Safety Investigation Report

TELEDYNE CONTINENTAL MOTOR IO-520-F ENGINE FAILURE ON 09 MAY 2011

Ref. AAIU-2011-23-FZEN-00-A**
Issue date: 29 June 2012
Status: Final
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FOREWORD

This report is a technical document that reflects the views of the investigation team on the circumstances that led to the accident.

In accordance with Annex 13 of the Convention on International Civil Aviation and EU Regulation 996/2010, it is not the purpose of aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the determination of the causes, and define recommendations in order to prevent future accidents and incidents.

In particular, Article 17-3 of the EU regulation EU 996/2010 stipulates that the safety recommendations made in this report do not constitute any suspicion of guilt or responsibility in the accident.

Unless otherwise indicated, recommendations in this report are addressed to the Regulatory Authorities of the State having responsibility for the matters with which the recommendation is concerned. It is for those Authorities to decide what action is taken.

The investigation was conducted by H. Metillon

The report was compiled by H. Metillon and was published under the authority of the Chief Investigator.

NOTES:

1. For the purpose of this report, time will be indicated in UTC, unless otherwise specified.
2. ICAO document 9859 “Safety Management Manual” was used to identify the hazard and the consequences related to the accident.
SYNOPSIS

Date and hour of the accident: 9 May 2011, around 9:00UTC

Aircraft: Cessna U206G

Accident location: FZEN Bansankusu airfield (Democratic Republic of Congo)

Aircraft owner: Aviation Sans Frontières Belgique ASBL

Type of flight: Private

Persons on board: 5

Abstract:
The engine of OO-A** failed when the airplane entered the circuit to land on runway 24 of FZEN. The propeller completely stopped turning around 6 seconds later. The pilot focused flying the airplane and took the decision to manage a steep descent in order to land on 06 runway instead of runway 24. The pilot landed the airplane successfully and succeeded to stop the airplane at the end of R/W 06 without damage. The first investigation, made on the incident site, showed that the engine crankshaft was fractured at cheek number 3.

Cause
The probable root cause of the crankshaft fracture is the installation, during the last engine overhaul, of an unapproved sealant on the parting surfaces of the crankcase halves.

Category of hazard identified during the investigation

1 Non adherence to approved data during maintenance.

Consequence

2 Engine failure (SCF-PP).

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1 Hazard – Condition or object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

2 Consequence – Potential outcome(s) of the hazard
1 FACTUAL INFORMATION

1.1 History of flight

The airplane OO-A** was operated by “Aviation Sans Frontières” for logistical support of Non Governmental Organizations.

On Monday 09 May 2011, a flight with 4 passengers was scheduled from Mbandaka to Basankusu airfield in the Democratic Republic of Congo.

After the refuelling, the pilot performed a normal pre-flight inspection, checked the W&B and put the passengers onboard. The airplane took off at 07:45Z.

After take off and climb, the airplane was levelled off at flight level 075 and flew without problem in direction of Basankusu airfield. (Distance between both airfields is around 118 Nm).

At 30 Nm from Basankusu airfield, the descent was initiated down to 2000 feet altitude and then the airplane proceeded to enter right downwind of runway 24.

At 1000 feet AGL all the engine parameters were normal (2400RPM, 21Hg, 100kts and 10° flaps) when suddenly the engine completely lost power and the propeller stopped turning, within 4 to 10 seconds.

After a quick review of the engine parameters and of the fuel selector position, the pilot focused flying the airplane and took the decision to manage a steep descent in order to land on the 06 runway.

The pilot landed successfully, as the airplane touched down between 500m and 1000m from the threshold and the pilot succeeded to stop at the end of runway 06 without damage.

The first examination of the engine on site by the supporting maintenance organization confirmed the engine failure was due to the rupture of the crankshaft.

“Aviation Sans Frontières” sent the engine back to Belgium for investigation. It arrived at AAIU(Be) at the end of November 2011.
1.2 Injuries persons

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Pilot</th>
<th>Passenger</th>
<th>Others</th>
<th>Total</th>
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<tbody>
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<td>Fatal</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>1</td>
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<td>Total</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

1.3 Damage to aircraft

The airplane was not damaged.

The on-site examination of the engine by the pilot immediately revealed a hole at the top of the right hand crankcase, above cylinders number 1 and 3.

