the PNG Accident Investigation Commission revised and reissued the Safety Recommendation. The Reissued Safety Recommendation states:

The PNG Accident Investigation Commission recommends that Honeywell Aerospace, in consultation with the Federal Aviation Administration, should re-evaluate *TSO’s 151b* and *151d* and *DO-367* related to EGPWS warnings and cautions, and ensure that the Honeywell EGPWS MK V Computer provides a **timely warning** in the form of a continuous **flashing** visual display of ‘**PULL UP**’ at the bottom of the Primary Flight Displays, as an absolute minimum standard. The **flashing** visual display ‘**PULL UP**’ **warning**, simultaneously with the aural caution ‘SINK RATE’, would require immediate action from the flight crew when encountering an excessive Rate of Descent at very low Radio Altitude, similar to that flown by the crew of P2-PXE as shown in Figure 1.

### Action requested

The PNG Accident Investigation Commission requests that Honeywell Aerospace note recommendation *AIC 19-R02/18-1004* (revised/re-issued), and provide a response to the AIC no later than 19<sup>th</sup> July 2019 (within 60 days of the issue date), and explain (including with evidence) how Honeywell Aerospace has addressed, or proposes to address, the safety deficiency identified in the revised/re-issued safety recommendation.

#### 4.2.3.2 AIC update dated 11 July 2019

During subsequent discussions with Honeywell and Boeing, the AIC was informed that such hard-aural warning might not be an option for older generation EGPWS.

Much more research is required and the AIC is actively working with the US NTSB, FAA, Honeywell, and Boeing. The *Safety Recommendations AIC 19-R02/18-1004* and *AIC 19-R17/18-1004* addressed to Honeywell and FAA respectively will remain Active pending the results of the ongoing research.

**Status of AIC recommendation: ACTIVE**

#### 4.2.4 Recommendation number AIC 19-R03/18-1004<sup>76</sup> to Air Niugini Limited

On 4 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, as a matter of urgency:

- (a) should ensure that all crew members are reminded of their obligation to comply with *PNG Civil Aviation Rules*, the *Air Niugini Special Emergency Procedures (SEP)*, and the *Air Niugini Corporate Emergency Response Manual*, in particular Section 6.9.3; and
- (b) should ensure all crew members are reminded of their obligation to ensure that passengers do not take any baggage from the aircraft.

##### Action requested

The AIC requests that Air Niugini Limited note recommendation AIC 19-R03/18-1004, and provide a response to the AIC as soon as possible, but no later than 1 May 2019 (within 90 days of the issue date), and explain (including with evidence) how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

##### 4.2.4.1 Air Niugini Safety Action

On 18 February 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R03/18-1004*. Air Niugini also provided documentary evidence of the safety action taken.

##### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

On 18 February 2019, the AIC reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken. The AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the AIC *Safety Recommendation AIC 19-R03/18-1004*.

The AIC assigned the Air Niugini Limited response a *fully satisfactory* rating, and recorded the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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#### 4.2.5 Recommendation number AIC 19-R04/18-1004<sup>77</sup> to Air Niugini Limited

On 4 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should review its policy and procedures in the *Safety and Emergency Procedures Manual (SEPM)* in relation to all aircraft in the Air Niugini fleet to ensure:

- (a) a responsible and capable adult passenger is seated in the over wing exit row on all flights; and
- (b) the passenger(s) seated in the over wing exit row are fully briefed on the tasks required to deploy the emergency exit and assist in passenger evacuation.

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<sup>76</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

<sup>77</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

## Action requested

The AIC requests that Air Niugini Limited note recommendation *AIC 19-R04/18-1004*, and provide a response to the AIC as soon as possible, but no later than 4 May 2019 (within 90 days of the issue date), and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

### 4.2.5.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R04/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted<sup>78</sup> amendment of the *Cabin Crew Administration Manual, Section 5.14.1* to require able bodied persons to occupy the over-wing exit seat on all flights. This instruction includes off-duty or passengering technical and cabin crew. The amendment specifies that when there are more than four (4) operating cabin crew on a flight, one shall occupy an over-wing exit seat.

## PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to cabin crew locations on the aircraft and the positioning of able-bodied persons in exit rows. The AIC is satisfied that the evidence addressed the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R04/18-1004*.

The AIC has assigned the Air Niugini Limited response a fully satisfactory rating, and records the Status of the *AIC Recommendation*: **CLOSED RESPONSE ACCEPTED**

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### 4.2.6 Recommendation number *AIC 19-R05/18-1004*<sup>79</sup> to Air Niugini Limited

On 4 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, in order to mitigate the risk of a cabin crew member being unable to reach the over wing exit due to passenger congestion, should:

- Review its policy and procedures in the *Safety and Emergency Procedures Manual (SEPM)* and the *Airport Services manual (ASM)* in relation to all aircraft in the Air Niugini fleet to ensure a cabin crew member is seated in the over wing exit row on all flights.

## Action requested

The AIC requests that Air Niugini Limited note recommendation *AIC 19-R05/18-1004*, and provide a response to the AIC as soon as possible, but no later than 4 May 2019 (within 90 days of the issue date), and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

### 4.2.6.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R05/18-1004*.

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<sup>78</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

<sup>79</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

The AIC's safety deficiency has not been fully addressed to ensure a cabin crew member can expeditiously reach the over-wing exit from the rear cabin crew station in the event of a water ditching due to passenger congestion in the aisle.

However, the AIC notes that in response to AIC *Safety Recommendation AIC 19-R04/18-1004*, Air Niugini provided documentary evidence of the safety action taken with the CASA PNG accepted amendment of the *Cabin Crew Administration Manual, Section 5.14.1* to require able bodied persons to occupy the over-wing exit seat on all flights. This instruction includes off-duty or passengering technical and cabin crew. The amendment specifies that when there are more than four (4) operating cabin crew on a flight, one shall occupy an over-wing exit seat.

### **PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response**

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to cabin crew locations on the aircraft and the positioning of able-bodied persons in exit rows. The AIC is satisfied that the evidence, while not fully addressing the AIC the safety concerns identified in the AIC *Safety Recommendation AIC 19-R05/18-1004*, meets the minimum safety standards.

The AIC has assigned the Air Niugini Limited response a *satisfactory intent rating*, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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#### **4.2.7 Recommendation number AIC 19-R06/18-1004<sup>80</sup> to Air Niugini Limited**

On 4 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure that cabin crew are fully conversant with the requirements of the *Safety and Emergency Procedures Manual (SEPM)*, Vol 6, Sect 2.14.4.2 with respect to the evacuation procedures when no life raft is deployed from the forward exit doors.

#### **Action requested**

The AIC requests that Air Niugini Limited note recommendation *AIC 19-R06/18-1004*, and provide a response to the AIC as soon as possible, but no later than 4 May 2019 (within 90 days of the issue date), and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

##### **4.2.7.1 Air Niugini Safety Action**

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R06/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted amendment of the *Standards Operating Procedures Manual, Volume 6, Section 2.13.1* to include ditching procedures. The Cabin Crew training includes evacuation procedures when no life raft is deployed.

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<sup>80</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

## **PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response**

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to ditching procedures and associated cabin crew training for occurrences when no life raft is deployed. The AIC is satisfied that the evidence addressed the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R06/18-1004*.

The AIC has assigned the Air Niugini Limited response a fully *satisfactory* rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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### **4.2.8 Recommendation number AIC 19-R07/18-1004<sup>81</sup> to Air Niugini Limited**

On 6 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should review the *Air Niugini Safety and Emergency Procedures Manual – Volume 6 (B737) Section 3.2.2 titled P2-PXC / P2-PXE – location of Emergency Equipment* to ensure the diagram clearly depicts the correct life raft stowage locations, and ensure all cabin crew are briefed on the correct location of the life rafts.

#### **Action requested**

The Accident Investigation Commission requests that Air Niugini Limited note recommendation *AIC 19-R07/18-1004*, and provide a response to the AIC as soon as possible, but no later than 5 May 2019 (within 90 days of the issue date), and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

#### **4.2.8.1 Air Niugini Safety Action**

On 18 February 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R07/18-1004*. Air Niugini also provided documentary evidence of the safety action taken, which included the amended depiction of the life raft locations.

## **PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response**

On 18 February 2019 the AIC reviewed the Air Niugini Limited response and the AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R03/18-1004*.

The AIC assigned the Air Niugini Limited response a *fully satisfactory* rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED.**

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<sup>81</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

#### 4.2.9 Recommendation number AIC 19-R08/18-1004<sup>82</sup> to Federated States of Micronesia, Division of Civil Aviation.

On 8 February 2019 the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that the Federated States of Micronesia, Division of Civil Aviation, as a contracting State to the *Convention on International Civil Aviation*:

- (a) should ensure that Chuuk International Airport meets *ICAO Annex 14 Standards* with respect to *Airport Emergency Planning* and specialist rescue services (equipment and personnel) for an emergency situation that might occur outside the airport perimeter in water; **or**
- (b) should ensure that if the State is unable to comply with the *Standards of Annex 14* as identified in (a) above, it will file the difference with ICAO between a State's national regulations and practices and the related *ICAO Annex 14 Standards and Recommended Practices*, and publish the filed difference(s) through the *Aeronautical Information Service*.

#### Action requested

The AIC requests that Federated States of Micronesia (FSM), Division of Civil Aviation (DCA) note recommendation *AIC 19-R08/18-1004*, and provide a response to the AIC no later than 7 May 2019 (within 90 days of the issue date), and explain including with evidence how the FSM DCA has addressed the safety deficiency identified in the safety recommendation.

##### 4.2.9.1 Federated States of Micronesia, Division of Civil Aviation Safety Action

On 7 May 2019, the Federated States of Micronesia, Division of Civil Aviation informed the PNG Accident Investigation Commission of its safety action to address the safety deficiencies identified in *Safety Recommendation AIC 19-R08/18-1004*.

The FSM DCA provided copies of the *Notification of Differences* filed with the International Civil Aviation with respect to the State's inability to meet the *ICAO Annex 14 Standards* for Airport Emergency Planning and specialist rescue services (equipment and personnel) for an emergency situation that might occur outside the airport perimeter in water. The FSM DCA also notified ICAO of difference relating to the State's inability to meet the *ICAO Annex 14 Standard* for Runway Safety End Area at Chuuk International Airport runways 04/22.

