AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/2/3/10415	
Aircraft Registration	ZS-FON	**Date of Accident**		29 January 2024		**Time of Accident**	1135Z
Type of Aircraft	Beechcraft King Air C90A			**Type of Operation**		Private Flight (Part 91)	
Pilot-in-command Licence Type	Airline Transport Pilot Licence (ATPL)			**Age**	42	Licence Valid	Yes
Pilot-in-command Flying Experience		**Total Flying Hours**		8 478.6		**Hours on Type**	246.7
Last Point of Departure	Lanseria International Aerodrome (FALA), Gauteng Province						
Next Point of Intended Landing	Bona-Bona Game Lodge Airfield, North West Province						
Damage to Aircraft	Substantial						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Runway 17 at Bona-Bona Lodge Airfield (GPS co-ordinates: 27°01'18.40" South 026°13'16.52" East) at an elevation 4 760 feet (ft)							
Meteorological Information	Surface wind: 170°/10kts; temperature: 31°C; visibility: 9999m						
Number of People On-board	1 + 2	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Monday, 29 January 2024, a pilot and two passengers on-board a Beechcraft King Air C90A twin-turboprop aircraft with registration ZS-FON took off on a private flight from Lanseria International Aerodrome (FALA) in Gauteng province to Bona-Bona Game Lodge Airfield in North West province. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that the flight from FALA to Bona-Bona Lodge was uneventful. However, during the landing roll on Runway 17, the left main wheel assembly separated from the axle and contacted the left (No.1) propeller, damaging the blades. The aircraft skidded on its left wheel axle and veered off to the left of the runway. The aircraft came to a stop on the grass area approximately 1 metre (m) from the edge of the runway. The No.1 engine propeller, the left main wheel hubs, and the left main landing gear strut were damaged. The occupants on-board the aircraft were not injured.

The investigation revealed that the left-side main landing gear wheel assembly separation was due to a failed outer bearing. The failure of the outer bearing was caused by a fracture on the front face rib which disintegrated due to the mechanical contact in that area. This damaged the wheel hubs assembly during the accident sequence.

Probable Cause/s and/ or Contributory Factors

A fracture on the front face rib caused the failure of the left main wheel outer bearing which led to the wheel separating from the axle during the landing roll.

SRP Date	10 December 2024	Publication Date	17 December 2024

Occurrence Details

Reference Number	**:** CA18/2/3/10415
Occurrence Category	**:** Accident (Category 2)
Type of Operation	**:** Private (Part 91)
Name of Operator	**:** Blue Skies and Tail Wind
Aircraft Registration	**:** ZS-FON
Aircraft Make and Model	**:** Beechcraft King Air C90A
Nationality	**:** South African
Place	**:** Runway 17 at Bona-Bona Game Lodge Airfield, North West Province
Date and Time	**:** 29 January 2024 at 1135Z
Injuries	**:** None
Damage	**:** Substantial

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and not to apportion blame or liability.

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Investigation Process

The Accident and Incident Investigations Division (AIID) was notified of the occurrence on 29 January 2024 at 1135Z. The occurrence was classified as an accident according to the CAR 2011 Part 12 and the International Civil Aviation Organisation (ICAO) STD Annex 13 definitions. Notifications were sent to the State of Registry, Operator, Design and Manufacturer in accordance with the CAR 2011 Part 12 and the ICAO Annex 13 Chapter 4. The State (United States of America) appointed an accredited representative and advisor. The investigator did not dispatch to the accident site for this accident.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigated accident
   Aircraft — the Beechcraft King Air C90A involved in this accident
   Investigation — the investigation into the circumstances of this accident
   Pilot — the pilot involved in this accident
   Report — this accident report

2. *Photos and figures used in this report were taken from different sources and may have been adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report were limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows, or lines.*

Disclaimer

Table of Contents

Abbreviation	Description
°	Degrees
°C	Degrees Celsius
AIID	Accident and Incident Investigations Division
ATPL	Airline Transport Pilot Licence
ATF	Authority-to-Fly
CAR	Civil Aviation Regulations
C of R	Certificate of Registration
C of A	Certificate of Airworthiness
CRS	Certificate of Release to Service
E	East
FALA	Lanseria International Aerodrome
Ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
Kt	Knots
M	Metres
METAR	Meteorological Aerodrome Report
MHz	Megahertz
MPI	Mandatory Periodic Inspection
QNH	Barometric Pressure Adjusted to Sea Level
S	South
SACAA	South African Civil Aviation Authority
Sct	Scattered Clouds
SAWS	South African Weather Service
TBO	Time Between Overhaul
VMC	Visual Meteorological Conditions
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. At 1056Z on Monday, 29 January 2024, a pilot and two passengers on-board a Beechcraft King Air C90A twin-turboprop aircraft with registration ZS-FON took off on a private flight from Lanseria International Aerodrome (FALA) in Gauteng province to Bona-Bona Game Lodge Airfield in the North West province. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2. The pilot reported that the flight from FALA to Bona-Bona Game Lodge Airfield was uneventful. The duration of the flight was approximately 40 minutes. Upon landing on Runway 17 at the airfield, the pilot feathered the propeller during the landing roll and the left main wheel assembly separated from the axle. The aircraft veered off to the left and he applied the right rudder pedal to correct the yaw; however, he was unsuccessful. He then applied the brakes to decelerate but the aircraft continued to veer off to the left. There was a loud noise before the aircraft yawed sharply to the left and off the runway where it came to a stop a metre from the edge of the runway. The pilot shut down the engines and secured the aircraft.

1.1.3. According to the pilot, one of the passengers remarked that he saw the left wheel assembly after its separation whilst the aircraft was still rolling on the runway. The left main wheel assembly was found approximately 50 metres (m) further from where the aircraft had stopped. The pilot also noticed that the left wheel assembly had struck the four blades of the No. 1 (left side) propeller. The left No.1 propeller main wheel hubs and the left main landing gear were damaged. No person was injured during the accident.

1.1.4. The accident occurred during daylight on Runway 17 at Bona-Bona Lodge Airfield at Global Positioning System (GPS) co-ordinates determined to be 27°01'18.40" South 26°13'16.52" East, at an elevation of 4 760 feet (ft).

Figure 1: Aerial view of the threshold of Runway 17 and the approximate area where the aircraft stopped. (Source: Google Earth)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	1	-	2	3	-
Total	**1**	**-**	**2**	**3**	**-**

Note: Other means people on the ground.

1.3. Damage to Aircraft

1.3.1 The aircraft was substantially damaged during the accident sequence.

Figures 2 and 3: Damage to the No.1 propeller blades (left) and the left main landing gear axle (right) post-accident. (Source: Pilot)

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	42
Licence Type	Airline Transport Pilot Licence (ATPL) – Aeroplane				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument Rating and Instructor Grade 2				
Medical Expiry Date	31 December 2024				
Restrictions	None				
Previous Accidents	None				

Note: Previous accidents refer to past accidents the pilot was involved in, when relevant to this accident.

Flying Experience:

Total Hours	8 478.6
Total Past 24 Hours	2.5
Total Past 7 Days	2.5
Total Past 90 Days	70.8
Total on Type Past 90 Days	5.4
Total on Type	246.7

1.5.1. The pilot was initially issued an Airline Transport Pilot Licence (ATPL) on 30 April 2010 by the Regulator (SACAA). The licence was revalidated on 24 November 2023 with an expiry date of 31 December 2024. The pilot was issued a Class 1 aviation medical certificate on 17 July 2023 with an expiry date of 31 July 2024. He had a total of 8 478.6 flight hours of which 246.7 were on the aircraft type.

1.6. Aircraft Information

1.6.1. The Beechcraft King Air C-90 (Source: Aircraft Maintenance Manual (AMM) https://www.globalair.com › specifications)

The Beechcraft King Air C90 is an all-metal, low-wing, twin-engine, turbo-propeller aircraft with retractable landing gear. The aircraft has conventional ailerons for roll, elevators for pitches, and a rudder for yaw controls. It has dual controls for the pilot and co-pilot, complemented with full-flight instrumentation to allow dual navigation systems, two-course selectors, dual gyro horizons, and dual turn and slip indicators.

