AIRCRAFT ACCIDENT SHORT REPORT

CA18/2/3/9768: ZU-INH: During a low-level aerial flight in the Kruger National Park the engine stopped, and the pilot executed a forced landing.

Date and time	:	9 February 2019 at 1230Z
Aircraft registration	:	ZU-INH
Aircraft manufacturer and model	:	Aeroprakt Ltd, A22-LS
Last point of departure	:	Satara Aerodrome, Kruger National Park
Next point of intended landing	:	Satara Aerodrome, Kruger National Park
Location of accident site with reference to easily defined geographical points (GPS readings if possible)		Kingfisherspruit Section, Kruger National Park GPS position: 24˚ 58' 060" South 031˚ 59' 171" East, elevation 846ft AMSL
Meteorological information	:	Wind: Light and variable; Temperature: 31˚C; Visibility: CAVOK
Type of operation	:	Private (Part 94)
Persons on board	:	1
Injuries	:	Minor
Damage to aircraft	:	Substantial

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 (2011), this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and **not to apportion blame or liability.***

Disclaimer:

This report is produced without prejudice to the rights of the South African Civil Aviation Authority (SACAA), which are reserved.

1. SYNOPSIS

1.1 On Saturday 9 February 2019, a micro-light aircraft with registration ZU-INH was involved in an accident in the Kruger National Park (KNP). The pilot stated that he was airborne for approximately one hour providing aerial support to ground teams during an anti-poaching operation when the engine stopped. The aircraft was being flown at low-level and, following an engine stoppage, the pilot executed a forced landing in a bush-type terrain. Shortly after touchdown, the aircraft nosed over and came to rest in an inverted attitude.

1.2 The pilot sustained several lacerations to his head when the aircraft nosed over during the forced landing. He was taken to a private hospital in Nelspruit by helicopter where he was treated and discharged later the same day.

1.3 The investigation determined that the pilot was unable to perform a successful forced landing after an engine stoppage in-flight.

2. FACTUAL INFORMATION

2.1 History of flight

2.1.1 On Saturday morning, 9 February 2019 at 0420Z, the pilot took off from Satara Camp in the Kruger National Park (KNP) in a microlight aircraft with registration marking ZU-INH. He stated that he was airborne for two and half hours after assisting ground teams with an aerial search for the carcass of a poached rhino in the Houtboschrand Section.

2.1.2 The pilot stated that after landing back at the Satara Camp Aerodrome, he refuelled the aircraft with 25 litres of Mogas RON 95 unleaded fuel. He stated that the left-wing tank had a total capacity of 57 litres and was almost 100% full. The right-wing tank had a capacity of 57 litres and was approximately 5 litres less from being full. The pilot further stated that there were approximately 105 litres of fuel on-board the aircraft and the total fuel capacity of the aircraft was 114 litres. The fuel consumption of the engine was approximately 15 litres per hour.

2.1.3 At approximately 1000Z, the pilot received a call from the Kingfisherspruit Section Ranger informing him that they were following fresh tracks of possible poachers and his assistance was required. He took-off at 1019Z from the Satara Camp Aerodrome, where the micro-light aircraft was hangared, and joined overhead the ground team several minutes later.

2.1.4 The pilot stated that he was flying a pattern where he alternated between left and right turns at the end of each leg, which was between 3 and 4 kilometres long. During one of these legs, while flying at a height of approximately 150ft (46m) above ground level (AGL), he felt the engine RPM starting to decay and the propeller pitch changed. He then *"worked the throttle forward and backwards, which caused absolutely no response."* Approximately 3 to 4 seconds later, the engine stopped. The pilot stated that he attempted an engine restart without success.

2.1.5 From this point on, the pilot focused outside in an attempt to find a place where he could execute a forced landing. He stated that the area straight ahead of him was densely vegetated with high trees. The area 45˚ to his left appeared to be slightly more open, and he turned in that direction and lined up the aircraft; he called Mayday three times. He stated that he brought the speed down to almost stall speed before touching down. Approximately 5 to 10 metres after touchdown, the nose wheel dug into the soft soil and the aircraft nosed over, coming to rest in an inverted attitude.

2.1.6 After the aircraft had come to rest, the pilot was hanging upside down, still restrained by the four-point safety harness. He could feel that he had hit his head quite hard as his head was bleeding. He managed to undo his safety harness; forced open the left door; and crawled out of the cockpit. He then returned briefly to the aircraft to ensure that the ignition and magnetos were switched off and the key was still in the ignition.

2.1.7 A helicopter that was also used in the operation landed near the accident site, and one of the passengers (a dog handler) got out and assisted the pilot with basic first aid. He washed the blood off his head with bottled water and wrapped it with bandages, which he obtained from the helicopter first aid kit, to stop the bleeding. Additional resources were requested, and another helicopter flew to the scene from Skukuza Camp with a medical doctor on-board. The doctor assessed the pilot on the scene and decided that he had to be taken to a hospital in Nelspruit where the lacerations to his head were stitched and the pilot underwent an X-ray examination for any possible neck injuries. He was discharged from hospital later the same day.

2.1.8 The accident occurred during daylight at a geographical position that was determined to be 24˚ 58’ 06.47” South 031˚ 59’ 17.87” East at an elevation of 846ft above mean sea level (AMSL).

Figure 1: The aircraft as it came to rest in an inverted position.

