ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 23-1005

Tropicair Limited

P2-JAU

Beechcraft Super King Air B200C

Nose Landing Gear Collapse During Landing Roll

Jacksons International Airport, Port Moresby

Papua New Guinea

1 September 2023

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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 serious incidents 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.

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About this report

On 1 September 2023 at 12:58 local time , the AIC was notified by an employee of the AIC through a phone call of an accident[1] involving a Beechcraft Super King Air B200C aircraft, registered P2-JAU, owned and operated by Tropicair Limited at Jacksons International Airport, Port Moresby.The AIC immediately commenced an investigation. The accident occurred at 12:51 on 1 September 2023.

This Final Report has been produced by the AIC, P.O Box 1709, Boroko 121, NCD, Papua New Guinea. It has been approved for public release by the Commission in accordance with *Para 6.5 of ICAO Annex 13*. The report is published on the AIC website www.aic.gov.pg.

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 Annex13, 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.

Maryanne J. Wal

Chief Commissioner

21 August 2024

[1] *Annex 13 to the Convention on International Civil Aviation* defines an accident as An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:
a) a person is fatally or seriously injured as a result of:
— being in the aircraft, or
— direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or — direct exposure to jet blast,
except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or
b) the aircraft sustains damage or structural failure which:
— adversely affects the structural strength, performance, or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, *except* for engine failure or damage, when the damage is limited to a single engine (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes), or for minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike (including holes in the radome); or
c) the aircraft is missing or is completely inaccessible.

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GLOSSARY OF ABBREVIATIONS

AGL	:	Above Ground Level
AIC	:	Accident Investigation Commission (PNG)
ATC	:	Air Traffic Control
AMSL	:	Above Mean Sea Level
AMM	:	Aircraft Maintenance Manual
AMP	:	Aircraft Maintenance Program
AOC	:	Air Operator Certificate
ARFF	:	Airport Rescue & Fire Fighting
ATC	:	Air Traffic Control
ATPL	:	Air Transport Pilot License
ATS	:	Air Traffic Service
CASA	:	Civil Aviation Safety Authority
CCTV	:	Closed Circuit Television
CPL	:	Commercial Pilot License
CVR	:	Cockpit Voice Recorder
DME	:	Distance Measuring Equipment
FDR	:	Flight Data Recorder
GPS	:	Global Positioning System
Kts	:	Knots
ICAO	:	International Civil Aviation Organisation
IOA	:	Instrument of Authorisation
ILS	:	Instrument Landing System
ME	:	Multi-Engine
MOC	:	Maintenance Organisation Certificate
MTOW	:	Maximum take-off weight
NAC	:	National Airports Corporation
NLG	:	Nose Landing Gear
NM	:	Nautical mile(s)
PIC	:	Pilot in Command
QRH	:	Quick Reference Handbook
SE	:	Single Engine
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
TAF	:	Terminal Aerodrome Forecast
UTC	:	Universal Time Coordinate
VHF	:	Very High Frequency
VFR	:	Visual Flight Rules
WAAS	:	Wide Area Augmentation System

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INTRODUCTION

SYNOPSIS

On 1 September 2023, at 12:51 local (02:51 UTC), a Beechcraft B200C Super King Air aircraft, registered P2-JAU, owned and operated by Tropicair Limited, sustained a Nose Landing Gear (NLG) assembly collapse during the landing roll on Runway 14R , at Jacksons International Airport. The aircraft was operating a non-scheduled passenger charter flight from Tari Airport, Hela Province to Jacksons International Airport, National Capital District, Papua New Guinea.

There were 7 persons on board the aircraft; Pilot in Command (PIC), Co-pilot and 5 passengers. There were no injuries reported. The Co-pilot was pilot flying, occupying the right seat and the PIC was pilot monitoring, occupying the left seat.

About 7 NM from Jacksons, passing 2,200 ft AMSL, whilst conducting the pre-landing checks, the flight crew observed an 'Unsafe Gear Indication' in the cockpit after they had selected the (DN) Down switch to extend the landing gear. They observed two green lights for the Left and Right Main Landing Gears , indicating a fully extended position and two red, parallel-wired indicator lights located on the landing gear control handle illuminated for the NLG, indicating that the NLG was not locked into the fully extended position. The flight crew stated that they recycled the landing gear, however, the same indication was observed (red light remained illuminated).The flight crew, therefore conducted a missed approach and continued runway heading to 2,500 ft AMSL to rectify the issue. While passing 1,700 ft AMSL, the flight crew subsequently actioned the Landing Gear Alternate Extension-Manual (Mechanical Landing Gear System) Procedure, however, the red light remained illuminated for the NLG.

The flight crew conducted two low fly passes for ATC and Tropicair respectively to confirm the position of the NLG. The first low fly pass was carried out and ATC advised flight crew that the NLG was not fully extended. The second low fly pass was conducted over Runway 14R for Tropicair personnel, who also advised that the nosewheel was not fully extended. After all attempts to get the NLG down was unsuccessful, the flight crew landed on Runway 14R with the partially extended NLG. The aircraft rolled for 520 m before it collapsed. The aircraft then continued forward with momentum for 105 m before coming to a stop adjacent to Taxiway Foxtrot.

The investigation determined that the NLG Actuator sustained internal failure, which prevented the NLG from fully extending. It was found from the manufacturer's teardown and inspection of the faulty NLG Actuator that the nut assembly had excessively worn threads and could be pulled out of the screw housing without any thread engagement. The operator had carried out the NLG Actuator lubrication at intervals required by the manufacturer, however, the investigation identified dry and thick grease/lubricant in the nut assembly. It is likely that if there was inadequate grease or lubricant in the nut assembly, it may have depleted overtime which resulted in the nut assembly threads excessively wearing out before the next service of the NLG Actuator was due.

The NLG Actuator lubrication carried out by the operator at specified due intervals were incorrectly referenced. The NLG Actuator lubrication procedure, if correctly referenced, would have directed the maintenance personnel to a separate NLG Actuator inspection procedure which is required to be performed before the lubrication to determine whether the actuator should be returned to service and inspected at specified intervals, overhauled or replaced. The investigation found that there were no records of this coinciding NLG Actuator inspection procedure.

The AIC issued a safety recommendation to the Operator to ensure that steps are implemented to ensure that the Beechcraft B200C Super King Air Aircraft Maintenance Manual procedures, such as the Nose Landing Gear Actuator inspection and lubrication procedure in Chapter 32-30-11,601 and 32-30-07,301 respectively, including other special inspection procedures are correctly referenced, carried out and recorded at specified due intervals.

The AIC notes that Tropicair Limited took prompt action to address the safety deficiencies identified by the AIC in one *Safety Recommendation* issued to Tropicair. The AIC has assessed the actions taken by Tropicair Limited and closed the *Safety Recommendation.*

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1 FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

On 1 September 2023, at 12:51 local (02:51 UTC[2]), a Beechcraft Super King Air B200C aircraft, registered P2-JAU[3], owned and operated by Tropicair Limited sustained a Nose Landing Gear Assembly collapse during landing roll on Runway 14R at Jacksons International Airport. The aircraft was operating a non-scheduled passenger charter flight from Tari Airport, Hela Province to Jacksons International Airport, National Capital District, Papua New Guinea.

Source: Google Earth, annotated by the AIC.

Figure 1:Depiction of P2-JAU Accident Flight Path and Final Resting Position.

There were 7 persons on board the aircraft: Pilot in Command (PIC), Co-pilot and 5 passengers. The Co-pilot was pilot flying, occupying the right seat and the PIC was pilot monitoring, occupying the left seat.

According to recorded data[4], the aircraft departed Tari Airport at 10:46, climbed to an altitude of 28,000 ft AMSL[5] and tracked Southeast for Port Moresby. At 11:55, the aircraft commenced descent from 28,000 ft AMSL.

At 12:11, while passing 10,000 ft AMSL at about 28 NM Northwest of Jacksons Airport, ATC gave clearance to descend to 2,500 ft AMSL for the ILS[6] approach via the Laloki Intercept[7] for Runway 14L.

At 12:12, passing 9,000 ft AMSL, the flight crew began the '*10,000 ft Check'* and subsequently proceeded with the prelanding checks (*Refer to Section 5.1, Appendix A*).

At 12:15, passing 4,000 ft AMSL, the aircraft was established on the ILS at 10 DME[8] and ATC subsequently instructed the flight crew to continue approach with clearance for landing on Runway 14L.

At 12:17, about 7 NM from Jacksons, passing 2,200 ft AMSL, whilst conducting the Pre-landing checks (*Refer to Section 5.1, Appendix A*), the flight crew observed an 'Unsafe Gear Indication' in the cockpit after they had selected the 'DN[9]' switch to extend the landing gear.

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

3 Hereafter, P2-JAU will be referred to as 'the aircraft'.

4 The recorded data is referring to the aircraft Cockpit Voice Recorder, Appareo V1000 data, and the ATC recorded data synchronized. Refer to section 1.11 for more information.

5 Above Mean Sea Level

6 Instrument Landing System.

7Flight route ,27 miles from STARF (waypoint) on a track of 109 degrees to 10 DME Moresby.

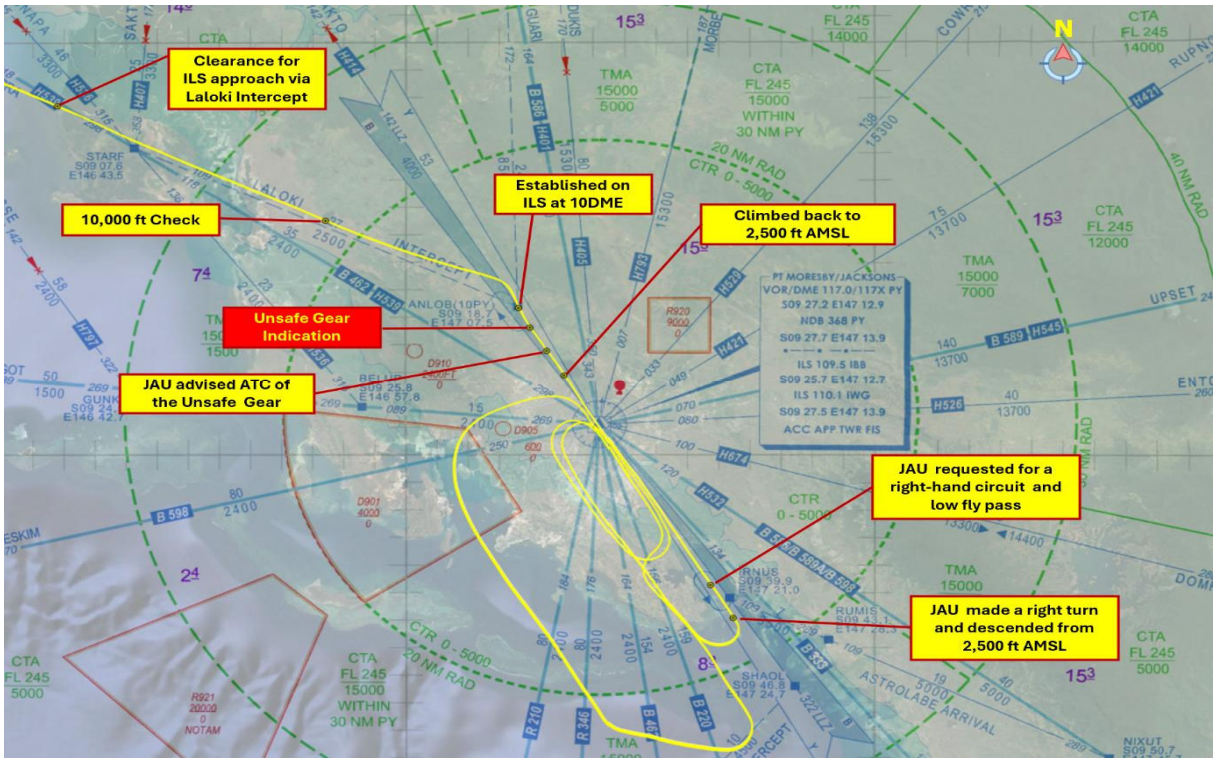
8 Distance Measuring Equipment (DME), navigation beacon, usually coupled with a VOR beacon, to enable aircraft to measure their position relative to that beacon.

9 Down

They observed two green lights for the Left and Right Main Landing Gears, indicating a fully extended position and two red, parallel-wired indicator lights located on the landing gear control handle illuminated for the Nose Landing Gear (NLG) indicating that the NLG was not locked into the fully extended position. The flight crew stated that they recycled[10] the Landing Gears, however, the same indication was observed (red light remained illuminated for the NLG).

At 12:18, the flight crew advised ATC of the unsafe gear indication and their intention to do a missed approach and track to Delta 901[11](D901) to rectify the issue. ATC cleared the aircraft for a missed approach and instructed them to continue runway heading and to maintain 2,500 ft AMSL due to D901 being occupied by another aircraft at that time. The flight crew acknowledged and while passing through 1,700 ft AMSL, they subsequently actioned the Landing Gear Alternate Extension-Manual (Mechanical Landing Gear System) Procedure from the *Beechcraft Super King Air B200/B200C Pilot's Check List for Abnormal Procedures* in the *Quick Reference Handbook* (QRH) (*Refer to Section 5.2, Appendix B*). However, the red light remained illuminated for the NLG. The flight crew stated during interview that since the red light remained illuminated, a decision was made for the PIC to take over control of Pilot Flying duties.

At 12:19, about 5 NM from Jacksons, recorded data showed that the aircraft initiated climb to 2,500 ft AMSL while maintaining runway heading. At 12:22, the flight crew contacted ATC and requested for a right-hand circuit and low fly pass so ATC could confirm the position of the NLG. ATC gave clearance to the flight crew to turn right for a right circuit for the low pass. Recorded data showed that at 12:23, the aircraft began to make a right turn and subsequently began descending from 2,500 ft AMSL.



Source: Google Earth, annotated by the AIC

Figure 2:Depiction of Flight Path-Approach, Go-Around, and Clearance for First Low Fly Pass.

At 12:27,while passing 800 ft AMSL, the flight crew advised ATC that they were turning onto finals for the low fly pass and were subsequently cleared for the low pass by ATC.

10. Recycling the landing gear refers to a specific procedure in aviation when the landing gear fails to extend properly during an aircraft's approach for landing. In the event that the landing gear fails to extend after the initial attempt, the pilot performs a second attempt, which is known as **"recycling"** the landing gear. During this process, the pilot retracts and then re-extends the landing gear in an effort to troubleshoot and resolve the issue.

11 Flying training area from ground to 4,000 ft AMSL.

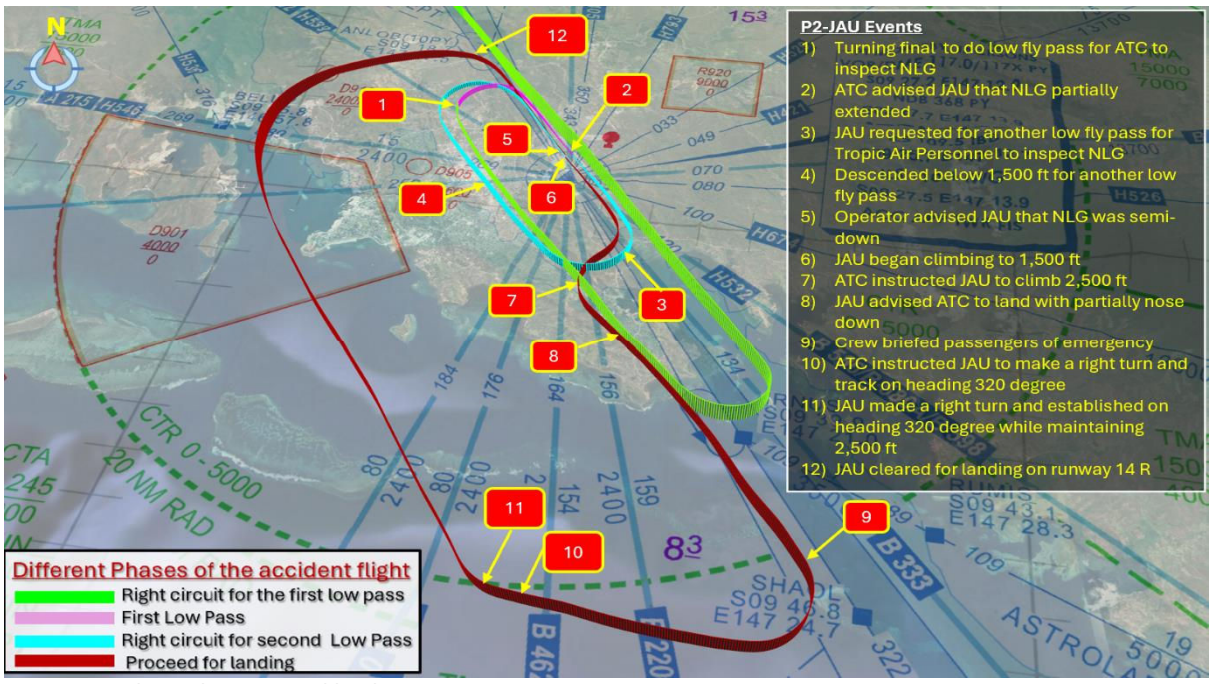
Recorded data showed that the aircraft continued to descend and levelled off at 200 ft AMSL (70 ft AGL[12]) for ATC to observe the NLG. At 12:29, ATC then advised the flight crew that the NLG appeared down, but at an angle and not fully extended. ATC then cleared the aircraft for a right circuit and to maintain 1,500 ft AMSL.

At 12:30, the aircraft climbed to and maintained 1,500 ft AMSL. The recorded data indicated that around this time, the flight crew requested for another low fly pass over Runway 14R to allow Tropicair personnel to observe the NLG from the ground and report to the crew. At 12:32, recorded data showed that following clearance from ATC, the aircraft began to descend below 1,500 ft AMSL for another low fly pass over the parallel runway, Runway 14R. At 12:34, while maintaining 200 ft AMSL (70 ft AGL), Tropicair personnel on the ground advised the flight crew that the nosewheel was semi-down and did not appear to be in the fully extended position.

At 12:35, recorded data showed that the aircraft began climbing and the flight crew was subsequently instructed by ATC to maintain 1,500 ft AMSL and runway heading. After all attempts to get the NLG down was unsuccessful, at 12:37, the flight crew advised ATC that they will land on Runway 14R with the NLG partially down. ATC subsequently instructed the flight crew to continue climb to 2,500 ft AMSL for traffic separation and management and maintain runway heading to allow two other inbound traffic to approach to land.