Airframe:

Manufacturer/Model	Raytheon Aircraft Company/ Beechcraft King Air C90A	
Serial Number	LJ-1735	
Year of Manufacture	2005	
Total Airframe Hours (At Time of Accident)	2 797.5	
Last Inspection (Date & Hours)	8 December 2023	2 782.9
Airframe Hours Since Last Inspection	14.6	
CRS Issue Date	8 December 2023	
C of A (Issue Date & Expiry Date)	5 June 2005	31 July 2024
C of R (Issue Date) (Present Owner)	17 July 2023	
Operating Category	Standard Normal Category	
Type of Fuel Used	Jet A1	
Previous Accidents	None	

Note: Previous accidents refer to past accidents the aircraft was involved in, when relevant to this accident.

Engine – Left (Number 1)

Manufacturer/Model	Pratt & Whitney / PT6-21
Serial Number	PCE-PE0624
Part Number	PT6A-21
Hours Since New	2 797.5
Hours Since Overhaul	TBO not yet reached

Propeller – Left (Number 1)

Manufacturer/Model	Hartzell / HC-E4N-3N
Serial Number	HH2203
Part Number	HC-E4N-3N
Hours Since New	2 797.5
Hours Since Overhaul	797.1

Engine – Right (Number 2)

Manufacturer/Model	Pratt & Whitney / PT6-21
Serial Number	PCE-PE0623
Part Number	PT6A-21
Hours Since New	2 797.5
Hours Since Overhaul	TBO not yet reached

Propeller – Right (Number 2)

Manufacturer/Model	Hartzell / HC-E4N-3N
Serial Number	HH2201
Part Number	HC-E4N-3N
Hours Since New	2 797.5
Hours Since Overhaul	797.1

1.6.2. The aircraft maintenance records (airframe, engine, propeller logbooks and the mandatory periodic inspection [MPI] work-pack) were reviewed. All the required maintenance service and manufacturer service directives, such as service bulletins and technical service instructions, were adhered to. The aircraft was issued the Certificate of Airworthiness (C of A) on 14 June 2023 with an expiry date of 31 July 2024.

1.6.3. An electrically operated hydraulic system retracts and extends the aircraft's landing gear. The hydraulic power pack is located in the centre of the wing section, forward of the main spar. As per the original equipment manufacturer (OEM) maintenance manual, the landing gear should be inspected at every 8 000 cycles or six years.

1.6.4. The main wheel consists of an inner and outer hub assembly made of cast magnesium.

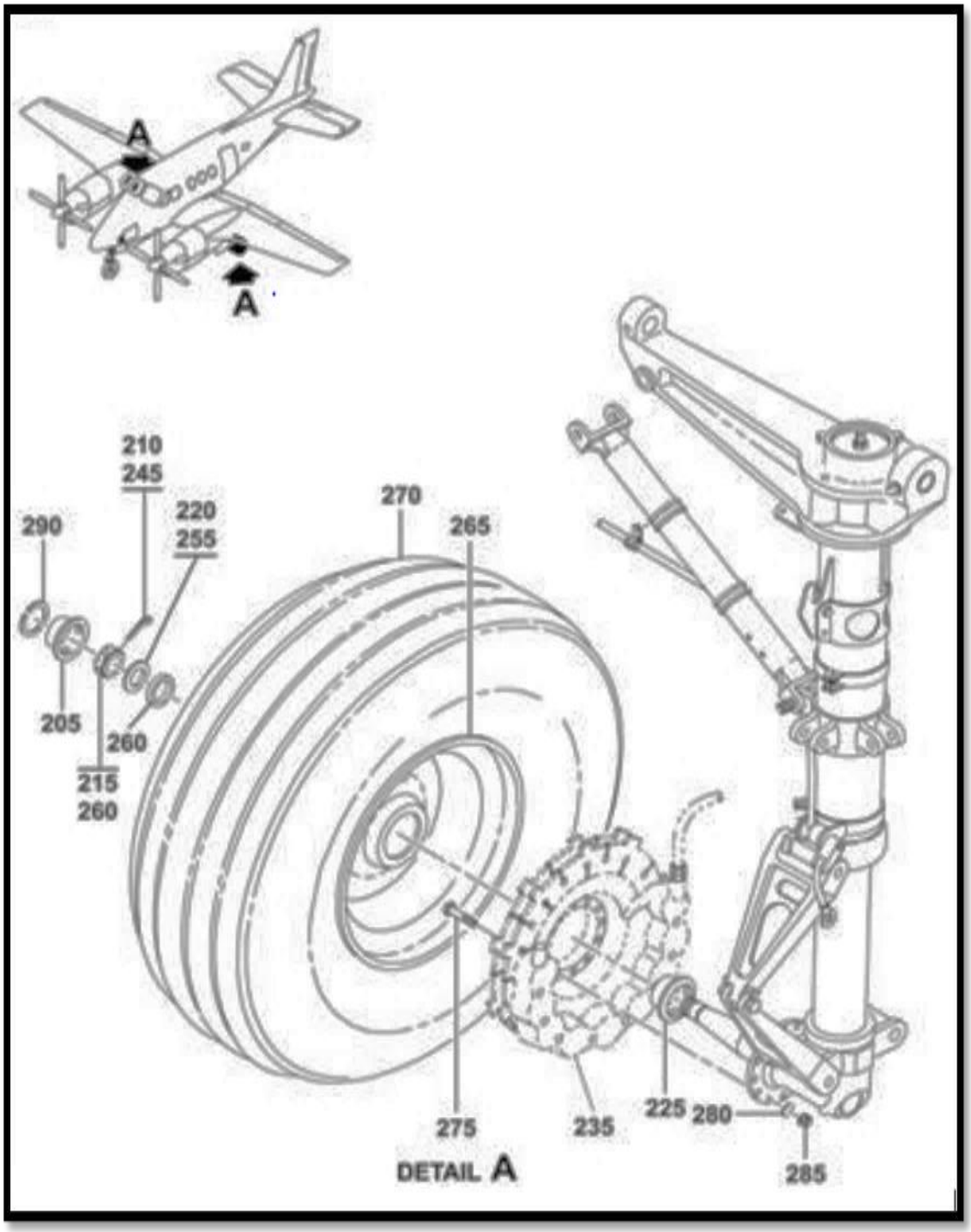


Diagram 1: Schematics of the main gear wheel.

Number indicated in the above figure	Component nomenclature
215/260	NUT
210/245	PIN- COTTER
220/255	WASHER
260	SPACER

Table 1: Components nomenclature of the main gear wheel.

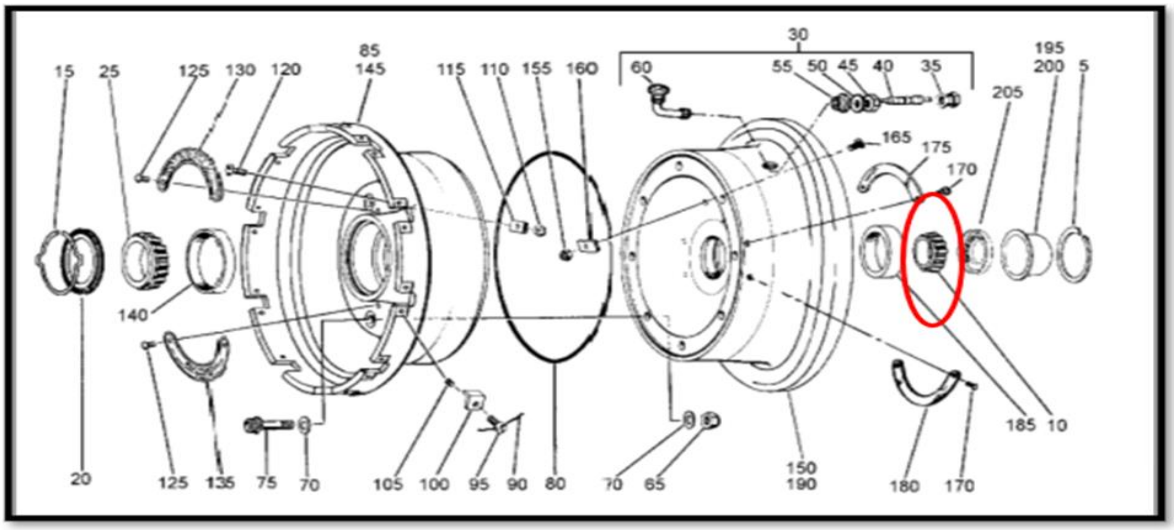


Diagram 2: Wheel hub assembly components.

