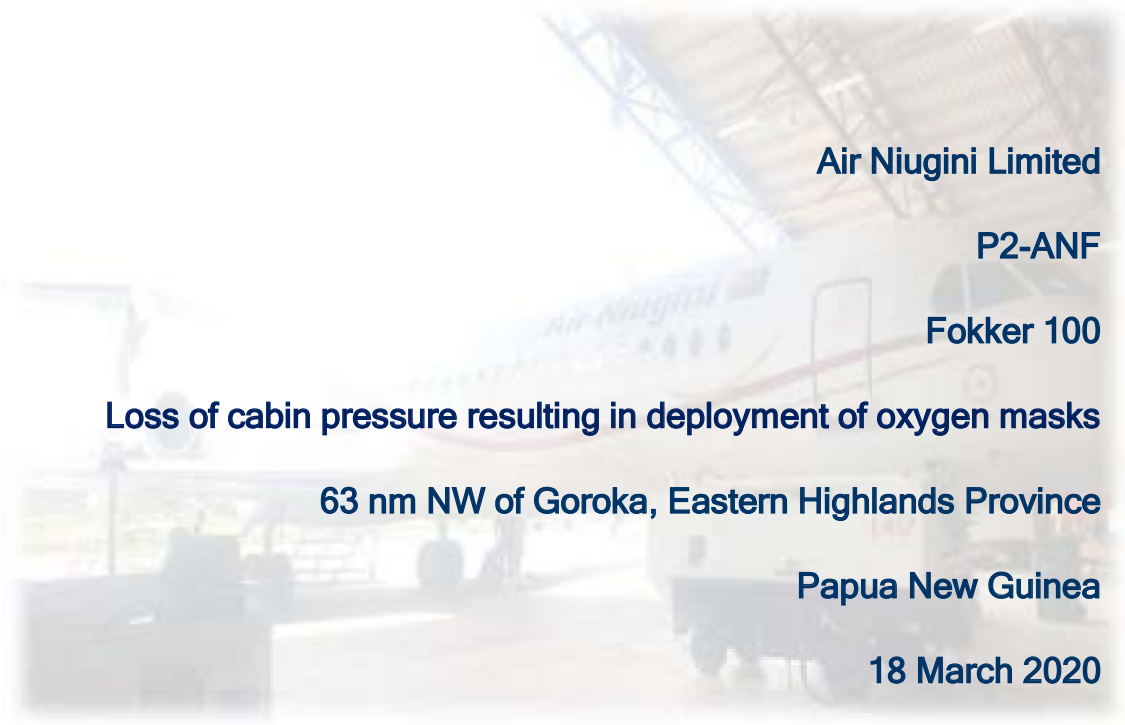
ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 20 - 2002



Air Niugini Limited

P2-ANF

Fokker 100

Loss of cabin pressure resulting in deployment of oxygen masks

63 nm NW of Goroka, Eastern Highlands Province

Papua New Guinea

18 March 2020

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

On 19 March 2020, at about 12:00 local time (02:00 UTC) the AIC was made aware about an alleged occurrence on 18 March 2020 involving a Fokker 100 aircraft, registered P2-ANF, owned and operated by Air Niugini Limited. The AIC immediately attempted establishing contact with the Civil Aviation Safety Authority of Papua New Guinea.

AIC commenced an investigation on the 19 March 2020 at 16:26, and on the next day, dispatched a team of investigators to Air Niugini Limited Maintenance facilities to commence onsite activities.

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

The report is based on the investigation carried out by the AIC under the Papua New Guinea *Civil Aviation Act 2000 (As Amended),* and *Annex 13* to the *Convention on International Civil Aviation*. It contains factual information, analysis of that information, findings and contributing (causal) factors, other factors, safety actions, and safety recommendations.

Although AIC investigations explore the areas surrounding an occurrence, only those facts that are relevant to understanding how and why the accident occurred are included in the report. The report may also contain other non-contributing factors which have been identified as safety deficiencies for the purpose of improving safety.

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

Hubert Namani, LLB
Chief Commissioner
22 November 2021

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GLOSSARY OF ABBREVIATION

AIC	**:** Accident Investigation Commission
ACP	: Air Conditioning Panel
AEP	: Aerodrome Emergency Plan
AIP	: Aeronautical Information Publication
AJTL	: Aeroplane and Journey Technical Log
ALERFA	: Alert Phase
AMD	: Aircraft Maintenance Division
AMM	: Aircraft Maintenance Manual
AMSL	: Above Mean Sea Level
ANL	: Air Niugini Limited
AOM	: Aircraft Operating Manual
AQD	: Aviation Quality Database
ARFF	: Airport Rescue and Fire Fighting Services
ATA	: Air Transport Association
ATC	: Air Traffic Control
ATPL	: Airline Transport Pilot Licence
ATS	: Air Traffic Services
AVSEC	: Aviation Security
CA	: Civil Aviation
CASA PNG	: Civil Aviation Safety Authority of Papua New Guinea
CAR	: Civil Aviation Rule
CDR	: Cabin Defect Report
CERM	: Corporate Emergency Response Manual
CC	: Cabin Crew
CC1	: Cabin Crew 1
CC2	: Cabin Crew 2
CC3	: Cabin Crew 3
CSMSM	: Corporate Safety Management System Manual
CVR	: Cockpit Voice Recorder
°C	: Degree Celsius
DMOC	: Duty Manager Operations Control
ECC	: Emergency Coordination Centre
ETA	: Estimated Time of Arrival
ETD	: Estimated Time of Departure
FAM	: Flight Administration Manual
FFCOM	: Fokker Flight Crew Operating Manual
FDR	: Flight Data Recorder
FIM	: Fault Isolation Manual
FIS	: Flight Information Services
FL	: Flight Level
FMP	: Feet per minute
ft	: Feet
FWC	: Flight Warning Computer
GM	: General Manager
HF	: High Frequency (3 000 to 30 000 kHz)
HP	: High Pressure

hPa	: hectopascal (Pressure Unit)
IAW	: In accordance with
ICAO	: International Civil Aviation Organisation
IFR	: Instrument Flight Rules
LAME	: License Aircraft Maintenance Engineer
LH	: Left Hand
LP	: Low Pressure
m	: Metres
MC	: Master Caution
MEL	: Minimum Equipment List
MFDU	: Multifunction Display Unit
MHz	: Megahertz
min	: Minutes
MTP A	: Maintenance Test Panel A
MW	: Master Warning
NAC	: National Airports Corporation
nm	: Nautical Miles
OC	: Operations Control
OOR	: Operations Occurrence Report
OPSOV	: Overpressure Shut-off Valve
PA	: Public Address
PALT	: Pressure Altitude
PF	: Pilot Flying
PIC	: Pilot in Command
PIREP	: Pilot Reports
PM	: Pilot Monitoring
PNG	: Papua New Guinea
PSI	: Pound Square Inch
QNH	: Query: Nautical Height (atmospheric pressure at sea level)
QRH	: Quick Reference Handbook
RH	: Right Hand
RPM	: Revolution Per Minute
SCC	: Senior Cabin Crew
SEPM	: Safety and Emergency Procedures Manual
SN	: Serial Number
SOPRV	: Shut-Off and Pressure Regulating Valve
SOTMV	: Shut-Off and Temperature-Modulating Valve
SSCVR	: Solid State Cockpit Voice Recorder
SSFDR	: Solid State Flight Data Recorder
UTC	: Coordinated Universal Time
VHF	: Very High Frequency
VFR	: Visual Flight Rules

INTRODUCTION

SYNOPSIS

On 18 March 2020, at 14:15 local (04:15 UTC), a Fokker 100 aircraft, registered P2-ANF, owned and operated by Air Niugini Limited, while on a scheduled passenger flight under instrument flight rules from Boram Airport, Wewak, East Sepik Province to Jacksons International Airport, Port Moresby, National Capital District, sustained a loss of cabin pressure, resulting in an emergency descent and deployment of oxygen masks. The aircraft diverted and landed at Madang Airport, Madang Province.

There were five crew: two pilots and three cabin crew, and 43 passengers on board the aircraft.

Following an earlier flight on the day of the occurrence, the aircraft had undergone unscheduled maintenance in relation to the bleed system, and after it was released to service, the flight in which the occurrence took place was conducted.

The aircraft departed Boram at 13:55 with a planned cruising altitude of 35,000 ft.

The crew reported that shortly after take-off, they noticed the *No.1 engine bleed fault* light illuminate on the overhead panel. They switched the No. 1 engine bleed off and back on. The fault did not recur, and the crew decided to continue the flight.

At 14:07, as the aircraft was climbing through about 23,000 ft the crew contacted Moresby Centre and requested for a 15 nm deviation left and right of track due to weather. Moresby Centre authorised the request. The crew initiated the deviation to the left.

At 14:07:36, while passing 28,900 ft, the aircraft reportedly entered cloud. The PIC activated the aircraft's engine anti-icing system, which remained activated for 28 seconds until it was manually deactivated by the PIC as they came out of cloud.

About 6 seconds after the engine anti-icing deactivated, a Master Caution indication was triggered. The crew also noticed fault lights relating to the bleed system, along with the activation of the Master Caution alert. The crew donned their oxygen masks and commenced *Double Bleed Fault* procedure, as the PIC levelled off the aircraft.

About 25 seconds after the Master Caution alert activation, the aircraft levelled off at about 30,000 ft and maintained that altitude for about 40 seconds, as the crew continued actioning the checklist items.

The PIC reported that shortly after they levelled off, he initiated a rapid descent to control the cabin pressure, as he observed an increasing rate of cabin altitude. The crew reported they switched off the No. 1 and No. 2 engine bleed systems.

While descending past 29,300 ft, the *Excessive Cabin Altitude* warning activated along with the *Master Warning* alert. The crew reported that they switched on the fasten seatbelt/no smoking sign, and advance to an emergency descent. The copilot reportedly made the emergency descent PA then manually activated the passenger oxygen masks. The crew proceeded with actioning *Emergency Descent* procedure.

While passing through 24,000 ft, the PIC broadcast a PAN and advised Moresby Centre of the emergency descent.

While passing 18,900 ft, the crew advised Moresby Centre that they were 63 nm from Goroka. Moresby Centre acknowledged and instructed the crew to advise when operations returned to normal. Moresby Centre Controller subsequently declared an emergency alert phase on P2-ANF.

When the aircraft reached 10,000 ft, the crew levelled off. The crew reported that they contacted Madang Tower and advised on their intentions to maintain 10,000 ft and requested to track to Madang and hold overhead. Madang Tower authorised the request and advised the crew to expect a normal approach and landing. Madang Tower subsequently notified Airport Rescue Fire Fighting services to be on standby at the aerodrome.

The crew reportedly removed their oxygen masks upon observing the *Excessive Cabin Altitude* warning lights go off.

The aircraft maintained a holding pattern for approximately 11 minutes as the crew reportedly reviewed the Quick Reference Handbook checklist items and subsequently, switched back on the No. 1 and No. 2 engine bleed systems, they observed a normalcy with the bleed systems. The flight crew provided a brief to the cabin crew, on the emergency and their intentions. The cabin crew then carried out their follow-up duties while the flight crew referred to and completed the *Manual Cabin Pressurisation Control* checklist items to adjust cabin pressure prior to landing.

P2-ANF landed at 14:46 and taxied to the parking bay where a normal disembarkation was conducted for all passengers and crew. There were no injuries or damage reported.

Madang ARFF stood down their services after they escorted the aircraft from the taxiway to the parking bay and the aircraft engines were completely shut down.

ATC emergency alert phase was cancelled at 14:50 by Moresby Centre Supervisor.

The occurrence was due to defective components in the aircraft's bleed system.

1 FACTUAL INFORMATION

1.1 History of the flight

On 18 March 2020, a Fokker 100 aircraft, registered P2-ANF and operated by Air Niugini Limited, was on a scheduled IFR[1] passenger flight from Boram Airport, Wewak, East Sepik Province to Jacksons International Airport, Port Moresby, National Capital District, when, at 14:15 local (04:15 UTC[2]), a cabin depressurisation event occurred. The aircraft subsequently diverted and landed at Madang Airport, Madang Province.

Figure 1: Depiction of the flight path from Boram to Madang.

The Pilot in Command (PIC) was the designated pilot flying while the copilot was the pilot monitoring.

The PIC, during interview, stated that after take-off from Boram, they noticed the *No.1 engine bleed fault* light illuminate on the overhead panel. They reset the No. 1 engine bleed system as required by the *Fokker 100 Quick Reference Handbook (QRH) Bleed Fault* checklist (See *Appendix A, 5.1.1*). The fault light did not reappear. The crew decided to continue the flight as planned.

The planned cruise altitude was FL350 (35,000 ft) and an initial track of 141º to Port Moresby via MUDIX[3].

1 Instrument Flight Rules: applied in cloud or whenever external cues are below Visual Flight Rules (VFR) minima which prohibit non-IFR pilots/aircraft. Source: *The Cambridge Aerospace Dictionary*.

