A

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigation Division** Form Number: CA 12-12a

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9174		
Aircraft Registration	**ZS-CBW**	**Date of Accident**	24 May 2013		**Time of Accident**	1100Z	
Type of Aircraft	Mooney M20E (Aeroplane)		**Type of Operation**		Private Flight		
Pilot-in-command Licence Type	Private Pilot		**Age**	41	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	Total Flying Hours		102.8		Hours on Type	74.1	
Last point of departure	Springs aerodrome (FASI): Gauteng Province						
Next point of intended landing	Heidelberg aerodrome (FAHG): Gauteng Province						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
300m from the threshold of Runway 24 at FAHG (GPS position: 26°30' 05" South 28°23' 41" East)							
Meteorological Information	Temperature:23℃ , Dew point:1℃ , Surface wind:120⁰/01kts,Gusting 12kts						
Number of people on board	1+3	**No. of people injured**	0	**No. of people killed**	0		

Synopsis

The pilot accompanied by three passengers departed in the aircraft from Springs Aerodrome following maintenance carried out on the aircraft. The pilot intended to route to Heidelberg Aerodrome which was the home base of the aircraft. According to the pilot, the aircraft approached Heidelberg Aerodrome from the North Easterly direction. Due to traffic in the circuit at the time, the pilot opted to orbit overhead Overkruin residential area before completing the unmanned joining procedures for landing at the Aerodrome on Runway 24.

The pilot reported that whilst completing an orbit to the right, he heard a clanking sound from the engine and approximately 30 seconds later the engine stopped. The pilot initiated a glide towards Heidelberg Aerodrome for forced landing. The aircraft landed 300m short of the threshold of Runway 24. The aircraft sustained substantial damage during the landing sequence. The occupants evacuated the aircraft unassisted and without injury.

During the investigation, an engine teardown was carried out to determine the cause of the engine stoppage. The evidence found showed that it was not manually possible to rotate the crankshaft of the engine. The cylinders exhibited scoring which was more prevalent on number 4 cylinder end piston pin that seized in the small end bush. As a result the number 4 bearing journal of the crankshaft fractured which caused the engine to fail and stop.

Probable Cause

Unsuccessful forced landing due to an engine failure in flight.

Contributing factor: The engine crankshaft had failed in fatigue mode failure.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner/Operator : M Visser
Manufacturer : Mooney Aircraft Incorporated
Model : M20E
Nationality : South African
Registration Marks : ZS-CBW
Place : Heidelberg Aerodrome
Date : 24 May 2013
Time : 1100Z

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.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) 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 establish legal liability****.*

Disclaimer:

This report is produced without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On 24 May 2013 the pilot accompanied by three passengers departed in the aircraft from Springs Aerodrome following a maintenance carried out on the aircraft engine due to high oil consumption and a rough running engine. The pilot stated that prior to departure from Springs Aerodrome during the engine run-up the engine indications were all normal. The pilot intended to route to Heidelberg Aerodrome which was the home base of the aircraft.

1.1.2 The aircraft approached Heidelberg Aerodrome from the North Easterly direction. Due to traffic in the circuit at the time, the pilot decided to orbit at 7000ft Above Mean Sea Level (AMSL) overhead Overkruin residential area before completing the unmanned joining procedures for landing on Runway 24 at the Aerodrome.

1.1.3 Whilst completing an orbit to the right overhead Overkruin, the pilot heard a clanking sound from the engine and approximately 30 seconds later the engine stopped. The pilot trimmed the aircraft for its best glide speed (100kts) and routed for Heidelberg Aerodrome, Runway 24.

1.1.4 The pilot communicated a Mayday call and stated his intentions on Heidelberg Aerodrome frequency whilst routing towards the field for landing.

1.1.5 The pilot then selected the aircraft undercarriage down which was 500m from the threshold of Runway 24. During the forced landing the aircraft impacted an embankment which resulted in the right main undercarriage detaching from the aircraft. The aircraft skidded across a public road before coming to rest next to a fence 300m from the threshold of Runway 24.