Number indicated in the above figure	Component nomenclature
5	Ring, Lock
10	Cone, Bearing, Outer
15	Retainer, Inner
20	Seal Assembly, Inner
25	Cone, Bearing, Inner
65	Nut, Self-locking
70	Washer, Countersunk
75	Bolt
85	Wheel Half Assembly, Inner
130	Identification Plate
135	Instruction Plate
140	Cup, Bearing, Inner
145	Wheel Half, Inner
150	Wheel Half Assembly, Outer
185	Cup, Bearing, Outer
190	Wheel Half, Outer
200	Cap, Hub (No Axle Hole)

Table 2: Components nomenclature of the wheel hub.

A mandatory periodic inspection (MPI) of the aircraft was conducted. According to the MPI procedures outlined in the King Air 90 Series Maintenance Manual 32-40-00-01, the following requirements apply to the main landing gear wheels inspection:

- *Inspect wheels for wear, damage and corrosion.*
- *Inspect wheel bearings and races for wear, pitting, cracks discolouration, rust or other indications of damage.*

The inspection was conducted in accordance with the Component Maintenance Manual (CMM): 32-00-00 and was recorded in the logbook.

1.7. Meteorological Information

1.7.1. The weather information below was obtained from the pilot's questionnaire.

Wind Direction	170°	Wind Speed	10kts	Visibility	9999m
Temperature	31°C	Cloud Cover	Scattered	Cloud Base	10000ft
Dew Point	unknown	QNH	unknown		

1.8. Aids to Navigation

1.8.1. The aircraft was equipped with standard navigational equipment as approved by the Regulator. There were no records indicating that the navigational equipment was unserviceable before the flight.

1.9. Communication

1.9.1. The aircraft was equipped with a standard communication system as approved by the Regulator. There were no recorded defects with the communication system before the flight.

1.10. Aerodrome Information

Aerodrome Name	Bona-Bona Game Lodge Airfield
Aerodrome Location	North West Province
Aerodrome Status	Unlicensed
Aerodrome GPS coordinates	27°01'16″ South 26°13'18″ East
Aerodrome Elevation	4 760 feet
Runway Headings	17/35
Dimensions of Runway Used	1 296m x 19m
Heading of Runway Used	17
Surface of Runway Used	Asphalt
Approach Facilities	Unmanned
Radio Frequency	124.80 Megahertz (MHz)

1.11. Flight Recorders

1.11.1. The aircraft was neither equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to the aircraft type.

1.12. Wreckage and Impact Information

1.12.1. The accident occurred on Runway 17 at Bona-Bona Game Lodge Airfield during the landing roll. The left main wheel assembly separated from the axle and advanced towards the No 1 engine and impacted the propeller blades and damaged them. The aircraft continued to skid on its left gear brake assembly for approximately 38m before it stopped next to the runway.

Figure 4: The aircraft after the accident and the scrape marks on the runway. (Source: Pilot)

1.12.2. The scrape mark on the runway extended from where the wheel assembly came off to the resting position of the aircraft (see Figure 4).

1.12.3. The wheel assembly separated and rolled forward and through the rotating left engine propellers, thus, causing damage to the propeller blades. The wheel was found on the paved taxiway a few metres from where the aircraft had stopped. The damage on the tyre was consistent with the damage caused by metal that had cut-through it. The inboard wheel hub was also damaged.

Figure 5: Damage to the left main landing gear inboard hub. (Source: Operator)

1.12.4 The propeller blade tips were damaged. One of the blades had evidence of tyre material on it (see Figure 6).

Figures 6, 7 and 8: Tyre material on the blade tip (left), and damage to the two propeller blades (middle and right). (Source: Pilot)

1.13. Medical and Pathological Information

1.13.1. None.

1.14. Fire

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

1.15. Survival Aspects

1.15.1. The accident was considered survivable as the cockpit and the cabin area were not compromised. The pilot and the passengers had their safety harnesses on during the flight.

1.16. Tests and Research

1.16.1. The CrashLab analysed the failed outboard cone bearing, part number 077100, to establish the cause.

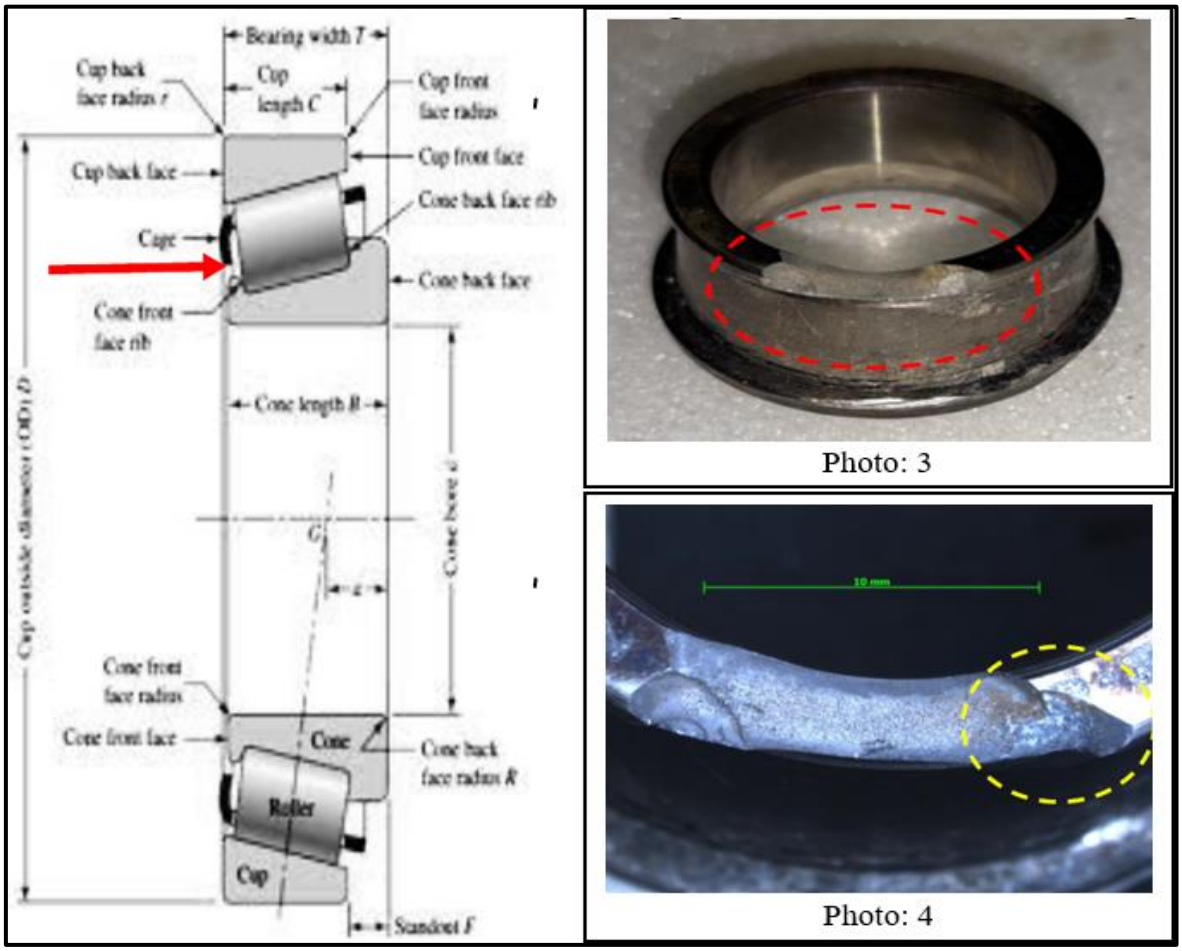


Figure 9: The failed bearing.

CrashLab Analysis Results:

- *The visual inspection of the outer cone-bearing inner ring revealed a fracture within the cone front face rib as shown above in Figure 9. (Photos 3 red dashed circle; Diagram 2 red arrow). Discolouration on the fracture surface (Photo 4, yellow dashed circle) suggests fracture initiation before final failure.*

Figure 10: The raceway surface condition.

The raceway surface revealed extensive wear damage (Photos 5 and 6).

