



FINAL REPORT
SERIOUS INCIDENT INVESTIGATION
AIC 17-2002

Papua New Guinea Defence Force - Air Transport Wing

P2-502

CASA CN235-100M

Landed on closed runway

Goroka Airport, Eastern Highlands Province

PAPUA NEW GUINEA

2 December 2017

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 object 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 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 into this occurrence, and the scope of an investigation, were based on many factors, including the level of safety benefit likely to be obtained from the investigation. The Serious Incident occurred on 2 December 2018 at 04:14 UTC (14:14 local time). The AIC was notified of this occurrence on 5 December 2017, at 05:02 UTC (15:02 local time). An off-site, fact-gathering investigation was immediately commenced. This occurrence involved a military aircraft operating in civilian airspace, into civilian airports, and carrying civilian passengers, and therefore, falls under the responsibility of the AIC in accordance with *Section 247* of the *PNG Civil Aviation Act 2000 (as amended)*.

There was no damage or injury involved. However, in accordance with the classification guidance in *Annex 13*, and the safety risks associated with this occurrence, it has been classified as a serious incident. This *Draft Final Report* has been produced in accordance with the *PNG Civil Aviation Act 2000 (as amended)*, ICAO *Annex 13* to the *Chicago Convention on International Civil Aviation*, and the *PNG Accident Investigation Commission's Policy and Procedures Manual*.

Military CASA CN235-100M aircraft landed on a closed runway

OCCURRENCE DETAILS

On 2 December 2017, at 04:12 UTC¹ (14:12 local), a CASA CN235-100M aircraft registered P2-502 using the call-sign Eagle 502 (Figure 1), owned and operated by the Papua New Guinea Defence Force, landed on a closed runway, runway 35 Left at Goroka Airport, Eastern Highlands Province. (Figure 2.) There were 31 persons on board, including two pilots and a pilot passenger who occupied the cockpit jump seat. None of the occupants were injured.

The copilot's headset was unserviceable during the descent, approach and landing at Goroka. The pilot in command (PIC) was the flying pilot², and was doing all communications with the Goroka tower controller. The pilot occupying the jump seat had a serviceable headset but was not using it. He was unaware that the copilot's headset was unserviceable.

The departure from Jacksons Airport Port Moresby, and the cruise phase of the flight were uneventful, and there was no adverse weather en-route. The crew reported that it was a smooth flight up to the navigation reporting Waypoint *Sunshine*³. At that Waypoint, Moresby Flight Service instructed the crew of Eagle 502 to transfer radio frequency to the Goroka Tower frequency at 25 miles from Goroka, and contact Goroka Tower.

At 03:58:39 the PIC contacted Goroka and stated: "*Goroka tower good afternoon, Eagle 502 we are approaching 27 miles, left 12,000 on descent, estimate circuit one two (meaning 04:12), request conditions*". The controller responded: "*Eagle 502 tower avinun sir, at this stage wind is light and variable, QNH 1013, temperature 25, cloud scattered to broken at about 8000 and quick breaks around, visibility okay.*"

When the PIC subsequently reported "*Eagle 502 is on finals*" the tower controller cleared Eagle 502 to land stating "*Eagle 502, 35 Right, clear to land*". However, the PIC read back "*Tower 35 Left, clear to land*". Forty-eight seconds later, while Eagle 502 was still on final approach, the PIC transmitted, "*Ah Tower, Eagle 502, advise if the full length of ah length of the runway is available*". The controller replied, "*Ah Eagle 502, yes that's affirm*". Sixty-one seconds later, when Eagle 502 was on late final approach, the PIC transmitted, "*Ok there seems to be a brown patch in the middle, so was wondering whether the touchdown point is further up.*" The controller replied, "*Eagle 1, Eagle 502, ah runway 35 Right*". (See transcript of recorded communications at Attachment A.)

Eagle 502 touched down a quarter of the way along the newly paved runway 35 Left. There was runway construction work in progress (WIP). The construction workers were monitoring the Goroka tower radio frequency. They heard the after-landing radio communications between Eagle 502 and the tower controller, when the PIC realised his error and the controller gave Eagle 502 the back-tracking taxi clearance.

On receipt of the clearance to back track along the runway, the PIC turned the aircraft and backtracked towards a closed taxiway as instructed. The construction workers removed the marker cones at each end of the taxiway to allow Eagle 502 to taxi via that taxiway to runway 35 Right, and thence to the airport terminal apron area.

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 accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

² Flying pilot. The pilot manipulating the aircraft's controls.

³ *Sunshine* was the name of a navigation reporting Waypoint 80 nm south of Goroka Airport on the track from Port Moresby to Goroka. The reporting point name was changed to *OMBOG* on 20 March 2016.



Figure 1: Military CASA CN235M P2-502.



Figure 2. Goroka Airport

ORGANISATIONAL ISSUES

PNGDF Air Transport Wing

Flight operational requirements

The flight crew had been rostered to operate Eagle 502 on 2 December 2017 for a return flight to Hoskins from Port Moresby. However, on 1 December 2017, the day prior to the incident⁴, the pilots were instructed to operate Eagle 502 from Port Moresby to Goroka Airport on 2 February, to deliver a coffin to Goroka, and then proceed to Hoskins. A senior military officer had recently passed away, and Headquarters PNGDF requested if the Eagle 502 could honour this task.

Flight crew pre-flight planning

The copilot was tasked to submit the flight plan. He received weather information and submitted the flight plan by email. No further flight operational information was sought or received by the pilots for their Goroka operation.

During interviews with AIC investigators, the pilots stated that no NOTAMs⁵ were obtained prior to their departure from Jackson's Airport, Port Moresby. Therefore, no NOTAMs for Goroka WIP, nor any associated information, was used by the pilots for the flight.

The pilots had planned their departure from Port Moresby for 02:00, however, the aircraft departed an hour later at 03:05.

The pilots planned to track via the navigation reporting Waypoint *Sunshine*, 80 nm south of Goroka Airport, on the Port Moresby to Goroka track. It is evident that the pilots were using superseded navigation charts, since the Waypoint name was changed to *OMBOG* on 20 March 2016. The pilots were not aware of the name change.

PNG Air Services Limited (PNGASL)

NOTAMs

NOTAM *GOROKA A1274* was current for the period between 20:00 on 28 November 2017 and 09:00 on 3 January 2018. The NOTAM stated:

GOROKA A1274:

1711282000/1801030900 EST. AD CTN. RWY 17R/35L CLSD DUE MAJOR RWY PAVEMENT REHABILITATION WIP.

*RMK: 1. ACCESS TO MAIN APN VIA NE PORTION OF TWY ALPHA
2. NW PORTION OF TWY ALPHA CLSD.*

Therefore Goroka runway 35 Left was closed. The remarks (RMK) informed pilots how to reach the main apron at the terminal due to the closure of the north-west section of taxiway "A".

