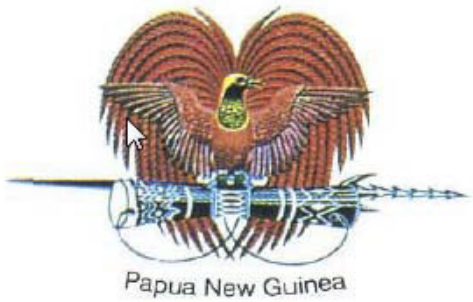


FINAL REPORT

AIC 13-1007

PAPUA NEW GUINEA

ACCIDENT INVESTIGATION COMMISSION

AIRCRAFT ACCIDENT REPORT

Air Niugini

P2-PXY

Avions de Transport Régional ATR 42-320 freighter

Madang Airport

Madang Province

PAPUA NEW GUINEA

19 October 2013

The Papua New Guinea Accident Investigation Commission (AIC) was informed of the accident by the PNG Civil Aviation Authority on 19 October 2013, and commenced an on-site investigation.

This Report, made publicly available on 14 October 2015 was produced by the AIC, PO Box 1709, Boroko 111, Papua New Guinea.

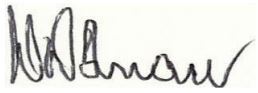
The report is based upon the investigation carried out by the AIC, in accordance with Annex 13 to the Convention on International Civil Aviation, Papua New Guinea (PNG) Act, and Civil Aviation Rules. New Guinea (PNG) Civil Aviation Act 2000 (As Amended), Civil Aviation Rules, and the Commissions of Inquiry Act 1951. It contains factual information, analysis of that information, findings and safety action taken to address identified deficiencies.

Readers are advised that in accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of an AIC aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents. (Reference: ICAO Annex 13, Chapter 3, paragraph 3.1.) Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose.

As the AIC believes that safety information is of greatest value if it is passed on for the use of others, readers are encouraged to copy or reprint for further distribution, acknowledging the AIC as the source.

When the AIC makes recommendations as a result of its investigations or research, safety is its primary consideration. The AIC nevertheless recognises that the implementation of recommendations arising from its investigations will in some cases incur a cost to the industry.

Readers should note that the information in AIC reports and recommendations is provided to promote aviation safety. In no case is it intended to imply blame or liability.



David Inau, ML

Chief Executive Officer

Accident Investigation Commission

14 October 2015

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INTRODUCTION

SYNOPSIS

On 19 October 2013, an Avions de Transport Régional ATR42-320 freighter, registered P2-PXY (PXY) and operated by Air Niugini, was scheduled to fly from Madang to Tabubil, Western Province, as flight PX2900 carrying a load tobacco for a client company.

There were three persons on board; the pilot in command (PIC), a copilot, and a PNG experienced DHC-8 captain whose function was to provide guidance during the approach into Tabubil. The PIC was the handling pilot and the copilot was the support monitoring pilot.

The flight crew taxied to the threshold end of runway 25 intending to use the full length of the runway. The take-off roll was normal until the PIC tried to rotate at V_R (speed for rotation, which the flight crew had calculated to be 102 knots). He subsequently reported that the controls felt very heavy in pitch and he could not pull the control column back in the normal manner.

Flight data recorder (FDR) information indicated that approximately 2 sec later the PIC aborted the takeoff and selected full reverse thrust. He reported later that he had applied full braking. It was not possible to stop the aircraft before the end of the runway and it continued over the embankment at the end of the runway and the right wing struck the perimeter fence.

The aircraft was substantially damaged during the accident by the impact, the post-impact fire and partial immersion in salt water. The right outboard wing section was completely burned, and the extensively damaged and burnt right engine fell off the wing into the water. Both propellers were torn from the engine shafts and destroyed by the impact forces.

The investigation found that the aircraft total load exceeded the maximum permissible load and the load limit in the forward cargo zone 'A' exceeded the zone 'A' structural limit. The mass and the centre of gravity of the aircraft were not within the prescribed limits.

The investigation also found that:

- Air Niugini's lack of robust loading supervision and procedures for the ATR 42/72 aircraft, and the inaccurate weights provided by the consignor/client company likely contributed to the overload.
- The Madang Airport fire-fighting tender vehicle did not have sufficient capacity to fight a more extensive aircraft fire.
- The Madang airport did not meet the ICAO Annex 14[1] Standard with respect to the required aerodrome category 6, for rescue and fire-fighting services.
- The Madang airport did not meet the ICAO Annex 14 Standard with respect to the runway end safety areas.

The Accident Investigation Commission made six safety recommendations to organisations including Air Niugini, PNG Air Services Ltd., the PNG National Airports Corporation, and

1 ICAO *Annex 14 Vol 1, Aerodrome Design and Operations,* current at the time of the accident was Fifth Edition 2009. The Sixth Edition was promulgated to States in July 2013 with an effective date 14 November 2013, to allow States time to make amendments to their procedures and practices before the effective date.

airline operators to address safety concerns identified during the investigation. The recommendations are published in Part 4 of this report, together with responses from the organisations, and the AIC assessment of the response with respect to addressing the identified safety deficiencies. They are also published on the AIC website; www.aic.gov.pg.

1 FACTUAL INFORMATION

1.1 History of the flight

On 19 October 2013, an Avions de Transport Régional ATR42-320 freighter, registered P2-PXY (PXY) and operated by Air Niugini, departed Port Moresby, National Capital District, for Madang, Madang Province, at 06:16 UTC[2] as flight PX2110. The aircraft was carrying 860 kg of mixed freight to be off-loaded in Madang. From Madang, the aircraft was scheduled to continue to Tabubil, Western Province, as flight PX2900, and from Tabubil it was to return to Port Moresby (Figure 1).

GoogleEarth image modified by the PNG AIC

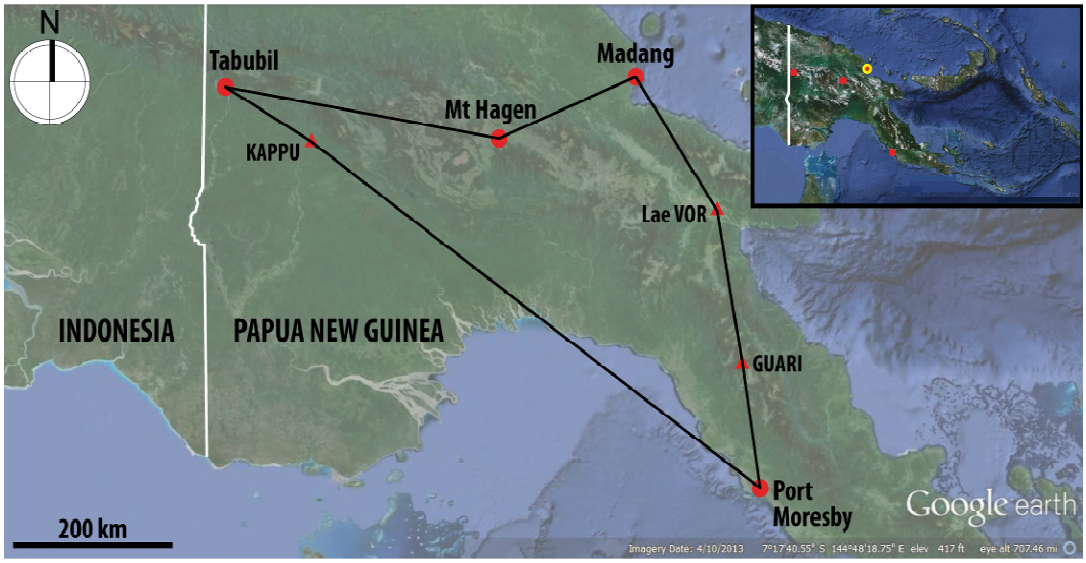

Figure 1: PXY flight-planned route

There were three persons on board; the pilot in command (PIC), a copilot, and a PNG experienced DHC-8 captain whose function was to provide guidance during the approach into Tabubil. The PIC was the handling pilot and the copilot was the support monitoring pilot.

During taxi at Port Moresby, the anti-skid warning light illuminated. The flight crew stopped the aircraft, carried out the relevant checklist, and determined from the aircraft performance charts that it was permissible to land at Madang with the anti-skid inoperative.

The flight to Madang was normal and the aircraft landed there at 07:32. The freight from Port Moresby was off-loaded and a cargo consisting entirely of cigarettes, packaged in large cardboard cartons, was loaded for Tabubil and Port Moresby.

The aircraft taxied to depart from runway 25 at 09:15. The flight crew taxied to the threshold end of runway 25 intending to use the full length of the runway. The take-off roll was normal until the PIC tried to rotate at V_R (speed for rotation, which the flight crew had calculated to be 102 knots).

2 The 24-hour clock is used in this report to describe the local time of day, Local Mean Time (LMT), as particular events occurred. Local Mean Time was Coordinated Universal Time (UTC) + 10 hours.

He subsequently reported that the controls felt very heavy in pitch and he could not pull the control column back in the normal manner. Flight data recorder (FDR) information indicated that approximately 2 sec later the PIC aborted the takeoff and selected full reverse thrust. He reported later that he had applied full braking. It was not possible to stop the aircraft before the end of the runway and it continued over the embankment at the end of the runway (Figure 2) and the right wing struck the perimeter fence (Figure 3).