Recorded data showed that at 12:39, the flight crew then briefed the passengers of the emergency and on what to expect and do on landing and then proceeded with the pre-landing checks and finals check in preparation for landing.

At 12:41, ATC instructed the flight crew to make a right turn and track on a heading of 320 degrees . The recorded data showed that the aircraft then conducted a right turn and subsequently established on a heading of 320 degrees while maintaining 2,500 ft AMSL. At 12:49, ATC cleared the aircraft for landing on Runway 14R.



Source: Google Earth, annotated by the AIC

Figure 3:Depiction of Flight Path-Low Fly Passes to Clearance for Landing on Runway 14R.

The flight crew subsequently conducted the approach for Runway 14R and touched down at 12:51.

12 Above Ground Level (AGL)-All altitude data obtained from the Appareo Unit recorded data are reference to the Jacksons Aerodrome elevation of 129 ft.

According to the PIC, both condition levers[13] were pulled to the fuel cut off position to shut off fuel to the engines just before touchdown. He further stated that on touchdown, he held the nose wheel up to keep the weight off the nosewheel until the speed reduced.

The aircraft rolled for 520 meters and when it finally slowed down, the NLG collapsed, and the nose dropped to the ground. The aircraft continued forward with momentum for 105 meters before coming to rest adjacent to Taxiway Foxtrot where Emergency Services[14] were standing by for assistance.

Video footage provided by National Airports Corporation (NAC) also showed that on touchdown, the nose wheel did not make contact with the runway surface during the landing roll before the NLG collapsed and the nose dropped to the ground.

The flight crew stated in the interview that once the aircraft came to a complete stop, a precautionary disembarkation was carried out. Video footage from NAC also showed that at 12:52, Airport Rescue & Fire Fighting (ARFF) assisted the passengers to disembark and moved them to a safe location away from the aircraft.

1.2 INJURIES TO PERSONS

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	2	5	7	Not applicable
TOTAL	2	5	7	-

Table 1:Injuries to Persons.

There were no injuries to persons as a result of this occurrence.

1.3 DAMAGE TO AIRCRAFT

The aircraft sustained substantial damage to both Left and Right Propeller Assemblies, Nose Structure and Left and Right Nose Landing Gear (NLG) Doors. *Refer to Section 1.12*.

1.4 OTHER DAMAGE

Limited to markings on the runway surface caused by the left-hand and right-hand propellers contacting the runway surface.

Evidence reviewed indicated that when the nose wheel collapsed, the aircraft continued travelling forward due to momentum, with the propeller blades striking the runway surface.

[13] The condition lever is a pilot actuated control located within the throttle quadrant of a turboprop engine equipped aircraft like the King Air B200C. It is used to control some functions of both the propeller and the engine, including fuel cut off.

[14] Refer to Section 1.15 'Survival Aspects'.

Figure 4:Runway Surface Markings-14R.

1.5 PERSONNEL INFORMATION

1.5.1 Pilot in Command

Age	: 67 years
Gender	: Male
Nationality	: Canadian
Type of licence	: ATPL (A[15])
Valid to	: Perpetual
Rating	:SE[16]/ME[17] Aeroplane (Land).SE<5700Kg, MTOW[18],ME:BN2; C402; DHC-6; BE20; BE90; DHC-8, C525B.
Total flying time	: 32,127.7 hours
Total on this type	: 29,588.4 hours
Total last 90 days	: 270.4 hours
Total on type last 90 days	: 192.2 hours
Total last 7 days	: 23.3 hours
Total on type last 7 days	: 23.3 hours
Total last 24 hours	: 4.5 hours

15 Aeroplane
16 Single Engine
17 Multi Engine
18 Maximum Take-off Weight

Total on the type last 24 hours	:	4.5 hours
Total on duty last 48 hours	:	15 hours
Total rest period(s) last 48 hours	:	33 hours
Medical class	: One	
Valid to	: 21 September 2023	
Medical limitation	: Spectacles	

The PIC was issued with an IOA by the Civil Aviation Safety Authority (CASA) of PNG on 23 March 2022 to carry out functions of a Category D Flight Instructor in accordance with *Rule 61.305 (d)* and carry out the functions of an Airline Flight Examiner in accordance with *Rule 61.905 (a) (2)*.

1.5.2 Co-pilot

Age	: 28 years
Gender	: Male
Type of licence	: CPL (A)
Valid to	: Perpetual
Rating	: PA28;DA42
Total flying time	: 606.3 hours
Total on this type	: 302 hours
Total last 90 days	: 130.1 hours
Total on type last 90 days	: 130.1 hours
Total last 7 days	: 6.3 hours
Total on type last 7 days	: 16.3 hours
Total last 24 hours	: 3.5 hours
Total on the type last 24 hours	: 3.5 hours
Total on duty last 48 hours	: 20 hours
Total rest period(s) last 48 hours	: 28 hours
Medical class	: One
Valid to	: 9 November 2023
Medical limitation	: Nil

1.6 AIRCRAFT INFORMATION

1.6.1 Aircraft Data

Aircraft manufacturer	: Hawker Beechcraft Corporation
Model	: B200C King Air
Serial number	: BL-39
Date of manufacture	: 1981
Nationality and registration mark	: PNG, P2-JAU
Name of the owner	: Tropicair Limited
Name of the operator	: Tropicair Limited
Certificate of Airworthiness No	: 295
Date of Issue	: 18 January 2013
Valid to	: Non-Terminating
Certificate of Registration No	**:** 295
Date of Issue	: 18 January 2013
Valid to	: Non-Terminating
Total time Since New	: 24,019.54 hours
Total Cycles Since New	: 23, 214 Cycles

1.6.2 Engine Data

Engine Type	: Turbo propeller
Manufacturer	: Pratt and Whitney, Canada
Type	: PT6A-42
Engine number one (Left)	
Serial Number	: PCE-93014
Total Time Since New	: 10,284.15
Engine Cycles	: 9,012
Time Since Overhaul	: 3,625.15
Cycles Since Overhaul	: 2,975
Engine number two (Right)	
Serial Number	: PCE-PJ0960
Time Since New	: 7,348.11
Engine Cycles	: 6,078
Time Since Overhaul	: 3,662.26
Cycles Since Overhaul	: 3,104

Evidence reviewed indicated that Engines were not a contributing factor to this accident.

1.6.3 Propeller Data

Manufacturer	: Hartzell Propeller Inc
Model	: HC-D4N-3A
Propeller number one (Left)	
Serial Number	: FY668
Total Time Since New	: 13,446.58
Total Time Since Overhaul	: 2,246.38
Propeller number two (Right)	
Serial Number	: FY3107
Total Time Since New	: 7,043.24
Total Time Since Overhaul	: 1,201.54

Evidence reviewed indicated that Propellers were not a contributing factor to this accident.

1.6.4 Beechcraft King Air Mechanical Landing Gear System.

According to the *King Air 200 Series Maintenance Manual and the King Air Pilot Operating Handbook P/N 101-590010-147*, the aircraft has a tricycle type landing gear system (*Refer to Figure 5*). The mechanical landing gear is operated by a 28-volt split-field series-wound motor located on the forward side of the center section spar which extends and retracts the landing gear. One field is used to drive the motor in one direction and the other drives the motor in the opposite direction. The landing gear motor is controlled by the handle placard LDG[19] GEAR CONTROL-UP-DN[20] located on the pilot's right subpanel.

The landing gear control handle is pulled out of a detent before it can be moved from either the UP or the DN position. The motor incorporates a dynamic braking system controlled with the "Up" and "Down" limit switches, which in conjunction with the landing gear locking mechanism prevents overtravel of the landing gear. When the pilot turns the switch Up or Down, it powers the motor, which then drives the torque shaft and transfers the energy through to extend or retract the MLG actuator.

Simultaneously, the NLG is actuated differently. The motor transfers the torque energy through a duplex chain from a sprocket on the gearbox torque shaft. This shaft then drives a series of rotating gears inside the actuator. These gears then rotate a screw into and out of a lubricated aluminium bronze alloy nut which is part of the NLG actuator assembly. Depending on which direction the motor moves, the screw is being driven into or out of a nut. As the screw is being driven out of the nut, it extends and pushes the brace forward until the nose landing gear is in a fully extended position (*Refer to Figure 6*).

Notched hook and plate attachments fitted to each main drag brace and the over-center action of the nose gear drag brace provide positive mechanical down-locks. A jackscrew (nut and screw) in each actuator holds the gear in the retracted position.

Visual indication of landing gear position is provided by individual green (three green lights) GEAR DOWN annunciators , arranged in a square and placarded NOSE-L-R[21] (*Refer to Figure 8*) on the pilot's right subpanel , adjacent to the control handle.

During the transition, when the landing gear extends or retracts, two red, parallel-wired indicator lights located on the landing gear control handle (*Refer to Figure 8*) illuminate to show that the gear is in transit or not properly locked. They also illuminate when the landing gear warning horn is actuated. Absence of illumination indicates that the gear is up and locked or down and locked.

19 Landing
20 Down
21 Left-Right

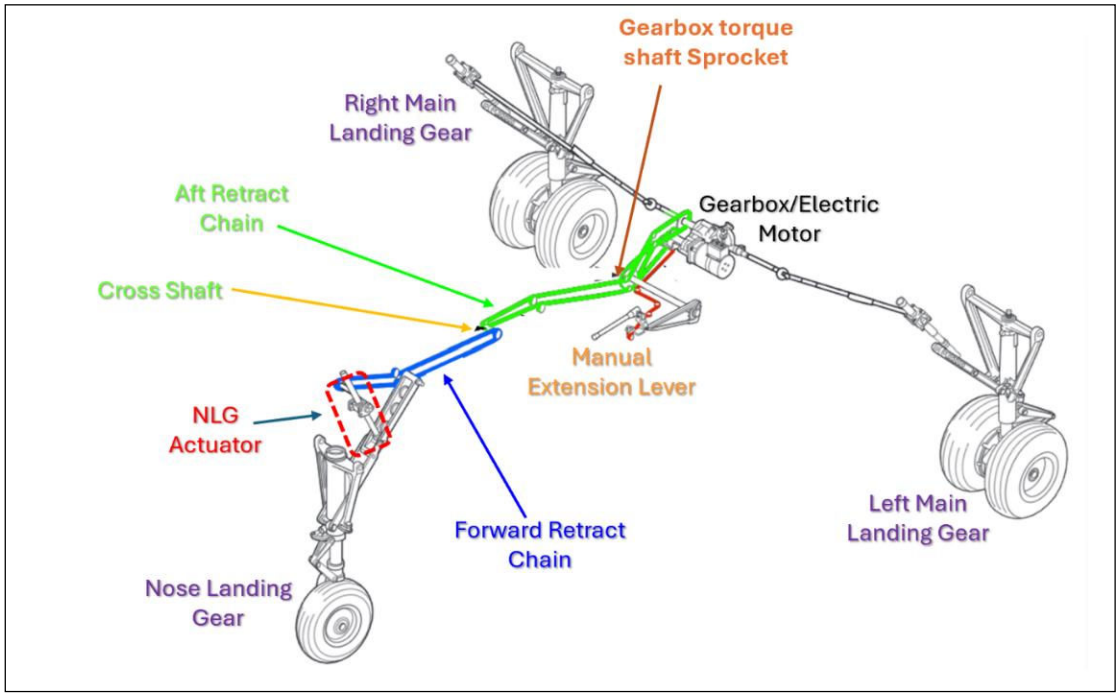


Figure 5:Mechanical Landing Gear System.

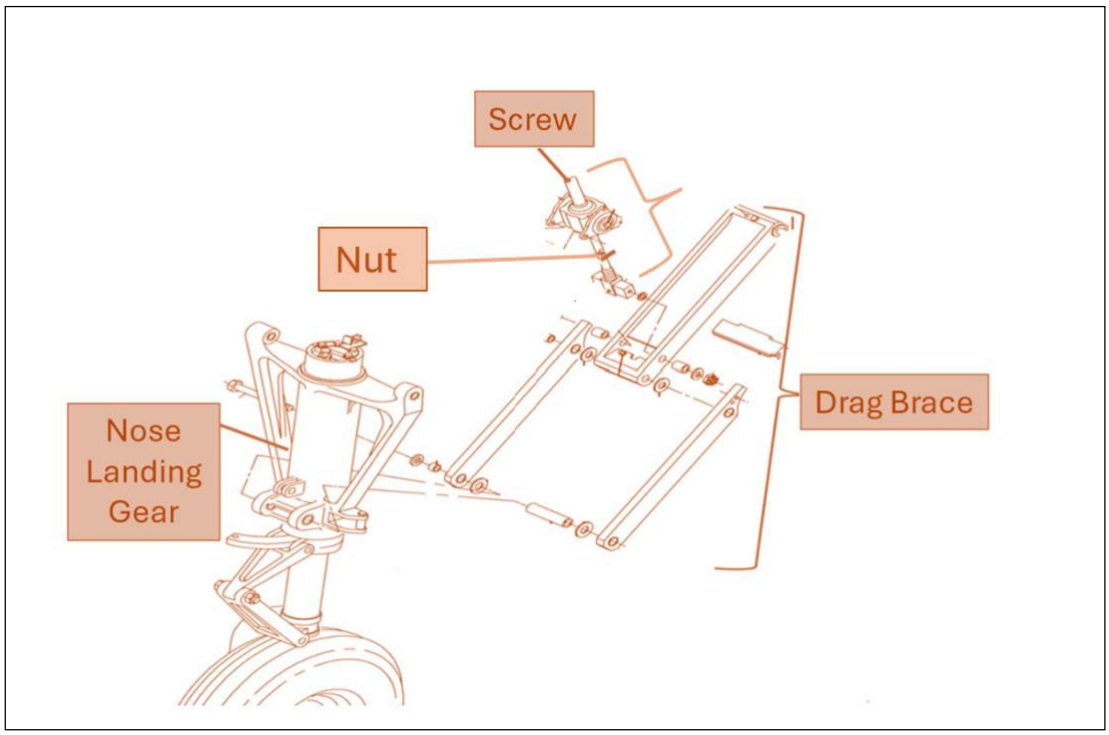


Figure 6:NLG Actuator Screw, Nut and Drag Brace.

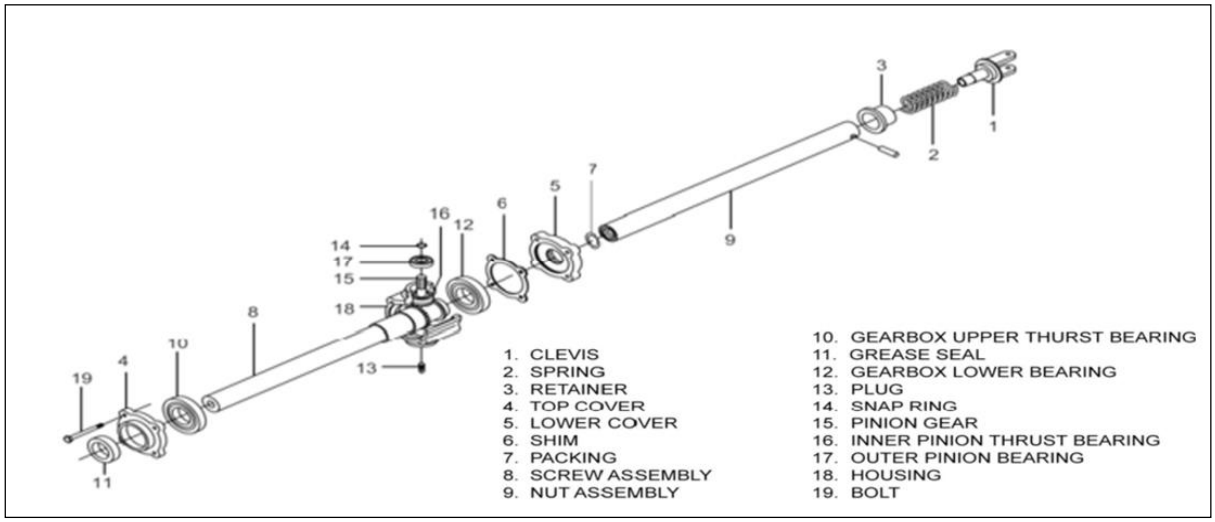


Figure 7:NLG Actuator components.

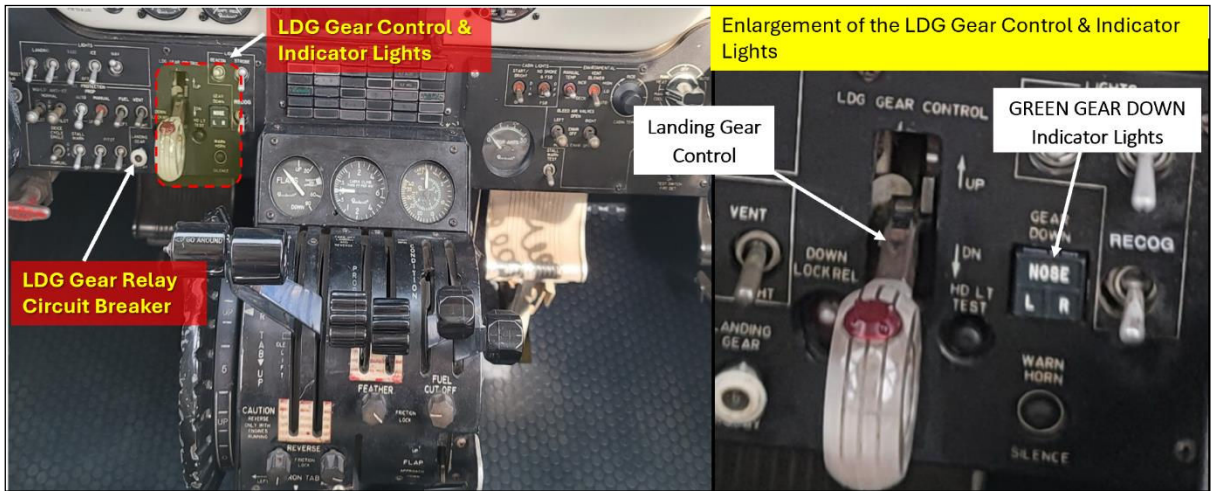


Figure 8:Landing Gear Controls.