Two other NOTAMs, *GOROKA A1284* and *GOROKA A1285* were also current. Both were valid for the period between 21:00 on 30 November 2017 and 08:00 on 18 December 2017 daily.

⁴ Throughout this report "incident" is used for brevity. However, this occurrence has been classified as a "serious incident" in accordance with ICAO Annex 13, Attachment C, which states: *Landings or attempted landings on a closed or engaged runway, on a taxiway or unassigned runway, constitute a serious incident.*

⁵ NOTAM: A Notice to Airmen is a notice filed with an aviation authority to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the safety of the flight.

The NOTAMs stated:

GOROKA A1284

1711302100/1712180800 EST. BTN 2100/0800 DLY. TWY BRAVO CLSD DUE WIDENING CONST WIP.

GOROKA A1285

1711302100/1712180800 EST. BTN 2100/0800 DLY. RWY CTN DUE NEW TURNING NODE CONST WIP AT RWY 35R END.

RMK: MEN AND EQPT TO VACATE PRIOR TO ACFT OPS.

These NOTAMs related to taxiway closures due to widening construction WIP. There was a further caution due to WIP on a new turning node at the end of runway 35 Right. The remark (RMK) informed that the construction workers and their equipment were to vacate prior to aircraft operations.

Tower controller

Following the completion of an ADC⁶ course at Port Moresby, the controller was posted to Goroka. While his ATS records stated that the posting was due to ‘*man power requirements*’ there was no indication that he was posted to Goroka before he was ready for the ADC responsibility. He subsequently underwent planned and specific Goroka ADC training, and successfully completed a proficiency assessment as an ADC at Goroka on 29 September 2017. Remarks on his report stated that he “*worked very hard during the dry season to gain his ratings, and that with the bad weather coming, it should give him plenty experience in dealing with bad weather operations*”. The report also stated that he “*is encouraged to use standard phraseologies at all times*”; and he “*tends to talk slowly at times, but this should improve with time and exposure*”.

The controller subsequently attained his initial ADC Ratings at Goroka on 2 Oct 2017.

Two months after receiving his ADC rating, on the day of the incident involving Eagle 502, the controller was rostered on duty to provide air traffic services as the sole tower controller at Goroka.

There was no ATIS⁷ available at Goroka. The transcripts of recorded communications revealed that the controller provided surface condition information to Eagle 502 following a request by the PIC. This included wind, QNH⁸, temperature, cloud and visibility information. However, runway information was not included in the information the controller provided to Eagle 502. (See transcript of recorded communications at Attachment A at time 03:58:58.)

The PNGASL internal investigation report stated:

The Tower Controller did not pick-up the wrong read-back on the runway by Eagle502.

04:05:06 – Eagle502 then responds to Tower by saying ‘Okay there seems to be brown patches in the middle so I was wondering whether the touch down point was further up.’

At this stage the Controller realizes that Eagle502 was committed to land 35Left and he broadcasts to Eagle502,

04:07:19 – Eagle1Eagle502...Runway35Right

⁶ ADC: Aerodrome Controller

⁷ ATIS: Automatic terminal information service, is a continuous broadcast of recorded aeronautical information in busier terminal areas, i.e. airports and their immediate surroundings. ATIS broadcasts contain essential information, such as current weather information, active runways, available approaches, and any other information required by the pilots, such as important NOTAMs. Pilots usually listen to an available ATIS broadcast before contacting the local control unit, which reduces the controllers' workload and relieves frequency congestion

⁸ QNH: A pressure setting used by pilots, air traffic control (ATC), and low frequency weather beacons to refer to the barometric setting, which when set on an aircraft's altimeter, will cause the altimeter to read altitude above mean sea level within a certain defined region.

The Controller advised that he was not too sure on what action to take after realising the CASA was committed to Runway35L because when he assessed the position of Eagle502 and what would have happened if he had instructed the military CASA to go-around.

There would have been insufficient space or allowance for the CASA to safely go-around as the perimeter fencing was a few about 20-30 meters away from the 17Right threshold (opposite end of Runway35L).

The Controller was trained by a new Controller who did not have a lot of experience to share⁹.

The Controller was not fully aware of when and how to submit an INI (immediately notifiable incident).

The Controller was not fully versed with emergency situations due to not being fully exposed to such situations during initial training and training at current location.

Aircraft flight crew and tower controller actions and communications

When the controller issued a clearance for Eagle 502 to land on runway 35 Right, the PIC responded “Tower 35 Left, clear to land”. Forty-eight seconds later the PIC asked the controller, “Ah Tower, Eagle 502, advise if the full length of ah length of the runway is available”.

The controller responded “Ah Eagle 502, yes that’s affirm”. Eagle 502 continued on final approach and reached a stage where the PIC was committed to land on the closed runway.

The internal PNGASL investigation report stated:

“...when just before the cone markers (abeam taxiway ‘D’) he lifted the plane slightly and landed going past the cone markers and onto the freshly sealed portion of the Runway 35Left”.

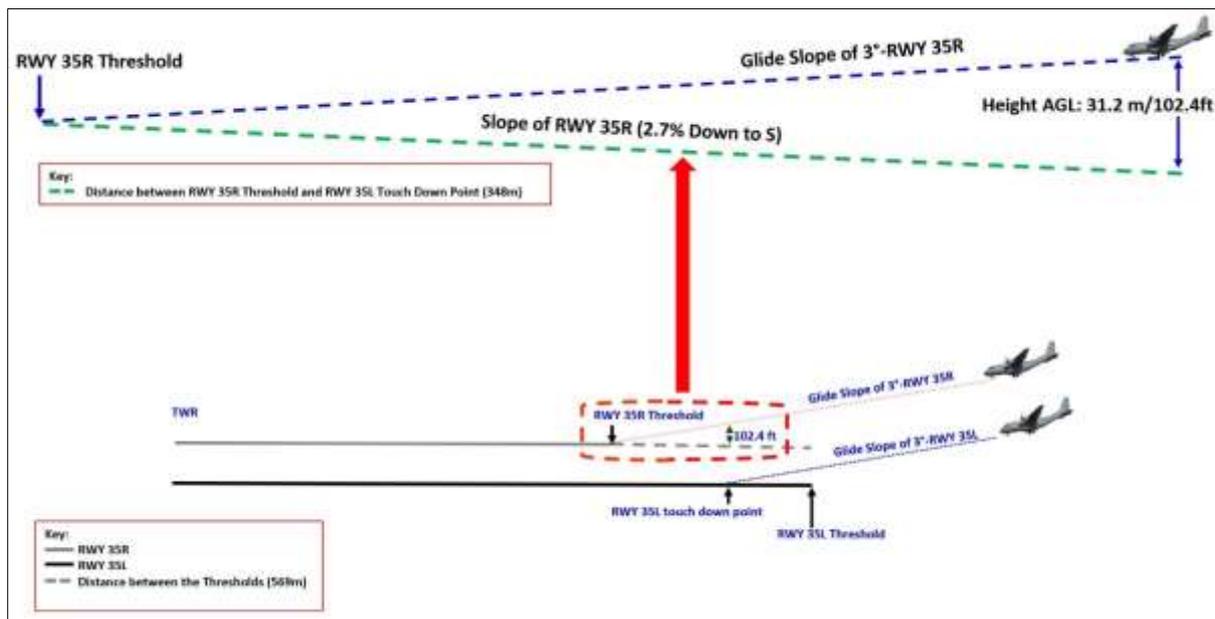


Figure 3: Diagram of glideslope relationship to the runways at Goroka Airport

⁹ In a clarifying statement, PNG ASL informed the AIC that the controller received On-the-Job training from the SATCO and the two rated controllers stationed at Goroka. The younger of the two rated controllers was the main training officer, but is deemed to be very competent, The new controller was checked by the AATSE, found to be competent, and was subsequently rated.