Figure 2: Aerial view of PXY and runway 07/25 at Madang

This caused the aircraft to yaw to the right and it entered a creek beyond the perimeter fence at approximately 45 degrees to its direction of movement (Figures 2 to 4). The right outboard wing section caught fire and the flight crew escaped through the hatch in the cockpit roof.

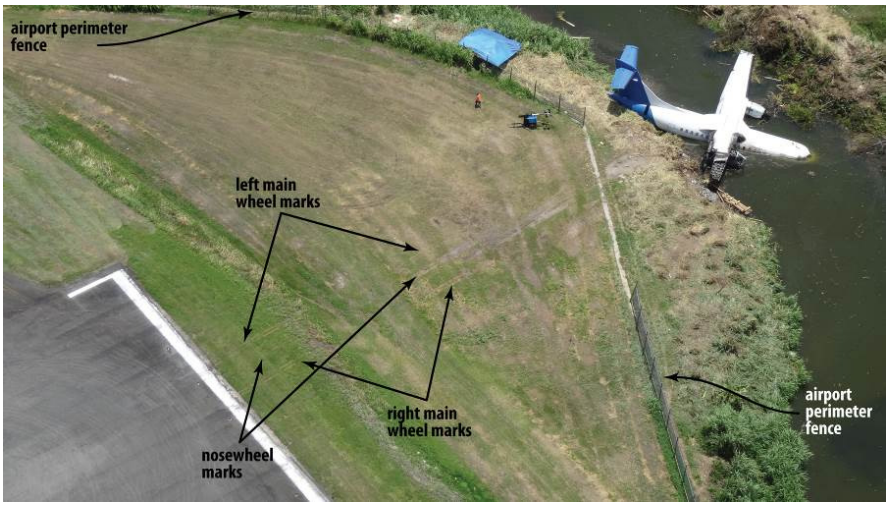

Figure 3: Aerial view of PXY and ground witness marks

Figure 4: PXY where it came to rest in the creek

The PIC, who was the last to remain on board, discharged the engine-bay fire extinguishers for each engine and switched off the battery master switch before leaving the aircraft.

The Madang Airport Fire and Rescue Service responded promptly and sprayed foam and water onto the fire in the right wing. The foam and water were exhausted before the fire was fully extinguished, but the fire did not spread to the right inboard wing section. Almost immediately after the accident, local people entered the aircraft through the hatch in the cockpit roof and the right door at the rear of the fuselage, and without authorisation began removing items from the cockpit and the cargo compartments.

1.2 Injuries to persons

The PIC, a 37 year old Spanish citizen was not injured.

The copilot, a 34 year old Spanish citizen suffered a minor injury.

The safety pilot, a 53 year old Australian citizen was not injured.

Table 5: Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	1	-	1	Not applicable
Nil Injuries	2	-	2	Not applicable
TOTAL	3	-	3	-

1.3 Damage to aircraft

The aircraft was substantially damaged during the accident by the impact with embankment and the airport perimeter fence, the post-impact fire and partial immersion in salt water, and subsequently by the salvage operation during which it was lifted out of the creek and moved to a position on the airfield. The right outboard wing section was completely burnt, and the extensively damaged and burnt right engine fell off the wing into the water. Both propellers were torn from the engine shafts and destroyed by the impact forces.

1.4 Other damage

The airport perimeter fence was severed. There was no other damage to property or the environment.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 37 years
Gender	: Male
Nationality	: Spanish
Type of licences	: PNG validation certificate of
	: Spanish ATPL
Valid to	: 1 December 2013
Licence numbers	: PNG validation certificate 409/2013 of
	: Spanish ATPL E00021718
Ratings	: ATR 42/72
Total flying time	: 7,110.0 hours
Total on this type	: 3,433.0 hours
Total hours PNG	: 13,214.0 hours
Total hours last 90 days	: 2,400.0 hours
Total hours last 7 days	: 10.1 hours
Last Competency Check	: 6 March 2013
Medical class	: One
Valid to	: 9 March 2014
Medical limitation	: Nil

Note: The Pilot in Command's Spanish ATPL was valid to 9 March 2014. However the PNG CASA Validation Certificate was valid to 1 December 2013. To fly the PNG registered ATR 42 aircraft, either a PNG ATPL licence or a PNG validation of the Spanish ATPL was required. The PNG CASA Validation Certificate No. 409/2013 incorrectly listed the pilot in command's Spanish ATPL number as E/FCL/00021718.

1.5.2 Copilot

Age	: 33 years
Gender	: Male
Nationality	: Spanish
Type of licences	: PNG validation certificate of
	: Spanish ATPL
Valid to	: 9 November 2013
Licence numbers	: PNG validation certificate 379/2013 of
	: Spanish ATPL E00023311
Ratings	: ATR 42/72
Total flying time	: 3,020.0 hours
Total on this type	: 2,420.0 hours
Total hours PNG	: Not available
Total hours last 90 days	: 95 hours
Total hours last 30 days	: 59 hours
Last Competency Check	: 14 July 2014
Medical class	: One

Note: The copilot's Spanish ATPL was valid to 30 June 2014. However the PNG CASA Validation Certificate was valid to 9 November 2013. To fly the PNG registered ATR 42 aircraft, either a PNG ATPL licence or a PNG validation of the Spanish ATPL was required. The PNG CASA Validation Certificate No. 379/2013 incorrectly listed the pilot in command's Spanish ATPL number as E0002311.

1.5.3 Safety pilot

Age	: 53 years
Gender	: Male
Nationality	: Australian
Type of licences	: PNG ATPL
Valid to	: 9 November 2013
Licence numbers	: P20790
Ratings	: DHC-8
Total flying time	: 13,214.0 hours
Total hours PNG	: 2,400.0 hours
Total hours last 90 days	: 140.0 hours
Total hours last 7 days	: 10.1 hours
Last Competency Check	: 15 February 2014
Medical class	: One

1.6 Aircraft information

1.6.1 Aircraft data

Aircraft manufacturer	: Avions de Transport Régional
Model	: ATR 42-320F
Serial number	: 087
Date of manufacture	: 1988 (in passenger configuration)
Date of conversion to freighter	: December 2001
Nationality and registration mark	: PNG P2-PXY
Name of the owner	: Air Niugini
Name of the operator	: Air Niugini
Certificate of Airworthiness number	: 301
Certificate of Airworthiness issued	: 15 July 2013
Valid to	: Non-terminating
Certificate of Registration number	: 301
Certificate of Registration issued	: 11 July 2013
Valid to	: Non-terminating
Total airframe hours	: 24,375 hours (At 18 October 2013)

1.6.2 Engine data

Engine type	: Turbo propeller
Manufacturer	: Pratt & Whitney Canada
Type	: PW121

Engine number one (Left)

Serial number	: 121259

Engine number two (Right)

Serial Number	: 120792

Engine status and performance were not relevant to this accident.

1.6.3 Propeller data

Propeller Type	: Constant speed, four bladed, full feathering, reversible
Manufacturer	: Hamilton Standard
Type	: 14 SF-5
Propeller number one (Left)	
Serial Number	: 900212
Propeller number two (Right)	
Serial Number	: 890532

Propeller status and performance were not relevant to this accident.

1.6.4 Weight and balance data

A consignment of 400 cartons of locally-manufactured cigarettes was sent by the Madang based client to Madang Airport for transport to Tabubil and Port Moresby. The consignment was composed of four types of cardboard cartons of approximately similar dimensions and weights (see Table 2). Each carton contained between 5,000 and 10,000 cigarettes depending if they were long or short type cigarettes. Three hundred and thirty cartons, of three different sizes, were loaded onto PXY and 70 cartons were returned to the client.

A diagram on the aircraft's load sheet showed the layout of the cargo compartments and the maximum permitted floor loading of each compartment (Figure 5).

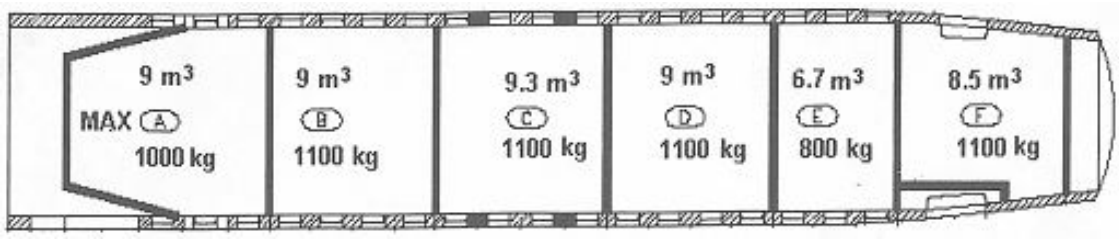

Figure 5: Diagram on PXY's load sheet showing compartments 'A' to 'F'

The PIC determined that the maximum cargo weight[3] to be loaded was 3,710 kg. During the AIC interview the Senior Cargo Officer stated that the PIC instructed 'Zone A to have 350 kg, 30 cartons'. The investigation determined that 30 cartons actually weighed 395 kg.

3 Because of fuel restrictions at Tabubil only 300 L of fuel would be available there to PXY, so the remainder necessary for the next two sectors (Madang to Tabubil, and Tabubil to Port Moresby) had to be uplifted at Madang. After refuelling at Madang, PXY had 3,400 L (2650 kg) of fuel on board.