1.6.5 Mechanical Landing Gear Alternate Extension-Manual Control

In the event that the landing gear fails to extend after placing the Landing Gear Control switch Down, the landing gears can be manually extended. The pilot manually powers the chain-drive system to extend the landing gears by pulling the LANDING GEAR RELAY circuit breaker located to the left of the landing gear control handle on the pilot's right subpanel (*Refer to Figure 8*) ,with the Landing Gear Control Switch handle in the DN (down) position. The alternate engage handle, located on the floor is pulled up and turned clockwise until it stops to engage.

Figure 9:P2-JAU Mechanical Landing Gear Alternate Extension-Manual Control.

This will electronically disconnect the motor from the system and lock the alternate drive system to the gear box. With the alternate drive locked in , the chain is driven by a continuous-action ratchet, which is activated by pumping the alternate extension handle located adjacent to the alternate engage handle, up and down until the three green gear-down annunciators are illuminated (*Refer to Figure 8*).

1.6.6 Maintenance/Airworthiness

The aircraft had a valid *Certificate of Airworthiness*, and the *Annual Airworthiness Review* was current at the time of the occurrence.

The maintenance records were reviewed during the investigation and identified discrepancies which are discussed under special inspections, findings and the analysis.

1.6.6.1 *Maintenance Planning and Programme*

The operator's Aircraft Maintenance Programme (AMP) for the B200-King Air aircraft was approved by CASA PNG pursuant to *Civil Aviation Rule (CAR) 91.607* on 12 February 2021.

The Programme was developed in accordance with the Aircraft and Engine Manufacturers relevant maintenance manual and regulatory requirements. The Maintenance Programme encompasses maintenance items (*Refer to Section 5.3, Appendix C*) which includes the Scheduled Inspection, Special Inspection and Overhaul discussed in *sections 1.6.6.2 to 1.6.6.4.*

1.6.6.2 *Scheduled Inspection*

1.6.6.2.1 200-Hour Phase Inspection Program

The Operator's scheduled Phase Inspection of the aircraft is divided into four phases. Each phase is required to be carried out every 200 hours +/-20 (allowable tolerance) on sections of the aircraft, which includes the Nose Landing Gear Area and Gear Retraction checks.

The four inspection phases form one complete inspection cycle, with each phase occurring every 200 hours and sequentially following the previous one.

A full inspection cycle is 800 hours and must be conducted within 24 months.

The operators Maintenance personnel mentioned in an interview with the AIC that they conduct phase inspections at intervals of 200 hours, accumulating to a total of 800 hours by the time Phase 4 inspection is due.

The specific inspection of the Nose Landing Gear Actuator in each Phase inspections are outlined in Table 2 as per the *Super King Air 200 Series Maintenance Manual (AMM), Chapter 5-20-01, 5-20-02, 5-20-03,* and *5-20-04, 'Scheduled Inspection Program*,' :

Phase	Hours	Areas Inspected
1	200	Noise, binding, and proper rigging in accordance with Chapter 32-30-11, 601, 32-31-27,501 and 32-31-29,501 of the MM.
2	400	Inspect actuator support brackets for damage, cracks and loose or missing fasteners. Inspect actuator (both types) for leakage. Inspect plumbing (hydraulic actuator only) for leak in accordance with Chapter 32-30-07-601 and 32-30-11-601 of the MM.
3	600	Noise, binding, and proper rigging in accordance with Chapter 32-30-11, 601
4	800	Noise, binding, and proper rigging in accordance with Chapter 32-3-11,601,32-31-27,501 and 32-31-29,501 in accordance with the MM

Table 2:Four Phase Inspections and Specific Inspection of the NLG Actuator.

The AIC reviewed maintenance records and found that the last phase inspection carried out before the accident was Phase 1, which was carried out at the Tropicair Engineering Hangar from 18 to 29 August 2023 in accordance with the *Super King Air 200 Series Maintenance Manual (AMM), Chapter 05-20-01-201* and recorded in the operator's *Work Order No. JAU-WP-023*.

According to the Operators Engineering personnel, the inspection carried out on the NLG Actuator as required in Phase 1 are visual inspections .

The total aircraft hours recorded during the Phase 1 inspection carried out was 24,012.48 hours and total cycles was 23,210. The last Phase 4 inspection (complete inspection cycle) which was carried out from 13 to 18 June 2022 before re-establishing the aircraft's inspection cycle, had a total of 23,618 aircraft hours and 23,838.26 cycles.

The aircraft hours accumulated between the Phase 4 Inspection and the last phase inspection (Phase 1) was 174.18 hours. This was within the required 200-hour interval before the next phase inspection.

The record also showed that the aircraft had accumulated 7.06 hours and 4 cycles between the last Phase 1 inspection and the time of the accident .

1.6.6.3 *Special Inspections*

The operator's Special inspections consist of components which includes the NLG Actuator that are subject to a thorough inspection and lubrication based on calendar time, operating hours or cycles, which do not coincide with the intervals established by the scheduled inspection program. The time periods for all inspections specified are based on average usage and average environmental conditions.

The *Super King Air Model 200 Series Maintenance Manual, Chapter 32-30-00* requires the NLG Actuator to be serviced. Chapter 32-30-11,601 requires the NLG Actuator to be inspected before it is lubricated in accordance with Chapter 32-30-07,301.

Chapter 5-20-05 of the *Super King Air Model 200 Series Maintenance Manual* (*Refer to Table 2*) contains the inspection intervals for components required to be inspected and lubricated under the Special Inspections Programme every 1000 cycles or 30 months whichever occurs first.

According to the operator, Special Inspection Tasks or 'Out-of-Phase' Inspection Tasks are tracked and monitored on the Traxxall Software and individually task- tracked accordingly via a routine software requested '*Duelist Report'* using the aircraft hours and cycles to determine the timing of the next required inspections.

1.6.6.3.1 Inspections of the NLG Actuator

The *Nose Landing Gear Actuator inspection* as per *Super King Air Model 200 Series Maintenance Manual, Chapter 32-30-11,601* (*Refer to 5.4.1, Appendix D1*) states that any time the Nose Landing Gear Actuator is removed (*Refer to* 5.4.2, Appendix D2) from the aircraft for lubrication, the actuator should be bench checked for total end play prior to lubrication.

The total end play measures the distance over which the nut assembly may be pushed in and out of the actuator housing. It also checks the actuator end play with the main landing gear actuator nut fully in and backed off one turn and half extended with the nut extended seven inches. Moreover, it also measures the end play on the nose gear actuators with the actuator nut fully in and backed off one turn, with the nut half extended, and with the nut extended 10.5 inches (*Refer to 5.4.1, Appendix D1).*

If the total end play measured at any one of the above noted positions is less than 0.016 inch the actuator may be returned to service and rechecked for end play using intervals. If the total end play is more than 0.016 inch but less than 0.018 inch, the actuator may be returned to service, but must be checked every 200 cycles. Whenever the end play in any position reaches 0.018 inch, the actuator should be overhauled or replaced.

There was no record of the NLG Actuator inspection carried out in accordance with *B200 AMM, 32-30-11,601* since the last overhaul on 20 July 2018 and recorded as required by *CAR Part 43.68 (a) (1) (2) and (3)* 'Maintenance records' (*Refer to Section 5.6, Appendix F*).

1.6.6.3.1.1 Statutory Declaration-Maintenance Record

During the involved parties review of the Draft Final Report, Tropicair Ltd submitted a Statutory Declaration containing the statement from relevant maintenance personnel declaring all the maintenance reportedly carried out on 15 June 2022 which included the NLG Actuator inspection required by *B200 AMM 32-30-11,601.*

1.6.6.3.2 Lubrication of the NLG Actuator

According to the manufacturer's requirement, the lubrication of the NLG Actuator is required to be carried out every 30 months or 1000 cycles, whichever occurs first (*Refer to 5.4.3,Appendix D3*). Records showed that at the time of the last overhaul on 20 July 2020, the aircraft had a total of 20,392 cycles. The NLG Actuator lubrication was carried out on 28 August 2020 when the aircraft had a total of 21,358 cycles and had accumulated a total of 966 cycles with a total of 24 months elapsed after the overhaul. The last NLG Actuator lubrication ,before the accident, was carried out on 15 June 2022 when the aircraft had a total of 22,435 cycles and had accumulated a total of 1,077 cycles; that's 77 cycles past the 1000 cycles requirement with a total of 22 months elapsed.

At the time of the accident, the total number of cycles had reached 23,214. Consequently, the cycles accumulated since the last NLG actuator lubrication on June 15, 2022, were 779 cycles, with a total of 15 months elapsed. This leaves 221 cycles remaining or 15 more months, whichever comes first, before the next lubrication is due.

According to the maintenance personnel who had carried out the lubrication of the NLG Actuator on 15 June 2022, the NLG actuator is removed from the aircraft and placed on the bench to check for end play and if findings are satisfactory then they proceed further on to lubrication where the NLG actuator is partially[22] disassembled to replenish or pack with grease when the same grease is used. However, in the case another type of grease is to be used then the NLG Actuator is sent for overhaul to be completely disassembled and components cleaned before lubrication.

22 Partially disassembling the NLG Actuator was further explained by the maintenance personnel as removing the bolt, grease seal, top cover and gearbox upper thrust bearing to replenish or pack grease (*Refer to Figure 7).*

According to the *AMM ,Chapter 32-30-07,301*,the Nose Landing Gear Actuator should not be lubricated until the Nose Landing Gear Actuator Inspection procedure in *Chapter 32-30-11,601* has been completed .The investigation reviewed the maintenance documents and identified that there was no evidence of an inspection being carried out and recorded prior to the lubrication on 28 August 2020 and 15 June 2022 respectively.

The maintenance records also showed that Work Order/Work Plan No *JAU WP2022-014* job information states: *NOSE LANDING GEAR-Perform the NOSE LANDING GEAR ACTUATOR LUBRICATION procedure (Ref. Chapter 32-30-00,201).* The investigation identified that the reference 32-30-00 was a general description and operation of the Mechanical Landing Gear System and not the specific reference for the Lubrication procedures of the NLG Actuator.

The Nose Landing Gear Actuator Lubrication was carried out and recorded as '*Lubrication carried out as required on nose landing gear actuator in accordance with AMM [23] 32-30-00 and satisfactory'* on 15 June 2022, (*Work Order Number JAU-WP2022-014*) by the operator (*Refer to 5.5.1, Appendix E1).*

The investigation also identified that the reference *32-30-27* on job number, *2020-0337* for the NLG Actuator lubrication carried out on 28 August 2020 (*Refer to 5.5.2, Appendix E2*) was also an incorrect reference. This reference was for the Landing gear motor gearbox - removal/installation procedure and not for the NLG Actuator lubrication procedure.

1.6.6.4 *NLG Actuator Overhaul*

According to the *Super King Air 200 Series Maintenance Manual*, '*Overhaul and Replacement Schedule Table*, *Table 607. ATA 32 - Landing Gear'*, the NLG actuator overhaul is carried out every 8000 cycles between overhaul or replacement or 6 years whichever occurs first or upon evidence of significant internal leakage.

The Operator's *NLG Actuator Overhaul Inspection and Lubrication Status Report* generated from Traxxall Software and associated documents provided to the AIC showed that the last overhaul of the faulty NLG Actuator was carried out on 20 July 2018 and is due for next overhaul on 20 July 2024 or when it reaches 8000 cycles, whichever occurs first.

At the time of the accident, the NLG actuator had accumulated 2,822 cycles and was in operation for about 5 years. Cycles remaining was 5,178 before the next overhaul of the NLG Actuator.

1.7 METEOROLOGICAL INFORMATION

1.7.1 NiuSky Pacific Meteorological Aerodrome Report

The Meteorological Aerodrome Report (METAR) that was provided by NiuSky Pacific Limited at time 02:00 UTC was as follows:

- **Wind:**140° at 10 kts
- **Visibility**: Greater than 10 km
- **Cloud**: Few at 3000 ft scattered at 30,000 ft
- **Temperature:** 24° dew point 18° QNH 1012

23 Aircraft Maintenance Manual

1.7.2 PNG National Weather Service Terminal Aerodrome Forecast 2 (TAF 2).

Terminal Aerodrome Forecast 2 (TAF 2) was issued by the PNG NWS at 22:00 and was valid from 00:00 to 24:00 on 1 September 2023:

- **Wind:** Variable at 3 kts
- **Visibility**: Greater than 10 km
- **Clouds:** scattered at 2000 ft

From 02:00:

- **Wind:** 140° at 10 kts
- **Cloud:** Scattered at 2000 ft
- **Visibility:** Greater than 10 km
- **Temperature:** 27° 30° 26° 27° QNH 1014 1013 1011 1012

Weather was not a contributing factor in the accident.

1.8 AIDS TO NAVIGATION

Ground-based navigation aids / onboard navigation aids / aerodrome visual ground aids and their serviceability were not a factor in this accident.

1.9 COMMUNICATIONS

All communications between Jacksons ATS unit and the flight crew were recorded by ground based automatic voice recording equipment for the duration of the flight. The ATS audio recordings showed that there was effective two-way communication on VHF between the Air Traffic Controllers and the crew.

1.10 AERODROME INFORMATION

Jacksons International Airport is located 8 km outside Port Moresby, the capital city of Papua New Guinea.

Location Indicator	AYPY-Port Moresby
Airport Operator	National Airports Corporation
Latitude	09 26.509 S
Longitude	147 13.144 E
Elevation	129 ft (39 m)
Primary Runway	14L/32R
Secondary Runway	14R/32R

Table 3:AYPY Aerodrome Information.

According to the *PNG Aeronautical Information Publication (AIP) dated 23 April 2020,* current at the time of the accident, Jacksons International Airport is a Category 8[24] aerodrome and has Rescue and Fire Fighting services available and three fire tenders on stand-by at the station.

24 Port Moresby International Airport is a Catergory 8 aerodrome. Category 8 coverage is provided for all the turbojet scheduled Regular Public Transport (RPT) flights and any 30 plus passenger non-turbo-jet scheduled RPT flights.

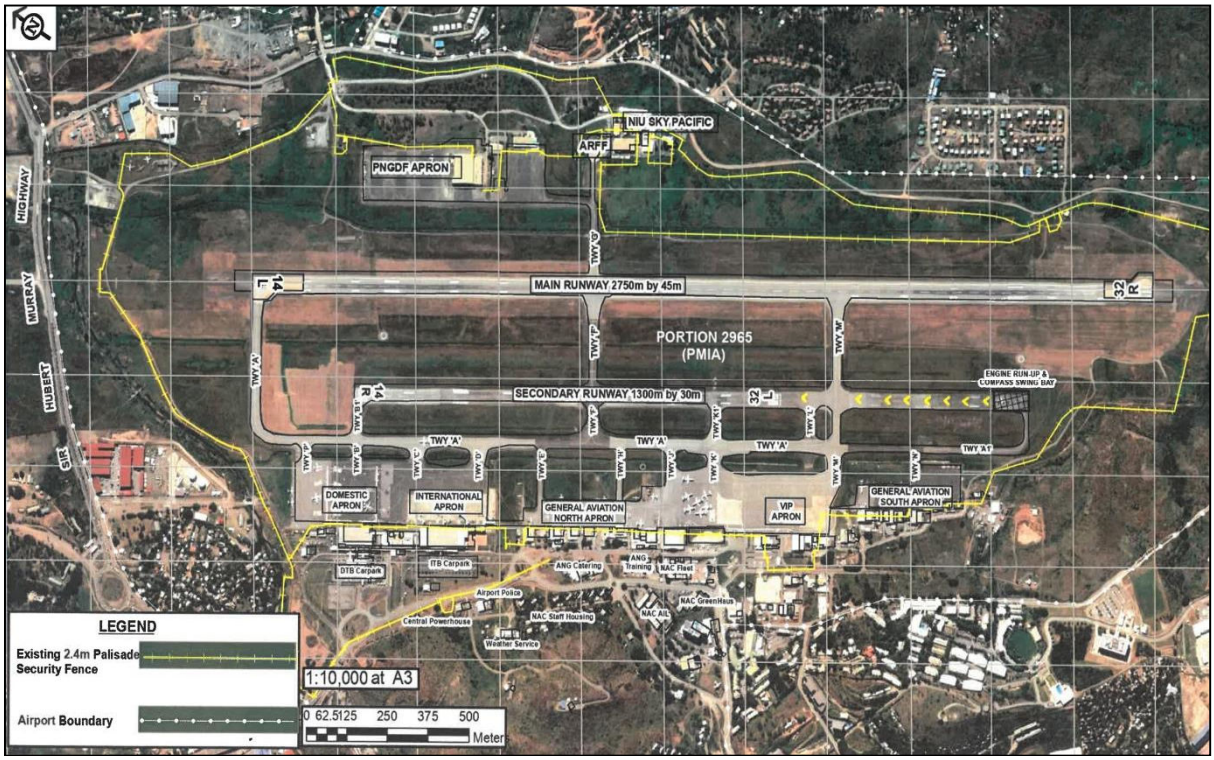


Figure 10:Port Moresby International Grid Map.

1.11 FLIGHT RECORDERS

The aircraft was equipped with a Cockpit Voice Recorder (CVR).The aircraft was not equipped with a Flight Data Recorder, and it was not required by *PNG Civil Aviation Rules*.

The table below outlines the CVR information.

Manufacturer	Universal Avionics Systems Corporation
Model	CVR-120A
Part Number	1606-00-00
Data Storage Memory	Solid-State
Serial Number	745
Recording Duration	At least 2 hours
Recorded Channels	4 Channels Channel 1-Captain, Channel 2-First Officer Channel 3- Crew 3 PA Channel 4- CAM

Table 4:SSCVR Information.

The aircraft's installed Cockpit Voice Recorder (CVR) was taken to the AIC Flight Recorder Laboratory to undergo data download, playback, and analysis. The data was successfully retrieved and utilized to complement the investigation.

Figure 11:CVR Download at the AIC Flight Recorder Laboratory.

1.11.1 Appareo Vision 1000

The aircraft was fitted with an Appareo Vision 1000 [25] recorder for flight data monitoring purposes. The unit captured the following information: cockpit image recording, intercom system audio for crew and ATS communications and WAAS[26] GPS[27] (latitude, longitude, groundspeed, vertical speed, GPS altitude, etc), attitude data (G forces) and rates of rotation. The unit has an SD card for storing recorded information.

The SD card was obtained by AIC and taken to the AIC Flight Recorder Laboratory for data extraction. The recorded information and parameters of the accident flight were extracted from the SD card by the AIC and was also utilized in the investigation.