Figure 2: The nose gear could be seen bent backwards

Figure 3: Front view of the aircraft

2.1.9 Investigation

After the accident, the wreckage was inspected on-site by three aircraft maintenance engineers (AMEs) from two different aircraft maintenance organisations (AMOs). According to a report that was made available to the investigating authority by one of the AMOs, they had visually inspected the airframe, fuel system and the engine after the aircraft was placed in an upright position on the scene. It was noted that both fuel shut-off valves were closed (one for each wing tank), this was done by one of the helicopter pilots who landed at the scene. There was no fuel in the wing fuel tanks as the aircraft was lying in an inverted attitude for four days prior to recovery. The fuel vents on this aircraft are located within the fuel caps, therefore, with the aircraft in an inverted attitude, the fuel would run out. First responders to the accident site stated that there was a strong smell of fuel at the scene as there should have been approximately 90 litres of fuel still in the two tanks at the time of the accident.

The two carburettor bowls were removed at the scene, each contained a very small amount of fuel which was clean. The colour of the fuel in the float chambers indicated Mogas RON 95 octane unleaded fuel, which was an approved fuel for the Rotax 912ULS engine. The airframe fuel filter, which was located behind the right front seat, was also inspected. It contained a very small amount of fuel which was clean.

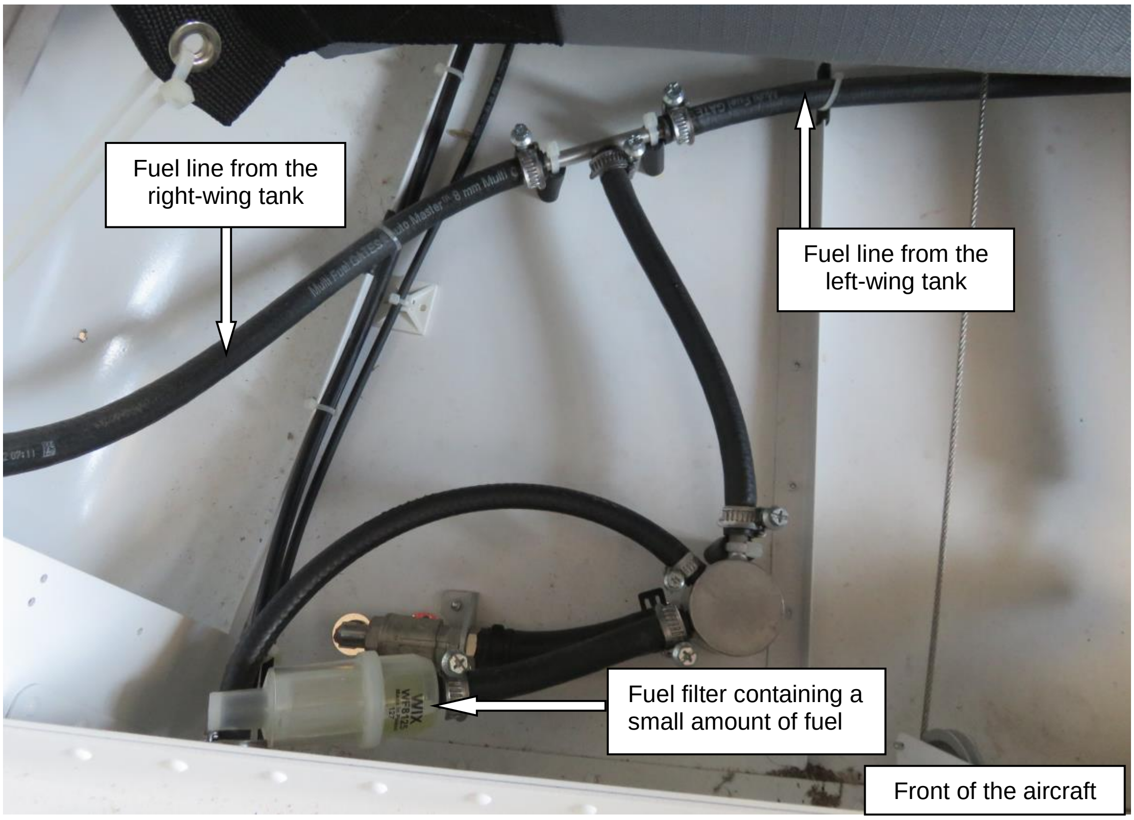


Figure 4: Fuel lines from the left- and right-wing tanks feeding under gravity into a T-fitting (this fuel plumbing is installed behind the two seats)