The copilot stated that he drew a loading diagram for the operator's ground handling staff showing the weight to be loaded in each of the aircraft's six cargo compartments 'A' to 'F'. However, the AIC was not shown the diagram.

The copilot provided details of the weight he said he requested to be loaded in each compartment at Madang. This was in accordance with the Load and Balance Chart prepared for the flight by the copilot and accepted by the PIC. (See Table 1)

Table 2: Loading calculated by the First Officer and entered on the aircraft load sheet

cargo compartment	maximum compartment loading (kg)	load (kg) calculated by flight crew at Madang
A	1,000	350
B	1,100	800
C	1,100	800
D	1,100	800
E	800	600
F	1,100	360
Total		**3,710**

The aircraft was loaded by the operator's ground staff with the assistance of some of the staff from British American Tobacco (BAT), the consignor/client. The operator's cargo supervisor stated after the accident that PXY had been loaded on the assumption that each carton weighed 12 kg, but that the cartons had not been weighed before they were loaded onto the aircraft. The client, who had manufactured and packed the cigarettes, provided average carton weights to the AIC on the basis of samples of 25 cartons of each of the three carton types loaded on PXY (see Table 2).

Table 3: PXY cargo summary

cigarette type	cartons sent to the airport by the client	cartons loaded	carton weight (kg) used by the operator's ground staff	actual carton weight (kg) (average weight of 25 cartons)	cargo supervisor-calculated weight (kg) loaded on PXY	actual weight (kg) loaded on PXY	maximum weight (kg) permitted by the load sheet
Spear 80s	288	288	12.00	13.16	3,456	3,790	
Spear 5s	12	12	12.00	12.44	144	149	
Cambridge	40	30	12.00	12.14	360	364	
Pall Mall	60	0					
total	400	330			**3,960**	**4,303**	**3,710**
overload						**593**	

The *Delivery Note* from the consignor/client company, British American Tabacco (BAT), listed gross and net weights as the same weight.

The AIC sought clarification from the BAT and was informed that in their computer generated system these weights were the same. Further clarification was sought from BAT.

On 11 August 2015, BAT informed the AIC that it does not record a difference between gross and net weight as it relies on the freight handler to *properly weigh and charge [BAT] for the goods entrusted to them to transport.* They rely on subsequent *internal audit checks* [that] *should pick up any charging anomalies should we be over-charged by reference to historical shipments.*

The investigation was unable to accurately determine the actual pre-takeoff distribution of cargo in the aircraft, because of the large number of cartons removed by local people before the investigation began. The BAT staff estimated that approximately 30 to 35 % of the cargo was removed in this way.

One of the BAT staff who assisted the operator's ground staff on the morning of the accident, and who had been inside PXY during loading, reported that he had a clear recollection of what had been loaded in compartment 'A'. He had assisted with the loading of other compartments as well, but said he could not remember exactly how the others had been loaded.

A reconstruction of the load in compartment 'A' was made on the basis of the BAT staff member's recollection (See Figure 6 and Table 3). When shown this reconstruction, three of the operator's ground staff agreed that its overall dimensions matched what they recalled having seen in compartment 'A'. The DHC-8 captain (the safety pilot) recalled that the cartons had been piled to 'chest height', consistent with the recollection of the client's staff member. Neither the pilot in command nor the copilot could recall what the load in compartment 'A' looked like after the loading of PXY had been completed.

Table 4: Reconstruction of the load in compartment 'A' according to the recollection of the client's staff member

Client staff member's recollection of loading in compartment 'A'					
	cigarette type	**cartons loaded**	**weight per carton (kg)**	**total weight (kg)**	**maximum weight (kg) permitted by the load sheet**
	Spear 80s	75	13.16	987	
	Spear 5s	12	12.44	149	
total		87		**1,136**	**350**
overload				**786**	

Figure 6: Reconstruction of the load in compartment 'A' according to the recollection of the client's staff member

When loaded on the aircraft, the 30 cartons requested by the PIC for cargo compartment 'A' would have only been two cartons high, by five cartons laterally across the compartment, by three cartons longitudinally along the compartment. The difference between the requested compartment load and the actual load should have been obvious.

The load in cargo compartment 'A' exceeded the maximum permissible compartment weight and therefore the maximum permissible structural load for compartment 'A' by 136 kg. The weight for cargo compartment 'A' as calculated by the pilots for the weight and balance of the aircraft should have been 350 kg. However, with 1,136 kg loaded in compartment 'A', the load in compartment 'A' exceeded the maximum permissible weight (for the required balance) by 786 kg.

The maximum (permissible) all up weight was 16,900 kg. The Load Chart listed the MAUW accepted by the PIC as 16,606 kg; 254 kg below the permissible MAUW. However, the actual total cargo weight was 597 kg heavier than listed on the load sheet. Therefore, the aircraft was 343 kg heavier than the permissible MAUW.

Figure 7: Reconstruction of the load for the 30 cartons as requested by the PIC

1.6.5 Minimum Equipment List

The aircraft departed from Port Moresby with the anti-skid brake system inoperative. The Air Niugini ATR 42 Minimum Equipment List relating to inoperative anti-skid brakes, permitted continued operation if the aircraft was operated in accordance with the Aircraft Flight Manual.

The aircraft was operated in excess of the maximum (permissible) all up weight. It was also operated in excess of the maximum permissible weight for cargo compartment 'A'.

The aircraft was not being operated in accordance with the Aircraft Flight Manual.

1.6.6 Fuel information

The fuel type used was JET-A1, otherwise known as AVTUR.

Total fuel on board was 3,400 L (2650 kg).

Fuel was not a contributing factor in this accident.

1.7 Meteorological information

The prevailing meteorological conditions were not a factor in the occurrence. The weather condition at Madang was CAVOK[4].

[4] CAVOK: Ceiling and visibility OK. Visibility greater than 10 km; no clouds below 5000 ft or below the highest minimum safe sector altitude whichever is highest; no significant weather.

1.8 Aids to navigation

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

1.9 Communications

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

1.10 Aerodrome information

The single runway at Madang was 07/25. The aerodrome elevation was 11 ft above mean sea level (AMSL) and the runway was 1569 m long, 30 m wide, and level.

The threshold of runway 07 was elevated above the surrounding ground. Just beyond the threshold, a steep embankment drops approximately 2.5 m (Figure 3). The airport perimeter fence was approximately 30 m beyond the foot of the embankment and beyond the fence there was a tidal creek (Figures 4).

1.10.1 Runway End Safety Area (RESA)

This investigation covers the accident involving a ATR 42 aircraft. However in considering the safety of operations at Madang, the accident investigation must consider the largest aircraft type operating into Madang. The Fokker F100 aircraft are operated into Madang Airport on regular public transport (RPT) services. It has a wingspan of 28 m, length 35.53 m, and fuselage width 3.3 m.

Annex 14[5], Volume 1, Section 1.6 provides the ICAO Standards for aerodrome reference codes.

> 1.6.1 An aerodrome reference code — code number and letter — which is selected for aerodrome planning purposes shall be determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended.
>
> 1.6.2 The aerodrome reference code numbers and letters shall have the meanings assigned to them in Table 1-1.
>
> 1.6.3 The code number for element 1 shall be determined from Table 1-1, column 1, selecting the code number corresponding to the highest value of the aeroplane reference field lengths of the aeroplanes for which the runway is intended.
>
> *Note.— The determination of the aeroplane reference field length is solely for the selection of a code number and is not intended to influence the actual runway length provided.*

5 ICAO *Annex 14 Vol 1, Aerodrome Design and Operations,* current at the time of the accident was Fifth Edition 2009. The Sixth Edition was promulgated to States in July 2013 with an effective date 14 November 2013, to allow States time to make amendments to their procedures and practices before the effective date.

1.6.4 The code letter for element 2 shall be determined from Table 1-1, column 3, by selecting the code letter which corresponds to the greatest wingspan, or the greatest outer main gear wheel span, whichever gives the more demanding code letter of the aeroplanes for which the facility is intended.

ICAO Annex 14, Table 1-1 below lists the aerodrome reference codes.

Table 1-1. Aerodrome reference code
(see 1.6.2 to 1.6.4)

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wingspan (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

a. Distance between the outside edges of the main gear wheels.

Figure 8: ICAO Annex 14 Table 1-1

Because Fokker F100 aircraft regularly operate into Madang the aerodrome code letter is predicated on its wingspan, which is 28 m, therefore Madang's Code letter is C, and Code number is 3.

Annex 14, Volume 1, Section 3.5 provides the ICAO Standards for RESA.

3.5.1 A runway end safety area shall be provided at each end of a runway strip where:

— the code number is 3 or 4;

3.5.3 A runway end safety area shall extend from the end of a runway strip to a distance of at least 90 m where:

— the code number is 3 or 4; extend from the end of a runway strip to a distance of at least 90 m.

Madang runway has water at each end. It does not have runway end safety areas (RESA) on its 1,569 m runway.

The runway did not conform to the International Civil Aviation Organization (ICAO) Annex 14 Standard.