25 The Appareo Memory Access Utility for the Vision 1000 allows for the download of flight data from the Vision 1000's internal memory. This information may be critical to an accident or incident investigation. The Vision 1000 contains two forms of data storage, i.e. memory: internal and removable. Internal memory contains the most recent flight data, is crash-hardened, and is designed for the primary purposes of accident investigation. Removable memory is in the form of an SDHC card, which operators can remove on a daily basis for flight review or FOQA purposes.

26 The Wide Area Augmentation System is an air navigation aid developed by the Federal Aviation Administration to augment the Global Positioning System, with the goal of improving its accuracy, integrity, and availability.

27 Global positioning system

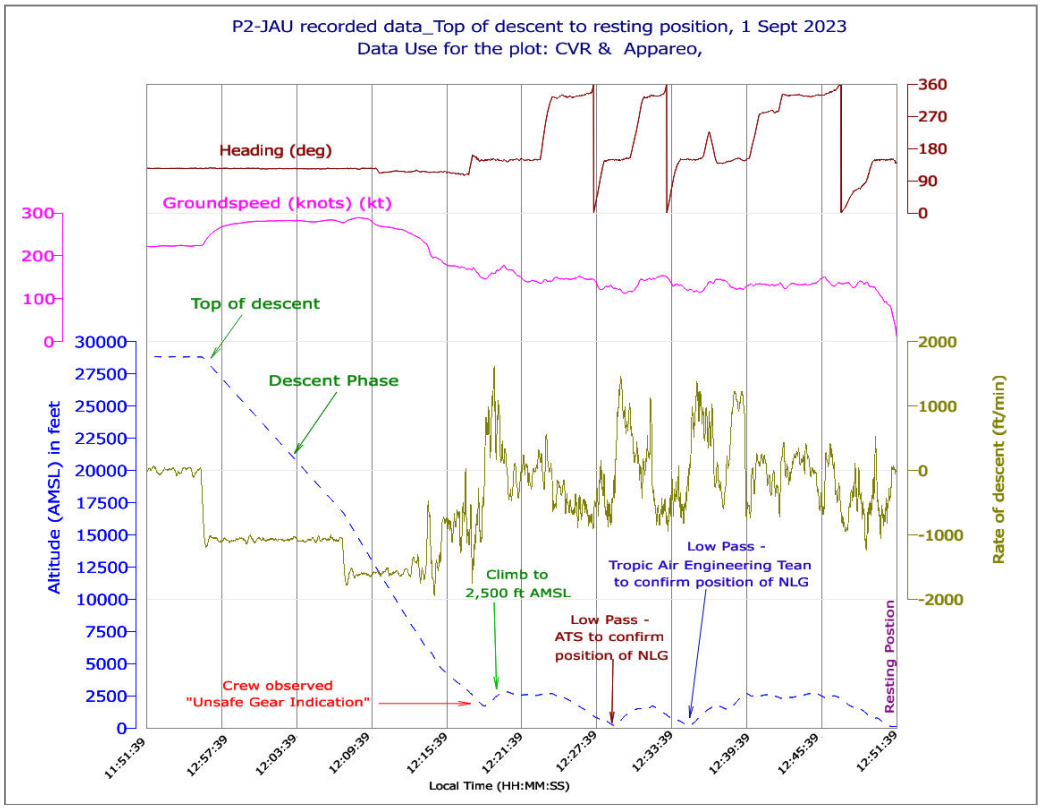


Figure 12:P2-JAU Top of Descent to Final Resting Position.

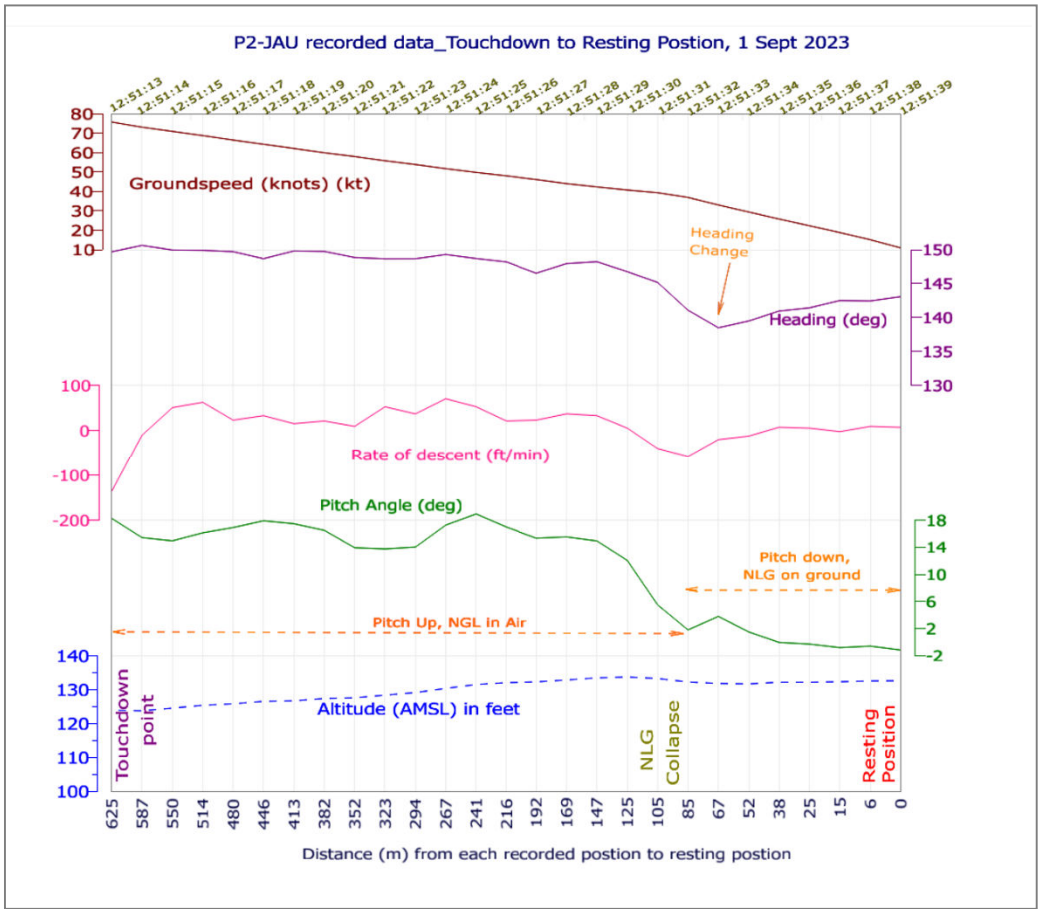


Figure 13:P2-JAU from Touchdown to Final Resting Position.

1.11.2 Other Recording sources

During the investigation, AIC obtained video footage from the National Airport Corporation (NAC) Airport CCTV[28], which captured the aircraft (P2-JAU) from its final approach to its resting position. Additionally, the ATS recording of the accident was obtained by AIC. AIC synchronized all available data sources, including the Solid-State Cockpit Voice Recorder (SSCVR), Appareo V1000, CCTV footage, and the ATS recording to complement the investigation.

1.12 WRECKAGE AND IMPACT INFORMATION

1.12.1 Overview of the Wreckage Distribution

The aircraft touched down with the Main Landing Gears and rolled for 520 m with partially extended NLG still in the air before it collapsed and subsequently the aircrafts nose dropped to the ground.

The aircraft then continued forward with momentum for 105 m before coming to rest adjacent taxiway Foxtrot (*Refer to Figure 14).*Total distance covered from touchdown to final resting position was 625 m.

When the aircrafts nose dropped to the ground, the left and right propeller blades struck the runway surface, causing damage to the left and right propeller assemblies. The nose structure and left and right nose landing gear (NLG) doors also sustained damage upon contact with the runway surface.

Figure 14:P2-JAU Landing Roll on Runway 14R to Final Resting Position.

28 Closed Circuit Television

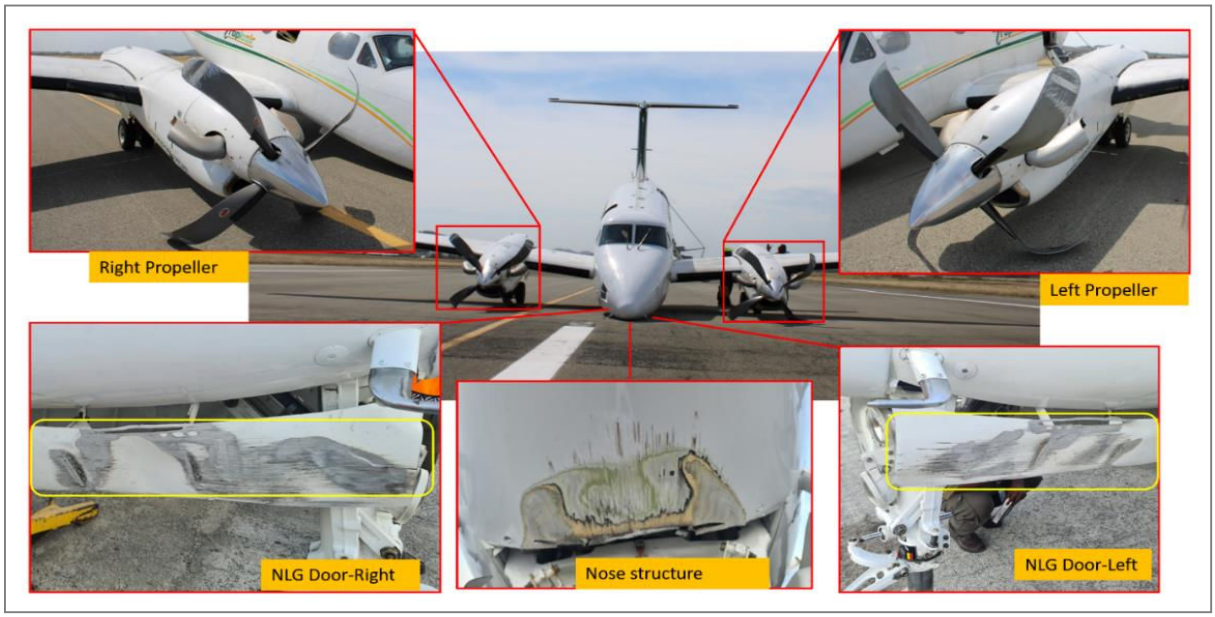


Figure 15:P2-JAU Overview of Damage Sustained.

1.12.2 Onsite Inspection

The aircraft was towed to the operator's maintenance hangar where retraction tests were done by Tropicair maintenance team in the presence of AIC onsite team to check the operation of the Nose Landing Gear system by placing the aircraft on a jack prior to the inspection. It was determined that the nose landing gear actuator had failed internally. No anomalies were noted with the landing gear system other than the failed nose landing gear actuator.

Figure 16:Retraction Test of the NLG and Inspection of the Faulty Actuator at Tropicair Hangar.

1.12.3 Offsite inspection of the faulty NLG Actuator.

Following the accident, the NLG Actuator was transported to the AIC Engineering Facility for inspection.

Faulty NLG Actuator information:

Specification	Component Data
Part Number	50-820208-5
Serial Number	ALG5268
Manufacturer	Aerospace Turbine Rotables, Inc
OEM	Hawker Beechcraft Corporation
Year of manufacture	TBA
Last Overhaul date	14-04-2018
Cycles since Overhaul	2,822
Overhaul Facility	Aerospace Turbine Rotables, Inc

Table 5:Faulty NLG Actuator Specification and Data.

The Actuator was inspected by removing the Lower and Upper Cover to check for lubrication and any other abnormalties. There was evidence of grease present, but it appeared dry.

The faulty NLG Actuator was later sent to Aerospace Turbine Rotables, Inc, the manufacturer of the NLG Actuator, in coordination with Textron and the Authorities from the State of Manufacturer[29] to perform further internal inspection at their facility. *Refer to Section 1.16 'Tests and Research'.*

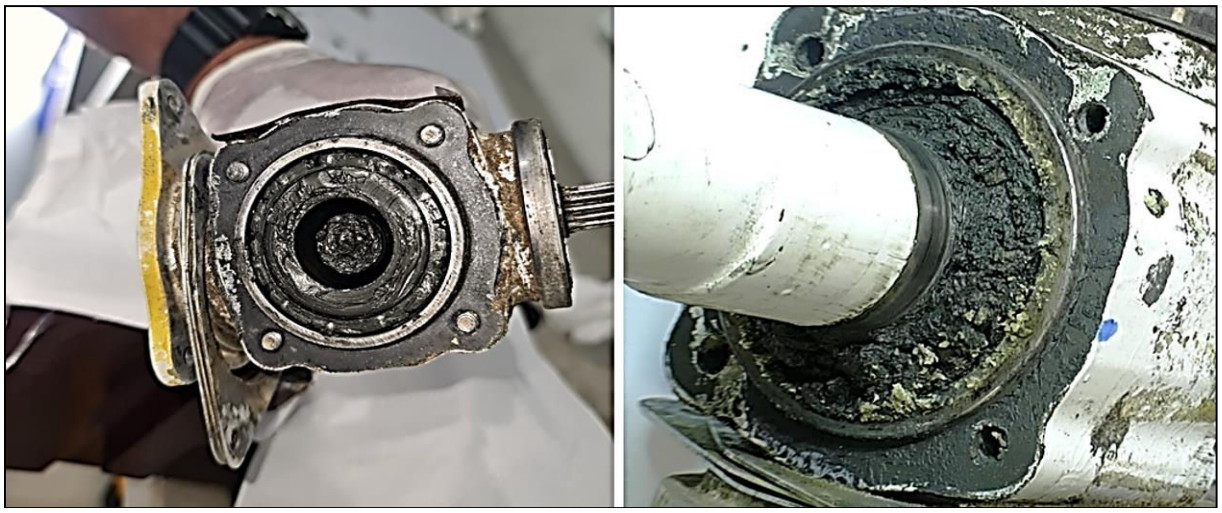


Figure 17:Inspection of the NLG Actuator at the AIC Engineering Workshop.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

No medical or pathological investigations were conducted as a result of this accident, nor were they required.

1.14 FIRE

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

29 National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA) who provided oversight and chain of custody during the teardown and inspection of the faulty NLG Inspection.

1.15 SURVIVAL ASPECTS

1.15.1 Aviation Rescue and Fire Fighting (ARFF).

According to the log of events and statements from Aviation Rescue and Fire Fighting (ARFF) personnel and recorded video footage provided by National Airports Corporation (NAC) to the AIC, at 12:29, NAC Rescue Base alerted all Stations about P2-JAU's emergency and to standby for emergency assistance.

At 12:30, ARFF, Tenders 1, 2 and 3 stood by in front of the Fire Station and NAC Car 02 at the Mustering Point which is located within Gate 14. At 12:48, Rescue Base advised all Stations that Local Standby[30] was escalated to a Full Emergency[31]. At 12:50 Car 02 escorted Civil Fire and St Johns Ambulance to the Mustering Point.

ATC then cleared ARFF to proceed straight to Taxiway Foxtrot and hold at the holding point towards Runway 14R.At 12:51, the aircraft landed with a partial NLG down and on landing roll, the NLG collapsed.

ARFF commenced Rescue and Evacuation by taking up position in case of a fire, but since there was no fire, they assisted the passengers and flight crew do a precautionary disembarkation from the aircraft at 12:53 through the main cabin door, which was opened by the co-pilot from inside. By 12:54, all passengers had disembarked the aircraft.

NAC video footage showed that due to the NLG collapse, the rear of the fuselage was slightly elevated, so when the airstair entrance door (cabin door) was opened outward and downward from inside by the co-pilot, the cabin door and stairway remained aloft.

According to ARFF personnel statements, the passengers were evacuated 100 metres up-wind to the forward command post. At 13:02, Rescue Car 02 and Tropicair shuttle bus were at the mustering point waiting for Alpha 01 and Rescue 01 vehicles to transport the passengers to the master point to be transported to Tropicair base. At 13:13, the passengers were then transported along with their baggages to Tropicair base.

The ARFF Duty Fire Officer advised Tenders 2 and 3 to return to the Station while Tender 1 remained on standby and later escorted the aircraft (P2-JAU) that was towed to the hangar.

At 13:47, the ARFF was advised by Jacksons Tower to stand down their services. At 14:39, Tender 1 returned to the base.

The investigation established that the Emergency response and assistance to the accident was carried out as per the required procedures.

30 Local Standby is declared when only the involvement of airport-based agencies are warranted.

31 According to Manual of Air Traffic Services (MATS) Ver.2,Full Emergency is declared when:

(a) activation of more than just airport based responding agencies is required;

(b) an aircraft approaching the airport is known or suspected to be in such a situation that there is danger of an accident;

(c) there is a crash on or in the immediate vicinity of the airport;

(d) a pilot declares a MAYDAY.

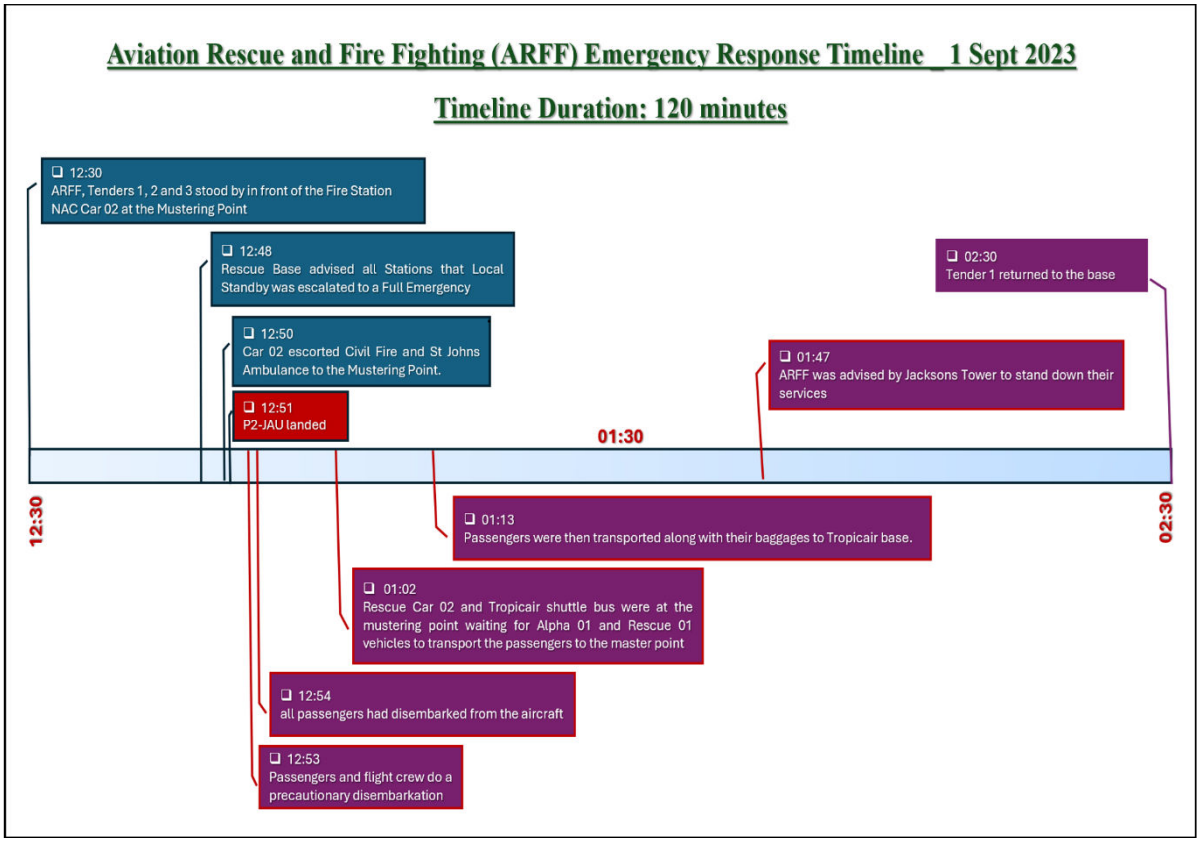


Figure 18:Timeline of the Emergency Response Events.

