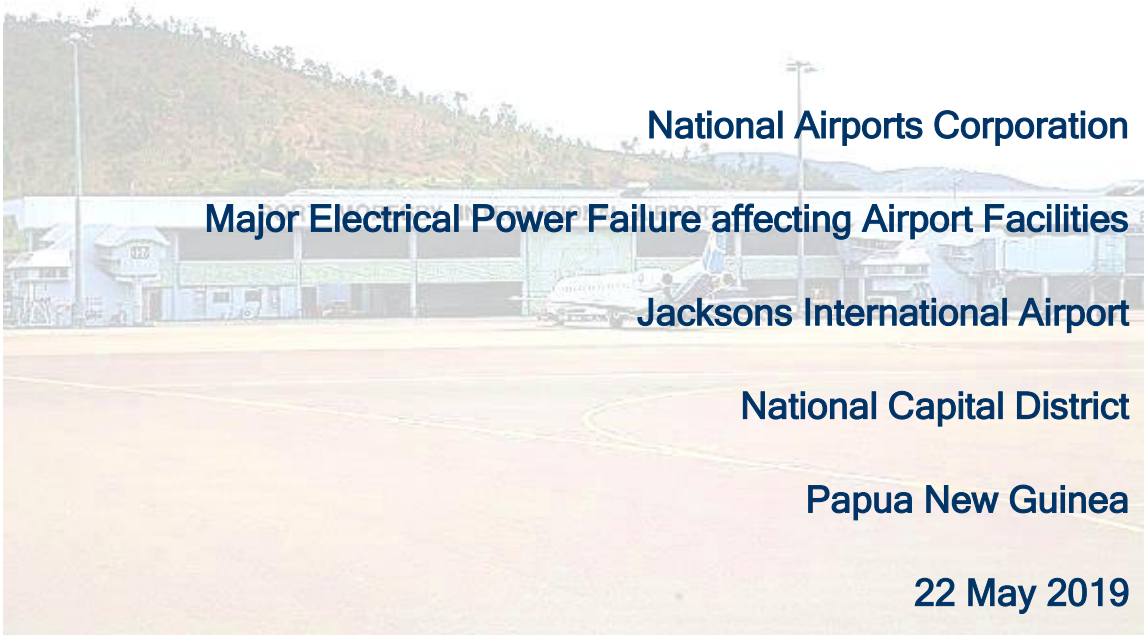
ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 19-2001



National Airports Corporation

Major Electrical Power Failure affecting Airport Facilities

Jacksons International Airport

National Capital District

Papua New Guinea

22 May 2019

About the AIC

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

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

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

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

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

About this Report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from the investigation in accordance with Annex *13 to the Convention on International Civil Aviation paragraph 5.4* which states in part "*the extent of the investigation and the procedure to be followed in carrying out such an investigation shall be determined by the accident investigation authority, depending on the lessons it expects to draw from the investigation for the improvement of safety"*.

On 22 May 2019, a major power outage occurred at 07:11 UTC[1] and lasted for 13 hours and 29 minutes, affecting Jacksons International Airport facilities and services. During the time of the outage, four aircraft conducting scheduled passenger operations, one of them an international flight, were affected by the lack of services available at Jacksons due to the power outage. The AIC was notified of the power outage by Papua New Guinea Air Services Limited at 21:40 on 23 May 2019, commencing an on-site investigation.

The AIC has produced this *report*[2] to fulfill its mandate under the *Civil Aviation Act 2000 (As amended),* in accordance with the requirements of ICAO *Annex 13* and the *PNG Accident Investigation Commission - Policy and Procedures Manual.*

[1] The 24-hour clock, in coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the serious incident, Papua New Guinea Time is UTC + 10 hours.

[2] The AIC's policy is to use the *ICAO Annex 13* and *Doc 9756 Part IV* format for detailed and complex reports. The shorter format report is normally used for less complex reports. This complex report does not use the ICAO guideline due to the investigation details not needing to address many of the *ICAO Annex 13* format paragraphs.

Occurrence Details

On 22 May 2019, at 07:11 UTC (17:11 local), a major power outage occurred at Jacksons International Airport, Port Moresby, National Capital District, which lasted for 13 hours and 29 minutes. During the power outage, four aircraft that conducted scheduled passenger operations (3 domestic and 1 international) under Instrument Flight Rules[3] (IFR) for Jacksons were affected. Two of the aircraft diverted to alternate airports. For the other two aircraft, one was able to approach and land at Jacksons, while the international flight had to delay at the departure airport in order to arrive at Jacksons during daylight.

The power outage affected the following facilities:

- All airfield lighting including the Precision Approach Path Indicator[4] (PAPI), Runway, Taxiway, Aerodrome Beacon[5] (ABN) and obstruction lights;
- Instrument Landing System[6] (ILS);
- Domestic and International Terminal apron lights, and
- Internet/emails, telephones and airport CCTV[7]

Other navigation aids including VOR, NDB and DME were not affected by the power outage and remained serviceable during the power outage period. These services were powered by PNG Air Services Limited (PNGASL)[8].

Figure 1: Some of the services were affected during the power outage

A Fokker F70 aircraft registered P2-ANU, owned and operated by Air Niugini Limited as flight number PX101, departed Goroka Airport, Eastern Highlands Province for Jacksons at 06:52. At 07:30 (19 minutes after the power outage began), when the aircraft was about 20 nautical miles (nm) from Jacksons, the flight crew was informed by the Air Traffic Control (ATC) about the lack of availability of services due to the

[3] IFR, Rules applied in cloud or whenever external cues are below VFR minima which prohibit non-IFR pilots/aircraft. Source: *The Cambridge Aerospace Dictionary*.
[4] Precision Approach Path Indicator, is a visual aid that provides guidance information to assist pilots to acquire and maintain the correct approach to an airport or an aerodrome.
[5] Aerodrome Beacon is a beacon installed at an airport or aerodrome to indicate its location to aircraft pilots at night.
[6] Instrument Landing System, is a precision runway approach aid employing two radio beams to provide pilots with vertical and horizontal guidance during the instrument landing approach.
[7] Closed - circuit television.
[8] Papua New Guinea Air Services Limited, a PNG State Aviation Enterprise whose primary business is to provide air navigation services to the domestic and international airline operators who use PNG air space.

power outage at the destination airport. At the time, Jacksons was in Visual Meteorological Conditions (VMC) and there was still daylight (the last light for Jacksons at that day was 08:19), which was considered by the flight crew as suitable to continue to Jacksons. Because ground aids including PAPI and ILS were not available due to the power outage, the flight crew conducted the approach to runway 14L using visual references and other instruments and navigation aids that were available to them. ANU landed at 07:36.

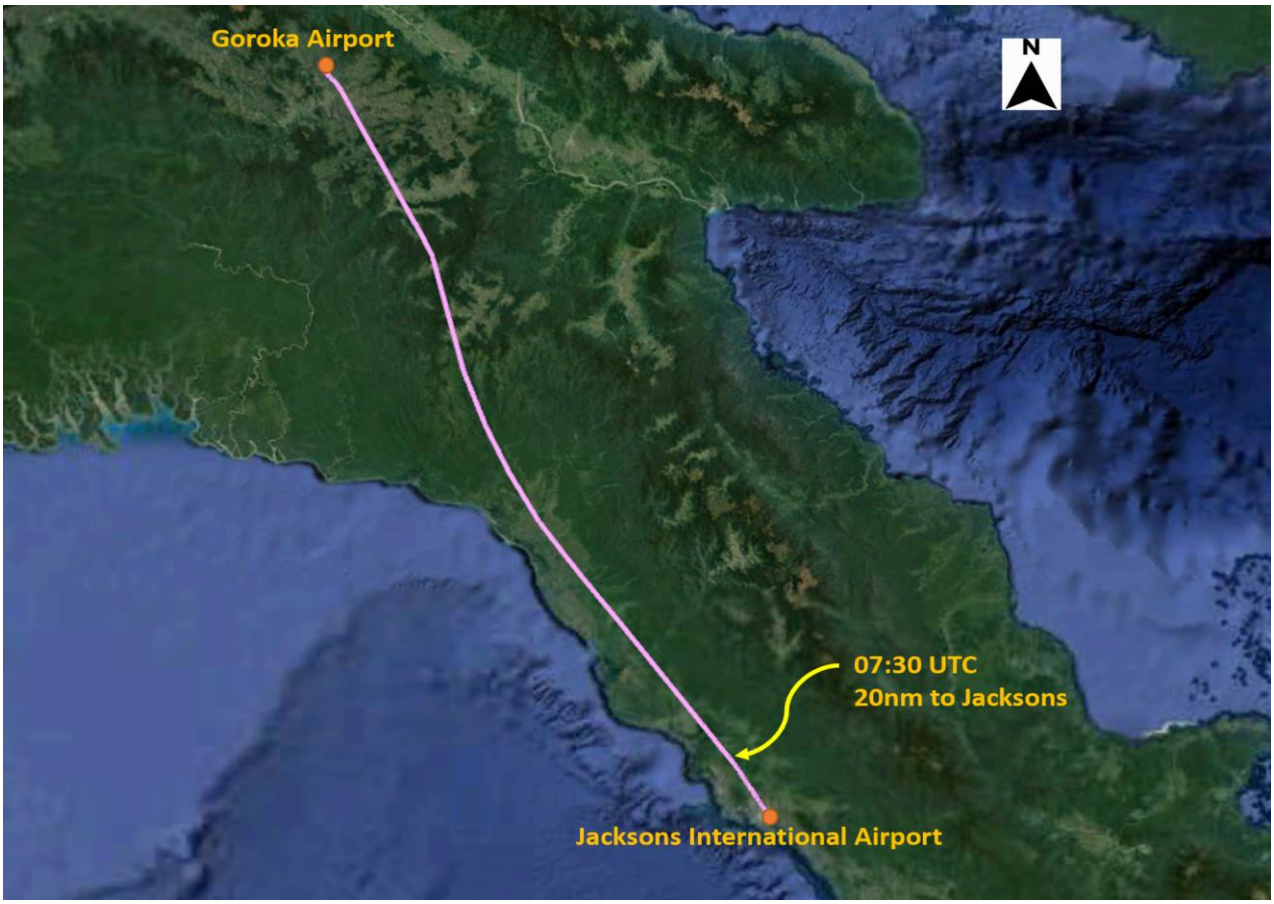


Figure 2: P2-ANU flight track highlighting the position where the aircraft was notified about the power outage

At 07:56 (45 minutes after the power outage at Jacksons began), an ATR 72-600 aircraft registered P2-ATF, owned by DAE Capital and operated by PNG Air Limited as flight number CG8509 departed from Nadzab Airport, Morobe Province for Jacksons. At about 08:25, when the aircraft was approximately 70nm from Jacksons, the flight crew was informed by ATC Radar of the power outage at Jacksons. They were also informed that power would be rectified and restored within a few minutes. While waiting for the power restoration, the flight crew decided to track towards Sakto[9], located approximately 50nm from Port Moresby, where they conducted one holding pattern and contacted company's Operations Office and were informed that power at Jacksons was not yet restored. Subsequently, the flight crew contacted ATC Radar and requested them to inform Nadzab Tower of their intention to divert and return to Nadzab, their nominated alternate airport. The diversion to Nadzab was commenced at 08:41and ATF landed at Nadzab at 09:27.

[9] Reporting point, which is 50nm NW of Jacksons.