On 8 May 2019, the FSM DCA informed the AIC that they were progressing having these differences publishing in the State's *Aeronautical Information Service* documents, and raising with the US FAA for issuing *NOTAMs*.

#### PNG Accident Investigation Commission (AIC) assessment of Federated states of Micronesia, Division of Civil Aviation response

The AIC has reviewed the Federated States of Micronesia, Division of Civil Aviation documents providing evidence to the AIC of the safety actions taken and proposed with respect the State's inability to meet these specific *ICAO Annex 14 Standards*. The AIC is satisfied that the evidence has addressed the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R08/18-1004* and the reference to the lack of Runway End Safety Area raised with FSM DCA during the investigation.

The AIC has assigned the FSM DCA response a **satisfactory intent rating**, and records the Status of the AIC Recommendation: **CLOSED RESPONSE ACCEPTED**

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<sup>82</sup> The safety deficiency/concern that that prompted this Safety Recommendation did not cause or contribute to this accident, because the pilots were unaware of the rapidly unfolding unsafe situation. However, in accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

#### 4.2.10 Recommendation number AIC 19-R09/18-1004<sup>83</sup> to Air Niugini Limited

On 17 February 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure that all flight crew are tested for competency in the vital actions and responses to be taken in the event of a GPWS or EGPWS warnings, and/or an unstabilised approach situation developing when below 1,000 feet amsl, and in instrument meteorological conditions.

##### Action requested

The Accident Investigation Commission requests that Air Niugini Limited note recommendation AIC 19-R09/18-1004, and provide a response to the PNG AIC within 60 days, but no later than 18 April 2019, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 19-R09/18-1004*.

##### 4.2.10.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R09/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted<sup>84</sup> amendment of the *Training and Checking Manual (TCM)*, Vol 1, Section 8.5 requiring all flight crew to be tested for competency in the vital actions and responses to be taken in the event of a GPWS or EGPWS warnings, and/or an unstabilised approach situation developing when below 1,000 feet amsl, and in instrument meteorological conditions.

The AIC obtained further evidence, including statements from flight crews, that the training and checking in the simulator now includes the requirements of the *TCM Vol 1, Section 8.5*.

##### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to simulator competency and testing of flight crews to address the identified safety deficiencies. The AIC is satisfied that the evidence addressed the safety deficiencies identified in the AIC *Safety Recommendation AIC 19-R09/18-1004*.

The AIC has assigned the Air Niugini Limited response a **fully satisfactory** rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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<sup>83</sup> The safety deficiency/concern that that prompted this Safety Recommendation did not cause or contribute to this accident, because the pilots were unaware of the rapidly unfolding unsafe situation. However, in accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

<sup>84</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

#### 4.2.11 Recommendation number AIC 19-R10/18-1004<sup>85</sup> to Air Niugini Limited

On 18 February 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure that:

- (a) *Section 2.5.1.4 of the Standards Operating Procedures Manual* is amended to use the operating verb “**shall**” for the instructions for compliance with the vital and essential safety of flight actions.
- (b) All Air Niugini Limited Operational and Training manuals are reviewed and revised as necessary and appropriate to use the operating verb “**shall**” when appropriate to ensure the importance of taking essential safety action is recognised.

##### Action requested

The Accident Investigation Commission requests that Air Niugini Limited note recommendation *AIC 19-R10/18-1004*, and provide a response to the PNG AIC within 60 days, but no later than 18 April 2019, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 19-R10/18-1004*, **in particular with respect to part (a) of the recommendation.**

##### 4.2.11.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R10/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted amendment of the *Standards Operating Procedures Manual*, *Section 2.5.1.4* to use the operating verb “*shall*” for the instructions for compliance with the vital and essential safety of flight actions.

Air Niugini further advised the AIC that it is progressively revising all manuals to use the operating verb “*shall*” where appropriate to ensure the importance of taking essential safety action is recognised.

##### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to the use of the operating verb “*shall*” for the instructions for compliance with the vital and essential safety of flight actions in order to address the identified safety deficiencies. The AIC is satisfied that the evidence addressed the safety deficiencies identified in the AIC *Safety Recommendation AIC 19-R10/18-1004 part (a)*, and that *Part (b)* will be progressively addressed.

The AIC has assigned the Air Niugini Limited response a ***satisfactory intent*** rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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<sup>85</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident, because the pilots were unaware of the rapidly unfolding unsafe situation. However, in accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

#### 4.2.12 Recommendation number AIC 19-R11/18-1004<sup>86</sup> to Air Niugini Limited

On 20 February 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited should, as a matter of urgency, ensure that the relevant Air Niugini manuals, including the *Quick Reference Handbook*, *Evacuation Checklist*, are amended to provide instructions and emergency procedures for the manual operation of the emergency lighting switch in the cockpit, and the switch located on the *Aft Attendant's Panel*, and that all pilots and Cabin Crew are instructed in their importance and use.

##### Action requested

The Accident Investigation Commission requests that Air Niugini Limited note recommendation AIC 19-R11/18-1004 and provide a response to the PNG AIC within 60 days, but no later than 20 April 2019, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 19-R11/18-1004*.

##### 4.2.12.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R011/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted<sup>87</sup> amendment of the *Safety and Emergency Procedures Manual (SEPM) Vol 6, Section 2.14.3 and 2.14.4*. Air Niugini further informed the AIC that the QRH is to be amended in consultation with Boeing.

##### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken with respect to evacuation procedures and checklists. The AIC is satisfied that the evidence mostly addressed the safety deficiencies identified in the AIC *Safety Recommendation AIC 19-R11/18-1004* and proposed action underway with Boeing will ensure the safety deficiency is fully addressed.

The AIC has assigned the Air Niugini Limited response a *satisfactory intent* rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED.**

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#### 4.2.13 Recommendation number AIC 19-R12/18-1004<sup>88</sup> to Air Niugini Limited

On 25 February 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited should, as a matter of urgency, ensure that the Training Reference Manual and all relevant Air Niugini manuals related to emergency evacuation are amended to ensure descriptors on drawings are clear and unmistakable, and that the Training Reference Manual and operational procedures clearly stress the requirement for life rafts to be deployed outside the aircraft before attempting inflation.

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<sup>86</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

<sup>87</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

<sup>88</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

### Action requested

The Accident Investigation Commission requests that Air Niugini Limited note recommendation *AIC 19-R12/18-1004* and provide a response to the PNG AIC within 60 days, but no later than 25 April 2019, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in *Safety Recommendation AIC 19-R12/18-1004*.

#### 4.2.13.1 Air Niugini Safety Action

On 26 March 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R12/18-1004*.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted<sup>89</sup> amendment of the *Safety and Emergency Procedures Manual (SEPM) Vol 6, Section 2.14.4.1* to require the life raft to be launched outside the aircraft. This amendment reinforces *Section 7.11.19.3* of the *Air Niugini Training Reference Manual*. The diagram and descriptors on drawings of the life raft have been redrawn to make them clear and unmistakable.

### PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken. The AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R12/18-1004*.

The AIC has assigned the Air Niugini Limited response a *fully satisfactory* rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**

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#### 4.2.14 Recommendation number AIC 19-R13/18-1004<sup>90</sup> to Civil Aviation Safety Authority of PNG

On 8 April 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that the Civil Aviation Safety Authority of PNG should draft *Civil Aviation Rule(s)* to require the fitment of image recorders in the cockpit of all *CAR Part 125* and *135* aircraft, and promulgate through the April 2019 *Notice of Proposed Rule Making (NPRM)* process.

### Action requested

The PNG Accident Investigation Commission requests that the Civil Aviation Safety Authority of PNG provide a response to the PNG AIC within 90 days, but no later than 7 July 2019, and explain including with evidence how CASA PNG has addressed the safety enhancement recommendation identified in *Safety Recommendation AIC 19-R13/18-1004*.

### Civil Aviation Safety Authority of PNG response

On 21 June 2019, the Civil Aviation Safety Authority of PNG wrote to the Accident Investigation Commission stating in part:

The fitment of image recorders on Part 125 and Part 135 aircraft is not related to this accident and has no bearing whatsoever on this accident which involves a Part 121 aircraft.

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<sup>89</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals

<sup>90</sup> The issue that prompted this Safety Recommendation did not cause or contribute to this accident.

Further, this is not an ICAO Standard and therefore cannot be justified for rule making. PNG Civil Aviation Rules have adequately transposed ICAO Annexes regarding Flight Recorder and Cockpit Voice Recorder requirements.

### **PNG Accident Investigation Commission (AIC) assessment of the Civil Aviation Safety Authority of PNG response**

The AIC has reviewed the CASA PNG response. While the AIC recommendation may have been better targeted to *Part 121* aircraft, all aircraft in the listed categories are important in this regard. The thrust of the recommendation calling for a *Notice of Proposed Rule Making* for safety enhancement benefits in accident and incident investigation outweighs the argument that it is not an *ICAO Standard*.

ICAO Standards are the minimum Standards. A State is not restricted and may exceed the *ICAO Standards*. In fact, ICAO encourages States to exceed the minimum Standards. *ICAO Annex 13* contemplates the use of cockpit image recordings in *Annex 13, Paragraph 5.12 (a)*, where protections are listed for accident and incident investigation records. Cockpit imagery falls under that protection.

The AIC therefore rejects the notion posed by CASA PNG and believes that CASA PNG should examine this subject further in the light of the compelling evidence of the benefits obtained in this investigation from the cockpit imagery which brought everything together in crystal clarity with irrefutable evidence that was not available from the FDR and CVR.

The AIC cites some of the numerous examples worldwide where cockpit imagery would have resolved all ambiguity and controversy and saved countless millions of US Dollars in investigation resources expended. Swissair 111, EgyptAir MS804, SilkAir 185, Germanwings 9525, are just a few examples.

CASA PNG has the sovereign right to exceed the minimum *ICAO Standards*.