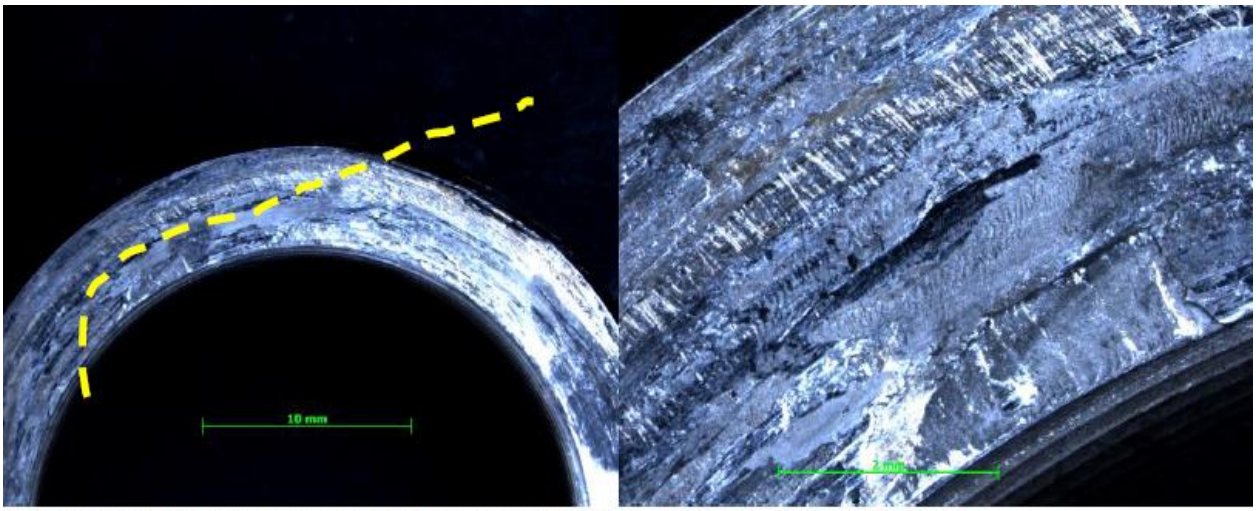


Photo 7: Outer cone back face/bearing cage interface (stereo)

Figure 11: Damage on the back area of the outer cone.

Extensive surface damage on the back cone face/bearing cage (Photo 7) indicates relative rotational movement within the assembly during operation.

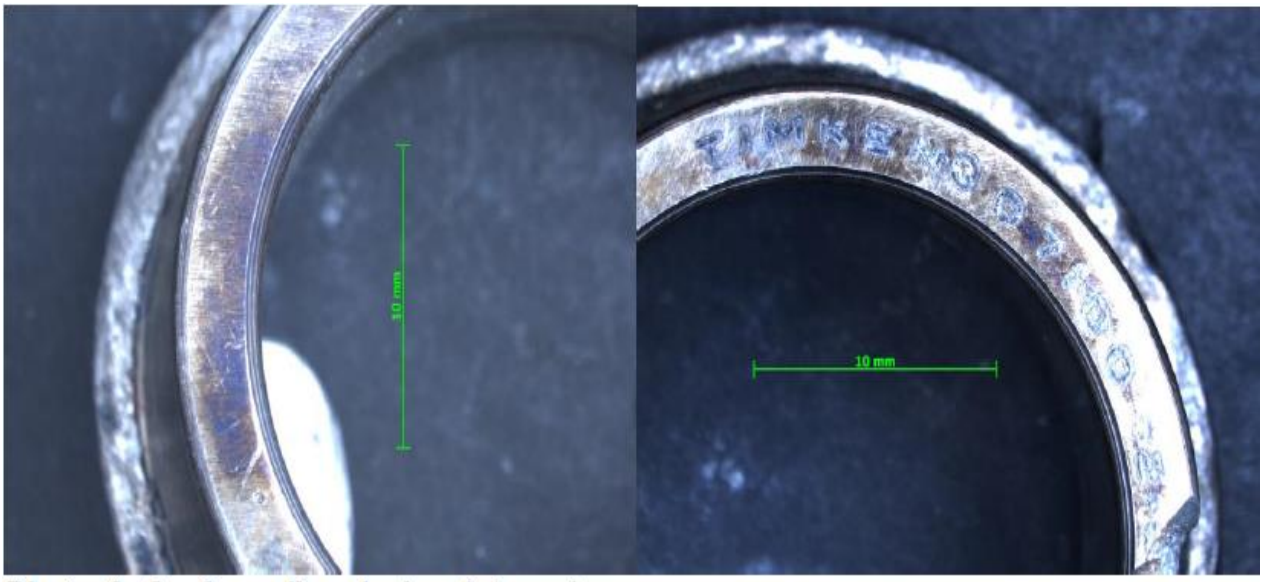
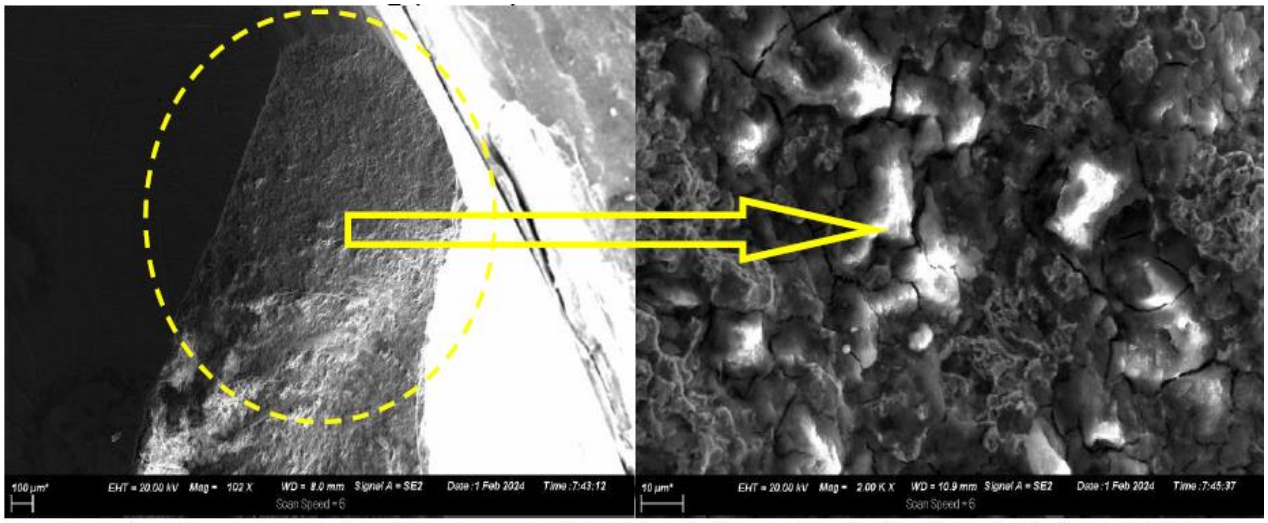


Photo 8: Surface discoloring (stereo)

Figure 12: Discolouration on the surface

Surface discolouration (Photo 8) can be attributed to high-temperature exposure during operation. However, the extent proved to be limited, suggesting the exposure time was limited and probably only during the final failure sequence.