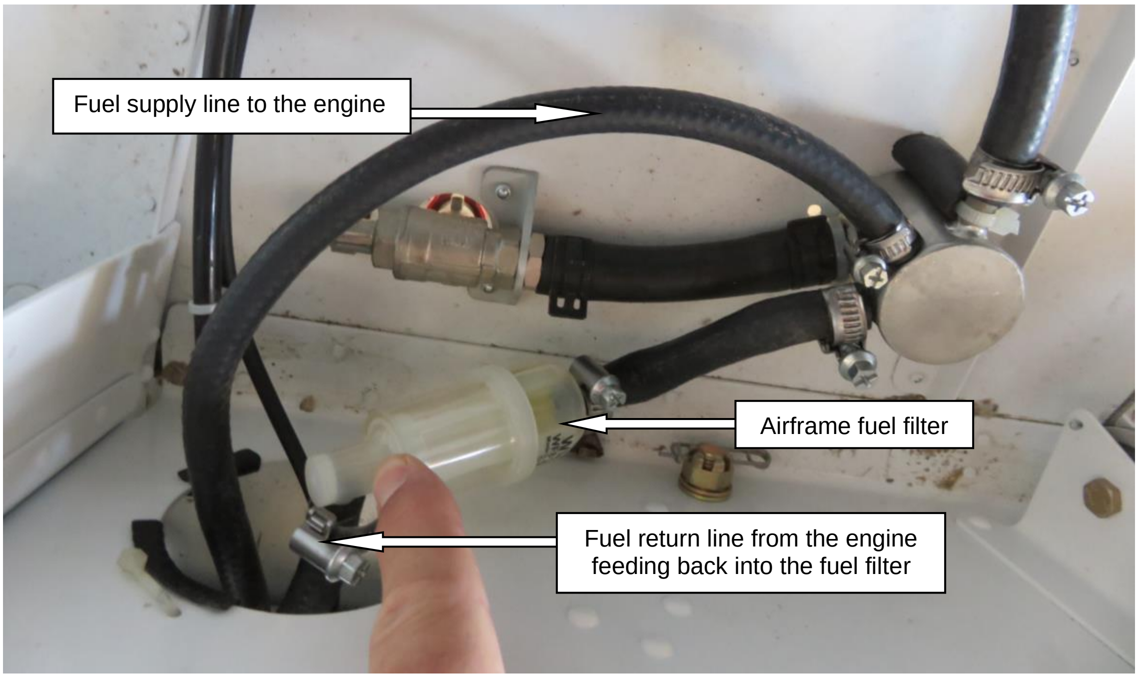


Figure 5: The airframe fuel filter located behind the right seat

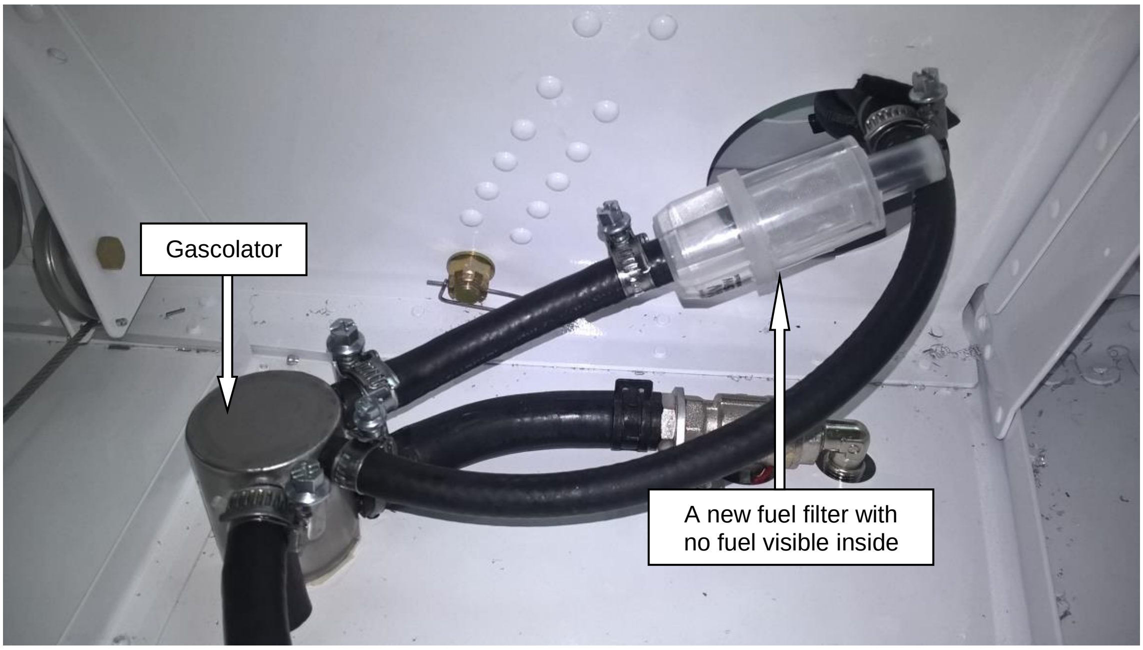


Figure 6: Fuel plumbing installation behind the right seat (photograph courtesy of Aeroprakt Ltd)