The PNG Civil Aviation Rule 139.53(c) (Amendment 1 Jan 2015) states:

> An applicant for the grant of an aerodrome certificate must ensure that a runway end safety area that complies with the physical characteristics specified in Appendix A is provided at each end of a runway at the aerodrome if:-
>
> (1) the runway is used for regular air operations for the carriage of passengers to and from Papua New Guinea; or
>
> (2) the runway is used for regular domestic air transport operations for the carriage of passengers by aeroplanes that have ICAO Code 4 category; or
>
> (3) the aerodrome is used for regular air transport operations for the carriage of passengers by aeroplanes that have a certificated seating configuration of 20 seats or more excluding any required crew member seat and a runway is upgraded to instrument runway.

The PNG Civil Aviation Rule 121.69, Use of aerodromes, (Amendment 1 Jan 2015) states:

> (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.

As of 10 October 2015, the following aerodromes in Papua New Guinea, from which international flights are operated, were required to have a RESA under the requirements of CAR Part 139.53(c)(1). Jacksons Airport, Port Moresby; Londlofit Airport, Lihir Island, New Britain; Momote Airport, Manus Island; Moro Aerodrome, Southern Highlands Province; Tokua Airport, Rabual, East New Britain Province.

Article 38 to the Convention on International Civil Aviation imposes an obligation on signatory States to notify ICAO of any differences between their national regulations (rules) and practices and the International Standards contained in the Annexes.

In August 2015, the AIC was informed by CASA that it had not notified ICAO of the difference in its CAR's from the ICAO Annex 14 RESA Standard. However, during the ongoing investigation, which included a review of CASA and Air Services Limited publications, the AIC found that AIP, GEN 1.7-14 under the heading Annex 14 Aerodromes Chapter 3.4 states:

> Papua New Guinea cannot implement RESA due to unavailability of an adequate area beyond the Stopway and runway lengths that are already too limited to accept further reduction by the implementing RESA. At the time of writing the CASA PNG has not notified the ICAO of the difference in its CAR's from the ICAO Annex 14 RESA Standard.

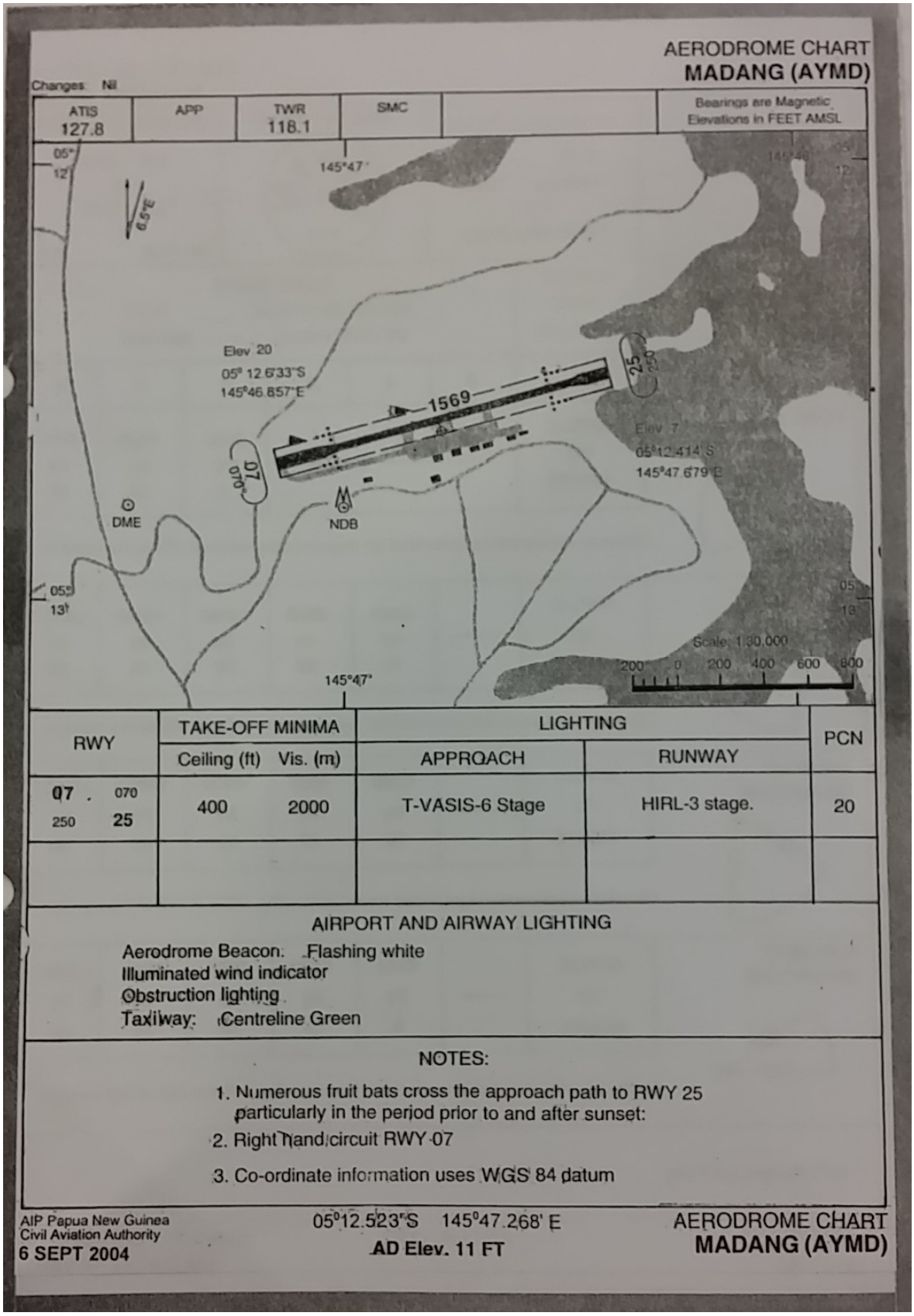

Figure 9: Madang aerodrome chart

1.10.2 Airport Emergency Plan (AEP) Manual

While the airport emergency procedures activated during this accident were effective, the investigation noted that the National Airport Corporation (NAC), Madang *Airport Emergency Plan* (AEP) manual's procedures did not meet the requirements of ICAO Annex 14. Examples include:

> Paragraph 9.1.5 recommends that the AEP 'document should include at least the following' and lists items a) to e). Point e) a grid map of the aerodrome and its immediate vicinity.
>
> The AEP does not contain a grid map.
>
> Paragraph 9.1.6 requires that 'The plan shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations'.
>
> The AEP page 19 under the heading 'Controller Marine Services':
>
> Point 2 states: When adequately staffed, despatch rescue boat to the crash location and effect rescue, utilising other craft as required.

Because the AEP uses the terminology that the marine rescue boat is to be despatched when *adequately* staffed, it is implied that it is not to be despatched unless it is adequately staffed. The Madang AEP therefore does not meet the intent of ICAO Annex 14 paragraph 9.1.6, because optimum response is not assured.

This accident involved a cargo aircraft that had a runway excursion off the southern end of the runway, coming to rest partially immersed in water of a creek. If it had been taking off in the opposite direction it would have come to rest in the water of the Madang harbour. Because Fokker F100 passenger aircraft regularly operate into Madang, the possibility of a runway excursion into the harbor involving the need to rescue almost 100 persons from the water cannot be ignored.

Annex 13, Paragraph 9.1.2 Aerodrome emergency exercise states:

> 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.

Annex 13, Paragraph 9.1.13 states:

> The plan shall be tested by conducting:
>
> 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.

The AEP Manual did not contain any reference to an aerodrome emergency exercise.

Furthermore, the Madang AEP Manual provided to the AIC for the investigation by the NAC appeared to be a draft document. There was no document number, approval or issue date, and no version reference. It could not be considered a controlled copy.

1.10.3 Rescue and fire fighting

The fire-fighting personnel of Madang Airport were alerted to the accident by the crash alarm activated by the Tower Controller. They responded by mobilizing the fire-fighting vehicle to the river bank alongside the aircraft wreckage.

The Madang Airport fire-fighting vehicle was dispatched in a timely manner to the accident site, and due to an operator error, only water was initially hosed (without foam fire suppressant) onto the fire in the right wing. Foam was subsequently added, but there was insufficient water remaining in the tanker to be able to use all the available foam to fight the fire. The quantity of water from the fire-fighting vehicle was exhausted, but was sufficient to extinguish the fire in the right wing.

The PNG AIP[6] AYMD AD 3-2, dated 16 October 2014 Edition 1, titled AYMD AD3.6 RESCUE AND FIRE FIGHTING FACILITIES STATED:

> 1 Ad category for fire fighting. Fire Protection: ICAO required Category 5 (Five).

Fokker F100 aircraft are operated into Madang Airport on scheduled services. It has a wingspan of 28 m, length 35.53 m, and fuselage width 3.3 m.

ICAO Annex 14, Table 9-1 provides the ICAO Standards with respect to aerodrome category for rescue and fire-fighting services.

6 Aeronautical Information Publication promulgated by the Civil Aviation Safety Authority of PNG

Table 9-1. Aerodrome category for rescue and fire fighting

Aerodrome category (1)	Aeroplane overall length (2)	Maximum fuselage width (3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

Figure10: ICAO Annex 14 Table 9-1

The Fokker F100 aircraft (length 35.53 m) and the Dash 8-Q400 aircraft (length 32.83 m) regularly operate into Madang aerodrome. The aerodrome category is predicated on the aircraft length, therefore Madang is a category 6 aerodrome.