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

3 Five letter waypoint: previously GOROKA NDB 'GA' decommissioned and amended to MUDIX on 07 November 2019 SOURCE: *AIP SUPPLEMENT AMENDMENT 6.*

Air Traffic Control (ATC) recordings showed that at about 14:07, the crew called Moresby Centre and requested for a deviation up to 15 nm left and right of track due to weather. Moresby Centre cleared P2-ANF to deviate left and right of track. The aircraft began deviating towards the left at about 23,000 ft.

The FDR data showed that at 14:13:17, while passing through 28,900 ft, both engine anti-icing[4] systems were activated. PIC confirmed during interview that he activated the aircraft's engine anti-icing systems as part of their standard procedure (See *Appendix A, 5.1.2*), as the aircraft encountered cloud.

As per the FDR data and the information provided by the PIC during his interview, at 14:13:36, while climbing through 29,100 ft, the PIC deactivated both engine anti-icing systems when they cleared cloud.

According to the crew, as the aircraft continued climbing the engine *No.1 engine bleed fault* light illuminated on the overhead panel, followed about 3 seconds later by the *No. 2 engine bleed fault* light accompanied by the Master Caution[5] (MC). The FDR data showed that at 14:13:42, as the aircraft reached about 29,200 ft, the MC activated. The crew stated during interview that immediately after the *double bleed fault* and MC activation, the Multifunction Display Unit (MFDU) displayed instructions identical to the *QRH Double Bleed Fault* checklist (See *Appendix A, 5.1.1*). The crew stated that they immediately donned their oxygen masks as the PIC levelled off the aircraft.

According to the FDR data, the aircraft levelled off at 14:14:17, maintaining an altitude of about 30,000 ft and at 14:14:56 commenced a rapid descent. During interview, the PIC stated that he initiated a rapid descent to control the cabin pressure, as the cabin rate of change indicator showed a cabin altitude increase rate of 2,000 FPM[6]. He also stated that as they descended, he turned the aircraft left towards the coastal area to avoid the higher ground, which was around Mt. Wilhelm area, Chimbu Province.

The copilot reported during interview that as they continued descent, the PIC switched off both engine bleed systems to reset them but, before the PIC switched them back on, the *Excessive Cabin Altitude* warning activated along with the Master Warning[7] (MW) alert. The FDR data indicated that the MW activated at 14:15:34, while descending through 29,300 ft. The crew recalled observing the cabin altitude indicator reading more than 14,000 ft and that, subsequently, the Excessive Cabin Altitude procedure was shown on the MFDU (See *Appendix A 5.1.3* for QRH checklist*)*. The procedure required the crew to don their oxygen masks and establish communication which they had actioned earlier as part of the MFDU *Double Bleed Fault* procedure.

According to the statements of the crew, the PIC immediately switched on the fasten seatbelt/no smoking sign and commenced an emergency descent while the copilot made the emergency descent public announcement (PA) and activated the passenger oxygen manual override *(PAX OXY MAN OVRD)*.

The crew stated that they actioned the MFDU Emergency Descent procedures (Refer to *Appendix A 5.1.3* for QRH checklist*)*. The FDR data indicated that at 14:15:36, while the aircraft was descending through 29,200 ft the thrust levers were set to idle, and at 14:15:37, the speed brake was retracted.

4 The engine anti-icing system uses hot engine bleed-air to give protection from ice on the engine intakes. Two identical systems are installed on Fokker 100, Left for Engine No. 1, and Right for Engine No. 2. SOURCE: *FOKKER 100 AIRCRAFT MAINTENANCE MANUAL.*

5 Annunciation of level 2 alerts which requires immediate pilot awareness and subsequent corrective or compensatory action.

6 Feet per minute.

7 These are red flashing lights used as ATTENTION GETTERS. Together with aural signals, they enable the flight crew to detect failures which require immediate crew action.

During their interviews, the cabin crew stated that they were carrying out inflight services when the fasten seatbelt/no smoking sign illuminated. A few seconds later, they felt the aircraft suddenly entered a rapid descent as the copilot made the emergency descent PA. The cabin crew secured all service equipment and took up their seats around the time the oxygen masks deployed in the cabin.

According to the information gathered in the investigation, at 14:16:30, as the aircraft passed 24,000 ft, the PIC declared a PAN and reported to Moresby Centre that they were descending to 16,800 ft.

The PIC called Moresby Centre again at 14:17:18 and advised that they were 63 nm from MUDIX, on descent. Moresby Centre acknowledged and instructed the crew to advise when operations returned to normal.

ATC recordings indicated that at about 14:19, Moresby Centre advised Madang FIS that the crew of P2-ANF had broadcast a PAN during an emergency descent. Moresby Centre then instructed Madang FIS to advise all traffic in their area of responsibility. Madang FIS advised Moresby Centre that there was no traffic and requested Moresby Centre to maintain communication with the crew. Moresby Centre acknowledged and subsequently declared the Alert Phase (ALERFA) on P2-ANF.

The crew continued the descent until reaching 10,000 ft, where they levelled off the aircraft. They initially opted to track to Nadzab Airport but, after assessing the weather conditions around that area, they opted for a diversion to Madang.

The crew stated that they contacted Madang Tower and advised that they had conducted an emergency descent and that at that time they were maintaining 10,000 ft. They requested to track to overhead Madang and further requested for traffic information. The crew stated that they were cleared to track to Madang as requested and to expect a normal approach. Madang Tower subsequently notified Airport Rescue Fire Fighting (ARFF) services to be on standby at the aerodrome.

The FDR data indicated that at 14:22:38, the *Excessive Cabin Altitude* warning deactivated. The crew stated during interview that after the *Excessive Cabin Altitude* warning went off, they removed their oxygen masks and, subsequently, they referred to the *QRH* and conducted a follow up review on the relevant checklists that were displayed on the MFDU during the emergency phase of the flight, and completed the remaining items on the *Emergency Descent* procedure and then reverted to the *Double Bleed Fault* procedure at which point they switched back on both engine bleed systems.

According to the FDR data, the aircraft was established overhead Madang at 14:28:11. The crew subsequently flew two holding patterns. The crew confirmed that they conducted a NITS[8] briefing with the cabin crew and advised the cabin crew to carry out their *follow up*[9] duties. They also stated that they completed the *QRH Manual Cabin Pressurisation Control Procedures* (See *Appendix A 5.1.4*).

The cabin crew reported that they checked the lavatory and passengers and reported back to the PIC that there were no injuries to the passengers. The cabin crew stated that the PIC then made a PA to passengers informing them that the flight would divert to Madang.

After completing the second holding pattern, at 14:39:39, the aircraft commenced a normal descent tracking South, then turned right about 9 nm from Madang Airport to intercept the approach path for runway 07. The aircraft established on the approach path for landing at an altitude of 1,233 ft.

The crew subsequently configured the aircraft, extended flap, and extended landing gear at 14:44:40.

The flight crew conducted the approach and landed at 14:46. After landing, the flight crew vacated runway and taxied to the parking bay, where all passengers and crew reportedly disembarked normally.

8 Provided by the PIC to the SCC on the Nature of emergency, intended plan, time available and special instructions, during an emergency.

9 Cabin crew duties to be performed following a depressurisation event (Refer to *Appendix B, 5.2.1*).

ARFF stood down their services after they escorted the aircraft from the taxiway to the parking bay and the aircraft engines were shut down.

According to records provided by ATC the emergency alert phase was cancelled at 14:50 by Moresby Centre Supervisor.

The flight crew informed AIC in an interview that they disembarked the passengers when they landed in Madang. They then notified their Engineering division in Port Moresby about the incident, and were advised by the Engineering Division to fly the aircraft to Port Moresby. The flight crew flew the aircraft back to Port Moresby with only the passengers' baggage while the cabin crew remained with the passengers in Madang as they (cabin crew) were not comfortable operating the aircraft to Port Moresby.

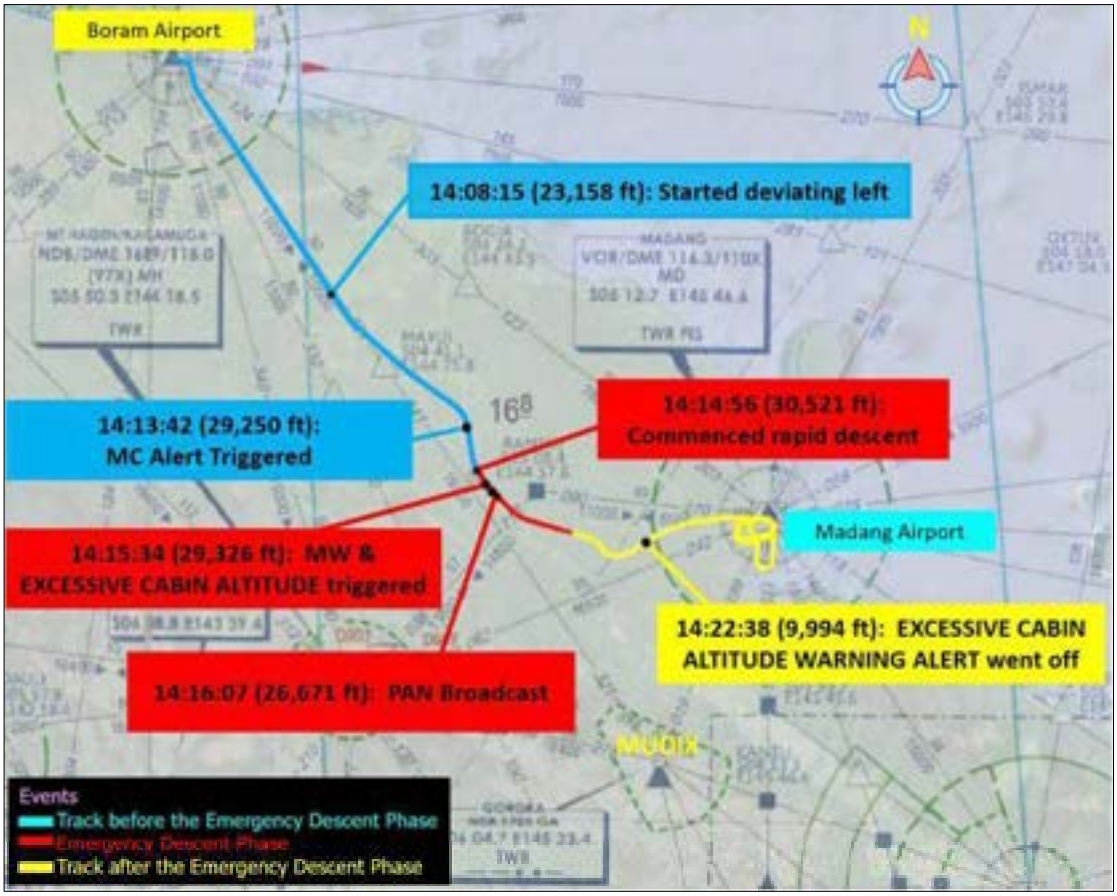


Figure 2: Depiction of the flight path from Boram to Madang with the events.

1.2 Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	5	43	-	Not applicable
TOTAL	5	43	48	-

Table 1: Injuries to persons

1.3 Damage to aircraft

There was no damage sustained by the aircraft as a result of this occurrence.

1.4 Other damage

Not applicable.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 39
Gender	: Male
Nationality	: Papua New Guinean
Type of license	: ATPL
Route competency check valid to	: 2 June 2020
Type rating	: Fokker 70/ 100
Total flying time	: 11,936.30 hours
Total hours in command	: 9,404.00 hours
Total hours on type	: 4,976.00 hours
Total hours last 30 days	: 60.70 hours
Total hours last 7 days	: 16.90 hours
Total hours last 24 hours	: 3.40 hours
Hours on duty prior to occurrence	: 3.00 hours
Hours off duty prior to this duty	: 21.00 hours
Medical class	: One
Valid to	: 2 September 2020
Medical limitation	: Nil

The PIC stated during interview with the AIC that he had about twenty years of experience as a pilot. The personal records of the PIC showed that he was employed by Air Niugini Limited on 09 September 2007. The PIC's training records showed that his recent *Safety and Emergency Procedures* recurrent

training was revalidated on 03 March 2020 and was valid to 06 March 2021.

1.5.2 Copilot

Age	: 36
Gender	: Male
Nationality	: Papua New Guinean
Type of license	: CPL
Route competency check valid to	: 3 September 2020
Type rating	: Fokker 70/100
Total flying time	: 4,993.40 hours
Total hours on type	: 1,876.50 hours
Total hours last 30 days	: 49.10 hours
Total hours last 7 days	: 10.60 hours
Total hours last 24 hours	: 2.20 hours
Hours on duty prior to occurrence	: 9.00 hours
Hours off duty prior to this duty	: 11.00 hours
Medical class	: One
Valid to	: 5 October 2020
Medical limitation	: Vision correction

The copilot stated that he had more than eight years of experience as a pilot. The personal records of the copilot showed that he was employed by Air Niugini Limited on 06 June 2011. The copilot's training records showed that his recent *Safety and Emergency Procedures* recurrent training was revalidated on 21 January 2020 and was valid to 31 January 2021.