A few weeks later, a licensed engineer of the supporting maintenance organization was sent to the site for the engine replacement and also for the first investigation of the broken engine.

The engineer removed, with some difficulties, the cylinder 1 and could see that the crankshaft was broken at cheek number 3. Important damage was also noticed to the neighbouring parts inside the crankcase.
1.4 Other damage
No other damage.

1.5 Personnel information
Pilot:
Sex: Male
Age: 57 years old
Nationality: Belgian
Medical certificate: Class 1, valid until 11 March 2012.

1.6 Aircraft and engine information
Airframe:
Manufacturer: Cessna Aircraft Company
Type: U206G
Serial number: U20603690
Built year: 1977
Airplane total time: 5169:13 Flight Hours

Figure 1: rupture of the crankshaft as seen after removal of one cylinder
Engine:
Manufacturer: Teledyne Continental Motors
Type: IO-520-F (9)
Serial number: 286023-R
Total flight hours: 1425 FH since the last overhaul, performed on February 2005. (3110 FH since the last “rebuilding” by TCM on January 1991)

Certificate of Registration:
Certificate of registration number 10093, delivered by BCAA on 15 December 2006.

Certificate of airworthiness:
EASA Form 25 delivered by BCAA on 24 January 2007.

Airworthiness Review Certificate:
EASA Form 15a renewed on 19 January 2011, valid until 24 January 2012.

History of the engine:
The engine Teledyne Continental Motors IO-520-F (9) SN: 286023-R was factory rebuilt on 8 April 1991 and was installed in the airplane at 2011FH (ACTT).
The engine almost flew the recommended time between overhaul (1685 FH instead of 1700FH) before being removed from service.

In February 2005, the engine had been overhauled and reinstalled on the airplane by the company “Air service International” (EASA Part 145 Approved facility number DK.145.0007). A copy of the delivered Certificate of Release to Service is enclosed at the end of this report.

This engine overhaul was performed when the airplane total time was 3695h and the engine time since the previous “Rebuilding” was 1685h.
As the crankshaft serial number denotes a manufacture date 31 January 1991, the crankshaft total time since manufacture was around 3110h when the rupture occurred.

There is no known record of propeller strike during the first 147 flight hours since engine overhaul (when the A/C was operated by previous owner) and it was demonstrated that no propeller strike occurred since the airplane was OO-A** registered.
The cylinders number 1 and 2 were replaced on 9 July 2009 at 729h since O/H and the cylinder number 3 was replaced on 3 February 2010 at 949h since O/H. All cylinders were replaced due to exhaust valve leakage.

An Airworthiness Directives compliance record dated 06 November 2006 originating from previous owner is given in appendix.

**Maintenance**

The maintenance was regularly performed by a BCAA approved Part M subpart F maintenance organization.

The last maintenance, a 200h inspection, was performed on 11 April 2011 at 5151 FH (ACTT), 18 FH before the engine failure.

Reportedly, the oil filter was cut for contamination examination and no anomaly was found.
2 ANALYSIS

2.1 First findings after stripping of the engine

It took a long time to send the engine back to Belgium and finally the engine was dismantled on 24 November 2011.

The engine accessories were removed and, after opening the crankcase, it was confirmed that the crankshaft was broken at cheek number 3, between main and rod journal number 2.

![Figure 2: view after crankcases splitting](image)

The following identification numbers and markings were found on the crankshaft:

- On the propeller flange: A319111N and “V/U”
- On the cheek number 4: 649130 (Note: two last digits are not certain)
- “VAR” and DU” on the cheek number 6
2.2 Damage description

A thorough visual inspection of the engine was performed during and after the engine disassembly, taking a particular attention to the engine damage inside the crankcase.

The following damage and/or findings were visible:

- The crankshaft was broken at cheek number 3 located between the rod journal number 2 and the main journal number 2.
- The inspection focused to distinguish the damage which was already present before the crankshaft rupture from those which were caused by the crankshaft rupture.
- Obviously, some damage located in the area of the crankshaft main journal number 2 and number 3 were present before the crankshaft failure.
  In particular, the main journal bearings number 2 and 3 had turned inside the crankcase. The crankshaft MJ number 2 housing was extremely worn due to the rotation of the bearings and the bearings were extremely worn and destroyed. This damage could not have been produced during the 4 to 10 seconds necessary to fully stop the engine after the power loss.
- The main journal bearings number 3 showed also evidence that they had turned inside the crankcase, but they were less damaged than bearings number 2.
- The bearings of connecting rod number 2 were extremely worn and damaged and showed traces of overheating. Additionally, one bolt of the connecting rod was broken, probably as a consequence of the crankshaft rupture.
- The crankcase halves showed evidence of fretting on the parting faces located around the thru bolts, in the area of the main journal bearing housings.
Figure 3: Rear side of the crankshaft

