SOUTH AFRICAN CIVIL AVIATION AUTHORITY

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

AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/9069		
Aircraft Registration	ZU-DOK	**Date of Accident**	11 August 2012		**Time of Accident**	1345Z	
Type of Aircraft	Zenith CH 701 (Aeroplane)		**Type of Operation**	Private			
Pilot-in-command Licence Type	National Pilot's Licence		**Age**	69	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	Total Flying Hours		3 371		Hours on Type	200,4	
Last point of departure	Emoyeni Airfield, Cato Ridge, KwaZulu-Natal						
Next point of intended landing	Emoyeni Airfield, Cato Ridge, KwaZulu-Natal						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Emoyeni Airfield beyond the end of runway 15 at GPS co-ordinates (S29°44'58.37", E030°33'0.99")							
Meteorological Information	Wind direction: 050º; Speed: variable; Temperature 24ºC; Visibility: CAVOK						
Number of people on board	1 + 1	**No. of people injured**	0	**No. of people killed**	0		

Synopsis

The pilot, accompanied by a passenger, took off from Emoyeni airfield with the intention of completing a circuit of the airfield. Shortly after rotation, at approximately 40 ft above ground level, the aircraft experienced a loss of power. The pilot attempted to land back on the runway, but lost control of the aircraft during the forced landing.

The aircraft hit the ground hard, causing its nose gear to collapse. It then bounced, overshot the runway and crashed a few metres short of the boundary fence, sustaining substantial damage. Neither the pilot nor passenger was injured, however.

The engine was recovered and investigated by Rotax-approved personnel. The investigation found that the engine power loss was probably due to interruptions of fuel flow to the engine, but could not conclusively determine the reason. The aircraft stalled at a height insufficient to allow the pilot to recover.

Probable Cause

Unsuccessful forced landing following a loss of engine power during take-off.6.13

Contributing factor/s:

A fuel vapour lock

No fuel return line fitted

IARC Date		Release Date	

AIRCRAFT ACCIDENT REPORT

Name of Owner	**:** CF KRISTENSEN
Name of Operator	**:** T HOLROYD
Manufacturer	**:** ZENITH
Model	**:** CH 701
Nationality	**:** South African
Registration Marks	**:** ZU-DOK
Place	**:** Emoyeni Airfield, beyond the end of runway 15 at co-ordinates (S29°44'58.37", E030°33'0.99")
Date	**:** 11 August 2012
Time	**:** 1345Z

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

Purpose of the Investigation

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer

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

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 The pilot took off on a private flight from Emoyeni airfield with the intention of flying circuits. Over the next 2,2 hours, he completed a total of five circuits and full-stop landings. After each circuit, the pilot rested for 35 minutes before continuing with the next flight. After the second circuit, 25ℓ of fuel was uplifted.

1.1.2 After a 10-minute break at 1345Z, the pilot took on a passenger and taxied to runway 15, intending to fly another circuit. After a delay of approximately 10 minutes at the holding point, they took off. Just after rotation, about 40ft above ground level (AGL) and at airspeed of 55mph, the engine started running roughly and then lost power completely.

1.1.3 The pilot pushed the control column forward to increase airspeed and to land back on the active runway.

1.1.4 During the forced landing, the aircraft landed hard at the end of runway 15, bounced, overshot the runway and came to rest on the grass verge near the perimeter fence.

1.1.5 The aircraft came to rest at the co-ordinates (S29°44'58.37", E030°33'0.99") and at an elevation of 2 322ft.

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1. The aircraft sustained substantial damage during the accident sequence. The undercarriage collapsed, the left wing separated at the root, and the nose and propeller were damaged.

Figure 1: The damage to the aircraft.