1.5.3 Senior Cabin Crew[10]

Age	: 26
Gender	: Female
Nationality	: Papua New Guinean
Position	: Cabin Crew 1 (one)
Annual competency checks valid to	: 15 May 2020
Type rating	: Fokker 100/70
Total flying time	: 2,217.80 hours
Total hours last 90 days	: 250.90 hours
Total hours last 7 days	: 24.27 hours
Total hours last 24 hours	: 7.23 hours

The personal records of the SCC showed that she had over three years of experience as a cabin crew. The training records of the SCC indicated that her recent *Safety and Emergency Procedures* recurrent training was revalidated on 08 October 2019 and was valid to 21 April 2020.

On the occurrence flight, the SCC occupied the forward crew station.

10 In-charge cabin crew member. *ICAO Doc 10062* definition: Cabin crew leader who has overall responsibility for the conduct and coordination of cabin procedures applicable during operations and during abnormal and emergency situations for flights operated with more than one cabin crew member.

1.5.4 Cabin Crew 2

Age	: 30
Gender	: Female
Nationality	: Papua New Guinean
Position	: Cabin Crew 2 (two)
Annual competency checks valid to	: 24 June 2020
Type rating	: Fokker 100/70
Total flying time	: 3,527.67 hours
Total hours last 90 days	: 218.05 hours
Total hours last 7 days	: 16.30 hours
Total hours last 24 hours	: 7.53 hours

The personal records of the CC2 showed that she had over five years of experience as a cabin crew. The training records of the CC2 showed that her recent *Safety and Emergency Procedures* recurrent training was revalidated on 12 November 2019, and valid to 29 May 2020.

On the occurrence flight, the CC2 occupied the mid crew station adjacent to Door 4 Left (4L). However, at the time of the occurrence, she occupied row 2, seat Bravo (2B). Refer to Figure 8.

1.5.5 Cabin Crew 3

Age	: 27
Gender	: Female
Nationality	: Papua New Guinean
Position	: Cabin Crew 2 (two)
Annual competency checks valid to	: 7 February 2020
Type rating	: Fokker 100/70
Total flying time	: 2,049.23 hours
Total hours last 90 days	: 222.17 hours
Total hours last 7 days	: 20.10 hours
Total hours last 24 hours	: 5.39 hours

The personal records of the CC3 showed that she had over three years of experience as a cabin crew. The training records of the CC3 showed that her recent *Safety and Emergency Procedures* recurrent training was revalidated on 17 March 2020, and valid to 21 October 2020.

On the occurrence flight, the CC3 occupied the aft crew station.

1.6 Aircraft Information

1.6.1 Aircraft data

Aircraft manufacturer	: Fokker
Model	: Fokker 100
Serial number	: 11351
Year of manufacture	: 1991

Total airframe hours	: 50,951.37
Total airframe cycles	: 52,461.00
Registration	: P2-ANF
Certificate of Registration number	: 009
Certificate of Registration issued	: 1 March 2019
Name of the owner	: Air Niugini Limited
Name of the operator	: Air Niugini Limited
Certificate of Airworthiness number	: 009
Certificate of Airworthiness issued	: 1 March 2019
Certificate of Airworthiness valid to	: Non terminating

1.6.1.1 *Engine data*

Engine type	: Turbofan
Year of Manufacture	: 1995
Manufacturer	: Rolls-Royce
Model	: 620-15

No. 1 engine (Left)

Serial number	: 17235
Total time since new	: 43,212.13 hours
Cycles since new	: 38,860.00

No. 2 engine (Right)

Serial number	: 17359
Total time since new	: 50,477.59 hours
Cycles since new	: 51,143.00

1.6.1.2 *Minimum Equipment List*

There was no outstanding Minimum Equipment List (item) at the time of the flight.

1.6.1.3 *Fuel information*

The investigation determined that fuel was not a contributing factor to the serious incident.

1.6.2 Aircraft Systems

1.6.2.1 *Bleed Air System*

According to the manufacturer's *Maintenance Manual*, the bleed air system supplies regulated pressure and temperature from the engines to different aircraft systems for air conditioning, pressurisation and anti-icing, and other functions.

As graphically described in Figure 3, bleed air travels to the different aircraft systems through ducting from the engine's Low Pressure (LP) and High-Pressure (HP) compressors. The LP compressor supplies bleed air when power levers are set to engine power higher than 80% N2[11] RPM. During low RPM operation, or when anti-icing system is in use, a Shut-Off and Temperature-Modulating Valve (SOTMV) connected to the HP compressor section lines opens allowing bleed air from the HP compressor.

During the operation of the anti-icing system, the SOTMV switches to the temperature modulating mode and operates in response to changes in bleed air. Before bleed air flows upstream, it is regulated enough to flow within the limit to meet the intended design purpose of the aircraft bleed system. The Shut-Off and Pressure Regulating Valve (SOPRV) brings the pressure of the bleed air supply flowing upstream to a range of 51 to 57 psi in accordance with design specifications.

The Overpressure Shut-off Valve (OPSOV) allows bleed-air supply pressure between 67.5 and 72.5 psi and protects the system from over-pressurisation if the SOPRV fails in the open position. The pressurised (regulated) bleed air reaches the manifold where it is available to the anti-icing, air conditioning and pressurisation system.

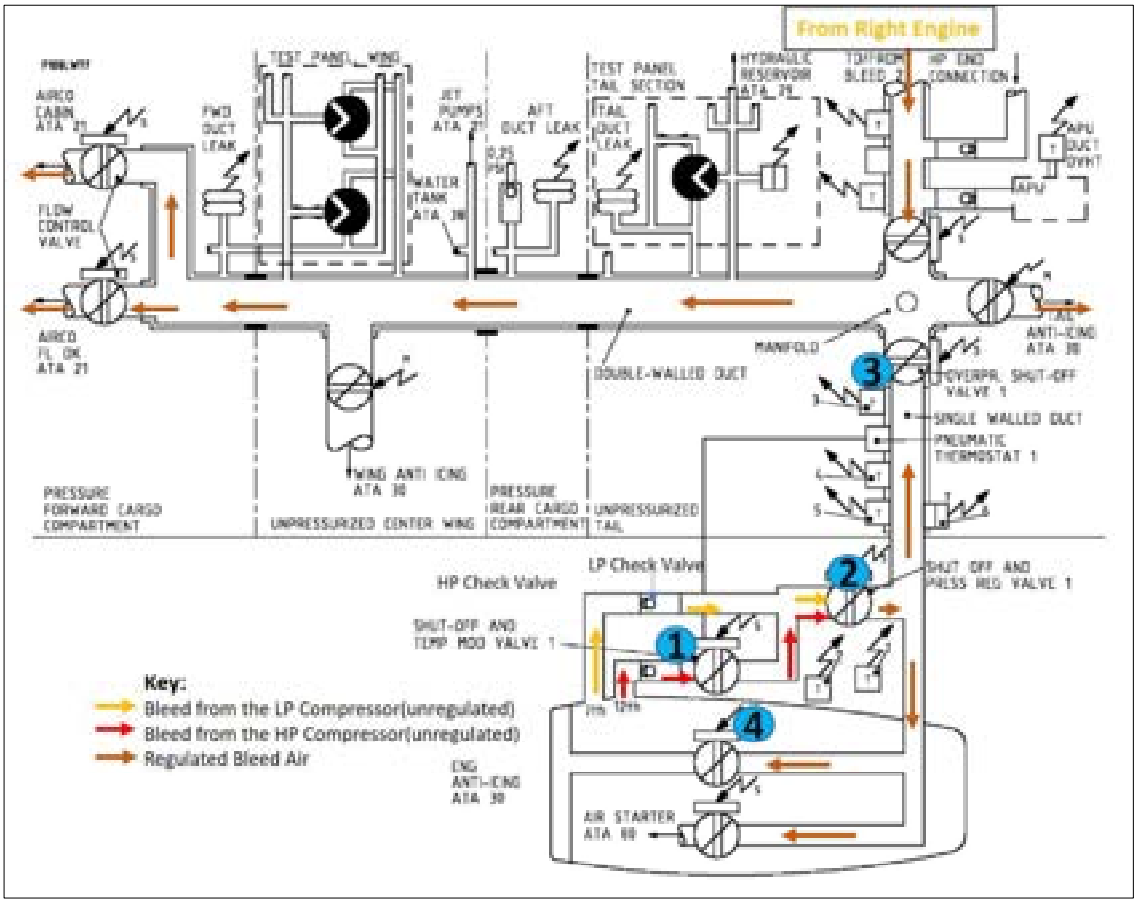


Figure 3: Bleed air schematics for No. 1 engine.

When the flight crew select the engine anti-icing on each of the engines, the engine anti-icing SOPRV opens, and the bleed air then enters it and into the leading edge of the nose cowl to remove ice and frost.

11 N2 - In a two spool axial flow jet engine, N2 refers to the rotational speed of the high speed spool which consists of the high pressure compressor and the high pressure turbine.

1.6.2.1.1 Flight Warning System

The bleed air system has its warning system that responds to faults occurring within the bleed system. Sensors identify when these faults are associated to the valves SOTMV, OPSOV or SOPRV, and send electrical signals to the flight warning computer (FWC), and from there to the overhead cockpit panel as *BLEED 1 FAULT* or *BLEED 2 FAULT*, as appropriate, accompanied with an alert message to the MFDU and an aural warning.

Specifically, during engine anti-icing activation, control sensors manage the SOTMV, allowing bleed air from the HP compressor to be supplied through the ducting system to the aircraft at a temperature of more than 265 degrees Celsius. If temperature reaches more than 300 degrees Celsius, the contacts in the primary overheat bi-metallic switch would close and send an electrical signal to the temperature-modulating control relay and the duct overheats relay to close the SOTMV and SOPRV respectively which will send *BLEED SYS 1 FAULT* or *BLEED SYS 2 FAULT* alert signals to the FWC, indicated by an amber light displayed on the overhead panel as *BLEED 1 FAULT* or *BLEED 2 FAULT*.

1.6.2.2 *Engine anti-icing*

Engine bleed air is used for engine, wing, and tail anti-icing. Anti-icing controls are located at the ANTI-ICING panel.

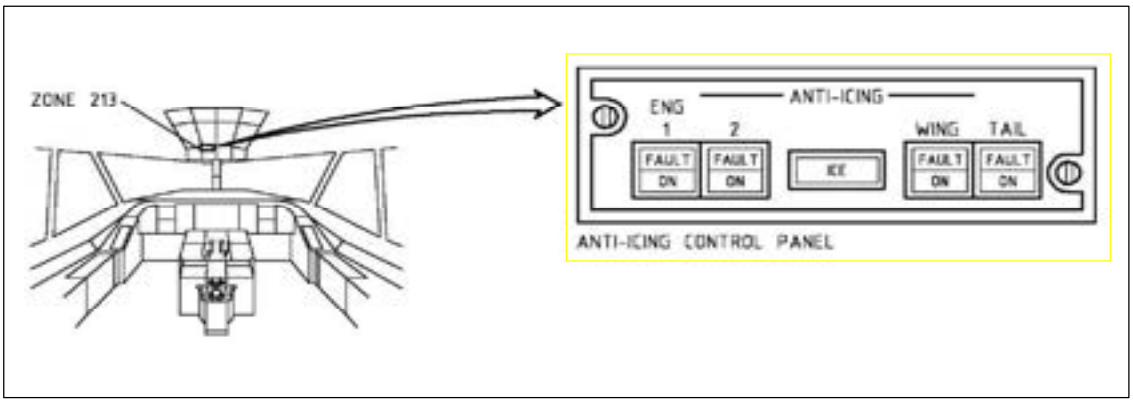


Figure 4: Anti - icing panel

The engine anti – icing system includes the pressure regulator and shut-off valve (PRSOV) and ducting. The PRSOV installed on each engine controls the flow of engine bleed-air to the engine air intake and keeps the flow of bleed-air at a constant pressure.

When engine anti-icing is turned on, the PRSOV is opened, provided the engine is running and bleed-air pressure is sufficient. Pressure regulated bleed air is now routed through the nacelle leading edge. Low pressure will be detected, and an alert presented to the FWC. The air that is discarded from the nacelle flows back into the engine, thus providing anti-icing for the air intake.

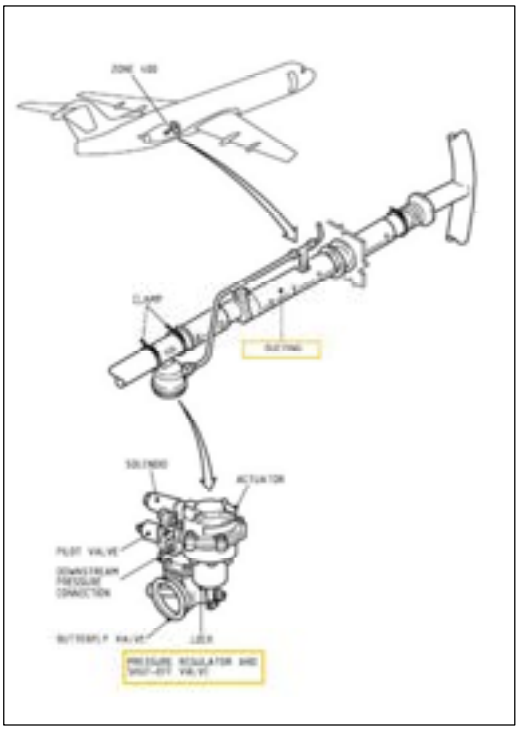


Figure 5: Engine anti-icing components

1.6.3 Defect

1.6.3.1 *Bleed System*

According to the Operator's post-occurrence maintenance records[12] , the right and left hand SOTMV and left hand SOPRV were found to be faulty and were subject to troubleshooting and replaced.