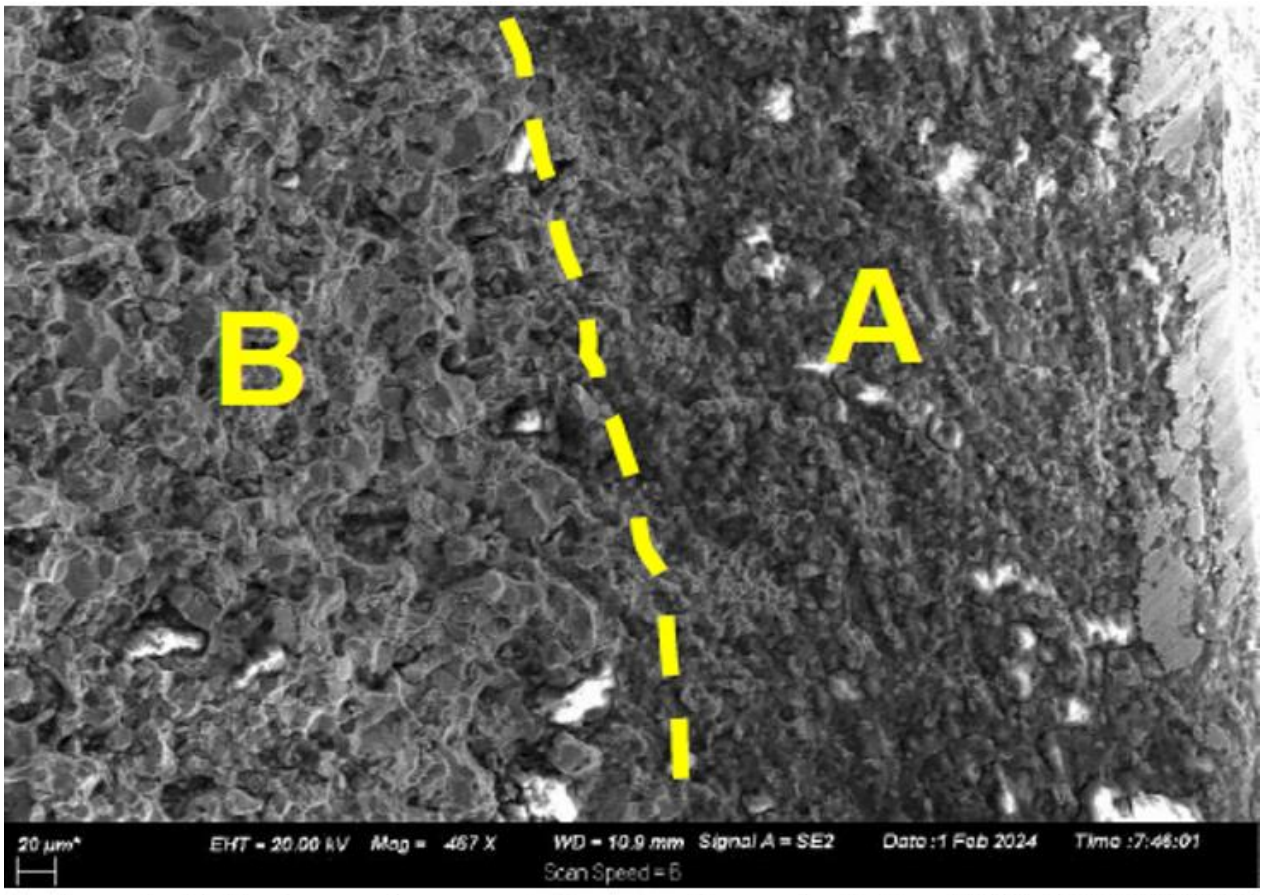
- High Magnification Inspection Results:



Fractograph 1: Fracture surface morphology, initiation zone (100-2000X, SE1, FEGSEM)

Figure 13: Morphology of the fractured surface

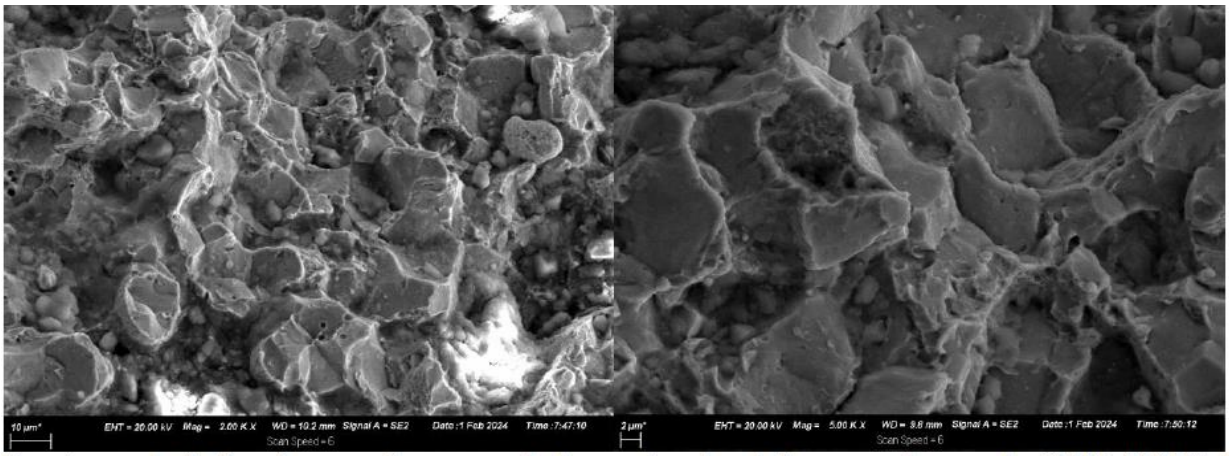
Fractured surface contamination (Fractograph 1) confirms that the pre-existing fracture within the cone front face rib (Photo 4) was exposed to operating conditions for an undetermined period before the final fracture.



Fractography 2: Fracture surface morphology showing contamination (407X, SE1, FEGSEM)

Figure 14: Morphology of the fractured surface showing contamination.

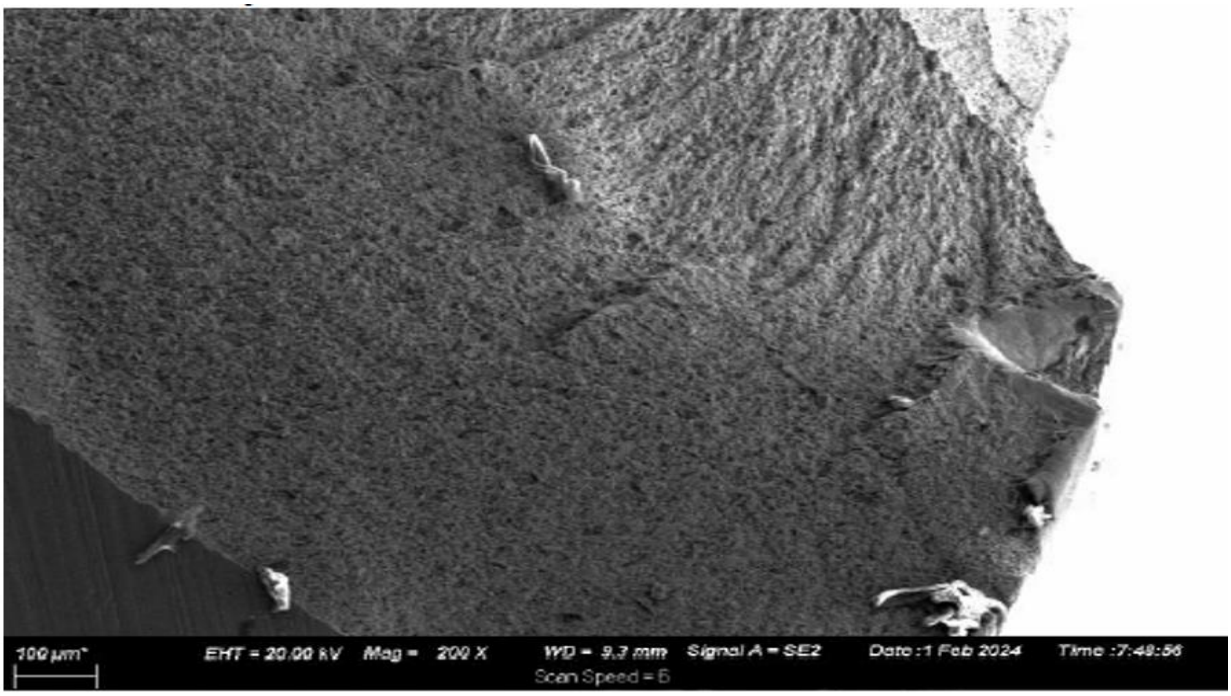
This notion is further supported by the clear transition from the pre-existing (A) to the final fracture morphologies (B) (Fractography 2, yellow dashed line).



Fractograph 3: Fracture surface morphology showing inter-granular mode (2000-5000X, SE1, FEGSEM)

Figure 15: Morphology showing intergranular mode of the fracture surface.

The central region fracture surface revealed clear indications of an intergranular morphology (Fractography 3). This condition is detrimental to the mechanical properties of the base material. It can be attributed to one or more of the following: incorrect heat treatment during manufacturing, exposure to high concentrations of atomic hydrogen or other discrepancies not determined by this investigation.



Fractography 4: Fracture surface morphology, final fast rupture (200X, SE1, FEGSEM)

Figure 16: Morphology of the fractured surface showing the final fast rapture.

Morphologies of the remainder of the fractured surface correspond with the final rupture and were most probably induced during the very final sequence of the failure.

Conclusions

- *The investigation results revealed a fracture within the cone front face rib of the left main wheel outer cone-bearing inner ring. This probably resulted in the mechanical interaction between the fractured section/s and the bearing rollers/raceway/separator assembly. The subsequent wear and damage to the separator possibly led to the disintegration of the cone-bearing assembly during operation.*

- *The inspection confirmed that the primary fracture had initiated at an undetermined operational period before the final failure.*

- *Indications of possible manufacturing discrepancies were noted but not investigated.*

- *Considering the catastrophic nature of the failure and the improbability of detecting a pre-existing fracture within the cone front face rib, it could be derived that normal maintenance inspection/s could not have predicted this failure.*

1.17. Organisational and Management Information

1.17.1. This was a private flight operated under the provisions of Part 91 of the CAR 2011 as amended.

1.17.2. The aircraft was maintained by an approved aircraft maintenance organisation (AMO). The AMO was issued an AMO Certificate on 27 November 2023 with an expiry date of 30 November 2024.