However, on the basis of the CASA PNG response that this recommendation cannot be justified for rule making believing that the PNG CARs adequately meet international Standards with respect to flight recorder requirements, the AIC has assigned the CASA PNG response an ***unsatisfactory rating***, and records the **Status of the AIC Recommendation: CLOSED RESPONSE NOT ACCEPTED**.

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#### **4.2.15 Recommendation number AIC 19-R14/18-1004<sup>91</sup> to Air Niugini Limited**

On 10 April 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that Air Niugini Limited should review the Air Niugini Risk Assessment process and methodology to ensure they meet *ICAO Annex 19 Standards*, and where risk assessments have been made by Air Niugini Limited with respect to aircraft operations that those risk assessments are reviewed to ensure they meet ICAO Standards.

#### **Action requested**

The PNG Accident Investigation Commission requests that Air Niugini Limited provide a response to the PNG AIC within 90 days, but no later than 9 July 2019, and explain including with evidence how Air Niugini Limited has addressed the safety deficiencies identified in Safety Recommendation AIC 19-R14/18-1004.

##### **4.2.15.1 Air Niugini Safety Action**

On 15 April 2019, Air Niugini Limited informed the PNG Accident Investigation Commission of its safety actions to address the safety deficiencies identified in *Safety Recommendation AIC 19-R14/18-1004*.

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<sup>91</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

Air Niugini also provided documentary evidence of the safety action taken with the CASA PNG accepted<sup>92</sup> amendment of the *Air Niugini Corporate Safety and Management System Manual, Chapter 8 (Hazard Identification and Reporting Program), Section 14, Sub-section 14.9 Steps in managing risks*, and the associated *Risk Assessment templates* to include a *Hazard identification* step before the *Risk Assessment* step.

*Sub-section 14.11, Identifying Risk*, has been amended to include *hazards that present risks*.

#### **PNG Accident Investigation Commission (AIC) assessment of Air Niugini Limited response**

The AIC has reviewed the Air Niugini Limited documents providing evidence to the AIC of the safety action taken. The AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the *AIC Safety Recommendation AIC 19-R14/18-1004*. However, the AIC has not seen evidence of the revised template in use.

Therefore, the AIC has assigned the Air Niugini Limited response a *satisfactory intent* rating, and records the **Status of the AIC Recommendation: CLOSED RESPONSE ACCEPTED**.

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#### **4.2.16 Recommendation number AIC 18-R17/18-1004<sup>93</sup> to US Federal Aviation Administration (FAA)**

On 20<sup>th</sup> May 2019, the PNG AIC issued the following recommendation:

The PNG Accident Investigation Commission recommends that the Federal Aviation Administration should re-evaluate *TSO's 151b* and *151d* and *DO-367* related to EGPWS warnings and cautions, and ensure that the Honeywell EGPWS MK V Computer provides a **timely warning** in the form of a continuous **flashing** visual display of **'PULL UP'** at the bottom of the Primary Flight Displays, as an absolute minimum standard. A **flashing** visual display **'PULL UP' warning**, accompanying an aural **'SINK RATE'**, would require immediate action from the flight crew when encountering an excessive Rate of Descent at very low Radio Altitude, similar to that flown by the crew of P2-PXE.

##### **Action requested**

The PNG Accident Investigation Commission requests that the Federal Aviation Administration note recommendation *AIC 19-R17/18-1004* and provide a response to the AIC no later than 19<sup>th</sup> July 2019 (within 60 days of the issue date), and explain, including with evidence, how the FAA has addressed, or proposes to address, the safety deficiency identified in the safety recommendation. Current status **ACTIVE**.

##### **4.2.16.1 AIC update at 11 July 2019**

During subsequent discussions with Honeywell and Boeing, the AIC was informed that such hard-aural warning might not be an option for older generation EGPWS.

Much more research is required and the AIC is actively working with the US NTSB, FAA, Honeywell, and Boeing. The *Safety Recommendations AIC 19-R02/18-1004* and *AIC 19-R17/18-1004* addressed to Honeywell and FAA respectively will remain Active pending the results of the ongoing research.

**Status of AIC recommendation: ACTIVE**

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<sup>92</sup> CASA PNG does not *approve* the Air Niugini manuals, rather it *accepts* the Air Niugini manuals.

<sup>93</sup> The safety deficiency/concern that prompted this Safety Recommendation may have been a contributing factor in this accident. The PNG AIC is in continued discussion with the US NTSB, Honeywell, Boeing and US FAA. This recommendation is the subject of ongoing research and the AIC Recommendation will remain **ACTIVE** pending the results of that research.

#### 4.2.17 Recommendation number AIC 19-R18/18-1004<sup>94</sup> to Jeppesen

On 5<sup>th</sup> June 2019, the PNG AIC issued the following recommendation:

The investigation found that the terminology used to indicate the *Transition Level*<sup>95</sup> on the approach charts for Pohnpei and Chuuk was not consistent.

On the *Chuuk RNAV (GPS) Rwy 04 Chart*, Jeppesen indicates the Transition Level as **Trans: FL 055** and on the *Pohnpei RNAV (GPS) X Rwy 09 Chart* as **Trans: FL 55** although both are referring to the same thing Trans alt: 5,500’.

The PNG Accident Investigation Commission recommends that Jeppesen should ensure that standard terminology is used on both (Chuuk RNAV (GPS) Rwy 04 and Pohnpei RNAV (GPS) X Rwy 09) instrument approach charts. Jeppesen should also ensure that terminologies and the layout used on all Jeppesen Instrument approach charts are consistent and standardised.

#### Action requested

The AIC requests that Jeppesen note recommendation *AIC 19-R19/18-1004*, and provide a response to the AIC no later than 25 July 2019 (within 60 days of the issue date), and explain (including with evidence) how Jeppesen has addressed the safety deficiency identified in the safety recommendation. Current status **ACTIVE**.

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<sup>94</sup> The safety deficiency/concern that prompted this Safety Recommendation did not cause or contribute to this accident. In accordance with *Annex 13*, safety deficiencies or concerns that are identified during the course of the investigation, while not causal to the accident, nevertheless should be addressed with the aim of accident prevention, which includes death or serious injury.

<sup>95</sup> The lowest flight level available for use above transition altitude and is the altitude at which the altimeter will be switched from standard pressure or QNE to the local pressure QNH. (Source *Cambridge Aerospace Dictionary*)

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## 5 APPENDICES

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### 5.1 APPENDIX A: Air Niugini Standard Operating Procedures (Current at the time of the accident)

#### 5.1.1 Operation below MDH, or MDA.

Section 12.4 of the *Air Niugini SOPM*, paragraph 7 states:

Operation below MDH, or MDA. Where a MDH, or MDA is applicable, no Pilot-in-Command shall operate an aircraft at any aerodrome below the MDA or MDH unless: the aircraft is continually in a position from which a descent to landing on intended runway can be made at a normal rate of descent using normal manoeuvres and where such a descent rate will allow touchdown to occur within TDZ of the runway of intended landing, and

- a. the flight visibility is not less than the visibility prescribed under [Rule] Part 95 for the in the instrument approach procedure being used; and
- b. at least one of the following required visual references for the intended runway is distinctly visible and identifiable to the pilot:
  - i. the approach lighting system, or
  - ii. the threshold markings, or
  - iii. the threshold lights, or
  - iv. the runway-end identification lights, or
  - v. the visual approach slope indicator, or
  - vi. the touchdown zone or touchdown zone markings, or
  - vii. the touchdown zone lights, or
  - viii. the runway or runway markings, or
  - ix. the runway lights.

The minimum visibility for a non-precision approach depends on the MDH and on the approach lighting and runway lighting / marking available. If any time after descent below MDA or DH/DA the PF cannot maintain visual references, he/she shall immediately execute a missed approach, follow the appropriate missed approach procedure and ATC shall be notified.

#### 5.1.2 Air Niugini stabilised approach procedure

The Air Niugini stabilised approach procedure, published in the *SOPM, Approach and Landing section, Sections 12.4 to 12.7*, version 11.0 dated 1 May 2017, was current at the time of the accident.

#### 5.1.3 Missed approach procedure

Section 12.4 of the *Air Niugini SOPM*, paragraph 7 states:

Each Pilot-in-Command shall:

- a) Immediately execute the missed approach procedure prescribed under [Rule] Part 95 if the requirements of paragraph (e)<sup>96</sup> are not met at any of the following times:
  - (i) When the aircraft is being operated below MDA, or
  - (ii) In the event of a loss of navigation guidance, or
  - (iii) Upon arrival at the missed approach point, or at a specified DA or DH, required to be used, and any time after that until touchdown.

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<sup>96</sup> Paragraph (e) refers to *Air Niugini SOPM, Section 2.4, 14* (e) that states: At night, the runway approach or runway lighting is in sight throughout the approach.

### 5.1.4 Go Around Policy

Section 12.4 of the *Air Niugini SOPM* states:

After commencement of any approach, a go-around should be the primary response when:

- Confusion exists or crew co-ordination breaks down.
- There is uncertainty regarding situational awareness.
- An instrument approach will not be continued to land at any airport beyond a point at which the limits of the operating minima specified for the approach in use would be infringed.
- Malfunction(s) threaten the successful completion of the approach.
- The approach becomes unstable in altitude, airspeed, glidepath, course, sink rate or configuration.
- Unexpected windshear is encountered.
- There is a GPWS / TAWS alert.
- There are ATC changes that will result in a rushed or unstabilised approach.

### 5.1.5 Stabilised Constant Descent Profile

The final segment of a non-precision approach (NPA) is required to be flown with the proper use of a stabilised constant descent profile, e.g. NDB, VOR, DME Arrival OR GPS Arrival.

The constant descent profile may be accomplished by:

- Vertical Navigation (VNAV).
- Flight Path Angle (FPA).
- Runway and Instrument Profile Approaches (Air Niugini Method).
- Other means that provide a stabilised constant path angle for the final segment of a non-ILS approach.

For Air Niugini Fokker and 900EX (domestic) operations only, the Runway and Instrument Profiles for each aerodrome runway can be found on the Flight Ace Route Data Card and the Route Guide Manual. These provide an approximate 3° slope path for each approach. e.g. PY14L is 3 x -200 profile which is  $(3 \times \text{DME} \times 100) - 200\text{ft}$ , which gives the height for the distance, i.e. at 9 DME PY the altitude should be  $2500\text{ft} > (3 \times 9 \times 100) - 200 = 2500\text{ft}$ .