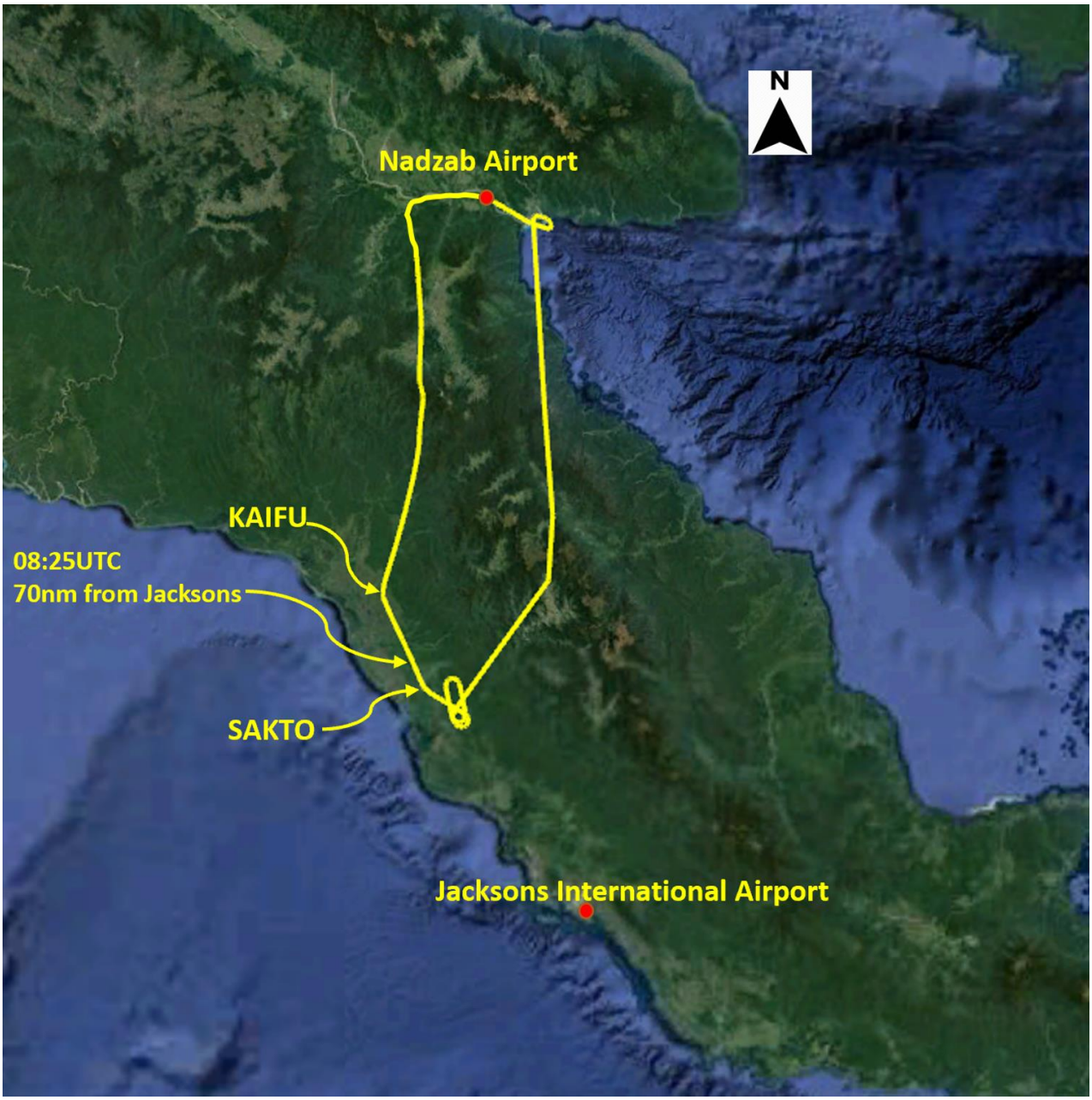


Figure 3: P2-ATF Flight Track highlighting the position where the aircraft was notified about the power outage

The other ATR 72-600 aircraft was registered P2-ATC, and also owned by DAE Capital and operated by PNG Air Limited as flight number CG8545. It departed Mount Hagen Airport, Western Highlands Province at 07:59 (48 minutes after the power outage at Jacksons began) for Jacksons. At 08:29, when the aircraft was approximately 200 nm from Jacksons (60 nm to Lugli[10]), the pilots were informed by ATC about the power outage at Jacksons and that it would last for the next three hours. The flight crew decided to track towards Lugli, reaching it at about 08:45, and from there, they diverted to Nadzab which was the alternate airport, landing at 09:20.

[10] Reporting point, which is 140nm NW of Jacksons

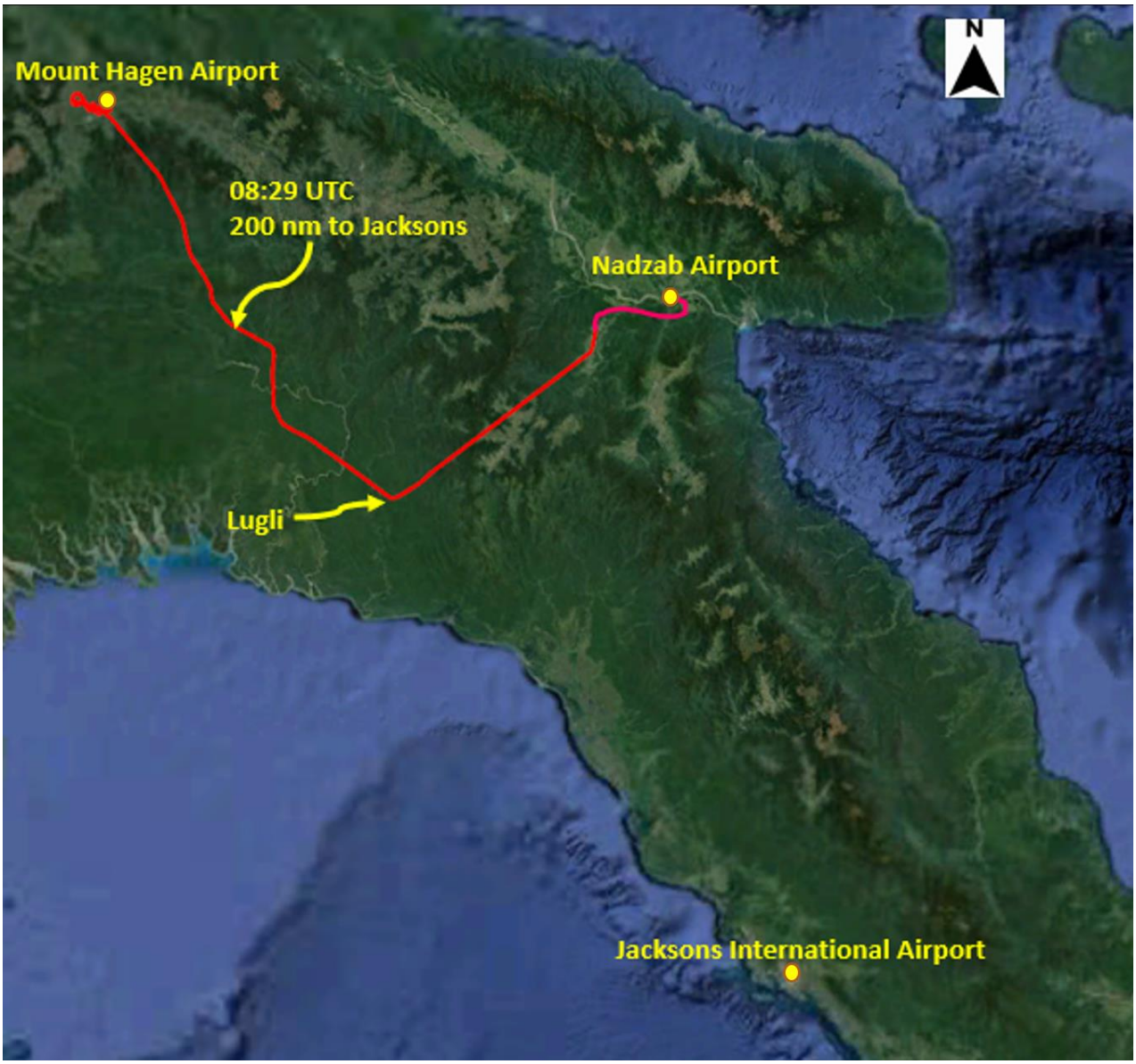


Figure 4: P2-ATC Flight Track highlighting the position where the aircraft was notified about the power outage

A Boeing 737-7L9 aircraft registered P2-PXD, owned by Loftlieder/Icelander and operated by Air Niugini Ltd as flight number PX11, was scheduled for an international passenger operation from Ninoy Aquino International Airport, Manila, Philippines for Jacksons. The flight crew was notified of the power outage at Jacksons while still on the ground at Manila. In accordance with the Air Niugini Ltd flight schedule, the intended departure time was 13:30 and the flight time to Jacksons was about 5 hours and 30 minutes. Considering that scheduled expected landing time at Jacksons was about 19:00 (05:00 am local time) and that would be before first light at the destination, the flight departure was delayed until 15:23 which allowed for the aircraft to land at Jacksons at 20:54 (6:54 am local time), after the first light[11].

[11] The time in the early morning when light first appears and before the sun rises. Different airports have different first light timing depending on their geographical locations and different months of the year. The first light at the time of P2-PXD's arrival was 19:55 as shown in Appendix A, First Light at Jacksons.