The AIC reviewed the recorded communications between the controller and Eagle 502, and prepared a transcript. (see Attachment A.) The AIC found that throughout the approach phase of the flight, the PIC did not have an understanding of the runway to be used.

The controller did not detect the PIC's error, and did not understand, or correctly determine, that Eagle 502 was lined up for, and landing on the closed runway.

The runway centerlines are 118 metres apart, and the runway 35 Right threshold is offset 569 metres to the north of the Runway 35 Left threshold. The runway 35 Right threshold is offset 348 metres to the north of the Runway 35 Left touchdown area. The approach profiles should therefore be expected to be clearly different, with an aircraft landing on Runway 35 Right being about 102 feet higher when abeam the Runway 35 Left touchdown point. (see Figure 3)

The controller did not visually monitor the approach of Eagle 502 in accordance with *ICAO Doc 4444, Chapter 7, Paragraph 7.1.1.2*, and the *Manual of Air Traffic Services RAC -3-24, Paragraph 10.14.24.2*. Therefore, the approach to the incorrect runway went undetected.

After landing and being cleared to back track on the runway, the PIC contacted the controller and stated: "Ah, 502 apologies, we just got confused with the instructions."

ICAO Doc 4444, Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM) requires runway information to be made available to the inbound traffic, (see Attachment B, *ICAO Doc 4444, Paragraph 7.4.1.2.3(a)*). The recorded communications reveal that the controller did not provide the runway information when Eagle 502 requested "conditions", on first contact with the Goroka controller. The subsequent radio communications were not in accordance with standard phraseology and resulted in confusion.

The runway clearance read-back errors went undetected by the controller and the PIC of Eagle 502. The copilot had an unserviceable headset and was unable to listen out, and provide communications support to the PIC during the descent and approach phases.

MATS¹⁰ RAC-3-26 Paragraph 10.14.26.4 states:

A military aircraft shall be instructed to "CHECK WHEELS" when being cleared to land or cleared for touch-and-go landing.

The controller did not comply with this requirement when clearing Eagle 502 to land.

ICAO Doc 4444, Chapter 7, Paragraph 7.1.1.2 – Procedures for Aerodrome Control Service states:

Aerodrome controllers shall maintain a continuous watch on all flight operations and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area. Watch shall be maintained by visual observation ...

(see Attachment B, *ICAO Doc 4444, Paragraph 7.1.1.2*.)

The *Manual of Air Traffic Services, RAC-3-24, paragraph 10.14.24 – DETERMINATION OF AIRCRAFT POSITION FOR CIRCUIT AND LANDING* states:

10.14.24.2 – In addition to a radio watch the tower controller shall maintain, as far as practicable, a continuous watch with the unaided eye and, if necessary, with binoculars, for the purpose of determining the position and ensuring the safety of aircraft.

The controller did not maintain a visual observation of the approaching Eagle 502, and did not observe that the aircraft was lined up with runway 35 Left throughout the approach.

¹⁰ MATS: *Manual of Air Traffic Services*.

The PIC's subsequent radio communications after Eagle 502 landed on the closed runway, and sighting the works on the runway and taxiways, alerted the crew of Eagle 502 to the situation.

About 12 minutes after Eagle 502 landed, and while it was still taxiing, the driver of runway works Car 5 asked the controller why the aircraft landed on the closed runway. The controller replied, "*the pilot didn't know it was closed*". Car 5 then asked the controller, "*Car 5 kindly, we, did they know that we have a NOTAM in place?*" The PIC of Eagle 502 responded: "*Ah Car 5, 502 we have not received any NOTAM. Ah, we just got this task in the morning, so we assume there was no NOTAMs, my apologies*".

PNG National Airports Corporation (NAC)

Method of Working Plan and markers

The PNG National Airports Corporation (NAC) is responsible for 22 airports¹¹ in PNG, and any other airport established by the Minister for Civil Aviation. The NAC responsibilities with respect to airports include their management and any maintenance works and the development of the aerodromes. Goroka aerodrome is one of NAC's airports, and in December 2015, NAC issued plans to undertake '*Aircraft Pavement Upgrading, and the construction of a New Terminal Building and Associated Works*'. A *Method of Working Plan (MOWP No. 004/2015 dated 7 Dec 2015)*¹² on *Goroka Aerodrome Aircraft Pavement Upgrading, New Terminal Building and Associated Works* was issued under Authority of *Civil Aviation Rule (CAR) Part 139*.

There were no runway closure markings, nor was there any taxiway closure marking as required by Annex 14 (see Attachment C), and in accordance with the *MOWP* required by *PNG CAR Part 139*.



Figure 4¹³. Runway works in progress viewed from runway 17 Right.

¹¹ Airport status as defined under *Civil Aviation Rules, Part 139*.

¹² MOWP: Goroka Aerodrome Aircraft Pavement Upgrading, New Terminal Building and Associated Works was issued under Authority of the *CAR Part 139 – Advisory Circular 139-4*.

¹³ Picture taken subsequent to the landing, and after remedial safety action was taken by NAC to mark the closed runway in accordance with the approved Method of Works Plan.



Figure 5. Runway 35 Left viewed from the landing point.

A NAC internal *Memo* dated 4 Dec 2017 (two days after the landing incident) stated:

“Apart from NOTAM Goroka A1274 closing the runway, there is no other physical indication that can be visually seen from the air that the runway is closed except for plants and workmen moving around on the runway.” Further, *“Though there is a SIGNAL CIRCLE available, this cannot be used (cross placed in circle) to indicate Airport is closed. One runway is still operational and in use.*

So as cone Markers with red Bands across runway, the upgrade is for whole runway from end to end. Placing those cone markers will only hinder and interfere with the upgrading work. The old bitumen on runway 17R/35L is stripped off and there is no runway markings.”