### 5.1.6 Stabilised Approach (Improved Procedure)

All flights must be stabilised by 1000ft above airport elevation in IMC and by 500ft above airport elevation in VMC. An approach is stabilised when all of the following criteria are met:

- The aircraft is on the correct flight path;
- Only small changes in heading/pitch are required to maintain the correct flight path;
- The aircraft speed is not more than  $V_{\text{ref}} + 20$  knots indicated airspeed and not less than  $V_{\text{ref}}$ ;
- The aircraft is in the correct landing configuration;
- Sink rate is no greater than 1,000 ft per min; if an approach requires a sink rate greater than 1,000 ft per min, a special briefing should be conducted;
- Power setting is appropriate for the aircraft configuration and is not below the minimum power for approach as defined by the aircraft operating manual.
- All briefings and checklists have been completed;

- Specific types of approaches are stabilised if they also fulfil the following; ILS approaches must be flown within one dot of the glideslope and localizer; during a circling approach, wings should be level on final when the aircraft reaches 300ft above airport elevation; and
- Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilised approach require a special briefing.

If a deviation exists at or below the stable approach gates (1,000 ft AGL in IMC or 500ft AGL in VMC) the PM shall make the relevant deviation call followed by the word “unstable”. The PIC shall announce “Go-around” and an immediate go-around procedure shall be conducted.

### 5.1.7 Aviation industry stabilised approach recommendations

The investigation noted that aviation industry stabilised approach recommendations include:

- Maintaining a stable speed, descent rate, and vertical/lateral flight path in landing configuration is commonly referred to as the stabilised approach concept.
- Any significant deviation from planned flight path, airspeed, or descent rate should be announced. The decision to execute a go-around is no indication of poor performance.

**NOTE:** Do not attempt to land from an unstable approach.

#### **Further recommended elements of a stabilised approach include:**

All approaches should be stabilised by 1,000 ft HAA in instrument meteorological condition (IMC) and by 500 feet HAA in visual meteorological conditions (VMC). An approach is considered stabilised when all of the following criteria are met:

- the aircraft is on the correct flight path.
- only small changes in heading/pitch are required to maintain the correct flight path.
- the aircraft speed is not more than VREF +20 knots indicated airspeed and not less than VREF.
- the aircraft is in the correct landing configuration.
- sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted.
- power setting is appropriate for the aircraft configuration.
- all briefing and checklist have been conducted.

Specific types of approaches are stabilised if they also fulfil the following:

- ILS approaches should be flown within one dot of the glideslope and localizer
- During a circling approach, wings should be level on final when the aircraft reaches 300 feet HAA.

Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilised approach require a briefing.

**NOTE:** An approach above elements of a stabilised approach require a special briefing that becomes unstabilised below 1,000 feet HAA in IMC or below 500 feet HAA in VMC requires an immediate go-around.

These conditions should be maintained throughout the rest of the approach for it to be considered a stabilised approach. If the above criteria cannot be established and maintained at and below 500 HAA, initiate a go-around.

### 5.1.8 Monitoring and Crosschecking

In the context of flight operations monitoring task and crosschecking are defined as:

*The observation and interpretation of the flight path data, configuration status, automation modes and on-board systems appropriate to the phase of flight. It involves a cognitive comparison against the expected values, modes and procedures. It also includes observation of the other crew member and timely intervention in the event of deviation. (CAA-UK Paper 2013/02, Monitoring for Pilots)*

The designated Pilot Flying (PF) is responsible for flying the aircraft in accordance with the operational brief and monitoring the flight path. The Pilot Monitoring (PM) will have an explicit set of activities designated by the Standard Operating Procedures (SOPs), and as such will have a specific and primary role to monitor the aircraft's flight path, communications and the activities of the PF. Both pilots will be responsible for maintaining their own big picture gained through cross checking each other's actions, communication of intent and diligent observation of the PF selections, mode activations and aircraft responses.

All accurate monitoring activities result in an output following judgment and decision making and this can take the form of:

- Verbalization to other pilot or self;
- Non-verbalization in the form of gesture/eye contact;
- Note-taking in the case of audit monitoring;
- Reinforcement of collective Situation Awareness (SA); and
- Maintenance of mental model.

During a non-precision approach, a standard instrument approach call-out must be made to facilitate awareness of flight path monitoring.

## 5.2 APPENDIX B: Crew Resource Management

(Current at the time of the accident)

### 5.2.1 Air Niugini's Crew Resource Management (CRM)

It is Air Niugini's aim to achieve high standards and strengthen them where needed. Integration of sound technical, procedural (SOP) and CRM standards will increase the probability of safe flight.

CRM is inseparable part of Air Niugini's culture. Crew members are required to exhibit the behaviours and skills espoused in CRM training.

The components of Air Niugini CRM training include:

- Initial Introduction / Awareness. Two 3-day CRM courses.
- Recurrent training. A 1-day refresher course over a 3-year cycle.
- Licence renewal – CRM training in accordance with Annex 6 Standards and CASA PNG approvals.

CRM equips operating crews on the use of all resources that are available on an aircraft.

The *Air Niugini Training Policy and Procedures Manual* states:

CRM combines individual skills and human factors knowledge with effective crew coordination. It is a model of management used to manage the following principles: Threat and Error Management; Crew performance; Situational awareness; Decision making.

Section 2.5.1.4 of the *Air Niugini SOPM*, titled *Challenge and Response* states:

When a crew member notices a significant deviation from standard procedures during a normal flight regime, he should communicate this immediately to the crew member flying. If he does not receive a response to his challenge either verbally or by corrective action, he should immediately repeat the challenge.

If there is still no response to the second challenge, then he should take over the control of the aircraft and restore a safe flight condition while he obtains assistance to determine the cause of the problem.

All crew members are to be aware of this challenge and response philosophy. If they are challenged, they must be prepared to respond immediately, either verbally or by taking corrective action.

The investigation found that during the events leading up to the time of the accident, the crew lost situational awareness. Investigations found that the crew performance lacked Threat and Error Awareness and Management.

*(See AIC Recommendation AIC 19-R10/18-1004 for Safety action taken by Air Niugini to address the challenge and response deficiencies identified with respect to the Air Niugini Standard Operating Procedures Manual, Section 2.5.14)*

## 5.3 APPENDIX C: Cabin Crew information

### 5.3.1 Cabin crew (CC2) Senior Economy Cabin

Age	: 58 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 1 April 2019
Total flying time	: 13,496.0 hours
Total time last 30 days	: 55.0 hours
Total on B737 last 30 days	: 25.4 hours
Total time last 7 days	: 18.4 hours
Total on B737 last 7 days	: 5.5 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.2 Cabin crew (CC3)

Age	: 39 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 28 November 2018
Total flying time	: 4,098.25 hours
Total time last 30 days	: 86.8 hours
Total on B737 last 30 days	: 42.7 hours
Total time last 7 days	: 16.4 hours
Total on B737 last 7 days	: 16.4 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.3 Cabin crew (CC4) Under training

Age	: 27 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 21 March 2019
Total flying time	: 2,458.1 hours
Total time last 30 days	: 26.6 hours
Total on B737 last 30 days	: 24.9 hours
Total time last 7 days	: 13.2 hours
Total on B737 last 7 days	: 13.2 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.4 Cabin crew (CC5)

Age	: 31 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 7 April 2019
Total flying time	: 2,672.0 hours
Total time last 30 days	: 101.75 hours
Total on B737 last 30 days	: 24.6 hours
Total time last 7 days	: 21.7 hours
Total on B737 last 7 days	: 15.1 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.5 Cabin crew (CC6) Trainer

Age	: 48 years
Gender	: Male
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 30 October 2019
Total flying time	: 14,418.0 hours
Total time last 30 days	: 66.6 hours
Total on B737 last 30 days	: 34.9 hours
Total time last 7 days	: 21.7 hours
Total on B737 last 7 days	: 18.5 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.6 Cabin crew (CC7) Check staff