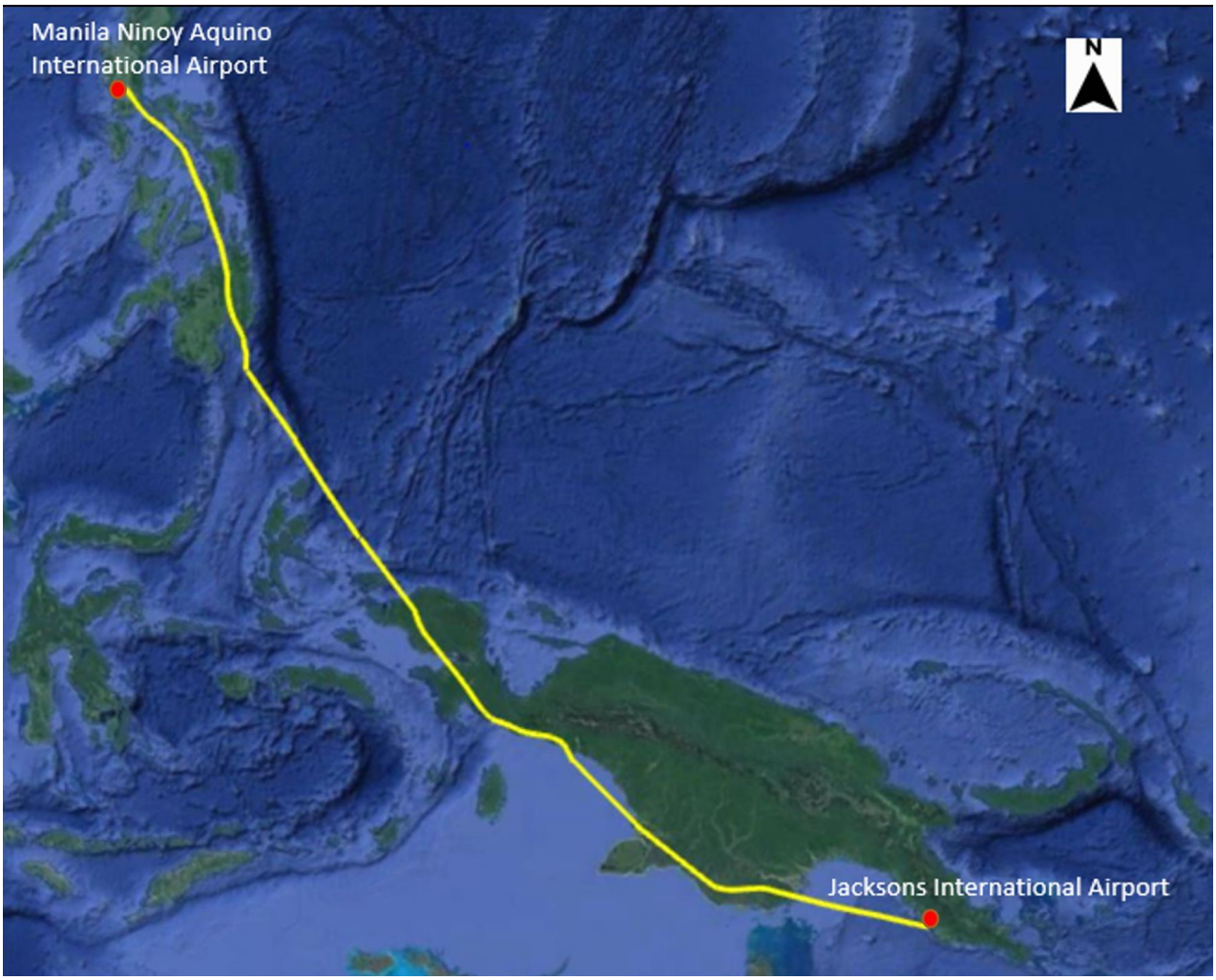


Figure 5: P2-PXD flight track

During the period of the outage, PNG Air Services Limited (ASL) issued five *NOTAMS*[12] *(A0621, A0622, A0623, A0626, A0628)* in response to the unserviceable aerodrome lights, approach and landing systems and aids as a result of the power outage.

The first of those *NOTAMs* was issued at 08:10, one hour after the power outage began. At the time the *NOTAM* was issued, ANU had landed at Jacksons. Meanwhile both P2-ATC and ATF had already been enroute to Jacksons for about 20 minutes.

At 12:14, after working to rectify the power outage for about 4 hours, *Hunn Karr Ltd*[13] technicians were able to power up the ILS for 32R using a temporary solution[14] which allowed PXD, the international flight from Manila, Philippines, to perform a precision approach and landing.

[12] NOTAM – Stands for Notice[s] to Airmen. It is 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.
[13]*Hunn Karr Ltd.* A local company with high voltage certification and experience, that was engaged in the urgent electrical works to restore supply to Southern Power House substation.
[14] Further information under Power Restoration section of this report.

Weather conditions and natural lighting

At the time ANU was notified of the power outage (07:30) and subsequently landed (07:36) there was still daylight, which enabled the flight crew to conduct the approach and landing at Jacksons runway 14L without requiring to use the non-available services. Information on the weather conditions available for the flight crew at the time allowed them to plan and perform the manoeuvers maintaining visual references.

Nevertheless, ATF and P2-ATC estimated times of arrival were during the hours of darkness, which was a consideration for both flight crews when planning their diversions to Nadzab. The same consideration led to the delayed departure of PXD from Manila.

NOTAM

NOTAMs are usually included in a *Preflight Information Bulletin*, prepared daily for the next day operations by PNGASL. During the power outage, the *NOTAMs* issued were through a *STOP Press NOTAM*[15]. Below is a table containing information from the PNGASL *Stop Press NOTAMs* (See Appendix B1) issued during the power outage.

Nr.	Day Date Time(local)	NOTAM Description	Remarks
1	WED 22 May 2019 09:10PM	PORT MORESBY A0622 1905221100/1905222000EST. AIRFIELD LGT NOT AVBL.	Initial NOTAM issued covering only the airfield lighting systems (visual aids)
2	WED 22 May 2019 09:41PM	PORT MORESBY A0622 1905221130/1905222000EST AIRFIELD LGT NOT AVBL DUE MAJOR PWR OUTAGE. RM K/ AD NOT AVBL TO NIGHT OPS PORT MORESBY A0623 1905221130/1905221900. RWY 14L/32R ILS NOT AVBL	NOTAM A0622 reviewed (30minutes later) to cover airfield lighting and AD NOT AVAILABLE during darkness hours. During mains power (PNG Power) failure both the standby gen-sets (northern & southern) were not available as well to power up the aerodrome lighting - total failure to the AD lights (visual aids) NOTAM raised to cover non-availability of a NON-VISUAL aid being NOTAVBL due to power supply. (Self-cancelling at 1900UTC, (0500AM local) Both ILS were switched off due nil flights plus to save battery power.
3	THU 23 May 2019 0700AM	STOP PRESS CANCELLATION ADVICE ISSUED FOR NOTAM PORT MORESY A0622	
4	THU23 May 2019 07:52AM	PORT MORESBY A0626 1905222130/1905230600 EST. RWY 14 ILS NOT AVBL DUE PWR OUTAGE	The NOTAM was published due to the duty runway being RWY 14 and self- cancelling at time 1905230600
5	THU 23 May 2019 12:52PM	PORT MORESBY A0628 1905230245/1905230700 EST RWY 32R GP NOT AVBL DUE PWR OUTAGE	This was raised later due to the aid being serviced by the Southern Power House (Genset not available) - NOTAM self-cancelling at 1905230700

Table 2: PNGASL Stop Press NOTAMs

There were also other NOTAMs related to the power outage issued on 23 May 2019 and included in the *Preflight Information Bulletin* for 24 May 2019 (See Appendix B2).

[15] A *Stop Press Notam* is a late inclusion of a *NOTAM* which is compiled as a pdf document and send out to concern parties

Aerodrome Information

Jacksons International Airport

Jacksons International Airport is located 8km outside Port Moresby, the capital city of Papua New Guinea, is the largest and busiest airport in the country. It is one of the 22 airports in Papua New Guinea owned and operated by the National Airports Corporation (NAC)[16] of Papua New Guinea.

According to the *PNG Aeronautical Information Publication (AIP)* current at the time of the occurrence, services provided by Jacksons included:

- Approach lights, runway lights and other lightings
- Primary and secondary power supplies
- Handling services and facilities.
- Passenger facilities.
- Rescue and firefighting services.
- ATS Communications facilities.
- Radio navigation and landing aids (including ILS, VOR, DME, and NDB).

Jacksons power supply system

At the time of the occurrence, Jacksons power supply system was made up of two sources. The primary source of power was supplied by PNG Power Limited (PPL) into the Central Power House (CPH) Ring Main Units[17] (RMU) where it was distributed to eight sub-stations in its supply network.

With regard to the secondary sources of power, the CPH also housed a main standby generator. Two of the sub-stations (Northern and Southern) were equipped with one back-up generator each. These were intended to act as additional power sources to cater for critical facilities including landing aids, runway and aerodrome lights and other navigational aids, as an extra redundancy in case of a complete power failure of the CPH.

[16] National Airports Corporation (NAC) owns and operates 22 national airports in Papua New Guinea, which Jacksons International Airport is one of them. NAC focuses on its principle function of owning, operating, managing and maintaining these airports. The NAC was formed in 2010 and exists under the Trustee Shareholding of PNG Minister for Civil Aviation and the Minister for Finance.

[17] The RMU comprises of high voltage power switch-gears acting as relays for power control.

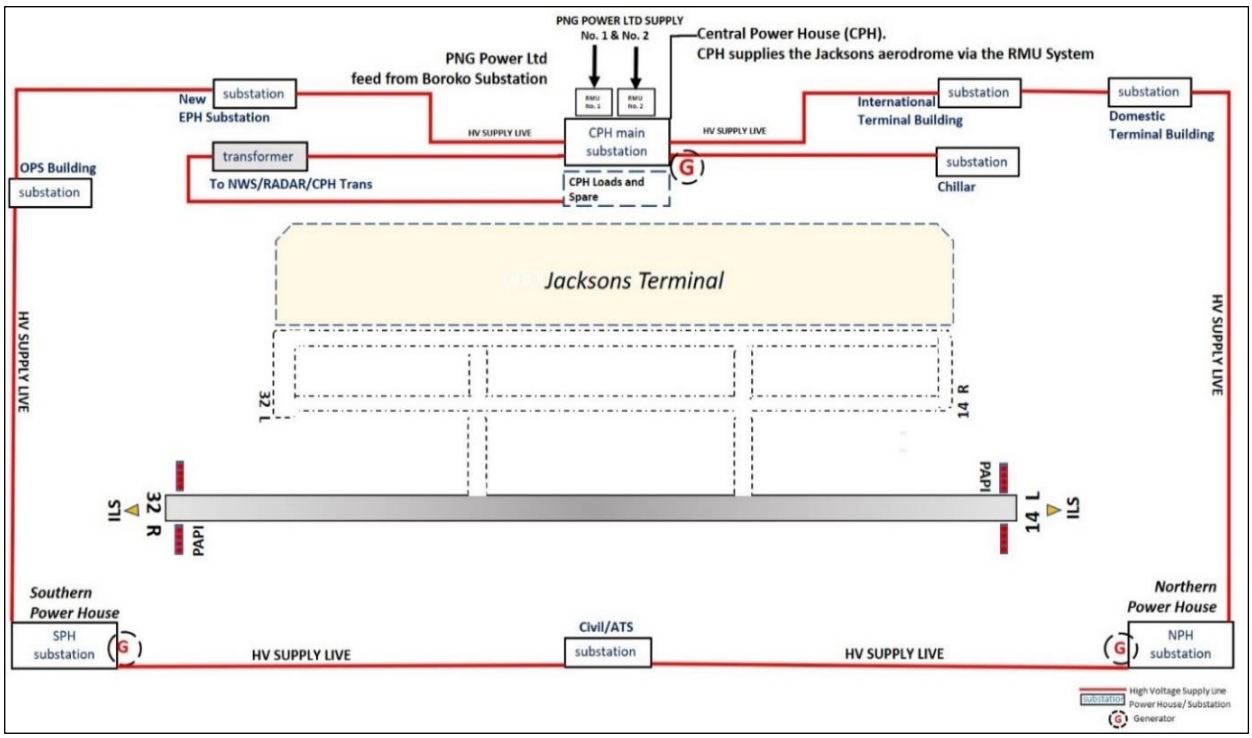


Figure 6: Schematic Diagram of the Existing power system at Jacksons

The loss of electrical power from the primary source (PNG Power Limited grid) caused a complete power loss to the airport facilities. The *PNG Aeronautical Information Publication (AIP)* for Jacksons *AYPY AD 2.15* (See Appendix C1) current at the time declared a Secondary Power Supply which fully conformed with *ICAO Annex 14 – Aerodromes* (see Appendix C2) and with *CAR Part 139 Aerodrome – Certification and Operation, Appendix H Electrical Systems* to immediately restore and maintain the provision of critical services.

Nevertheless, in the context of the occurrence the CPH and the generators located at the Northern and Southern sub-stations did not enter operation, which made it impossible to restore the power supply for the airport facilities and also for the critical services (ILS, PAPI, runway and taxiway lightings, etc.). According to NAC, there was no record of previous failures of the Secondary power source that would inhibit it to automatically initiate when required.

When the secondary power supply did not automatically initialize, a technical team from the airport operator NAC was sent to the power stations to manually activate the generators. However, they were unable to manually activate them and found issues that in the end required external contractors to get involved for the power restoration as detailed later in this report.

As part of the investigation, the AIC requested documentation on the system operation, monitoring and maintenance and diagrams of the power system, which was not provided by the NAC. The lack of this documentation was also identified by the external contractors engaged to restore the system operation and by the airport operator itself, in an internal investigation report.