1.1.6 The occupants of the aircraft did not sustain any injuries and evacuated the aircraft unassisted.

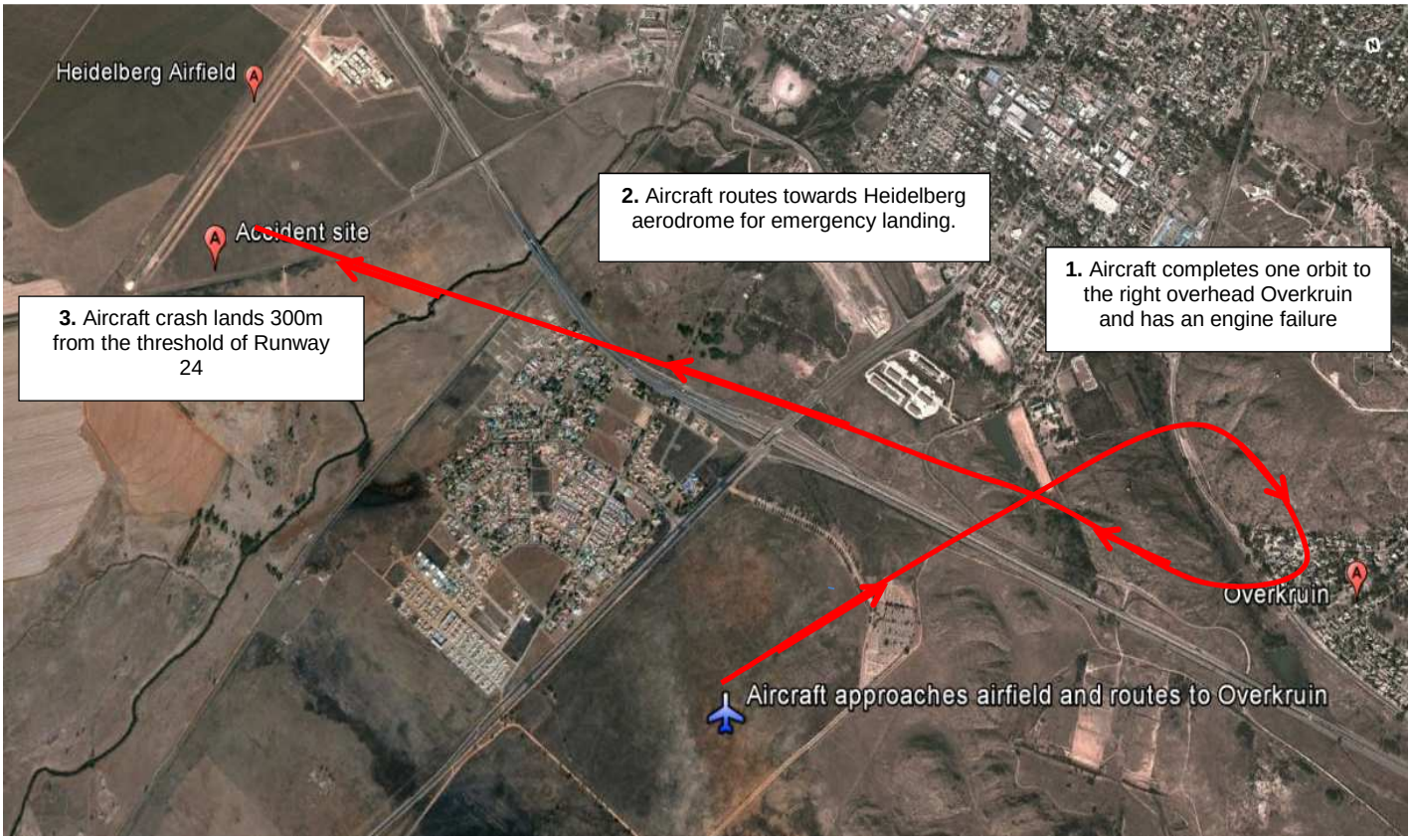

Figure 1: Flight path of the accident aircraft

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	-
None	1	-	3	-

1.3 Damage to Aircraft

1.3.1 The aircraft was substantially damaged.

Figure 2: A view of the aircraft as it came to rest

1.4 Other Damage

1.4.1 No other damage was caused.

1.5 Personnel Information

Nationality	South African	Gender	Male	Age	41
Licence Number	0272382615	Licence Type	Private Pilot		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	28 February 2014				
Restrictions	Corrective lenses				
Previous Accidents	None				