The ATR 72 aircraft (length 27.17 m) and the Dash 8-300 aircraft (length 25.68 m) also operate into Madang. The required aerodrome category for these aircraft is category 5.

On 13 October 2015, the National Airports Corporation wrote to the AIC about the Madang Airport rescue fire-fighting category. The letter quoted from Annex 14, but commenced mid-sentence … *where the number of movements of the aeroplanes* … and omitted the second sentence. *It is important to note that the concession included in 9.2.3 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.*

The full wording of the Annex is crucial to understanding the Annex 14 Standard. It states:

> 18.3 Level of protection to be provided
>
> 18.3.1 In accordance with Chapter 9, 9.2, aerodromes should be categorized for rescue and fire fighting purposes and the level of protection provided should be appropriate to the aerodrome category.
>
> 18.3.2 However, Chapter 9, 9.2.3, permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in 9.2.3 is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

The lower level of protection and concession to downgrade to a lesser category only applies for a *limited period*, and then only *when there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements*.

The difference in length between the aircraft mentioned above that operate into Madang does not constitute a wide range of difference in length as contemplated by the Annex 14 Standard.

ICAO Annex 14 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.

ICAO Annex 14 Paragraph 9.2.9 recommends that:

> The principal extinguishing agent should be:
>
> a) a foam meeting the minimum performance level A; or
>
> b) a foam meeting the minimum performance level B; or
>
> c) a foam meeting the minimum performance level C; or
>
> d) a combination of these agents;
>
> except that the principal extinguishing agent for aerodromes in categories 1 to 3 should preferably meet a performance level B or C foam.

ICAO Annex 14 Paragraph 9.2.10 recommends that:

> The complementary extinguishing agent should be a dry chemical powder suitable for extinguishing hydrocarbon fires.

Table 9-2. Minimum usable amounts of extinguishing agents

	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
Aerodrome category	Water (L)	Discharge rate foam solution/ minute (L)	Water (L)	Discharge rate foam solution/ minute (L)	Water (L)	Discharge rate foam solution/ minute (L)	Dry chemical powders (kg)	Discharge Rate (kg/second)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1 800	1 700	1 100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2 200	180	2.25
6	11 800	6 000	7 900	4 000	5 800	2 900	225	2.25
7	18 200	7 900	12 100	5 300	8 800	3 800	225	2.25
8	27 300	10 800	18 200	7 200	12 800	5 100	450	4.5
9	36 400	13 500	24 300	9 000	17 100	6 300	450	4.5
10	48 200	16 600	32 300	11 200	22 800	7 900	450	4.5

Note.— The quantities of water shown in columns 2, 4 and 6 are based on the average overall length of aeroplanes in a given category.

Figure 11: ICAO Annex 14 Table 9.2

ICAO Annex 14, Table 9.2 above shows that the minimum usable amounts of extinguishing agents for performance level C and B, at a Category 6 aerodromes, are 5,800 L to 7,900 L of water and a discharge rate of foam solution/minute of 2,900 L to 4,000 L respectively.

Also the required quantity of the complementary agents of dry chemical powders was 225 kg with a discharge rate of 2.25 kg/sec.

The investigation was advised that the Madang Airport fire tender vehicle was an Oshkosh T1500. The tender's water, foam, and dry chemical capacity and discharge rates as follows:

Capacity:

Water: 5,678 L

Foam: 795 L

Dry Chemical Powder: 225 kg

Discharge rates:

Water and foam: Roof turret 2,838 L/min

Bumper turret: 1,135 L/min

Hand lines: 567.8 L/min

Dry chemical powder 9.97 kg/min (0.166 kg/sec)

While Madang Airport met the Annex 14 requirement for water and foam and discharge rates for the category 4 aerodrome for the ATR 42 operation, the investigation determined that the Madang Airport did not meet the ICAO Annex 14 Standard with respect to the aerodrome category for rescue and fire-fighting services for the Fokker F100 and Dash 8-Q400 category 6 operations.

At the time of the accident the CASA PNG has not notified the ICAO of the difference in its CAR's from the ICAO Annex 14 Standards with respect to aerodrome category for rescue and fire-fighting services.

1.11 Flight recorders

The aircraft was fitted with a cockpit voice recorder (CVR) and a flight data recorder (FDR). The CVR (part no. 93-A100-83 and serial no. 59830) and FDR (part no. S800-20000-00 and serial no. 00960) were manufactured by Loral Data Systems, now L-3 Aviation Recorders. The CVR and FDR were located in the aircraft's tail section and were not damaged during the accident. Both recorders were recovered from the accident site and transported to Port Moresby. They were then transported by an AIC officer to the Australian Transport Safety Bureau (ATSB) in Canberra, Australia, for examination and data download. They were received by the ATSB on 22 October 2013.

The CVR was downloaded and an examination showed that the audio from the accident flight had been successfully recorded. The FDR system comprised the FDR, a SAGEM flight data acquisition unit (FDAU), aircraft sensors, and a tri-axial accelerometer. For PXY, the recorded parameters included

- pressure altitude
- radio altitude
- indicated airspeed
- magnetic heading
- pitch attitude
- roll attitude
- control surface positions (aileron, elevator, spoiler, flap, and pitch trim)
- accelerations (lateral, longitudinal, and vertical)
- total air temperature
- engine parameters (propeller RPM, torque, high pressure rotor speed N_H, low pressure rotor speed N_L, fuel flow, inter-turbine temperature ITT, and propeller low pitch)
- radio transmitters keyed/not keyed.

From the FDR and CVR data/information the investigation determined that the copilot called V1 29.9 seconds after commencing the take-off roll when the aircraft had travelled 900 m. He called 'Rotate' 0.5 sec later when the aircraft had travelled a further 30 m. The aircraft speed was 112 kt and the aircraft had travelled 930 m from brakes release.

The FDR showed elevator deflection commanding a rotation had been initiated 29.5 sec after brakes release when the aircraft had travelled 870 m, but the aircraft did not respond. A torque decrease consistent with power levers being retarded was observed on the FDR data 33.0 sec after brakes release when the aircraft had travelled 1,090 m. The command 'stop' was heard on the CVR 34.5 sec when the aircraft had travelled 1,175 m after brakes release. The aircraft travelled 160 m between the Vr call position and the position on the runway when the power levers were retarded. The investigation determined that P2-PXY left the sealed runway end at a speed of 35 kt.

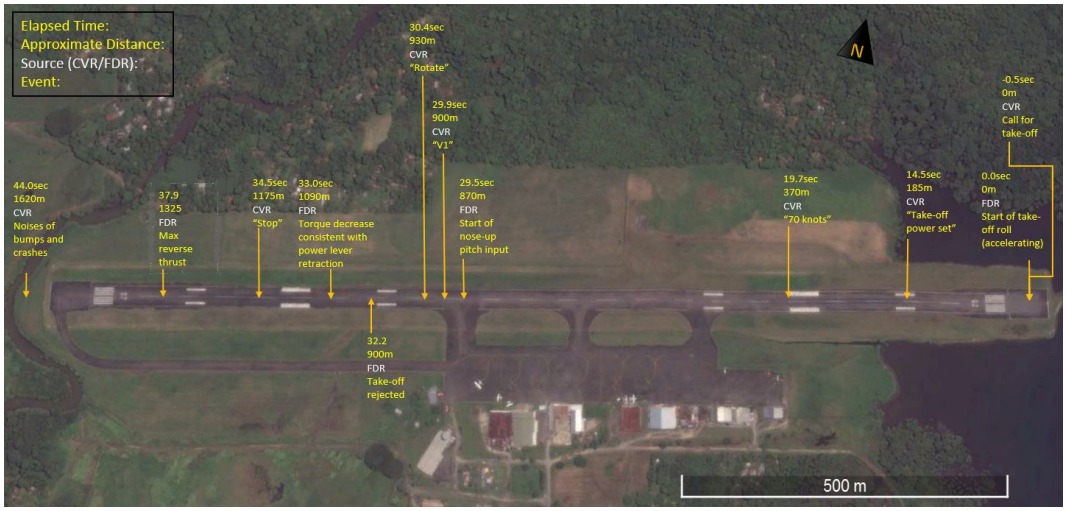

Figure 12: Madang runway with position of FDR and CVR recorded events
(See Appendix 1 for enlarged diagram for clarity)

1.12 Wreckage and impact information

The aircraft was substantially damaged during the accident by the impact with the airport perimeter fence, the post-impact fire and partial immersion in salt water, and subsequently by the salvage operation during which it was lifted out of the creek and moved to a location on the airfield. The right outboard wing section was completely burned, and the right engine fell off the wing into the water. Both propellers were destroyed.

1.13 Medical and pathological information

No medical or pathological investigation was conducted as a result of this occurrence.

1.14 Fire

Fuel from the disrupted right wing fed the intense post-impact fire that consumed the outboard section of the right wing. The aircraft was substantially damaged by the post-impact fire. There was no evidence of pre-impact fire.

1.15 Survival aspects

The accident was survivable. However, the crew had to exit the aircraft through the cockpit roof escape hatch.

1.16 Tests and research

Apart from the load reconstructions as described in 1.6.4 Weight and balance, no other tests or research were required to be conducted as a result of this occurrence

1.17 Organisational and management information

1.17.1 The operator

Air Niugini

P O Box 7186

Boroko, NCD

Papua New Guinea

Air Niugini leased the aircraft from a European company, Farnair Eorope, which also supplied the pilots.