1.4 Other Damage

1.4.1 None

1.5 Personnel Information

Nationality	British	Gender	Male	Age	69
Licence Number	0270190358	Licence Type	Nation Pilot's Licence		
Licence valid	Yes	Type Endorsed	No		
Ratings	Night, Instrument, Instructor and Safety Pilot				
Medical Expiry Date	31 May 2013				
Restrictions	Corrective lenses				
Previous Accidents	None				

Flying Experience

Total Hours	3371,8
Total Past 90 Days	40,0
Total on Type Past 90 Days	27,5
Total on Type	200,4

1.6 Aircraft Information

Airframe

Type	Zenith CH 701	
Serial Number	75419	
Manufacturer	Zenith	
Date of Manufacture	2004	
Total Airframe Hours (At time of Accident)	598,4	
Last Annual Inspection (Date & Hours)	29 April 2012	527,7
Hours since Last Annual Inspection	70,7	
C of A (Issue Date)	15 May 2012	
C of R (Issue Date) (Present owner)	9 December 2010 (CF Kristensen)	
Operating Categories	Training	

1.6.1 The aircraft documentation (Certificate of Registration, Certificate of Authority to Fly, and Mass & Balance Certificate) was reviewed and found to be valid.

Engine

Type	Rotax 912 ULS
Serial Number	5643045
Hours since New	598,4
Hours since Overhaul	TBO not yet reached

1.6.2. The aircraft maintenance documentation was reviewed during the investigation. The following was identified:

(i) The engine maintenance documentation did not indicate details of unscheduled maintenance carried out from 28 October 2004 to 11 August 2012.

(ii) The approved person (AP) who conducted the last annual inspection stated that the engine fuel system had not been fitted with a fuel return line. He said that most of the aircraft he maintained were not fitted with a fuel return line as it was unnecessary.

1.6.3. The engine manufacturer has published the following maintenance requirements applicable to the Rotax engine. (Abbreviations: SI = service instruction; SB = service bulletin; STI = service technical instruction; ASB = alert service bulletin)

(i) ASB-912-016UL fuel hose, dated 25 May 2012: requesting replacement of pressure fuel hose at pump side part no. 893114.

(ii) ASB-912-060 oil pump bolts 1, dated 26 Jan 2012: checking of pump fixing bolts for correct torque.

(iii) ASB912-059 crankshaft crack, dated 15 November 2011: checking crank power journal (power take-off side).

(iv) SB-912-052[1] governors use, dated 17 October 2008: installation/use of governor.

(v) SB-912-058-UL [1] washer on flywheel, dated 15 April 2011: replacement of washer part no. 944072(flywheel hub).

(vi) SI-912-020[1] fuel line, dated 15 April 2008 running modification on fuel line.

(vii) Sl-912-014-r1 [1] non-approved spares, dated 15 April 2008: non-approved modifications or use of unapproved engine components or accessories.

1.6.4. The above service bulletin and service instructions were published to facilitate the safe use of the engine. There was no information recorded in the engine log book which indicated that the approved person had complied with the servicing publications.

1.6.5. Two of the bulletins concerned the fuel line modification (SI-912-020[1] fuel line, dated 15 April 2008) and fuel hose replacement request (ASB-912-016UL fuel hose, dated 25 May 2012) respectively.

1.6.6. The fuel line modification (SI-912-020[1]) included the modification of the intake manifold, which required machining of the attachment for flexible fuel lines. It gave a further instruction to replace the manifold if necessary to allow for the modification. The system involved a fuel return line and rerouting of fuel lines.

Propeller

Type	KEIV
Serial Number	C13799
Hours since New	589,4
Hours since Overhaul	TBO not yet reached

1.6.7. There were no anomalies found on the propeller.

1.7 Meteorological Information

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

Wind direction	050º	Wind speed	Variable	Visibility	CAVOK
Temperature	24ºC	Cloud cover	Nil	Cloud base	Nil
Dew point	Unknown				

1.8 Aids to Navigation

1.8.1. The aircraft was equipped with standard navigational equipment as per the approved equipment list by the regulator. There were no recorded defects with the equipment prior to the flight.