1.16 Tests and Research

On 28 February 2024, Aerospace Turbine Rotables Inc conducted a comprehensive inspection of the faulty NLG Actuator. This examination involved a teardown or disassembly, inspection and analysis of the faulty NLG Actuator and its components to assess or to render its failure mode, current condition or state and to identify the root cause of the failure.

Before commencing the teardown and inspection process, a preliminary inspection of the exterior of the faulty NLG Actuator was conducted by documenting the general condition of the NLG Actuator.

1.16.1 Teardown and Inspection of the Faulty NLG Actuator.

The Manufacturer carried out a thorough teardown and inspection of the faulty NLG Actuator to examine all its components. During this process, it was confirmed that all components of the Actuator, including the Nut Assembly, Screw Assembly, Gearbox Lower Bearing, Housing, Gearbox Upper Thrust Bearing, Pinion Gear and Snap Ring, Clevis Pin, Spring and Retainer and Inner Pinion Thrust Bearing were present.

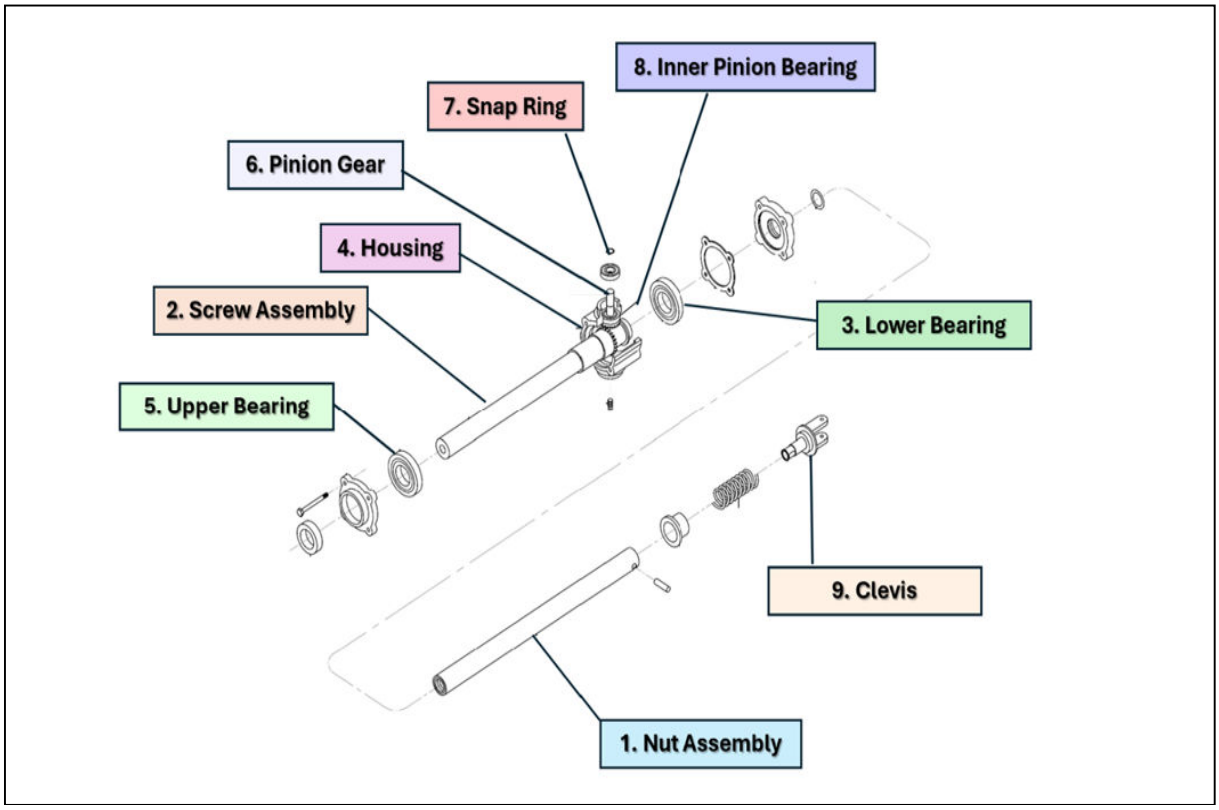


Figure 19:NLG Actuator Components Inspected.

The observations were documented for each component by the manufacturer. Below is a table summarizing the manufacturer's observations during the disassembly and inspection process.

No.	Actuator's Internal Component	Observation
1	Nut Assembly	✈Pulled completely out of the screw assembly without rotating its thread. ✈Excessive worn threads that prevented it from engaging with the housing screw. ✈Grease present appeared thick and dry.
2	Screw Assembly	✈Insufficient amount of grease observed, ✈Grease was slightly dry and stiff. ✈No damage found on the interior. ✈No noticeable wear on any of the gear teeth. ✈Some corrosion present on the inside diameter surface.
3	Gearbox Lower Bearing	✈Grease present but it was thick, pasty, dry and stiff. ✈Bearing was stiff to rotate by hand.
4	Housing	✈Grease present but it appeared very dry and stiff.
5	Gearbox Upper Thrust Bearing	✈Grease present but it appeared very dry, stiff and crumbly. ✈Bearing was stiff to rotate by hand.
6	Pinion Gear	✈No damage found. ✈All teeth were present and minimal wear observed. ✈Grease present but dry and stiff.
7	Pinion Gear Snap Ring	✈No damage found.
8	Inner Pinion Thrust Bearing	✈Grease present but was thick and gummy. ✈Bearing was stiff to rotate by hand.
9	Clevis Pin, Clevis, Spring and Retainer	✈Clevis exhibited corrosion.

Table 6:Summary of Observations.

Refer to *Section 5.7, Appendix G* for an extract from the Aerospace Turbine Rotables Inc Report, which provides details of the teardown and inspection of the faulty NLG Actuator, including the observations.

1.16.2 Detailed Inspection of certain components

The Manufacturer identified the following components for further examination: Screw Assembly, Pinion Gear, Nut Assembly, Clevis and Actuator Support. The identified components were then cleaned with the appropriate solvent and dried with air compression. They were then laid out on a clean paper towel for further examination.

Figure 20:Components cleaned with solvent for further examination.

The detailed inspection identified that all the components examined had minor wear and corrosion, whereas the Nut Assembly had excessively worn threads.

1.16.2.1 *Screw Assembly*

All the Bevel Gear teeth were present, and there was no noticeable wear. There was some corrosion present on the inside diameter surface of the screw housing, possibly due to inadequate grease before cleaning.

Figure 21:Bevel Gear Teeth.

1.16.2.2 *Pinion Gear*

The Spline Gear portion of the Pinion Gear was inspected, there was no damage found. All the Pinion Gear teeth were present, with minimal wear. The Pinion Gear Snap Ring was examined, with no damage noted. There appeared to be some light wear on the Pinion Gear shaft.

Figure 22:Pinion Gear

1.16.2.3 *Clevis Pin, Clevis Spring and Retainer*

The Clevis Pin, Clevis Spring and Retainer were examined. Before cleaning, there was grease on the Clevis shaft, but it was dry and tacky. The bottom side (Spring side) of the Clevis flange showed considerable debris and corrosion. The Retainer had a layer of dry, tacky grease on its interior.

The Clevis was cleaned with solvent and inspected. There is a light layer of corrosion over the center portion of the Clevis , which is relatively uncommon.

Figure 23:Clevis Pin, Clevis Spring and Retainer.

1.16.2.4 *Landing Gear Actuator Support*

Before cleaning, both Landing Gear Supports were examined. The minimal grease that was present was dry and sticky (old). Both Landing Gear Support Bearings were removed from the Landing Gear Actuator Supports. The Pinion-Gear-side Bearing, when rotated by hand, felt smooth, and rotated freely.

The Plug-side Bearing, when rotated, felt very rough, and would only rotate approximately 180° before binding and rotating no further.

Figure 24:Landing Gear Actuator Support.

1.16.2.5 *Nut Assembly*

The grease was cleaned from the clevis-end of the Nut Assembly. The interior of the Nut Assembly was then rinsed with solvent and drained through a filter, in order to collect any debris such as metal shavings. The process was repeated approximately 10 times. The debris that was collected was less than the total loss of threads observed on the Nut Assembly. This indicates that either the debris had migrated somewhere else prior to the analysis, or the debris migrated out of the threads through extend and retract operations.

Figure 25:Nut Assembly Rinsed with Solvent.

The threaded portion of the Actuator Nut Assembly was compared to that of a new Nut Assembly. The Minor Diameter of the subject Nut Assembly was measured and compared to that of a New Nut Assembly. The diametric difference was .6256"-.5138"[32].

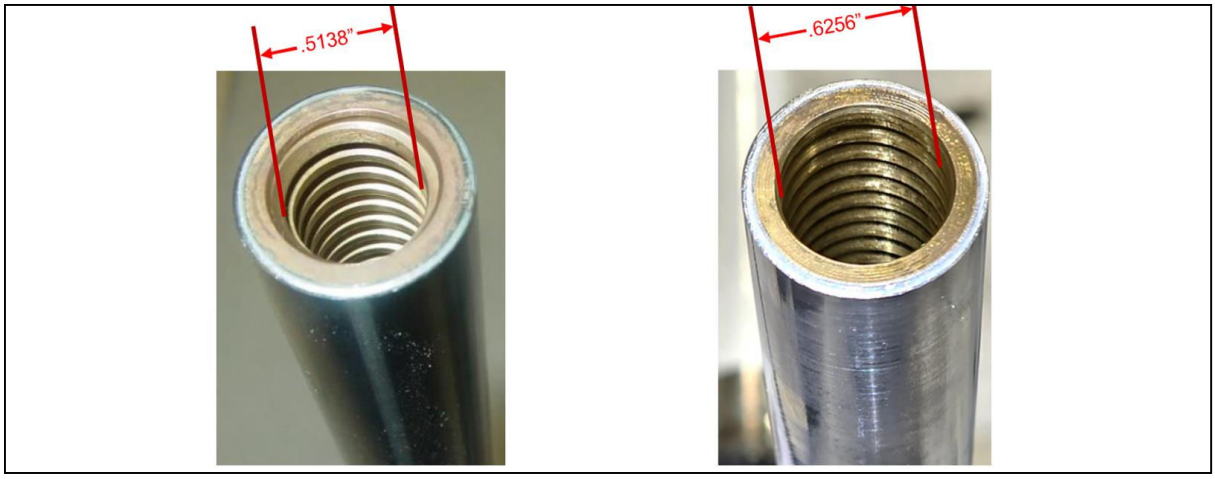


Figure 26 L to R: Threaded portion of the New Nut Assembly Compared to the Subject Nut Assembly.

1.16.3 Manufacturer's Inspection Summary

A teardown and internal inspection of the faulty NLG Actuator by the Manufacturer showed that the Nut Assembly was found with excessively worn threads on the nut assembly preventing it from engaging with the screw housing. All other components had minor wear and corrosion. The grease present in the Nut Assembly appeared somewhat thick and dry. The grease present in all other parts of the Nose Landing Gear Actuator also appeared dry and stiff.

One possible explanation is that the Nose Landing Gear failed to extend due to the excessively worn threads on the nut assembly, preventing it from engaging with the Screw Housing. This was evident during the teardown when the Nut Assembly could be pulled out without any thread engagement which could be caused by inadequate lubrication in the nut assembly. Another possible reason for the failure is an error in rigging. If the actuator was improperly installed or rigged, then it could cause an excessive force on the actuator causing the threads in the nut assembly to strip.

1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION

1.17.1 Aircraft Owner and Operator: Tropicair Limited

Tropicair Limited (PNG) Head Office and Maintenance Facility is at Port Moresby, National Capital, Port Moresby, Papua New Guinea. It commenced its operations in 1998 and operates domestically and internationally where approval has been granted by CASA PNG.

The company conducts Air Operations under a *Part 119/125/135 Air Operator Certificate* in the following categories:

- Domestic/International Single Engine Aeroplane IFR Cargo Operations, and
- Domestic Single Engine Aeroplane VFR Air Operations
- Domestic/International Multi Engine Aeroplane IFR Air Operations

At the time of the accident, the Operator had an *AOC # 119/015* issued on 25th November 2020 and effective from 30 November 2020 until 30 November 2023.

32 The AIC calculated the difference to be 0.1118 inch.

The AOC is issued pursuant to *section 47 (3) and 49 of the CA Act 2000 (as amended)* and *Part 119.9* and authorises Tropicair Limited to perform commercial air operations (scheduled and non-scheduled) in accordance with its exposition and *Part 119/135/125.*

The Operator had a *MOC # 145/015* issued on 27 November 2020 and effective from 01 December 2020 until 31 May 2024. The company also contracts out its aircraft Maintenance to authorised maintenance organizations.

1.18 ADDITIONAL INFORMATION

There was no other additional information that was relevant to the circumstances leading up to the accident.

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

The investigation was conducted in accordance with *PNG Civil Aviation Act 2000 (as amended*) and *PNG Civil Aviation Rules*, and PNG Accident Investigation Commission approved policies and procedures, and in accordance with the *Standards and Recommended Practices* of *Annex 13* to the *Convention on International Civil Aviation*.

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2 ANALYSIS

2.1 Maintenance

An aircraft's landing gear actuators are crucial for extending and retracting the landing gear system. The investigation concluded that the accident resulted from the NLG failing to fully extend to the down and locked position. This triggered the illumination of two red, parallel-wired indicator lights located on the landing gear control handle in the cockpit, indicating that the NLG was not fully extended.

During the initial investigation phase, it was found that the failure of the nose landing gear to fully extend was due to the NLG actuator's inability to operate to its full capacity or functional requirements. Initial inspections and tests revealed that internal failure of the NLG Actuator was the cause. The investigation focused primarily on the NLG actuator, warranting further examination.

The manufacturer's inspection and conclusion from the disassembly and examination of the faulty NLG actuator corroborated the AIC's initial investigative hypothesis. The examination confirmed an internal failure of the actuator, which hindered it from fulfilling its functional requirements, consequently preventing the full extension of the nose landing gear. Additionally, the examination identified excessive wear on the threads of the actuator's nut assembly and anomalies in the grease, leading to the conclusion by the manufacturer that inadequate lubrication or improper rigging may have been the cause. The AIC concurs with the manufacturer's assessment that the excessive wear on the nut assembly threads and anomalies in the grease could be linked to inadequate lubrication.

The operator's maintenance records indicated that lubrication for the NLG Actuator was performed on 28 August 2020 after the last overhaul and the last lubrication was performed on 15 June 2022, about 15 months prior to the accident. Records indicated that at the time of the accident, there were 221 cycles remaining before the next lubrication procedure. The NLG Actuator lubrication performed and recorded on 28 August 2020 and 15 June 2022 had an incorrect procedure reference. The correct reference for the lubrication procedure 32-30-07,301 would have directed maintenance personnel to a separate inspection procedure, 32-30-11,601, which requires a bench check for total end play to determine whether the NLG Actuator may be returned to service and rechecked for end play at specified intervals, overhauled or replaced. After the NLG Actuator inspection, it is partially disassembled for lubrication then rechecked to ensure that the actuator is correctly assembled and reinstalled in the aircraft. The investigation found that there was no record of this coinciding NLG Actuator inspection procedure being carried out.

The operator provided a Statutory Declaration and statement from relevant maintenance personnel listing maintenance reportedly carried out on the NLG Actuator on 15 June 2022; however, the AIC was not provided with maintenance records as evidence to enable the AIC to determine the veracity of the Statutory Declaration and statement.

It is the view of the AIC that although the NLG actuator lubrication was carried out and recorded at the specified intervals, the presence of thick and dry grease in the nut assembly threads, may indicate that if there was inadequate grease or lubricant in the nut assembly, it may have depleted overtime which resulted in the nut assembly threads excessively wearing out before the next service of the NLG Actuator was due.

Another issue which the manufacturer of the NLG actuator pointed out was improper rigging. The AIC agrees that improper rigging, to whatever degree it may exist as a condition, would certainly contribute to the deterioration and failure of the actuator. Eliminating improper rigging as a condition in this scenario, does not reduce the risk of failure of the actuator posed by not conducting all required and timely maintenance in accordance with the Aircraft maintenance manual. Records of checks for proper rigging were observed by the AIC and it was noted that it was carried out a few days prior to the accident. It is therefore unlikely that improper rigging was a factor.

The system redundancy in the Nose Landing Gear system was ineffective because both the main system and the redundancy system relied on the actuator. In this configuration, if the actuator failed, there would be no option available to facilitate the full extension of the nose landing gear. This could potentially pose safety concerns, as it leaves the aircraft vulnerable to landing gear failures without any fallback options for the pilot to rely on.

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3 CONCLUSIONS

3.1 FINDINGS

3.1.1 AIRCRAFT

a) The aircraft was certified and equipped in accordance with existing *PNG Civil Aviation Rules (CARs)* and approved procedures.

b) The aircraft had a valid *Certificate of Airworthiness*, Certification of Registration and Certificate of Annual Airworthiness Review in compliance with existing PNG CARs.