1.17.2 National Airports Corporation (NAC)

The Madang Airport operator was the National Airports Corporation Ltd. The NAC was responsible for the safe operation of the airport and its infrastructure. It was responsible for ensuring that Madang Airport was in compliance with the International Standards and Recommended Practices in accordance with ICAO Annex 14.

Compliance with PNG legislation and ICAO Annex 14 Standards and Recommended Practices is assessed by the Civil Aviation Safety Authority of PNG before an Aerodrome Operator's Certificate can be issued by CASA PNG.

The issues relating to non-compliance with the International Standards and Recommended Practices of Annex 14 have been discussed at section 1.10 of this report.

1.17.3 Operational aspects

At the time of the accident Air Niugini did not have its own robust ground handling procedures for the ATR 42/72 operation to ensure the safe load distribution of freight loaded onto the ATR 42/72 aircraft. There was also no robust procedure for the flight crew to check load distribution.

The procedures used were those of the European leasing company, and subsequent to the accident these procedures were not available to the AIC.

1.17.4 CASA surveillance of Air Niugini flight operations

During the investigation the Civil Aviation Safety Authority of PNG (CASA) informed the AIC about the Load Control Procedures Manual reviews conducted by CASA at 'entry' of the ATR42/72 Freighter aircraft onto the PNG register.

CASA advised that a project team comprising Air Niugini/CASA PNG SMEs was set-up to discuss, agree and progress the SOE leading up to the introduction of the ATR 42/72, Farnair aircraft onto the PNG register & ANG AOC Ops specs. In August 2013, following the ICAO Significant Safety Concern (SSC) against the State of PNG, CASA further improved its internal processes by adopting a more structured five phase-approach to all new Air Operator Certificate (AOC) issued or a major variation to an AOC such as the one involving the introduction of the ATR aircraft onto the Air Niugini AOC. However, it is important to note that this introduction project occurred before these improvements.

About June/July 2013, CASA FOPs (Flying Operations) focussed their limited resources and efforts mainly on the *FLIGHT CREW COMPETENCY & TRAINING* aspects including detailed reviews of the Flight Crew Training Manual & determination of equivalence of the FARNAIR FC (Freight Company) training standards to PNG Civil Aviation Rule (CAR) Part 141. CASA advised that although the Air Niugini team had developed and submitted a Ground Operations Manuals suite for the project, it now appears that the CASA team may have simply 'validated' the *Ground Operations* manuals based on the fact that they were developed from the FARNAIR (EASA [European Aviation Safety Agency] APPROVED) manuals. This was due mainly to resource and time constraints for such large projects where CASA carries out detailed reviews on some manuals based on 'risk-assessments' carried out at the time, while it may carry out 'samples-reviews' on others based on 'validation' of counterpart Civil Aviation Authorities' endorsements such as CASA Aust, CAA NZ , EASA or FAA. CASA assured the AIC that post-accident reports and recommendations from the AIC are included in their risk-assessments in future projects to take into account valuable lessons learnt.

1.18 Additional information

On-site examination of the wreckage by representatives of the aircraft manufacturer assisting the investigation revealed no evidence of any pre-existing discontinuity of the flight controls systems. The stick pusher actuator was found to be in the normal position.

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with Papua New (PNG) Guinea Civil Aviation Act 2000 (as amended), Commissions of Inquiry Act 1951 (as amended), the PNG Civil Aviation Rules 2015 (as amended), and the PNG Accident Investigation Commission's approved policies and procedures, and in accordance with the Standards and Recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

2.1 Rescue and fire fighting

The fire-fighting vehicle was dispatched in a timely manner to the crash site, and was able to extinguish the fire in the right wing of the aircraft. The water and foam were exhausted in fighting the fire.

While the fire-fighting vehicle at Madang had sufficient quantity of water and foam to extinguish the fire in the right wing of the ATR 42, it is likely that the quantity of water and foam would have been insufficient to extinguish an aircraft fire larger than that which enveloped the right wing.

The Rescue and fire-fighting services did not meet the following ICAO Annex 14 requirements:

- There was insufficient foam/fire suppressant agent to meet the minimum performance level C and B requirements for Madang, a Category 6 aerodrome.
- There was no evidence that a dry chemical powder, suitable for extinguishing hydrocarbon fires, was available as a complementary extinguishing agent.

2.2 Runway end safety area (RESA)

The Madang Airport runways do not have runway end safety areas (RESA) at either end. The PNG Civil Aviation Rules permit ATR 42/72 and Fokker 100 aircraft to operate into Madang and other airports within PNG that do not have a RESA.

The investigation determined that PXY left the sealed runway end at a speed of 35 kt. The investigation determined that at the deceleration rate as it left the sealed runway, it would have needed 278 m to stop, in the absence of frangible material in a RESA.

The aircraft anti-skid braking system on PXY was inoperative, however the investigation determined that it did not contribute to the accident.

While the evidence strongly suggests that PXY would not have been able to be stopped in the available length even if a RESA had been available, the lack of a RESA must be viewed as a greater safety hazard for the higher weight faster take-off speed jet aircraft such as the Fokker 100.

The CAR effectively provides a PNG Rule-based exemption from compliance with ICAO Annex 14 with respect to RESA. Also, the AIP-GEN 1.7-14, copy of the difference against the ICAO Annex 14 RESA Standard, informs operators that RESA may not be available at PNG aerodromes. However, in the absence of operators ensuring that their operating procedures and practices mitigate the risk associated with not having a RESA, these documents do not provide a safety-based outcome.

2.3 National Airports Corporation

While the airport emergency procedures activated during this accident were effective, the investigation noted that the National Airport's Corporation (NAC), Madang *Airport Emergency Plan* (AEP) manual's procedures did not meet the requirements of ICAO Annex 14, Volume 1.

The investigation found that these deficiencies briefly covered in Section 1.10.2 of this report, require a complete review of the adequacy of the Madang *Airport Emergency Plan* (AEP) manual to ensure that it meets the ICAO Annex 14, Volume 1 requirements.

An area of immediate safety concern is the lack of availability of marine rescue in the event of an aircraft having a runway excursion off the northern end of the runway and coming to rest in the water of the Madang harbour.

Because Fokker F100 passenger aircraft regularly operate into Madang, the possibility of a runway excursion into the harbor involving the need to rescue almost 100 persons from the water cannot be ignored.

2.4 Air Niugini

At the time of the accident Air Niugini did not have its own robust ground handling procedures for the ATR 42/72 operation to ensure the safe load distribution of freight loaded onto the ATR 42/72 aircraft. There was also no robust procedure for the flight crew to check load distribution.

The procedures used were those of the European aircraft leasing company, and subsequent to the accident were not available to the AIC.

The copilot stated that he drew a loading diagram for the operator's ground handling staff showing the weight to be loaded in each of the aircraft's six cargo compartments 'A' to 'F'.

The Air Niugini Senior Cargo Officer was instructed by the pilot in command to put a maximum of 350 kg, 30 cartons, in the forward zone 'A'. The investigation determined that 30 cartons actually weighed 395 kg.

The AIC obtained a copy of the *ATR42/320 CARGO LOAD SHEET AND BALANCE CHART* that was signed by the pilot in command, however the load of freight and the freight distribution in the zones within the aircraft did not accurately reflect the details on the signed *ATR42/320 CARGO LOAD SHEET AND BALANCE CHART.*

The investigation found that the lack of robust procedures and the inaccurate weights provided by the consignor/client company likely contributed to the overload.

The aircraft anti-skid braking system was in-operative, and the flight was permitted to operate without an operative anti-skid brake system, if operated in accordance with the Aircraft Flight Manual. The investigation found that because the aircraft load was in excess of the maximum permissible weight, and the cargo zone 'A' weight exceeded the structural limit, the aircraft was not being operated in accordance with the Aircraft Flight Manual.

2.5 British American Tobacco (consignor/client)

The *Delivery Note* from British American Tobacco (BAT), the consignor/client company, listed gross and net weights as the same weight for their cartons of cigarettes.

BAT informed the AIC that it does not record a difference between gross and net weight as it relies on the freight handler to *properly weigh and charge [BAT] for the goods entrusted to them to transport.*

The investigation determined that this inaccurate listing of weights likely contributed to the aircraft being overloaded.

3 CONCLUSIONS

3.1 Findings

3.1.1 Aircraft

a) The aircraft was certified, equipped and maintained in accordance with existing PNG Civil Aviation Rules and approved procedures.

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 within the prescribed limits.

d) The aircraft total load exceeded the maximum permissible load and the load limit in the forward cargo zone 'A' exceeded the zone 'A' structural limit.

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

f) Anti-skid brake system inoperative, however that did not contribute to the accident.

g) All control surfaces were accounted for.

h) The aircraft was substantially damaged by impact forces and a post-impact fire.

3.1.2 Crew / pilots

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

3.1.3 Flight operations

a) The flight crew carried out normal radio communications with the Madang ATC unit.

b) Braking performance analysis indicated that, in the conditions existing at the time of the accident, the aircraft could not have stopped on the runway available.

c) The pilot in command's decision to abort the takeoff was appropriate.

3.1.4 Operator

a) The operator did not have robust procedures for load weight and balance assurance on the ATR 42/72 operations.