1.9 Communications

1.9.1 The aircraft was equipped with VHF communication equipment approved by the regulator. There were no recorded defects with the equipment prior to the flight.

1.9.2 The pilot broadcast on the unmanned frequency of 124.8 MHz at the airfield.

1.10 Aerodrome Information

Aerodrome Location	Emoyeni Airfield	
Aerodrome Co-ordinates	S29°44'50.52", E030°33'0.46"	
Aerodrome Elevation	2 340ft	
Runway Designations	15/33	02/20
Runway Dimensions	600m	500m
Runway Used	15	
Runway Surface	Grass	
Approach Facilities	None	

1.11 Flight Recorders

1.11.1 The aircraft was not equipped with a flight data recorder or cockpit voice recorder. Neither recorder was required by the relevant aviation regulations.

1.12 Wreckage and Impact Information

1.12.1 The aircraft crashed on the grass beyond runway 15 a few metres before the perimeter fence.

1.12.2 The aircraft struck the ground with the nose wheel first in a nose-down attitude.

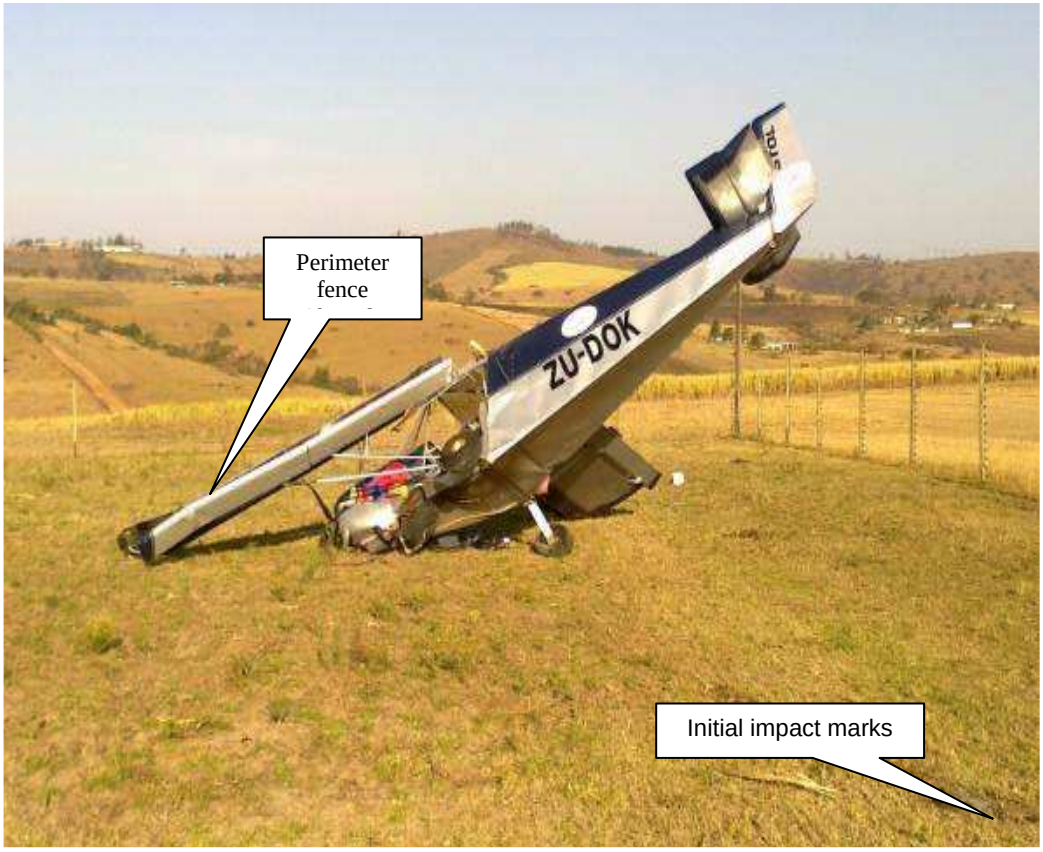

Figure 2: The aircraft came to rest and suffered severe damage.

