SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-57

LIMITED SERIOUS INCIDENT INVESTIGATION REPORT

Reference Number	CA18/3/2/1384										
Classification	Serious Incident		**Date**	9 December 2021			**Time**	0800Z			
Type of Operation	Private (Part 94)										
Location											
Place of Departure	Wings Park Aerodrome, near East London, Eastern Cape Province			Place of Intended Landing			Virginia Aerodrome (FAVG), KwaZulu-Natal Province				
Place of Occurrence	First Beach at Port St Johns, Eastern Cape Province										
GPS Co-ordinates	Latitude	31°37' 33.99" S		Longitude	029°33'00. 71" E		Elevation	3 feet			
Aircraft Information											
Registration	ZU-NDP										
Make/Model	Jabiru J430 (Serial Number: 353)										
Damage to Aircraft	Minor			Total Aircraft Hours			1 877.5				
Pilot-in-command											
Licence Type	Private Pilot Licence (PPL)			Gender	Male		Age	47			
Licence Valid	Yes										
Total Hours on Type	1 269.1			Total Flying Hours			2 015.3				
People On-board	1 + 1	Injuries	0	Fatalities	0		Other (on ground)	0			
What Happened											

On Thursday morning, 9 December 2021, a pilot and a passenger on-board a Jabiru J430 aircraft with registration ZU-NDP took off on a private flight from Wings Park Aerodrome, near East London in the Eastern Cape province, to Virginia Aerodrome (FAVG) in KwaZulu-Natal province. The flight was conducted under visual flight rules (VFR) by day and under the provisions of Part 94 of the Civil Aviation Regulations (CAR) 2011 as amended.

Approximately one hour into the flight and 140 nautical miles (nm) from FAVG in proximity to Port St Johns, the engine suddenly lost power and, shortly thereafter, it stopped. The pilot then scanned the area for a suitable place to execute a forced landing, and decided on the beach at Port St Johns. During the forced landing, the nose gear dug into the soft sand, bringing the aircraft to a stop.

Post-incident examination of the aircraft indicated no visible damage to the nose gear and the propeller. The two occupants were not injured.