Power restoration

The *NAC Internal Investigation Report*, which was provided to the AIC by NAC, indicated that two independent contractors, *Schneider Electric Australia*[18] and *Hunn Karr Ltd*, were engaged by NAC for consultation, repair and maintenance of the airport's 11kV grid system and the substations due to the failure of the power system. Individual reports from those contractors were also provided to the AIC.

Schneider Electric Australia carried out inspections on all eight sub-stations' electrical rooms and their 11kV switchboard on the aspects of safety, ventilation (heating and air conditioning), and additional room information including hazards safety warnings, excess water drainage system, and visible condensation. The following table highlights some of the issues identified

Some of the substation system components were found to have had defects affecting their function while other system components rendered not operational as shown in table below.

Issues	Powerhouses							
	CPH	NPH	SPH	ATS	DTB	ITB	EPH	OPS
Battery/UPS Operational	✓	•	•	•	•	•	•	•
Single Line Diagram available/updated	•	•	•	•	•	•	•	•
Oil leakage availability	✓	✓	•	✓	•	✓	•	•
Relays Operational	•	•	✓	•	•	•	•	•
Safety tool kits is correct & complete	•	•	•	•	•	•	•	•
Water Drainage	✓	✓	•	✓	•	•	✓	•
Key CPH – Central Powerhouse NPS – Northern Powerhouse SPH – Southern Powerhouse ATS – ATS Powerhouse DTB – Domestic Terminal Building ITB – International Terminal Building EPH – EPH Powerhouse OPS – Operational Powerhouse	Key ✓ Yes • No							
Note: Chillar is one of the 8 substations. No inspection information was provided								

Table 3: Issues as found during Schneider Electric inspection.

Hunn Karr Ltd was engaged at the time of the outage to restore power supply to the Southern Power House substation because when the power was restored, there was no power available to that sub-station. After identifiying the critical failure of the 11kV switchboard, the contractor provided a solution by connecting to an available PNG Power Limited line within the locality and interlocking it with the site generator system, which to the date of this report was still in use.

Other mitigating actions proposed by the NAC internal investigation report to ensure proper operation of the power system under its different possible requirements included:

- A *Short-Term Solution*, procuring an 11kV rated ring main unit to connect Southern sub-station powerhouse to the existing airport supply system, which was expected to be completed before the end of 2019. On 30th April 2020, NAC informed AIC that this solution was delayed and expected to be completed in June 2020.

- A *Long-Term Solution*, consisting of a major power system upgrade which would involve replacing all power system sets, was expected to be completed by the second quarter 2020. On 30th

[18] *Schneider Electric Australia* is a subsidiary of the *Schneider Electric* SE, a French multinational corporation headquartered in Rueil-Malmaison, France. *Schneider Electric Australia* was the supplier of most existing power system equipment during the airport development stage.

April 2020, NAC informed AIC that the implementation of this solution was delayed due to funding, expecting to commence with its implementation in the 1st Quarter of 2021.

Organisational change and operational performance

Through the years, airport related functions evolved from Civil Aviation Agency (CAA) to Office of Civil Aviation (OCA) then to Department of Civil Aviation (DCA), and later to PNG Civil Aviation Authority (CAA), that remained in place until the Civil Aviation Act 2000 and its subsequent amendments, separated the regulatory functions from the commercial functions of the CAA by establishing four separate State Aviation Organisations in the aviation sector, namely the Civil Aviation Safety Authority (CASA PNG), PNG Air Services Limited (PNGASL), the Accident Investigation Commission (AIC), and the National Airports Corporation (NAC).

Particularly, NAC was established in 2010 evolving from the Airport Division of the former CAA. As part of its functions in accordance with the Civil Aviation Act 2000 (as amended) NAC shall improve, develop, maintain, operate and manage the national airports, currently 22 including Jacksons International Airport.

According to the *NAC Internal Safety Investigation Report*, Jacksons Power Supply System was implemented in the early 1990's as part of the *Port Moresby International Airport Redevelopment Project* funded by the Japanese Government's Japan International Cooperation Agency (JICA) and the system included automated control and monitoring for both remote and local management of the power supply system operations. The expected target for replacement of the power supply equipment was 15 years. However, to the date of the occurrence, the replacement was never done.

The NAC report also indicates that during the period the company had evolved from the Airport Division functions of the PNG DCA to the CAA and finally to NAC, certain steps were not taken into consideration regarding technical staff training and maintenance contracts of the power system to ensure upkeep of the power supply system. Considering the report, probable contributing factors could have been related to lack of funds, continuous management changes and lack of technical understanding and capabilities to operate and maintain the power system. Some of these contributing factors could have led to the lack of documentation regarding processes and procedures for maintaining and operating the power supply system that was identified during the investigation conducted by the AIC.

ICAO Doc. 9859 – Safety Management Manual, paragraph 2.3.8 and following establish the concept of "practical drift" to explain how operational performance of any system "drift away" from its original baseline. ICAO states that *tasks, procedures, and equipment are often initially designed and planned in a theoretical environment, under ideal conditions, with an implicit assumption that nearly everything can be predicted and controlled, and where everything functions as expected*.

In the case of the power outage, the theoretical performance of the system (or operational baseline) was given by the *PNG AIP*, which established the availability of Secondary Power supply in the event of a primary power outage, which is also in accordance with *International Standards and Recommended Practices* of *ICAO Annex 14* and national regulations included in *CAR Part 139*.

ICAO Doc. 9859 also establishes that *in reality, the operational performance often differs from the assumed baseline performance as a consequence of real-life operations in a complex, ever-changing and usually demanding environment. Since the drift is a consequence of daily practice, it is referred to as a "practical drift". The term "drift" is used in this context as the gradual departure from an intended course due to external influences.*

The investigation also revealed that there were significant organisational changes affecting the airport operator throughout the years, and during these periods of change not only the target for replacement of the

system was not met, but also the knowledge and expertise to keep the system running at an operational performance level compatible with the baseline was lost and therefore, when the secondary power system was required to operate in the context of the occurrence, the "practical drift" had already degraded the operational performance to a point in which it was unable to respond to the requirement.

With regard to the management of change, *Appendix 2* to *ICAO Annex 19 – Safety Management* which provides the *Framework for a Safety Management System*, and states that *the service provider shall develop and maintain a process to identify changes which may affect the level of safety risk associated with its aviation products or services and to identify and manage the safety risks that may arise from those changes*. *ICAO Doc. 9859 – Safety Management Manual* further elaborates on the management of change and explains that factors such as significant restructuring of the organisation, changes in safety regulatory requirements, significant changes in staffing levels and changes in key personnel, and other factors, are likely to trigger formal change management.

At a national level, *Civil Aviation Rule (CAR) Part 100 – Safety and Quality Management Systems*, adopts *ICAO Safety Management International Standards*, and *Section 100.65 Change Management* requires the establishment and maintenance of documented procedures for managing changes to the certificate holder's organisation and operation.

In the context of the AIC's safety investigation, NAC provided its *Safety Management System Manual* to the AIC. It was observed that the requirements of *CAR Part 100 Section 100.65*, were identified and addressed[19].

A thorough review of the specific contents about management of change contents in NAC *Safety Management System Manual* showed that:

Section 8.0 – Management Accountability, established that the *Engineering General Manager NAC* and the *Engineering & Facilities Manager (PMIA)* positions were responsible for *identifying potential safety hazards associated with new business activities or changes to existing operational or facility*.

Section 11.0 – Risk Management Process, Sub section 11.2 – New Activities, provides for examples on where *risks may arise as a result of new activities or changes to the existing environment*, and further elaborates indicating that *a risk assessment must be completed whenever a change in conditions or environment is planned including projects, tasks and events*.

Section 13.0 – Safety Promotion and Communication, Sub section 13.1 Aerodrome Safety Promotion, paragraph 13.1.1 indicates that Safety Alerts are issued when there is an urgent need to promulgate safety related information or action such as after a change to the operational environment.

As observed, the mentioned statements about management of change included in *NAC Safety Management System Manual* even when they satisfied the national requirements of *CAR Part 100*, were mainly focused in allowing the organisation to identify risks associated with changes mainly at the operational level, and therefore, only some of the managerial positions directly related to operational activities were assigned with the responsibilities for identifying potential hazards associated to changes in the environment and operational activities. By focusing mostly on operational activities, the NAC process for management of change may not be able to identify elements requiring formal change management actions, such as those related to significant restructuring of the organisation or significant changes in staffing levels and key personnel, as foreseen by ICAO.

Nevertheless, *NAC Safety Management System Manual* in its *Risk Assessment Template*, identified the failure to meet *CAR Part 139* as a risk that could lead to the loss of aerodrome certificate, due to insufficient

[19] *Part 100 Matrix of the NAC Safety Management System as shown in Appendix D of this report*

processes, lack of procedures and training, and established mitigating actions regarding the airport operations manual, trained and competent staff, a process of inspection named “3 tier”, regular communication with CASA PNG and auditing process.

Even when the secondary power source is a requirement for the airport based on *CAR Part 139*, NAC was unable to provide evidence to the AIC indicating that, as part of their safety management processes, hazard identification and mitigating actions were adopted prior to this significant safety occurrence.

Nevertheless, on 12 September 2019, and as part of the internal activities conducted by NAC, a Risk Assessment was conducted, identifying a number of hazards in the operation of the secondary power supply, with the highest level of likelihood and severity (25 out of 25), and proposing a series of mitigating actions in order to decrease the risks, which is detailed in *Appendix E – NAC Risk Assessment*.

AIC Comments

In the context of the occurrence, Jacksons International Airport was unable to maintain the provision of the services, operational baseline declared in the *PNG AIP* and required by national regulations and international standards for commercial aircraft operation, including landing and navigation aids, runway and taxiway landings amongst others, due to the failure of both the primary and secondary sources of electrical power.

The lack of services availability affected four aircraft conducting commercial air transport passenger operations. Only one of the aircraft that was informed about the power outage 19 minutes after it commenced was able to continue the approach and landing using other aids that remained available and weather conditions allowed to maintain visual references and because natural lighting was still present.

In the meantime, two of the other aircraft initiated their flights to Jacksons from their respective departure airports approximately 45 minutes after the power outage started, but both were only notified by the Air Traffic Services with information provided by NAC after about 30 minutes of flight. Despite of the delay in informing the aircraft, both flight crews were provided with significantly different and misleading information. One of them was informed that the power outage would last for few minutes and the other crew was informed that the power failure would remain for approximately 3 more hours, which in the end affected their flight planning and subsequent diversion to Nadzab, an alternate airport for both flights.

Moreover, the information provided to those two aircraft with regard to the duration of the power outage was completely inaccurate, because the power outage in the end lasted an additional 12 hours.

With regard to the fourth aircraft involved, the information about the power outage was received by the flight crew before initiating its international flight from Manila, Philippines, which allowed them to delay the departure ensuring the landing at Jacksons was made during daylight.

The primary source of power for the airport facilities and services relies on the electrical grid feed by PNG Power Limited, and in the event of a failure of this system such as the one that happened in the context of the investigated occurrence, the secondary power source is expected to enter into operation automatically to restore the operation of the critical facilities, services and aids required for air transport operations.

Nevertheless, at the time of the occurrence the secondary power source was unable to enter into operation as a consequence of faulty and failed essential operational components. The investigation documented that environmental conditions, prolonged use of obsolete components, improper and inadequate maintenance and servicing, lack of technical documentation and proper training for technical personnel contributed to the occurrence.

Additionally, it was determined that the power system configuration and components dated from early 1990's and were expected to be replaced after approximately 15 years, which to the date of this report was not yet achieved.