1.6.3.2 *Passenger oxygen masks*

During interview, the cabin crew reported that about 12 passenger oxygen masks came loose when pulled on, and oxygen units at row seats 9 EFG, 14 EFG and 21 AB did not deploy/open. The SCC stated that these defects were not recorded in the cabin defect report form (See *Appendix B, 5.2.2*). The SCC also stated that the defect was included in her operations occurrence report (OOR) form[13] to the safety department and a copy attached to the voyage report[14] for cabin crew department.

The investigation found that these defects were not recorded on the *Aircraft Journal Technical Log (AJTL) 5790* and there were no records of maintenance actions taken to rectify them (Refer to *Section 1.17.4*).

12 Refer to *Section 1.18.4 Operator's Post-Occurrence Maintenance.*

13 The Operator's occurrence reporting form, accepted by CASA PNG and meets the requirements of CAR Part 12 requirements SOURCE: *AIR NIUGINI CORPORATE SAFETY MANAGEMENT SYSTEM MANUAL.*

14 Completed daily after each flight by the SCC and forwarded to the Manager Cabin Crew, who addresses issues accordingly and provide feedback where necessary SOURCE: *AIR NIUGINI CABIN CREW ADMINISTRATION MANAUAL.*

1.6.4 Recurring Defects

In the review of the AJTL by the AIC it was identified that recurring defects[15] involving the Bleed Air System occurred between September 2019 and the date of the occurrence.

Between the period 18/09/19 to 23/09/19- AJTL J 9966, J 9970, J 9976, J 9979, J 9981, J 9982

Between the period 25/09/19 to29/09/19- AJTL J 9985, J 9988, J 9994

Between the period 16/11/19 to 22/11/19-AJTL K 0085, K 0093, K 3603

Between the period 11/03/20 to 16/03/20-AJTL K5777, K 5782, K 5786.

The investigation also reviewed the quarterly reliability reports of 2019 and found that in the 2nd quarter of 2019 ATA 36-Pneumatic Systems was in the top 5 ATA delays and cancellations for F70/Fl00 Fleets.

According to the AJTL K5789, earlier on the day of the occurrence, there was one unscheduled maintenance action carried out on the aircraft regarding Bleed 1 fault on take-off from Goroka (see Table 2).

AJTL No. /Item	Defect Date	Defect	Action	Released to service date
K 5789/1	18/03/20	FOR INFOR BLEED 1 FAULT ON TAKEOFF. PROC ACTIONED & CLEARED	INFOR NOTED WITH THANKS - RESET SATISFACTORY - NIL FAULTS. MONITOR & REPORT, REFER MM 36-11-00	18/03/20

Table 2: Unscheduled maintenance recorded on AJTL 5789 Item 1.

The LAME 1[16] stated during interview that he attended to the defect as reported on the AJTL when the aircraft arrived in Port Moresby from Goroka. He commenced troubleshooting; set the No.1 engine power to idle and turned the aircraft bleed system and MFDU on to check if the fault would recur. He confirmed that there was no fault observed. He then turned on the pneumatically operated systems; anti-icing, air conditioning and pressurization system, and pulled the Bleed 1 and Bleed 2 circuit breakers while pressing the Bleed 1 and 2 switches on the air-conditioning panel. He confirmed that he still did not observe any bleed system related faults. He therefore released the aircraft back to service.

About a month after the occurrence, on 26 April 2020, two SOTMVs and one SOPRV were replaced, and a functional test was carried out. The aircraft was released back to service on 29 April 2020, after a return to service check and a post defect rectification verification flight were conducted.

15 A defect that occurs three times or more in seven days and require special attention and technical expertise until they are rectified permanently (Maintenance Control Manual, Volume 1, Section 2.11.3.3).

16 License Aircraft Maintenance Engineer: See *Appendix C,5.3.1* for LAME 1 personal information.

1.7 Meteorological information

The TAF[17] for Madang was issued by PNG National Weather Service and was in effect on the day of the serious incident between 12:00pm, 18 March 2020 – 12:00 am 19 March 2020:

Wind	: 90 degrees at 10 knots
Weather	: Clear visibility with light showers and rain, scattered clouds at 1,600 feet, scattered clouds at 3,000 feet and broken clouds at 12,000 feet.
INTER	: intermediate weather expected between 02:00 – 14:00 UTC (12:00, 18 March 2020 – 00:00 am 19 March 2020) is reduced visibility to 4 km, heavy showers and rain and broken clouds at 800 feet.
Air Pressure	: 1012, 1010, 1011 and 1013 hPa respectively (three-hour interval between 02:00 – 14:00 UTC on 18 March 2020 -) (three-hour interval between 12:00, 18 March 2020 – 00:00 19 March 2020).

1.7.1 Pilot observation

The PIC stated during interview that when they had passed MAIYU[18], which is about 80 nm SE of Wewak, he looked ahead of their track and saw cloud build up to 40,000 ft, about 90 nm from Wewak all the way to overhead Goroka and slightly beyond. Consequently, the crew requested diversion of 15 nm left and right of the track to avoid the weather.

1.8 Aids to navigation

Ground-based navigation aids, on-board navigation aids, and aerodrome visual ground aids and their serviceability were not factors in this serious incident.

1.9 Communications

The aircraft was fitted with both VHF and HF systems. All communication was conducted on the VHF.

All communication between the crew of P2-ANF and the Air Traffic Services (ATS) was recorded by ground based automatic voice recording equipment. All relevant audio recordings were retrieved for the investigation.

According to the audio recording, the communication was readable throughout the flight and emergency.

1.10 Aerodrome information

Name of aerodrome	: Madang Airport
Location indicator	: AYMD
Airport operator	: National Airports Corporation (NAC)
Runway 07 dimension	: 1, 570 m x 30m
Runway 25 dimension	: 1, 570 m x 30m
Latitude	: 5°12'30.00"S
Longitude	: 145°47'15.60"E
Elevation	: 18 ft (5.5 m)

17 Terminal Area Forecast.

18 Five letter waypoint indicator.

Aeronautical Information Publication (AIP), states that Madang Airport has a Category 6 Rescue and Fire Fighting service available and has two fire tenders on stand-by at the station. The operational hours begin at 06:30 and ends at 17:30.

1.11 Flight recorders

The aircraft was fitted with a solid-state cockpit voice recorder (SSCVR) and a separate solid-state flight data recorder (SSFDR).

The FDR identifying information:

- Manufacturer: Honeywell
- Model: SSFDR
- Part Number: 980 – 4120 – DXUS
- Serial Number: 10629
- Recording Duration: At least 25 hours

The CVR identifying information:

- Manufacturer: Honeywell
- Model: SSCVR
- Part Number: 980 – 6022 – 001
- Serial Number: 0385
- Recording Duration: At least 2 hours

The SSCVR was manufactured by Honeywell, with 5 input channels of cockpit audio as; Command, First Officer, Passenger Address (PA), Cockpit Area Microphone (CAM) and a Mixed Band (MB) which was a combination of the channels Command, First Officer and PA. The MB and the CAM had a recording capacity of about 120 minutes while the other three channels had a recording capacity of about 30 minutes.

The SSCVR and SSFDR were downloaded by AIC on 19 March 2020. The analysis of the data showed that since the Master Caution activation in-flight until the shut-down of the aircraft at Madang Airport, the time was about 36 minutes. However, this portion was not available in the SSCVR data retrieved as the subsequent operations to ferry the aircraft back to Jacksons International Airport and the maintenance activities conducted afterwards exceeded the maximum recording time and overwrote that data.

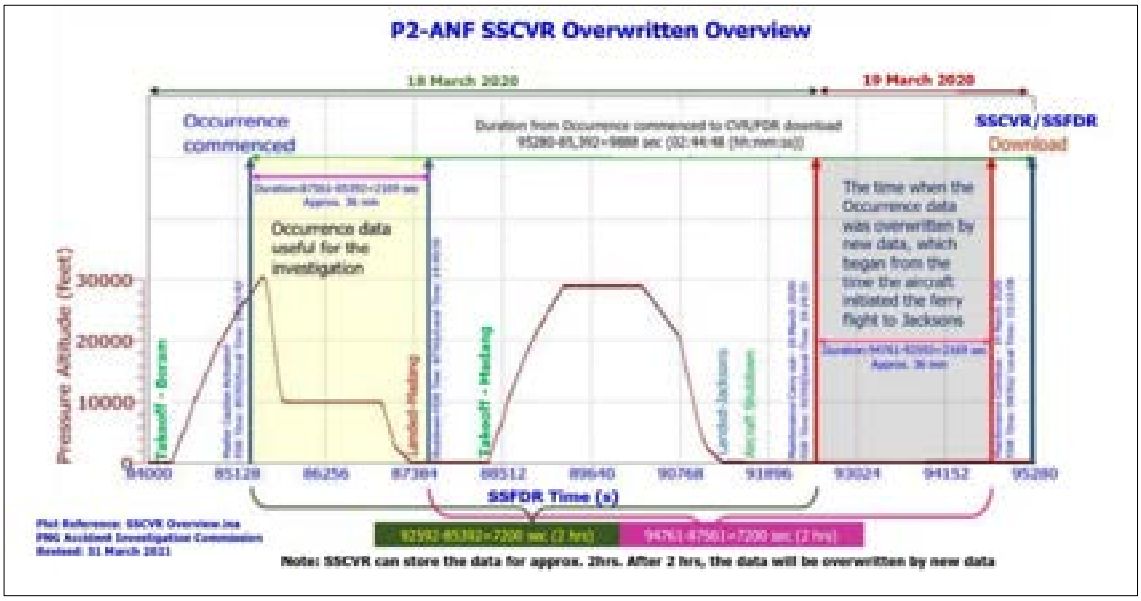


Figure 6: Overview of the SSCVR being overwritten.

The SSFDR was downloaded during the investigation by AIC on 19 March 2020. The relevant parameters for this occurrence are shown in Figure 7.

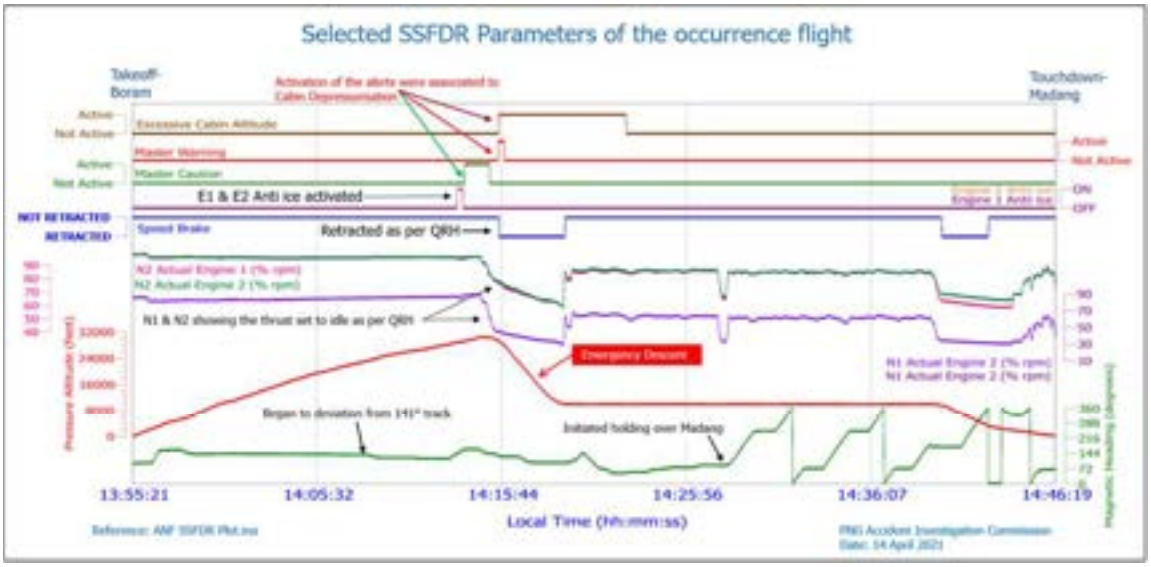


Figure 7: P2-ANF SSFDR overview.

Apart from the parameters presented in the previous figure, the AIC also derived the estimate latitude and longitude which were used to recreate the aircraft's landing roll and taxi.