1.12.3 The aircraft struck the ground with the nose gear first. The right main landing gear then collapsed and the aircraft bounced.

1.12.4 During the second contact with the ground, the nose wheel collapsed to the left and the aircraft lost momentum. The impact damaged the propeller blades, nose section and wings.

1.12.5 The wreckage was localised and largely intact.

1.13 Medical and Pathological Information

1.13.1 The pilot and passenger did not require medical attention and evacuated the aircraft unassisted.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The aircraft was equipped with a standard shoulder harness and low body straps for both the pilot and passenger seat. These had been used by the occupants and had helped to ensure they escaped unscathed.

1.16 Tests and Research

1.16.1 Engine Inspection

A maintenance-approved person inspected the aircraft after the accident. His observations were as follows:

(i) The fuel pipelines were routed next to the hot section of the engine without proper insulation.

(ii) The fuel system was not fitted with a fuel return line to help prevent fuel vapour lock form occurring.

(iii) The fuel system pipe lines did not have fuel restriction.

1.16.2 Test

(i) The engine underwent a propeller strike inspection for further investigation in accordance with the procedure in the 900 Series Rotax Maintenance Manual, 72-00-00, p24 (dated October 2010).

(ii) There were no defects found on the engine components that could have contributed to loss of engine power. After the propeller shock load inspection and tests, the engine was declared serviceable.

1.16.3 Research

Reference: Rotax Operator's Manual 912 LSU, Chapter 7(7.2) Fuel System

Figure 3 *below shows the flow of fuel from fuel tank (1) via a coarse filter (2) the fire cock (3) and fine filter (4) to the mechanical fuel pump (5). From the pump, fuel passes on via the fuel manifold (6) to the two carburettors.*

The return-line diverts fuel flows back to the fuel tank and suction side of the fuel system.

NOTE: The return line serves to avoid formation of vapour lock.

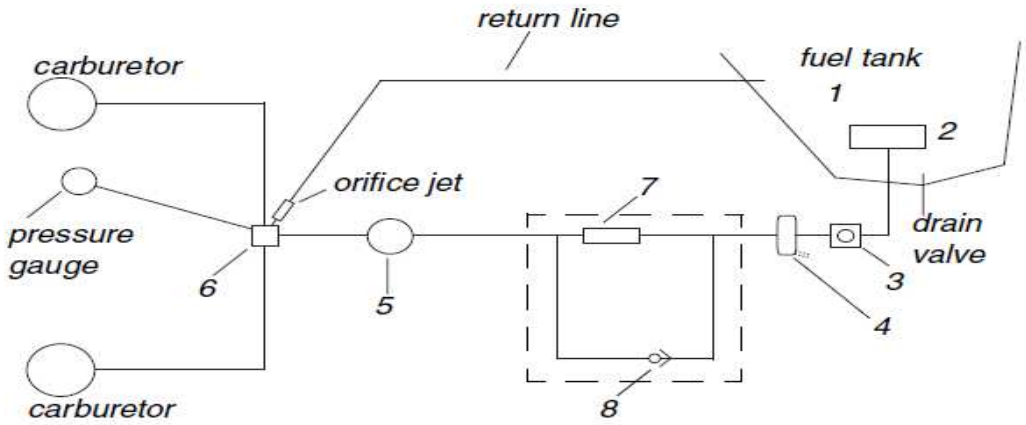

Figure 3: Shows the fuel system diagram.

1.17 Organisational and Management Information

1.17.1 This was a private flight.

1.17.2 The APs who maintained the aircraft were approved by RAASA.

1.18 Additional Information

1.18.1 Heat builds up readily in small engine compartments due to insufficient air-cooling. The engine compartment of the Zenith CH 701 is small and subject to this problem. The picture below shows the fuel line routing of this aircraft.