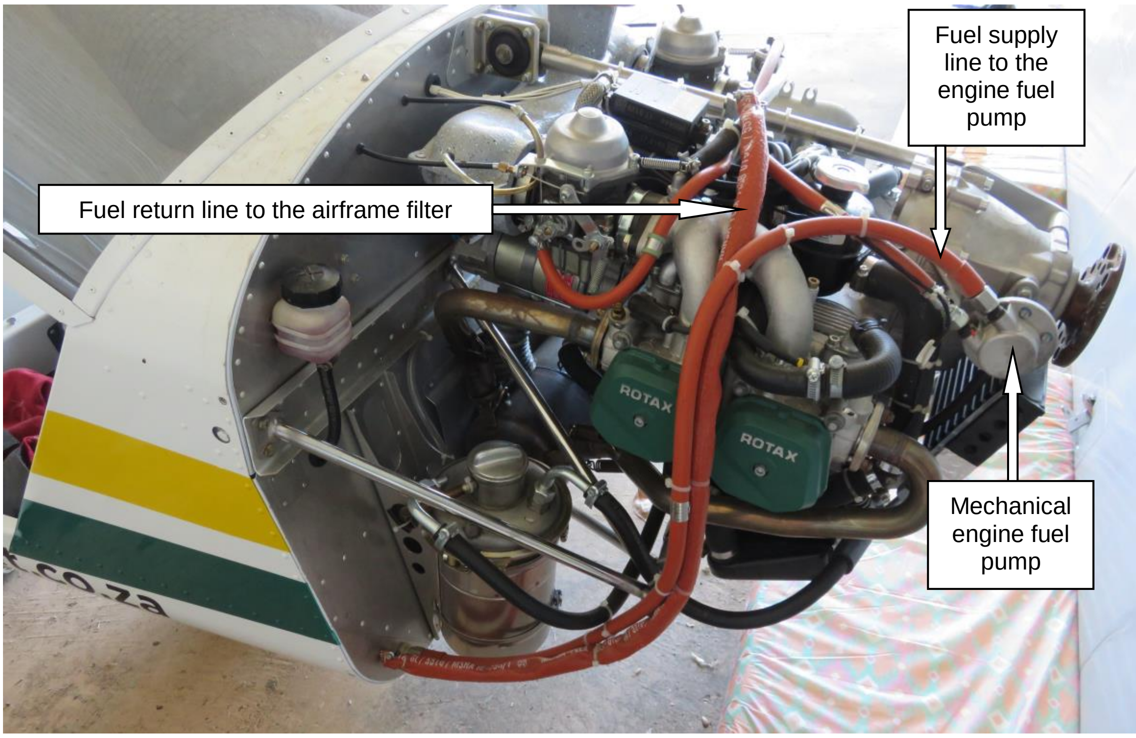


Figure 7: A view of the right side of the engine still within the airframe of ZU-INH

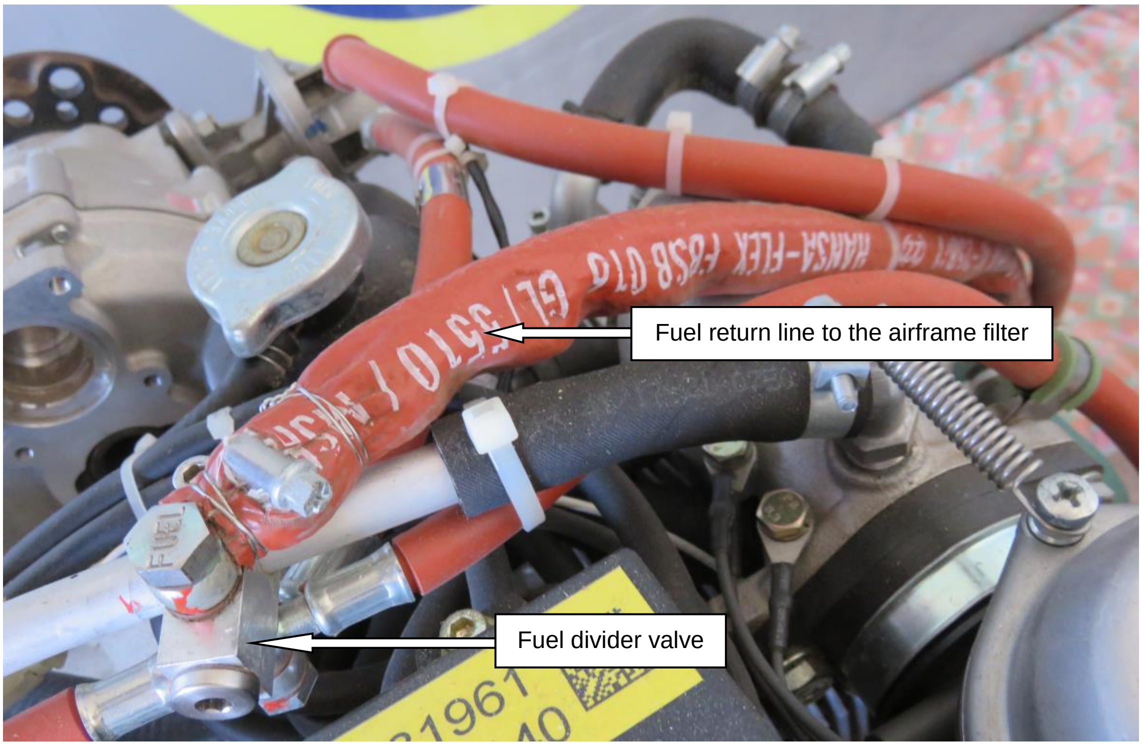


Figure 8: The fuel divider valve (spider valve) located on top of the engine (ZU-INH)