During the time period between the installation of the system and the occurrence, the airport operator evolved from the OCA to DCA then CAA and finally to NAC. During these significant organisational changes, essential steps to ensure upkeep of the aviation safety critical power supply system were not considered and became evident during the investigation because of the lack of documentation regarding processes and procedures for maintaining and operating the power supply system, which was a clear indication of a "practical drift" of the operational performance from its baseline.

Moreover, safety management processes described in *NAC Safety Management System Manual* were mostly focused on identifying changes directly related to operational activities, and may not be able to identify factors regarding significant restructuring of the organisation or significant changes in staffing levels and key personnel as triggers for formal management of change processes. Under the conditions observed, the safety management processes currently in place will not prevent similar occurrences to happen in the future.

Being the secondary power supply system a requirement included in *CAR Part 139*, risks associated to failure in its operation should have been identified as part of the safety management process of NAC, especially considering that one of the main risks identified in the *Risk Assessment Template* is the failure to meet *CAR Part 139*. Because NAC did not identify the risks timely, it was impossible for them to apply the anticipated mitigating actions associated to processes, procedures and training as presented in the *Risk Assessment Template* and revealed a lack of effectiveness in the safety management processes in place.

Moreover, it was only on 12 September 2019 (four months after the occurrence) that NAC conducted a *Risk Assessment* to the operation of the secondary power supply in which a series of hazards, risks and mitigating actions were internally identified.

The AIC has concluded that the power systems at Jacksons International Airport did not meet the operational baseline required to comply with the minimum international standards of *ICAO Annex 14 - Aerodromes* and national regulations included in *CAR Part 139 Aerodrome – Certification and Operation* to ensure operational continuity for air transport operations. Upgrading Jacksons Airport power systems will be essential to actually meet the minimum standards to ensure that continuous reliable power is supplied to essential facilities and services, to avoid similar occurrences jeopardizing safety in the future.

Safety Recommendations

Recommendation number AIC 20-01/19-2001 to National Airport Corporation

Date Issued: 18 May 2020

The PNG Accident Investigation Commission (AIC) recommends that the National Airport Corporation should ensure that all the issues identified in the context of this investigation are rectified in a timely manner to improve and upkeep the Power Systems at Jacksons International Airport to achieve an operational baseline consistent with the minimum international applicable standards of *ICAO Annex 14* and national regulations included in *CAR Part 139 Aerodrome – Certification and Operation*, ensuring the availability of a Secondary power source when required to maintain operational continuity.

Action requested

The AIC requests that NAC note recommendation AIC 20-01/19-2001, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how NAC has addressed the safety deficiency identified in the safety recommendation.

Closing Statement

On 17 August 2020, NAC informed the PNG Accident Investigation Commission of the ***Safety Action*** taken to address the deficiencies identified in Safety Recommendation AIC 20-01/19-2001 and provided evidence with regard to it. NAC stated that:

> *"Immediate action taken to correct and restore power supply back to Jacksons International Airport included:*
>
> *i. Disconnection of Southern Substation from the Jacksons International Airport high voltage ring.*
> *ii. Connection of Southern Substation to 2G Estate PNG Power Source.*
> *iii. Installation of a new Ring Main Unit, Automatic Transfer Switch for the 180KVA Cummins Local Genset."*

NAC also stated that in order to prevent similar occurrences in the future, the entire high voltage facilities and equipment at Jacksons International Airport will be replaced and upgraded. The scope and cost has been already determined but the project will be subject to funding allocation.

The AIC assigned this response as *satisfactory* and recorded the **Status of the AIC recommendation: CLOSED RESPONSE ACCEPTED.**

Recommendation number AIC 20-02/19-2001 to National Airport Corporation

Date Issued: 18 May 2020

The PNG Accident Investigation Commission (AIC) recommends that the National Airport Corporation should ensure that documented procedures are in place on the following areas:

1) power system operations (**Recommendation number AIC 20-02/19-2001a**).
2) maintenance of the power systems (**Recommendation number AIC 20-02/19-2001b**)

3) training for technical officers responsible for the maintenance of the power systems (**Recommendation number AIC 20-02/19-2001c**)

Action requested

The AIC requests that NAC note recommendation AIC 20-02/19-2001a, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how NAC has addressed the safety deficiency identified in the safety recommendation.

Closing Statement

On 17 August 2020, NAC provided response to the AIC 20-02/19-2001 stating that the operational manuals of the power system had been lost or destroyed and the power system was operated by technical officers with whatever knowledge, skills and experience they had gain with the past 20 years.

NAC further explained that the maintenance of the high voltage system, whether it be breakdown maintenance, corrective maintenance or preventative maintenance were all outsourced to competent and licensed electrical contractors. NAC estimates that since most of the repair and maintenance are outsourced, training of the technical officers for repair and maintenance was not required.

NAC established a preventative action to be developed in the future, subject to funding, consisting in upgrading the entire power system.

According to AIC assessment, NAC response and safety actions developed will not address the safety issues identified during the investigation and the safety deficiencies identified will remain until other actions are developed in the future. The AIC assigned this response as *unsatisfactory* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE NOT ACCEPTED.**

Recommendation number AIC 20-03/19-2001 to National Airport Corporation

Date Issued: 18 May 2020

The PNG Accident Investigation Commission (AIC) recommends that the National Airport Corporation should ensure that all technical officers responsible for the maintenance of the Power Systems at Jacksons International Airport should be equipped with the skills and knowledge for continuous upkeeping of the systems.

Action requested

The AIC requests that NAC note recommendation AIC 20-03/19-2001, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how NAC has addressed the safety deficiency identified in the safety recommendation.

Closing Statement

On 17 August 2020, NAC provided response to the AIC 20-03/19-2001 stating that:

> *"The Jacksons International Airport has three (3) highly qualified and competent senior electrical trades person with high voltage license Class II which limited to High Voltage Switching and Safety Procedures. Class II license only permits electrical trades persons to perform high voltage switching only, repair and maintenance, preventative maintenance including HV design and audits are not applicable and these are currently outsourced by NAC to its contractors."*

In their response, NAC also proposed a preventative action statement as follows:

> *"In order to prevent similar occurrences in the future, the management of NAC has taken a proactive approach to replace and upgrade the entire high voltage facilities and equipment at Jacksons International Airport. To date, the project scope and cost estimates have been completed and submitted to CADIP to be funded by ADB.*
>
> *As part of the high voltage upgrade electrical project, qualified electrical trades personal including electrical engineers will be trained and licensed to perform some of the activities to ensure asset integrity and upkeeping of the system."*

According to AIC findings during the investigation and the safety deficiencies identified, NAC technical officers are responsible for maintaining the power system, and without equipping these officers with appropriate skills and knowledge, the risk will remain. The project for upgrading the system NAC is proposing, when implemented, may address the safety deficiencies, however, there is no time frame for the actual implementation and, moreover, in the meantime, the safety deficiencies that gave origin to this Safety Recommendation will not be effectively addressed.

The AIC assigned the response from NAC as *unsatisfactory* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE NOT ACCEPTED.**

Recommendation number AIC 20-04/19-2001 to National Airport Corporation

Date Issued: 18 May 2020

The PNG Accident Investigation Commission (AIC) recommends that the National Airport Corporation should develop, implement and improve safety assurance activities such as audits, observations and Safety Performance Indicators (SPIs) directly oriented to identify areas and activities that could be "practically drifting", and the timely mitigation of their associated safety risks.

Action requested

The AIC requests that NAC note recommendation AIC 20-04/19-2001, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how NAC has addressed the safety deficiency identified in the safety recommendation.

Closing Statement

On 17 August 2020, NAC provided response to the AIC 20-04/19-2001 stating that:

"NAC has developed specific, time-bound actions around safety assurance.

1.As detailed in Section 2.6 of NAC's newly developed SMS-QMS Implementation Plan, introduction of formalized processes for the development and enhancement of appropriate SPI's has now prioritized and moved forward, to be fully implemented by October 31, 2020. When finalized, those process will be provided to AIC.

2.As detailed in Section 4.1.12 of SMS-QMS Implementation Plan, the formalization of processes to include observations and audits so as to address risk such as "practical drift" has been prioritized and will be implemented by October 31, 2020. When finalized, those process will be provided to AIC."

According to AIC assessment, the plan will address the aim of Safety recommendation AIC 20-04/19-2001 when fully implemented. Evidence on effective implementation, if provided by NAC, will allow AIC to

reassess the Status of the Recommendation if necessary. The AIC assigned this response as a *satisfactory intent* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE ACCEPTED.**

Recommendation number AIC 20-05/19-2001 to National Airport Corporation

Date Issued: 18 May 2020

The PNG Accident Investigation Commission (AIC) recommends that the National Airport Corporation should review the safety management processes and procedures, including but not limited to those contained in the *Safety Management System Manual* and *Risk Assessment Template* to ensure that:

1) Processes and procedures related to management of change enable to identify significant restructuring of the organisation, significant changes in staffing levels and key personnel as triggers for formal management of change processes. (**Recommendation number AIC 20-05/19-2001a**).

Action requested

The AIC requests that NAC note recommendation AIC 20-05/19-2001a, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how NAC has addressed the safety deficiency identified in the safety recommendation.

Closing Statement

On 17 August 2020, NAC provided response to the AIC 20-05/19-2001a stating that:

"NAC has developed specific, time-bound actions around NAC organizational levels and Change Management processes.

As detailed in Section 4.1.20 of NAC's SMS-QMS Implementation Plan, the introduction and formalization of processes to identify significant restructuring of the organization, significant changes in staffing levels and key personnel as triggers for formal management of change processes has been prioritized and moved forward, to be fully implemented by October 31, 2020. When finalized, those processes will be provided to AIC."

In the assessment conducted by the AIC, it was observed that the evidence indicates that NAC Safety Management Manual will describe and explain the process and criteria for formal hazard analyses due to major organisational change or change in key employees, and will include the process for ensuring appropriate levels of management authority and expertise for hazard analyses due to major organisational change or change in key employees, to ensure NAC conduct formal hazard analyses for major organisational change or change in key employees , including subject matter experts and senior management from appropriate departments to ensure all trigger factors are considered.

According to AIC assessment, the plan will address the aim of Safety recommendation AIC 20-05/19-2001a when fully implemented. Evidence on effective implementation, if provided by NAC, will allow AIC to reassess the Status of the Recommendation if necessary. The AIC assigned this response as a *satisfactory intent* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE ACCEPTED.**

On 17 August 2020, NAC provided response to the AIC 20-05/19-2001b stating that:

"NAC has developed specific, time-bound actions around NAC organizational levels and Change Management processes.

As detailed in Section 4.1.20 of NAC's SMS-QMS Implementation Plan, the introduction and formalization of processes to ensure that safety management responsibilities are at the appropriate operational level have been prioritized and moved forward, to be fully implemented by October 31, 2020. When finalized, those processes will be provided to AIC."

In the assessment conducted by the AIC, it was observed that the evidence indicates that NAC Safety Management Manual will describe and explain the process and criteria for formal hazard analyses due to major organisational change or change in key employees, and will include the process for ensuring appropriate levels of management authority and expertise for hazard analyses due to major organisational change or change in key employees, to ensure NAC conduct formal hazard analyses for major organisational change or change in key employees , including subject matter experts and senior management from appropriate departments to ensure all trigger factors are considered.