1.18. Additional Information

1.18.1. None.

1.19. Useful or Effective Investigation Techniques

1.19.1. None.

2. ANALYSIS

2.1. General

From the available evidence, the following analysis was made with respect to this accident. This shall not be read as apportioning blame or liability to any organisation or individual.

2.2. Analysis

2.2.1. The pilot's ATPL and associated ratings (night, instrument, Grade 2 instructor) were current. The pilot's Class 1 medical certificate was also current. The pilot's qualifications and medical fitness aligned with the regulatory requirements for safe flight operation.

2.2.2. The aircraft was issued the Certificate of Airworthiness (C of A) on 14 June 2023 with an expiry date of 31 July 2024. The Certificate of Release to Service (CRS) was current at the time of the flight.

2.2.3. The last 100-hour MPI was completed within the required timeframe and the landing gear maintenance was performed with no anomalies noted. Although the maintenance and inspection were conducted as per the prescribed procedures, the accident occurred 14.6 hours after the aircraft was released to service.

2.2.4. The damage to the left main wheel outer bearing caused the separation of the main wheel assembly from the axle. The examination and laboratory analysis of the bearing revealed the cone face rib fractured in operation.

2.2.5. The fact that this issue was undetectable during regular maintenance indicates a gap in identifying manufacturing defects through routine inspections.

3. CONCLUSION

3.1. General

From the available evidence, the following findings, causes, and contributing factors were made with respect to this accident. These shall not be read as apportioning blame or liability to any organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusion heading:

- **Findings —** are statements of all significant conditions, events, or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this accident.
- **Contributing factors —** are actions, omissions, events, conditions or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident occurring, or would have mitigated the severity of the consequences of the accident. Identifying contributing factors does not imply the assignment of fault or the determination of administrative, civil, or criminal liability.

3.2. Findings

3.2.1 The pilot was initially issued an Airline Transport Pilot Licence (ATPL) on 30 April 2010 under the provisions of Part 61 of the CAR 2011. The ATPL licence was reissued on 24 November 2023 with an expiry date of 31 December 2024.

3.2.2 The pilot was issued a Class 1 aviation medical certificate on 17 July 2023 with an expiry date of 31 July 2024.

3.2.3 The aircraft's Certificate of Registration (C of R) was issued to the current owner on 17 July 2023.

3.2.4 The aircraft was issued the Certificate of Airworthiness (C of A) on 14 June 2023 with an expiry date of 31 July 2024.

3.2.5 The latest 100-hour mandatory periodic inspection (MPI) of the aircraft was completed and certified on 8 December 2023 at 2782.9 airframe hours. The Certificate of Release to Service (CRS) was issued on 8 December 2023 with an expiry date of 7 December 2024 or at 2882.9 airframe hours, whichever comes first.

3.2.6 The accident occurred at 2 797.5 airframe hours which meant that the aircraft had accrued 14.6 hours since the last MPI.

3.2.7 The aircraft maintenance organisation (AMO) which performed the last maintenance inspection had an AMO Certificate that was issued on 27 November 2023 with an expiry date of 30 November 2024.

3.2.8 The outer cone-bearing front face rip fracture occurred during mechanical interaction whilst the aircraft was operated which led to the disintegration of the assembly.

3.3. Probable Cause/s

3.3.1. A fracture on the front face rib caused the failure of the left main wheel outer bearing, which led to the wheel separating from the axle during the landing roll.

3.4. Contributory Factor/s

3.4.1 None.

4. SAFETY RECOMMENDATIONS

4.1. General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report. The AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.2. Safety Recommendation/s

4.2.1. It is recommended that the manufacturer reviews its maintenance program to ensure that a proper mandatory inspection is performed on the failed components. The inspection should include any of the non-destructive testing (NDT) methods of crack detection.

5. APPENDICES

5.1. **Appendix A:** Failure Analysis and Investigation Crash Laboratory Results.

This report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

Appendix A

COMPILED BY	Crash LAB	PAGE 1 OF 9
COMPILED FOR: Global Av. Claims	INVESTIGATION REPORT: MAIN WHEEL ROLLER BEARING FAILURE, BEECHCRAFT C90B, AIRCRAFT No ZS-FON	DOCUMENT NUMBER FA-007-01-24
		DATE 2024-02-05 / ISSUE 1

ITEM:	LEFT-HAND MAIN WHEEL OUTER ROLLER BEARING, LEFT-HAND MAIN GEAR ASSEMBLY, BEECHCRAFT KING AIR C90B, AIRCRAFT NUMBER ZS-FON

1. INTRODUCTION & BACKGROUND INFORMATION

1.1. The damaged inner ring from the outer cone-bearing of the main landing gear wheel assembly (Photo 2) originating from a Beechcraft King Air C90B, aircraft registration no ZS-FON, (Photo 1), serial No LJ-1735, was submitted to determine the most probable sequence of events towards the failure during operation.

1.2. The TTSN for the airframe and the failed component amounts to 2782.9 hours while exposed to 1995 landing gear cycles. The component's lifetime is based upon 'condition'.

Photo 1: Accident site, ZS-FON[1]

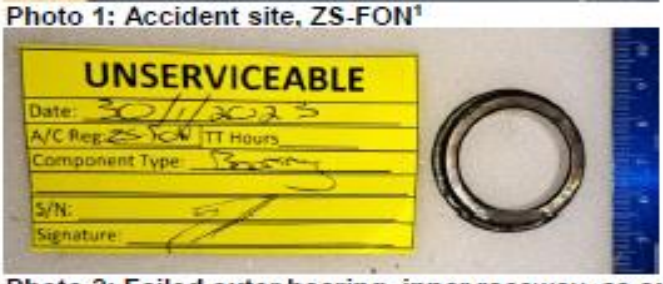


Photo 2: Failed outer bearing, inner raceway, as supplied (digital)

1.2. This report is divided into the following sections:

[1] Courtesy GAC

AC	Advisory Circular	NDE	Non-Destructive Evaluation
AD	Airworthiness Directive	NDI	Non-Destructive Inspection
AISI	American Iron and Streel Institute	NDT	Non-Destructive Testing
AME	Aircraft Maintenance Engineer	NLG	Nose Landing Gear
AMO	Aircraft Maintenance Organization	OEM	Original Equipment Manufacturer
ASI	Air-Speed Indication/or	OHSA	Occupational Health and Safety Act
ASTM	American Society for Testing and Materials	POD	Probability of Detection
BE	Big End	QMS	Quality Management System
DPI	Dye-Penetrant Inspection	RC	Rockwell C-scale
EBSD	Electron Back-Scatter Diffraction	RH	Right-Hand
ECSA	Engineering Counsel of SA	RoD	Rate of Descend
EDS	Energy-Dispersive X-ray Spectroscopy	RT	Radiographic Testing
FAA	Federal Aviation Authority	SABS	South African Bureau of Standards
FOD	Foreign Object Damage	SACAA	South African Civil Aviation Authority
HE	Hydrogen Embrittlement	SB	Service Bulletin
HIC	Hydrogen Induced Cracking	SCC	Stress Corrosion Cracking
HSS	High-Strength Steels	SE	Small End
ICAO	International Civil Aviation Authority	SEM	Scanning Electron Microscope
IG	Inter-Granular	TBO	Time Before Overhaul
IR	Infra-Red or Thermal Testing	TG	Trans-Granular
LH	Left-Hand	TSO	Time Since Overhaul
MAUW	Maximum All-Up Weight	TTSN	Total Time Since New
MLG	Main Landing Gear	UT	Ultra-Sonic Testing
MPI	Magnetic Particle Inspection	VSI	Vertical Speed Indication

2. APPLICABLE DOCUMENTS

(a) Cessna SB: SEB 94-19.

3. INVESTIGATIVE PERSONNEL

(a) The investigative member and compiler of this report is Mr C.J.C. Snyman. Mr Snyman is a qualified Physical Metallurgist (Metallurgical Engineering, ECSA Registration: Prof. Eng. Tech. No 201670194), Radiation Protection Officer (RPO, NNR, No 281) and Aircraft Accident Investigator.