Flying Experience:

Total Hours	102.8
Total Past 90 Days	9.8
Total on Type Past 90 Days	9.8
Total on Type	74.1

1.6 Aircraft Information

Airframe:

Type	Mooney M20E	
Serial Number	285	
Manufacturer	Mooney Aircraft Incorporated	
Year of Manufacture	1967	
Total Airframe Hours (At time of Accident)	4267.12	
Last Annual Inspection (Date & Hours)	6 February 2013	4247.44
Hours since Last Maintenance Inspection	19.68	
C of A (Issue Date)	11 October 1978	
C of R (Issue Date) (Present owner)	06 February 2013	
Operating Categories	Part 91	

Engine:

Type	Lycoming IO-360-A1A
Serial Number	L-660-51
Hours since New	4267.12
Hours since Overhaul	367.42

Propeller:

Type	Hartzell HC-C3YR-RF
Serial Number	DY6338B
Hours since New	616.91
Hours since Overhaul	121.21

Weight and Balance

Basic Empty Weight	1654lbs
Pilot and Passengers	606lbs
Fuel on board	154lbs
Take-off weight	2414lbs

Note: The maximum take-off weight for this aircraft is 2 575 lbs. The aircraft was within the take-off weight limitation.

1.6.1 The aircraft had 75 litres of Avgas on board, the fuel quantity was sufficient for the flight from FASI to FAHG.

1.7 Meteorological Information

1.7.1 An official weather report from the South African Weather service was obtained for the closest weather station to Heidelberg. Data was recorded from the Springs Aerodrome Station.

Wind direction	120°	Wind speed	Gusting 12kts	Visibility	CAVOK
Temperature	23℃	Cloud cover	Clear	Cloud base	-
Dew point	1℃				

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with the minimum visual flight rules (VFR) navigation equipment required by the regulations. There were no recorded defects on the navigation equipment prior to the flight.

1.9 Communications

1.9.1 The aircraft was equipped with VHF radio communication equipment as required by the regulations. There were no recorded defects on communication equipment prior to the flight.

1.9.2 The pilot communicated a Mayday call on Heidelberg Aerodrome VHF frequency 124.8 MHz.

1.10 Aerodrome Information

1.10.1 Heidelberg Aerodrome is a SACAA licenced facility.

Aerodrome Location	FAHG (Heidelberg Aerodrome)	
Aerodrome Co-ordinates	S28˚21’36.0” E024˚13’48.0”	
Aerodrome Elevation	5100 feet	
Runway Designations	06/24	34/16
Runway Dimensions	1200m	650m
Runway Used	24	
Runway Surface	Asphalt	
Approach Facilities	Nil	

1.11 Flight Recorders

1.11.1 The aircraft was not fitted with a cockpit voice recorder (CVR) or a flight data recorder (FDR), and neither was required by regulations to be fitted to this type of aircraft.

1.12 Wreckage and Impact Information

1.12.1 The aircraft impacted an embankment which resulted in the right hand undercarriage separating from the aircraft. The aircraft continued to travel for 22m across a public road before coming to rest 300m from the threshold of Runway 24 on a magnetic heading of 315°.

1.12.2 Witness marks on the propeller indicate that the engine was not producing power but wind milling on impact. The evidence of this can be seen by the damage caused to the propeller blades. All three blades of the propeller was sustained damage at the blade tips, bended over facing toward the cockpit. It shows the manner in which the aircraft skidded on the ground until it came to rest.

1.12.3 The aircraft sustained substantial damage to the fuselage, propeller, undercarriage and wings.

Figure 3: Indicates the skid marks across the road made by the aircraft prior to coming to rest.

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The accident was considered to be survivable due to the low kinetic energy associated with the impact. The cockpit and cabin area were still intact after the ground impact, thus preventing any injury caused to the occupants.