According to AIC assessment, the plan will address the aim of Safety recommendation AIC 20-05/19-2001b when fully implemented. Evidence on effective implementation, if provided by NAC, will allow AIC to reassess the Status of the Recommendation if necessary. The AIC assigned this response as a *satisfactory intent* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE ACCEPTED.**

On 17 August 2020, NAC informed the PNG Accident Investigation Commission of the ***Safety Action*** taken to address the deficiencies identified in Safety Recommendation AIC 20-05/19-2001c and provided an SMS-QMS implementation plan which, when implemented, will include time-bound actions to ensure the processes required by the Safety Recommendation are reviewed and updated, to ensure consistency between the Risk Assessment Template and effective management actions.

According to AIC assessment, the plan will address the aim of Safety recommendation AIC 20-05/19-2001c when fully implemented. Evidence on effective implementation, if provided by NAC, will allow AIC to reassess the Status of the Recommendation if necessary. The AIC assigned this response as a *satisfactory intent* and recorded the **Status of the AIC recommendation**: **CLOSED RESPONSE ACCEPTED.**

General Details

Date and time:	22 May 2019 – 07:11 UTC
Occurrence category:	Serious incident
Primary occurrence type (ICAO):	Occurrences involving aerodrome design, service or functionality issues (ADRM: Aerodrome)
Location:	Port Moresby / Jacksons International Airport

Aircraft Details

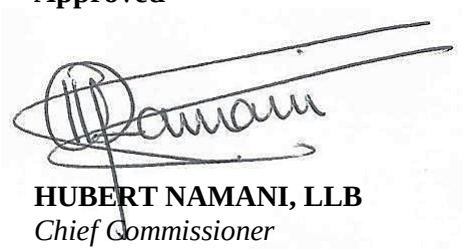
Manufacturer and model:	ATR 72-600	
Registration:	P2-ATF	
Serial number:	1461	
Type of operation:	Scheduled Domestic Commercial Passenger Air Transport Operation	
Persons on board:	Crew: 4	Passengers: 34 (including 1 infant)
Injuries:	Crew: NIL	Passengers: NIL
Damage	No damage	

Manufacturer and model:	ATR 72-600	
Registration:	P2-ATC	
Serial number:	1347	
Type of operation:	Scheduled Domestic Commercial Passenger Air Transport Operation	
Persons on board:	Crew: 4	Passengers: 13 (including 1 infant)
Injuries:	Crew: NIL	Passengers: NIL
Damage	No damage	

Manufacturer and model:	Fokker70	
Registration:	P2-ANU	
Serial number:	1347	
Type of operation:	Scheduled Domestic Commercial Passenger Air Transport Operation	
Persons on board:	Crew: 4	Passengers: Not Available
Injuries:	Crew: NIL	Passengers: NIL
Damage	No damage	

Manufacturer and model:	B737-7L9	
Registration:	P2-PXD	
Serial number:	1347	
Type of operation:	Scheduled International Commercial Passenger Air Transport Operation	
Persons on board:	Crew: 6	Passengers: Not Available
Injuries:	Crew: NIL	Passengers: NIL
Damage	No damage	

Approved

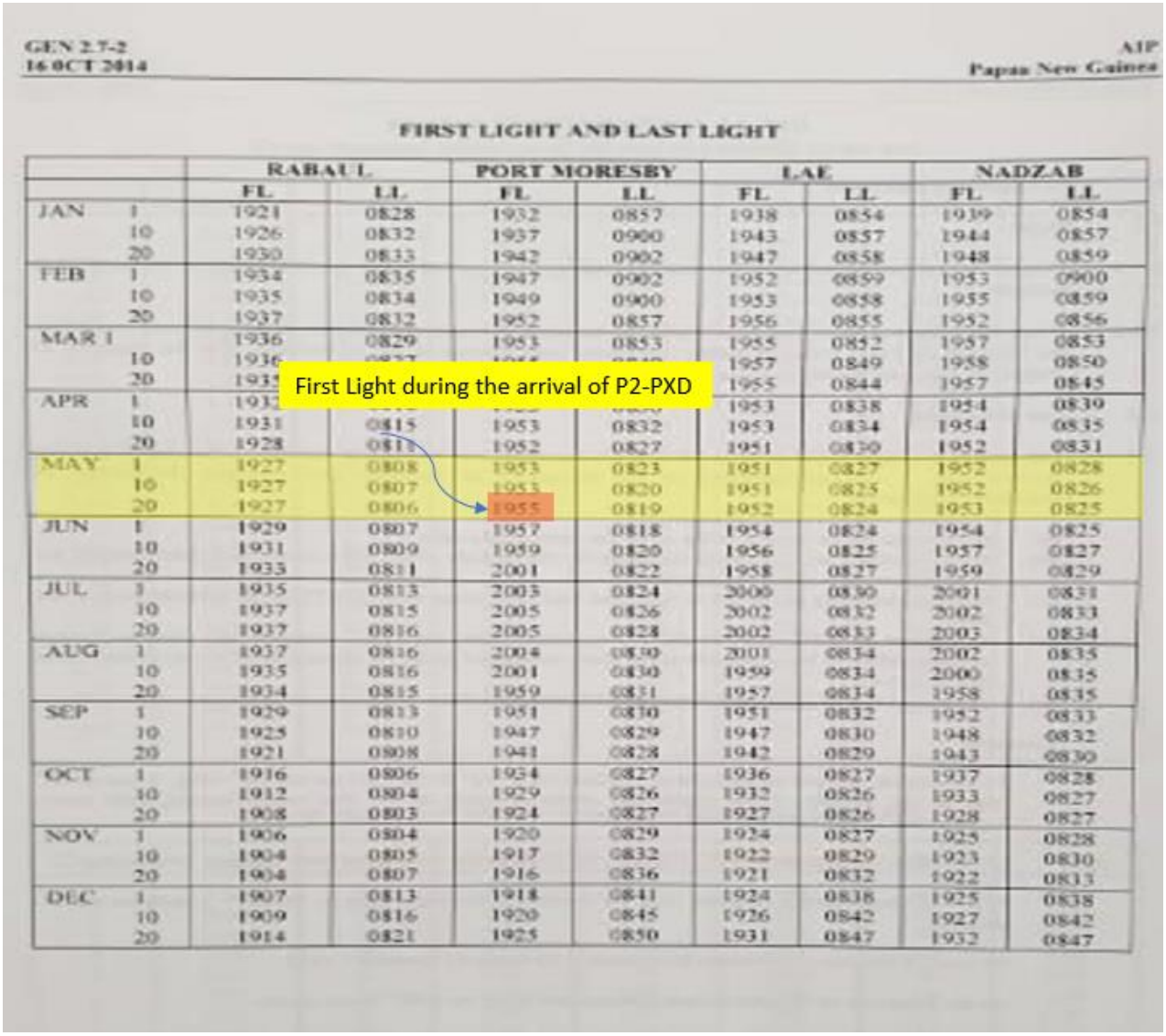


HUBERT NAMANI, LLB
Chief Commissioner
2 October 2020

APPENDIXES

Appendix A: First light for Jacksons

Highlighted below is the first light timing (1955UTC) for Jacksons during the arrival of P2-PXD from Manila



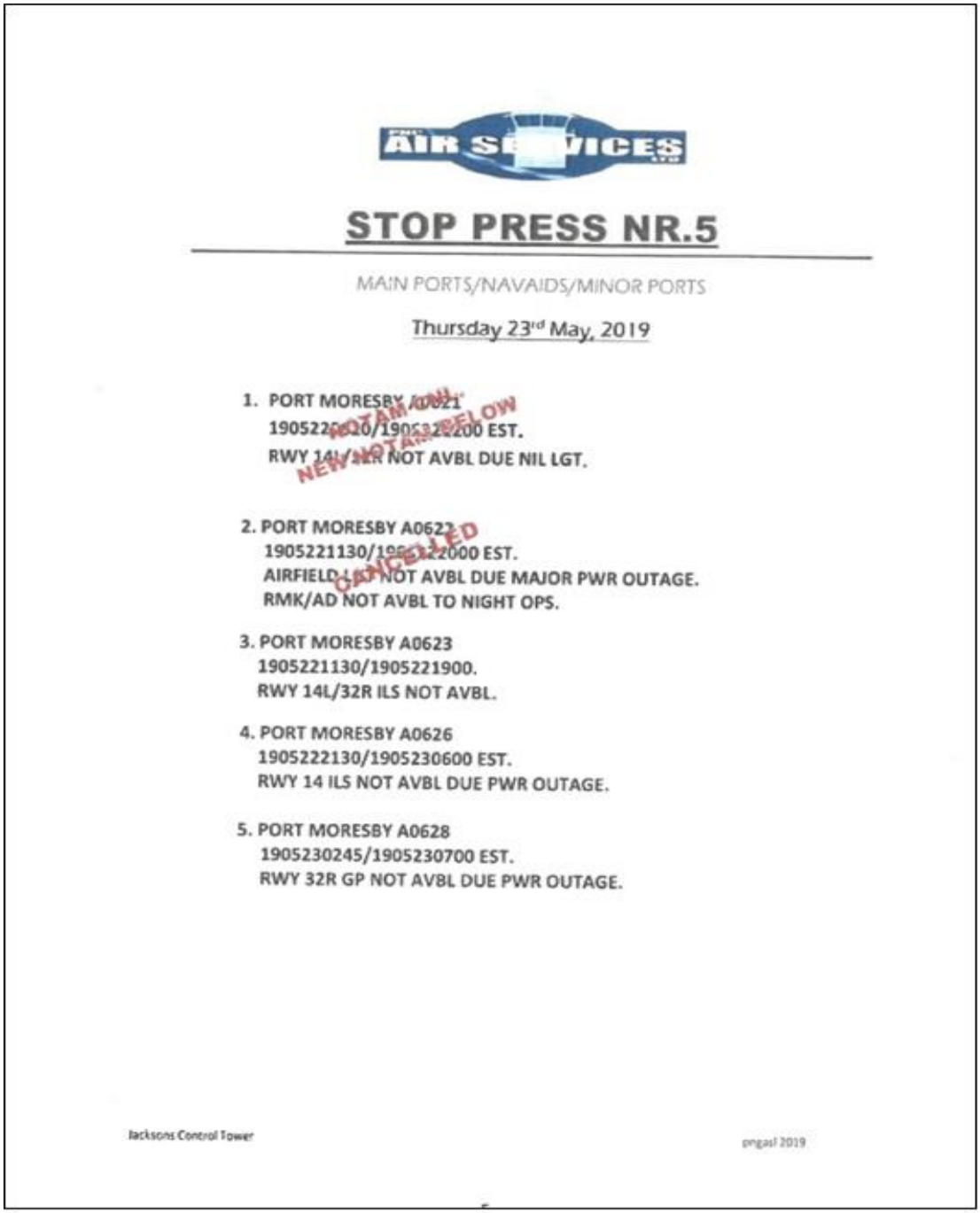
FIRST LIGHT AND LAST LIGHT

		RABAUL		PORT MORESBY		LAE		NADZAB	
		FL	LL	FL	LL	FL	LL	FL	LL
JAN	1	1921	0828	1932	0857	1938	0854	1939	0854
	10	1926	0832	1937	0900	1943	0857	1944	0857
	20	1930	0833	1942	0902	1947	0858	1948	0859
FEB	1	1934	0835	1947	0902	1952	0859	1953	0900
	10	1935	0834	1949	0900	1953	0858	1955	0859
	20	1937	0832	1952	0857	1956	0855	1952	0856
MAR	1	1936	0829	1953	0853	1955	0852	1957	0853
	10	1936				1957	0849	1958	0850
	20	1935				1955	0844	1957	0845
APR	1	1931				1953	0838	1954	0839
	10	1931	0815	1953	0832	1953	0834	1954	0835
	20	1928	0811	1952	0827	1951	0830	1952	0831
MAY	1	1927	0808	1953	0823	1951	0827	1952	0828
	10	1927	0807	1953	0820	1951	0825	1952	0826
	20	1927	0806	1955	0819	1952	0824	1953	0825
JUN	1	1929	0807	1957	0818	1954	0824	1954	0825
	10	1931	0809	1959	0820	1956	0825	1957	0827
	20	1933	0811	2001	0822	1958	0827	1959	0829
JUL	1	1935	0813	2003	0824	2000	0830	2001	0831
	10	1937	0815	2005	0826	2002	0832	2002	0833
	20	1937	0816	2005	0828	2002	0833	2003	0834
AUG	1	1937	0816	2004	0830	2001	0834	2002	0835
	10	1935	0816	2001	0830	1959	0834	2000	0835
	20	1934	0815	1959	0831	1957	0834	1958	0835
SEP	1	1929	0813	1951	0830	1951	0832	1952	0833
	10	1925	0810	1947	0829	1947	0830	1948	0832
	20	1921	0808	1941	0828	1942	0829	1943	0830
OCT	1	1916	0806	1934	0827	1936	0827	1937	0828
	10	1912	0804	1929	0826	1932	0826	1933	0827
	20	1908	0803	1924	0827	1927	0826	1928	0827
NOV	1	1906	0804	1920	0829	1924	0827	1925	0828
	10	1904	0805	1917	0832	1922	0829	1923	0830
	20	1904	0807	1916	0836	1921	0832	1922	0833
DEC	1	1907	0813	1918	0841	1924	0838	1925	0838
	10	1909	0816	1920	0845	1926	0842	1927	0842
	20	1914	0821	1925	0850	1931	0847	1932	0847

