SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/2/3/8995	
Aircraft Registration	**ZU-AKW**	**Date of Accident**	14 December 2011			**Time of Accident**	1625Z
Type of Aircraft	Koala Super Special			**Type of Operation**		Private	
Pilot-in-command Licence Type		Commercial	**Age**	27		**Licence Valid**	Yes
Pilot-in-command Flying Experience		Total Flying Hours	+289,4			Hours on Type	5,4
Last point of departure	Swartkops Aerodrome (FASK) (Gauteng)						
Next point of intended landing	Swartkops Aerodrome (FASK) (Gauteng)						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
On the R55 tar road near Laudium, 5 nm south-west of Pretoria							
Wind: Visibility: Temperature: Dew point: Cloud cover: Cloud base:	Weather was fine; Surface Wind: light/03 kt, Visibility: 10 000 m,						
Number of people on board	1+1	**No. of people injured**	0	**No. of people killed**	1 + 1		

Synopsis

The pilot and a passenger who was the future owner of the aircraft, departed from Swartkops Aerodrome (FASK) on a local private flight to the General Flying Area.A witness observed the aircraft flying overheard his house in a slightly south-westerly direction, at approximately 500 to 600 ft above ground level (AGL). He lost sight of the aircraft when his vision was obscured by a wall; at that stage, he heard the engine of the aircraft stop completely.

Three other witnesses, who were busy at the Swartkops shooting range near the R55 tar road, stated that they observed the aircraft flying just above treetop height in a southerly direction at approximately 1625Z. They could not hear the engine running and noted that the aircraft was losing height rapidly. The aircraft suddenly rolled to the right before the accident occurred.The aircraft crashed into a vehicle with four occupants travelling on the R55 road. The pilot and passenger were fatally injured. The driver and the passengers of the vehicle sustained no injuries.
The aircraft was destroyed in the accident.

Probable Cause

Engine failure in-flight.

Contributory factor: Although it appears that fuel exhaustion caused the engine to stop, it could not be conclusively determined, due to the impact damage caused to the aircraft fuel system and the electrical wiring harnesses of the aircraft.

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner	**:** Francois Haarfhoff Familie Trust
Name of Operator	**:** GM Scheepers
Manufacturer	**:** Sport Aviation Products
Model	**:** Koala Super Special
Nationality	**:** South African
Registration Marks	**:** ZU-AKW
Place	**:** R55 road near Laudium, south-west of Pretoria
Date	**:** 14 December 2011
Time	**:** 1625Z

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:

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 According to a female friend of the pilot, the pilot flew four (4) private flights, which included the fatal flight on the day of the accident. She flew with the pilot on the flight just before the accident occurred and occupied the left cockpit seat.

1.1.2 The pilot and a passenger who was the future owner of the aircraft, departed from Swartkops Aerodrome (FASK) on the last local private flight in the local flying area.

1.1.3 A witness who resides at the left-hand downwind leg for Runway 02 at Swartkops Air Force Base in Valhalla, observed the aircraft flying in the Swartkops circuit at approximately 1600Z. Shortly thereafter, he observed the aircraft again flying overhead his house in a slightly south-westerly direction, approximately 500 to 600 ft AGL. He lost sight of the aircraft when his vision was obscured by a wall and then heard the engine of the aircraft stop completely.

1.1.4 Three other witnesses, who were busy at the Swartkop shooting range near the R55 road, stated that they observed the aircraft flying just above treetop height in a southerly direction at approximately 1625Z. They could not hear the engine running and noted that the aircraft was losing height rapidly and rolling to the right. They then lost sight of the aircraft and heard a loud bang when the aircraft hit the ground. The witnesses immediately rushed to the accident site to render assistance, but found both occupants fatally injured.

1.1.5 The aircraft crashed into a vehicle with four occupants traveling on the R55 road. The driver and the passengers of the vehicle sustained no injuries.

1.1.6 The pilot and passenger on board the aircraft were fatally injured. The aircraft was destroyed in the accident.

1.2 Injuries to Persons

Injuries	Pilot	Crew	Pass.	Other
Fatal	1	–	1	–
Serious	–	–	–	–
Minor	–	–	–	–
None	–	–	–	–

1.3 Damage to Aircraft

1.3.1 The aircraft was partly destroyed during the impact sequence.

Figure 1: Extensive damage to aircraft

1.4 Other Damage

1.4.1 The aircraft collided with a vehicle, causing substantial damage to the vehicle.

Figure 2: Damage to vehicle

1.5 Personnel Information

1.5.1 Pilot-in-Command:

Nationality	South Africa	Gender	Male	Age	27
Licence Number	0272257916	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Night, Instructor and Instrument				
Medical Expiry Date	30 September 2013				
Restrictions	None				
Previous Accidents	None				

1.5.2 Flying Experience

Total Hours	+389,4
Total Past 90 Days	Unknown
Total on Type Past 90 Days	5,4
Total on Type	5,4

1.5.2.1 The pilot's flying logbook was not located after the accident occurred. All attempts to locate the pilot's flying logbook were unsuccessful.

1.5.2.2 According to the pilot's curriculum vitae, he held the position of Flight Instructor (Grade III) at the Defence Flying Club at Swartkops military aerodrome from March 2011 to date with a total of 384 flying hours.

1.5.2.3 The instructor that completed the accident pilot's conversion onto the aircraft type supplied the aircraft accident investigators with the following flying hours:

- 20 November 2011 – ZU-AKW 1,7 hours dual convex
- 28 November 2011 – ZU-AKW 0,7 hours dual convex
- 28 November 2011 – ZU-AKW 0,5 hours solo convex
- 28 November 2011 – ZU-AKW 2,5 hours solo ferry flight to Swartkops aerodrome.

In total, the pilot thus flew 5,4 hours on the Koala before the day of the accident.

1.6 Aircraft Information

Airframe:

Type	Koala Super Special	
Serial Number	NVZ2	
Manufacturer	Sport Aviation Products	
Year of Manufacture	1994	
Total Airframe Hours (At time of Accident)	+2 802	
Last Annual Inspection (Date & Hours)	19 November 2011	Tacho 2 797,3 Hobbs 191,7
Hours since Last MPI	4,7 hours	
Authority To Fly (Issue Date)	26 March 2012 (registered owner)	
C of R (Issue Date) (Present owner)	22 February 2010	
Operating Categories	Private	

1.6.1.1 According to the RAASA Annual Inspection Notification form Number RA 24.1, an annual inspection was carried out on 19 November 2011 at 191,7 Hobbs hours on the Koala Super Special.

1.6.1.2 According to the flight folio, the relevant annual inspection was carried out for renewal of the authority to fly in regards to the change of ownership.

1.6.1.3 It was observed that the tachometer hours ran currently with the Hobbs hours at the time. However, the tachometer hours reflected the total aircraft airframe hours.

1.6.1.4 According to the flight folio, the engine and propeller operating hours were as follows during the last annual inspection on 19 November 2011:

1.6.2 Engine**:**

Type	Rotax UL582
Serial Number	4013572
Hours since New	51,6 (Hobbs)
Hours since Overhaul	Unknown

1.6.3 Propeller:

Type	PProp 72x52
Serial Number	N3036 FEC 264
Hours since New	22,8 (Hobbs)
Hours since Overhaul	Unknown

1.7 Meteorological Information

1.7.1 Weather information as reported by the South African Weather Service:

- The nearest weather station for the area where the accident occurred is situated in Erasmus Rand, Waterkloof. The reports from the station showed that the surface wind was light at 3 kts; horizontal visibility was more than 10 km with a lowest cloud base of 3 500 ft AGL. The surface temperature was 21℃ with a QNH of 1014 HPA. The satellite and radar imagery shows no thunderstorms or bad weather over the area where the accident occurred.

Date: 2011-12-14
FAPR 141600Z 07003KT 999 FEW035 BKN060 21/14 Q1014=
FAPR 141700Z 10002KT CAVOK 20/14 Q1014=

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigation equipment as approved by the Regulator for the aircraft type. No defects with navigational equipment were reported prior to the flight.

1.9 Communications

1.9.1 The aircraft was equipped with standard communications equipment as approved by the Regulator for the aircraft type. No defects of communications equipment were reported prior to the flight.

1.10 Aerodrome Information

1.10.1 The aircraft took off from Swartkops Aerodrome (Unlicensed Military Aerodrome)

Aerodrome Location	5NM SW of Pretoria	
Aerodrome Co-ordinates	S25° 48 28.59 E028° 09 50.15	
Aerodrome Elevation	4 794 ft AMSL	
Runway Designations	02/20	06/24
Runway Dimensions	1 988 x 30 m	1 398 x 44 m
Runway Used	Runway 02	
Runway Surface	Tar	
Approach Facilities	None	

1.10.2 The pilot accompanied by the passengers planned to land back at Swartkops Aerodrome. The accident occurred outside the boundaries of the aerodrome.

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 (helicopter).

1.12 Wreckage and Impact Information

1.12.1 The aircraft descended during flight in a southerly direction and hit the roof of a vehicle travelling in a northerly direction on the R55 road near Laudium, south-west of Pretoria. The aircraft wreckage came to rest on the verge of the road. Although the aircraft was destroyed during the impact sequence with the vehicle and the road, the wreckage remained virtually intact, with some debris scattered close to the main wreckage. Damage sustained to the propeller indicated that the propeller was turning at a slow speed during the impact sequence.

Figure 3: The aircraft impacted a vehicle on the tar road and came to rest on the verge of the road

Figure 4: The main wreckage of the aircraft. The propeller blades indicated low rpm during the impact sequence

1.13 Medical and Pathological Information

1.13.1 The pilot was the holder of a medical certificate which was valid until 30 September 2012.

1.13.2 The results of the post-mortem examination and toxicology tests were not available at the time of compiling the report. Should any of the results, once received, indicate that medical aspects might have affected the performance of the pilot, this will be considered as new evidence and the investigation re-opened.