1.15.2 The occupants were properly restrained by the aircraft equipped safety harness.

1.16 Tests and Research

1.16.1 The engine a Lycoming IO-360-A1A serial number L-660-51 was removed from the wreckage and was transported to an approved engine maintenance facility. An engine teardown inspection was carried out on 05 June 2013 in order to determine the most probable cause for the engine failure. Due to impact damage (unable to rotate the engine) it was not possible to perform a bench test procedure.

1.16.2 Engine teardown inspection findings:

- *There was no visible damage to the exterior of the engine.*
- *Manual rotation of the crankshaft was not possible.*
- *The cylinders exhibited scoring however this was more prevalent on the number 4 cylinder and the piston pin was seized in the small end bush.*
- *The number 4 bearing journal of the crankshaft was fractured. The big end bearing was damaged by the fracture but showed no sign of lack of oil lubrication.*
- *There was no evidence of lack of lubrication oil anywhere in the engine.*

1.16.2.1 The fracturing of the crankshaft caused the engine failure, and the engine stopped rotating very shortly after the separation occurred.

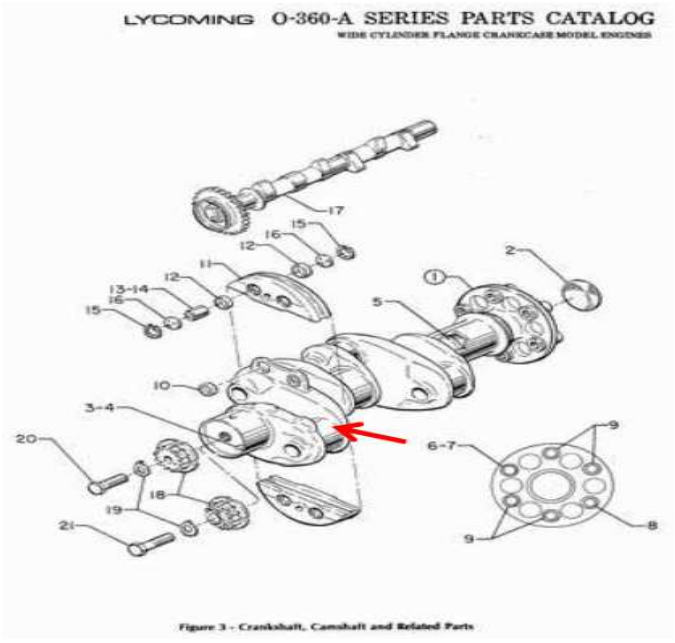

Figure 4: Typical Lycoming Crankshaft Assembly for 0-360 series engine

1.16.3 The crankshaft was subjected for metallurgical analysis, a stereo and scanning electron microscope investigation was completed on the crankshaft to determine the cause of the failure. The investigation revealed the following:

- *A fracture corresponding with a fatigue mode failure under conditions of high frequency and low load.*
- *The position of the point initiation proved to be in the radius area of the number 4 connecting rod big end bearing journal.*
- *The fatigue failure progressed over an undetermined period of operational time.*