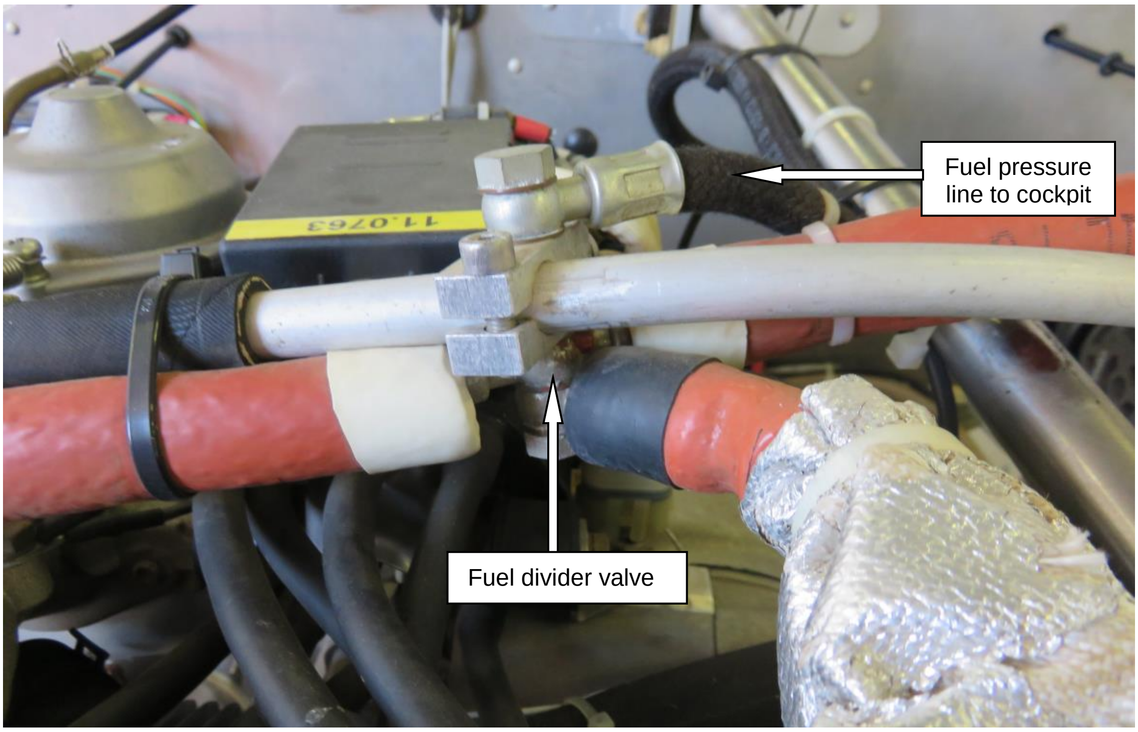


Figure 9: The fuel divider valve from another similar type of aircraft, with a fuel pressure line to the cockpit

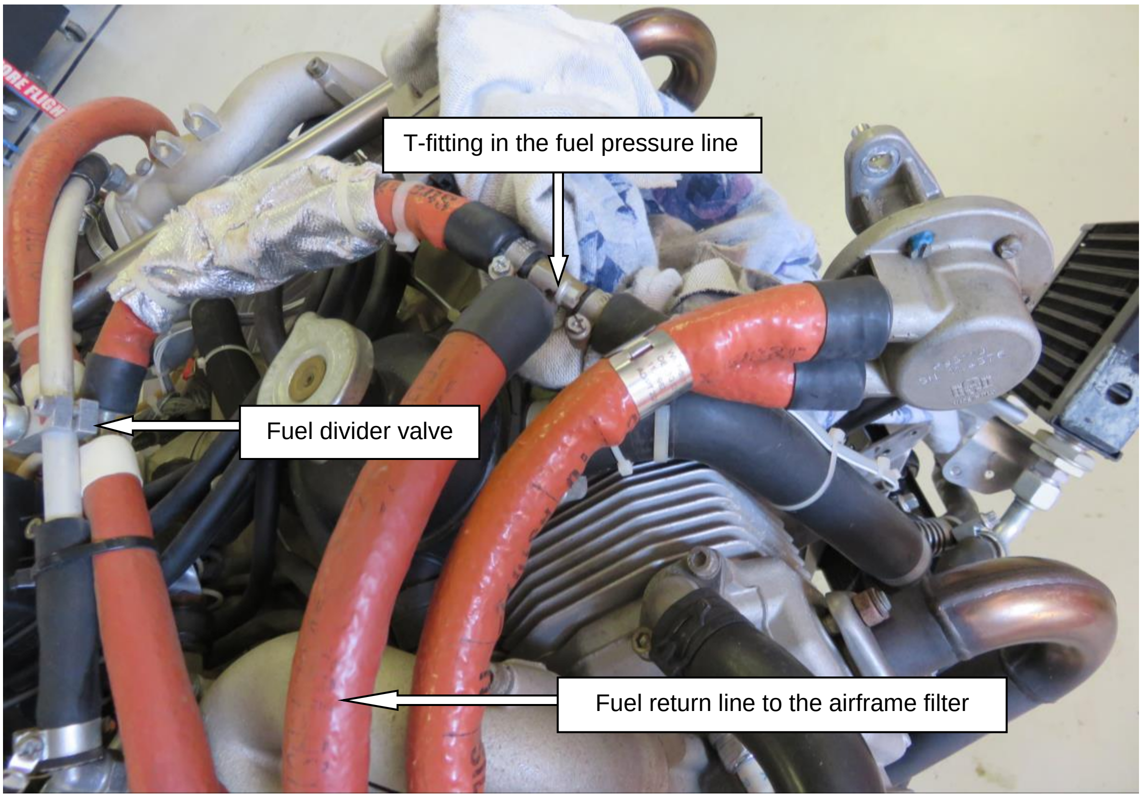


Figure 10: The fuel return line bleeding off from a T-fitting located within the fuel supply line from the engine driven fuel pump to the fuel divider valve (From a similar type of engine and aircraft)