1.12 Wreckage and impact information

Not applicable.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 Cabin

During interview, the cabin crew stated that they were conducting their inflight cabin services when the flight crew switched on the fasten seatbelt/no smoking sign. They assumed it was a signal for expected turbulence. The CC2 stated that she made a PA to passengers regarding turbulence and then continued with inflight duties.

The CC3 reported that she was at row 15 when she began feeling her ears block and throat dryness. A few seconds later, CC3 observed the fasten seatbelt sign illuminate and heard the PA made by the CC2.

The cabin crew reported that they felt the aircraft suddenly commence a gradual descent. They recalled the copilot making an emergency PA;

"Attention! Attention! Emergency Descent."

The SCC stated upon hearing the PA, she immediately took up her seat at the forward crew station in time to see the oxygen masks deploy in the cabin. The CC3 stated that she quickly took the cart to the rear galley area where she stowed it away before the oxygen masks deployed. She quickly checked the lavatories, took up her crew seat and donned her oxygen mask. The CC2 reported that she quickly stowed away and secured all carts and catering equipment at the forward galley, then occupied row 2, seat Bravo (2B) and donned her oxygen mask.

The SCC and CC3 reported that some passengers were unsure of how to activate the oxygen masks, therefore they used hand gestures to indicate to these passengers on how to pull down and wear their oxygen masks. The passengers subsequently donned their oxygen masks.

CC3 stated that the passenger at row 20, seat Bravo (20B) pulled down on the first mask and it came out, so he pulled on the second one and donned it. She also stated that the passenger at row 21, seat Alfa (21A) moved to row 20, seat Foxtrot (20F) as the oxygen units / masks at row 21 did not deploy.

The cabin crew stated that they had remained seated for about 15 minutes before the flight crew made another PA stating;

"Cabin Crew carry out your follow up duties"

The cabin crew subsequently checked on each other, then checked the lavatories and confirmed that they were vacant. They then checked the passengers and confirmed that the passengers were calm and did not require medical assistance. Subsequently, the SCC reported to the PIC on the status of cabin.

The cabin crew also reported that oxygen units did not open/deploy above row seats 9 EFG, 14 EFG and 21 AB (Refer to *Section 1.15.2).*

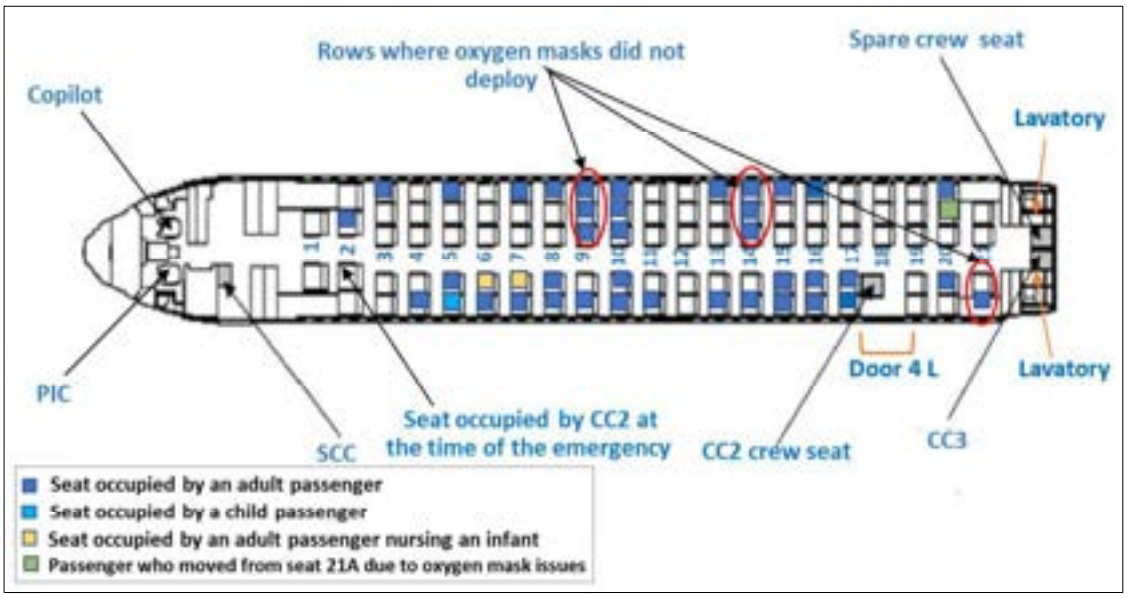


Figure 8: Cabin layout including crew and passenger seating arrangement.

The cabin crew stated that when they arrived at Madang Airport, the passengers were met by customer service officers upon disembarking the aircraft.

At the time of the occurrence, the cabin crew members were within their duty and flight time limitations in accordance with the Operator's *Cabin Crew Administration Manual Section 9.1.6* and *CAR Part 122.257*.

1.15.2 Cabin emergency warning system and procedures

During interview, the cabin crew stated that there was no pre-recorded PA heard in the cabin, as stated in the Operator's *Safety and Emergency Procedures Manual (SEPM), Volume 1, Section 5.5.3* which states;

1. *On aircraft fitted with a tape recorder, the Decompression Emergency Warning Announcement will be made automatically should the cabin pressure altitude ever exceed 14,000 ft.*

   Note: *Any PA announcement will override the decompression emergency warning announcement.*

2. *On aircraft not fitted with a tape recorder or if the auto announcement is inoperative or fails to operate, the Pilot Monitoring (PM) or designated Flight Deck crew member will make an announcement using the PA system:*

   This is an emergency pull an oxygen mask down – place the mask over your nose and mouth – breathe normally – remain seated with your seat belt fastened.

The Manufacturer stated that according to their document management system, the Service Bulletin SBF100-23-045 App.06 (See *Appendix D*) had been accomplished on P2-ANF. The existing Music and Pre-recorded Announcement Reproducer was replaced with a Becker DP-4100 digital player. The new system does not contain an automatic decompression warning announcement.

The investigation found that the Operator's active *Fokker 100 Aircraft Operation Manual (AOM)* did not contain any information on either the existing Music and Pre-recorded Announcements Reproducer or the Becker DP-4100 digital player.

1.15.3 Airport Rescue and Fire Fighting

According to the Aviation Rescue and Fire Fighting Service (ARFFS) at Madang Airport, Madang ATC Tower notified the ARFFS at 14:32 via a phone call to the Fire Control Centre (FCC) of an imminent emergency landing for ANF as a result of an in-flight cabin air pressure problem.

During an interview with Madang Airport's Chief Fire Warden, he stated that the FCC disseminated the emergency information to the rest of the ARFFS team through the PA system at which time the ARFFS immediately responded by deploying a six men crew with two fire trucks. The Chief Fire Warden also stated that the ARFFS treated the emergency as an abnormal landing and responded to the emergency in accordance with *Aerodrome Emergency Procedures for Emergency No. 5 – Abnormal Landings*.

The Aviation Fire Service Incident Report provided by the ARFFS to AIC showed that both fire trucks were positioned at Taxiway Charlie (C) and Taxiway Delta (D). According to the ARFFS journal entry, P2-ANF touched down on Runway 07 at Madang Airport at 14:46.

During interview, the Chief Fire Warden stated that after the aircraft completed the landing roll, the two fire trucks entered the runway and, one on each side, escorted the aircraft as it backtracked and exited via taxiway C onto parking bay number 04 (see Figure 9).

Figure 9: Ground roll direction of the aircraft post touchdown at Madang Airport.

The Chief Fire Warden further stated that the two fire trucks parked behind, on each side of the aircraft and remained until the aircraft's engines were shut down.

The ARFFS journal entry showed that the ARFFS crew subsequently stood down from the emergency ARFFS duties and returned to the station at 14:50.

1.16 Tests and research

Not Applicable.

1.17 Organisational and management information

1.17.1 General

Air Niugini Limited is a State Owned Enterprise, with its headquarters in Air Niugini Haus, 7 Mile, Port Moresby, PNG. Its main operational base and maintenance base is located at Jacksons International Airport at 7 Mile, Port Moresby. Air Niugini operates both domestically and internationally.

1.17.1 Operator's Emergency Response Plan

The Operator's *Corporate Emergency Response Manual (CERM), Section 1.7.3 'Operations Control'* states;

> *Operations Control has the responsibility to identify an emergency situation or potential emergency situation and to respond accordingly, including calling out the Response Management Team.*
>
> ***NOTE:** To satisfy the requirements of ORG 1.3.1, Operations Control has the authority, as delegated by General Manager Ground Operations and Aviation Security, to carry out this responsibility, including making an initial assessment as to whether an emergency situation is an "operational emergency" or requires a corporate emergency response.*

The Operator informed the AIC that the occurrence did not require an emergency response at Corporate level.

1.17.2 Operator's Internal Occurrence Reporting

An Operational Occurrence Report (OOR) on Double bleed fault and air diversion was submitted by the PIC to Safety Department and entered into the Aviation Quality Database (AQD) system (Occurrence No 0292-20). An Assessment Summary of the fault (20/AI/336) was provided by the Operator to the AIC. The assessment stated:

> *RH SOPRV removed and replacement valve installed IAW AMM 36-11-05-400-914-A. Leak check c/out - Satisfactory. LH SOTMV removed and replacement valve installed IAW AMM 36-11-03. Leak check c/out satis. RH SOTMV replacement valve installed IAW AMM 36-11-03. Leak check c/out satis. Functional and Operational test of SOPRV and SOTMV c/out IAW AMM 36-11-05-720-815-A and AMM 36-11-03-720-835- A satisfactory at this time. SOTMV close at 80% and remain closed above 90% N2. Aircraft verification flight c/out. Aircraft satisfactory.*

An OOR was also submitted by the CC1 to Safety Department and entered into AQD (Occurrence 0299-20) for oxygen masks in three panels that did not deploy and 12 masks came loose from the tube.

The PIC had stated in an email to AIC that CC1 had advised him of oxygen masks that did not deploy The PIC then advised CC1 to enter the defect in the CDR. However, there was no evidence of the defect been entered in the CDR nor the AJTL.

The AJTL (K5790) for the flight only listed the following defects:

- *SELECTION OF ENG 1 & 2 ANTI ICING ON @FL 290 LED TO A DOUBLE BLEED FAULT WHICH EVENTUALLY LED TO AN EMERGENCY DESCENT*
- *PAX OXYGEN SYS MAN OVRD ACTIVATED DURING EMERGENCY DESCENT*
- *CREW OXYGEN MASKS USED*
- *BOTH COWLS & ACCESS PANELS FOR BOTH TMSOV'S OPENED FOR ACCESS ENG 1 & 2*

Corrective actions were taken for the listed defects and released to service.

The PIC also stated that upon landing in Port Moresby, he verbally advised the engineers and showed them where the masks did not deploy.

An assessment summary 20/AI/343 of the defect (oxygen masks not deploying) did not identify any defects in the oxygen masks as no entry was made in the CDR nor in the AJTL.

1.18 Additional information

1.18.1 Altitude and cabin pressurisation

According to various studies on human physiology in the air environment, above 10,000 ft of altitude in the Standard Atmosphere, the use of supplementary oxygen is anticipated to avoid adverse physiological effects that could occur as a result of human exposure to the decrease in atmospheric pressure resulting in lower concentrations of oxygen.

Aircraft equipped with pressurisation systems, even when physically operated at altitudes well above 10,000 ft, have the capacity to maintain an internal pressure as if they were flying at 8,000 ft or lower, which allows normal human performance without the need for supplementary oxygen.

In the event of a cabin depressurisation during flight, the occupants of the aircraft are exposed to the existing conditions at the physical altitude in which the aircraft is flying, hence the use of supplementary oxygen and a rapid descent to an altitude equal or below 10,000 ft become necessary to avoid adverse physiological effects.

1.18.2 Operators post occurrence maintenance

The post-occurrence maintenance records showed that during the troubleshooting process, the Shut-off Temperature Modulating Valve (SOTMV) and the Shut-off and Pressure Regulating Valve (SOPRV) were replaced.

Shut-off Temperature Modulating Valve (SOTMV)

According to the Operator's LAME 2[19], on the 19 March 2020, he, together with maintenance person went onboard to take the reading on the Maintenance Test Panel (MTP) A. He conducted an engine run to do the functional test of the SOTMV in accordance with *TASK 36-11-03-720-835-A Operational test - SOTMV*. He stated that he proceeded to *Step 6* but the SOTMV did not close at the expected 77% power, hence, he progressively increased the engine power where above 90%, the SOTMV momentarily closed, and opened again on both engines. The SOTMV were determined to be faulty.

Shut-off and Pressure Regulating Valve (SOPRV)

On 23 March 2020, LAME 2 carried out a functional test of the SOPRV in accordance with the AMM and found both SOPRV were operating at 60 psi, outside the normal operational range of 51 to 57 psi. He then adjusted both SOPRVs. LH SOPRV was regulating within the required rate of 53 psi. However, RH SOPRV was then regulating at 48 psi.