1.14 Fire

1.14.2 There was no pre- or post-impact fire.

1.15 Survival Aspects

1.15.1 The accident was considered not survivable due to the kinetic forces involved and severe disruption of the aircraft fuselage and cockpit area.

1.16 Tests and Research

1.16.1 The aircraft wreckage and engine were recovered from the accident site by the South African Air Force and stored at Swartkops Aerodrome.

1.16.2 As an initial prognosis indicated a possible engine failure during flight, a detailed investigation of the engine and components was requested after the accident, to be conducted by CrashLAB's physical metallurgist and aircraft accident investigator.

1.16.3 **CrashLAB Investigation Report**

The wreckage of the Koala Super Special light aircraft and the two-stroke Rotax 582 engine and propeller were transported in separate containers and submitted to the CrashLAB investigator for a detailed investigation. The full CrashLAB investigation report is attached as Annexure C to this report. Some of the findings on the report are as follows:

1.16.3.1 Fuel system components

One of the two 20-litre aft fuel tanks received contained approximately six litres that were retrieved. The intermediate fuel tank was not recovered to establish the quantity of fuel that remained in the fuel tank, which was a vital piece of evidence. The front 15-litre tank was not recovered during the investigation. The quantity of fuel that remained in the intermediate fuel tank was considered as vital information to determine whether the engine had a loss of power due to a lack of fuel prior to the fatal landing.

The dual electric in-line fuel pumps were tested and proved to be serviceable on impact. The parallel electric in-line standby fuel pump did not operate when tested, which implied that it was most probably unserviceable on impact. Because the parallel fitted in-line pneumatic mechanical fuel pump was found serviceable, it can be assumed that the

probable failure of the stand-by pump did not contribute to the accident. The in-line fuel filter gave no clear indication of congestion and the fuel stop valve was presumed to have been open on impact.

1.16.3.2 Electrical system

Aircraft battery

The 12 V battery was destroyed on impact. No clear indications of leakage, fire, loose connections or other discrepancies could be found.

The wiring harnesses were found extensively damaged on impact and severed from connecting points. Some wires had been cut during the recovery process. Visual inspection revealed no clear indications of an in-flight electrical fire, loose connections etc. and all wiring harnesses were presumed serviceable.

Fuel pump supply

The dual aft fuel pumps were found disconnected. The wiring of the forward stand-by fuel pump was found severed.

1.16.3.3 Fuel lines

The greater part of the fuel line system was retrieved. No clear indications of fuel leakage, blockage or in-flight fire were noted; they were therefore assumed serviceable on impact. Some of the major fuel lines were severed when the wreckage was recovered.

1.16.3.4 Aft fuel tanks

Visual inspection of both 20-litre aft main fuel tanks revealed no clear indication of fuel leaks, blockage or other pre-impact damage. The level floater was damaged on impact. The ram-air in-line filter was found satisfactory. Approximately six litres of fuel were retrieved from one of the main tanks.

1.16.3.5 The engine did not reveal any malfunction except the impact damage. The No. 2 piston revealed severe scuffing marks 180° apart that can be attributed to piston movement at an incline inside the shifted sleeve/pod on and after impact. This may be an indication that the engine still rotated somewhat on impact. No further indications of blow-by, ring failure, seizure or high temperature exposures were noted.

1.17 Organizational and Management Information

1.17.1 According to the Recreation Aviation Administration of South Africa (RAASA) document, the last private Authority To Fly Certificate for the registered owner was issued on 31 March 2011 with an expiry date of 26 March 2012.

1.17.2 According to the SACAA application for registration of aircraft and change of ownership document, the future owner completed the document on 12 December 2011.

1.17.3 According to the application for the renewal of an Authority To Fly Certificate for the non-certified aircraft, registration ZU-AKW, RAASA form RA 24.2(b) was completed and signed by the future owner on 12 December 2011, with the total aircraft airframe hours at 2 801,5 hours.

1.17.4 An approved person (AP) of the Aero Club of South Africa carried out an inspection on the aircraft and completed an annual inspection notification form on 19 November 2011 as required before the change of ownership could take place.

1.17.5 At the time of the accident, the change of ownership had not taken place and hence the Authority To Fly Certificate for the aircraft was still valid in the name of the registered owner.

1.17.6 The representative of RAASA stated that none of the above actions would have made the flight unlawful. The existing Authority To Fly Certificate was still valid as

the change of ownership had not yet taken effect.

1.18 Additional Information

1.18.1 According to the Koala Super Special Light aircraft flight manual:

- The two main (aft) fuel tanks have a capacity of 20 litres each
- The Intermediate fuel tank has a capacity of 15 litres
- The fuel burnoff @ 60 mph is 17 litres/hour
- The power-on stall is 24 mph and the power-off stall is 35 mph

1.18.2 The aircraft's two aft fuel tanks with a capacity of 20 litres each, are located behind the cockpit seats and lower than the intermediate fuel tank, which has a capacity of 15 litres. Fuel is transferred from the two aft fuel tanks to the intermediate tank by two in-line electrical fuel pumps. A timer is also installed to the electrical fuel system that can be set for a certain time for the electrical fuel pumps to operate and to pump fuel from the aft fuel tanks to the intermediate fuel tank. A mechanical pneumatic fuel pump supplies fuel from the 15-litre intermediate fuel tank to the carburettors and subsequently the engine.

1.18.3 The sight gauge (level indicator) for the intermediate fuel tank is fitted at the lower right side of the instrument panel.

1.18.4 During the flight, the pilots are responsible for transferring fuel from either or both aft fuel tanks to the intermediate tank by selecting one or both electrical fuel pumps. For the No. 1 electrical fuel pump to operate, the fuel timer switch must be selected to "ON" and the timer at zero (0) minutes, and/or the manual switch must be set on Pump 1 for Pump 2 to operate. The manual switch must be set at Pump 2.

1.18.5 According to the representative of RAASA:

1) The intention to purchase the aircraft was first expressed on 23 September 2011.
2) An inspection which would accompany the sale transaction was done on 19

November 2011. Such inspections are usually required with the change of ownership even though the current Authority To Fly Certificate is still valid.

3) Subsequent to the inspection, the application form for the new Authority To Fly Certificate was completed on 12 December 2011.
4) At the same time, on 12 December 2011, application form CAR47A for the change of ownership and registration was completed.
5) Before any of the forms were submitted, the fatal accident occurred.

None of the above actions would have made the flight unlawful. The existing Authority To Fly Certificate was still valid as the change of ownership had not yet taken effect.

1.18.6 A female friend of the pilot stated that the pilot flew four (4) private flights, which included the fatal flight on the day of the accident. She flew with the pilot on the flight just before the accident occurred and occupied the left cockpit seat. She also stated that she arrived at the scene shortly after the accident and noted that there was no evidence of fuel spillage or a smell of fuel at the accident site, nor was there any sign of a pre- or post-impact fire.

1.19 Useful or Effective Investigation Techniques

1.19.1 Not applicable.

2. ANALYSIS

2.1 A witness stated that the aircraft flew over his house in a slightly south-westerly direction, approximately 500 to 600 ft AGL. He lost sight of the aircraft when his vision was obscured by a wall; shortly thereafter, he heard the engine of the aircraft stop completely.

2.2 Three other witnesses, who were busy at the Swartkop shooting range near the R55 road, stated that they observed the aircraft flying just above treetop height in a southerly direction at approximately 1625Z. They could not hear the engine running and heard a loud bang when the aircraft hit the ground. The witnesses immediately rushed to the accident site to render assistance, but found both occupants fatally injured.

2.3 During the follow-up investigation conducted by an appointed independent investigator, the cockpit-mounted fuel pump selection switch gear as found pointed towards the No. 1 aft electrical transfer fuel pump selected to operate by both the fuel timer switch at Pump 1 position. However, the pump numbers could not be traced to a specific unit due to the loss of the relevant wire harness during the impact sequence.

2.4 The engine did not reveal any malfunction except impact damage. The No 2 piston revealed severe scuffing marks 180˚ apart that can be attributed to piston movement at an incline inside the shifted sleeve/pod on and after impact. This may be an indication that the engine rotated somewhat on impact. No further indications of blow-by, ring failure, seizure or high temperature exposures were noted.

2.5 According to available information, there was no sign of fuel spillage or a smell of fuel at the accident site, nor was there any sign of a pre- or post-impact fire.

2.6 The pilot executed a forced landing following an engine failure. The cause of the engine failure could not be determined.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot was in possession of a valid commercial pilot's licence. There was no evidence that the aircraft type rating was endorsed on the licence.

3.1.2 The pilot had a valid aviation medical certificate with no restrictions.

3.1.3 According to available information, the pilot flew approximately three local private flights with children as passengers before the fatal flight on 14 December 2011.

3.1.4 Shortly thereafter on the same day, the pilot and the passenger, who was also the new owner of the aircraft, departed Swartkops unlicensed military aerodrome on a local private daylight flight. The aircraft was involved in a fatal accident during the flight and both the pilot and passenger succumbed to their injuries.

3.1.5 According to RAASA, the last private Authority To Fly Certificate was issued to the previous registered owner on 31 March 2011 with an expiry date of 26 March 2012.

3.1.6 On 19 November 2011, an AP for the Aero Club of South Africa carried out an annual inspection on the aircraft, completed and signed the annual inspection notification for the non-certified aircraft for the future owner of the aircraft.