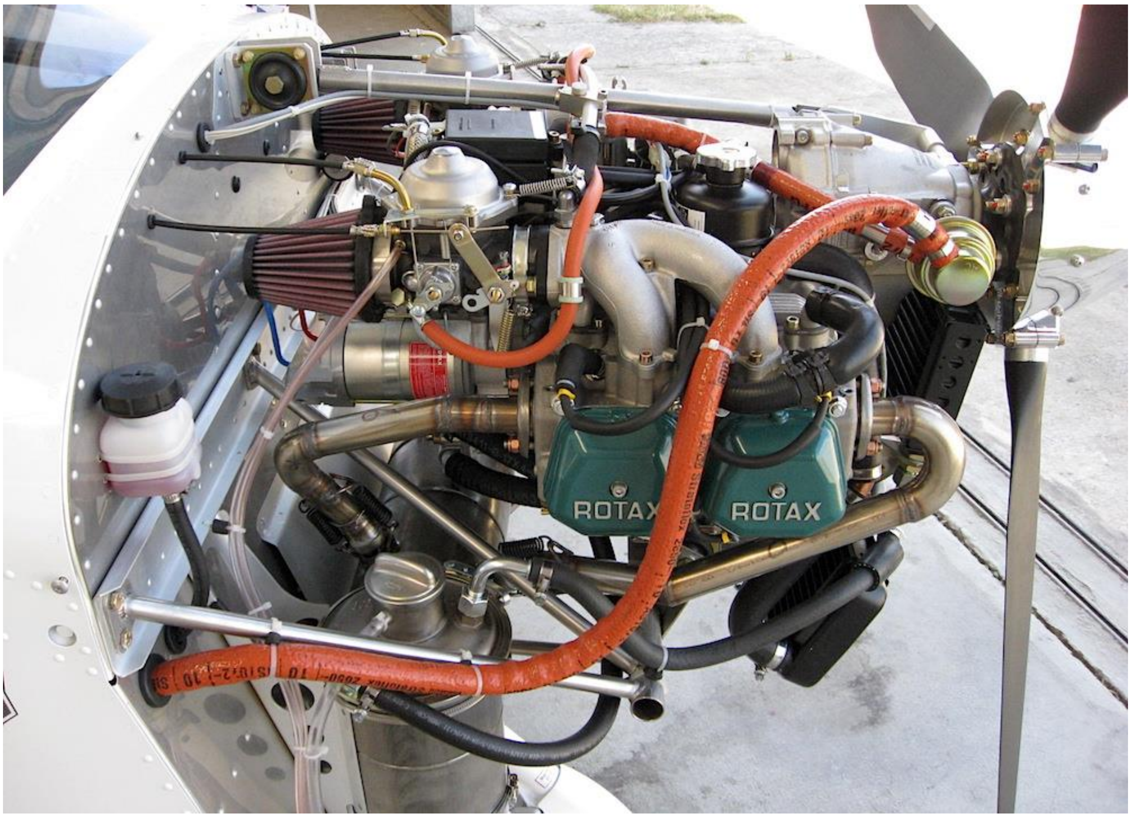


Figure 11: The same engine installed in the same aircraft type with no fuel return line (Courtesy of Foxbat Australia)

2.1.10 The three-bladed propeller revealed two broken composite blades with one blade intact. Once the wreckage was at the AMO facility, a loaner propeller was obtained, which was fitted to the propeller gearbox flange and an engine ground run was performed with the engine in the airframe (as recovered). The engine started and ran normally throughout the test run (from the video footage taken).

2.1.11 The airframe fuel system as described in the Pilot's Operating Handbook (POH) can be found attached to this report as Annexure A. The system description is very basic. The investigator had been in consultation with the aircraft manufacturer in Kiev, Ukraine, in order to obtain a more detailed airframe fuel system for this aircraft. Detailed drawings of the system were received, but no documented description was provided.

2.1.12 The engine fuel system was obtained from the Rotax website www.flyrotax.com and can be found attached to this report as Annexure B. An official request with regards to the engine fuel system was sent to the engine manufacturer via their website platform, however, by the time this report was concluded, no correspondence was received from them.

2.1.13 The engine fuel system as depicted in Annexure B indicate a fuel return line from the engine to the tank (item 13). During an inspection of the wreckage, it was noted that the aircraft manufacturer had opted to route the fuel return back to the airframe fuel filter as can be seen in Figure 5. Another aircraft of the same type, a 2012 model was inspected by the investigator, and the fuel return line (pipe) was found to also feed back to the airframe fuel filter, but the plumbing of this aircraft, as could be seen in Figures 9 and 10, differ to that of the accident aircraft which was a 2018 model. The 2012 model aircraft was also equipped with a fuel pressure gauge in the cockpit and had an auxiliary fuel pump (electrical) installed.

2.1.14 Information Safety Notice: Rotax 912 Series Fuel Return Line (Mandatory)

Source: https://www.rotax-owner.com/en/flightsafety/476-ai476

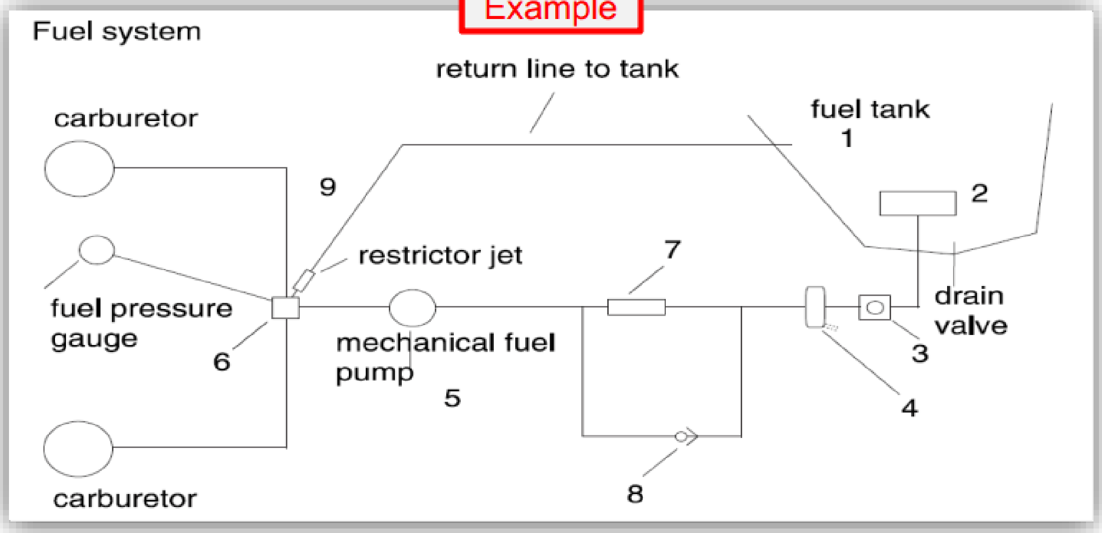
Incorporation of the **mandatory** fuel return line of Rotax Engine Type 912 (Series)