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

d) There was no evidence of airframe failure or system malfunction on the aircraft prior to the accident.

e) The aircraft had a NLG Actuator malfunction which contributed to the accident.

f) The aircraft, while structurally intact, had sustained substantial damage.

3.1.2 MAINTENANCE

a) The Operator's approved Aircraft Maintenance Program (AMP) was developed in accordance with the Beechcraft Super King Air 200 Series Aircraft Maintenance Manual (AMM).

b) The NLG Actuator Servicing Procedure, captured in the operators AMP requires the inspection and lubrication to be carried out in accordance with the Beechcraft Super King Air 200 Series AMM, Chapters 32-30-11,601 and 32-30-07,301 respectively.

c) Beechcraft Super King Air 200 Series AMM, Chapters 32-30-11,601 requires the NLG Actuator inspection to be carried out before the actuator is partially disassembled for lubrication.There was no record of the coinciding NLG Actuator inspections carried out at specified due intervals since the last overhaul on 20 July 2018.

d) The NLG Actuator lubrication was carried out on 28 August 2020 after the last overhaul at the specified due interval.The last lubricaton of the NLG Actuator was carried out 15 months prior to the accident at 1077 cycles;77 cycles past the required 1000 cycles.

e) The references on the work order form for the NLG Actuator lubrication had incorrect references.

f) The references recorded for the NLG Actuator lubrication carried out on 28 August 2020 and 15 June 2022 respectively were incorrect.

g) At the time of the accident, the aircraft had accumulated 779 cycles or 15 months had elapsed since the last lubrication was carried out. This was within the manufacturer's required 1000 cycles or 30 months before next lubrication.

h) The NLG Actuator was completely disassembled and inspected by the manufacturer and it was found that the nut assembly threads were excessively worn and the grease was dry and thick.

3.1.3 FLIGHT CREW

a) The PIC was properly licensed, medically fit, and adequately rested to operate the flight in accordance with existing *PNG CARs*.

b) The co-pilot was properly licensed, medically fit, and adequately rested in accordance with existing *PNG CARs*.

c) The flight crew's knowledge and understanding of the aircraft systems was adequate.

3.1.4 FLIGHT OPERATIONS

a) The flight was conducted in accordance with the procedures in the operator's standard operating procedures.

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

c) The flight crew handled the emergency accordingly by carrying out the appropriate actions.

d) The flight crew carried out mitigating actions from when the aircraft landed to when its NLG collapsed to avoid a catastrophic outcome.

3.1.5 FLIGHT RECORDER

a) The aircraft was equipped with a Cockpit Voice Recorder (CVR).

b) The aircraft was not equipped with a Flight Data Recorder, and it was not required by *PNG Civil Aviation Rules*.

c) The aircraft was also fitted with an Appareo Vision 1000 recorder for flight data monitoring purposes which was utilised during the investigation.

3.1.6 SURVIVABILITY

a) The accident was survivable. There were no injuries to the passengers and flight crew.

b) Emergency Response and assistance to the accident was carried out as per the Airport Emergency Response procedures.

c) There was effective communication between ATC and Emergency Services. The response to the Emergency was quick. A precautionary disembarkation of the passengers and flight crew was carried out in a timely manner and passengers moved to a safe location to be transported to the Operator's base.

3.2 Causes [Contributing factors]

The NLG collapse during landing roll was determined to have occurred because the NLG did not fully extend and lock into the fully extended position. The investigation found that this was due to the internal failure of the NLG Actuator.

Further inspections of the faulty NLG Actuator by the manufacturer found that the actuators nut assembly threads were excessively worn, allowing the nut assembly to freely move through the screw housing without any thread engagement. The grease in the nut assembly was found to be thick and dry. The operator had carried out the NLG Actuator lubrication at specified due intervals required by the manufacturer, however, the dry and thick grease identified in the nut assembly indicates that there may have been inadequate grease or lubricant in the nut assembly which depleted overtime, resulting in the nut assembly threads excessively wearing out before the next service (inspection and lubrication) of the NLG Actuator was due.

The NLG Actuator lubrication carried out by the operator at specified due intervals were incorrectly referenced. The NLG Actuator lubrication procedure, if correctly referenced, would have directed the maintenance personnel to a separate NLG Actuator inspection procedure which is required to be performed to determine whether the actuator should be returned to service and inspected at specified intervals, overhauled or replaced before partially disassembling the actuator for lubrication. The investigation found that there were no records of this coinciding NLG Actuator inspection procedure.

3.3 Other factors

The investigation identified safety deficiencies or concerns during the investigation that while not causal to the accident, nevertheless, should be addressed with the aim of accident prevention. The investigation identified the following safety deficiencies or concerns:

- The investigation identified incorrect reference *(32-30-00,201)* on the Work Order/Plan No.JAU-WP2022-014 form for the Nose Landing Gear Actuator Lubrication procedure. The reference *32-30-00,201* is for the *general description of the Mechanical Landing Gear System*.

- The Work Pack Resolution Record, Revision 4, dated January 2019, Item No 25, *maintenance required for the Nose Landing Gear Actuator Lubrication (Mechanical),Part No: Nose Landing Gear Assembly SN:JAU Nose],* reference 32-30-27,401 is for the Landing gear motor gearbox - removal/installation procedure and not for the lubrication.

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4 SAFETY RECOMMENDATIONS

4.1 SAFETY RECOMMENDATION

4.1.1 Recommendation number AIC 24-R01/23-1005 to Tropicair Limited.

The PNG Accident Investigation Commission (AIC) recommends that Tropicair Limited should ensure that steps are implemented to ensure that the Beechcraft B200C Super King Air Aircraft Maintenance Manual procedures, such as the Nose Landing Gear Actuator inspection and lubrication procedures in Chapters 32-30-11,601 and 32-30-07,301 respectively, including other special inspection procedures are correctly referenced, carried out and recorded at specified due intervals.

Action requested.

The AIC requests that Tropicair Limited note recommendation *AIC 24-R01/23-1005* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how Tropicair Limited has addressed the safety deficiency identified in the safety recommendation.

4.1.1.1 *Tropicair Limited Preventive Action*

On 9 July 2024, Tropicair Limited informed the PNG Accident Investigation Commission of the preventive actions taken to address the safety deficiencies identified in *Safety Recommendation AIC 24-R01/23-1005* by;

- Issuing an Internal Engineering Memo (TM-37) to Tropicair Engineering staff, dated 20 May 2024, instructing the Engineering staff to accurately record maintenance conducted which is an extremely important step in the task procedure for all maintenance events (*Refer to Section 5.8.1, Appendix H1*).

- Amending the Tropicair Aircraft Maintenance Programme (AMP)-Beechcraft B200-King Air to include '*Landing Gear Actuator Replacement (Mechanical*)' which is required by the B200 AMM to be carried out every 30 months or 1000 cycles. The amended AMP was approved pursuant to *Rule Part 119.61* of the Civil Aviation Regulation by CASA PNG on 29 April 2024 (*Refer to Section 5.8.2, Appendix H2: Amended and Approved AMP*).

PNG Accident Investigation Commission (AIC) assessment of Tropicair Limited response

The AIC reviewed the Tropicair Limited documents providing evidence to the AIC of the safety action taken. The AIC is satisfied that the evidence satisfactorily addresses the safety deficiencies identified in the AIC *Safety Recommendation AIC 24-R01/23-1005*.

The AIC has assigned the Tropicair Limited response a *fully satisfactory rating* and records the Status of the AIC Recommendation: **Closed Response Accepted.**

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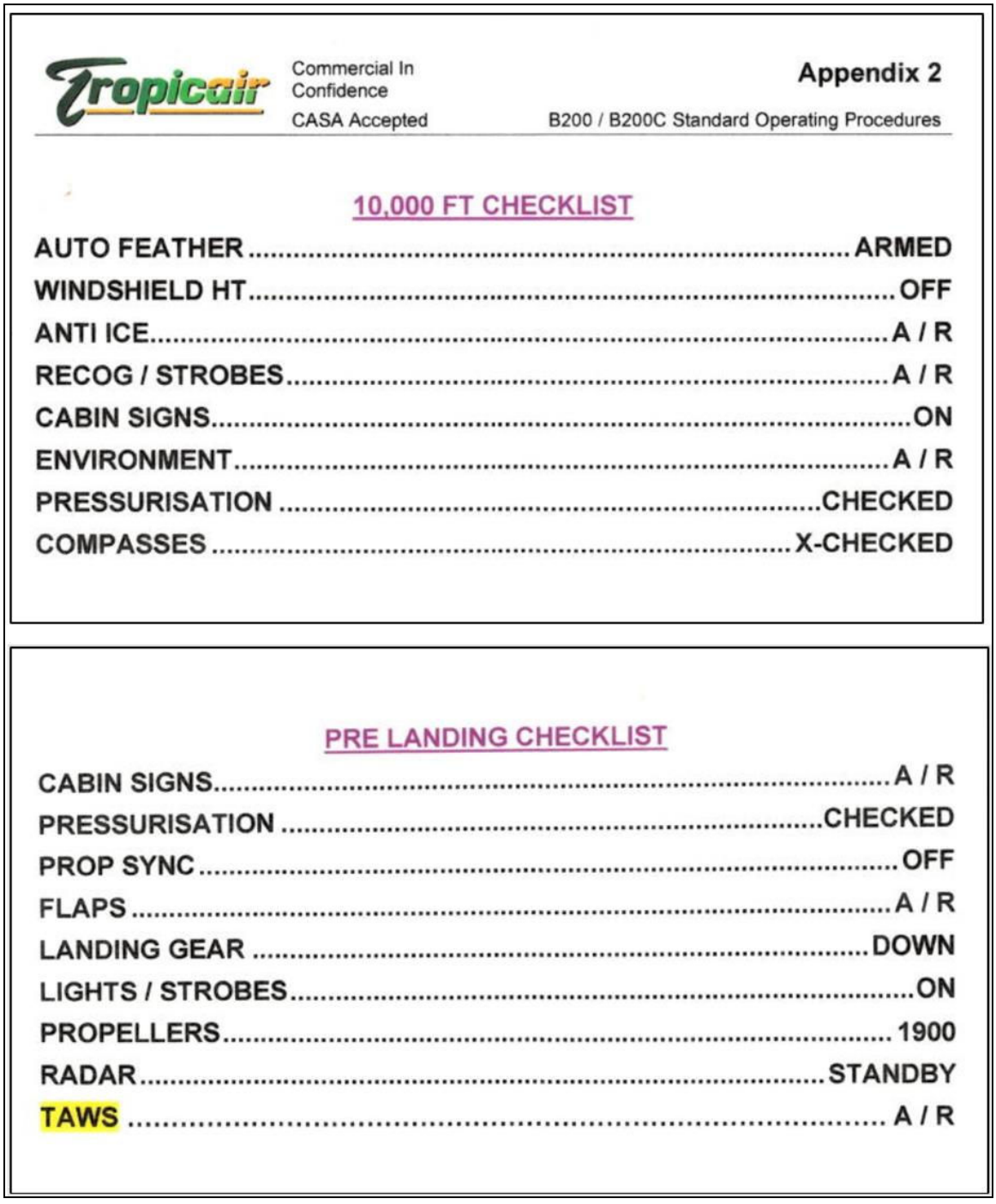
5 APPENDICES

5.1 Appendix A: B200C Super King Air Checklists & Procedures



Tropicair

Commercial In Confidence

CASA Accepted

Appendix 2

B200 / B200C Standard Operating Procedures

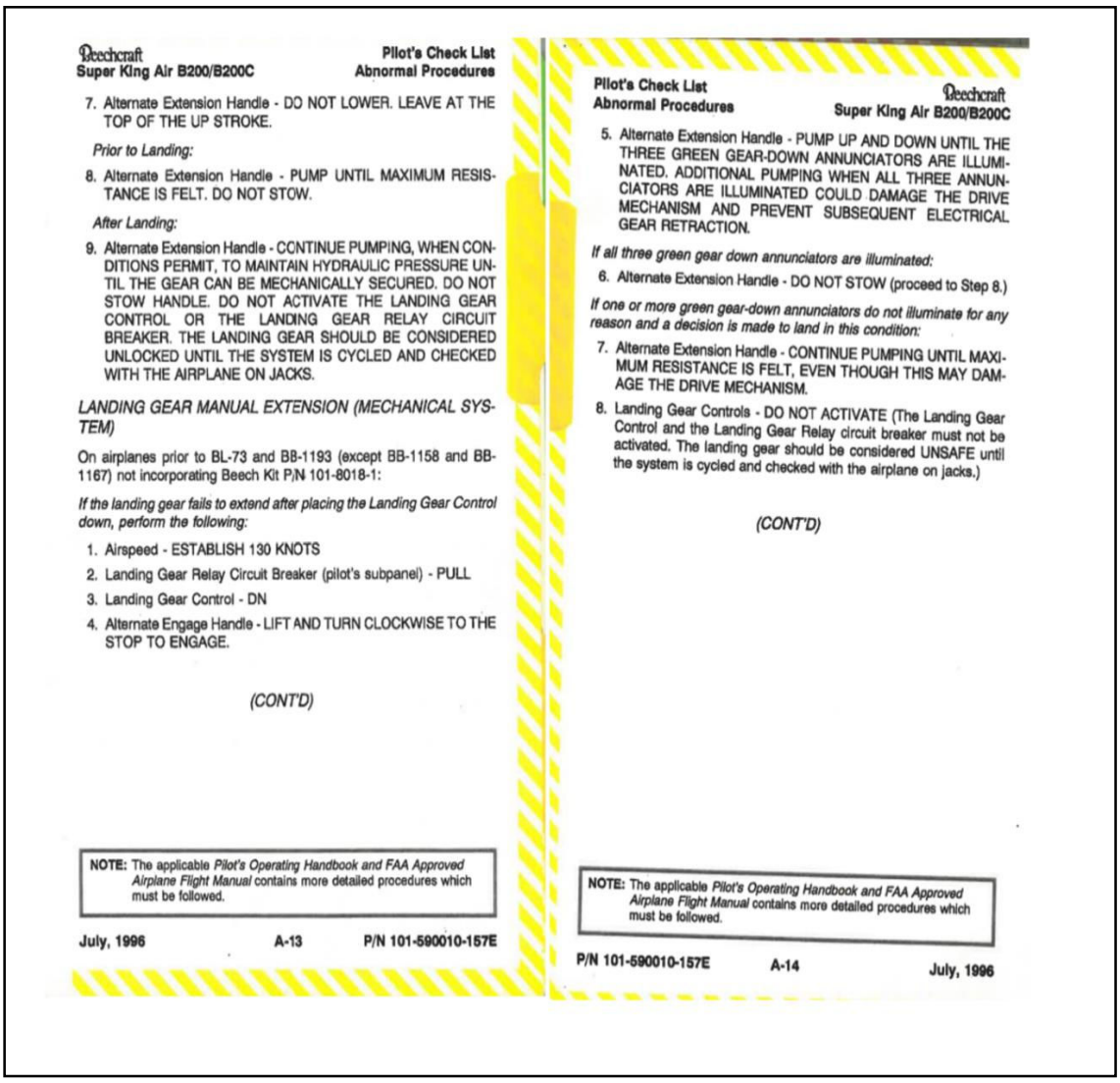
10,000 FT CHECKLIST

AUTO FEATHER	ARMED
WINDSHIELD HT	OFF
ANTI ICE	A / R
RECOG / STROBES	A / R
CABIN SIGNS	ON
ENVIRONMENT	A / R
PRESSURISATION	CHECKED
COMPASSES	X-CHECKED

PRE LANDING CHECKLIST

CABIN SIGNS	A / R
PRESSURISATION	CHECKED
PROP SYNC	OFF
FLAPS	A / R
LANDING GEAR	DOWN
LIGHTS / STROBES	ON
PROPELLERS	1900
RADAR	STANDBY
TAWS	A / R

5.2 Appendix B: Landing Gear Manual Extension Procedure.



Beechcraft
Super King Air B200/B200C

Pilot's Check List
Abnormal Procedures

7. Alternate Extension Handle - DO NOT LOWER. LEAVE AT THE TOP OF THE UP STROKE.

Prior to Landing:

8. Alternate Extension Handle - PUMP UNTIL MAXIMUM RESISTANCE IS FELT. DO NOT STOW.

After Landing:

9. Alternate Extension Handle - CONTINUE PUMPING, WHEN CONDITIONS PERMIT, TO MAINTAIN HYDRAULIC PRESSURE UNTIL THE GEAR CAN BE MECHANICALLY SECURED. DO NOT STOW HANDLE. DO NOT ACTIVATE THE LANDING GEAR CONTROL OR THE LANDING GEAR RELAY CIRCUIT BREAKER. THE LANDING GEAR SHOULD BE CONSIDERED UNLOCKED UNTIL THE SYSTEM IS CYCLED AND CHECKED WITH THE AIRPLANE ON JACKS.

LANDING GEAR MANUAL EXTENSION (MECHANICAL SYSTEM)

On airplanes prior to BL-73 and BB-1193 (except BB-1158 and BB-1167) not incorporating Beech Kit P/N 101-8018-1:

If the landing gear fails to extend after placing the Landing Gear Control down, perform the following:

1. Airspeed - ESTABLISH 130 KNOTS
2. Landing Gear Relay Circuit Breaker (pilot's subpanel) - PULL
3. Landing Gear Control - DN
4. Alternate Engage Handle - LIFT AND TURN CLOCKWISE TO THE STOP TO ENGAGE.

(CONT'D)

NOTE: The applicable *Pilot's Operating Handbook and FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

July, 1996 A-13 P/N 101-590010-157E

Pilot's Check List
Abnormal Procedures

Beechcraft
Super King Air B200/B200C

5. Alternate Extension Handle - PUMP UP AND DOWN UNTIL THE THREE GREEN GEAR-DOWN ANNUNCIATORS ARE ILLUMINATED. ADDITIONAL PUMPING WHEN ALL THREE ANNUNCIATORS ARE ILLUMINATED COULD DAMAGE THE DRIVE MECHANISM AND PREVENT SUBSEQUENT ELECTRICAL GEAR RETRACTION.

If all three green gear down annunciators are illuminated:

6. Alternate Extension Handle - DO NOT STOW (proceed to Step 8.)

If one or more green gear-down annunciators do not illuminate for any reason and a decision is made to land in this condition:

7. Alternate Extension Handle - CONTINUE PUMPING UNTIL MAXIMUM RESISTANCE IS FELT, EVEN THOUGH THIS MAY DAMAGE THE DRIVE MECHANISM.
8. Landing Gear Controls - DO NOT ACTIVATE (The Landing Gear Control and the Landing Gear Relay circuit breaker must not be activated. The landing gear should be considered UNSAFE until the system is cycled and checked with the airplane on jacks.)