3.1.5 Air Traffic Services and airport facilities

a) ATC provided prompt and effective assistance by the timely activation of the 'crash' alarm.

3.1.6 Flight recorders

a) The aircraft was equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR) in accordance with the PNG Civil Aviation Rules.

b) The flight recorders recorded valid data.

c) The FDR recorded the required channels.

3.1.7 Medical

a) There was no evidence that incapacitation or physiological factors affected the flight crew performance.

3.1.8 Survivability

a) The accident was survivable, and all three crew members evacuated the aircraft without injury.

3.1.9 Airport

a) The Madang Airport fire-fighting unit responded quickly and extinguished the fire in the right wing with the available fire-fighting agents, water and foam.

b) The available fire-fighting agents, water and foam, were exhausted fighting the fire in the right wing.

c) The Madang Airport fire-fighting tender vehicle did not have sufficient capacity to fight a more extensive aircraft fire.

d) The Madang airport did not meet the ICAO Annex 14 Standard with respect to the required aerodrome category 6 for rescue and fire-fighting services.

e) The Madang airport did not meet the ICAO Annex 14 Standard with respect to the runway end safety areas.

3.1.10 Safety oversight

a) The PNG Civil Aviation Safety Authority's safety oversight of the Air Niugini ATR 42/72 procedures and operations was inadequate.

3.1.11 Cargo consignor/client

a) The *Delivery Note* from the consignor/client company, listed gross and net weights as the same weight for their cartons of cigarettes.

3.2 Contributing factor

The investigation found that Air Niugini's lack of robust loading procedures and supervision for the ATR 42/72 aircraft, and the inaccurate weights provided by the consignor/client company likely contributed to the overload.

3.3 Other factors

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

a) The Madang Airport fire-fighting tender vehicle did not have sufficient capacity to fight a more extensive aircraft fire involving an aircraft larger than the ATR 42.

b) The Madang Airport did not meet the ICAO Annex 14 Standard with respect to the required aerodrome category 6, for rescue and fire-fighting services.

c) The Madang Airport did not meet the ICAO Annex 14 Standard with respect to the runway end safety areas.

d) The Madang Airport did not meet the ICAO Annex 14 Standards with respect to the required *Airport Emergency Plan*.

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 Safety actions

4.1.1 Air Niugini

On 1 July 2014, Air Niugini promulgated its amended *ATR42/72 Cargo Ground Handling and Weight & Balance Manual* for use by 'outports' as version 2.0.1. The procedures are in accordance with section 452 of the International Air Transport Association (IATA) Airport Handling Manual.

The promulgated *Recommended Loading Practices* for the ATR42 are at section 3.4.4 of the Air Niugini manual, and for the ATR72 at section 4.4.4 of the Air Niugini manual and cover:

- aircraft structure limitations; and
- area load limitations;

with examples and explanatory diagram showing how to calculate load limits.

Air Niugini informed the AIC that a *DOMESTIC LOAD WEIGHT STATEMENT* is now prepared for a specific aircraft load and signed by the person who prepared the document. The Load Controller also must sign the completed form. The *DOMESTIC LOAD WEIGHT STATEMENT* includes the weight of the cargo and any special loads such as hazardous or dangerous goods. The completed document for a recent flight, sighted during the investigation, included in the 'REMARKS' column, the weights to be loaded in each of the aircraft cabin zones. The load supervisor ensures that the aircraft is loaded in accordance with the *DOMESTIC LOAD WEIGHT STATEMENT*.

A document titled *SPECIAL LOAD – NOTIFICATION TO CAPTAIN* detailing any hazardous / dangerous goods in the freight consignment is given to the PIC. The document is required to be signed by the person assuring the pilot in command that the aircraft is LOADED AS SHOWN. It then must be signed by the PIC before the aircraft departs.

The *LOAD SHEET AND BALANCE CHART*, a Farnair Europe document, is also prepared, signed and given to the load supervisor before loading is commenced. The *LOAD SHEET AND BALANCE CHART* is checked and the pilot in command (PIC) signs in the acceptance certification box on the form:

> I HEREBY CERTIFY THAT THIS AIRCRAFT HAS BEEN LOADED IN ACCORDANCE WITH THE CURRENT LOADING MANUAL.

4.1.2 British American Tobacco

On 11 August 2015, British American Tobacco (BAT) wrote to the PNG Accident Investigation Commission (AIC) and with reference to the concerns raised by the AIC about consignment note /invoice listed weights stated:

> As a result, BATPNG will make the following changes to its processes. Such changes are being made simple to further improve our processes and assist the AIC in this matter rather than from any concern as to liability. The steps we are taking are set out below:
>
> - We have lodged a request with the relevant Group personnel to change our pro-forma invoices to remove the gross and net weight from our invoices. At this time, I do not know how long this will take or indeed whether this is possible (given that we use one SAP system globally and so any changes require substantial vetting to ensure no inadvertent impact on other BAT entities from such a change). A copy of the relevant email is attached for your records.
> - We will only provide the approximate weight to our freight carriers when seeking an estimate of costs.
> - We will remind relevant personnel not to sign consignment forms, such as an Airway Bill, unless they have observed the goods being weighed by the Carrier or Airline, in instances where we procure freight service directly with a carrier or Airline and not a third party service provider.

4.1.3 National Airports Corporation

In summary, since the accident occurred in October 2013, NAC has undertaken the following to meet compliance requirements and improve service levels for emergency response capability:

- Replacement of ARFF vehicle to meet category of operation. 2 Fire Tenders are under procurement and will be delivered in November (next month) under CADIP program funded by ADB.
- Recruitment and training of the fire officers. This is being addressed using our training officer. Phase 2 of this program now being organised to cover Nazdab, Madang, Hagen and Goroka.
- Safety flash issued to all RFF stations immediately after the accident to address operator's errors which resulted in water only being discharged initially during the emergency response phase in 2013.
- Improved communication from control tower and to emergency response agencies such as ARFF service, police, hospital, and civil fire service. (PNGASL installed these, fixed line communications). Our fire tenders are now equipped with fixed VHF radios including the RFF watch room and our safety officers airside vehicles backed up by hand held radios as well.
- We have now established safety and compliance functions at Regional Airports division with compliance officers at Headquarters. Also AEP program, internal audit program, have been set up and running. Airport Facilitation Committees program also have been set up at Madang Airport chaired by the Airport Operations Manager.

- AEP training was conducted specifically to address issues experienced during the accident in 2013 and AEP program established and being conducted in accordance with Madang ACE.
- AEP room is available although not fully equipped with all facilities required for emergency operations. This will be further improved as part of our AEP improvement activities.
- For Public protection, NAC has taken our oversight of all gates leading to airside, including control of Gate 6 which was controlled by Airlines. Also all gates in the perimeter fence for airside access have now been locked and accessed by authorised personnel.

4.2 Recommendations

As a result of the investigation into the accident involving an Avions de Transport Régional ATR42-320 freighter, registered P2-PXY (PXY) at Madang Airport, the Papua New Guinea Accident Investigation Commission issues the following recommendations to address safety concerns identified in this report. These recommendations and safety actions/responses, and the Accident Investigation Commission (AIC) assessments are also published on the AIC website under the Tab 'Recommendations'.

4.2.1 Recommendation number AIC 15-R15/13-1007 to Papua New Guinea airline operators **(Air Niugini; Airlines PNG; Travel Air Ltd; Hevilift (PNG) Ltd)**

The Accident Investigation Commission recommends that PNG airline operators review their published procedures and ensure their procedures mitigate the risks associated with a runway end safety area (RESA) not being available at PNG airports, other than Port Moresby International (Jacksons Airport). The runway end safety area requirements are contained in ICAO Annex 14 Volume 1.

4.2.1.1 Air Niugini response

Response dated 11 September 2015.

> Air Niugini has reviewed its process and procedures and has amended its published procedures to mitigate the risks associated with operating into airfield that do not have a runway end safety area (RESA), as required by the Safety recommendation: AIC 15-R15/13-1007.
>
> It should be noted that almost all aerodromes in PNG have been constructed or are operated without a RESA a recommended by ICAO.
>
> According to CAR 121.69(a)(2)(i)(ii), RESA is a requirement for all airfields that are certified as International Aerodromes.
>
> Madang is considered a Domestic Aerodrome which does not require a RESA per the ICAO Standard.
>
> Regardless, Air Niugini has taken a further step to review its process by applying for an exemption to the RULE (stated above) to operate to ALL aerodromes without RESA.

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

The AIC has assessed the Air Niugini response as satisfactorily addressing the identified safety deficiency. With respect to AIC 15-R15/13-1007 addressed to Air Niugini, the **Status of the AIC Recommendation: Closed**

4.2.1.2 Travel Air response

Response dated 12 October 2015.

> Due to runway shortening at Vanimo Airport currently being 1,320 meters in length, the following calculation based upon data from the Fokker 50 Airplane Flight Manual regarding the Take-Off Weight Limited by Field length Requirements is as follow:
>
> *Data was supplied to the AIC.*
>
> When using Flaps 10/15, this will yield in a more weight and less distance.
>
> Although the condition as described is not a limiting factor for the operation at Vanimo, r/w length of 1,320 meters, take-off flap setting 5, I strongly recommend all crew using flaps 15 for take-off.
>
> Coordinating with loadmaster for proper loading the aircraft and requiring flight crew awareness operating at Vanimo Airport will surely prevent Travel Air operation into an unwanted situation.
>
> For all other airports Travel Air is operating, those runways with no RESA are not affecting the TOW.