3.1.7 On 12 December 2011, an application for the renewal of an Authority To Fly Certificate for the aircraft ZU-AKW was filled in and completed in the name of the future owner of the aircraft. The aircraft's total airframe hours since new was 2 801,5 hours at the time.

3.1.8 According to the representative of RAASA:

1. The intention to purchase the aircraft was first expressed on 23 September 2011.
2. An inspection which could accompany the sale transaction was done on 19 November 2011. Such inspections are usually required at the change of ownership even though the current Authority To Fly Certificate is still valid.

3. Subsequent to the inspection, the application form for the new Authority To Fly Certificate was completed on 12 December 2011.
4. At the same time, on 12 December 2011, application form CAR47A for the change of ownership and registration was completed.
5. Before any of the forms were submitted, the fatal accident occurred.

None of the above actions would have made the flight unlawful. The existing authority to fly was still valid as the change of ownership had not yet taken effect.

3.1.9 The pilot and passenger sustained fatal injuries during the impact sequence. The occupants of the vehicle escaped without any injuries.

3.1.10 The aircraft was almost completely destroyed during the impact sequence.

3.1.11 There was no evidence that a pre- or post-impact fire occurred.

3.1.12 The aircraft wreckage was recovered for further investigation by a qualified physical metallurgist, metallurgical engineering and aircraft accident investigator, registered with the National Nuclear Regulator (NNR).

3.1.13 According to the Authority To Fly Certificate document, the Authority To Fly was still registered in the name of the current owner. The aircraft was privately operated and not utilised for remuneration.

3.1.14 Although SACAA form CAR47A (application for registration of aircraft and change of ownership) was completed and endorsed before the accident occurred, the Authority To Fly Certificate as regards the future owner had not yet been issued by RAASA. According to the representative of RAASA, the current

Authority To Fly Certificate for the aircraft was therefore still valid in the name of the registered owner (seller) of the aircraft. (This document is attached to the accident report as Annexure A.)

3.2 Probable Cause(s)

3.2.1 Unsuccessful forced landing.

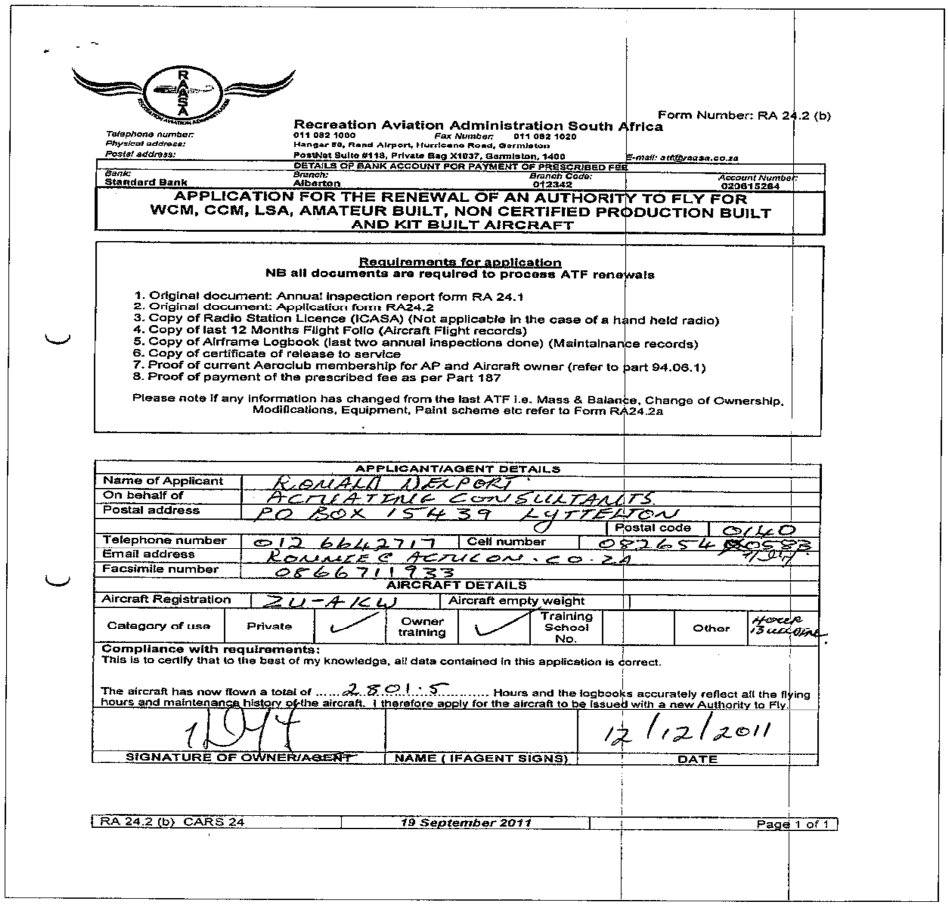
3.2.2 Although it appears that fuel exhaustion caused the engine to stop, it could not be conclusively determined, due to the impact damage caused to the aircraft fuel system as well as the electrical wiring harnesses of the aircraft.

4. SAFETY RECOMMENDATIONS

4.1 None.

5. APPENDICES

5.1 Annexure A, B and C



Form Number: RA 24.2 (b)

Recreation Aviation Administration South Africa

Telephone number: 011 082 1000 | Fax Number: 011 082 1020
Physical address: Hangar 98, Rand Airport, Hurricane Road, Germiston
Postal address: PostNet Suite #118, Private Bag X10037, Germiston, 1400
E-mail: atf@rasa.co.za

DETAILS OF BANK ACCOUNT FOR PAYMENT OF PRESCRIBED FEE

Bank:	Branch:	Branch Code:	Account Number:
Standard Bank	Alberton	012342	020615284

APPLICATION FOR THE RENEWAL OF AN AUTHORITY TO FLY FOR WCM, CCM, LSA, AMATEUR BUILT, NON CERTIFIED PRODUCTION BUILT AND KIT BUILT AIRCRAFT

Requirements for application
NB all documents are required to process ATF renewals

1. Original document: Annual inspection report form RA 24.1
2. Original document: Application form RA24.2
3. Copy of Radio Station Licence (ICASA) (Not applicable in the case of a hand held radio)
4. Copy of last 12 Months Flight Folio (Aircraft Flight records)
5. Copy of Airframe Logbook (last two annual inspections done) (Maintainance records)
6. Copy of certificate of release to service
7. Proof of current Aeroclub membership for AP and Aircraft owner (refer to part 94.06.1)
8. Proof of payment of the prescribed fee as per Part 187

Please note if any information has changed from the last ATF i.e. Mass & Balance, Change of Ownership, Modifications, Equipment, Paint scheme etc refer to Form RA24.2a

APPLICANT/AGENT DETAILS

Name of Applicant	RONALD DELPORT		
On behalf of	ACTIVATIME CONSULTANTS		
Postal address	PO BOX 15439 LYTTELTON	Postal code	0140
Telephone number	012 6642717	Cell number	0826548068
Email address	RONNIE@ACTION.CO.ZA		
Facsimile number	0866711933		

AIRCRAFT DETAILS

Aircraft Registration	ZU-AKW	Aircraft empty weight							
Category of use	Private	✓	Owner training	✓	Training School No.		Other	Hover /3 weeks	

Compliance with requirements:
This is to certify that to the best of my knowledge, all data contained in this application is correct.

The aircraft has now flown a total of ..... 2801:5 ..... Hours and the logbooks accurately reflect all the flying hours and maintenance history of the aircraft. I therefore apply for the aircraft to be issued with a new Authority to Fly.

SIGNATURE OF OWNER/AGENT	NAME (IFAGENT SIGNS)	DATE
		12/12/2011

RA 24.2 (b) CARS 24 | 19 September 2011 | Page 1 of 1

Annexure "A"

FRANCOIS HAARHOFF FAMILIE TRUST
P O Box 1096
Kroonstad
9500

Expiry Date: 2012/03/26

AUTHORITY TO FLY - PRIVATE

AUTHORITY TO FLY ISSUED IN TERMS OF REG 24.02.3

1	DETAILS OF APPLICANT:	**FRANCOIS HAARHOFF FAMILIE TRUST**
2	DETAILS OF AIRCRAFT	
2.1	Registration marks:	**ZU-AKW**
2.2	Aircraft Maufacturer/builder:	**SPORT AVIATION PRODUCTS**
2.3	Aircraft model:	**KOALA SUPER SPECIAL**
2.4	Serial Number:	**NVZ 2**
2.5	Engine type and Model.	**ROTAX 582**
2.6	Engine Serial Number:	**4013572**

3 This aircraft is hereby issued with an authority to fly in terms of Part 24.02.3 of Civil Aviation Regulations 1997, as amended with respect to the aircraft detailed in paragraph 2 of this permit. This permit replaces the requirement for the issue of a certificate or airworthiness in terms of regulation 21.08.1A

4 CONDITIONS AND LIMITATIONS

4.1 The aircraft is privately operated and not utilised for remuneration

4.2 The aircraft is serviceable before each flight and has undergone an annual inspection during the 12 months immediately preceeding any flight and is correctly certified in the applicable aircraft record.

4.3 All flights are conducted under VMC by day and unless unavoidable will not be undertaken over built-up areas and open-air assemblies of persons except for the purpose of take off and landing.

4.4 All the requirements of Part 24 and Part 94 of the Civil Aviation Regulations 1997, as amended are met

4.5 This authority to fly is rendered invalid if the ownership of the aircraft is changed.

4.6 This authority to fly is rendered invalid if the aircraft is involved in an accident

4.7 This document or certified copy must be carried in the aircraft at all times

4.8 The aircraft may not be operated over any foreign country without special permission from the authority of that country.