"The purpose of this information Safety Notice is to inform ROTAX operators and owners about the mandatory fuel return line that is required to be incorporated into the aircraft's fuel system design.
As per the ROTAX installation manual, a Mandatory "restricted" fuel return line is to be incorporated within the aircraft's fuel system. The purpose of the fuel return line is to help bleed off any vapours that may form within the fuel system that could cause vapour lock, resulting in a possible loss of engine power.

Please reference the latest ROTAX installation manual and check with the manufacturer of the aircraft to verify that a fuel return line has been incorporated within the design of the aircraft's fuel system. The latest Rotax Installation Manual can be found at www.FlyRotax.com or www.RotaxOwner.com

Return line	Via the return line (5) surplus fuel flows back to the fuel tank and suction side of fuel system.	
	NOTE:	The return line prevents malfunctions caused by the formation of vapor lock.

Example



Additional Information

What is this Information Safety Notice about and how does it affect aviators?

Field reports have indicated a potential for fuel vapour lock leading to loss of engine power or stoppage due to one or more of the following variables:

- ***Fuel system design***
- ***Engine cowling design***
- ***Fuel quality***
- ***Seasonal adjustment on fuel***
- ***High ambient temperatures***

Owners and operators need to consider all of the above and understand how they may contribute to fuel system vapour formation.

Fuel system design

Fuel system design is one factor in managing the formation of vapour in the fuel system due to heat soak. Fuel system components in close proximity to engine heat *sources should be adequately protected from heat soak. Fuel line routing, heat shielding, fire sleeve, etc. all influence fuel system temperatures.*

Engine cowling design

Engine cowling design is another factor, which can greatly influence heat soak on engine fuel system components. Tightly cowled engines can run much hotter under-cowl temperatures than more open cowl designs during certain conditions such as taxiing and climb.

Owners and operators need to understand their aircraft's temperature limitations and respect them. Rotax defines maximum engine component operational temperatures in the respective engine installation manual.

Fuel quality

Fuel quality can have a large influence on the formation of vapour. Inadequate storage, handling and contamination can all affect fuel quality. Always respect the minimum fuel requirements as outlined by Rotax, maintain good storage practices and source the best quality fuel possible.

Seasonal adjustments

Seasonal adjustment of fuel by manufacturers for high summer temperatures and low winter temperatures may affect the fuel vaporisation rates. This can have consequences when using winter grade fuel in hot summer months. ***Always use seasonally correct fuel.***

High ambient temperatures

High outside ambient temperatures may increase under-cowl operating temperatures and, therefore, increase the fuel system heat soak. Owners and operators may need to adjust performance expectations when operating in such conditions.

Conclusion

In consideration of the above variables, Rotax has updated the engine installation manual to mandate the use of a fuel return line. Such a design helps to vent off the formation of fuel vapours, increasing the safety margin. Owners and operators are urged to consider all the aforementioned and review their fuel system design with their respective aircraft manufacturers."

2.1.15 In Annexure C, which is attached to this report, the engine manufacturer had issued several warnings under the sub-heading *Safety Information*, with reference to the utilisation of this engine. These warnings, which are highlighted in red, state that *"Non-compliance can result in serious injuries or death".*

2.1.16 A placard on the instrument panel of the accident aircraft states the following:

WARNING
AMATEUR BUILT AIRCRAFT
This aircraft is not required to comply with all the regulations for type certified aircraft.
To be operated for sport and recreational purposes only.
You fly in this aircraft at your own risk

3. Findings

3.1 The pilot held a private pilot licence (PPL) that was initially issued to him on 29 June 2006 and valid until 30 September 2019. The aircraft type was endorsed on his licence.

3.2 The pilot held an aviation medical certificate (Class 2) that was issued by a designated aviation medical examiner on 3 July 2018 with an expiry date of 31 July 2019.

3.3 The pilot had conducted his conversion onto the Aeroprakt A22 type aircraft on 14 June 2016.

3.4 The pilot had accumulated a total of 2 577.7 flying hours of which 147.2 hours were on the micro-light aircraft type. He had flown 84.7 hours on type during the past 90 days prior to the accident.

3.5 The pilot suffered several lacerations to his head and was examined on site by a medical doctor based at the Skukuza Camp in the KNP. He was then flown to a private hospital in Nelspruit by helicopter where the lacerations to his head were stitched and an X-ray of his neck was taken. He was discharged from hospital later the same day.

3.6 The aircraft was registered on the South African Register in the Non-Type Certified Aircraft (NTCA) category.

3.7 This was a private flight conducted under the provisions of Part 94 (Non-Type Certified Aircraft) of the CAR 2011.

3.8 The aircraft was issued with a certificate of release to service on 14 January 2019 with an expiry date of 8 October 2019 or 201.8 airframe hours, whichever comes first.

3.9 The aircraft was issued with an authority to fly on 9 October 2018 with an expiry date of 8 October 2019.

3.10 The last maintenance inspection prior to the accident flight was carried out on 14 January 2019 at 101.8 airframe hours. Since the inspection was certified, a further 40.3 hours were flown.