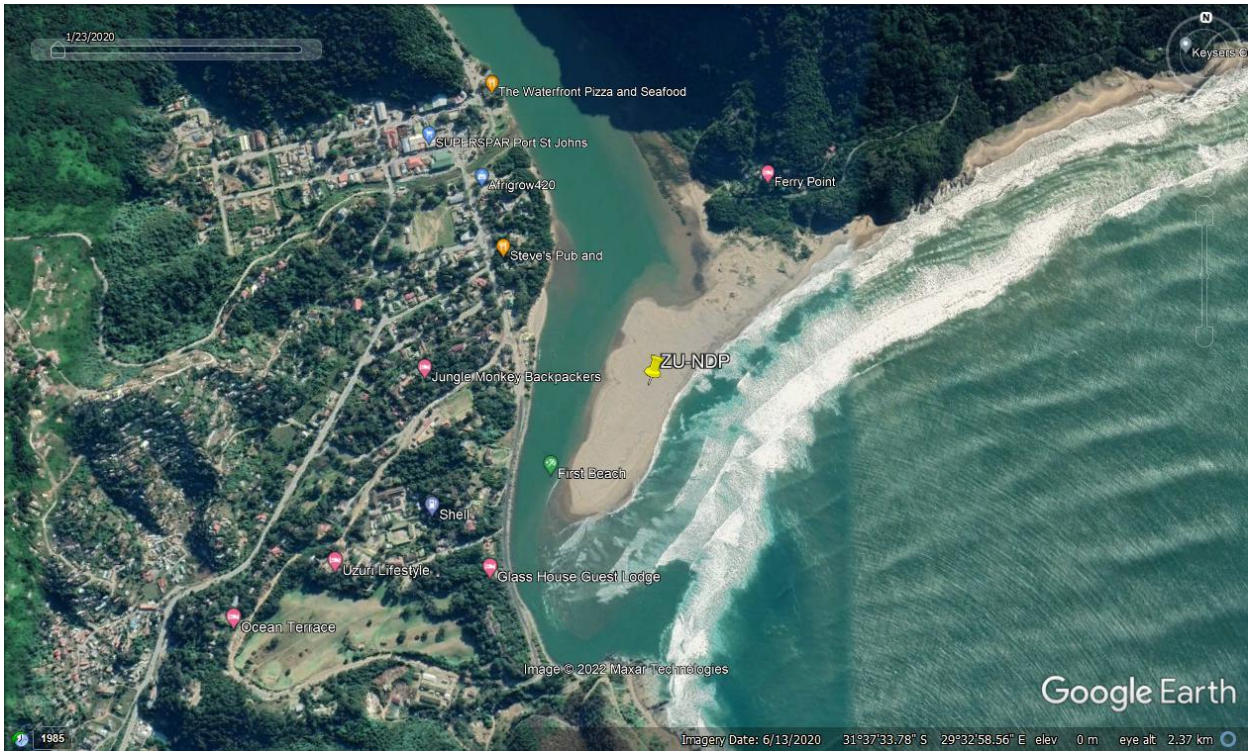


Figure 1: The yellow pin indicates the place of landing. (Source: Google Earth)

Figure 2: The aircraft as it came to rest. (Source: Pilot)

The Pilot

The pilot was initially issued a Private Pilot Licence on 20 September 2005. The current issuance had an expiry date of 30 September 2022. The aircraft type (Jabiru J430) was endorsed on his licence. At the time of the serious incident, the pilot had flown a total of 2 015.3 hours, of which 1 269.1 hours were on the aircraft type.

The Aircraft

The aircraft, a Jabiru J430 with serial number 353, was manufactured in 2007. The last annual inspection was carried out on 7 April 2021 at 1 818.6 airframe hours. The aircraft was flown a further 58.9 hours since inspection. The aircraft was fitted with a Jabiru 3300 engine with serial number 33A1194. The engine total hours at the time of the accident were 1 818.6 hours. The time between overhaul (TBO) for this engine type is 2 000 hours. The aircraft was issued an Authority to Fly (ATF) on 26 August 2019 with an expiry date of 31 August 2022. The propeller that was fitted on the aircraft was a two-bladed Jabiru 60x53, with hub serial number 0783.