Date of Issue 2011/03/31

FOR RECREATION AVIATION ADMINISTRATION OF SOUTH AFRICA

Tel. 011 827 9330 Fax 011 827 9329

ANNEXURE "B"

COMPILED BY CRASH-LAB AIRCRAFT INVESTIGATION

ITEM: **ROTAX UL582 TWO STROKE ENGINE, FISHER (AVIATION SPORT PRODUCTS) KOALA SUPER SPECIAL LIGHT AIRCRAFT, SERIAL NUMBER NVZ 2, AIRCRAFT NUMBER ZU-AKW**

1. INTRODUCTION

1.1 ACCIDENT INFORMATION

1.1.1. A Fisher Koala Super Special light aircraft manufactured by Aviation Sport Products, aircraft number **ZU-AKW** (Photo 2) and serial number **NVZ 2**, was involved in a CAT 5 accident on the 14th of December 2011 (Photo 1) resulting in both crewmembers to be fatally injured. The accident aircraft impacted with a moving vehicle prior to final impact with hard ground.

1.1.2. The initial prognosis derived by the investigating officers from the South African Civil Aviation Authority point towards a possible engine mishap during flight resulting in a forced landing. Therefore, the SACAA requested a detailed investigation into the aircraft engine and accessories to determine the most probable causational factor/s for failure during operation.

1.1.3. The aircraft was recovered from the crash site by the South African Air Force.

Photo 1: ZU-AKW crash site (courtesy Beeld)

Photo 2: ZU-AKW

1.2. SUPPLIED PARTS

1.2.1. Wreckage, Engine and Propeller (Hours as per last MPI dated 19/11/2011). The two stroke Rotax engine, model UL582 with serial number 4013572 (Photo 3) with total hours of 51.6, and wood based PIETPROP 72x52 propeller, serial number N3036 FEC 264 and total hours of 22.8, was supplied in separate container from with the remainder of the wreckage of ZU-AKW, with total flying hours of 2801.5.

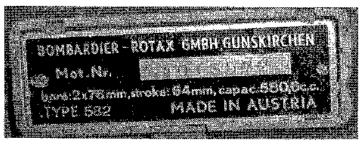


Photo 3: Engine plate (digital)

Annexure C 1

1.2.2. Fuel system components. The remains from the fuel lines, 3x electric fuel pumps, 1x mechanical fuel pump, 1x fuel stop valve as well as the a damaged in-line fuel filter were supplied. One of the two 20 litre (green) aft fuel tanks supplied contained approximate 6 litres that was retrieved in the Laboratory for testing purposes. No 'on-site' fuel sample/s was supplied.

1.2.3. Electrical system components. Various damaged electrical wiring harnesses, selected cockpit instrumentation and switchgear as well as the 12V battery were supplied.

1.2.4. Information. The following documentation were supplied by the SACAA, current and previous owners as well as researched sources:

(a) Koala Flight Manual for ZU-AKW

(b) Koala Maintenance and Logs for ZU-AKW

(c) ZU-AKW Certificate of Registration

(d) ZU-AKW Authority to Fly

(e) ZU-AKW Annual Inspection Certificate

(f) Comments from current and previous owners (attached)

(g) Engine specifications and Operation (Rotax)

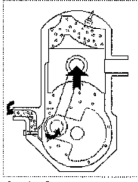
1.3. BACKGROUND INFORMATION

1.3.1. Rotax UL582 Engine. The two-cylinder, two-cycle 582UL displaces 580 cc, develops 65 horsepower, and uses liquid cooling for its in-line cylinders and heads. Oil injection, CDI ignition and an integral alternator. See Table 1 for selected specifications applicable to this investigation. See Diagram 1 for the basic description of the two-stroke cycle.

DESCRIPTION:	Two cycle, two cylinder, rotary valve engine, oil-in-fuel lubrication or oil pump, liquid cooled, with integrated water pump
BORE:	76.0 mm (2.99 in.)
STROKE:	64.0 mm (2.52 in.)
DISPLACEMENT:	580.7 cc (35.44 cu. in.)
COMPRESSION:	Theoretical: 11.5 - effective 5.75
POWER OUTPUT:	48 kw (64.4 HP SAE) at 6500 1/min
TORQUE:	75 nm (55.3 ft. lbs.) at 6,000 1/min.
MAX RPM:	6800 1/min.
DIRECTION OF ROTATION	Counter- clockwise, viewed towards PTO (Clockwise with Reduction installed)
CYLINDER:	2 light alloy cylinder with cast iron sleeves
PISTON:	aluminium cast piston with 2 piston rings
IGNITION SYSTEM:	Breakerless Ducati Capacitor Discharge Dual Ignition with magneto generator
GENERATOR OUTPUT:	170 Watts AC at 6000 RPM and 13.5 RMS
IGNITION TIMING:	1.96 mm or .077" (18 BTDC)
SPARK PLUG:	1.96 mm or .077" (18 BTDC)
ELECTRODE GAP:	0.5 mm (.02")

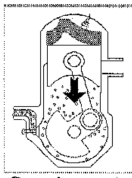
CARBURETOR:	2 x Bing 54 36 mm Slide Valve
FUEL PUMP:	Pneumatic fuel pump
FUEL:	Regular or Premium Gasoline, octane number not below RON 90 (unleaded)
ENGINE LUBRICATION:	Oil-in- fuel with Super two-cycle oil ASTM/CEC standard, mixing ratio
PROPELLER SHAFT DIRECTION:	Clockwise, viewed towards prop flange
STARTER:	Rewind Starter Standard
STANDARD VERSION INCLUDES:	Engine with carburettors w/ clamps, fuel pump, exhaust system

Table 1: Rotax UL582 Engine Specifications (courtesy Rotax Engines)



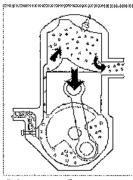
Intake

The fuel/air mixture is first drawn into the crankcase by the vacuum that is created during the upward stroke of the piston. The illustrated engine features a poppet intake valve; however, many engines use a rotary value incorporated into the crankshaft.



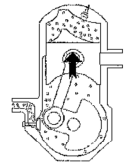
Crankcase compression

During the downward stroke, the poppet valve is forced closed by the increased crankcase pressure. The fuel mixture is then compressed in the crankcase during the remainder of the stroke.



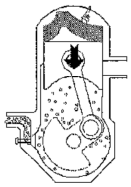
Transfer/Exhaust

Toward the end of the stroke, the piston exposes the intake port, allowing the compressed fuel/air mixture in the crankcase to escape around the piston into the main cylinder. This expels the exhaust gasses out the exhaust port, usually located on the opposite side of the cylinder. Unfortunately, some of the fresh fuel mixture is usually expelled as well.



Compression

The piston then rises, driven by flywheel momentum, and compresses the fuel mixture. (At the same time, another intake stroke is happening beneath the piston).



Power
At the top of the stroke, the spark plug ignites the fuel mixture. The burning fuel expands, driving the piston downward, to complete the cycle. (At the same time, another crankcase compression stroke is happening beneath the piston.)
Diagram 1: Two stroke operation basics

1.3. This report is divided into the following sections:

2. APPLICABLE DOCUMENTS/INFORMATION ATTACHED

(a) Electronic copy of all relevant Reports, Researched information and Photographs.

3. DEFINITIONS

(a)	OEM	Original Equipment Manufacturer
(b)	SACAA	South African Civil Aviation Authority
(c)	SEM	Scanning Electron Microscope
(d)	EDS	Energy Dispersive X-ray Analysis

4. PERSONNEL

(a) The investigative member and compiler of this report is Mr C.J.C. Snyman, ID number 6406105057080. Mr Snyman is a qualified Physical Metallurgist (H.N.Dip Metallurgical Engineering, Tech. PTA), Radiation Protection Officer (RPO) registered with the National Nuclear Regulator (NNR) and Aircraft Accident Investigator (SCSI).

5. APPARATUS AND METHODOLOGY

(a) The apparatus employed for this investigation are Stereo- Light Microscopes and Digital Camera.

(b) The methodology included a visual investigation of supplied parts followed by a Stereoscopic investigation.

6. INVESTIGATION RESULTS

Notes: 1. Investigation performed on supplied parts only.
2. Where stated, the level of serviceability of selected components was assumed due to unavailability.

3. Only systems relevant to the engine performance were investigated.

6.1. Electrical System.

6.1.1. Battery. The 12V battery was destroyed on impact. No clear indications of leakage, fire, loose connectors or other could be determined and are therefore assumed serviceable.

6.1.2. Wiring Harnesses. All harnesses were extensively damaged and severed from connecting points. Some wiring has been cut post-impact by the recovery/transport teams. The visual inspection revealed no clear indications of in-flight electrical fire, loose connections or other and all wiring harnesses are therefore presumed serviceable.

6.1.3. Fuel Pump Supply. The dual aft fuel pumps (Photo 6) were found disconnected. The wiring of the forward stand-by fuel pump (Photo 10) was found severed.