(CONT'D)

NOTE: The applicable *Pilot's Operating Handbook and FAA Approved Airplane Flight Manual* contains more detailed procedures which must be followed.

P/N 101-590010-157E A-14 July, 1996

5.3 Appendix C: Operators Aircraft Maintenance Programme-B200 King Air.

5.5 Appendix A4- Aircraft Maintenance Program - Beech B200-King Air

Aircraft call-sign rego to which this programme applies: **P2-MAX, P2-JON, P2-JAU**		
Person who is responsible for scheduling the maintenance: **Maintenance Controller**		
Aircraft	**Reference Documents**	
Beech B200 King Air	B200 Maintenance Manual Part No. 101-590010-19	
Maintenance Item	**Periods**	**Standard**
Pre-Flight & Post-Flight Inspection Check.	Before-Flight & After-Flight Day.	Tropicair SOP Manual & AFM.
Phase 1 – 4 Inspections	At 200 (+/-20) Hour Intervals. Complete All 4 Phase Inspection Checks within 24 Months Period.	Maintenance Manual Chapter 5: 5-20-01, 5-20-02, 5-20-03, 5-20-04
Airworthiness Limitations	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 04-00-00
Unscheduled Maintenance Checks	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-50-00
Continuous Corrosion Control Inspection	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-29-00
Time Limits – Overhaul & Replacement	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-11-00
Engine	**Reference Documents**	
PT6A-42	Pratt & Whitney PT6A-42 Maintenance Manual Part No. 3021442 Pratt & Whitney Canada SB 3002 Pratt & Whitney Canada SB 3003	
Maintenance Item	**Periods**	**Standard**
Scheduled Inspections	200 (+/- 20) Hours	B200 Maintenance Manual Chapter 05-00-00 Time Limits, Maintenance Checks & P&WC MM Table 601.
Special Inspection	IAW Manufacturer Requirement	Pratt & Whitney PT6A-42 Maintenance Manual Part No. 3021442
Engine Overhaul	4100 Hours or 144 Months	Pratt & Whitney SB 3003 PWC Document STP # 442

Continued....

5.4 Appendix D: NLG Actuator Servicing

5.4.1 Appendix D1: NLG Actuator Inspection Procedure-Super King Air Model 200 Series Maintenance Manual

BEECHCRAFT®
SUPER KING AIR MODEL 200 SERIES
MAINTENANCE MANUAL

NOSE AND MAIN LANDING GEAR ACTUATOR - INSPECTION/CHECK
(BB-2 thru BB-1157, BB-1159 thru BB-1166, BB-1168 thru BB-1192; BT-1 thru BT-30; BL-1 thru BL-72 and BN-1 thru BN-4 without Kit No. 101-8018 Installed)

1. Information

Refer to Standard Practices - Airframe Chapter 20-14-00, 201 for information on tools and equipment referenced in Table 601. Refer to Standard Practices - Airframe Chapter 20-15-00, 201 for information on recommended materials referenced in Table 601.

Table 601. Tools/Equipment and Recommended Materials

ITEM	TOOLS AND EQUIPMENT	ITEM	RECOMMENDED MATERIALS
165	Dial Indicator		

2. Nose and Main Landing Gear Actuator

WARNING: Place the airplane on jacks prior to performing any inspection or maintenance. After performing maintenance of any type on the landing gear system and before releasing the airplane to service the landing gear must be cycled from the fully extended to fully retracted and back to fully extended a least once, checking for proper operation and rigging.

CAUTION: Jacking of an airplane for the purpose of landing gear operation inspection, servicing or maintenance, should be accomplished within an enclosed building or hangar. In the interest of safety, should it become necessary to jack the airplane in the open, wind velocity in any direction and terrain variations must be compensated for prior to jacking the airplane.

A. Inspection

Any time the landing gear actuators are removed from the airplane for lubrication (every 1000 cycles of operation or 30 months, whichever occurs first - Ref. 05-20-05, 601), each actuator should be bench checked for total end play. Check each actuator as follows before disassembly for lubrication:

(1) Using an extension rod paralleled to the nut assembly, clamp a dial indicator (165, Table 601) or equivalent, to the nut assembly shaft so the deflector lever of the dial indicator rests against the gear housing of the actuator (Ref. Figure 601). Flatten the extension rod where it contacts the nut assembly shaft to make sure that there is firm clamping.

CAUTION: To avoid damaging the actuator, DO NOT bottom out the actuator spring while compressing it to measure end play.

(2) Applying approximately 100 pounds of force in either direction, move the nut assembly shaft (15) in and out several times while measuring by dial indicator the distance over which the nut assembly may be pushed in and out of the actuator housing.

CAUTION: Any rotation of the drive pinion, torque shaft or nut assembly can cause an erroneous measurement.

(3) Check the actuator end play with the main landing gear actuator nut fully in and backed off one turn, with the nut half extended and with the nut extended seven inches.

(4) Measure the end play on the nose gear actuators with the actuator nut fully in and backed off one turn, with the nut half extended, and with the nut extended 10.5 inches.

(5) If the total end play measured at any one of the three noted positions of the preceding step is less than 0.016 inch the actuator may be returned to service and rechecked for end play using the intervals in Chapter 05-20-05, 601. If the total end play is more than 0.016 inch but less than 0.018 inch, the actuator may be returned to service, but must be checked every 200 cycles. Whenever the end play in any position reaches 0.018 inch, the actuator should be overhauled or replaced.

(6) After the actuator has been lubricated, check the total end play to make sure that the unit has been correctly assembled following lubrication.

(7) The end play check of the input pinion gear of the screw jack actuators, both main and nose, should be done with the actuators out of the airplane as explained below:

(a) Apply a force of 125 to 150 pounds outward from the gear housing directly to the pinion shaft (Ref. Figure 602). If the thrust bearing is improperly installed, this will unseat the bearing and the end play will be 0.050 to 0.080 inch or more. This force may be applied by a 12 to 1 ratio lever blocking against the gearbox for a fulcrum, and applying an 11 pound force at the handle of the lever.

(b) If this check reveals proper installation, the torque shaft should be connected in the same position as removed.

(c) If the thrust bearing is found to be improperly installed in either the nose or main gear actuator, the unit should be overhauled or replaced. Make sure that the thrust bearing is installed as shown (Ref. Figure 603).

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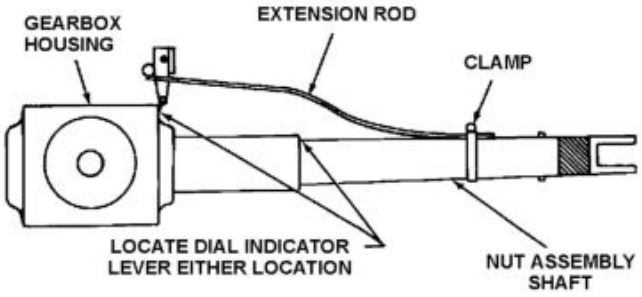

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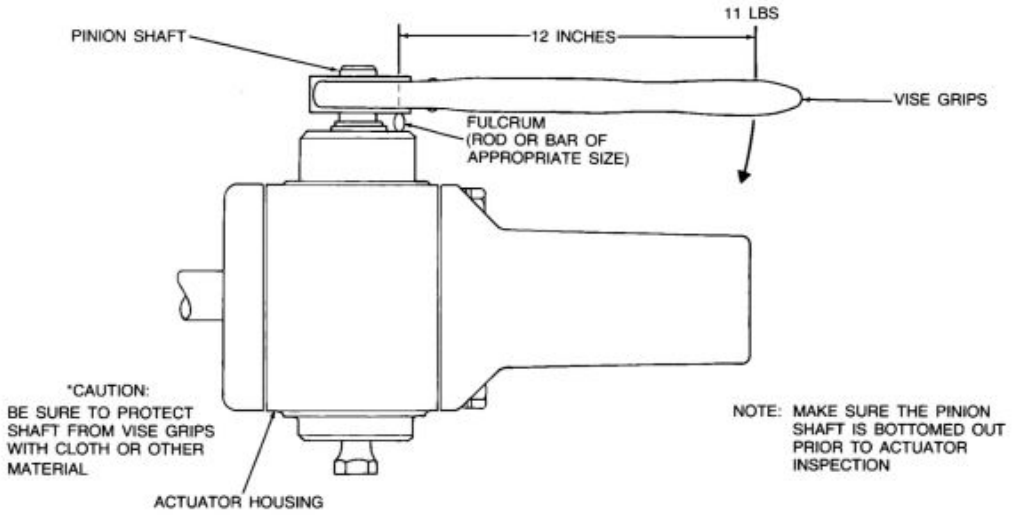
Actuator Inspection
Figure 601 (Sheet 1)

E74545



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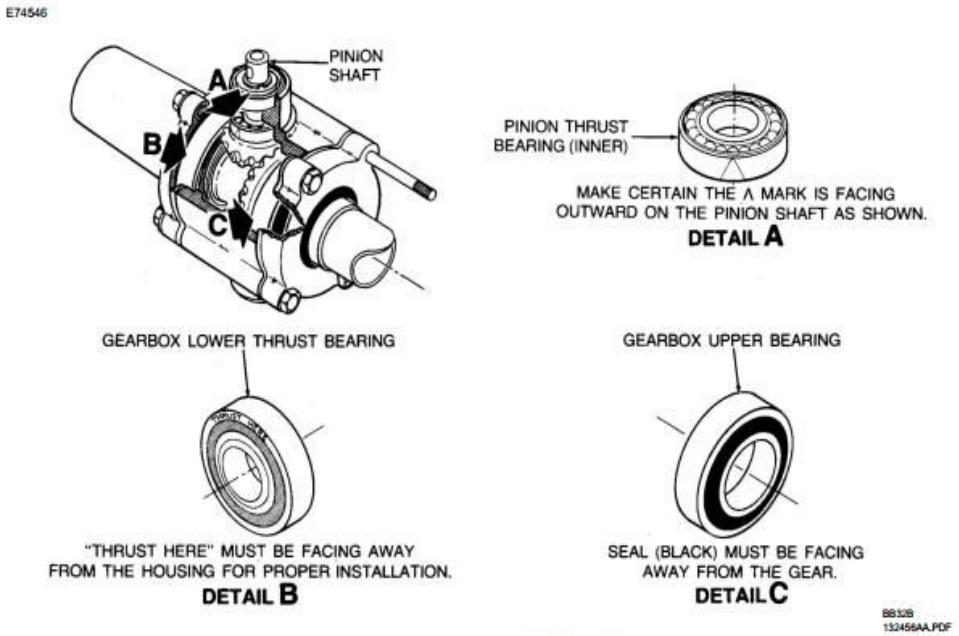
End play Check of Input Pinion Gear
Figure 602 (Sheet 1)



Pinion Thrust Bearing Installation
Figure 603 (Sheet 1)

5.4.2 Appendix D2: Nose Landing Gear Actuator Removal/Installation Procedure-Super King Air Model 200 Series Maintenance Manual.

BEECHCRAFT®
SUPER KING AIR MODEL 200 SERIES
MAINTENANCE MANUAL

NOSE LANDING GEAR ACTUATOR - REMOVAL/INSTALLATION
(BB-2 thru BB-1157, BB-1159 thru BB-1166, BB-1168 thru BB-1192; BT-1 thru BT-30; BL-1 thru BL-72 and BN-1 thru BN-4 without Kit No. 101-8018 Installed)

1. Information

Refer to Standard Practices - Airframe Chapter 20-14-00, 201 for information on tools and equipment referenced in Table 401. Refer to Standard Practices - Airframe Chapter 20-15-00, 201 for information on recommended materials referenced in Table 401.

Table 401. Tools/Equipment and Recommended Materials

ITEM	TOOLS AND EQUIPMENT	ITEM	RECOMMENDED MATERIALS
		02-029	Lubricating Paste

2. Nose Landing Gear Actuator

WARNING: Place the airplane on jacks prior to performing any inspection or maintenance. After performing maintenance of any type on the landing gear system and before releasing the airplane to service the landing gear must be cycled from the fully extended to fully retracted and back to fully extended a least once, checking for proper operation and rigging.

CAUTION: Jacking of an airplane for the purpose of landing gear operation inspection, servicing or maintenance, should be accomplished within an enclosed building or hangar. In the interest of safety, should it become necessary to jack the airplane in the open, wind velocity in any direction and terrain variations must be compensated for prior to jacking the airplane.

A. Removal
(1) Place the airplane on jacks (Ref. 07-10-05, 201).
(2) Retract the gear slightly to relieve tension on the actuator shock spring (Ref. Figure 401).
(3) Release tension on the chain at the idler sprocket in the nose wheel well.
(4) Remove the two bolts securing the two-piece drive shaft together, then slide the larger shaft half from the actuator and the smaller half from the bearing.
(5) Remove the bolt securing the actuator yoke to the drag leg; note the placement of the shim washers (if installed).
(6) Remove the screws securing the actuator support bearing to the brackets and remove the actuator from the airplane.

B. Installation
(1) Position the actuator and the support bearings in the support bracket and install the attaching screws (Ref. Figure 401). Use shims as required between the actuator supports and the mounting brackets in the wheel well to center the actuator with respect to the center of the landing gear strut. The allowable end play of the actuator with respect to its supports is 0.005 to 0.040 inch.
(2) Place the drive shaft in position on the actuator, install the retract chain on the sprocket and secure the support bearing (if removed) with attaching screws.
(3) Insert the smaller half of the drive shaft in the larger half with the retaining bolt holes aligned, then engage the larger half with the actuator and the smaller half with the bearing and secure them together with the two retaining bolts.

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MAINTENANCE MANUAL

(4) Install the retract chain on the sprocket.

NOTE: Make sure the actuator is extended completely before connecting the actuator to drag brace to prevent actuator damage.

(5) Connect the actuator to the nose gear drag brace by installing the stop bolt and shim washers in the same order as noted in the disassembly (Ref. 32-30-07, 601) if the yoke and drag brace do not operate smoothly.

NOTE: Apply lubricating paste (02-029, Table 401) to the stop bolt through the lubricator (Ref. Figure 402).

(6) Rig the landing gear.

5.4.3 Appendix D3: NLG Actuator Lubrication Procedure-Super King Air Model 200 Series Maintenance Manual.

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SUPER KING AIR MODEL 200 SERIES
MAINTENANCE MANUAL

NOSE LANDING GEAR ACTUATOR - SERVICING
(BB-2 thru BB-1157, BB-1159 thru BB-1166, BB-1168 thru BB-1192; BT-1 thru BT-30; BL-1 thru BL-72 and BN-1 thru BN-4 without Kit No. 101-8018 Installed)

1. Information

Refer to Standard Practices - Airframe Chapter 20-14-00, 201 for information on tools and equipment referenced in Table 301. Refer to Standard Practices - Airframe Chapter 20-15-00, 201 for information on recommended materials referenced in Table 301.

Table 301. Tools/Equipment and Recommended Materials

ITEM	TOOLS AND EQUIPMENT	ITEM	RECOMMENDED MATERIALS
		03-003	Aeroshell Grease 64
		03-015	Lubricating Grease
		06-015	Dry Cleaning Solvent

2. Nose Landing Gear Actuator

WARNING: Place the airplane on jacks prior to performing any inspection or maintenance. After performing maintenance of any type on the landing gear system and before releasing the airplane to service the landing gear must be cycled from the fully extended to fully retracted and back to fully extended a least once, checking for proper operation and rigging.

CAUTION: Jacking of an airplane for the purpose of landing gear operation inspection, servicing or maintenance, should be accomplished within an enclosed building or hangar. In the interest of safety, should it become necessary to jack the airplane in the open, wind velocity in any direction and terrain variations must be compensated for prior to jacking the airplane.

A. Lubrication

CAUTION: DO NOT MIX greases of different types. Overhaul of the actuator is recommended if the grease is to be changed as the actuator will need to be completely disassembled and all components thoroughly cleaned before lubrication. Aeroshell Grease 17 is not compatible with Aeroshell Grease 64 even though qualified to the same MIL-G-21164 specification.

NOTE: If the same grease is to be used, the following procedure may be used to partially disassemble the actuator to replenish the grease.

The nose landing gear actuator should not be lubricated until the NOSE AND MAIN LANDING GEAR ACTUATOR INSPECTION procedure Chapter 32-30-11, 601 has been completed.

Every 1000 cycles or 30 months, remove the actuator from the airplane as described under the NOSE LANDING GEAR ACTUATOR REMOVAL procedure Chapter 32-30-07, 401 and disassemble as follows (Ref. Figure 301):

(1) Remove the actuator nut assembly (9) from the actuator.
(2) Clean the nut assembly (9) with dry cleaning solvent (06-015, Table 301). Make sure that the threads are clean.
(3) Visually check the condition of the threads of the nut assembly (9).

(4) If needed, refer to the Component Maintenance Manual when assembling the actuator (Ref. King Air Component Maintenance Manual, Chapter 32 - Supplier Publications, Beechcraft Landing Gear Actuators Manufactured Component Maintenance Manual with Illustrated Parts List).