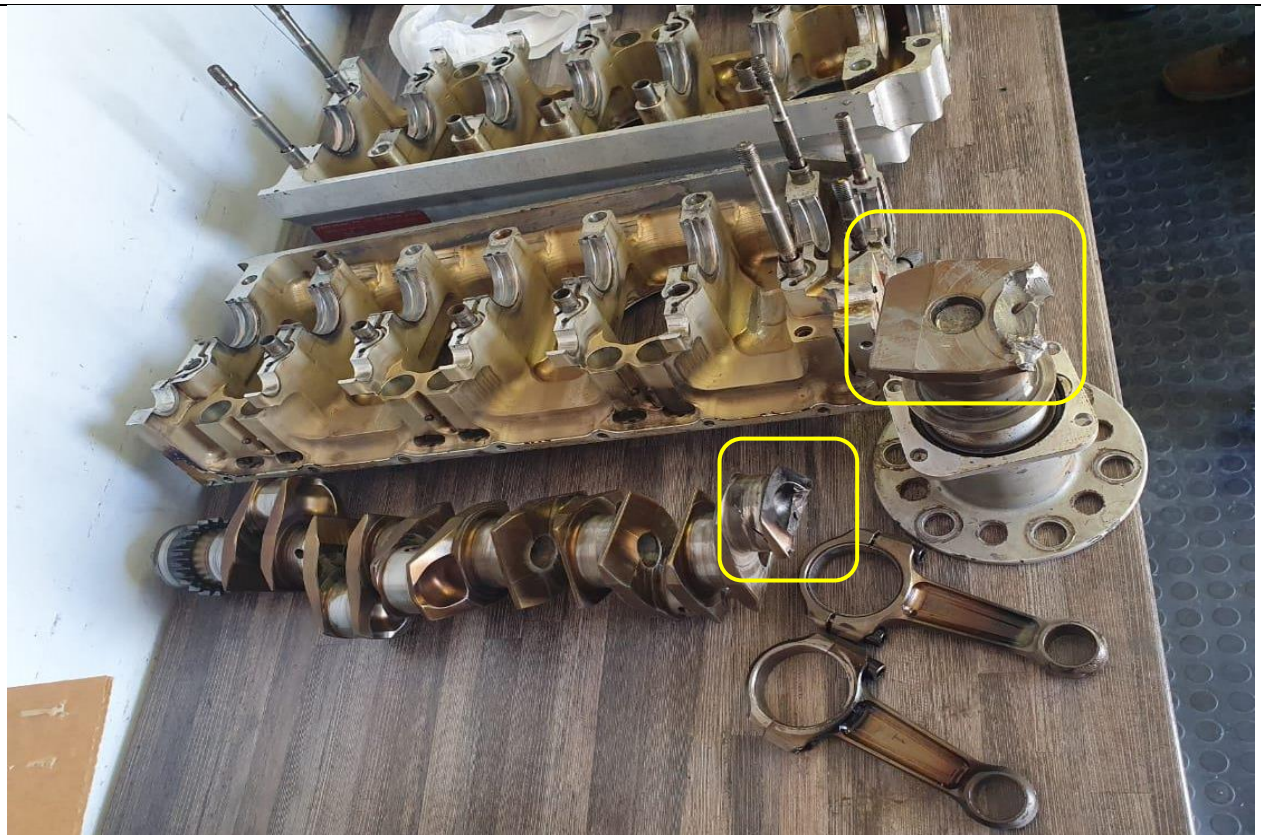


Figure 3: The dismantled engine with the fractured crankshaft. (Source: Manufacturer)

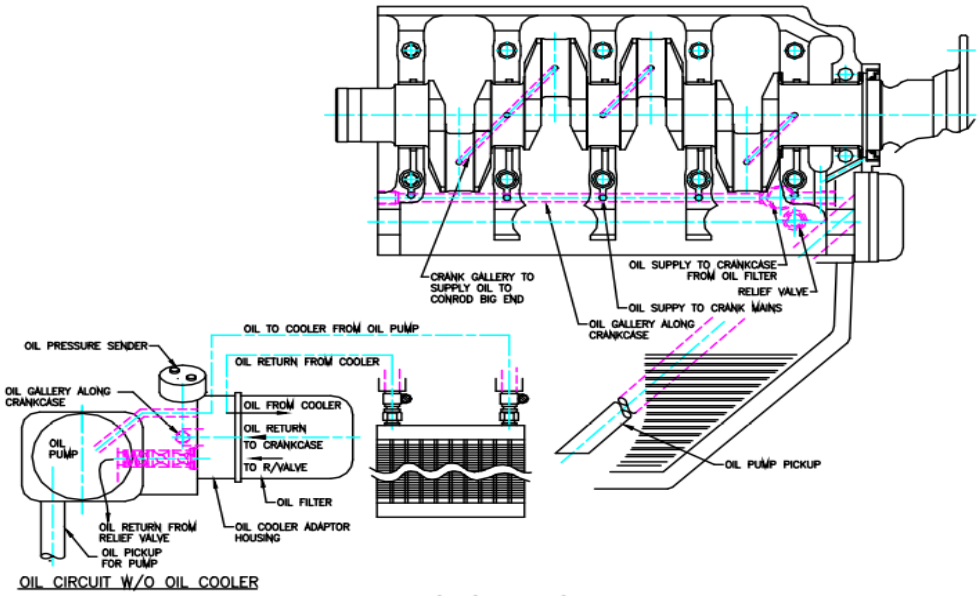


Diagram 1: Oil system schematic. (Source: Manufacture)

Following this serious incident, the fractured crankshaft assembly from a Jabiru 3300 engine, serial no 33A1194, originating from a Jabiru J430, registration number ZU-NDP, was submitted to the University of Pretoria (UP) – Laboratory for Microscopy & Microanalysis – to determine the most probable contributary cause/s of its failure during operation.

APPARATUS AND METHODOLOGY

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

Photo 2: Fractured crankshaft assembly (digital).

INVESTIGATION RESULTS

<u>Note 1</u>: Only the supplied parts were considered

The visual inspection revealed a fractured crank shaft at the No. 1 Conrod Big End (BE) position (Photos 2 and 3, red arrows; Diagrams 1 and 2, red arrow).

The No. 1 BE journal revealed extensive post-failure corrosion that is inductive of high temperature exposure (Photo 3).