Figure 4: Propeller side of the crankshaft

Figure 5: Main journal number 1

Figure 6: Main bearings number 1
Figure 7: Main Journal number 2

Figure 8: Main bearings number 2

Figure 9: Main journal number 3

Figure 10: Main bearings number 3
2.3 Airworthiness Directives considerations

The Airworthiness Directives compliance record dated 06 November 2006 from previous owner is given in appendix.

This listing originates from “Air service International” and was delivered to the new owner “Aviation sans Frontières Belgique ASBL” when the airplane was sold.

No new Airworthiness Directive regarding the crankshaft were published since this listing had been written.

Out of the AD listing, 4 are dealing specifically with the engine crankshaft.

<table>
<thead>
<tr>
<th>AD Reference</th>
<th>Effective date (mmddyy)</th>
<th>Subject</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>77-05-04</td>
<td>03/11/1977</td>
<td>Crankshaft – Check propeller operation and oil filter.</td>
<td>Recurrent every 10h up to 100h. Not applicable</td>
</tr>
</tbody>
</table>
As seen on the above table, all the airworthiness directives concerning the crankshaft were properly performed.

2.4 Additional findings

After the splitting of the crankcase, we noticed that the parting surfaces of the crankcase halves had been reassembled using a white silicone appearance sealant.

This sealant was clearly present and was in (relative) good condition at the top parting surfaces of the crankcase halves and also at the aft portion of the mating surfaces at the accessory section.

By contrast, the white sealant had completely worn out and was no more visible on the mating surface around the through bolts while a lot of remains of white sealant were present along their borders.

The bearing slot of bearings number 3 were completely worn out and evidence of turning were visible on the outer surface of the bearings (bright appearance).
Figure 12: Examples of elongated bearing tang lock slot

Figure 13: Examples of white sealant remains around the through bolts mating surfaces
2.5 Probable cause of the crankcase fretting and of the turning of the bearings

Normally the reassembly of crankcase halves must be performed using “Permatex Aviation Grade 3” and a silk thread as mentioned in “Section XIII Final Assembly and test” of Overhaul Manual reference X30039. Among other chapter 8-6 (g) of the O/H Manual mentions the following:

Spread a thin film of No.3 Aviation Permatex on the left crankcase parting flange. Lay lengths of No.50 silk thread on parting flange. Thread should be inside the bolt holes but never on the edge.

Furthermore, the Service Information Letter SIL99-2B concerning the “Current Listing of Sealants, Lubricants, & Adhesives authorized by TCM” gives a detailed guideline about the “Engine Crankcase Threading Diagram”.

Both manufacturer O/H Manual and SIL refer clearly to Permatex and Silk Thread method to ensure the different parts of the crankcase are oil-tight.

Moreover, SIL99-2B provides on page 15 a drawing showing precisely where the silk thread must be installed. (A copy of this page is enclosed at the end of this report).

Figure 14: Drawing of SIL99-2B page 15.
SIL99-2B warns also the engine installer in order to apply thread and Permatex only as illustrated.

![Figure 15: Warning of SIL99-2B page 15.](image)

Obviously, a white sealant was used when putting the crankcase halves together instead of Permatex and silk thread.

Moreover, this white sealant was also installed on the parting surfaces located around the through bolts, which is not recommended by SIL99-2B.

After consultation with a TCM specialist it was confirmed that no additional means to ensure oil-tight in the area of the through bolt was necessary when the new style through bolts incorporating 2 O-rings were installed.

Finally, we can say that the installation of a sealant around the through bolts was both unapproved and unnecessary.

By using anything else than Permatex and Silk thread it will not be possible to obtain the proper torque/clamping force required to keep the crankcase halves together.

SIL99-2B warns also the engine installer in order to apply thread and Permatex only as illustrated.

If anything else other than Permatex and Silk string is used, the crankcase halves will move over time and wear out any type of sealant/silicon material that may have been applied.