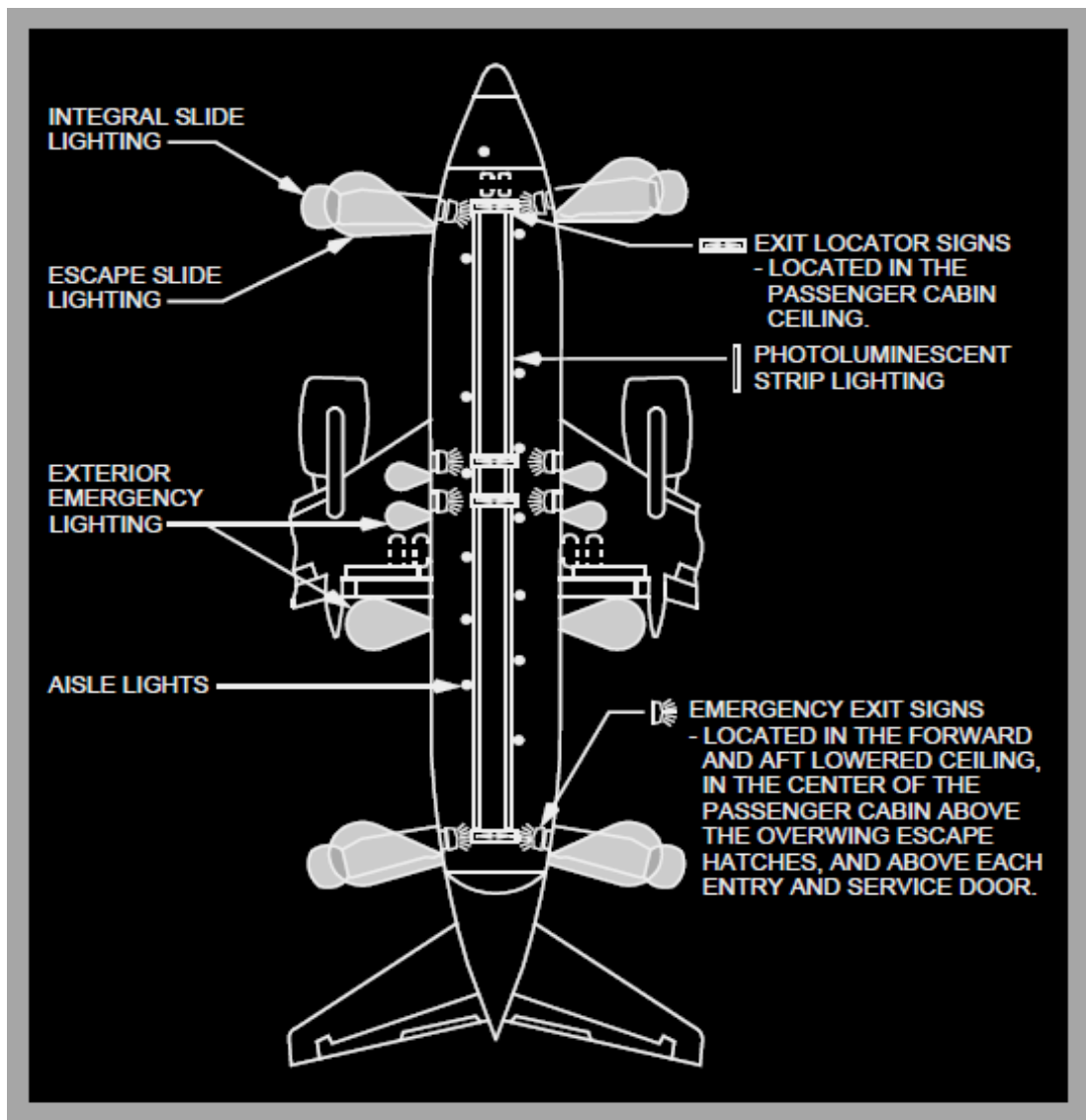
Age	: 58 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 12 November 2018
Total flying time	: 10,430.0 hours
Total time last 30 days	: 28.7 hours
Total on B737 last 30 days	: 20.7 hours
Total time last 7 days	: 5.5 hours
Total on B737 last 7 days	: 5.5 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

### 5.3.7 Cabin crew (CC8) Observing check staff

Age	: 44 years
Gender	: Female
Nationality	: Papua New Guinean
Type of Certificate	: B767/B737
Valid to	: 25 November 2018
Total flying time	: 11,629.0 hours
Total time last 30 days	: 75.9 hours
Total on B737 last 30 days	: 32.7 hours
Total time last 7 days	: 11.25 hours
Total on B737 last 7 days	: 5.5 hours
Total time last 24 hours	: 4.2 hours
Total time on B737 last 24 hours	: 4.2 hours
Time off duty prior to the flight	: 11.3 hours
Time on duty prior to the flight	: 1.2 hours
Time awake prior to the flight	: 2.75 hours
Duration of sleep prior to duty period	: 7.0 hours approx.

## 5.4 APPENDIX D: Cabin Safety

### 5.4.1 Emergency Exit Lights



**Figure 35: Air Niugini's Boeing B737, P2-PXE Emergency exit lighting**

(Source Air Niugini Boeing 737 *Flight Crew Operations Manual*.)


## 5.4.2 Over wing Exit Passenger briefing Card



**Figure 36: A scanned copy of the Passenger Safety Briefing Card**

(Source Air Niugini Overwing Exit Passenger Safety Briefing card)

### 5.4.3 Air Niugini SEPM Vol 6, Section 2.14.4.2 – Evacuation drills – Ditch with life raft.



**General Safety Procedures**

Safety and Emergency Procedures Manual - Volume 6 (B737)

<b>Evacuation Commands – Ditch with Life raft</b>	
<b>Door 1L/1R</b>	<b>O/wing Exits (LHS/RHS)</b>
Evacuate! Evacuate!	
Open your seatbelt	
Come this way	
There is a Life raft here	
Hurry Move faster	
	Step through
Pull both red tags when exiting	
	Stay on your feet
Step into Life raft	
Do not jump	
Move to the far end	
Sit with your feet towards the centre	

**NOTE:** CC2 will remain at the AFT door and shout blocked exit commands.

Version 4.0 01-May-17

General Safety Procedures

Document Owner: General Manager Flight Operations

Page 2-27

Figure 37: Air Niugini Safety and Emergency Procedures Manual (SEPM) volume 6, section 1.14.4.2

## 5.5 APPENDIX E: RNAV (GPS) Approach chart briefings

### 5.5.1 PTKK RNAV (GPS) Rwy 4

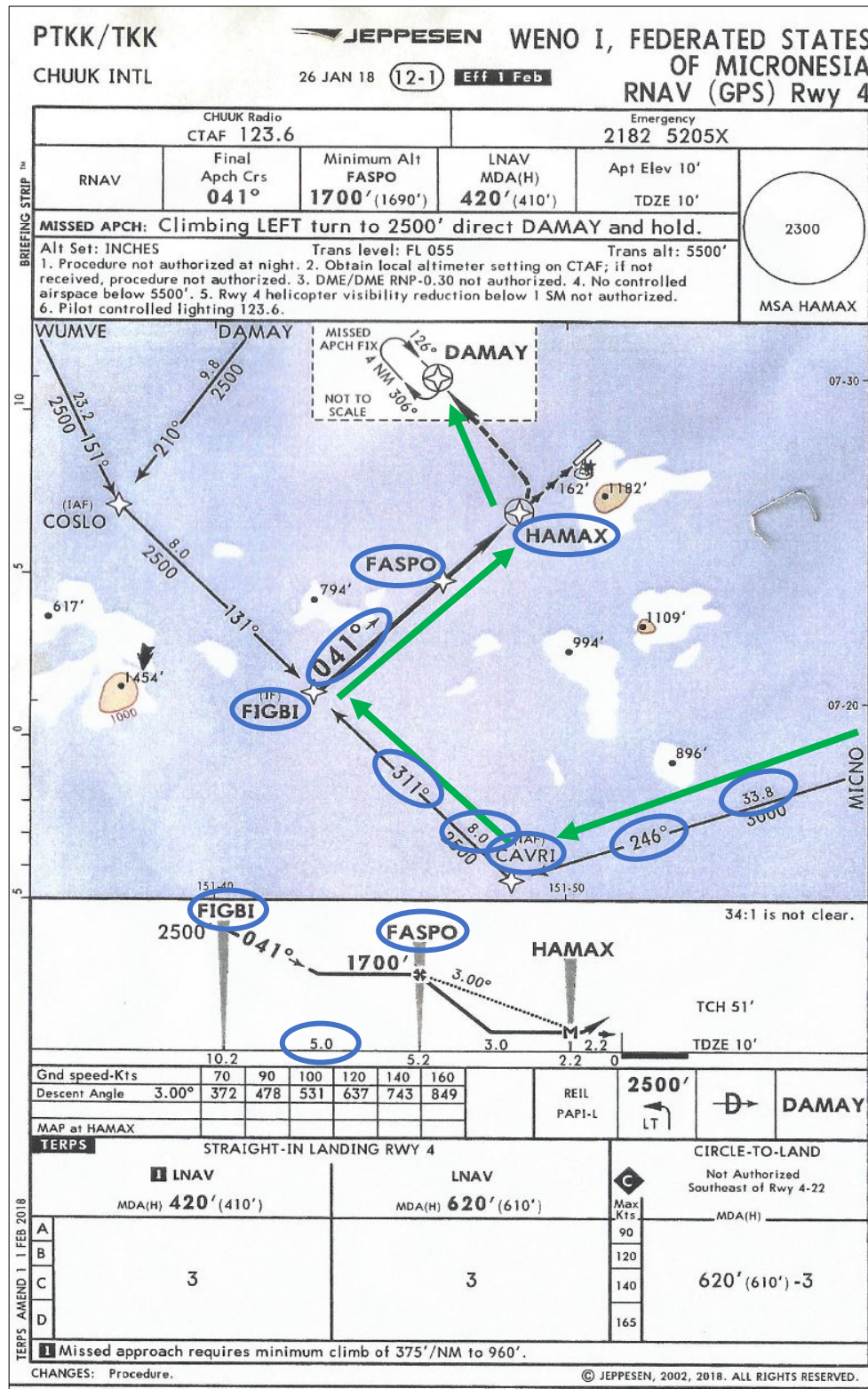


Figure 38: PIC's brief on the *PTKK RNAV (GPS) Rwy 4* approach chart.