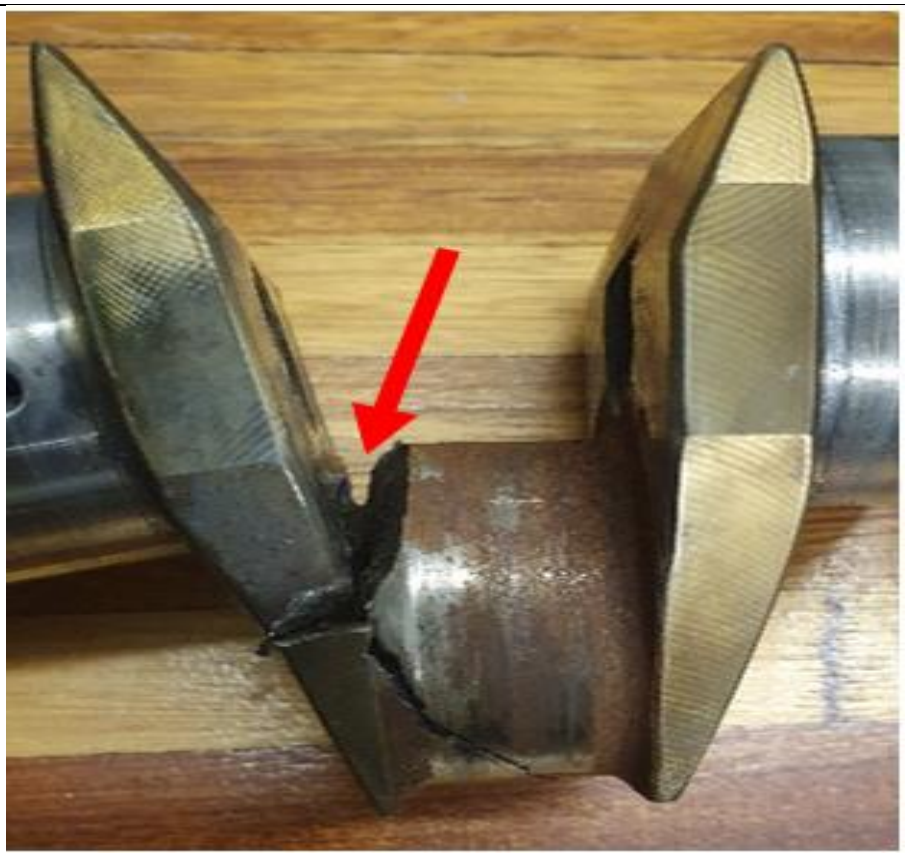


Photo 3: Conrod fracture position (digital).

The fracture surface revealed indications towards a fatigue failure mode (Photo 4) originating at two locations within radii with progression directions as indicated (Photo 5, red arrows).

Photo 4: Fractured surface morphology (digital).

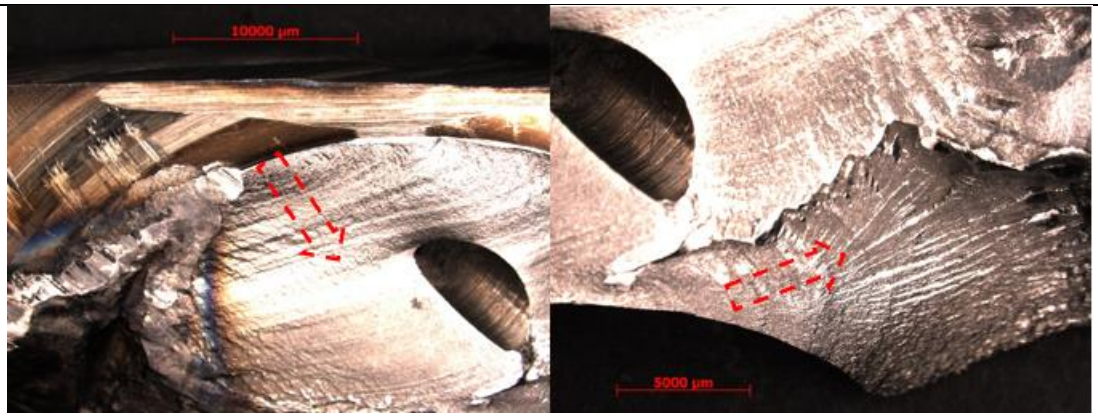


Photo 5: Fractured surface morphology (stereo).