ICAO Annex 14, Vol 1, Chapter 7, VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS, 7.1 Closed runways and taxiways, or parts thereof, states:

7.1.1 A closed marking shall be displayed on a runway or taxiway or portion thereof which is permanently closed to the use of all aircraft.

7.1.3 On a runway, a closed marking shall be placed at each end of the runway, [or portion thereof, declared closed, and additional markings] shall be so placed that the maximum interval between markings does not exceed 300 m. On a taxiway a closed marking shall be placed at least at each end of the taxiway or portion thereof closed.

7.1.4 The closed marking shall be of the form and proportions as detailed in Figure 7-1, Illustration a), when displayed on a runway, and shall be of the form and proportions as detailed in Figure 7-1, Illustration b), when displayed on a taxiway. The marking shall be white when displayed on a runway and shall be yellow when displayed on a taxiway.

Note. — When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

A NAC internal *Memo* dated 4 December 2017 stated:

... placing those cone markers will only hinder and interfere with the upgrading work.

The NAC Occurrence Report: RA/OOR:040/2017, dated 18 December 2017 stated:

Unserviceable crosses were not available due to vandalism. Each time the runway unserviceable crosses are put they are removed by unknown persons.

During an interview with AIC investigators, a NAC officer reiterated the concern in the NAC report about vandalism, stating that vandalism of the markers was a reason for not leaving them on the runway at all times.

Weather

There was no significant weather at the time of arrival of Eagle 502 at Goroka.

Serious incident notification

This serious incident occurred on 2 December 2018 at 04:14. The AIC was notified of this occurrence on 5 December 2017, at 05:02. An off-site, fact-gathering investigation was immediately commenced.

Section 60 of the Civil Aviation Act 2000 (as amended), and Civil Aviation Rule Part 12.55 requires a serious incident to be notified to the Authority (CASA) as soon as practicable. CASA Advisory Circular AC 12-1, Section 8.1, further specifies that the initial notification is to be made by the fastest means possible.

Section 62 of the Civil Aviation Act 2000 (as amended) requires that CASA notify the AIC as soon as practical after receiving a notification under Section 60.

The serious incident was not notified to CASA or the AIC in accordance with mandated requirements under the *Civil Aviation Act* and *Civil Aviation Rules*. *Civil Aviation Rule Part 12.57* requires the submission of further details within 3 working days of the serious incident on a *Form CA005* or another means acceptable to the Authority.

The controller stated that he was unsure of how and when to complete the *CA005* notification form for submission to CASA.

AIC COMMENT

The AIC determined that the pre-flight planning and pre-flight briefing conducted by the flight crew of Eagle 502 was inadequate. The pilots informed the AIC investigators that they had concerns about the new NAIPS¹⁴ system, and an unreliable email communication system within the PNGDF ATW establishment. However, the investigation established that there was ample time prior to the flight for the pilots to ensure they obtained a thorough pre-flight briefing, including having a face to face briefing at the PNG ASL Briefing Office.

The pilots planned to track via the navigation reporting Waypoint Sunshine, 80 nm south of Goroka Airport on the track from Port Moresby to Goroka. It is evident that the pilots were using superseded navigation charts, since that Waypoint name was changed to OMBOG on 20 March 2016. The pilots were not aware of the name change.

As a consequence of inadequate pre-flight briefing, no NOTAMs were obtained by the pilots prior to departure. They also did not request, and as a result did not obtain, Goroka NOTAMs from Air Traffic Control or Flight Service during the flight.

¹⁴ NAIPS: National Aeronautical Information Processing System providing weather, flight plan submission, NOTAM notification and updates of various information necessary.

Therefore, the crew deprived themselves of vital operational information about Goroka Airport, specifically the runway WIP. That oversight by the flight crew also deprived them of any relevant aircraft weight performance calculation information that may have been safety critical for landing on the shorter runway, runway 35 Right, which was the runway in use at the time of their landing at Goroka.

Paragraph 7.4.1.2.3 of ICAO Doc 4444 requires that the “*runway to be used*” information shall be provided to an inbound aircraft prior to the aircraft entering the traffic circuit. (see Attachment B.)

The recorded communications revealed that the controller did not provide the runway information when Eagle 502 requested “conditions”, on first contact with the Goroka controller.

Throughout the approach phase of the flight, the PIC did not have an understanding of the runway to be used.

The controller did not detect the PICs error, and did not understand or correctly determine, that the PIC of Eagle 502 was lined up for, and intended landing on, the closed runway.

The controller did not visually monitor the approach of Eagle 502 in accordance with *ICAO Doc 4444, Chapter 7, Paragraph 7.1.1.2*, and the *Manual of Air Traffic Services RAC -3-24, Paragraph 10.14.24.2*. Therefore, the approach to the incorrect runway went undetected.

The copilot’s headset was unserviceable. The pilot occupying the jump seat had a serviceable headset but was not using it. He was not aware that the copilot’s headset was unserviceable. The copilot did not request the use of the jump seat pilot’s headset.

That scenario resulted in the operation of the aircraft being a single-pilot operation with respect to communication with the Tower Controller. This was an added serious safety concern with respect to listening out for other aircraft.

Neither the PIC nor the Tower Controller detected the runway clearance read-back errors. Those undetected errors, likely contributed to the potentially unsafe landing on the closed Goroka runway during construction works.

The runway was not marked in accordance with the *ICAO Annex 14* requirements and the approved *Method of Works Plan*. That was also a contributing factor that led to the potentially unsafe landing on the closed Goroka runway during construction works.

Notification of serious incident

This serious incident occurred on 2 December 2017 at 04:14 UTC (02:12 local time). The AIC was notified on 5 December 2017, at 05:02 UTC (15:02 local time). An off-site, fact-gathering investigation was immediately commenced. Notification of the serious incident was not in accordance with *Section 60* of the *Civil Aviation Act*.

SAFETY ACTION

Papua New Guinea defence Force (PNGDF) safety action

On 10 December 2017, the AIC received a safety action statement, with accompanying evidence, from the PNGDF Air Transport Wing (ATW), which demonstrated that the following actions had been taken with respect to addressing the pre-flight briefing deficiencies in PNGDF ATW:

1. *A NAIPS account had been created on 6 December 2017.*
2. *A minute was circulated to all ATW aircrew reminding them of their responsibility to obtain all required pre-flight briefing information prior to any flight and the conduct of proper pre-flight briefings for the flying crew.*

National Airports Corporation (NAC) safety action

On 18 December 2017 in its Occurrence Report: RA/OOR: 040/2017, Paragraph 8.0 Corrective Actions, the National Airports Corporation stated:

1. *Runway Unserviceable Crosses have been placed on the main runway daily and will be removed at the end of the day to avoid vandalism.*
2. *Advice PNGASL for specific wording to be used during first contact with aircraft.*
3. *Re-issue Operational Circular with new dates.*
4. *NOTAM review.*
5. *Lit Runway Crosses (to be further discussed).*
6. *Review all other projects carried out by CADIP¹⁵.*

PNG Air Services Limited (PNGASL) safety action

On 4 April 2018, PNGASL provided the AIC a copy of its recommendations as a result of its internal PNGASL Air Safety Investigation Report.