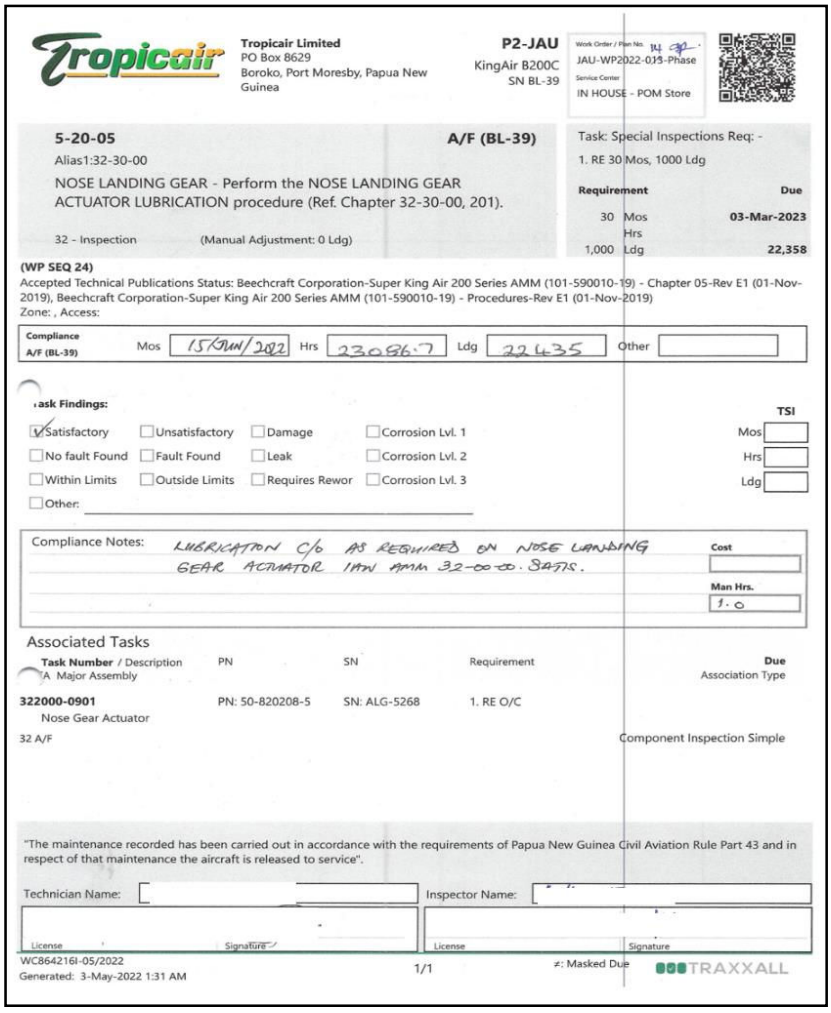
NOTE: Proof tests and break in are not required after lubrication, provided that the actuator is assembled with the original shims, or that new shims of the same thickness as the original shims are installed in the same location as the original shims and that no other new actuator components (with the exception of packings and seals) are installed.

(5) Apply grease to the threads and fill the actuator nut assembly (9) approximately half full with lubricating grease (03-003, Table 301) or (03-015, Table 301) while taking care to prevent air traps. Using care not to damage the packing in the lower cover (5), insert the nut assembly (9) into the lower cover (5) and screw into the actuator until fully retracted.

(6) Install the actuator in the airplane as described under the NOSE LANDING GEAR ACTUATOR INSTALLATION procedure (Ref. 32-30-07, 401).

5.5 Appendix E:NLG Actuator Lubrication Records

5.5.1 Appendix E1: Operator's Work Order Number JAU-WP2022-014



Tropicair

Tropicair Limited
PO Box 8629
Boroko, Port Moresby, Papua New Guinea

P2-JAU
KingAir B200C
SN BL-39

Work Order / Part No. 14
JAU-WP2022-015-Phase
Service Center
IN HOUSE - POM Store

5-20-05 A/F (BL-39)
Alias1:32-30-00
NOSE LANDING GEAR - Perform the NOSE LANDING GEAR ACTUATOR LUBRICATION procedure (Ref. Chapter 32-30-00, 201).
32 - Inspection (Manual Adjustment: 0 Ldg)

Task: Special Inspections Req: -
1. RE 30 Mos, 1000 Ldg

Requirement		Due
30	Mos	03-Mar-2023
	Hrs	
1,000	Ldg	22,358

(WP SEQ 24)
Accepted Technical Publications Status: Beechcraft Corporation-Super King Air 200 Series AMM (101-590010-19) - Chapter 05-Rev E1 (01-Nov-2019), Beechcraft Corporation-Super King Air 200 Series AMM (101-590010-19) - Procedures-Rev E1 (01-Nov-2019)
Zone: , Access:

Compliance A/F (BL-39) Mos 15/JUN/2022 Hrs 23086.7 Ldg 22635 Other

Task Findings:
☑ Satisfactory ☐ Unsatisfactory ☐ Damage ☐ Corrosion Lvl. 1
☐ No fault Found ☐ Fault Found ☐ Leak ☐ Corrosion Lvl. 2
☐ Within Limits ☐ Outside Limits ☐ Requires Rewor ☐ Corrosion Lvl. 3
☐ Other:

TSI
Mos
Hrs
Ldg

Compliance Notes: LUBRICATION C/O AS REQUIRED ON NOSE LANDING GEAR ACTUATOR IAW AMM 32-00-00. SATIS.
Cost
Man Hrs. 1.0

Associated Tasks

Task Number / Description A Major Assembly	PN	SN	Requirement	Due Association Type
322000-0901 Nose Gear Actuator	PN: 50-820208-5	SN: ALG-5268	1. RE O/C	
32 A/F				Component Inspection Simple

"The maintenance recorded has been carried out in accordance with the requirements of Papua New Guinea Civil Aviation Rule Part 43 and in respect of that maintenance the aircraft is released to service".

Technician Name: Inspector Name:
License Signature License Signature

WC864216I-05/2022
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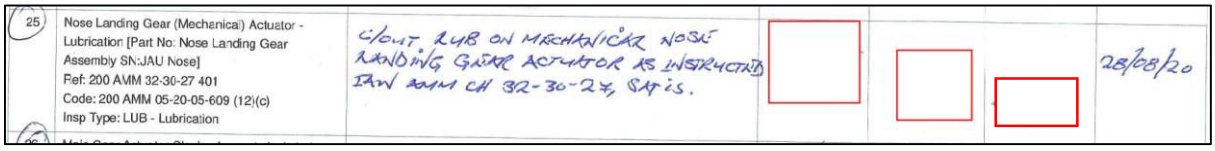
5.5.2 Appendix E2: Operator's -Work Pack Resolution Record (145,119 & CAMO), Job Number 2020-0337



25 Nose Landing Gear (Mechanical) Actuator - Lubrication [Part No: Nose Landing Gear Assembly SN:JAU Nose]
Ref: 200 AMM 32-30-27 401
Code: 200 AMM 05-20-05-609 (12)(c)
Insp Type: LUB - Lubrication

C/OUT LUB ON MECHANICAL NOSE LANDING GEAR ACTUATOR AS INSTRUCTED IAW AMM CH 32-30-27, SATIS.

28/08/20

5.6 Appendix F: Civil Aviation Rule Part 43-General Maintenance Rules

43.66 Non-destructive testing

(a) A person performing maintenance on an aircraft or aircraft component where the applicable maintenance data requires a non-destructive test using fluorescent penetrant, magnetic particle, eddy current, ultrasonic or radiography methods must hold an aviation maintenance specialist certificate issued under Part 66 for the application of a specified NDT technique using specified equipment.

(b) A person must perform non-destructive testing using appropriate methods, techniques and practices acceptable to the Director.

43.67 Welding

(a) A person performing maintenance on an aircraft or aircraft component where the applicable maintenance data requires welding to be performed must hold an aviation maintenance specialist certificate issued under Part 66 for the application of a specified welding technique using specified equipment.

(b) A person must perform welding using appropriate methods, techniques and practices acceptable to the Director.

43.68 Maintenance records

(a) Except as provided in paragraph (b), a person performing maintenance on an aircraft or component must, on completion of the maintenance, record the following information in the appropriate maintenance logbook:

(1) details of the maintenance including, where applicable,
- (i) the identity of any inspection carried out; and
- (ii) a description of the work performed; and
- (iii) the technical data used; and
- (iv) the requirement for an operational flight check if the maintenance requires a flight check under rule43.103(a)(4):

(2) if a component is removed or fitted during the maintenance—
- (i) a description of the component; and
- (ii) its part number and serial number, if any; and
- (iii) the references to the applicable release documentation:

(3) details of any measurements or test results, including the results of any ground or air tests that have been performed as part of that maintenance:

(4) for altimeter system test and inspection, the date and maximum altitude to which the altimeter has been tested:

(5) if an AD is actioned as part of the maintenance, -
- (i) the AD number; and
- (ii) the revision date; and
- (iii) the means of compliance:

5.7 Appendix G: Extract from the Aerospace Turbine Rotables Inc Report of Teardown and Inspection of NLG Actuator, Part No 50-820208-5, Serial No ALG-5268.

7.0 Teardown Inspection

7.1 Nut Assembly

Initial inspection of the Nut Assembly revealed that the Nut Assembly could be pulled completely out of the Screw Assembly without rotating its threads (Figure 6). It did not have adequate thread contact to inhibit it from pulling straight out of the screw housing without rotation. Inspection of the exterior of the nut assembly and clevis indicted that there were no dents, scratches, bends or any other damage on the exterior of the nut assembly or clevis. Grease was present on the Nut Assembly, but it was thick and dry (Figure 7).

Figure 6 – Nut Assembly Removal Without Rotation

Figure 7 – Nut Assembly Threads with Grease

1919 E Northern Street, Wichita, KS 67216
Phone: 316-943-6100 • Fax: 316-943-2252

7.2 Screw Assembly

No damage was found on the interior of the Screw Assembly, although an insufficient amount of grease was observed (Figure 8).

Figure 8 – Screw with Grease

7.3 Lower Cover

The actuator Lower Cover was removed in order to inspect the Gearbox Lower Bearing. Grease was present but it was thick and pasty, as it would if it were old (Figure 9).

Figure 9 – Gearbox Lower Bearing with Grease

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7.4 Top Cover and Lower Bearing

The actuator Top Cover was removed and examined. The grease appeared very dry and crumbly as it would if it were old. The grease in the Gearbox Upper Thrust Bearing had the same appearance (Figure 10).

Figure 10 – Top Cover and Gearbox Upper Thrust Bearing with Grease

7.5 Housing

Grease was present on the inside of the housing, but it appeared dry and stiff as if it were old (Figure 11).

Figure 11 – Actuator Housing with Grease but Dry and Stiff

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7.6 Screw Assembly

The Screw Assembly was examined (Figure 12). The grease was slightly dry and stiff. There was no noticeable wear on any of the gear teeth. There is some corrosion present on the inside diameter surface of the Screw Assembly, possibly due to inadequate grease.

Figure 12 – Actuator Screw Assembly with Grease but Dry and Stiff

7.7 Gearbox Lower Bearing, Removed

The Gearbox Lower Bearing was examined (Figures 13 and 14). Grease was present, but it appeared old, as evidenced by being dry and stiff. The bearing was stiff to rotate by hand.

Figure 13 – Gearbox Lower Bearing with Grease, but Dry and Stiff

Figure 14 – Gearbox Lower Bearing with Grease, but Dry and Stiff, Other Side

7.8 The Gearbox Upper Thrust Bearing

The Gearbox Upper Thrust Bearing was examined. Grease was present, but it was very dry and stiff, as if it were old (Figure 15). The bearing was stiff to rotate by hand.

Figure 15 – Gearbox Upper Thrust Bearing with Grease, but Dry and Stiff

7.9 The Spline Gear portion of the Pinion Gear

The Pinion Gear was inspected, with no damage found. All of the teeth were present, and they showed only minimal wear (Figure 16). The Pinion Gear Snap Ring was examined, with no damage noted.

Figure 16 –The External Spline Gear Portion of the Pinion Gear Prior to Removal

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7.10 Snap Ring and Pinion Gear

The Snap Ring was then removed from the Pinion Gear, and the Pinion Gear was removed from the Housing. The Pinion was inspected. No damage was observed. Grease was present on the inside Pinion Gear, but it was dry and stiff as if it were old. No excessive wear was found on the teeth or shaft (Figures 17 and 18).

Figure 17 – Pinion Gear with Grease, but Dry and Stiff

Figure 18 – Pinion Gear with Grease, but Dry and Stiff

7.11 Inner Pinion Thrust Bearing

The Inner Pinion Thrust Bearing was removed and inspected (Figure 18). Grease was present but it was thick and gummy. When rotated by hand, the bearing rotation was stiff.

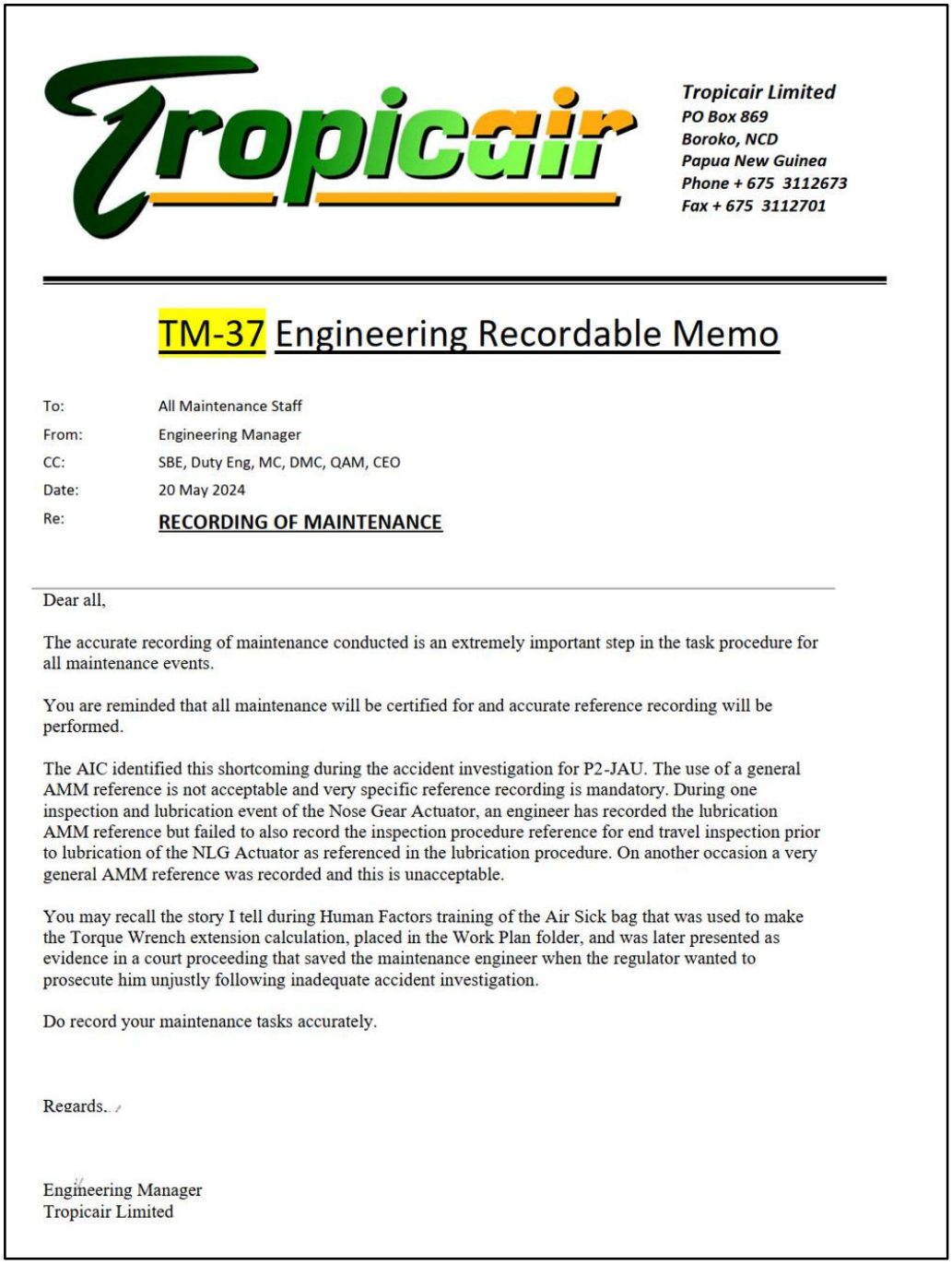
The Outer Pinion Bearing was removed and inspected (Figure 19). Grease was present, but it was thick and gummy. When rotated by hand, the bearing rotation was very stiff.

Figure 19 – Inner Pinion Thrust Bearing with Grease, but Thick and Gummy

Figure 20 – Outer Pinion Bearing with Grease, but Thick and Gummy

5.8 Appendix H: Safety Recommendation-Evidence of Preventive Action Taken

5.8.1 Appendix H1: Engineering Recordable Memo



Tropicair Limited
PO Box 869
Boroko, NCD
Papua New Guinea
Phone + 675 3112673
Fax + 675 3112701

TM-37 Engineering Recordable Memo

To: All Maintenance Staff
From: Engineering Manager
CC: SBE, Duty Eng, MC, DMC, QAM, CEO
Date: 20 May 2024
Re: **RECORDING OF MAINTENANCE**

Dear all,

The accurate recording of maintenance conducted is an extremely important step in the task procedure for all maintenance events.

You are reminded that all maintenance will be certified for and accurate reference recording will be performed.

The AIC identified this shortcoming during the accident investigation for P2-JAU. The use of a general AMM reference is not acceptable and very specific reference recording is mandatory. During one inspection and lubrication event of the Nose Gear Actuator, an engineer has recorded the lubrication AMM reference but failed to also record the inspection procedure reference for end travel inspection prior to lubrication of the NLG Actuator as referenced in the lubrication procedure. On another occasion a very general AMM reference was recorded and this is unacceptable.

You may recall the story I tell during Human Factors training of the Air Sick bag that was used to make the Torque Wrench extension calculation, placed in the Work Plan folder, and was later presented as evidence in a court proceeding that saved the maintenance engineer when the regulator wanted to prosecute him unjustly following inadequate accident investigation.

Do record your maintenance tasks accurately.

Regards.

Engineering Manager
Tropicair Limited

5.8.2 Appendix H2: Amended and Approved AMP

5.5 Appendix A4- Aircraft Maintenance Program - Beech B200-King Air

Aircraft call-sign Rego to which this programme applies: **P2-MAX, P2-JON, P2-JAU, P2-KTO**		
Person who is responsible for scheduling the maintenance: **Maintenance Controller**		
Aircraft	**Reference Documents**	
Beech B200 King Air	B200 Maintenance Manual Part No. 101-590010-19	
Maintenance Item	**Periods**	**Standard**
Pre-Flight & Post-Flight Inspection Check.	Before-Flight & After-Flight Day.	Tropicair SOP Manual & AFM.
Phase 1 – 4 Inspections	At 200 (+/-20) Hour Intervals. Complete All 4 Phase Checks within 24 Months Period.	Maintenance Manual Chapter 5: 5-20-01, 5-20-02, 5-20-03, 5-20-04
Scheduled Inspection Program – Special Checks	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-20-05
Airworthiness Limitations	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 04-00-00
Unscheduled Maintenance Checks	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-50-00
Continuous Corrosion Control Inspection	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-29-00
Time Limits – Overhaul & Replacement	IAW Manufacturer Requirement.	B200 Maintenance Manual Chapter 05-11-00
Landing Gear Actuator Replacement (Mechanical)	30 Months or 1000 Landings	B200 Maintenance Manual Chapter 05-20-05 Table 609