19 See Appendix C, 5.3.2 for LAME 2 personal information.

On the 27 April 2020, RH SOPRV was then adjusted by LAME 3[20] and found satisfactory in accordance with *Functional Test - Shut-Off and Pressure Regulating Valve (SOPRV) (with the engines running).*

In an interview with AIC, LAME 3 stated that he conducted pneumatic valve test on the LH and RH SOPRV and LH and RH SOTMV in accordance with the AMM. The following results were observed during the test:

AJTL No	Defect	Action Taken	Maintenance Release Date
AJTL No. K5800/1-4:	REFER K5790/1: SELECTION OF ENG 1 & 2 ANTI-ICE ON LED TO A DOUBLE BLEED FAULT.	PROGRESSIVE T/SHOOTING C/O AS PER FOKKER ADVICE & IAW AMD97s' F36-200320-50A, F36-200323-00A, F36-200324-00A, F36-200328-00A & F36-200421-50A, ALL SATIS AT THIS TIME. PNEUMATIC SYSTEM HEALTH CHECK C/O & THE FOLLOWING FAILURES OBSERVED; LH SOPRV FAILED. L4 COMING ON AT 61PSI - OUTSIDE HP LIMITS. TEST C/O IAW AMM 36-11-05-720-825A. LH SOTMV FAILED. GAUGE 3 READING AT HP - 21PSI - OUTSIDE LIMITS. RH SOTMV FAILED. GAUGE 3 READING AT HP - OFF SCALE. SOTMV TESTS PERFORMED IAW AMM 36-11-03-720-825-A.	27/04/2020

Table 3: Post occurrence maintenance results for SOPRV and SOTMV.

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with the Papua New Guinea *Civil Aviation Act 2000 (As Amended)*, and the Accident Investigation Commission's approved policies and procedures, and in accordance with the Standards and Recommended Practices of *Annex 13* to the Convention on International Civil Aviation.

20 See Appendix C, 5.3.3 for LAME 3 personal information.

2 ANALYSIS

2.1 General

The analysis section of this report discusses relevant facts which contributed to the onset of the emergency and serious incident.

The investigation determined that there were no issues with the aircraft and its systems apart from the defect in the bleed air system. The analysis will therefore focus on the following issues but not necessary under separate headings:

- Operations,
- Aircraft systems and maintenance.

2.2 Operations

2.2.1 Operational procedures

The flight crew activated the engine anti-icing system as part of the standard procedure when the aircraft entered cloud.

Subsequent to the double bleed fault along with the activation of the Master Caution alert, the crew proceeded to action the *Double Bleed Fault* procedure. As required by the procedure, the crew donned their oxygen masks and established communication. They then switched off the bleed 1 and 2 systems and when they would have been about turn them back on, a Master/Excessive Cabin Altitude Warning triggered, in response to which the crew proceeded with the *Excessive Cabin Altitude* procedure, prioritising it over the continuation of the *Double Bleed Fault* as the *Excessive Cabin Altitude* is an emergency procedure. Emergency procedures requires crews' immediate actions for the safety of the aircraft and its occupants.

The first two action items of the *Excessive Cabin Altitude* procedure are identical to that of the *Double Bleed Fault* procedure and therefore they were actioned prior to the crew receiving the *Master/ Excessive Cabin Altitude* Warning alert. The investigation determined that the PIC switched on the fasten seatbelt/no smoking sign at this time, prior to announcing and commencing the emergency descent. Hence, the cabin crew assumed that the seatbelt/no smoking sign was switched on due to expected turbulence.

The crew initiated emergency descent and proceeded with the *QRH Emergency Descent* procedure. As the CVR recordings were partially overwritten during the post occurrence operation and maintenance, the investigation was unable to determine the status and specific timings of a number of items from the *Emergency Descent* procedure including ATS disconnection, Flight Mode selection and Transponder setting.

Although not contributory to this occurrence, the investigation determined that, as the aircraft was not equipped with a tape recorder with an automatic *Decompression Emergency Warning Announcement*, at the onset of the emergency the flight crew should have made the following announcement using the PA system *"this is an emergency pull an oxygen mask down – place the mask over your nose and mouth – breathe normally – remain seated with your seat belt fastened"*. This announcement does not only have the intention of providing awareness to the cabin crew, but it also assists the passengers, by reinforcing the instructions that the cabin crew should provide during the initial safety briefing about use of oxygen masks. However, according to the information gathered, that announcement was never done.

Nevertheless, when the cabin crew received the *"Attention! Attention! Emergency descent"* announcement, they were able to conduct the appropriate actions to manage the emergency in the cabin.

2.3 Aircraft systems and maintenance

2.3.1 Bleed system

The investigation found that there were irregularly intermittent faults in the bleed air systems of the aircraft, observed in a number of opportunities well before the day of the occurrence and had been identified by the Operator as recurrent defects. Particularly, these faults reoccurred earlier on the 18 March 2020, and during the operation in which this serious incident took place.

In the context of the occurrence, as the SOTMVs were not functioning according to the engine RPM and the SOPRVs were regulating above the upper limit, bleed air may have been supplied in excess and at high temperature, causing the overheat switch to close the SOPRVs and SOTMVs and with this, discontinuing the supply of bleed air to the aircraft, leading to the increase in cabin altitude that originated the cabin depressurisation event.

The investigation identified that as the faults were occurring at irregular intervals, and flight crews and maintenance were conducting tests and resets of the system when they occurred, which temporarily solved the issues and allowed the continuation of flights or the release of the aircraft back to service, no additional fault identification or troubleshooting procedures, nor effective follow-up, were conducted by the Operator to identify and address the underlying causes of these faults.

Moreover, it was only during the post-occurrence maintenance actions that a number of components were found defective in both engine bleed systems and, in particular, the SOTMVs and SOPRVs, which were then replaced.

2.3.2 Oxygen system

The investigation was unable to determine the cause of the defective oxygen units at row seats 9 EFG, 14 EFG and 21 AB, which did not deploy during the onset of the emergency, due to the absence of maintenance records, because of these defects not being reported by the cabin crew using the cabin defect report form.

3 CONCLUSIONS

3.1 Findings

3.1.1 Aircraft

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

b) The aircraft had a valid Certificate of Airworthiness.

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

d) There were recurrent defects in the bleed air systems well before the occurrence.

e) The underlying causes of the recurrent defects in the bleed air systems were not identified nor addressed before the occurrence.

f) The failure in the SOPRVs and SOTMVs led to an increase in cabin altitude and a subsequent cabin depressurisation event.

g) During post occurrence maintenance SOTMVs and SOPRVs were replaced.

h) Defects in the oxygen masks that did not activate in flight were not recorded in a cabin defect report form.

3.1.2 Flight crew

a) The flight crew members were licenced and qualified for the flight in accordance with existing regulations.

b) The flight crew members were medically fit and adequately rested to operate the flight.

c) The flight crew and cabin crew were in compliance with the flight and duty time regulations.

3.1.3 Flight operations

a) The flight was conducted in accordance with the procedures in the company Operations Manual.

b) The flight crew carried out normal radio communications with the relevant ATC units.

c) The pilot made an early decision to divert towards a suitable aerodrome while attempting to determine the extent of the emergency.

d) The flight crew broadcast a PAN during the emergency descent, which was acknowledged by ATC.

e) The flight crew donned their oxygen masks at the onset of the emergency.

f) The flight crew manually deployed passenger and cabin crew oxygen masks.

g) The flight crew did not make the Decompression Emergency Warning Annunciation.

h) The flight crew made an emergency PA to which the cabin crew responded, managing the emergency in the cabin.

3.1.4 Operator

a) The Operator identified that in-flight emergency did not require an emergency response at corporate level.

3.1.5 Air Traffic Services and airport facilities

a) ATC provided prompt and effective assistance to the flight crew.

3.1.6 Flight recorders

a) The aircraft was equipped with a Solid State Flight Data Recorder and a Solid State Cockpit Voice Recorder as required by regulation.

b) No data useful for the investigation was obtained from the SSCVR as it was overwritten during post occurrence events.

3.1.7 Medical

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

b) There was no evidence that the flight crew suffered any sudden illness or incapacity which might have affected their ability to control the aircraft.

3.1.8 Survivability

a) Eight oxygen masks were not deployed during the manual activation of masks.

b) There were no reported injuries.

c) The Alert phase was declared immediately upon receipt of the PAN call.

d) ARFFS were on standby prior to P2-ANF landing.

e) After the aircraft completed the landing roll, the two ARFF fire trucks entered the runway and escorted the aircraft as it backtracked and exited via taxiway C onto parking bay number 04.

f) ARFFS ceased their services at the parking bay after the shutdown of P2-ANF's engines.

3.2 Causes [Contributing factors]

The loss of cabin pressure inflight was due to the simultaneous faults with the PRSOV and SOTMV within the engine bleed systems.

The aircraft had recurrent defects on the bleed systems. The investigation found that no proper fault isolation and troubleshooting were applied to identify and address the underlying causes of the faults prior to the occurrence.

Moreover, due to the intermittent characteristics of the faults, the system tended to operate in a normal manner when subject to tests and resets done either by maintenance or flight crews whenever those faults appeared, which difficulted a more in-depth maintenance assessment and action.

4 RECOMMENDATIONS

4.1 Recommendations

As a result of the investigation into the serious incident involving the Fokker 100 aircraft, registered P2-ANF, when it experienced a cabin depressurisation event at flight level 29, 326 ft, about 63 nm from Goroka, the Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.1.1 Recommendation number AIC 21-R05/20-2002 to Air Niugini Limited

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure the use of its cabin defect report forms is reinforced for cabin crew to ensure that all cabin defects are recorded and reported in a timely manner, to enable and facilitate maintenance actions.

Action requested

The AIC requests that Air Niugini Limited note recommendation AIC 21-R05/20-2002 and provide a response to the AIC within 90 days, but no later than 04 October 2021, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

4.1.2 Recommendation number AIC 21-R06/20-2002 to Air Niugini Limited

The PNG Accident Investigation Commission recommends that Air Niugini Limited, should ensure that in their Fokker 100 series aircraft not fitted with tape recorders or if the automatic announcement is inoperative or fails to operate, the appropriate announcement will be made in accordance with the Operator's *Safety and Emergency Procedures Manual*, when applicable.

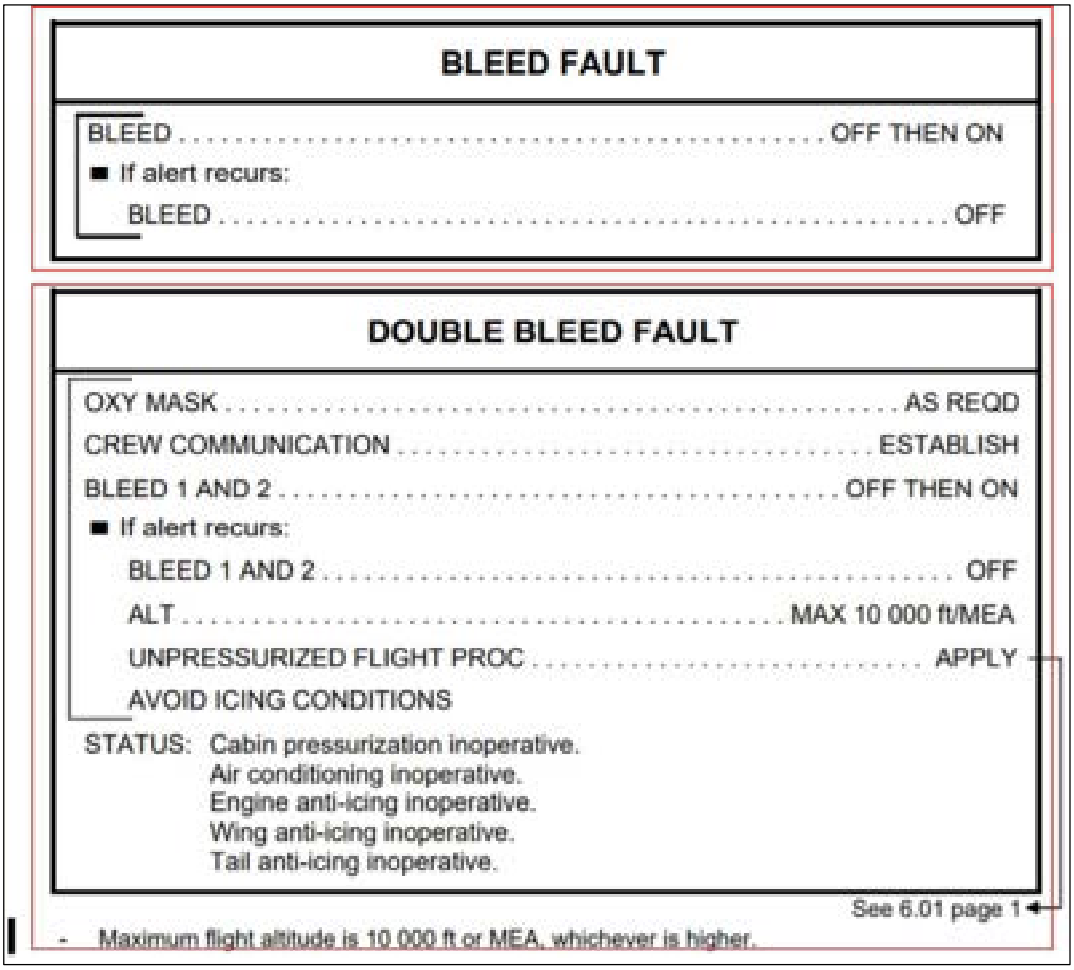
Action requested

The AIC requests that Air Niugini Limited note recommendation AIC 21-R05/20-2002 and provide a response to the AIC within 90 days, but no later than 04 October 2021, and explain including with evidence how Air Niugini Limited has addressed the safety deficiency identified in the safety recommendation.