Once this occurs the main bearings begin to rotate causing the bearing slots to impact the opposite crankcase half causing an impression to begin.

It will also be noticed that the bearing begins “shifting” forward and aft also elongating the bearing tang lock slot.
Once the elongation begins, it is only a matter of time, before the bearing shifts forward and aft enough to impact the rotating crankshaft on or near the main bearing journals forward and aft radius’s. This impact causes a nick in the outer nitriding layer and allows heat to build up in that particular area.

Finally, the different parts became more and more damaged, probably showing an exponential evolution, and the combination of the following factors leaded inexorably to the crankshaft separation:

- When rotating, the main journal bearings limited drastically the oil pressure necessary to properly lubricate the connecting rod number 2 the consequence being that extreme friction occurs at the connecting rod bearings.
- The extreme wear at the main journal housing did not allow the crankshaft to be adequately supported during rotation => vibration and deformation of the crankshaft.
- The friction of MJ bearings number 2 against the crankshaft main journal radius caused damage in the outer nitriding layer rendering the crankshaft brittle in this area.
3 CONCLUSIONS

3.1 Findings

- The engine stopped operating when the airplane was entering the circuit in order to land.
- There was no visible indication during the pre flight inspection and during the last flight showing that the engine’s condition was degrading rapidly.
- First investigation on site showed that the engine suffered extensive damage; in particular the crankshaft was broken.

3.2 Causes

The probable root cause of the crankshaft fracture is the installation, during the last engine overhaul, of an unapproved sealant on the parting surfaces of the crankcase halves.
In particular, using anything else other than Permatex and Silk string around the through bolts mating surface will cause over time chafing of the crankcase halves, bearing looseness and finally crankshaft rupture.

4 SAFETY RECOMMENDATION

Recommendation 2012-P-11 to CAA-DK

AAIU(be) recommends the Danish Civil aviation Authority to investigate the maintenance organization in order to determine if the installation of an unapproved sealant on the parting surfaces of the crankcase halves was limited, or not, to the particular OO-A** engine and to recall eventual other concerned engines.
ENCLOSURE No.1: Certificate of Release to Service engine TCM IO-520-F (9) SN: 286023-R

<table>
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<th>ITEM</th>
<th>DESCRIPTION</th>
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<td>2</td>
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<td>MAGNETO</td>
<td>10-3443-50-4</td>
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<td>646458</td>
<td>OVERHAUL</td>
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Remarks:
- ENGINE OVERHAULD /M 6000 NM 3500 NM 3900 NM
- MAGNETO OVERHAULD /M 6000 NM 3500 NM 3900 NM