First Light during the arrival of P2-PXD

Appendix B: PNG ASL NOTAMS issued during the power outage period

Appendix B1: STOP PRESS



PNG AIR SERVICES LTD

STOP PRESS NR.5

MAIN PORTS/NAVAIDS/MINOR PORTS

Thursday 23rd May, 2019

1. PORT MORESBY A0621
   1905220620/1905222200 EST.
   RWY 14L/32R NOT AVBL DUE NIL LGT.

   NOTAM ON NEW NOTAM BELOW

2. PORT MORESBY A0622
   1905221130/1905222000 EST.
   AIRFIELD LGT NOT AVBL DUE MAJOR PWR OUTAGE.
   RMK/AD NOT AVBL TO NIGHT OPS.

   CANCELLED

3. PORT MORESBY A0623
   1905221130/1905221900.
   RWY 14L/32R ILS NOT AVBL.

4. PORT MORESBY A0626
   1905222130/1905230600 EST.
   RWY 14 ILS NOT AVBL DUE PWR OUTAGE.

5. PORT MORESBY A0628
   1905230245/1905230700 EST.
   RWY 32R GP NOT AVBL DUE PWR OUTAGE.

Jacksons Control Tower

pngasl 2019

Appendix B2: NOTAMS – Preflight Information Bulletin for 24 May 2019

Nr.	Day Date Time(local)	NOTAM Description	Remarks
6	THU 23 May 2019 06:39PM	Daily bulletin for Friday 24/05/19 published with following NOTAMs included: PORT MORESBY A0412 1904080130/1907080600 EST. AD CTN DUE 50% OF LIGHTING OUTAGE WI TWY ALPHA. LIGHTING NOT AVBL PORTION OF TWY ALPHA FM HOLDING PT OF 14R TO 14L. LIGHTING AVBL WI TWY FOXTROT AND TWY MIKE EAST OF TWY ALPHA. PORT MORESBY A0640 1905230750/1905240600 EST. RWY 14 ILS NOT AVBL DUE PWR OUTAGE PORT MORESBY A0641 1905230755/1905240600 EST RWY 32 GP NOT AVBL DUE UNREL PWR SUPPLY.	
	07:05PM-STOP PRESS NR.1	CANCEL PORT MORESBY A0412-AD CTN. NOTAM REVIEWED TO A0645 PORT MORESBY A0645 1905230730/1905231000 EST. AD CTN DUE 50% AIRFIELD LGT NOT AVBL: (WIP TO RESTORE) 1. 32R PAPI 2. ALL TAXI LGT 3. 32R THR LGT 4. OBST LGT MET/NAVAID SHELTER, GP HUT, 14LOC/NDB HUT. 5. RWY 14L/32R RWY LGT BELOW FULL CAPACITY (EVERY 2nd LGT AVBL)	This was done in close consultation with NAC
7	THUR 23 May 2019 09:18PM	STOP PRESS ISSUED-CANCELLATION NOTICE PORT MORESBY A064S - CANCELLED	NAC RESTORED AIRFIELD LIGHTTING
8	FRI 24 May 2019 09:24AM	STOP PRESS-CANCELLATION NOTICE ISSUED ON PORT MORESBY NOTAMS A0640 and A0641	Southern Power House (Gen-set) restored both RWY 14 & 32 ILS equipment available on standby power as per NAC's restoration to the southern powerhouse gen-set. The restoration works, were carried out, in close consultation with PNG ASL technicians to ensure the visual & non-visual aids were all brought back to normal operations.

Appendix C: Secondary Power Supply requirement

Appendix C1: *PNG AIP AIPAYPY AD 2.15 Other lighting and Secondary Power Supply*

Aerodrome	Port Moresby/ Jacksons International Airport		
	Latitude: 09°26' 27.66 "S		Longitude: 147° 13'5 .78"E
Elevation	129ftAMSL		
RWY(LDA)	14L/ 32R (2,750m)		14R/32L (1,300 m)
PAPI	14L/ 32R	**ILS**	14L/ 32R
ABN/IBN location, characteristics and hours of operation	ABN RELOCATED AND BEAMING FM NEW LOCATION. COORD S092 26 40.5 E147 12 47.4		
TWY Edge and Centerline LOT	Blue		
Secondary Power supply/switch over time:	Conforms fully with the requirements of Annex 14Chapter 8 for Cat II		
	Emergency lights available to all RWY location and characteristics as required by Annex 14 Chapter 5. Hazard Beacon, Holding point light, Obstruction light, Lighted WDI, RWY THR/Edge lighting.		

NOTE: *All information in this table is referenced directly from the Aeronautical Information Publication (AIP of PNG)*

Appendix C2: *ICAO Annex 14 Chapter 8, Paragraph 8.1.10*

8.1.10 **Recommendation.**— *The following aerodrome facilities should be provided with a secondary power supply capable of supplying power when there is a failure of the primary power supply:*

a) the signalling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;

Note.— The requirement for minimum lighting may be met by other than electrical means.

b) all obstacle lights which, in the opinion of the appropriate authority, are essential to ensure the safe operation of aircraft;

c) approach, runway and taxiway lighting as specified in 8.1.6 to 8.1.9;

d) meteorological equipment;

e) essential security lighting, if provided in accordance with 9.11;

f) essential equipment and facilities for the aerodrome responding emergency agencies;

g) floodlighting on a designated isolated aircraft parking position if provided in accordance with 5.3.24.1; and

h) illumination of apron areas over which passengers may walk.

Note.— Specifications for secondary power supply for radio navigation aids and ground elements of communications systems are given in Annex 10, Volume I, Chapter 2.

Appendix D: *Part 100 Matrix of NAC SMS Manual*

APPENDIX – U Part 100 Matrix – Safety Management System

The matrix satisfies Rule Part 100 Safety Management System requirements.

GENERAL
Purpose
100.1(a)
(1) Part 109 - Regulated Air Cargo Agents – Certification
(2) Part 119 – Air Operator Certification:
(3) Part 139 – Aerodrome – Certification and Operation:
(4) Part 140 – Aviation Security Service Organisations – Certification:
(5) Part 141 – Aviation Training Organisations – Certification and Operation:
(6) Part 144 – Supply Organisations –Certification:
(7) Part 145 – Aircraft Maintenance Organisations – Certification:
(8) Part 146 – Aircraft Design Organisations – Certification:
(9) Part 148 – Aircraft Manufacturing Organisations – Certification:
(10) Part 171 – Aeronautical Telecommunication Service Organisations – Certification:
(11) Part 172 – Air Traffic Service Organisations - Certification:
(12) Part 173 – Air Navigation Service Organisations – Certification:
(13) Part 174 – Aviation Meteorological Service Organisations – Certification:
(14) Part 175 – Aeronautical Information service Organisations – Certification.
Definitions
100.3

SAFETY MANAGEMENT SYSTEM		
Rule	**Exposition Ref**	**Compliance**
Establishment for a Safety Management System		
100.51	SMS Document	Y
Safety Policy		
100.53(a)	CHP 7.0; pp 13	Y
100.53(b)	CHP 7.0 – 7.2; pp 13 – 15	Y
Safety Objectives		

100.55	CHP 9.1; pp 23 – 24	Y
Roles, Responsibilities and Authorities		
100.57(a)(1)	CHP 9.0; pp 23	Y
100.57(a)(2)	CHP 8.0; pp 16 – 22	Y
100.57(a)(3)	CHP 8.0; pp 16 – 22	Y
100.57(a)(4)	CHP 9.2; pp 25 (App. A&B – pp 50-52)	Y
100.57(b)	CHP 8.0; pp 16 – 17	Y
Hazard Identification		
100.59(a)	CHP 12.0; pp 32-33	Y
100.59(b)(1)	CHP 13.0; pp 34 – 35 (App 0 & S)	Y
100.59(b)(2)	Appendix I – pp 71	Y
100.59(c)	CHP 12.1; pp 32	Y
Risk Management		
100.61(a)	CHP 11.0; pp 27 – 31	Y
100.61(b)(1)	CHP 11.0; pp 28	Y
100.61(b)(2)	CHP 11.4 – 11.8; pp 29 – 30	Y
100.61(b)(3)	CHP 11.9; pp31	Y
100.61(b)(4)	CHP 12.1; pp 32	Y
Interfaces		
100.63(a)	CHP 9.2; pp 24 – 25	Y
100.63(b)(1)	CHP 9.1 pp 23 – 24	Y
100.63(b)(2)	CHP 9.1; pp 23 – 24	Y
100.63(b)(3)	CHP 9.1; pp 23 – 24	Y
100.63(b)(4)	CHP 9.1 ; pp 23 – 24	Y
100.63(b)(5)	CHP 9.1; pp 23 – 24	Y
Change Management		
100.65(a)	CHP 7.0; pp 13	Y
100.65(b)(1)	CHP 7.0; pp 13	Y
100.65(b)(2)	CHP 7.0; pp 13	Y
100.65(b)(3)	CHP 11.1; pp 27	Y
100.65(b)(4)	CHP 7.0; pp 13	Y
100.65(b)(5)	Appendix C & D; pp 53 -55	Y
Internal Communication and Consultation		
100.67(a)	CHP 13.0; pp 34 – 35	Y
100.67(a)(1)(i)	CHP 13.1; pp 34	Y
100.67(a)(1)(ii)	CHP 12.0; pp 32 – 33	Y
100.67(a)(1)(iii)	CHP 17.4; pp 42 - 43	Y
100.67(a)(1)(iv)	CHP 18.2; pp 46	Y

PMIA RING MAIN UNIT POWER SYSTEMS

PMIA AERODROME	Power Supply OPERATIONAL RISKS
Quarterly Risk Management Report Period Ending:	
Risk Register Last Updated:	
Risk Assessment Level (Strategic/Oper	OPERATIONAL

Reviewed By: Mark Sahin, Gabriel Anarea, Manuai Kametan, Brigid Sikani, John Tomo, Bill Bouraga, Martin Geno, John Kose Isu