6.2. Fuel System.

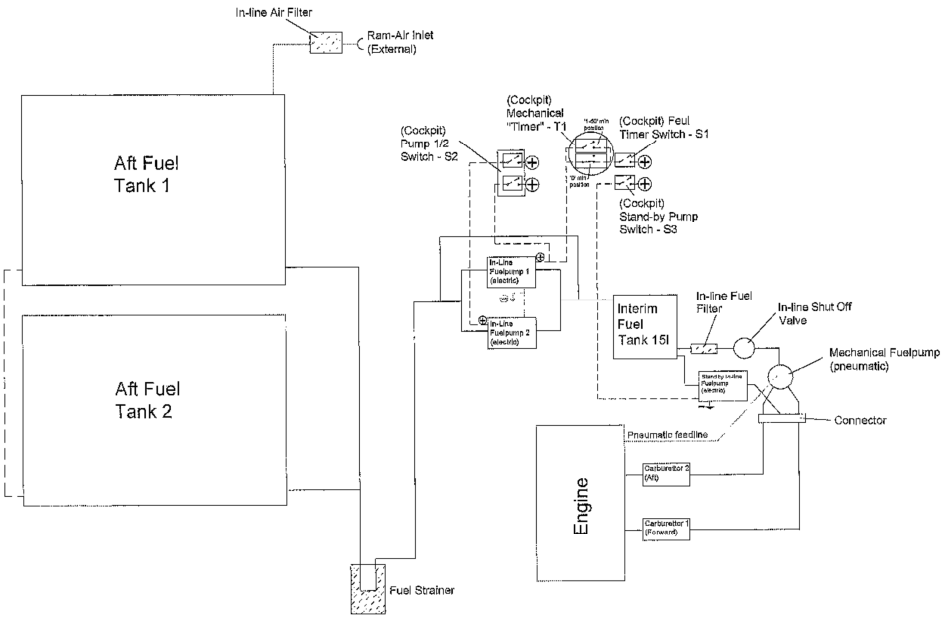


Diagram 2: ZU-AKW Fuel and Electrical Systems (approximate and applicable only)

6.2.1. Fuel Lines. The majority of the fuel line system was retrieved. No clear indications of leakage, blockage or in flight fire was noted and therefore assumed serviceable on impact. The recovery team cut some of the major fuel lines. Taking into account the uniqueness of the accident aircraft's fuel system layout, the retrieved parts, combined with information received from previous owners, were utilized to compose the most probably fuel system layout diagram as depicted in **Diagram 2**.

6.2.2. AFT Tanks. The visual inspection of both the 20 litre aft main fuel tanks (Photo 4) revealed no clear indications of leakage, blockage or other pre-impact damages. The level floater was damaged on impact. The ram-air in-line filter proved to be in good condition. The Laboratory retrieved approximately 6 litres of fuel from one of the main tanks. The aft tanks are assumed serviceable on impact.

Photo 4: AFT main fuel tanks (digital)

6.2.3. Fuel Strainer. The fuel strainer (Photo 5) was still fitted with limited damages and therefore presumed serviceable on impact.

Photo 5: Fuel strainer (digital)

6.2.4. Dual, In-line Fuel Pumps 1 and 2. Both the in-line, parallel mounted fuel pumps (Photo 6) were retrieved and proved to be in good condition. The pumps performed favourable when attached to a 12V source and are therefore proved mechanically serviceable on impact.

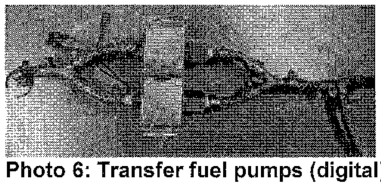


Photo 6: Transfer fuel pumps (digital)

6.2.5. Intermediate Tank. The 15 litre intermediate tank was not supplied for this investigation. (A detailed inspection of photographic evidence revealed no clear indication whether the intermediate tank was in fact recovered the crash site.) The intermediate tank was installed behind the instrument panel, aft from the firewall with a glass-tube level indicator on the instrument panel visible by the crew (Photo 42). Therefore no clear indication/s are available to determine the intermediate tank level on impact, but, taking into account the limited amount of fuel/oil contamination behind the instrument panel, it can be derived that the fuel level was most probably less that the maximum possible 15 litres.

6.2.6. In-line Shut-off Valve. The in-line fuel shut-off valve (Photo 7, blue arrow) was retrieved and in good condition. The position of the valve (Open or Close) on impact could not be conclusively determined. Due to the improbability of the crew changing this valve setting during flight, it is presumed to have been in the fully open position on impact.

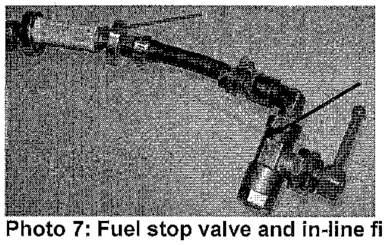


Photo 7: Fuel stop valve and in-line filter (digital)

6.2.7. In-line Filter. The inline fuel filter was severely damaged on impact (Photo 7, red arrow) but revealed no clear indications of clogging and therefore assumed to be serviceable on impact.

6.2.8. In-line Mechanical Pump. The pneumatically drive in-line mechanical fuel pump proved to be in good condition (Photo's 8 and 9). The pneumatic line was found disconnected, most probably on impact. The mechanical pump is presumed serviceable.

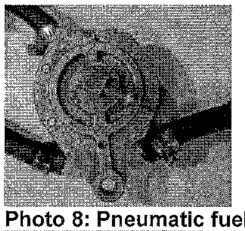


Photo 8: Pneumatic fuel pump (digital)

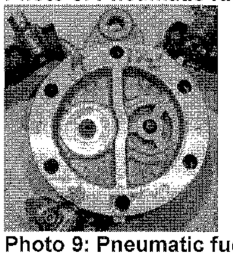


Photo 9: Pneumatic fuel pump (digital)

6.2.9. Stand-by Electric Fuel Pump. The electric stand-by fuel pump (Photo 10), fitted parallel to the mechanical fuel pump (Diagram 2), revealed limited impact damages. When connected to a 12V source, the stand-by fuel pump proved to be unserviceable. It could not conclusively be determined if this can be related to the impact.

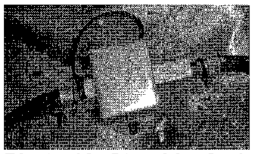


Photo 10: Stand-by fuel pump (digital)

6.2.10. Connector. The connector (Photo 11) proved to be in good condition and rendered serviceable.

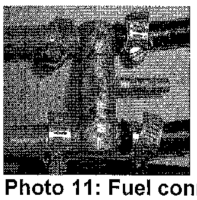


Photo 11: Fuel connector (digital)

6.2.11. Carburettor No 1 (Forward). The visual outer inspection of the forward Bing 54 type no 1 carburettor (Photo 12, Diagram 3) revealed an impact fractured vent line (31; Photo 12, blue arrow), fuel feed line and float chamber (25; Photo 13, red arrow). The still attached air filter (Photo 12, yellow arrow) revealed some impact damages and post-impact contamination with no clear indications of pre-impact clogging or other. The inner dual floaters (21) were not retrieved. The throttle cable was still attached as in the as found condition.

Teardown results: The top cover plate (9) was removed and revealed the rubber-ring (8) to be in position and good condition (Photo 15, red arrow).

The piston spring (7) was correctly fitted into the spring cup (6) and the needle clip (5) in the proper position on the needle (4; Photo 16, red arrow).

The carburettor-piston (3; part no 2306, Photo 17) proved to slightly sticky on removal but can be attributed to post-impact FOD ingestion.

The idle adjust screw (30) was found at a set position of 12.5mm from casing (Photo 14, red arrow) and in good condition. It was removed for following 12 full turns.

The air mix adjustment screw (28; Photo 14, yellow arrow) was removed following 19 full turns.

The float chamber (25) was severed on impact leaving the gasket (24) slightly damaged but in position (Photo 18, green arrow).

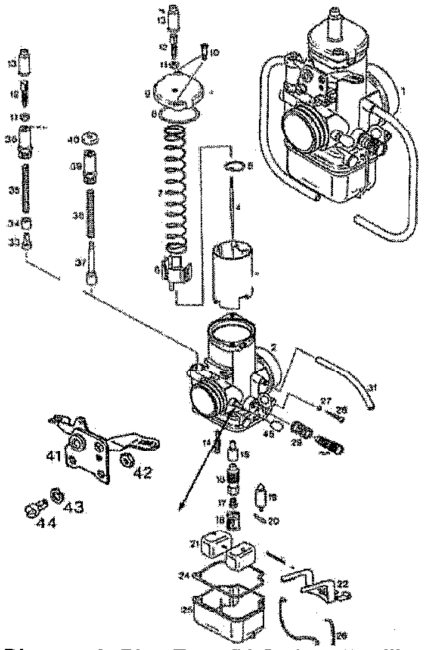
The sieve sleeve (18) was not retrieved.

The main jet (17) was removed indicating size number 158 (Photo 18, blue arrow). Some post-impact induced foreign matter was noted but no clear indications of carbon build-up or other.

The mixing tube (16), needle jet (15) with size number 2.72 was removed without obstruction and proved to be in good condition.

The idle jet (14) with size number 55 (Photo 18, yellow arrow) was removed but revealed no obstruction or other.

The pin was removed (Photo 18, red arrow) in order to release the float arm bracket (22), spring clip (19) and float needle (20). All parts proved to be in good condition with no obstruction or stickiness.