**Note:**

→ shows direction in which the chart was briefed; and

○ shows items mentioned

5.5.1.1 Required Jeppesen Chart briefing as per Air Niugini SOPM

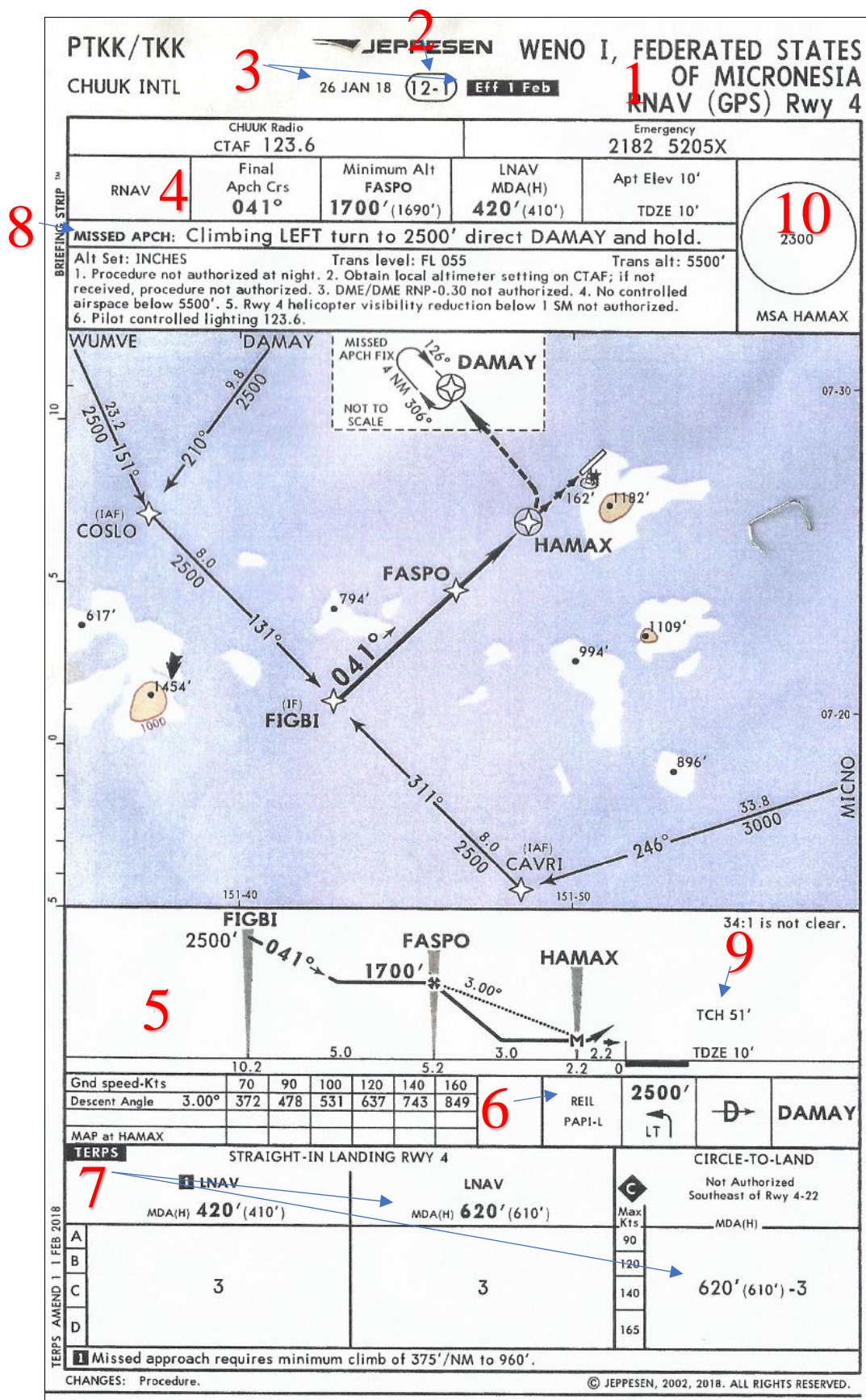


Figure 39: Required approach chart briefing as per Air Niugini SOPM

## 5.5.2 PTPN RNAV (GPS) Rwy 9

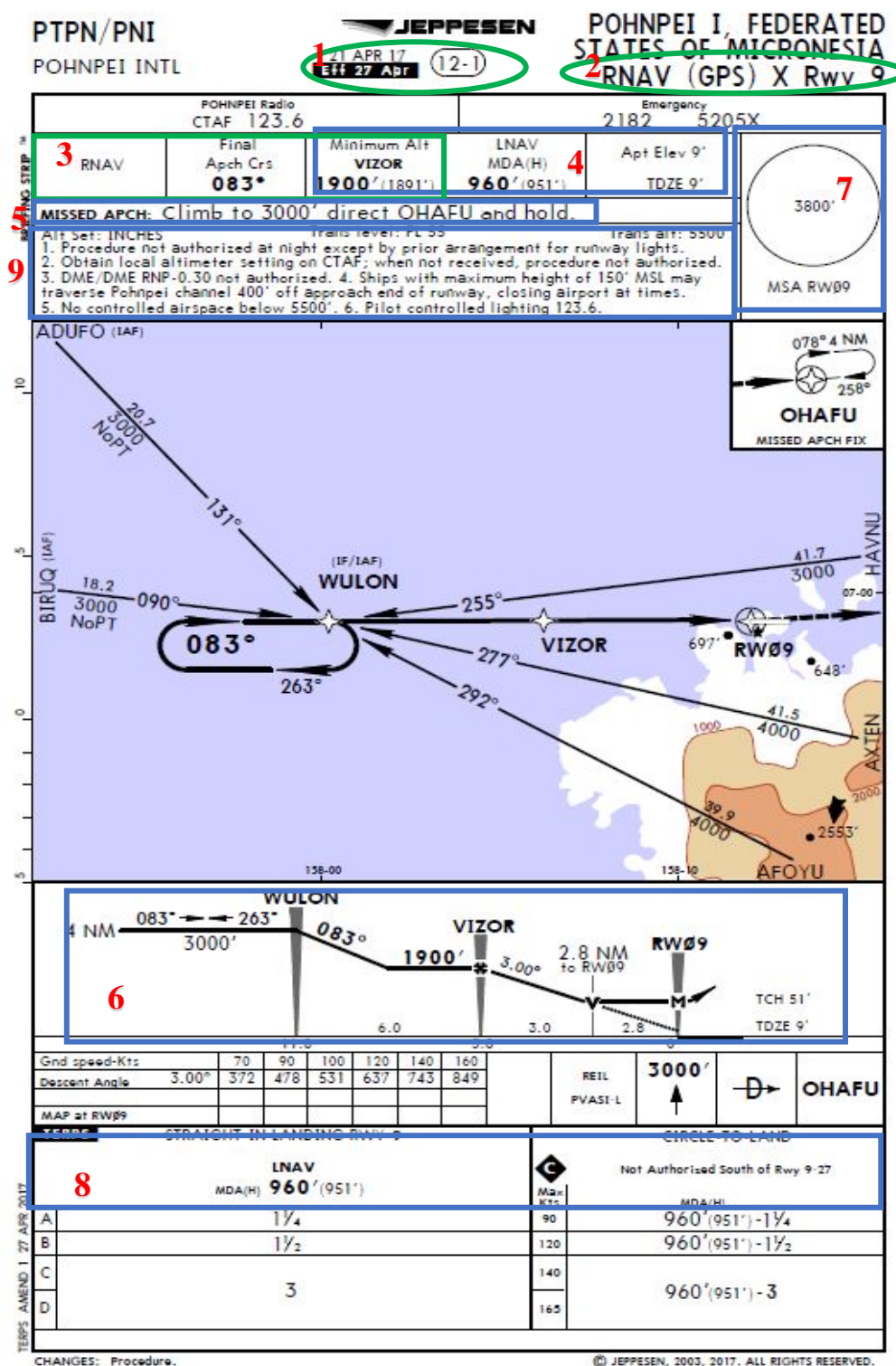


Figure 40: PIC's brief on the PTPN RNAV (GPS) Rwy 9 approach chart

Note:

  Shows the items that were briefed by the PIC before being interrupted by San Francisco radio; and

  Shows the continuation of the approach chart briefing after communication with ATC.

5.5.2.1 Required Jeppesen Chart briefing as per Air Niugini SOPM

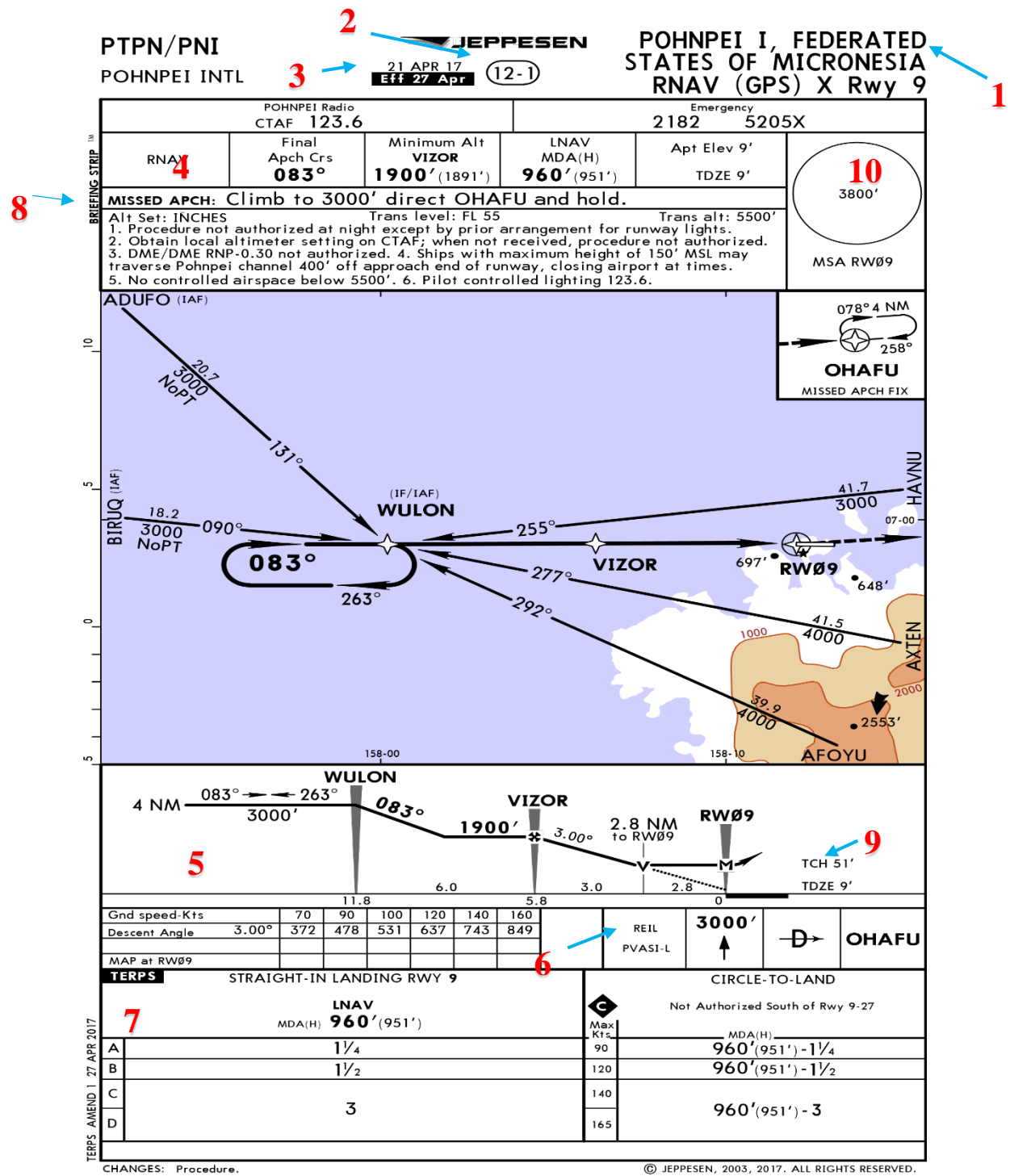


Figure 41: Required approach chart briefing as per Air Niugini SOPM

### 5.5.3 Jeppesen chart briefing (Air Niugini SOPM – Section 11.9)

## 11.9 Jeppesen Chart Briefing

Crew intending to conduct an Instrument approach must brief the approach chart thoroughly in a standardized and logical sequence each time so other crew members can sequentially follow through. The PF would normally brief the PM. Following is the order of briefing the Jeppesen chart.