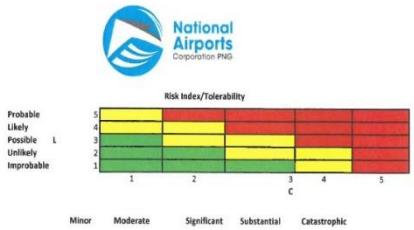
Likelihood Ranking: **(suggested time frame: 3-5 years)** 1 = Improbable, 2 = Unlikely, 3 = Possible, 4 = Likely, 5 = Probable

Consequence Ranking: 1 = Minor, 2 = Moderate, 3 = significant, 4 = Substantial, 5 = Catastrophic

Safety 1 = Minor Injuries, 2 = Major Injuries, 3 = Single Fatalities, 4 = Multiple fatalities (e.g. up to 100), 5 = Multiple Fatalities (e.g. over 100)
Security 1 = Minor breach of regulations, 2 = Reportable breach of regulation, 3 = Prosecution, 4 = Short airport closure, 5 = long airport closure
Environment 1 =Short term local damage, 2 = Short Term Regional Damage, 3 = Long Term Local Damage, 4 = Long Term Widespread Damage, 5 = Widespread Permanent Damage
Financial 1 = Up to K tens of thousands, 2 = K hundreds of thousands, 3 = K millions, 4 = K tens of millions, 5 = K hundred of millions
Reputation & Legal 1 = Improvement notice, minor local reputation damage, 2 = Prohibition notice, major local reputation damage, 3 = Prosecution with fine, national adverse media coverage
4 = Directors charged with corporate killings, fraud etc., International adverse media coverage, short term, 5 = Directors convicted of corporate killing, fraud, etc. international adverse media coverage - >

Control Rating 1 = Excessive - where 'controls exceed the level required to manage the risk'
2 = Optimal - where controls are comprehensive and commensurate with the risk. All controls are working as evidenced
3 = Adequate - 'Some shortfall in level of controls but these do not material affect the level of residual risk
4 = Inadequate - where ' weaknesses and inefficiency in controls do not treat the risk as intended. Remedial action in place and residual rating has been adjusted accordingly

Date: 12/09/2019 **Matrix Zone (RAG)**
R=Red (High); A=Amber (Medium); G=Green (Low)



Operations	Risk (Threat to Achievement of Business Objective)	Root Causes (Aerodrome Responsibility)	Owner	The Risk Scored at Inherent Level			Mitigating Actions	Early Warning Indicators/Embedded Monitors	Risk Scored at Residual Level								
											Consequence						
PMIA RMU HV RISK ASSESSMENT. COMPLETE POWER FAILURE	Format: EVENT leading to CONSEQUENCE resulting in EFFECT ON BUSINESS OBJECTIVE			Likelihood	Consequence Categories	Matrix Zone (RAG)	Format: Who, What Action, How Frequent, How Evidenced	Format: Include Comment on Effectiveness	Control Rating	Likelihood	Safety	Security	Environment	Finance	Reputation & Legal	Matrix Zone (RAG)	Tolerable Region
1	HAZARD: PPL HV FAILURE & CPH GENSET FAIL TO START. SEPAMS (Contrl & Monitoring) SYSTEM U/S. OUTCOMES: 1. No power supply to all Airport. 2. Aircraft Accident/incident. 3. Aerodrome Closure. 4. Loss of business/legal action taken. 5. No aircraft landing resulting in loss. 6. Incur cost/Unbudgeted Cost. 7. Personnel/Public injuries or Death. 8. Destruction to properties/facilities. 9. Reputational Risk. 10. Public Outcry.	1. Lack of Maintenance 2. No budget allocation 3. Negligence of duty 4. Lack of management support 5. No in-house expertise 6. Lack of specialized training 7. Aging & Obsolete Equipment 8. Lack of quality control (SME) 9. Skill gap	Tech Services Tech Services Tech Services ManCom Tech Services/HR Tech Services Tech Services SARC Tech Services/HR	5	5	25	1. Maintenance Program/Implement Maintenance Programs. 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement Inspections program 5. Training/Awareness 6. Scheduled Audits	2	3	1	2	1	1	2	6A	Tolerable/Medium Risk - requires management decsion
2	HAZARD: PPL HV FAILURE & ANY SWITCH GEAR FAILS. SEPAMS (Contrl & Monitoring) SYSTEM U/S. OUTCOME: 1. No power supply to all Airport 2. Aircraft Accident/Incident 3. Aerodrome Closure 4. Loss of business/legal action taken 5. No aircraft landing resulting in loss 6. Incur cost/Unbudgeted Cost 7. Personnel/Public injuries or Death 8. Destruction to properties/facilities 9. Reputational Risk 10. Public Outcry	1. Lack of Maintenance 2. No budget allocation 3. Negligence of duty 4. Lack of management support 5. No In-house expertise 6. Lack of specialized training 7. Aging & Obsolete Equipment 8. Lack of quality control (SME) 9. Skill gap	Tech Services Tech Services Tech Services ManCom Tech Services/HR Tech Services Tech Services SARC Tech Services/HR	5	5	25	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement Inspections program 5. Training/Awareness 6. Scheduled Audits	2	3	1	2	1	1	2	6A	Tolerable/Medium Risk - requires management decsion
3	HAZARD: PPL HV FAILURE & HV CABLE FAULTY. SEPAMS (Contrl & Monitoring) SYSTEM U/S. OUTCOME: 1. No power supply to all Airport 2. Aircraft Accident/Incident 3. Aerodrome Closure 4. Loss of business/legal action taken 5. No aircraft landing resulting in loss 6. Incur cost/Unbudgeted Cost 7. Personnel/Public injuries or Death 8. Destruction to properties/facilities 9. Reputational Risk 10. Public Outcry	1. Lack of Maintenance 2. No budget allocation 3. Negligence of duty 4. Lack of management support 5. No in-house expertise 6. Lack of specialized training 7. Aging & Obsolete Equipment 8. Lack of quality control (SME) 9. Skill gap	Tech Services Tech Services Tech Services ManCom Tech Services/HR Tech Services Tech Services SARC Tech Services/HR	5	5	25	1. Maintenance Program/Implement Maintenance Programs. 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement Inspections program 5. Training/Awareness 6. Scheduled Audits	2	3	1	2	1	1	2	6A	Tolerable/Medium Risk - requires management decsion
4	HAZARD: CPH GENSETS FAIL TO START. GENSET AT BOTH NORTHERN & SOUTHERN START UP AND RUNNING. (PARTIAL FAILURE) OUTCOME: 1. No power supply to DTB & ITB facilities. 2. Flights are canelled. 3. Loss of business due to canelled flights. 4. Airlines not happy with NAC. 5. Public out cry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	3	4	12	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)		3	2	1	1	1	1	1	2G	G

PMIA RING MAIN UNIT POWER SYSTEMS

Operations	Risk	Root Causes	Owner	The Risk Scored at Inherent Level			Mitigating Actions	Early Warning Indicators/Embedded Monitors	Risk Scored at Residual Level								
	(Threat to Achievement of Business Objective)	(Aerodrome Responsibility)									Consequence						
PMIA RMU HV RISK ASSESSMENT. COMPLETE POWER FAILURE	Format: EVENT leading to CONSEQUENCE resulting in EFFECT ON BUSINESS OBJECTIVE			Likelihood	Consequence Categories	Matrix Score (RAG)	Format: Who, What Action, How Frequent, How Evidenced	Format: Include Comment on Effectiveness	Control Rating	Likelihood	Safety	Security	Environment	Finance	Reputation & Legal	Matrix Zone (RAG)	Tolerable Region
5	HAZARD: PPL HV FAILURE. CPH GENSETS HAS NO FUEL. GENSET AT BOTH NORTHERN & SOUTHERN START UP AND RUNNING. (PARTIAL FAILURE). OUTCOME: 1. No power supply to DTB & ITB facilities. 2. Close down both DTB & ITB 3. Flights are canelled. 4. Loss of business due to canelled flights. 5. Airlines not happy with NAC. 6 Public outcry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	3	4	12	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement inspections program 5. Training/Awareness 6. Scheduled Audits	3	2	1	1	1	1	1	2G	Acceptable Risk
6	HAZARD: ATS(Automatic Transfer Switch) AT NORTHERN SUBSTATION FAIL. (PARTIAL FAILURE) OUTCOME: 1. No power supply to half (50%) of AFL & Navaids. 2. Pilots will raise safety concerns. 3. Flights are canelled. 4. Reduce Reference Codes for both Aircraft & Aerodrome. 5. Loss of business due to canelled flights. 6. Airlines not happy with NAC. 7. Public outcry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	4	3	12	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement inspections program 5. Training/Awareness 6. Scheduled Audits	3	2	1	1	1	1	1	2G	Acceptable Risk
7	HAZARD: ATS(Automatic Transfer Switch) AT SOUTHERN SUBSTATION FAIL. (PARTIAL FAILURE) OUTCOME: 1. No power supply to half (50%) of AFL & Navaids. 2. Pilots will raise safety concerns. 3. Flights are canelled. 4. Reduce Reference Codes for both Aircraft & Aerodrome. 5. Loss of business due to canelled flights. 6. Airlines not happy with NAC. 7. Public outcry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	4	3	12	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement inspections program 5. Training/Awareness 6. Scheduled Audits	3	2	1	1	1	1	1	2G	Acceptable Risk
8	HAZARD: NORTHERN SUBSTATION & SOUTHERN SUBSTATION TRANSFORMERS FAULTY. (PARTIAL FAILURE) OUTCOME: 1. No power supply to half (50%) of AFL & Navaids. 2. Pilots will raise safety concerns. 3. Flights are canelled. 4. Reduce Reference Codes for both Aircraft & Aerodrome. 5. Loss of business due to canelled flights. 6. Airlines not happy with NAC. 7. Public outcry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	4	3	12	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement inspections program 5. Training/Awareness 6. Scheduled Audits	3	2	1	1	1	1	1	2G	Acceptable Risk
9	HAZARD: PPL POWER FAILURE. CPH GENSETS START UP AND RUNNING.STANDBY GENSETS FAIL TO START BOTH AT SOUTHERN & NORTHERN SUBSTATIONS. OUTCOME: 1. No power supply to half (50%) of AFL & Navaids. 2. Pilots will raise safety concerns. 3. Flights are canelled. 4. Reduce Reference Codes for both Aircraft & Aerodrome. 5. Loss of business due to canelled flights. 6. Airlines not happy with NAC. 7. Public outcry.	1. Lack of maintenance. 2. No budget allocation. 3. Negligence of duty. 4. No in-house expertise. 5. Lack of Quality Control. 6. Skill gap.	Tech Services Tech Services Tech Services Tech Services/HR SARC Tech Services/HR	3	5	15	1. Maintenance Program/Implement Maintenance Programs 2. Maintain as per Operations Manual 3. Have the proper tools to maintain/repair. 4. Adequate funding. 5. Management support. 6. Recruitment and Training of Engineers. 7. Training of Technical officers to address skill gap 8. Replace & Upgrade aging equipment. 9. Maintain Daily, Weekly ,Monthly & Annual Reports. 10. Carryout system audit as required by O&M 11. SMS Awareness (safety reporting) 12. Succession Planning (SME)	1. HQ/Tech Services to monitor and Tech Personnel to update 2. Tech Officers to report promptly on status of system to HQ/Tech Services. 3. Engineering to assist as and when required. 4. Implement inspections program 5. Training/Awareness 6. Scheduled Audits	3	2	1	1	1	1	1	2G	Acceptable Risk