1		See Bing Carbs - Complete	
3	963-579	Carb Piston	1
4		See Bing Tuning Components	
5	963-500	Needle Clip	1
6	827-345	Spring Cup	1
7	938-655	Piston spring	1
8	831-450	Rubber Ring	1
9	963-720	Cover Plate	1
10	241-430	Screw 5x12	2
11	942-541	Nut 5x0.75	2
12	241-440	Screw 6x0.75	2
13	250-370	Grommet	1
14		See Bing Tuning Components	1
15		See Bing Tuning Components	1
16	963-700	Mixing Tube	1
17		See Bing Tuning Components	1
18	261-625	Sleve Sleeve	1
19	251-705	Valve w/ Viton Tip	1
20	261-710	Needle Clip	1
21	861-180	Float	2
22	861-190	Float Bracket	1
23	929-700	Pin	1
24	630-720	Gasket	1
25	261-010	Float stopmer	1
26	963-180	Spring Clip	1
27	831-710	O Ring	1
28	963-135	Air Screw	1
29	938-640	Spring	1
30	963-160	Adjustment Screw	1
31	256-035	Vent Line 120mm	1
32	961-300	Connector	1
33	963-740	Starting Piston	1
34	258-850	Sleeve	1
35	851-250	Spring	1
36	963-750	Choke Housing	1
37	258-847	Choke Piston	1
38	239-730	Compression spring	1
39	261-770	Choke Housing	1
40	260-490	Rubber Cap	1
41	261-755	Choke Lever Assy.	1
42	261-200	Nut 5mm	1
43	945-750	Lockwasher	2
44	240-791	Screw 5x16	2
45	860-610	Rubber Cap	1

Diagram 3: Bing Type 54 Carburettor Illustrated Parts List

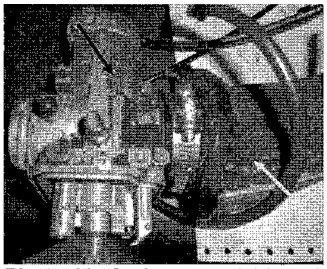


Photo 12: Carburettor 1 (digital)

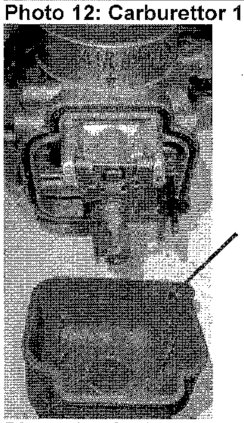


Photo 13: Carburettor 1 float chamber (digital)

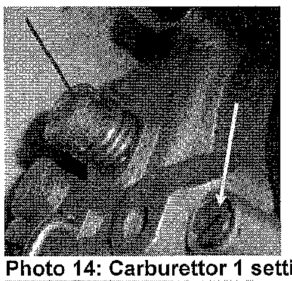


Photo 14: Carburettor 1 setting screws (digital)

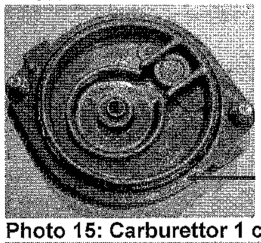


Photo 15: Carburettor 1 cover top (digital)

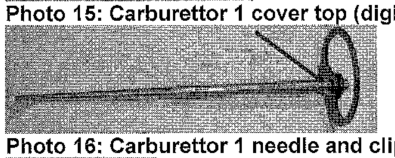


Photo 16: Carburettor 1 needle and clip (digital)

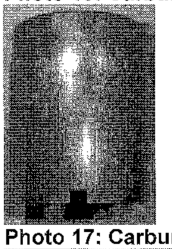


Photo 17: Carburettor 1 piston (digital)

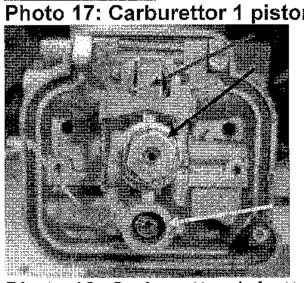


Photo 18: Carburettor 1 bottom (digital)

6.2.12. Carburettor No 2 (Aft). The visual outer inspection of the aft Bing 54 type no 2 carburettor (Photo 19, Diagram 3) revealed an impact fractured vent line (31; Photo 19, blue arrow) but with fuel feed line and float chamber (25; Photo 19, red arrow) still in position. The still attached air filter (Photo 19, yellow arrow) revealed some impact damages and post-impact contamination with no clear indications of pre-impact clogging or other. The throttle cable was still attached as in the as found condition but without a rubber grommet (13) in position.

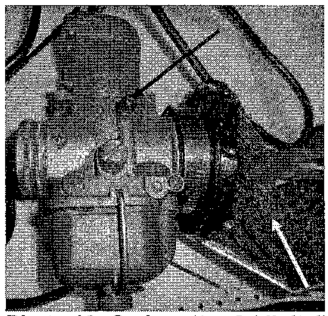


Photo 19: Carburettor 2 (digital)

Teardown results: The top cover plate (9) was removed and revealed the rubber-ring (8) to be in position and good condition. A small amount of foreign matter was noted that could be attributed to the absence of the rubber grommet.

The piston spring (7) was correctly fitted into the spring cup (6) and the needle clip (5) in the proper position on the needle (4). Some scouring marks were noted on the needle surface (Photo 20, red arrow).

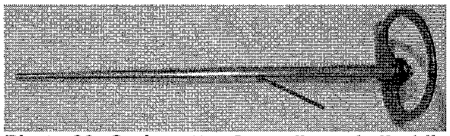


Photo 20: Carburettor 2 needle and clip (digital)

The carburettor-piston (3; part no 2306) proved less sticky than carburettor no 1 on removal.

The idle adjust screw (30) was found at a set position of 11.88mm from casing (Photo 14, red arrow) and in good condition. It was removed for following 11.5 full turns.

The air mix adjustment screw (28; Photo 14, yellow arrow) was removed following 10 full turns.

The float chamber (25) was removed from position with both floaters (21) in position and in good condition (Photo 21, red arrow). A test performed revealed no leakage into the floats. The float chamber gasket (24) was found in position but, due to a foreign object jammed between the chamber and casing interfaces during fitment (Photo 22, red arrow), the gasket was extensively damaged (Photo 22, blue arrow).

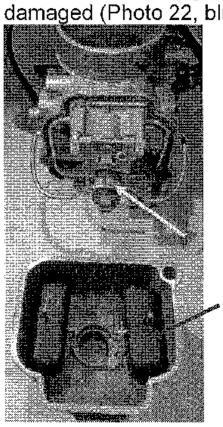


Photo 21: Carburettor 2 float chamber (digital)

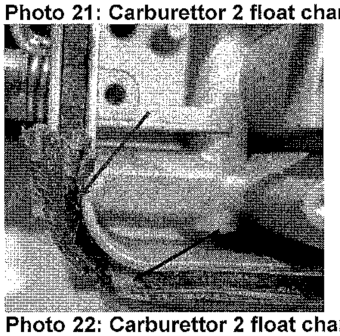


Photo 22: Carburettor 2 float chamber gasket (digital)

The sieve sleeve (18) was found in position and clean (Photo 21, yellow arrow).

The main jet (17) was removed indicating size number 158 with no clear indications of carbon build-up or other.

The mixing tube (16), needle jet (15) with size number 2.72 was removed without obstruction and proved to be in good condition.

The idle jet (14) with size number 55 was removed but revealed no obstruction or other and showing less wear than carburettor no 1.

The pin was removed in order to release the float arm bracket (22), spring clip (19) and float needle (20). All parts proved to be in good condition with no obstruction or stickiness.

6.3. Engine

6.3.1. Propeller and Gearbox. The propeller spinner was destroyed on impact. The no 1 blade (Photo 23, red arrow) revealed little leading edge damages pointing towards a low rpm/power setting on impact. The no 2 blade (Photo 24, red arrow) also showed impact damages consistent with a low rpm/power setting and applied force towards the aft direction of impact.

Considering the irregular surface as well as direction of impact forces on collision with a moving vehicle, the interpretation of the damages inflicted unto the propeller should be considered with care.

The propeller hub with main bearing (still intact and in position) fractured on impact (Photo 25, blue arrow) with no clear indications of pre-existing failures. The forward bearing was forced onto the driveshaft (Photo 25, red arrow) leaving clear impact marks with no rotational indications consistent with a low rpm/power setting, no hint of seizure or other. The aft bearing (Photo 26, yellow arrow) was impact damaged but intact and in position. The vibration absorber (Photo 26, red arrow) failed on impact in a manner consistent with a low rpm/power setting. The propeller flange was found still attached. A section of the impact fractured power take off (PTO) main drive gear was retrieved (Photo 27) with no clear indications of pre-impact fractures.

Photo 23: Propeller (digital)

Photo 24: Propeller (digital)

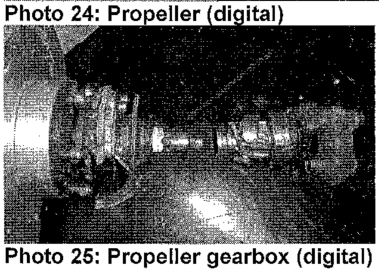


Photo 25: Propeller gearbox (digital)

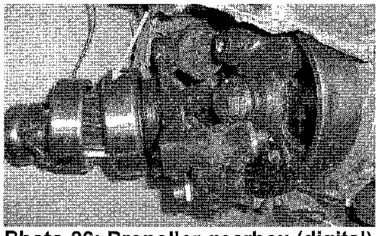


Photo 26: Propeller gearbox (digital)

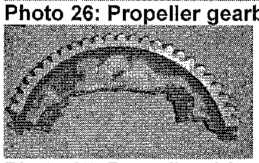


Photo 27: Propeller drive gear (digital)

6.3.2. Engine. The Rotax 582 two-stroke engine (Diagram 4) was fitted in the inverted configuration on ZU-AKW (Photo 28).

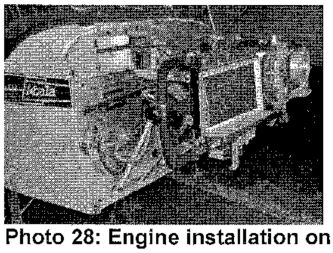


Photo 28: Engine installation on ZU-AKW (courtesy Francois Haarhoff Trust)

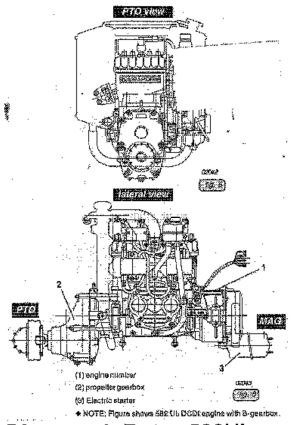


Diagram 4: Rotax 582UL engine layout

The fractured gearbox casing (Photo 29, blue arrow) revealed the PTO wheel (Photo 29, red arrow) in good condition with no indications of slippage on the crankshaft PTO end.