### Climb and Cruise

#### Standard Operating Procedures Manual

1. The title of the appropriate approach chart being used
2. The chart number
3. The chart date and chart effective date
4. The Briefing Strip with:
  - The Approach and frequency
  - Final Approach course
  - Height check
  - DA(H) or MDA(H)
  - Airport elevation/Runway elevation
5. The profile of the approach with any pertinent points including the Final Approach Point (FAP) or Final Approach Fix (FAF). An approach profile may be included depending on the type of approach.
6. The approach lighting type
7. The appropriate Minima DA(H) or MDA(H) for a straight-in landing approach or circle-to-land **AND** the appropriate Visibility for that approach and aircraft category.
8. **If Not Visual:**
  - Missed Approach Point (MAP)
  - Missed Approach procedure
9. **If Visual:**
  - The Threshold Crossing Height
  - The anticipated exit taxiway and taxiways to the parking bay.(Using Terminal and Taxiway charts)

Figure 42: Excerpt from *Air Niugini SOPM, Section 11.9*

10. Other items:

- MSA
- Holding
- Notes

## 11.10 Cabin Preparation Notice

Approaching the top of descent point the flight crew are to make the public address

“Cabin Crew prepare the cabin for arrival”.

This provides the cabin crew a cue that descent will be commencing shortly and cabin preparations are finalised in preparation for the approach and land phase.



## 5.6 APPENDIX F: Precision Approach Path Indicator (PAPI)

PAPI is a light system that consists of two, three or four boxes of lights that provides a visual indication of an aircraft's position on the glidepath or landing profile. Depending on the flightpath angle, lights will appear red or white.

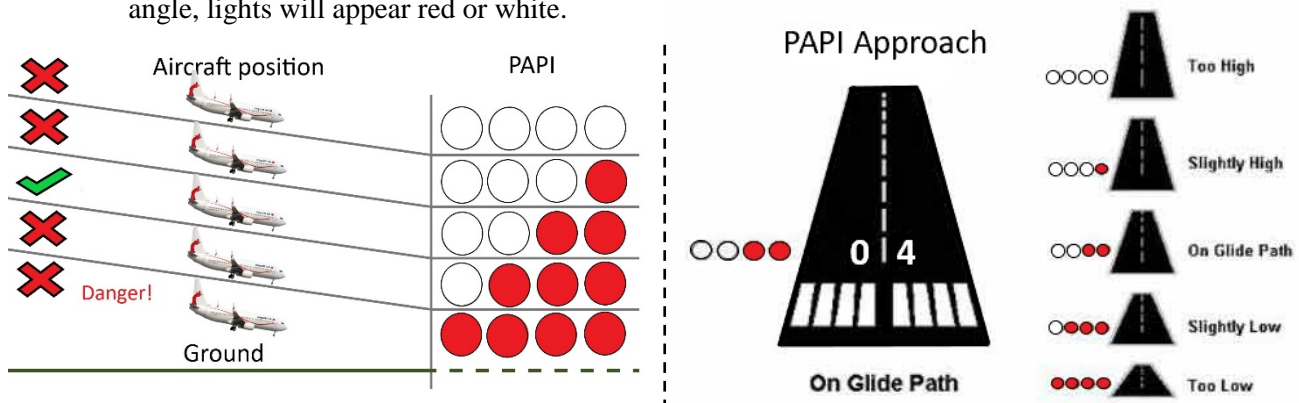


Figure 43: PAPI lights indicating profile if flown against 3-deg flightpath.

The following table shows the description of visual indications of PAPI lights as depicted in figure 43:

PAPI indication	Definition	Remarks	Touchdown point
<b>Four whites</b>	Too high	The aircraft is too high on profile	Land too long
<b>Three whites, one red</b>	Slightly high	The aircraft is slightly high on profile	Land slightly long
<b>Two whites, two reds</b>	On profile	The aircraft is on profile	Correct landing point
<b>One white, three reds</b>	Slightly low	The aircraft is slightly low on profile	Land slightly short
<b>Four reds</b>	Too low	The aircraft is too low on profile	Land too short

PXE actual glidepath at the MDA is depicted in the figure 44 below.

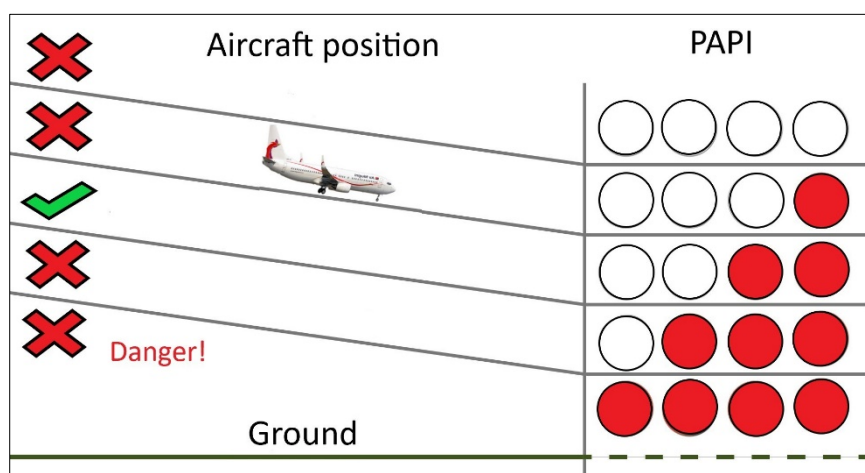


Figure 44: PXE flight profile at the MDA on approach to land

## 5.7 APPENDIX G: FDR/AFIRS Derived Data

### 5.7.1 FDR data P2-PXE Approach to Chuuk International Airport Runway 04

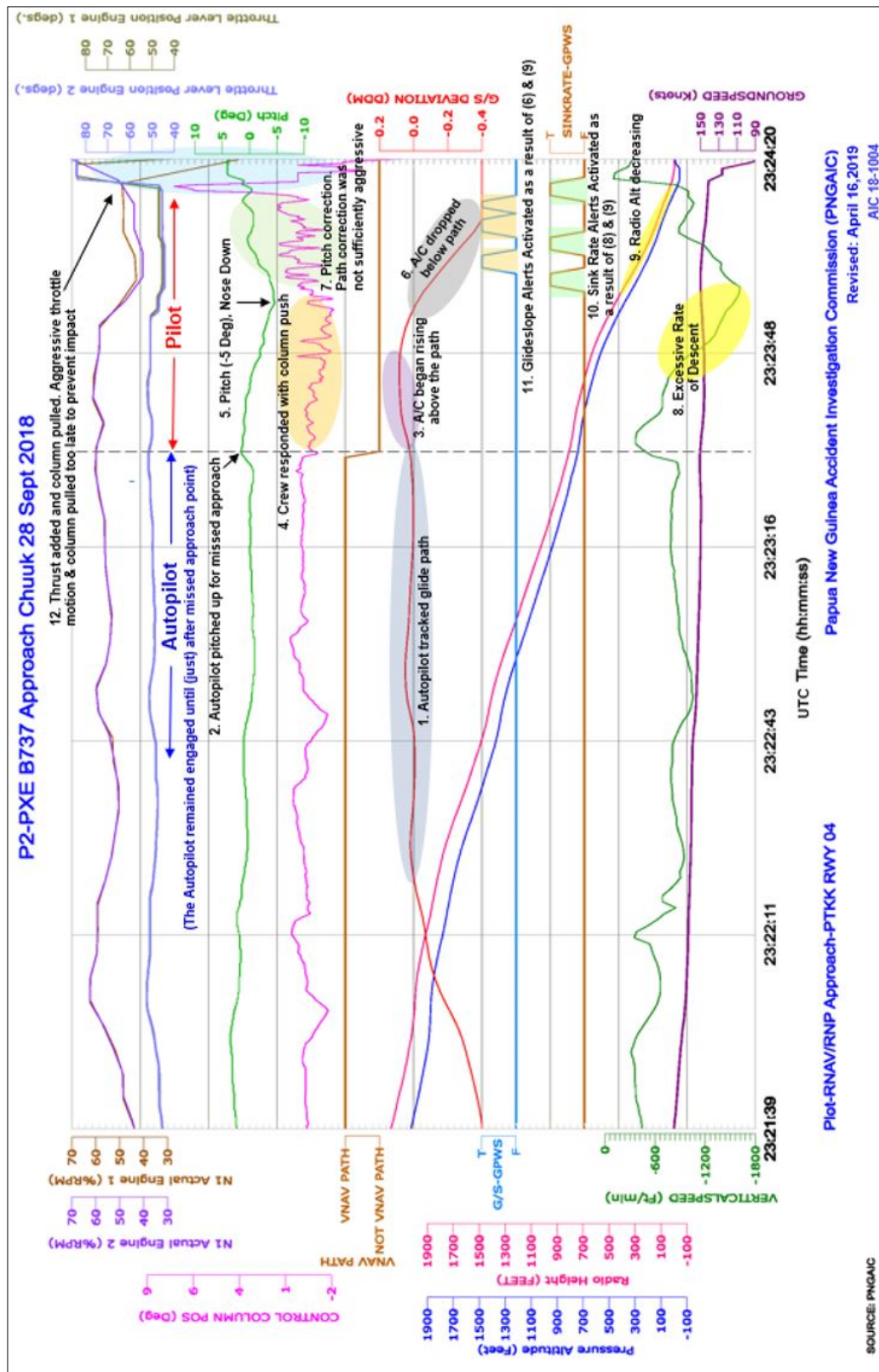


Figure 45: FDR Data plot  
(Figure 6 page 18)