The ATC advanced training to include:

a) Refresher training including emergency procedures and completion of incident reports;

In addition, the circumstances of the incident should be de-identified and published as a Safety Bulletin for the benefit of all PNGASL ATS staff.

In instances where an officer is stood down for investigation purposes, in the absence of capability to conduct Control Tower Simulator based refresher training, counselling should include reviewing the circumstances of the incident such that a repeat event is unlikely. At present, PNGASL does not have the capability to enable the Goroka Airport environment in the current Control Tower Simulator situated in Port Moresby.

On 25 April 2018, PNGASL provided the following Safety Statement to the AIC.

Following the incident, the Aerodrome Controller was counselled in respect of ensuring correct pilot read-back of all ATC instructions and challenging pilots if and when there is doubt that an instruction has been clearly heard and understood. The controller was also checked and found to be competent in the duties of an Aerodrome Controller at Goroka. Further, the circumstances of the incident have been recorded for inclusion in future simulator training scenarios to better ensure no repeat.

¹⁵ CADIP: Civil Aviation Development Investment Program.

Other factor¹⁶

During the investigation into this serious incident at Goroka, the AIC found evidence, that while not contributory to the serious incident, nevertheless could cause an accident or a serious incident if not immediately rectified.

The CASA CN235-100M aircraft, registered P2-502 and operating as Eagle 502, sustained an engine failure on 13 July 2016 during a flight from Telefomin to Vanimo, Sundaun Province.

The maintenance rectification action necessitated the removal of the right engine Propeller Gearbox (PGB) at Vanimo Aerodrome. A replacement PGB, Serial Number UDAG0616 was fitted to the right engine to enable the aircraft to be ferried to Port Moresby for further repairs.

The AIC investigation into the Goroka incident found that the replacement PGB had been placed in storage 7 years before the July 2016 incident.

Storage preservation requirements, confirmed in a written statement from the Original Equipment Manufacturer (OEM), state that a PGB in storage for more than 36 months must be sent to a PGB Original Equipment Manufacturer's facility for inspection.

That inspection action was not carried out, and the PGB fitted in 2016 remained on the aircraft on 19 December 2017¹⁷. The aircraft was still engaged in flying operations throughout PNG, carrying military personnel and civilians. The PGB fitted to the right engine of Eagle 502 (P2-502) was classified as unserviceable, rendering the aircraft unairworthy.

While not contributory to the serious incident at Goroka, the significant maintenance safety deficiency nevertheless could cause an accident or a serious incident if not immediately rectified. The AIC therefore issued the following recommendation on 19 December 2017.

¹⁶ Other factors is used for safety deficiencies or concerns that are identified during the course of the investigation, that while not causal to the accident, nevertheless should be addressed with the aim of accident and serious incident prevention, and the safety of the travelling public.

¹⁷ On 7 February 2018, the PNGDF informed the AIC that from 22 January 2018, Eagle 502 was "shut down", awaiting a replacement PGB.

SAFETY RECOMMENDATIONS

Recommendation number AIC 17-R06/17-2002 to PNG Defence Force

The PNG Accident Investigation Commission recommends that Commander PNG Defence Force (PNGDF) should require the replacement of the unserviceable Propeller Gearbox (PGB) Serial Number UDAG0616, currently fitted to the right engine of CASA CN-235M aircraft registered P2-502, before further flight.

Action requested

The AIC requests that the Commander PNG Defence Force (PNGDF) note recommendation AIC 17-R06/17-2002, and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how the PNGDF has addressed the safety deficiency identified in the AIC investigation report AIC 17-2002.

PNG Defence Force (PNGDF) response

On 7 February 2018, the Commander PNGDF informed the PNG Accident Investigation Commission that:

1. *Our aircraft CASA Eagle 502 has been shut down to allow for the PGB to be extracted and undergo an inspection by the manufacturer or their certified agent. The items required for the inspection have been purchased and we are awaiting their arrival from overseas;*
2. *There will be no further operations by Eagle 502 until the current PGB has been inspected and cleared in accordance with Air Regulations; and*
3. *We are in the process of purchasing a new PGB which will be fitted as soon as possible.*

PNG Accident Investigation Commission (AIC) assessment of PNG Defence Force (PNGDF) response

On 8 February, 2018 the AIC reviewed the PNGDF response addressing the recommendation AIC 17-R06/17-2002 addressed to PNGDF. The AIC assigned this response a satisfactory intent rating, and recorded the Status of the AIC Recommendation: **MONITOR**.

Current safety action status

At the date of issuing this *Final Serious Incident Investigation Report*, the AIC was continuing to monitor the status of the PGB rectification action on Eagle 502 (P2-502), and was awaiting evidence from PNGDF of the completion of their proposed safety action. Status **MONITOR**.

Further Safety Recommendations

While not contributory to the serious incident at Goroka, the AIC investigation into this serious incident found a need to amend the Aeronautical Information Publication, to enhance the safety of aircraft operations at Goroka Airport. The investigation found that:

- as a result of the extensive runway works at Goroka Airport, the *Aeronautical Information Publication (AIP) AYGA, Section 3*, is not accurate and therefore does not reflect the correct data, in particular the runway data; and
- the *Aeronautical Information Publication, Flight Supplement*, does not contain *Holding and Instrument Approach to Land Procedures (IAL)*, and an *Aerodrome Chart* for Goroka Airport.

The AIC therefore issued the following recommendations *AIC 18-R01/17-2002* and *AIC 18-R02/17-2002* on 13 April 2018.

Recommendation number *AIC 18-R01/17-2002* to Civil Aviation Safety Authority of PNG

The PNG Accident Investigation Commission recommends that the Civil Aviation Safety Authority of PNG should require a review of the Aeronautical Information Publication (AIP), AYGGA, 3.1 to 3.5, to ensure the information relating to Goroka Airport is accurate, with specific attention to ensure that runway data is accurate, as a result of the extensive runway works.

Action requested

The AIC requests that the Civil Aviation Safety Authority note recommendation *AIC 18-R01/17-2002*, and provide a response to the AIC within 90 days of the issue date (due date 11 July 2018), and explain (including with evidence) how the CASA has addressed the safety deficiency identified in the AIC investigation report *AIC 17-2002*. AIC Status: **ACTIVE**.

Recommendation number *AIC 18-R02/17-2002* to Civil Aviation Safety Authority of PNG

The PNG Accident Investigation Commission recommends that the Civil Aviation Safety Authority of PNG should require the promulgation of *Holding and Instrument Approach to Land Procedures (IAL)*, and an *Aerodrome Chart* for Goroka Airport, in the *Aeronautical Information Publication, Flight Supplement*.