29 June 2012
# Enclosure N°2: Airworthiness Directives Records Engine TCM IO-520-F (9) SN: 286023-R

<table>
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<th>Directive Reference</th>
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<tr>
<td>LTA CONTINENTAL D-1077-099 Ref.: AD Y7-05-05, S8 M01-6</td>
<td>CRANKSHAFT FAILURE</td>
<td>CHECK FIRST 100 H. SEE SB FOR COMPLIANCE IF NOT PROBLEMS FOUND NO MORE ACTION. SEE AD NOTE FOR INSTRUCTION.</td>
<td>X</td>
<td>X</td>
<td>06.05.1977 + 10 H / FREQ = 10 H</td>
<td>06.07.2001</td>
<td>NA (TIME INST.)</td>
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<tr>
<td>LTA CONTINENTAL D-1077-28G Ref.: AD Y7-13-22R1, S8 M01-17</td>
<td>CRANKCASE CRACKS</td>
<td>SEE CASTING NO. FOR AFFECTED CRANKCASE. ALL CRANKCASE WITH CONT. LOGO NOT AFFECTED.</td>
<td>X</td>
<td>X</td>
<td>20.08.1977 + 50 H / FREQ = 100 H</td>
<td>10.08.2004</td>
<td>NA</td>
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<tr>
<td>LTA CONTINENTAL D-1077-394 Ref.: S8 Y7-353</td>
<td>CYLINDER VALUE CRANKSHAFT</td>
<td>SB AUFHÖHNET KONSTANTEN AB APF ENG. ALL 104 FROM CONTINENTAL OR ROLLS ROYCE.</td>
<td>X</td>
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<td>LTA CONTINENTAL D-1079-2101 Ref.: AD Y7-10-05-06, S8 M01-261</td>
<td>LOSS OF OIL PRESSURE INDICATION</td>
<td>FOR AFB SN. SEE AD NOTE. PUMP ASSY OR OIL PRESS RELIEF VALVE CHANGED IN SERVICE FROM 1.4.79 - 6.1.79</td>
<td>X</td>
<td></td>
<td>25.08.1991 + 50 H</td>
<td>05.07.2001</td>
<td>NA (TIME INST.)</td>
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<td>LTA CONTINENTAL D-1082-255 Ref.: AD Y7-22-03, S8 M01-261</td>
<td>TURBINE HOUSING CRACK INSPECTION</td>
<td>AFFECTED MODEL 323510 AND 3X ENG. INSPECTION UNTIL PART B OF AD NOTE IS PERFORMED.</td>
<td>X</td>
<td></td>
<td>22.03.1993 + 50 H / FREQ = 200 H</td>
<td>08.07.2001</td>
<td>NOT INSTALLED</td>
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<td>LTA CONTINENTAL D-1083-555 Ref.: AD Y7-10-04-R3, S8 M01-19</td>
<td>SEE SB FOR AFFECTED CYL. PIN</td>
<td>INSPE CYL. BARREL FOR CRACKS. CYL. MANUFACTURED BY TELODYN CONT. ON OR AFTER 01.01.1981. SEE SB FOR APP. ENGINE SB.</td>
<td>X</td>
<td></td>
<td>17.12.1987 + 36 H / FREQ = 36 H</td>
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<tr>
<td>LTA CONTINENT D-1993-123</td>
<td>VALVE RETAINER KEY INSTALLATION INSPECT.</td>
<td>ALL NEW MANUF. J OIH FROM CONTIN 1993. INSP. FOR PROPER INST. OF INT/EXT. VALVE RETAINER KEY</td>
<td>X</td>
<td>22.07.1993 + 1 D</td>
<td>06.07.2001</td>
<td>3.246 AC TT</td>
<td>NA (TIME INST.)</td>
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<tr>
<td>LTA CONTINENT D-1994-101</td>
<td>OIL FILTER FROM MANUF. CHAMPION</td>
<td>INSPECT CHAMPION OIL FILTER FOR MANUF. DATE</td>
<td>X</td>
<td>18.08.1994 + 1 D, OR 5 H, WHAT OCCURS FIRST</td>
<td>06.07.2001</td>
<td>3.246 AC TT</td>
<td>NA (TIME INST.)</td>
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<tr>
<td>LTA CONTINENT D-1996-233/3</td>
<td>MAGNET TIMING</td>
<td>ONE OR MORE CYL PN 641917 AND BELOW BOTH MAGNETOS 24 + 1 ALL CYL PN 641917 AND HIGHER BOTH MAGNETOS 24 + 1</td>
<td>X</td>
<td>15.09.1993 + 50 H</td>
<td>10.08.2004</td>
<td>3.052 AC TT</td>
<td>NA</td>
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<td>LTA CONTINENT D-1995-283</td>
<td>OIL FILTER ADAPTER FROM CESSNA</td>
<td>ALL ENGINES FROM CESSNA AIRCRAFT COMPANY. ADAPTER PN SEE LTA. NOT CONTINENTAL ADAPTERS</td>
<td>X</td>
<td>10.10.1995 + 100 H</td>
<td>23.06.2001</td>
<td>3.261 AC TT</td>
<td>NA WC</td>
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<tr>
<td>LTA CONTINENT D-1995-054</td>
<td>EXHAUST VALVE ROCKER ARM</td>
<td>ONLY ENG. MODJ WITH SB65465W. ONLY ROCKER ARMS FROM PERFORMANCE ENGINEERING. REPLACE AFFECTED ROCKER ARMS WITHIN 24 H</td>
<td>X</td>
<td>29.01.1999 + 1 D, OR 5 H, WHAT OCCURS FIRST</td>
<td>06.07.2001</td>
<td>3.245 AC TT</td>
<td>NA KHP</td>
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<tr>
<td>LTA CONTINENT D-1995-262</td>
<td>CRANKSHAFT CRAKES (SIX CYLINDER ENGINES)</td>
<td>PERFORM INSPECTION AT EACH OVERHAUL OR IF CRANKSHAFT HAS BEEN DURCHGEFHSRT</td>
<td>X</td>
<td>26.01.1998 + 1 D</td>
<td>08.02.2005</td>
<td>3.695 AC TT</td>
<td>DURCHGEFHSRT</td>
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## Directive list