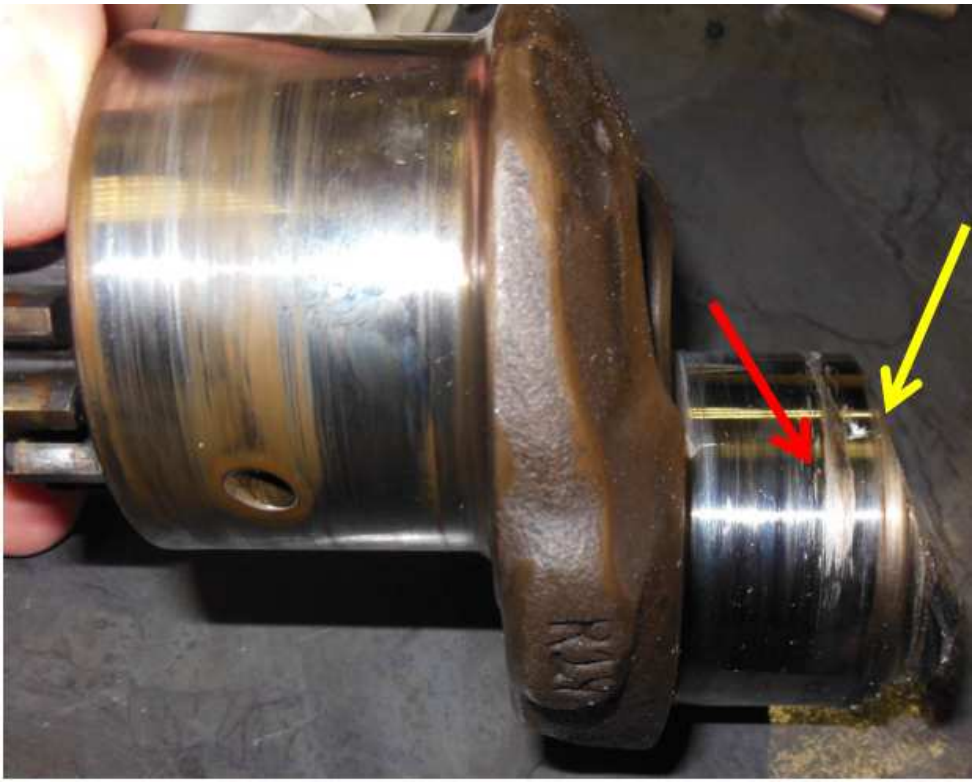

Figure 5: Fracture and scoring damage of the number 4 connecting rod big end bearing journal.

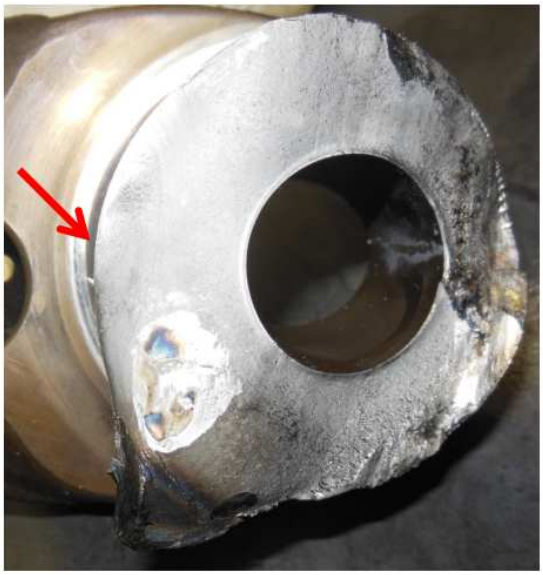

Figure 6 & 7: Fracture showing initiation point and scoring damage aft and forward

1.16.3.1 According to the metallurgical report the following could have contributed towards the fatigue failure:

- ***Vibration:***
  - *Incorrect balancing of the propeller may induce sufficient strain to initiate a fatigue fracture under normal operating conditions.*
- ***Bearing:***
  - *Incorrect seating and/or type of the relevant connecting rod big end bearing may have induced the noted scouring marks at the interface. The excessive wear may introduce higher temperatures at the relevant positions with subsequent lubrication breakdown that may in turn lead to fatigue inducing surface stress raiser in vicinity of the initiation point. Furthermore pre- or post- detonation or even over boost of the relevant piston could cause damage to the big end bearing resulting in 'nipping' the journal surface that may lead to the same type of failure*
- ***Overhaul procedure:***
  - *Some indications of machining induced scoring were noted in close proximity of the initiation point that may act as detrimental surface stress raisers. It is not clear from this investigation if the marks were introduced post-failure and/or if any prior reworking of the relevant crankshaft completed.*

1.16.4 Crankshaft maintenance history

- The accident crankshaft, serial number 74709 was installed on the engine as a new unit on 10 May 1981.
- On 14 November 2006 a Non-destructive testing (NDT) inspection was carried out on the crankcase and its components during an engine overhaul. The crankcase and crankshaft were certified serviceable.

Note: The NDT inspection is testing of materials for surface or internal flaws without causing any destruction or harm to the material under test.