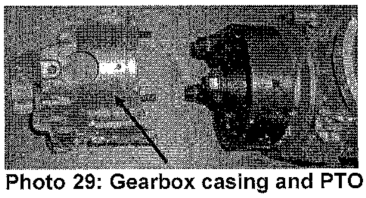


Photo 29: Gearbox casing and PTO wheel (digital)

Both the CDI's was still in position with the aft unit extensively damaged on impact (Photo 30, red arrow). Inspection of the duel sparkplugs (numbered 1 to 4 starting forward; Photo 32) showed numbers 2 and 3 to be in position and intact while numbers 1 and 4 was fractured on impact. The sparkplug wires was still intact and connected to the respective CDI's. On removal all sparkplugs revealed no clear indications of severe carbon build-up, oil deposits or other discrepancies (Photo 32).

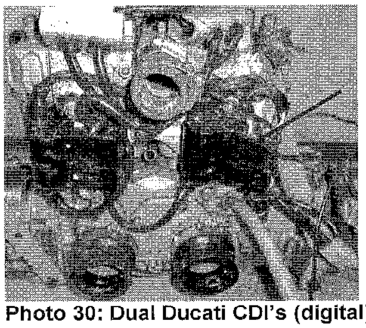


Photo 30: Dual Ducati CDI's (digital)

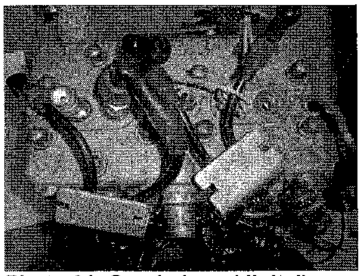


Photo 31: Sparkplugs (digital)

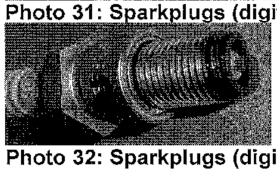


Photo 32: Sparkplugs (digital)

The engine cylinder heads revealed slight disparity in colour inside the combustion chamber between the no 1 (forward) and no 2 (aft) pods with distinctive sputter surrounding the sparkplug holes (Photo 33, red arrow). No clear indications of gasket blow-by, coolant seepage or other were noted. Inspection of the piston heads revealed a slight variation in carbon depositing (Photo 34) with severe scuffing marks on the sleeve of the no 2 pod (Photo 34, red arrow).

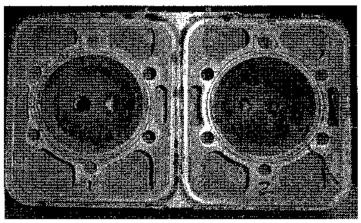


Photo 33: Cylinder heads (digital)

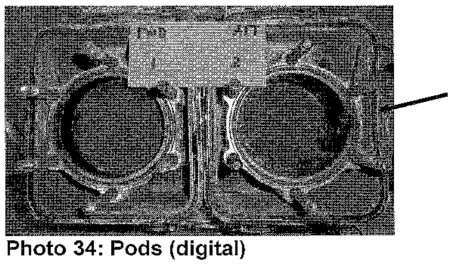


Photo 34: Pods (digital)

The pod bolts (Photo 35) showed severe bending damages that can be related to the aft impact indentation noted on the no 2 pod (Photo 34, blue arrow) causing the pods to shift in a forward direction relative to the engine casing. On removal of the pods the no 1 piston proved to be in good condition (Photo 36) with rings intact and no clear signs of excessive wear, high temperature exposure, seizure or blow-by.

The no 2 piston revealed severe scuffing marks 180° apart (Photo's 36 and 37, red arrows). These marks can be attributed to piston movement at an incline inside the shifted sleeve/pod on and after impact. This may be an indication that the engine rotated on impact. No further indications of blow-by, ring failure, seizure or high temperature exposure were noted.

The pod gasket (green) proved to be in good condition.

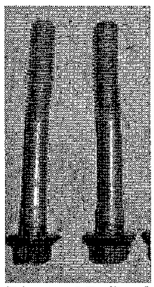


Photo 35: Pod bolts (digital)

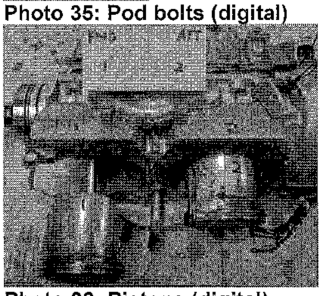


Photo 36: Pistons (digital)

Photo 37: No 2 piston (digital)

The crankcase revealed several impact fractures (Photo 38, red arrow). The set of crankshaft bearings numbered M1 to M5 (Photo 38, blue arrow) showed no signs of wear, seizure or exposure to high temperatures. The matching crankcase bearing contact surfaces revealed no signs of rotational damages or other. The crankshaft (Photo 38, orange arrow) was found in good condition. The connecting rods (Photo 38, green arrow) showed no signs of bending or temperature induced discolouring with both the big-end and piston needle bearings in good condition. The rotary valve drive gear system was found in excellent condition (Photo 38, yellow arrow).

No indications of lubrication breakdown were noted with regard to the crankshaft assembly.

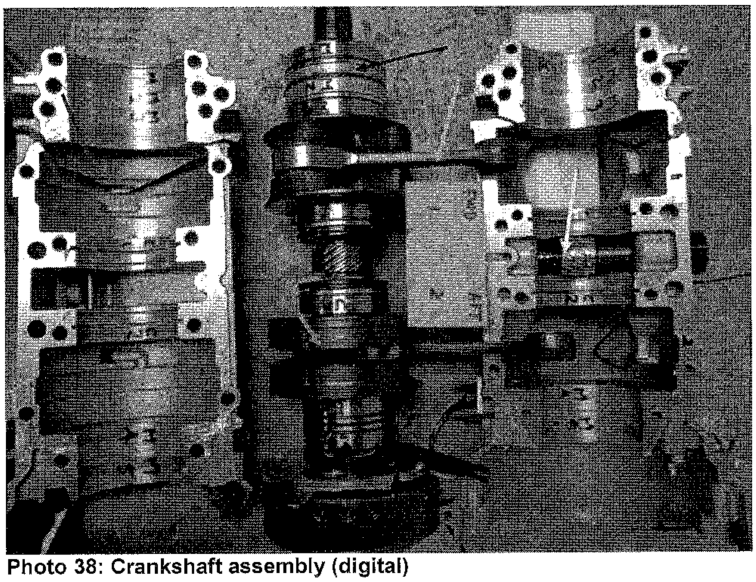


Photo 38: Crankshaft assembly (digital)

Although the oil feed line and reservoir was found separated from the engine, the rotary valve assembly (Photo 39) revealed no clear indications of wear with the O-ring intact and in place.

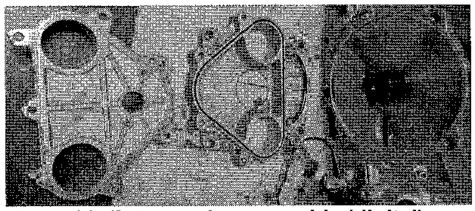
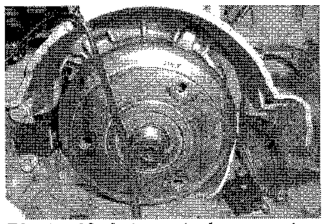


Photo 39: Rotary valve assembly (digital)

The integrated generator stator casing (MAG end) was fractured on impact with damages to the generator (Photo 40). No clear indications of electrical fire or other were noted. The starter assembly was severed from the engine on impact.



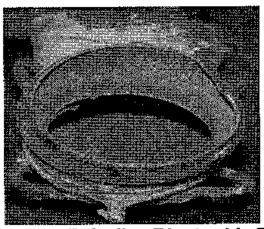


Photo 40: Integrated generator assembly (digital) **Photo 41: Exhaust (digital)**

The exhaust system was severely damaged on impact but showed no signs of excessive soot build-up (Photo 41).

6.4. Cockpit Instrumentation and Switchgear

6.4.1. Main Electrical Supply Selectors. The Master Switch and Mags 1 and 2 were destroyed and presumed to be in the "ON" position on impact.