At higher magnifications the fatigue fracture mode was confirmed (Fractograph 1). Fracture surface deposits (EDS 1) corresponding with sleeve bearing base material was noted, confirming the time-dependent nature of the fatigue fracture progression.

The Main Journal/Crankcase Bearings revealed indications of significant wear and metal impregnation (Photo 5). The former could be considered within limits considering the Total Time Since New (TTSN) while the latter is supportive towards oil pressure/quantity during operation.

The conrod assembly inspection revealed high temperature exposures to the SEs, excessive wear to the moving parts of the No 1 Conrod assembly and significant wear to the 2-6 BE bearings (Photo 7) - the latter could be considered within limits considering the TTSN.

Photo 7: Conrod and BE Bearing conditions (digital).

A discrepancy was noted between the No. 1 Conrod BE and the remaining BE bearing Part Numbers (Photo 8; Table 1).

Photo 8: Variation in part numbers – Conrad BEs 2-5 (left) and Conrod BE 1 (right) (digital).

Excessive wear of the No. 1 Conrod BE bearing was noted in contrast with the remaining BE bearings (Photo 9; Fractograph 3).

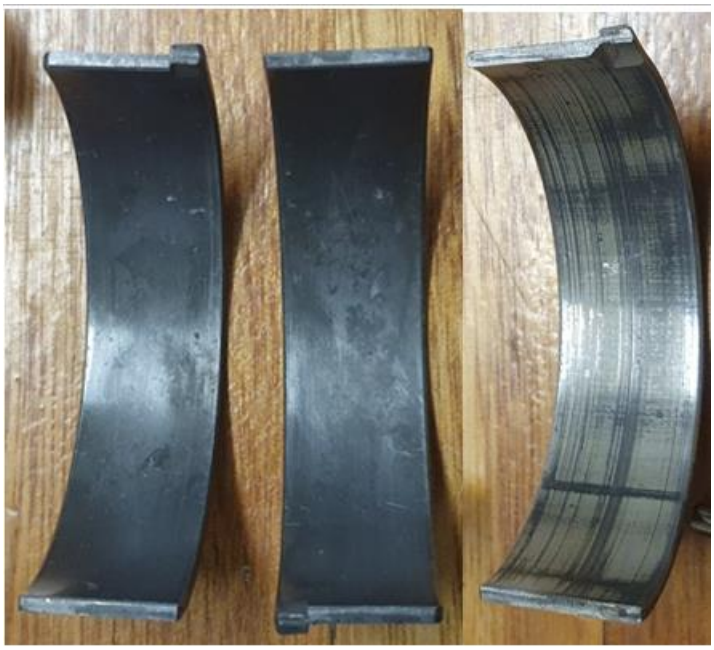


Photo 9: Variation in surface wear – No 1 Conrod BE bearings (left), remaining BE bearing (right) (Digital)

The as-manufactured sleeve bearing layers are a Fe-base material plated first with Cu (Copper) followed by Ni (Nickel), Pb (Lead) and finally Sn (Tin) (EDS 2).

EDS results from the No. 1 BE bearing revealed that the greater part of the top Sn-layer was removed during operation while the remaining No 2-6 BE Bearings revealed the opposite (EDS 3 and 4).

The variation in wear-rates between the No. 1 and the remaining BE bearings could result in similar dimensional (thickness) variations over a period of operational time.

Conrod Position	Big End Bearing		Conrod		
	Part No	Condition	Part No	Big End Condition	Small End Condition
1	24JA07 8290 STD	Excessive Wear/ No heat indicators	132-099-22J	Heat indicators/ No fractures/ Excessive wear forward side	Heat indicators/ No fractures
2	··Fm KU JR01 STD	Significant Wear/ No heat indicators	132-100-22J	No Heat indicators/ No fractures	Heat indicators/ No fractures
3	··Fm KU JR01 STD	Significant Wear/ No heat indicators	132-101-22J	No Heat indicators/ No fractures	Heat indicators/ No fractures
4	··Fm KU JR01 STD	Significant Wear/ No heat indicators	132-102-22J	No Heat indicators/ No fractures	Heat indicators/ No fractures
5	··Fm KU JR01 STD	Significant Wear/ No heat indicators	132-103-22J	No Heat indicators/ No fractures	Heat indicators/ No fractures
6	··Fm KU JR01 STD	Significant Wear/ No heat indicators	132-104-22J	No Heat indicators/ No fractures	Heat indicators/ No fractures

Table 1: Conrod assembly information.