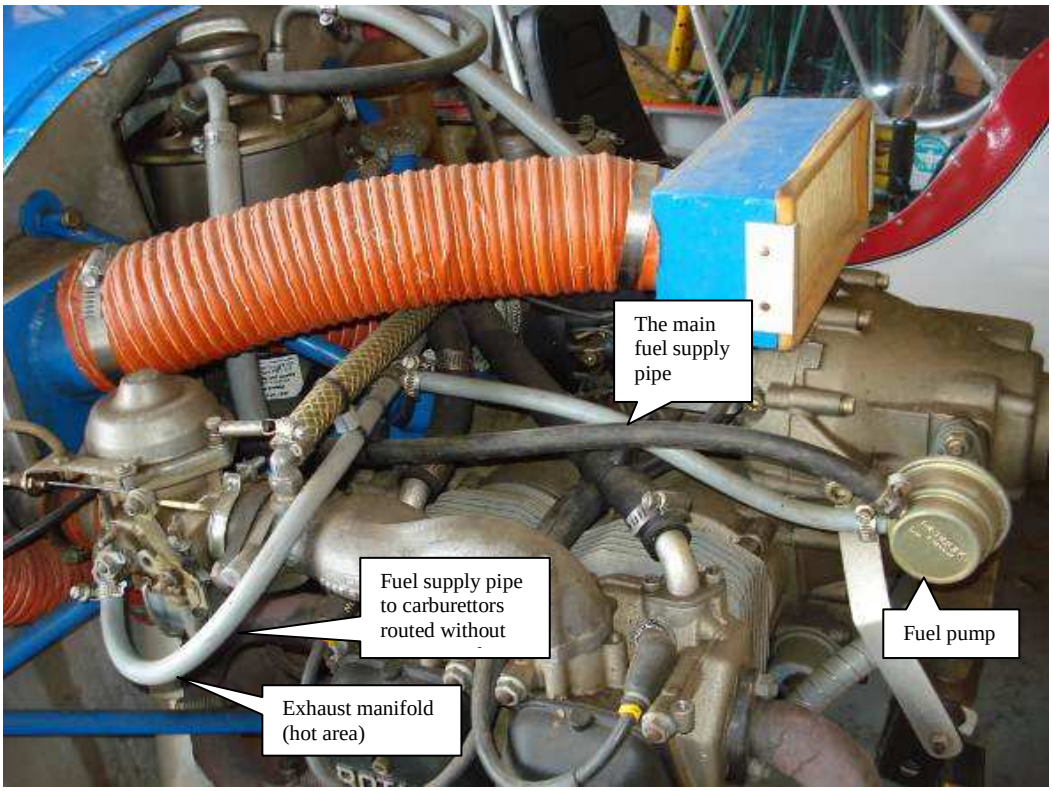

Figure 4: The routing of the fuel lines in the engine compartment.

1.18.2 Engine running rough

Reference: Rotax 912 Series, Aircraft Engine M M, Chapter 05-50-00, p5 Rev. 3, October 1/2005

May be caused by the failure of the ignition system, or a fault in the carburettor may be the reason (fuel supply, contamination in float chamber or float needle valve, float chamber venting, false air intake due to defective carburettor flange, engine temperature too low, too lean carburettor jetting due to conditions prevailing in intake silencer).

According to the Rotax Operator's Manual, one of the causes for rough running is a false fuel-air mixture. This occurs when the fuel pipelines are subjected to high temperature without proper insulation. The heat causes fuel to vaporise, affecting the balance of the fuel-air mixture.