Action requested

The AIC requests that the Civil Aviation Safety Authority note recommendation *AIC 18-R02/17-2002*, and provide a response to the AIC within 90 days of the issue date (due date 11 July 2018), and explain (including with evidence) how the CASA has addressed the safety deficiency identified in the AIC investigation report *AIC 17-2002*. AIC Status: **ACTIVE**.

General Details

Date and time	2 February 2017 — 04:12 UTC	
Occurrence category	Serious Incident	
Primary occurrence type	Landing on a Closed (under maintenance) runway	
Location	Goroka Airport, Goroka, Eastern Highlands Province	
Altitude	5,400 ft	
Coordinates	Latitude: 6° 5' 7.06" S	Longitude: 145° 23' 33.44" E

Crew Details

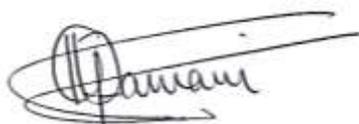
Pilot in Command		
Nationality	Papua New Guinea	
Licence type	Military qualification Cat B (Q)	
Total hours	3,293.5 hours	
Total hours on type	2,593.5 hours	
Total hours last 30 days	49.5 hours	
Total hours last 7 days	26.5 hours	

Copilot		
Nationality	Papua New Guinea	
Licence type	Military qualification Cat C (Q/R)	
Total hours	449.2 hours	
Total hours on type	189.9 hours	
Total hours last 30 days	28.3 hours	
Total hours last 7 days	13.0	

Aircraft Details

Aircraft manufacturer and model	CASA CN235-100M	
Registration	P2-502 Call sign: Eagle 502	
Serial number	C-049	
Total time in service	4,193.3 hours	
No. 1 Engine (left)		
Manufacturer and model	General Electrics CT7-9C	
Serial number	GE-E-309217	
No. 2 Engine (right)		
Manufacturer and model	General Electrics CT7-9C	
Serial number	GE-E-309200	
Type of operation		
Persons on board	Crew: 2	Passengers: 29
Injuries	Crew: 0	Passengers: 0
Damage	Nil	

Approved



Hubert Namani, LLB

Chief Commissioner

25 May 2018

ATTACHMENT A

Transcript of Goroka Tower recorded communications

Goroka Tower Transcript for Serious Incident on Eagle502

Time	From	To	Transcript
03:58:39	Eagle502	Tower	Goroka tower good afternoon Eagle 502 we are approaching 27miles left 12,000 on descent estimate circuit 12, request conditions.
03:58:58	Tower	Eagle502	Eagle 502 tower avinun sir, at this stage wind is light and variable QNH 1013, temperature 25, cloud scattered to broken at about 8000 and quick breaks around, visibility okay.
03:58:59	Eagle502	Tower	Eagle 502.
04:05:02	Eagle502	Tower	Eagle 502 is on finals.
04:05:05	Tower	Eagle502	Eagle 502 35 Right clear to land.
04:05:07	Eagle502	Tower	Tower 35 Left clear to land.
04:05:55	Eagle502	Tower	Ah Tower, Eagle 502, advise the full of ah length of the runway is available?
04:06:06	Tower	Eagle502	Ah Eagle 502, yes that's affirm.
04:06:08	Eagle502	Tower	Ok, there seems to be a brown patch in the middle, so was wondering whether the touchdown point is further up.
04:07:19	Tower	Eagle502	Eagle 1, Eagle 502, ah runway 35 Right.
04:07:23	Eagle502	Tower	Eagle 502 apologies.
04:07:36	Eagle502	Tower	Ah, 502 are we able to taxi?
04:07:45	Tower	Eagle502	Ah, 502 ah, you can backtrack from there.
04:07:47	Eagle502	Tower	502 thank you.
04:08:10	Eagle502	Tower	Ah, 502 apologies, we just got confused with the instructions.
04:08:12	Tower	Eagle502	Eagle 502.
04:08:50	Tower	Car 4	Car 5, correction car 4 Goroka tower.
04:09:07	Tower	Car 5	Car 5 Goroka tower.
04:09:20	Eagle502	Tower	Ah, 502 request someone to remove the cone markers.
04:09:23	Tower	Eagle502	Ah, 502 stand by.
04:09:24	Eagle502	Tower	Standing by, 502.
04:09:39	Tower	Car 3	Car 3 Goroka tower.
04:09:53	Tower	Rescue 1	Rescue 1 portable, Goroka tower.
04:10:02	Tower	Tender 1	Tender 1, Goroka tower.
04:10:05	Tender 1	Tower	Tender 1, tower go ahead.
04:10:07	Tower	Tender 1	Tender 1, tower can you go to MAF taxiway and remove the cones for aircraft to backtrack.
04:07:26	Tender 1	Tower	Tender 1 copied.
04:07:29	Tender 1	Tower	Tower tender 1 roger.
04:07:30	Tower	Tender 1	Tender 1 many thanks.
04:11:34	Tender 1	Tower	Goroka tower tender 1. Request clearance to enter runway 17 Left for taxiway MAF and remove the cone marker.
04:11:35	Tower	Tender 1	Tender 1, approved.
04:11:36	Tender 1	Tower	Tender 1.
04:14:08	Tender 1	Tower	Goroka tower tender 1. Complete removing the cone marker and vacated runway 17 Left.
04:14:10	Tower	Tender 1	Ah tender 1, could you please replace the cone markers.
04:14:39	Tender 1	Tower	Tender 1.
04:16:27	Car 5	Tower	Tower Car 5. Request clearance to cross runway 35 Right/17 Left.
04:16:29	Tower	Car 5	Car 5, approved.
04:16:30	Car 5	Tower	Approved, Car 5.
04:17:18	Car 5	Tower	Tower Car 5, clear of runway.
04:17:19	Tower	Car 5	Car 5.
04:17:35	Tower	Tender 1	Tender 1, many thanks.
04:18:54	Car 5	Tower	Tower Car 5.
04:19:04	Tower	Car 5	Car 5 tower go ahead.
04:19:05	Car 5	Tower	Tower, can you advise why did we have that aircraft landing on the new runway that we are constructing, can you advise?.
04:19:20	Tower	Car 5	Ah Car 5 tower, the pilot didn't know it was closed.
04:19:22	Car 5	Tower	Car 5 kindly, we, did they know that we have a NOTAM in place?
04:19:40	Eagle502	Car 5	Ah Car 5, 502 we have not received any NOTAM. Ah, we just got this task in the morning, so we assume there was no NOTAMs, my apologies.
04:22:36	Car 5	Tower	Tower Car 5.
04:22:49	Car 5	Tower	Tower Car 5.
04:22:50	Tower	Car 5	Car 5, go ahead.
04:25:52	Car 5	Tower	Car 5, can you advise the, did you guys instruct the aircraft to land using the 35 Left or was it a misunderstanding?
04:07:27	Tower	Car 5	Ah he was instructed to land 35 Right, but I think it was a misunderstanding.
04:07:29	Car 5	Tower	Copied that Car 5.
04:24:19	Car 5	Tower	Tower Car 5 Requesting clearance to cross movement area.
04:24:20	Tower	Car 5	Car 5 approved.
04:24:21	Car 5	Tower	Approved Car 5.
04:24:55	Car 5	Tower	Tower Car 5. Clear of movement area.
04:24:57	Car 5	Tower	Car 5.