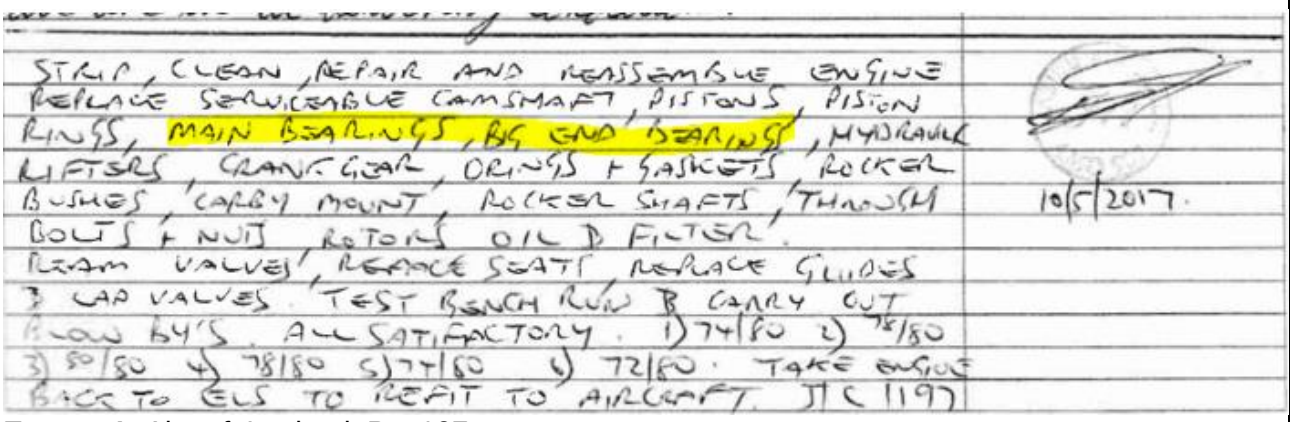
DISCUSSION AND CONCLUSION/S

Note 2: *The conclusions are based on the investigation results obtained from the supplied parts/components and information only. All information supplied to this investigation from other parties are considered factual.*

The Investigation results revealed the crankshaft fractured at the No. 1 Conrod BE position within the radii with **fatigue** as the primary failure mode. The most probable causational factor/s towards the originating of the fatigue failure could be one, or a combination of the following:

Incorrect Conrod BE bearing fitted at the No. 1 position: Although the reason/s for the noted discrepancy between the No. 1 and the remaining BE bearing Part Numbers could not be affirmed by this investigation, the variations in wear-rate between the bearings were noticeable. The latter could result in dimensional (thickness) variations during operation that will be detrimental to the applied stress at the crankshaft No. 1 Conrod BE journal position. Although the relevant aircraft logbook revealed no indication of an overhaul procedure due to the remaining Time Between Overhaul (TBO) of 122.4 hours, there is an inscription towards inspection/maintenance surrounding the crankshaft assembly dated 10 May 2017

(Extract 1). However, no mention is made towards the replacement of the No. 1 Conrod BE bearing.


STRIP, CLEAN, REPAIR AND REASSEMBLE ENGINE
REPLACE SERVICEABLE CAMSHAFT, PISTONS, PISTON
RINGS, MAIN BEARINGS, BIG END BEARINGS, HYDRAULIC
LIFTERS, CRANK GEAR, ORINGS + GASKETS, ROCKER
BUSHES, CARBY MOUNT, ROCKER SHAFTS, THROUGH
BOLTS + NUTS, ROTOR, OIL & FILTER.
REAM VALVES, REPLACE SEATS, REPLACE GUIDES
& LAP VALVES. TEST BENCH RUN & CARRY OUT
FLOW BY'S. ALL SATISFACTORY. 1) 74/80 2) 76/80
3) 80/80 4) 78/80 5) 74/80 6) 72/80. TAKE ENGINE
BACK TO ELS TO REFIT TO AIRCRAFT. JTC 1197
10/5/2017.