1.18.3 Vapour lock

Information extracted from: BP fuel news ISSUED SUPERSEDES: February 7, 2002 PET0206, February 14, 2000 Page: 1 of 2

VAPOUR LOCK IS A SYMPTOM OF EXCESSIVE VAPOUR FORMATION

Power loss, rough running, stalling and difficult starting when the engine is hot can result from excessive vapour formation in your engine's fuel system. In extreme cases the car just stops. The cause is evaporation of some of the more volatile components of the fuell. Bubbles of vapour from in the fuel system can prevent the easy flow of fuel. This is called vapour lock. The engine will stop because it is not receiving enough fuel. It will not restart until cooled and the fuel can flow again. Opening the bonnet or pouring water over the fuel pump to cool the fuel can sometimes assist in overcoming the vapour lock.

Aircraft design is an important factor; some models will be affected while others are not. Fuel formulation is also important; some fuels will start to vaporize readily while others do not. A third major factor is ambient temperature; fuel will vaporize more readily on a hot day than on a cool day.

1.19 Useful or Effective Investigation Techniques

1.19.1. None

2. ANALYSIS

2.1 On the day of the accident, the pilot completed five circuits and full-stop landings prior to the accident flight. On completion of each circuit, the aircraft was given enough time to cool down during each stop. This helped to cool down the fuel temperature in the fuel lines, which were routed next to the hot exhaust manifold.

2.2 After the final circuit before the accident flight, the aircraft was allowed to cool for only10 minutes before being started again. Because of this, the 10-minute delay at the holding point, and the fact that the ambient temperature was 24ºC, the fuel in the pipe lines increased in temperature and remained so for an extended period, causing the fuel to vaporise.

2.3 The pilot reported that while the aircraft was climbing, the engine started running rough and then lost power completely. The vaporised fuel had brought about an imbalance of the fuel-air mixture in the intake, causing the engine to run rough. Because of the considerable heat in the fuel lines, even more fuel vaporised, forming a vapour lock, which caused the engine to lose power completely and stop.

2.4 If the fuel return line had been fitted, it would have reduced the chance of vapour lock formation. Vaporised fuel is extracted from the fuel line and routed back to the main fuel tank to be changed into liquid.

3. CONCLUSION

3.1 Findings

3.1.1 The pilot did not have the aircraft type endorsed on his licence.

3.1.2 The pilot was flying with a passenger on board at the time of the accident.

3.1.3 The aircraft had a valid certificate of authority to fly, which was obtained in compliance with existing regulations.

3.1.4 Not all SIs and SBs published by Rotax were complied with.

3.1.5 The aircraft is a home-built type.

3.1.6 There was no vapour return line fitted to the fuel system, as specified by Rotax Operator's Manual 912 LSU, Chapter 7(7, 2) Fuel System.

3.2 Probable Cause/s

3.2.1 Unsuccessful forced landing following loss of engine power during take-off.

3.3 Contributory Factor/s

3.3.1 A fuel vapour lock.

3.3.2 No fuel return line fitted.

4. SAFETY RECOMMENDATIONS

4.1 None

5. APPENDICES

5.1 Appendix A: Certificate of release to service of the engine

Appendix A

Certificate of release to service of the engine

ROTEC AIR cc

ROTAX AIRCRAFT ENGINES

Tel.: (016) 428-2955 / Fax: 086 736 3143 Email: gideonrotax@telkomsa.net P.O Box 28482 Sonlandpark 1944
CK / CC: 2005/029263/23 VAT REG NR: 4450220652

Certificate of Release to Service

Rotax Engine Serial Number: 5643045

Engine Type: 912 ULS

Aircraft Make: SKY JEEP 701.

Aircraft Reg: ZU-DOK

Aircraft Owner: HANS DE BEER

Crankshaft runout check after propstike:

I hereby certify that I am satisfied that the above-mentioned engine are in every way serviceable for fligh.

Signed by:

AERO CLUB OF S.A. Approved Person 190 APPROVED PERSON SCHEME

Date: 30/5/2013

AMO/AP Stamp:

10 Karnelian, Avenue, Waldrif, Vereeniging 1939 Cell: 083 371 0091