ATTACHMENT B

ICAO Doc 4444 Chapter 7 – Procedures for Aerodrome Control Service

The Procedures detailed in *ICAO Doc 4444, Air Navigation Services - Air Traffic Management (PANS-ATM)* are complementary to the *Standards and Recommended Practices* contained in *ICAO Annex 2 - Rules of the Air*, and *Annex 11 - Air Traffic Services*. The *Procedures for Air Navigation Services - Air Traffic Management (PANS-ATM)* specify, in greater detail than in the *Standards and Recommended Practices*, the actual procedures to be applied by air traffic services units in providing the various air traffic services to air traffic.



ICAO

Doc 4444

PROCEDURES FOR AIR NAVIGATION SERVICES

Air Traffic Management

Sixteenth Edition, 2016



This edition supersedes, on 10 November 2016, all previous editions of Doc 4444.

7.1 Functions of Aerodrome Control Towers

Excerpt from *ICAO Doc 4444, Chapter 7*. Refer to *paragraph 7.1.1.2*

7.1 FUNCTIONS OF AERODROME CONTROL TOWERS

7.1.1 General

7.1.1.1 Aerodrome control towers shall issue information and clearances to aircraft under their control to achieve a safe, orderly and expeditious flow of air traffic on and in the vicinity of an aerodrome with the object of preventing collision(s) between:

- a) aircraft flying within the designated area of responsibility of the control tower, including the aerodrome traffic circuits;
- b) aircraft operating on the manoeuvring area;
- c) aircraft landing and taking off;
- d) aircraft and vehicles operating on the manoeuvring area;
- e) aircraft on the manoeuvring area and obstructions on that area.

7.1.1.2 Aerodrome controllers shall maintain a continuous watch on all flight operations on and in the vicinity of an aerodrome as well as vehicles and personnel on the manoeuvring area. Watch shall be maintained by visual observation, augmented in low visibility conditions by an ATS surveillance system when available. Traffic shall be controlled in accordance with the procedures set forth herein and all applicable traffic rules specified by the appropriate ATS authority. If there are other aerodromes within a control zone, traffic at all aerodromes within such a zone shall be coordinated so that traffic circuits do not conflict.

Note.— Provisions for the use of an ATS surveillance system in the aerodrome control service are contained in Chapter 8, Section 8.10.

7.1.1.3 The functions of an aerodrome control tower may be performed by different control or working positions, such as:

- a) aerodrome controller, normally responsible for operations on the runway and aircraft flying within the area of responsibility of the aerodrome control tower;
- b) ground controller, normally responsible for traffic on the manoeuvring area with the exception of runways;
- c) clearance delivery position, normally responsible for delivery of start-up and ATC clearances to departing IFR flights.

7.3 Information to Aircraft by Aerodrome Control Towers

Excerpt from *ICAO Doc 4444, Chapter 7. Refer to paragraph 7.4.1.2.3*

Note.— Significant meteorological conditions in this context include the occurrence or expected occurrence of cumulonimbus or thunderstorm, moderate or severe turbulence, wind shear, hail, moderate or severe icing, severe squall line, freezing precipitation, severe mountain waves, sandstorm, duststorm, blowing snow, tornado or waterspout in the take-off and climb-out area.

7.4.1.2.3 Prior to entering the traffic circuit or commencing its approach to land, an aircraft shall be provided with the following elements of information, in the order listed, with the exception of such elements which it is known the aircraft has already received:

- a) the runway to be used;
- b) the surface wind direction and speed, including significant variations therefrom;
- c) the QNH altimeter setting and, either on a regular basis in accordance with local arrangements or if so requested by the aircraft, the QFE altimeter setting.

Note.— The meteorological information listed above is to follow the criteria used for meteorological local routine and special reports, in accordance with Chapter 11, 11.4.3.2.2 to 11.4.3.2.3.

7.4.1.3 ESSENTIAL LOCAL TRAFFIC INFORMATION

7.4.1.3.1 Information on essential local traffic shall be issued in a timely manner, either directly or through the unit providing approach control service when, in the judgement of the aerodrome controller, such information is necessary in the interests of safety, or when requested by aircraft.

7.4.1.3.2 Essential local traffic shall be considered to consist of any aircraft, vehicle or personnel on or near the manoeuvring area, or traffic operating in the vicinity of the aerodrome, which may constitute a hazard to the aircraft concerned.

7.4.1.3.3 Essential local traffic shall be described so as to be easily identified.

7.4.1.4 RUNWAY INCURSION OR OBSTRUCTED RUNWAY

7.4.1.4.1 In the event the aerodrome controller, after a take-off clearance or a landing clearance has been issued, becomes aware of a runway incursion or the imminent occurrence thereof, or the existence of any obstruction on or in close proximity to the runway likely to impair the safety of an aircraft taking off or landing, appropriate action shall be taken as follows:

- a) cancel the take-off clearance for a departing aircraft;
- b) instruct a landing aircraft to execute a go-around or missed approach;

ATTACHMENT C

ICAO Annex 14 – Aerodromes – Vol 1 – Aerodromes Design and Operations.



ICAO

International Standards
and Recommended Practices

Annex 14 to the Convention on International Civil Aviation

Aerodromes

Volume I

Aerodrome Design and Operations

Seventh Edition, July 2016



This edition supersedes, on 10 November 2016, all previous editions of Annex 14, Volume I.

For information regarding the applicability of the Standards and Recommended Practices, see Chapter 1, 1.2 and the Foreword.

Annex 14, Chapter 7 – Visual Aids for Denoting Restricted Use Areas

Excerpts from *ICAO Annex 14, Volume 1, Chapter 7*

CHAPTER 7. VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS

7.1 Closed runways and taxiways, or parts thereof

Application

7.1.1 A closed marking shall be displayed on a runway or taxiway or portion thereof which is permanently closed to the use of all aircraft.

7.1.2 **Recommendation.**— *A closed marking should be displayed on a temporarily closed runway or taxiway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.*

Location

7.1.3 On a runway a closed marking shall be placed at each end of the runway, or portion thereof, declared closed, and additional markings shall be so placed that the maximum interval between markings does not exceed 300 m. On a taxiway a closed marking shall be placed at least at each end of the taxiway or portion thereof closed.