Extract 1: Aircraft Logbook Pg. 107

<u>Incorrect manufacturing of the Crankshaft</u>: Considering the point of fatigue fracture initiation within the radii, which proved historically to be the most common location, the possibility of incorrect machining of the crankshaft can neither be confirmed nor be excluded.

No clear indications and/or results of pre-failure crankshaft inspections, visual and NDT, were supplied to this investigation – it is therefore assumed that none were completed since new.

<u>What was found:</u>

(i) The pilot was issued a Private Pilot Licence (PPL) on 28 September 2005. His last validation flight was on 20 September 2021 with an expiry date of 30 September 2022. The Jabiru J430 was endorsed on his licence. His Class 2 medical certificate was issued on 2 September 2021 with an expiry date of 30 September 2023.

(ii) The aircraft's Certificate of Registration was issued to the current owner on 13 December 2016. The aircraft was issued an Authority to Fly (ATF) certificate on 26 August 2019 with an expiry date of 31 August 2022.

(iii) According to the latest Certificate of Release to Service (CRS) issued for ZU-NDP, the aircraft's last annual inspection was carried out on 7 April 2021 at 1 818.6 airframe hours. Since the inspection, a further 58.9 hours were flown with the aircraft.

(iv) Examination of the ZU-NDP's flight folios and defect reports had no outstanding defects that required rectification relating to the aircraft's engine before the serious incident. The last maintenance was carried out by an approved person (AP) with a valid approval certificate, and was qualified to carry out maintenance on the aircraft type.

(v) According to the pilot, 80 litres (L) of Avgas 100LL fuel remained in the fuel tanks after the serious incident. Examination of the flight folio showed no records of oil upliftment except when the annual inspection was carried out. According to maintenance records, the significant Jabiru Service Bulletins (SBs) and Service Letters (SLs) were carried out on 7 April 2021.

(vi) The aircraft was recovered a day after the serious incident and was taken to the manufacturer's facility for a detailed examination. The propeller was found not damaged, the nose landing gear suspension shaft was found bent. According to the manufacturer, the aircraft was fitted with larger tyres, which included a redesign of the nose gear strut assembly. The option for larger tyres was not available from the manufacturer's specifications and an application for a modification was not found in the Regulator's database.

(vii) The engine was removed from the airframe because the engine ground test run could not be performed as it was not possible to turn the engine. During a teardown inspection of the engine, it was found that the crankshaft had sheared. It is likely that the engine could have been overfilled at some point of its operational life.

(viii) According to available information, the No.1 Conrod BE bearing (Part number: FM KU JR01 STD) was replaced on 10 May 2017 with Part Number 24JA07 8290, which was not recognised by the manufacturer, therefore, the investigation concluded that the No1. Conrod bearing was not a manufacturer-approved part.

(ix) Fine weather conditions prevailed at the time of the flight, which had no bearing on this serious incident.

Probable Cause

It is likely that the engine failed as a result of the heat caused between the crankshaft and the big end conrod, resulting in metal wear and fatigue crack which subsequently caused the failure of the crankshaft. The failed crankshaft caused the engine to stop, which led the pilot to execute a forced landing.

Contributing Factor

The No.1 conrod bearing which was fitted prior to the accident flight was not a manufacturer-approved part.

Safety Action/s

None.

Safety Message and/or Safety Recommendation/s

1. It is recommended to the operators/AMOs to always ensure the fitment of the manufacturer-approved components or part/s in their engines or aircraft to avoid incidents such as this one.

2. It is recommended that the Regulator (SACAA) conducts an audit of the AMO and operator to ensure conformance to their issued approvals and ensure that there are established methods within the operator and the AMO to prevent incidents such as these from occurring.

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 apportion blame or liability****.*

About this Report

Decisions regarding whether to investigate and the scope of an investigation is based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, no investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this brief report. The report has been compiled using information supplied in the initial notification, as well as follow-up information to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as possible safety action/s that the industry might want to consider in preventing a recurrence of a similar accident.

This report provides an opportunity to share safety message/s in the absence of an investigation.

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.

Disclaimer

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