1.16.5 Other maintenance:

a) On 17 October 2008 during an engine repair for a high oil temperature indication during flight, the AMO inspected and certified that all service bulletins for the crankshaft were complied with. The following work was completed on the engine following the repair:

- Cylinders were honed and new rings fitted.
- Crankshaft main bearings were replaced.
- Crankshaft oil seals were replaced.

b) On 6 May 2013 the aircraft underwent maintenance at an approved maintenance organisation following a rough running engine and high oil consumption. The following components were replaced that were unrelated to the crankshaft.

- An exhaust seat valve
- Piston ring set
- Gasket set

1.17 Organizational and Management Information

1.17.1 The owner of the aircraft operated it on private flights in terms of Part 91.

1.17.2 According to available information, the aircraft was maintained by an approved aircraft maintenance organisation (AMO).

1.18 Additional Information

1.18.1 Inflight engine stoppage procedure as stipulated in the Pilot's Operating Handbook (POH).

"Should there be indications of engine malfunction and it is determined that a forced landing will be necessary, maximum gliding distance can be obtained by maintaining 105 IAS with propeller wind milling and landing gear and flaps retracted. With the propeller stopped, use 100 IAS".

Emergency locator transmitter	*ARMED*
Seat Belts/Shoulder Harnesses	*SECURE*
Cabin door	*UNLATCHED*
Fuel selector	*OFF*
Mixture	*IDLE CUTOFF*
Magneto starter switch	*OFF*
Wing flaps	*Full DOWN*
Landing gear	*DOWN if conditions permit*
Approach speed	*80KIAS*
Master switch	*OFF, prior to landing*
Wings	*LEVEL attitude*

1.19 Useful or Effective Investigation Techniques

1.19.1 None

2. ANALYSIS

2.1 Pilot (Man):

2.1.1 The pilot was suitably qualified for the flight and had completed a pre-flight of the accident aircraft prior to departure.

2.1.2 Following the engine failure the pilot complied with the emergency procedure stipulated in the POH due to the early extension of the aircraft undercarriage the aircraft rate of descent increased. This resulted in the aircraft having insufficient height to continue the glide onto Runway 24. The aircraft subsequently touched down in a field 300m short of the threshold of Runway 24 at Heidelberg Aerodrome.

2.2 Aircraft (Machine):

2.2.1 The crankshaft and crankcase was inspected on 14 November 2006 when the engine was overhauled. Following a NDT inspection the crankshaft and crankcase were found to be in a serviceable condition and reinstalled.

2.2.2 The aircraft had undergone maintenance at an approved maintenance facility prior to departing to Heidelberg aerodrome. The maintenance intervention was due to high oil consumption and a rough running engine. The crankshaft damage would not have been visible during this maintenance inspection.

2.2.3 The aircraft had flown 367.42 hours since the engine overhaul prior to the accident. During this period fatigue to the crankshaft could have started and resulted in its failure at the time of the accident.

2.2.4 The crankshaft in the accident aircraft was approximately 32 years old and had not been replaced since new, dated 10 May 1981 however all service bulletins were complied with and routine inspections did not warrant a replacement of the crankshaft.

2.2.5 The metallurgist investigation of the crankshaft revealed a fracture corresponding with a fatigue mode failure. The exact cause of the failure could not be established however the Metallurgist report indicated that possible causes of the failure could be as a result of imbalance of the propeller, incorrect seating of the bearing or machine induced scoring during the overhaul procedure.

2.3 Environment:

2.3.1 The weather conditions at the time of the accident were fine and would not have contributed to the accident.

2.4 **Mission:**

2.4.1 The intention of the flight was to reposition the aircraft to its home base following maintenance to the engine at Springs aerodrome, following excessive oil consumption and a rough running engine.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was licensed and qualified for the flight in accordance with existing regulations.

3.1.2 The maintenance records indicated that the aircraft was maintained in accordance with existing regulations and manufactures requirements.

3.1.3 The damage to the crankshaft would not have been visible during the last maintenance intervention and during the pilot's pre-flight inspection.

3.1.4 The crankshaft failure was as a result of a fatigue mode failure.

3.2 Probable cause

3.2.1 Unsuccessful forced landing following an engine failure in flight.

3.3 Contributing factors

3.3.1 The engine crankshaft had failed in fatigue mode failure.

4. SAFETY RECOMMENDATIONS

4.1 None.

5. APPENDICES

5.1 None