## 5.7.2 FDR/AFIRS derived data P2-PXE Chuuk approach

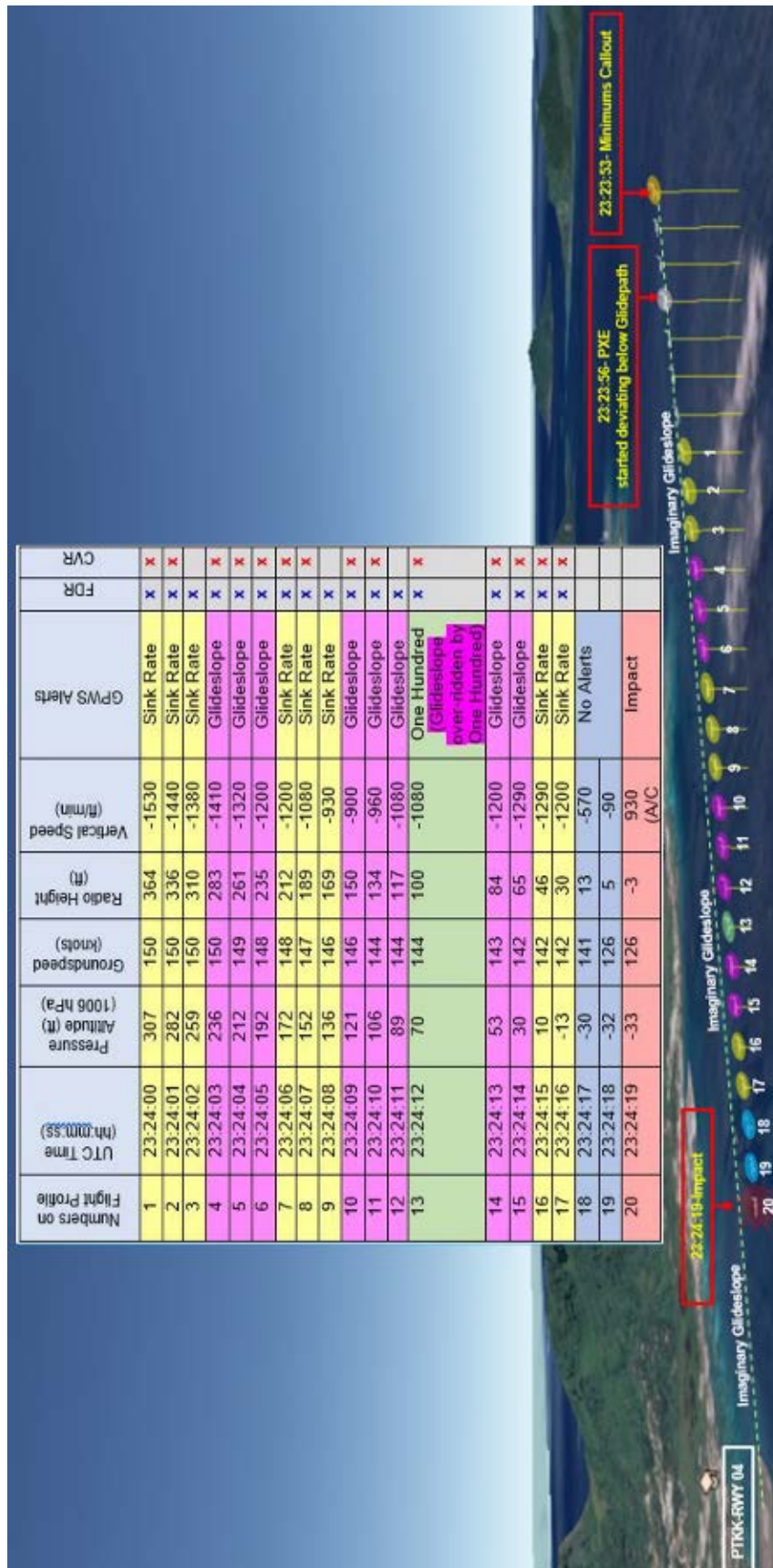
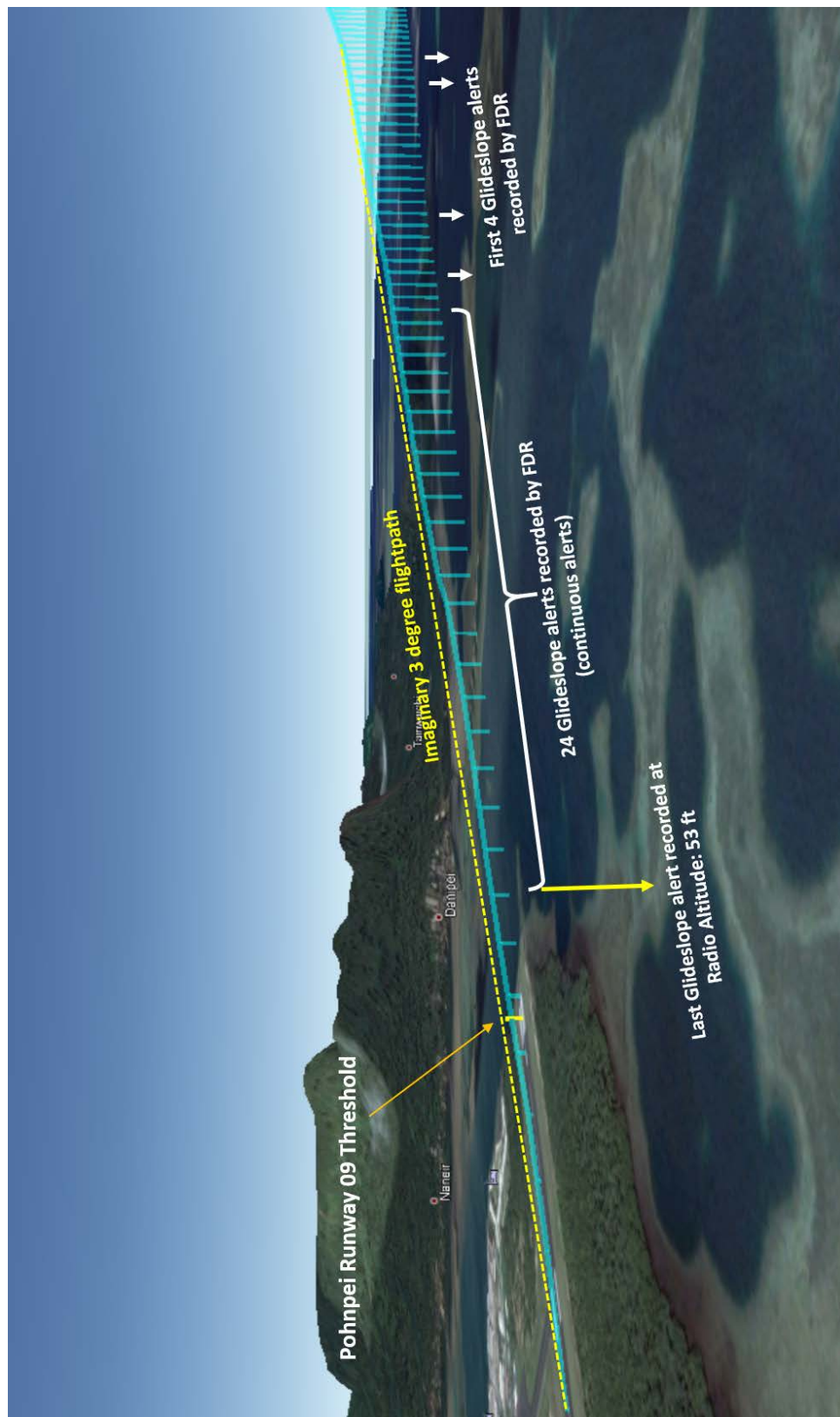


Figure 46: Glideslope and Sink Rate aural alerts graphic using derive data  
(Figure 13 page 24)

### 5.7.3 Pohnpei Runway 09 approach EGPWS 28 Glideslope aural alerts



**Figure 47: Pohnpei approach flight path**  
(Refer to Section 2.4.1 page 51)

## 5.8 APPENDIX H: TSO-151b, Alert Prioritisation Scheme

### FEDERAL AVIATION ADMINISTRATION MINIMUM PERFORMANCE STANDARD (MPS) FOR A TERRAIN AWARENESS AND WARNING SYSTEM FOR CLASSES A AND B (continued)

ALERT PRIORITIZATION SCHEME			
Priority	Description	Alert Level	Comments
1	Reactive Windshear Warning	W	
2	Sink Rate Pull-Up Warning	W	continuous
3	Excessive Closure Pull-Up Warning	W	continuous
4	RTC Terrain Warning	W	
5	V1 Callout	I	
6	Engine Fail Callout	W	
7	FLTA Pull-Up warning	W	continuous
8	PWS Warning	W	
9	RTC Terrain Caution	C	continuous
10	Minimums	I	
11	FLTA Caution	C	7 s period
12	Too Low Terrain	C	
13	PDA ("Too Low Terrain") Caution	C	
14	Altitude Callouts	I	
15	Too Low Gear	C	
16	Too Low Flaps	C	
17	Sink Rate	C	
18	Don't Sink	C	
19	Glideslope	C	3 s period
20	PWS Caution	C	
21	Approaching Minimums	I	
22	Bank Angle	C	
23	Reactive Windshear Caution	C	
Mode 6 a	TCAS RA ("Climb", "Descend", etc.)	W	continuous
Mode 6 a	TCAS TA ("Traffic, Traffic")	C	Continuous

**NOTE 1:** These alerts can occur simultaneously with TAWS voice callout alerts.

**NOTE 2:** W = Warning, C = Caution, A = Advisory, I = Informational

**Table 4: TSO-151b, Alert Prioritisation Scheme**

**Figure 48: TSO-151b, Alert Prioritisation Scheme**

## 5.9 APPENDIX I: Data retrieval and flight animation



Figure 49: SSFDR memory chip board connected to Memory Access Retrieval System (MARS)



Figure 50: Flight animation from recorded data and cockpit image recording (video) lower right