4.2.1.2.1 PNG Accident Investigation Commission (AIC) assessment of Travel Air response

The AIC has assessed the Travel Air response as satisfactorily addressing the identified safety deficiency. With respect to AIC 15-R15/13-1007 addressed to Travel Air, the **Status of the AIC Recommendation: Closed**

4.2.1.3 Airlines PNG response

Response dated 9 October 2015.

> As requested by PNG AIC, Airlines PNG has reviewed our published procedures for regulated take-off weight (RTOW) performance and confirms that this data mitigates the risk of no RESA at various PNG airports.
>
> Airlines PNG use APG as our performance calculation provider and publishes this data in our CASA accepted RTOW manual. The performance data published ensures that accelerate stop distance availability (ASDA) is available as part of the calculation when reviewing the weight based on air temperature and humidity.

4.2.1.3.1 PNG Accident Investigation Commission (AIC) assessment of Airlines PNG response

The AIC has assessed the Airlines PNG response as satisfactorily addressing the identified safety deficiency. With respect to AIC 15-R15/13-1007 addressed to Air Niugini, the **Status of the AIC Recommendation: Closed**

4.2.1.4 Hevilift (PNG) Ltd response

On 16 August 2015, Hevilift provided details covering loading and flight operations at Madang. On 14 October, Hevilift provided the following information with respect to mitigating the risk of not having a RESA at aerodromes used by the Hevilift ATR aircraft.

Appendix to Response to AIC RESA Mitigation.

Hevilift to review their published procedures and the following procedures we believe mitigate the risks associated with a runway end safety area (RESA) **not being available at PNG airports**, other than Port Moresby International (Jacksons Airport).

The risk mitigation is for all airports into which Hevilift operates the ATR.

- Hevilift have introduced specific accelerate/stop exercises in current June-December 2015 into LOFT simulator training. This also includes out of trim scenarios.
- Hevilift are consulting with possible clients who intend building ATR (Part 121) size airports in PNG for future operations. We have recommended that RESA's be included in these plans. To date this recommendation has been accepted by one such project however this is commercially sensitive and no detail is available.
- Hevilift uses an external performance contractor (APG) for all ATR performance data and the lack of RESA's are included in all calculations.
- Flight crew performance training in all type rating training and refresher training is provided which includes RESA requirements in performance calculations.

4.2.1.4.1 PNG Accident Investigation Commission (AIC) assessment of Hevilift (PNG) Ltd response

The AIC has assessed the Airlines PNG response as satisfactorily addressing the identified safety deficiency. With respect to AIC 15-R15/13-1007 addressed to Hevilift (PNG) Ltd, the **Status of the AIC Recommendation: Closed**

4.2.2 Recommendation number AIC 15-R16/13-1007 to the Civil Aviation Safety Authority of PNG

The Accident Investigation Commission recommends that the Civil Aviation Safety Authority of PNG ensure that PNG airline operators' (Air Niugini; Airlines PNG; Travel Air Ltd; Hevilift (PNG) Ltd) published procedures mitigate the risks associated with a runway end safety area (RESA) not being available at PNG airports, other than Port Moresby International (Jacksons Airport). The runway end safety area requirements are contained in ICAO Annex 14 Volume 1.

4.2.2.1 Civil Aviation Safety Authority of PNG (CASA) response

Despite reminders being sent to CASA, the AIC did not receive a response from CASA addressing the identified safety deficiency.

4.2.2.1.1 PNG Accident Investigation Commission (AIC) assessment of *Civil Aviation Safety Authority of PNG (CASA)* response

As a result of the AIC not receiving a response from CASA addressing the identified safety deficiency with respect to AIC 15-R16/13-1007 addressed to CASA, the AIC assigned this nil response an **unsatisfactory** rating, and records the **Status of the AIC Recommendation: Active**

4.2.3 Recommendation number AIC 15-R17/13-1007 to the Civil Aviation Safety Authority of PNG

The Accident Investigation Commission recommends that the Civil Aviation Safety Authority (CASA) of PNG review the capacity for PNG airports to provide runway end safety areas (RESA) that meet the Standards prescribed in the International Civil Aviation Organization (ICAO) Annex 14 Volume 1.

- If the National Airports Corporation is unable to meet the RESA Standard at its airports in accordance with ICAO Annex 14, the CASA should file a difference with ICAO (in accordance with the obligation imposed by Article 38 to the Convention on International Civil Aviation) as soon as possible.

4.2.3.1 Civil Aviation Safety Authority of PNG (CASA) response

Despite reminders being sent to CASA, the AIC did not receive a response from CASA addressing the identified safety deficiency.

4.2.3.1.1 PNG Accident Investigation Commission (AIC) assessment of Civil Aviation Safety Authority of PNG (CASA) response

As a result of the AIC not receiving a response from CASA addressing the identified safety deficiency with respect to AIC 15-R17/13-1007 addressed to CASA, the AIC assigned this nil response an **unsatisfactory** rating, and records the **Status of the AIC Recommendation: Active**

4.2.4 Recommendation number AIC 15-R19/13-1007 to the PNG National Airports Corporation (NAC)

The Accident Investigation Commission recommends that the PNG National Airports Corporation (NAC) ensure that PNG airports having water or swampy terrain along the departure and/or arrival paths are equipped, in accordance with the ICAO Annex 14, Paragraph 9.2.2 Standard, with specialist rescue services and fire-fighting equipment appropriate to the hazards and risks.

4.2.4.1 PNG National Airports Corporation (NAC) response

Despite reminders being sent to the NAC, the AIC did not receive a response from NAC addressing the identified safety deficiency.

4.2.4.1.1 PNG Accident Investigation Commission (AIC) assessment of PNG National Airports Corporation (NAC) response

As a result of the AIC not receiving a response from NAC addressing the identified safety deficiency with respect to AIC 15-R19/13-1007 addressed to NAC, the AIC assigned this nil response an **unsatisfactory** rating, and records the **Status of the AIC Recommendation: Active**

4.2.5 Recommendation number AIC 15-R20/13-1007 to the PNG National Airports Corporation (NAC)

The Accident Investigation Commission recommends that the National Airports Corporation review the procedures and equipment used by airport Rescue and Fire Fighting Services at its airports to ensure that they meet the minimum requirements specified in the International Civil Aviation Organization's Annex 14 and meet the safety requirements for their airports' operations.

4.2.5.1 PNG National Airports Corporation (NAC) response

On 13 October 2015, the National Airports Corporation responded to the recommendation and stated:

Procedures

We agree with the recommendation on the **procedures**. Under strategy 3, (Safety & Regulatory Compliance) of NAC strategic direction, gradual steps are in progress to introduce SOPs to improve and standardise procedures for all RFF established airports by 2016. This will capture both staff competency and regulatory requirements of Annex 14 and CAA [sic] Rules Part 139.

Equipment and Manpower

NAC is getting two new fire trucks and firefighting equipment under ADB funding delivered by the CADIP program under NAC in November 2015 (next month). This also includes refurbishment of fire stations at the RFF established airports. This will make NAC fire services fully compliant with safety requirements, thus exceeding category 6 in terms of rescue and fire-fighting capability.

Manpower capability

In terms of manpower requirements for CAT 6 RFF operation, NAC is now implementing the second phase of the RFF recruitment and training program which will deliver an additional 8 RFF personnel for Madang Airport when it is concluded this year. This will provide the full RFF manpower requirement for Madang Airport. Phase 1 of this program commenced with Jacksons, now completed and phase 2 will cover not only Madang but also Nadzab, Hagen, Tokua, and Goroka.

4.2.5.1.1 PNG Accident Investigation Commission (AIC) assessment of PNG National Airports Corporation (NAC) response

The AIC has assessed the National Airports Corporation response as satisfactorily addressing the identified safety deficiency. With respect to AIC 15-R20/13-1007 addressed to Hevilift (PNG) Ltd, the **Status of the AIC Recommendation: Closed**

4.2.6 Recommendation number AIC 15-R21/13-1007 to the PNG National Airports Corporation (NAC)

The Accident Investigation Commission recommends that the PNG National Airports Corporation ensure that its:

1. *Airport Emergency Plans* are reviewed to ensure they meet the Standards and Recommended Practices of *ICAO Annex 14, Volume 1*.
2. Airports having water or swampy terrain along the departure and/or arrival paths are equipped, in accordance with the ICAO Annex 14, Paragraph 9.2.2 Standard, with specialist rescue services and fire-fighting equipment appropriate to the hazards and risks.

4.2.6.1 PNG National Airports Corporation (NAC) response

Despite reminders being sent to the NAC, the AIC did not receive a response from NAC addressing the identified safety deficiency.

4.2.6.1.1 PNG Accident Investigation Commission (AIC) assessment of PNG National Airports Corporation (NAC) response

As a result of the AIC not receiving a response from NAC addressing the identified safety deficiency with respect to AIC 15-R21/13-1007 addressed to NAC, the AIC assigned this nil response an **unsatisfactory** rating, and records the **Status of the AIC Recommendation: Active**

5 APPENDIXES

5.1 Appendix 1: Madang runway with position of FDR and CVR recorded events