Characteristics

7.1.4 The closed marking shall be of the form and proportions as detailed in Figure 7-1, Illustration a), when displayed on a runway, and shall be of the form and proportions as detailed in Figure 7-1, Illustration b), when displayed on a taxiway. The marking shall be white when displayed on a runway and shall be yellow when displayed on a taxiway.

Note.— *When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.*

7.1.5 When a runway or taxiway or portion thereof is permanently closed, all normal runway and taxiway markings shall be obliterated.

7.1.6 Lighting on a closed runway or taxiway or portion thereof shall not be operated, except as required for maintenance purposes.

7.1.7 In addition to closed markings, when the runway or taxiway or portion thereof closed is intercepted by a usable runway or taxiway which is used at night, unserviceability lights shall be placed across the entrance to the closed area at intervals not exceeding 3 m (see 7.4.4).

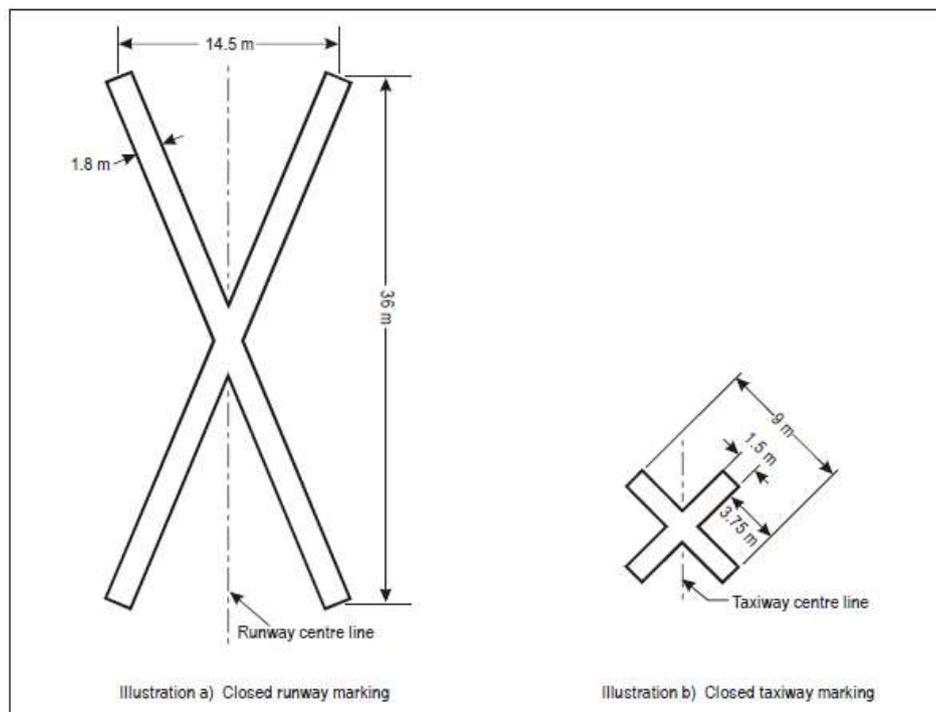


Figure 7-1. Closed runway and taxiway markings

7.2 Non-load-bearing surfaces

Application

7.2.1 Shoulders for taxiways, runway turn pads, holding bays and aprons and other non-load-bearing surfaces which cannot readily be distinguished from load-bearing surfaces and which, if used by aircraft, might result in damage to the aircraft shall have the boundary between such areas and the load-bearing surface marked by a taxi side stripe marking.

Note.— The marking of runway sides is specified in 5.2.7.

Location

7.2.2 **Recommendation.**— A taxi side stripe marking should be placed along the edge of the load-bearing pavement, with the outer edge of the marking approximately on the edge of the load-bearing pavement.

Characteristics

7.2.3 **Recommendation.**— *A taxi side stripe marking should consist of a pair of solid lines, each 15 cm wide and spaced 15 cm apart and the same colour as the taxiway centre line marking.*

Note.— *Guidance on providing additional transverse stripes at an intersection or a small area on the apron is given in the Aerodrome Design Manual (Doc 9157), Part 4.*

7.3 Pre-threshold area**Application**

7.3.1 **Recommendation.**— *When the surface before a threshold is paved and exceeds 60 m in length and is not suitable for normal use by aircraft, the entire length before the threshold should be marked with a chevron marking.*

Location

7.3.2 **Recommendation.**— *A chevron marking should point in the direction of the runway and be placed as shown in Figure 7-2.*

Characteristics

7.3.3 **Recommendation.**— *A chevron marking should be of conspicuous colour and contrast with the colour used for the runway markings; it should preferably be yellow. It should have an overall width of at least 0.9 m.*

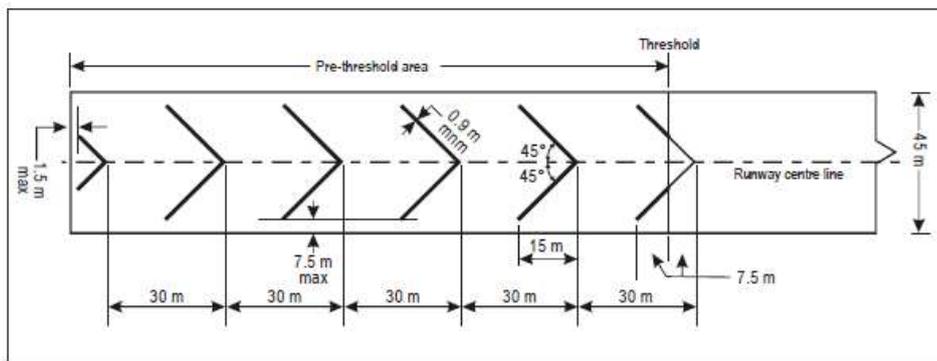


Figure 7-2. Pre-threshold marking

7.4 Unserviceable areas

Application

7.4.1 Unserviceability markers shall be displayed wherever any portion of a taxiway, apron or holding bay is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely. On a movement area used at night, unserviceability lights shall be used.

Note.— Unserviceability markers and lights are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Location

7.4.2 Unserviceability markers and lights shall be placed at intervals sufficiently close so as to delineate the unserviceable area.

Note.— Guidance on the location of unserviceability lights is given in Attachment A, Section 14.

Characteristics of unserviceability markers

7.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

Characteristics of unserviceability lights

7.4.4 An unserviceability light shall consist of a red fixed light. The light shall have an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which it would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

Characteristics of unserviceability cones

7.4.5 **Recommendation.**— *An unserviceability cone should be at least 0.5 m in height and red, orange or yellow or any one of these colours in combination with white.*

Characteristics of unserviceability flags

7.4.6 **Recommendation.**— *An unserviceability flag should be at least 0.5 m square and red, orange or yellow or any one of these colours in combination with white.*

Characteristics of unserviceability marker boards

7.4.7 **Recommendation.**— *An unserviceability marker board should be at least 0.5 m in height and 0.9 m in length, with alternate red and white or orange and white vertical stripes.*