4. APPARATUS AND METHODOLOGIES

(a) The methodology included visual inspection of the affected part/s, sample preparation and Light-, Stereo- and FEGSEM/EDS analysis.

(b) Apparatus:

Type	Make/Model	Operator
Stereo-Microscope	Zeiss Discover V20	C.J.C. Snyman
Scanning Electron Microscope	Zeiss 540 Crossbeam FEGSEM	C.J.C. Snyman
EDS	Oxford Aztec	C.J.C. Snyman

5. INVESTIGATION RESULTS

5.1. Visual- and Low-Magnification Inspection results: Cone Bearing, Part no 07100:

The visual inspection of the outer cone-bearing inner ring revealed a fracture within the cone front face rib (Photo 3, red dashed circle; Diagram 2, red arrow). Fracture surface discoloring (Photo 4, yellow dashed circle) suggest fracture initiation prior to final failure.

The raceway surface revealed extensive wear damages (Photo's 5 and 6).

Extensive surface damages at the cone back face/bearing cage interface (Photo 7) indicates relative rotational movement within the assembly during operation.

Surface discoloring (Photo 8) can be attributed to high temperature exposure during operation. However, the extend thereof proved to be limited suggesting the exposure time was limited and most probably only during the final failure sequence.

5.2. High Magnification Inspection results:

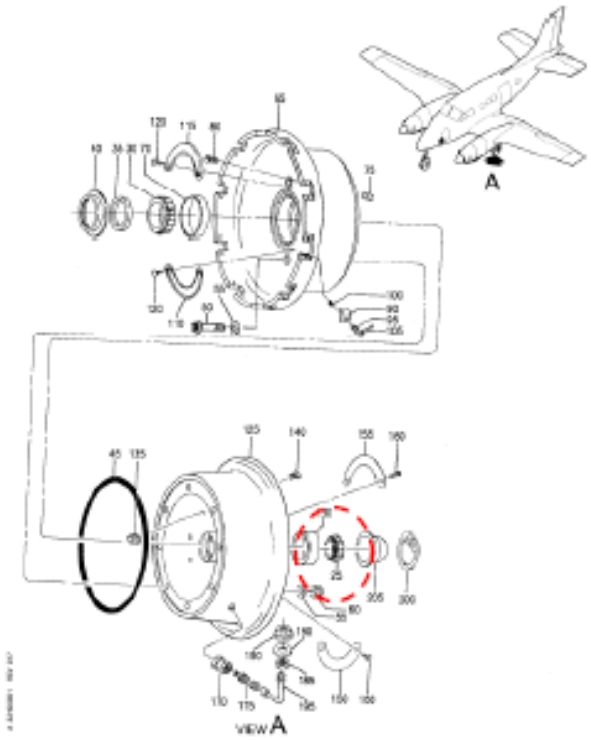
Indications of fracture surface contamination (Fractograph 1) confirms that the pre-existing fracture within the cone front face rib (Photo 4) was exposed to operating conditions for undetermined period prior to final fracture. This notion is further supported by the clear transition from the pre-existing- (A) to the final fracture morphologies (B) (Fractograph 2, yellow dashed line).

The central region fracture surfaces revealed clear indications of an inter-granular morphology (Fractograph 3). This condition is detrimental to the mechanical properties of the base material and can be attributed to one or more of the following: Incorrect heat treatment during manufacturing, exposure to high concentrations of atomic Hydrogen, or other discrepancies not determined by this investigation.

The morphologies of the remainder of the fracture surfaces corresponds with final rupture and were most probably induced during the very final sequence of the failure.

Beechcraft Corporation

KING AIR C90, C90A, C90GT & B90 ILLUSTRATED PARTS CATALOG



MAIN GEAR WHEEL
SHEET 1 OF 2

32-40-00-01
PAGE 7
FEB 01/19

Diagram 1: LH MLG assembly[2]

[2] Courtesy Beechcraft

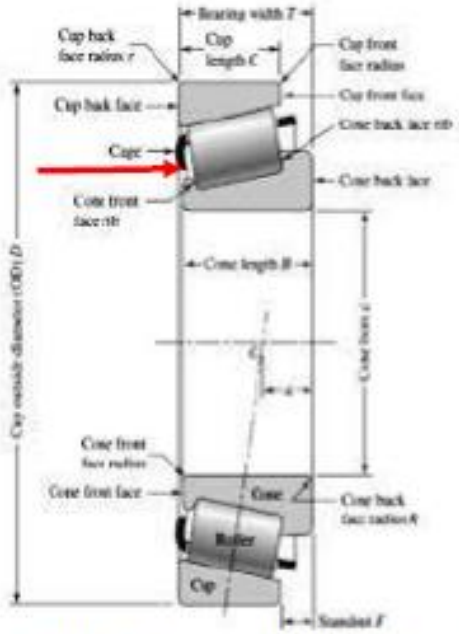


Diagram 2: Cone roller bearing nomenclature

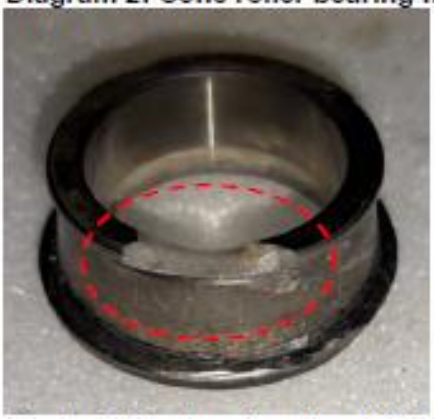


Photo 3: Fracture location (digital)

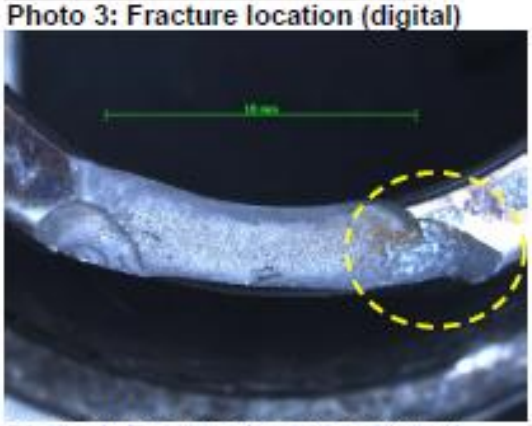


Photo 4: Fracture location (stereo)

Photo 5: Raceway surface condition (digital)

Photo 6: Raceway surface condition (stereo)

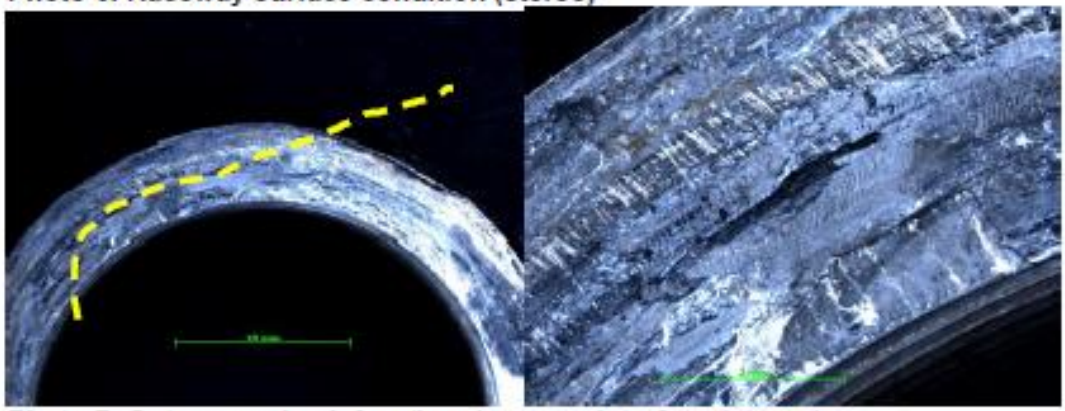


Photo 7: Outer cone back face/bearing cage interface (stereo)