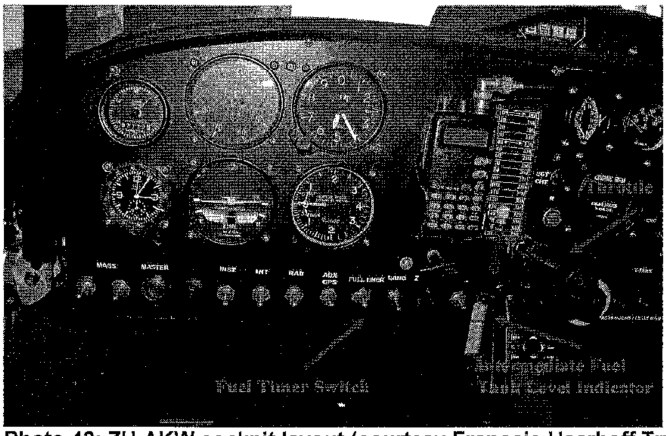


Photo 42: ZU-AKW cockpit layout (courtesy Francois Haarhoff Trust)

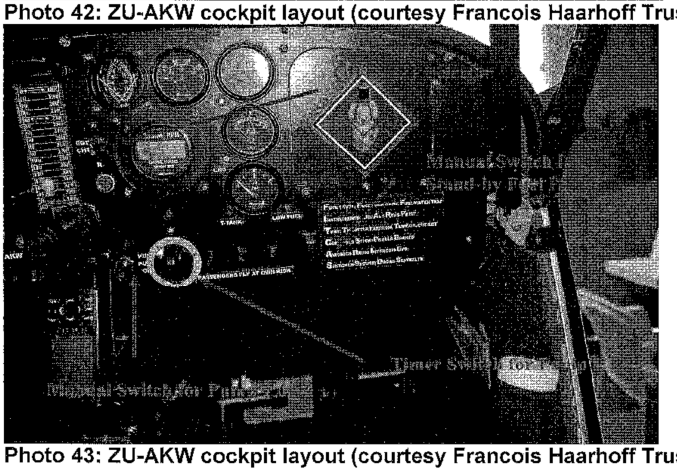


Photo 43: ZU-AKW cockpit layout (courtesy Francois Haarhoff Trust)

6.4.2. Fuel Pump Selectors.

***Note**: During flight the crew are responsible to transfer fuel from the two aft main tanks to the intermediate tank by means of one, or both, of the in-line electrical fuel transfer pumps. For the primary (dual) pump no 1 to operate, the Fuel Timer switch (Photo 42) must be selected "ON" and the Timer (Photo 43) at the "0 minutes" position, and/or, the Manual Switch must be set on "Pump 1" (Photo 43).*

For the pump no 2 to operate the Manual Switch (Photo 43) must be set at "Pump 2". Note that the designations for Pump 1 and Pump 2 are not visible behind the Timer switch dial.
The Fuel Timer switch (Photo 42) was not recovered. The Timer switch was found at the "0 minutes" position (Photo 4443red arrow). All indications are that the Timer switch was fitted at later time as it partially obscure the Manual Pump switch insignia. The Manual Pump Switch was found jammed behind the GPS bracket (yellow arrow) and at the "Pump 1" position (blue arrow).

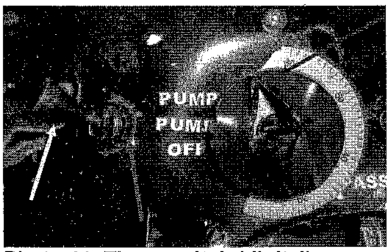


Photo 44: Timer switch (digital)

6.4.3. Other Selectors. The CHT selector was found at the "R" (rear (aft) cylinder head, sparkplug no 3) position (Photo 43). The Stand-by Fuel Pump switch (Photo 43) was not recovered. The Throttle was found at the "IDLE" position (Photo 43).

6.5. Miscellaneous Investigation Results

6.5.1. Fuel Mixture. The fuel was not preserved under ideal and prescribed conditions and no 'on-site' sample was presented for this investigation. By means of extended temperature exposure the volatile fuel component was vaporised from three similar samples retrieved from one of the aft main tanks. The remaining oil component was measured indicating an average of 6:100 ratio oil/fuel mixture. This proved to be within prescribed OEM limits.

7. DISCUSSION AND CONCLUSIONS

Note: All conclusions are based on the investigation results obtained from the supplied parts only.

Considerations:

(i) Due to the extent of impact damages a number of deductive assumptions had to be made in order to motivate the most probable cause/s.

(ii) This investigation assumes that the investigation into all other possible causes for this accident has been completed i.e. control surface failure, etc.

(iii) This investigation was not involved with the 'on-site' preliminary investigation and the subsequent preservation of the evidence, hence the integrity of supplied evidence is assumed to be proficient and in the **'as found'** condition.

(iv) The crew opted for a precautionary/emergency landing a relative short distance from the airfield. At the time of the emergency transpiring, the altitude should have been between 1000 (circuit altitude for FASK) and 3000 ft (typical approach altitude towards FASK from GF1 via Attridgeville) AGL and descending. These presiding factors considered it could be derived that the crew experienced an emergency to such an extent that an immediate landing of the aircraft was imperative.

(v) No information with regard to radio communication between the tower, or other aircraft, and the accident crew was presented to this investigation.

7.1. Discussion

7.1.1. Propeller. The propeller assembly proved serviceable on impact. Damages point towards a **low rpm/power** setting on initial impact (moving vehicle) that most probably resulted in the separation of the assembly from the engine prior to final impact with hard ground.

7.1.2. Engine. The inverted engine assembly proved to be serviceable on impact revealing no clear indications of in-flight mechanical failure.

Damages to the aft piston and sleeve are evident of rotation on impact and therefore signify that the **engine was operating** at the time of final impact, albeit at **low rpm/power**.

Take into consideration that the crew would have opted for a low power setting during the final phase of the landing (hence the throttle setting as found) and, at typical final approach airspeeds, the sizeable propeller will not generate significant 'wind milling'. It can therefore be derived that the rotational damages noted was most probably inflicted between the initial (moving vehicle) and final impact following the separation of the propeller (leaving the engine without load and free to increase rpm).

The apparent loss of engine power in flight can be considered a primary causational factor for the crew's decision to attempt a precautionary landing. The three leading causes for engine power loss are fuel starvation and/or electrical failure followed by mechanical breakdown. Electrical supply (spark) can be excluded to an extent as the engine was in fact rotating on impact as well as being fitted with a dual CDI system for added reliability. This leaves the most probable cause for loss of power as (total or partial) **fuel starvation** in flight.

7.1.3. Carburettor System. Both Bing 54 carburettors proved to be in **good mechanical condition** with the most common failures ruled out during the teardown procedure. Carburettor no 2 (aft) revealed some discrepancies regarding assembly and settings, the latter probably responsible for the variations in colour between the two cylinder heads. Nevertheless, taking into account the operational hour exposure since fitment and the number of sorties completed just prior to the accident, none could confidently be related to the apparent loss in engine power in this case. No carburettor de-icing system was installed.

7.1.3. Fuel System. The fuel/oil mixture proved to **within OEM limits**. Approximately 6 litres of fuel was retrieved from one of the aft main tanks by this investigation pointing away from total fuel starvation. The intermediate 15-litre tank was not supplied and all indications are that this vital piece of evidence was not recovered from the accident site. Considering the relatively low degree of fuel/oil contamination to the instrument panel, it can be derived that less than 15 litres of mixture was present on impact that destroyed the intermediate tank. The complete fuel feed line system was not retrieved or supplied and assumed to be intact without leak- or blockages. The **dual, electric in-line fuel pumps** were tested on a 12V source and proved to be **serviceable** on impact. The parallel, electric in-line **stand-by fuel pump** did not operate when attached to the same source implicating that it probably was **unserviceable** on impact. Taking into account that the parallel fitted, in-line **pneumatic mechanical fuel pump** proved to be in **good working condition**, it can be assumed that the potential failure of the stand-by pump did not contribute to this accident. The in-line fuel filter revealed no clear indications of congestion and the fuel stop valve are presumed to have been open on impact.

The cockpit mounted fuel pump selection switch gear in the 'as found' condition point towards the number 1 aft transfer fuel pump selected to operate by both the Fuel Timer switch in the "ON" position (assumed) and Timer being at "0 minutes" (POWER ON), and, the manual Fuel Selector switch at the "PUMP 1" position. (The pump numbers could not be located to a specific unit due to the loss of the relevant wiring harness. Deductive reasoning is based on information supplied by the previous owner/s. Furthermore, the possibility that Pump 2 could have been connected to the Timer system cannot be excluded.) In this case Pump 2 would not be selected to operate at the time of impact.

7.1.4. Electrical System. All the relevant wiring harnesses were extensively damaged on impact and during recovery and could therefore not conclusively be declared serviceable. The possibility therefore exist that one, or possibly both, of the transfer fuel pumps were disconnected in flight from the electrical supply prior to the accident leaving the transfer to the intermediate tank interrupted.

7.1.5. Cooling System. The cooling system was destroyed on impact but no clear evidence of leakage that may have resulted in engine over-temp was noted and is therefore assumed to have been **serviceable** on impact.

7.2. Conclusions

The most probable causes, in no particular order of probability, for the crew to perform an immediate precautionary/emergency landing are the following:

7.2.1. In flight failure of transfer fuel pump/s. The possibility exists that the somewhat complicated and unique fuel transfer system could have played a significant role in the decision making process of an inexperienced crew resulting in unknowingly selecting a single fuel pump (no 1 or 2) by means of two parallel systems to transfer fuel. If the selected fuel pump (or both) became inoperative in flight the resultant effect will be the ultimate total/partial fuel starvation of the engine. The possible confusing effect of the Timer switch obscuring the insignia relating to which pump is selected cannot be disregarded.

7.2.2. Failure to transfer fuel from aft to intermediate tanks. Improper crew monitoring of intermediate fuel tank level by means of the cockpit tube indicator resulting in untimely activating of the transfer fuel pump system. The resultant effect will be comparable to 7.2.1.

7.2.3. High CHT indications. The CHT selector was found in the "R" position suggesting that the crew was monitoring the aft cylinder head temperature. This factor based on the disparity in colour of the aft no 2 piston assembly indicating possible higher operating temperatures when compared to the no 1 piston, could have impelled the crew to perform a precautionary landing.

7.2.4. Carburettor Icing. Although no clear indications are presented based on prevailing weather or other, possible carburettor icing of one or both units during the descent phase cannot be ignored as possible contributing factor.

8. RECOMMENDATIONS

8.1. The investigation attempted to collect further evidence from the wreckage but was informed that the remains was discarded by the Defence Flying Club where it was originally stored. This seriously hampered this investigation and, taking into account the number of fatalities involved and the possible legal implications thereof, it is strongly recommended that all evidence must be preserved and quarantined in the prescribed manner.

9. DECLARATION

9.1. All digital images has been acquired by the author and displayed in an un-tampered manner.