5 APPENDICES

5.1 Appendix A: Flight Operation

5.1.1 Fokker 100 QRH Abnormal Procedure _ *Bleed Fault* and *Double Bleed Fault* checklists



BLEED FAULT

BLEED . . . . . OFF THEN ON

■ If alert recurs:

BLEED . . . . . OFF

DOUBLE BLEED FAULT

OXY MASK . . . . . AS REQD

CREW COMMUNICATION . . . . . ESTABLISH

BLEED 1 AND 2 . . . . . OFF THEN ON

■ If alert recurs:

BLEED 1 AND 2 . . . . . OFF

ALT . . . . . MAX 10 000 ft/MEA

UNPRESSURIZED FLIGHT PROC . . . . . APPLY

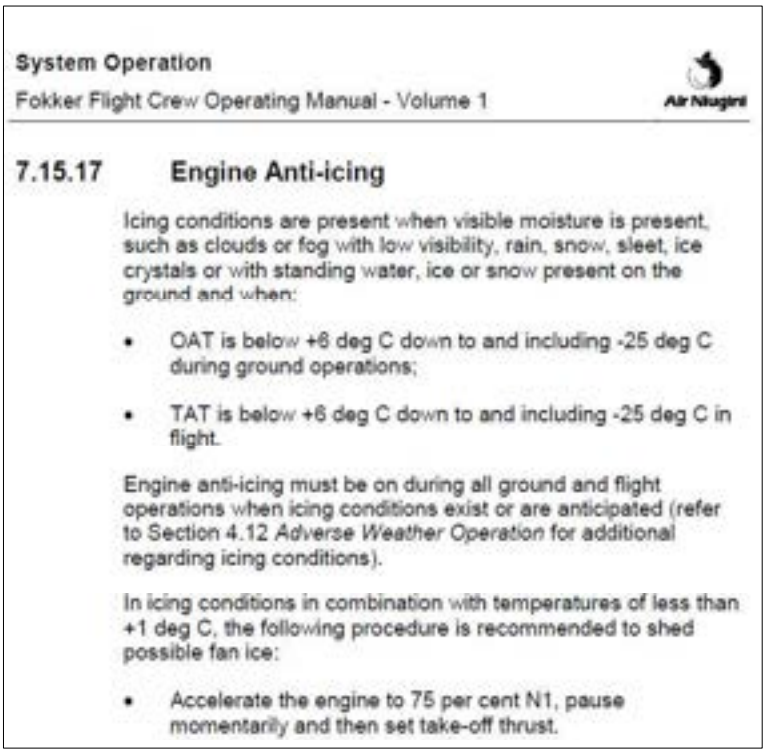
AVOID ICING CONDITIONS

STATUS: Cabin pressurization inoperative.
Air conditioning inoperative.
Engine anti-icing inoperative.
Wing anti-icing inoperative.
Tail anti-icing inoperative.

See 6.01 page 1

- Maximum flight altitude is 10 000 ft or MEA, whichever is higher.

5.1.2 *Engine Anti-icing procedure.*



System Operation

Fokker Flight Crew Operating Manual - Volume 1

Air Niugini

7.15.17 Engine Anti-icing

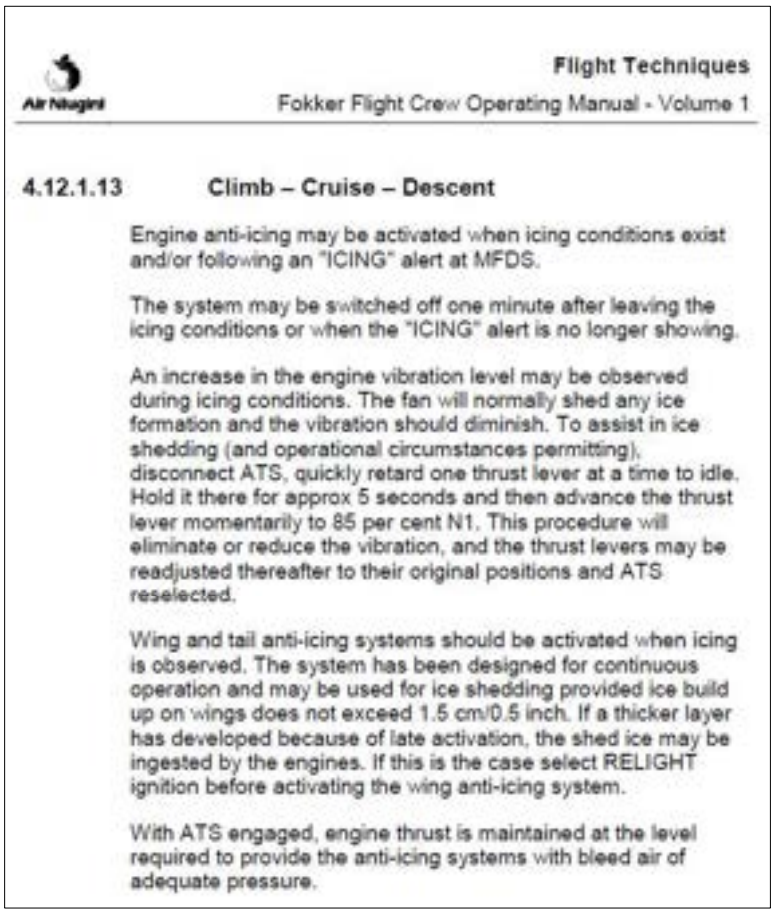
Icing conditions are present when visible moisture is present, such as clouds or fog with low visibility, rain, snow, sleet, ice crystals or with standing water, ice or snow present on the ground and when:

- OAT is below +6 deg C down to and including -25 deg C during ground operations;
- TAT is below +6 deg C down to and including -25 deg C in flight.

Engine anti-icing must be on during all ground and flight operations when icing conditions exist or are anticipated (refer to Section 4.12 *Adverse Weather Operation* for additional regarding icing conditions).

In icing conditions in combination with temperatures of less than +1 deg C, the following procedure is recommended to shed possible fan ice:

- Accelerate the engine to 75 per cent N1, pause momentarily and then set take-off thrust.



Air Niugini

Flight Techniques

Fokker Flight Crew Operating Manual - Volume 1

4.12.1.13 Climb – Cruise – Descent

Engine anti-icing may be activated when icing conditions exist and/or following an "ICING" alert at MFDS.

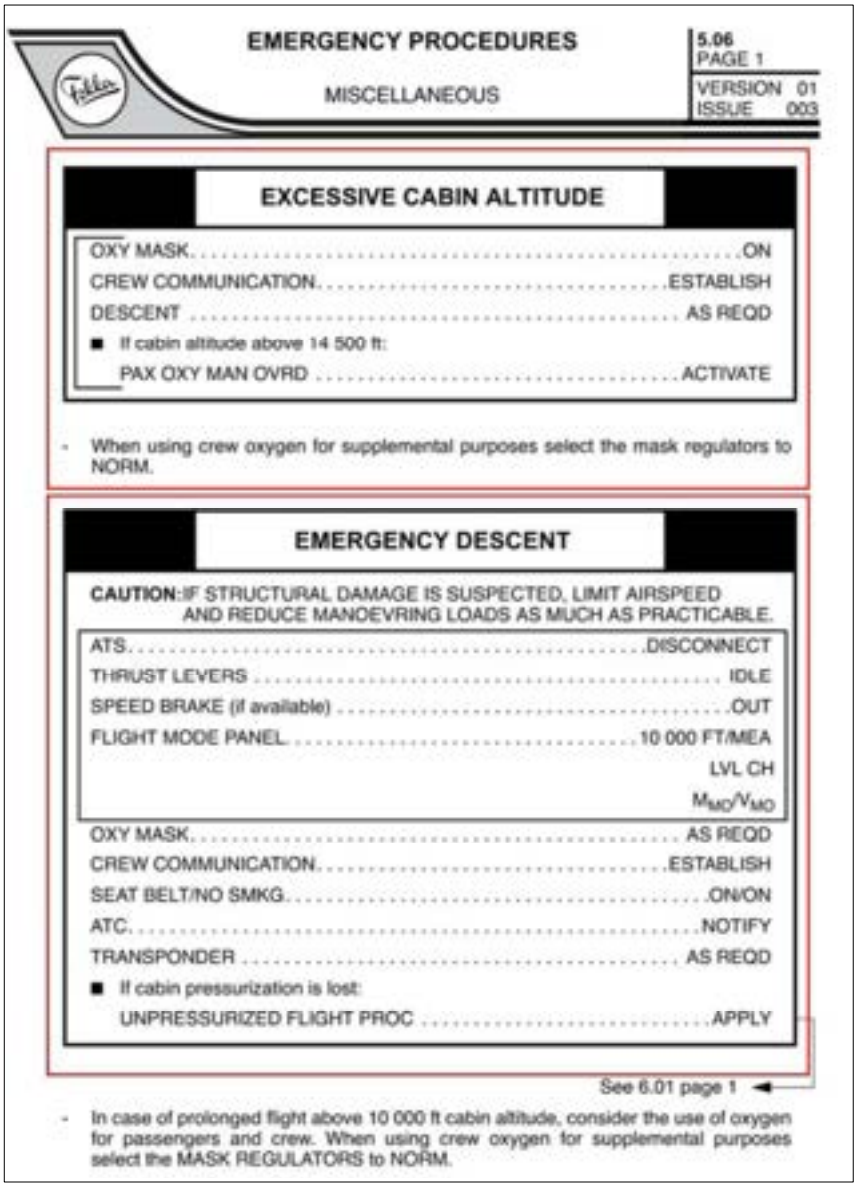
The system may be switched off one minute after leaving the icing conditions or when the "ICING" alert is no longer showing.

An increase in the engine vibration level may be observed during icing conditions. The fan will normally shed any ice formation and the vibration should diminish. To assist in ice shedding (and operational circumstances permitting), disconnect ATS, quickly retard one thrust lever at a time to idle. Hold it there for approx 5 seconds and then advance the thrust lever momentarily to 85 per cent N1. This procedure will eliminate or reduce the vibration, and the thrust levers may be readjusted thereafter to their original positions and ATS reselected.

Wing and tail anti-icing systems should be activated when icing is observed. The system has been designed for continuous operation and may be used for ice shedding provided ice build up on wings does not exceed 1.5 cm/0.5 inch. If a thicker layer has developed because of late activation, the shed ice may be ingested by the engines. If this is the case select RELIGHT ignition before activating the wing anti-icing system.

With ATS engaged, engine thrust is maintained at the level required to provide the anti-icing systems with bleed air of adequate pressure.

5.1.3 Fokker 100 QRH Emergency Procedures _ *Excessive Cabin Altitude* and *Emergency Descent* checklists



EMERGENCY PROCEDURES

MISCELLANEOUS

5.06
PAGE 1
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ISSUE 003

EXCESSIVE CABIN ALTITUDE

OXY MASK ..... ON
CREW COMMUNICATION ..... ESTABLISH
DESCENT ..... AS REQD
■ If cabin altitude above 14 500 ft:
PAX OXY MAN OVRD ..... ACTIVATE

- When using crew oxygen for supplemental purposes select the mask regulators to NORM.