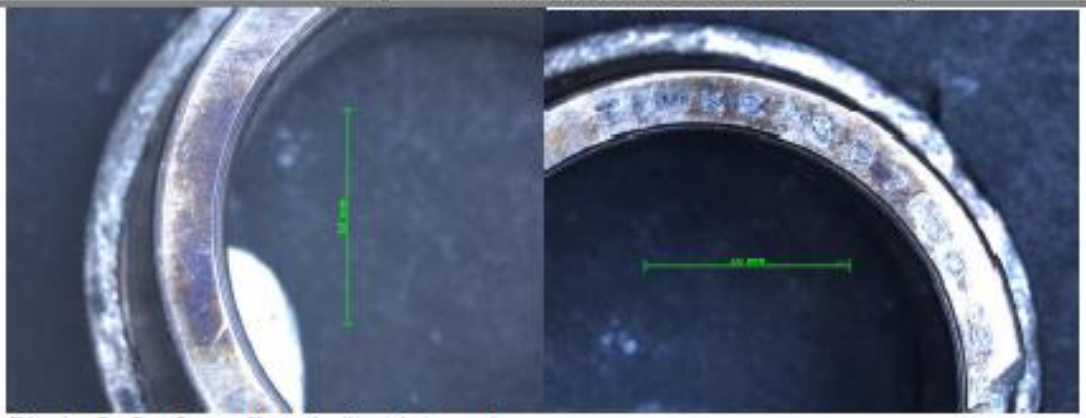
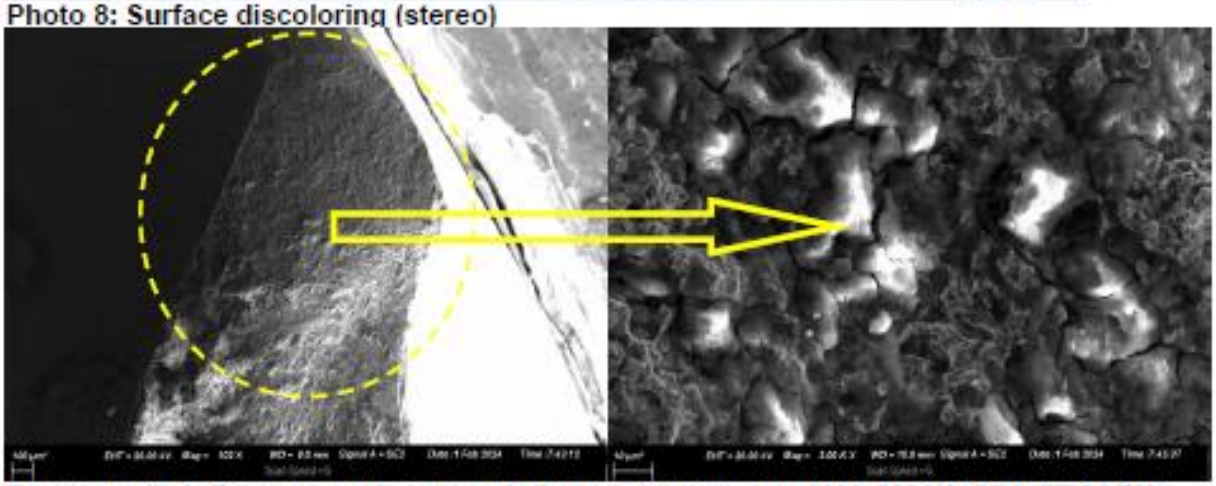
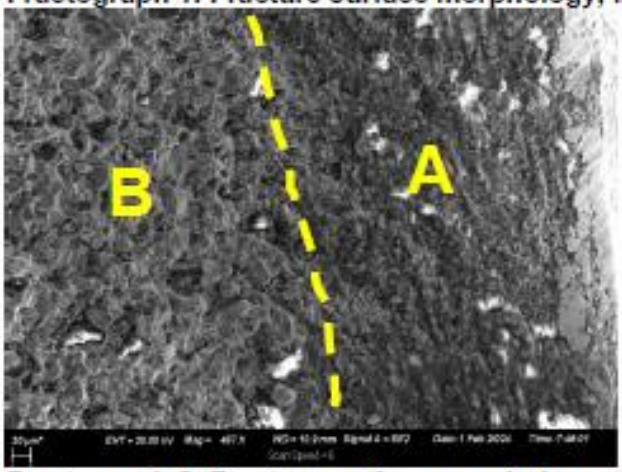


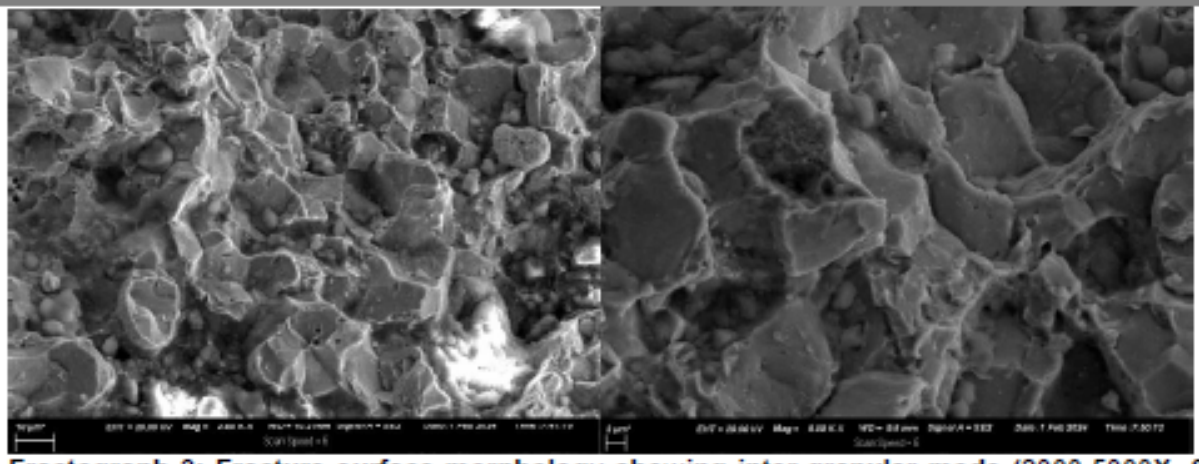
Photo 8: Surface discoloring (stereo)



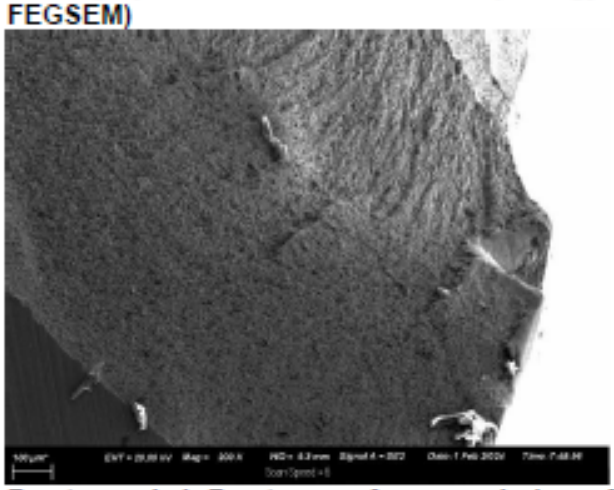
Fractograph 1: Fracture surface morphology, initiation zone (100-2000X, SE1, FEGSEM)



Fractograph 2: Fracture surface morphology showing contamination (407X, SE1, FEGSEM)



Fractograph 3: Fracture surface morphology showing inter-granular mode (2000-5000X, SE1, FEGSEM)



Fractograph 4: Fracture surface morphology, final fast rupture (200X, SE1, FEGSEM)

6. DISCUSSION AND CONCLUSIONS

Applicable Notes:

1. *All conclusions are based on the investigation results obtained from the supplied parts only.*
2. *All written-, electronic- and/or verbal information presented to this investigation are considered as factual.*

6.1 The investigation results revealed a fracture within the cone front face rib of the LH Main Wheel outer cone-bearing inner ring. This most probably resulted in the mechanical interaction between the fractured section/s and the bearing rollers/raceway/separator assembly. The subsequent wear and damages to the separator possibly led to the disintegration of the cone- bearing assembly during operation.

6.2. The inspection confirmed that the primary fracture initiated an undetermined operational period prior to final failure.

6.3. Indications of possible manufacturing discrepancies were noted but not investigated.

6.4. Considering the catastrophic nature of the failure and the improbability of detection of a pre-existing fracture within the cone front face rib, it can be derived that this failure could not have been predicted by *normal* maintenance inspection/s.

7. RECOMMENDATIONS

7.1. It is recommended that the investigation results and component are shared with the bearing OEM for further analysis.

8. DECLARATION

8.1. All digital images have been acquired by the author and displayed in an un-tampered manner, except when stated otherwise.