<table>
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<tr>
<th>Direktive, Referenz</th>
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<th>Anmerkung Insp.</th>
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<tr>
<td>LTA CONTINEN D-1999-393 Ref.: AD 98-17-11</td>
<td>CRANKSHAFT INSPECTION</td>
<td>CRANKSHAFT FROM NEILSEN BALANCING SERVICE FAA NO. ND79182X. CRANKSHAFT INSTALLED 01.02.95 AND UP.</td>
<td>X</td>
<td>08.10.1996 + 10 H</td>
<td>06.07.2001 3,246 AC TT</td>
<td>NA (TIME INST.)</td>
<td>KHP</td>
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<tr>
<td>LTA CONTINEN D-2000-1752 Ref.: AD 2000-23-21, SB 00-05D</td>
<td>CRANKSHAFT INSPECTION</td>
<td>ALL ENGINE OVERHAULED OR REPAIRED AFTER 01.04.1998 TO 31.03.2000</td>
<td>X</td>
<td>01.00.2000 + 10 H</td>
<td>06.07.2001 3,246 AC TT</td>
<td>NA (TIME INST.)</td>
<td>KHP</td>
</tr>
<tr>
<td>LTA CONTINEN D-2001-150 Ref.: AD CN 2001-139A</td>
<td>FEHLERHAFT DURCHGEFÄHRTE ARBEITEN</td>
<td>ALLE MOTOREN UND KOMPONENTEN DIE BEI DER FAA PROVENCE AERO MAINTENANCE &amp; REPAIR HOEGERE REPARATURER WURDEN.</td>
<td>X</td>
<td>31.05.2001 + 1 D</td>
<td>08.07.2001 3,246 AC TT</td>
<td>NA</td>
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<td>NON CONFORMITIES OF MAINTENANCE</td>
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<td>X</td>
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<td>LH MAINTENANCE INTERVALS FOR MAGNETOS</td>
<td>650H INSPECTION ALL TGM/BENDIX MAGNETOS</td>
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<td>06.04.2005 / FREQ = 4 Y OR 500 H</td>
<td>09.02.2005 3,957 AC TT</td>
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<td>RH MAINTENANCE INTERVALS FOR MAGNETOS</td>
<td>500H INSPECTION ALL TGM/BENDIX MAGNETOS</td>
<td>X</td>
<td>06.04.2005 / FREQ = 4 Y OR 500 H</td>
<td>09.02.2005 3,957 AC TT</td>
<td>DURCHFÄHRT</td>
<td>KHP</td>
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29 June 2012
ENCLOSURE N°3: Selected extract of SIL 99-2B

FIGURE 6. 0470, 10470, L/10520, L/TS10520, 10550 SANDCAST ENGINE CRANKCASE THREADING DIAGRAM

CRANKCASE SEALANT AND THREADING PROCEDURE

1. Use full strength non-thinned Permatex aviation grade 3D. Shake or mix well before using.

2. Apply Permatex Number 3D to the 2-4-6 case half. Apply Permatex only in areas where thread is shown. When applying, use short light brush strokes until an even thin coat is obtained. The Permatex should be viscous enough that most of the brush marks disappear; if not, use a new can of Aviation Permatex. Allow the Permatex to air dry to a tacky condition before threading.

NOTE...
Do not apply Permatex to crankshaft nose seal area.

3. Apply a thin translucent coat of TCM Gasket Maker P/N 646942 not to exceed .010 inch thick to 1-3-5 case half. Apply Gasket Maker in all areas that will mate with areas where Permatex was applied on 2-4-6 case half.

4. Apply and position grade D silk thread P/N 641543 on case halves as specified in Figure 6.

WARNING
Apply thread and permatex only as illustrated.

5. Clean crankcase crankshaft front oil seal land with Locquer Primer “N” and apply an even coat of gasket maker.

6. Assemble crankcase halves, install and torque all crankcase hardware in proper sequence in accordance with the applicable overhaul manual as soon as possible.

NOTE...
Take care to prevent displacement or damage to the crankshaft oil seal and silk thread. Insure thrust washer halves and bearing halves remain in place.

Be sure free ends of thread are covered by gaskets except at the nose oil seal.

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