EMERGENCY DESCENT

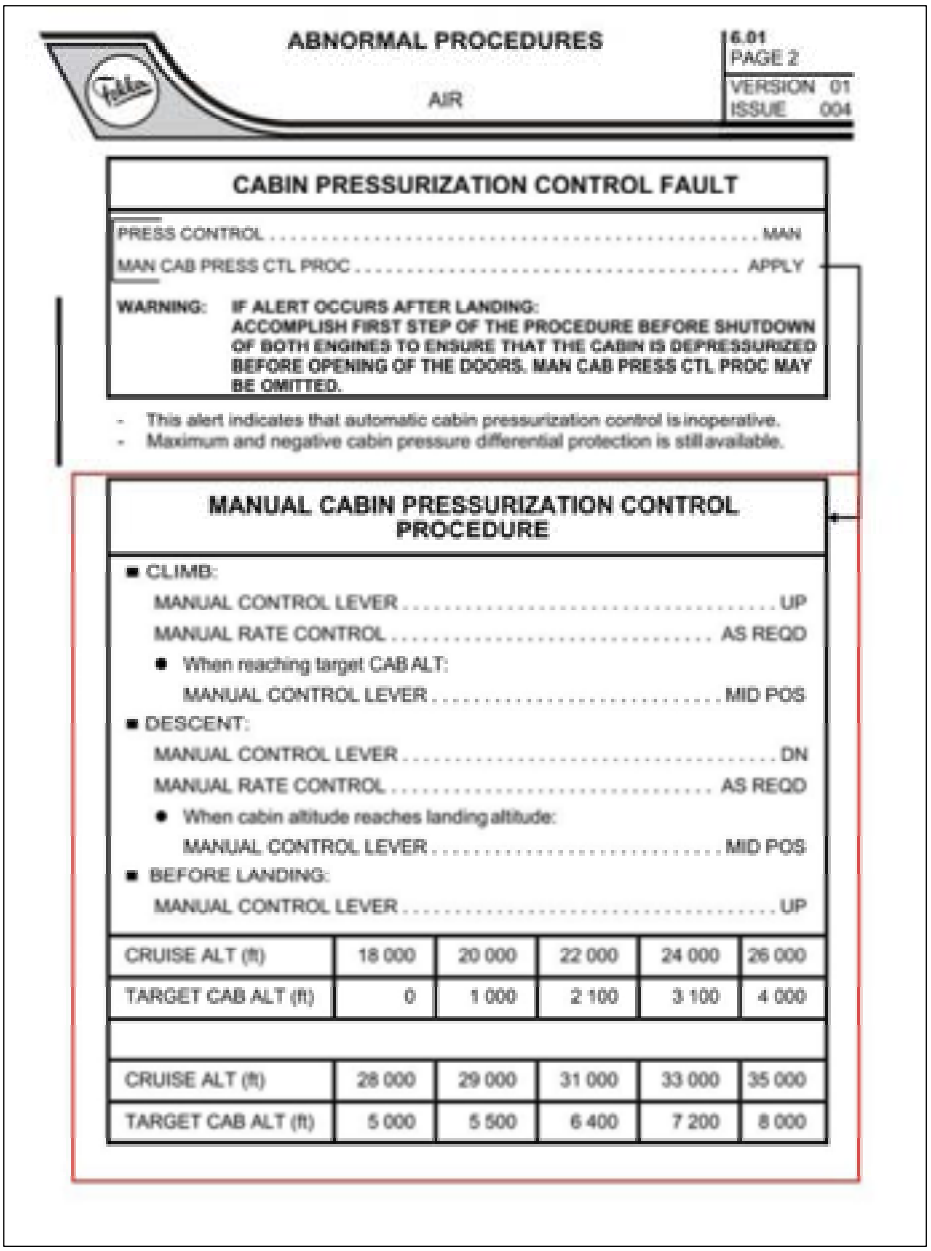
CAUTION: IF STRUCTURAL DAMAGE IS SUSPECTED, LIMIT AIRSPEED AND REDUCE MANOEVRING LOADS AS MUCH AS PRACTICABLE.

ATS ..... DISCONNECT
THRUST LEVERS ..... IDLE
SPEED BRAKE (if available) ..... OUT
FLIGHT MODE PANEL ..... 10 000 FT/MEA
LVL CH
M_{MO}/V_{MO}
OXY MASK ..... AS REQD
CREW COMMUNICATION ..... ESTABLISH
SEAT BELT/NO SMKG ..... ON/ON
ATC ..... NOTIFY
TRANSPONDER ..... AS REQD
■ If cabin pressurization is lost:
UNPRESSURIZED FLIGHT PROC ..... APPLY

See 6.01 page 1

- In case of prolonged flight above 10 000 ft cabin altitude, consider the use of oxygen for passengers and crew. When using crew oxygen for supplemental purposes select the MASK REGULATORS to NORM.

5.1.4 Fokker 100 QRH Abnormal Procedure _ *Manual Cabin Pressurisation Control* checklist



ABNORMAL PROCEDURES

AIR

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CABIN PRESSURIZATION CONTROL FAULT

PRESS CONTROL ..... MAN

MAN CAB PRESS CTL PROC ..... APPLY

WARNING: IF ALERT OCCURS AFTER LANDING: ACCOMPLISH FIRST STEP OF THE PROCEDURE BEFORE SHUTDOWN OF BOTH ENGINES TO ENSURE THAT THE CABIN IS DEPRESSURIZED BEFORE OPENING OF THE DOORS. MAN CAB PRESS CTL PROC MAY BE OMITTED.

- This alert indicates that automatic cabin pressurization control is inoperative.
- Maximum and negative cabin pressure differential protection is still available.

MANUAL CABIN PRESSURIZATION CONTROL PROCEDURE

■ CLIMB:

MANUAL CONTROL LEVER ..... UP

MANUAL RATE CONTROL ..... AS REQD

● When reaching target CAB ALT:

MANUAL CONTROL LEVER ..... MID POS

■ DESCENT:

MANUAL CONTROL LEVER ..... DN

MANUAL RATE CONTROL ..... AS REQD

● When cabin altitude reaches landing altitude:

MANUAL CONTROL LEVER ..... MID POS

■ BEFORE LANDING:

MANUAL CONTROL LEVER ..... UP

CRUISE ALT (ft)	18 000	20 000	22 000	24 000	26 000
TARGET CAB ALT (ft)	0	1 000	2 100	3 100	4 000

CRUISE ALT (ft)	28 000	29 000	31 000	33 000	35 000
TARGET CAB ALT (ft)	5 000	5 500	6 400	7 200	8 000

5.2 Appendix B: Cabin Safety Procedures

5.2.1 *Cabin crew follow up duties.*

3. Decompression Drill – Cabin Crew:

Immediate Actions
Sit down and strap in
Fit nearest passenger type mask
Check oxygen is flowing
When the PIC makes his announcement "*Will the Cabin Crew carry out their follow-up duties*"
Transfer to a portable O_2 bottle or use spare masks
Check crew and toilets
Attend to passengers
Report to CC1
CC1 reports to PIC

4. Chemical System:

   A. Chemical oxygen generators will operate for a minimum of 12 minutes. Activated generators cannot be shut off.

5. Follow-Up Duties

   A. Ensure all crew are on either portable oxygen or on the fixed system.

   B. Ensure passengers are placed on the fixed system.

   C. Attend to any injuries.

5.2.2 *Cabin Defect Report Form*

5.12 Forms

5.12.1 Bar Forms

This form is used for recording of bar sold or consumed during the flight. This document must be completed at the conclusion of a tour of duty or when changing aircraft. It must be completed 15 minutes prior to landing. It is essential that the form is completed correctly and correcting fluid is NOT TO BE USED to correct mistakes.

5.12.2 Aircraft Bar/Food Order Form

This form is used by the galley operator for ordering uplifts back to standard number required.

5.12.3 Cabin Defect Report Form – MC-B2

1. If throughout the day an item becomes unserviceable, which was initially serviceable, the defect shall be reported in the CDR.
   - The CDR is to be presented and signed by the Captain before start of descent.
   - If a defect is discovered after the CDR has been presented to the Captain, the new defect shall be entered and signed by the Captain after engine shutdown, before the Captain disembarks.
2. Cabin Crew member reporting is to enter **FLIGHT No. / AIRCRAFT REG: / DATE.**
   - Each defect shall be entered separately in the **DEFECT** column with each defect numbered 1, 2, 3, and 4 in the **ITEM** column.

NOTE: Besides reporting any Cabin Defects in the Cabin Defects Report (CDR) book, these defects should also be reported in the Voyage Report form for reference and follow up by Cabin Crew Management team.

Form MC-B2 **Air Niugini** **CABIN DEFECTS REPORT**

FLIGHT No. _____ AIRCRAFT REG: **P2-** DATE: _____

ITEM	DEFECT	RECTIFICATION/DEFERRAL/TRANSFER	CERTIFICATION
		RECTIFICATION	SIGNATURE AUTH
		DEFERRED, REFER TO DE No:	DATE
		TRANSFERRED TO:	
		RECTIFICATION	SIGNATURE AUTH
		DEFERRED, REFER TO DE No:	DATE
		TRANSFERRED TO:	
		RECTIFICATION	SIGNATURE AUTH
		DEFERRED, REFER TO DE No:	DATE
		TRANSFERRED TO:	
		RECTIFICATION	SIGNATURE AUTH
		DEFERRED, REFER TO DE No:	DATE
		TRANSFERRED TO:	

AIRCRAFT CAPTAIN REVIEW: THE ABOVE LISTED ITEMS REVIEWED AND AIRWORTHINESS AND/OR SAFETY ITEMS TRANSFERRED TO THE AIRCRAFT JOURNEY AND TECHNICAL LOG.

_____
AIRCRAFT CAPTAIN

DISTRIBUTION: WHITE (ORIGINAL): REMOVE AFTER RECTIFICATION/DEFERRAL IS SIGNED.
PINK COPY: ROUTE TO MAINTENANCE CONTROL, AIR NIUGINI.
YELLOW COPY: TO REMAIN IN THE CABIN DEFECTS REPORT BOOK AS THE ON BOARD COPY.

5.3 Appendix C: Engineering

5.3.1 *LAME 1 personal information*

Age	: 32
Gender	: Male
Nationality	: Papua New Guinean
Position	: LAME
Type of license	: Mechanical
Type rating	: F28-MK 70/100, DHC 8 - 100/200/300
Issuing Authority	: CASA PNG

5.3.2 *LAME 2 personal information*

Age	: 55
Gender	: Male
Nationality	: Papua New Guinean
Position	: LAME
Type of license	: Mechanical
Type rating	: DH 8 – 100/200/300, F28 – MK 100, B767 – 200/300, B737 – 600 - 900, AMD F900, F70/100
Issuing Authority	: CASA PNG

5.3.3 *LAME 3 personal information*

Age	: 35
Gender	: Male
Nationality	: Papua New Guinean
Position	: LAME
Type of license	: Mechanical
Type rating	: F28-MK 70/100, DH 8 100 – 300, B737 600 - 900
Issuing Authority	: CASA PNG

5.4 Appendix D: Service Bulletin F100-23-045

STORK Fokker

Service Bulletin
Fokker 70/100

Proforma

COMMUNICATION

Passenger Entertainment - The Introduction of a Digital Music and Announcement Player

1. Planning Information

   A. Effectivity

      (1) F28 Mark 0070/0100 aircraft serial numbers: 11244 thru 11585.

   B. Concurrent Requirements

      (1) Not applicable.

   C. Reason

      (1) The digital music (and announcement) player is a solid state digital player for MP3 format compressed data. The digital technology offers less maintenance costs and easy operation. The audio is stored on memory cards and can be read and written with a standard personal computer.

Page	1	2	3	4													
Revision	-	-	-	-													

D. Description

(1) An Appendix to this Proforma Service Bulletin will tell you how to:
- Remove the existing music and announcement reproducer (If applicable).
- Rework the aircraft wiring.
- Install the new digital music player.
- Test the system.

E. Compliance

(1) Optional.

F. Approval

(1) The technical content of this document is approved by EASA or under the authority of DOA nr. EASA.21J.059.

(2) Specific configurations may be subject to separate approval, which will be covered by the applicable appendix.

G. Manpower

(1) Approximately 15 man-hours are necessary to do this modification on one aircraft. The elapsed time will be 8 hours for 2 man (men).
Both mentioned figures are rough estimates. More detailed manpower information will be included in an Appendix to this Proforma Service Bulletin.

H. Weight and Balance

(1) Will be part of the Appendix.

I. Electrical Load Data

(1) Will be part of the Appendix.

J. Software Accomplishment Instructions

(1) Not applicable.

K. References

(1) The modification is covered by Fokker internal reference ECR 015515 and ECR 015552.

L. Publications Affected

(1) This SB affects the publications listed below:

(a) Maintenance Documentation

- Fokker 70/100 Aircraft Maintenance Manual (AMM) chapter 23-32
- Fokker 70/100 Wiring Manual (WM) chapter 23-32
- Fokker 70/100 Illustrated Parts Catalog (IPC) chapter 23-32
- Fokker 70/100 Trouble Shooting Schematics Manual (TSSM).

(b) Maintenance Programs

Not affected.

(c) Special Instructions for Continued Airworthiness (ICA)

Will be part of the Appendix.

(d) Operational Documentation

Not affected.

(2) For incorporation of this Service Bulletin in your documentation refer to SBF100-00-001 (Service Bulletin Introduction, section 4 "Incorporation of Service Bulletins in Documentation of Fokker Services").

M. Interchangeability or Intermixability of Parts

(1) Will be part of the Appendix.

2. Material Information

A. Material – Price and Availability

(1) On request we will supply you a customized modification proposal including prices and lead-times.

(2) A customized modification proposal will include an EASA approved Appendix, mod kit(s) and revisions of the affected documentation (if applicable).

(3) You can contact your Fokker Services Account Manager for such a modification proposal.

B. Material Required

(1) Will be part of the Appendix.

C. Tooling - Price and Availability

(1) Will be part of the Appendix.

D. Drawings Required

(1) Will be part of the Appendix.

3. Accomplishment Instructions

A. Because this is a Proforma Service Bulletin, we do not include the "Accomplishment Instructions". They will be included in an Appendix to this Proforma Service Bulletin.