3.11 The aircraft was airborne for about one hour, and approximately 90 litres of fuel remained in the fuel tanks at the time of the accident, which drained from the wing tanks as the aircraft nosed over, coming to rest in an inverted attitude. The aircraft remained in an inverted attitude and was only recovered four days after the accident.

3.12 According to the engine manufacturer, the correct grade of fuel was used—MOGAS RON 95 Octane—during this flight. The average fuel consumption was 15 litres per hour.

3.13 After recovery of the aircraft to an AMO, a loaner propeller was fitted to the engine and an engine ground run was performed with the engine in the airframe. No abnormalities were noted; the engine ran normally.

3.14 There was no fuel pressure gauge installed on this aircraft, nor was the aircraft equipped with an electrical auxiliary fuel pump as recommended by the engine manufacturer.

3.15 The fuel return line (airframe fuel system) was installed on the accident aircraft but did not route back to the fuel tank (suction side of the fuel system) as discussed in sub-paragraph 2.1.14 of this report and also as per the official Rotax fuel system as contained in the Installation Manual (Annexure B). Instead, it was connected to the airframe fuel filter as depicted in Figure 5.

3.16 The primary purpose of the fuel return line, according to the engine manufacturer, serves to avoid the formation of fuel vapour in the system.

3.17 The engine manufacturer issued very specific guidance material as per the Installation Manual (see Annexure B) on the requirement of the fuel return line and what routing it should follow (needed to route back to the fuel suction system, that is, the fuel tank of the aircraft). The aircraft was fitted with a fuel return line, but the plumbing was found not to follow the requirements as set out by the engine manufacturer, but instead the fuel return line connected to a filter as illustrated in this report.

3.18 In Figures 7, 10 and 11 in this report, the same type of engine was installed in the same type of aircraft but different airframes. Neither of these three engine installations were consistent with one another, especially with regards to the fuel return line.

3.19 The aircraft was equipped with a Stratos Magnum 601 ballistic parachute which was factory fitted. The pilot did not deploy the device as he was flying too low (approximately 150 ft AGL) at the time. The minimum safe deployment altitude for this device is 590ft (180m) AGL during level flight, according to the manufacturer's website: www.stratos07.cz

3.20 The airframe structure sustained substantial damage during the accident sequence.

3.21 The pilot reported that the wind was light and variable, and the temperature was 31˚C at the time of the accident.

4. Probable cause

4.1 The aircraft engine stopped during flight and the pilot conducted an emergency landing. During landing, the aircraft nose-dived and came to rest in an inverted position. The cause of engine stoppage could not be determined.

5. Contributory factors

5.1 Design deviation

The airframe fuel system, specifically the plumbing, with regards to the fuel return line on this aircraft was found to differ from the guidance provided by the engine manufacturer as contained in the Rotax 912 Series Installation Manual, Edition 2. The fuel return line should feed back to the fuel tank suction side of the airframe fuel system, which was not the case.

5.2 Engine cooling

The effect of adequate engine cooling while flying in conditions associated with high ambient temperature could have played a role in this flight. The Rotax Installation Manual states that vapour lock should be avoided by ensuring the temperature of the fuel lines are kept below 45˚C (114˚F). The fuel line from the airframe to the mechanical fuel pump is critical.

6. References used in the report

6.1 The AMO that inspected and recovered the aircraft from the accident site compiled a technical report on their findings, which was made available to the investigating authority.

6.2 Information and photographs were obtained from the aircraft owner, the AMO which recovered the wreckage, as well as the Aeroprakt aircraft agents in South Africa.

6.3 The aircraft manufacturer, Aeroprakt Ltd, based in Kiev, Ukraine, was consulted on the airframe fuel system and the ballistic parachute.

6.4 Information on the engine fuel system was obtained from the Internet at: https://www.flyrotax.com/services/technical-documentation.html (Official Rotax engine website).

6.5 Information was also source from Foxbat, Australia (Pty) Ltd

6.6 Information was also source from the Rotax engine agents in South Africa, (Comet Aviation Supplies)

6.7 SACAA pilot questionnaire (form: CA 12-03).

7. Safety Recommendation

7.1 None

8. Organisation

8.1 This was a private flight, which was operated under the provisions of Part 94 of the Civil Aviation Regulations of 2011 as amended.

9. Safety Actions

9.1 It is recommended that all Aeroprakt A22LS aircraft registered in South Africa be equipped with a (i) fuel pressure gauge as well as (ii) an electrical auxiliary fuel pump as standard equipment. The Rotax Installation Manual extract attached as Annexure B emphasise that these requirements should be met.

This will allow the pilot(s) with a cockpit indication whereby he or she can monitor the fuel pressure during flight and, should it decay or start fluctuating, the electrical auxiliary fuel pump can be switched on to ensure a positive fuel flow is restored to the engine-driven fuel pump.

9.2 The fuel return line from the engine to the airframe should meet the prescribed guidelines as called for by the Rotax Information Safety Notice: 912 Series Fuel Return Line (Mandatory) whereby the fuel return line should root back to the fuel tank(s), which would include the fuel suction system.

9.3 It is recommended that the aircraft manufacturer considers a retrofit whereby a header fuel tank is installed within the fuel system; similar to what is found in certain Cessna model aircraft that are equipped with reciprocating engines.

9.4 It is recommended that should the operator (South African National Parks) consider to re-introduce this aircraft type back into its fleet, it should consider flying the aircraft on Avgas fuel, especially during the warmer summer months. Avgas is an approved fuel for this engine type. This should be conducted in consultation with the engine and aircraft manufacturer.

9.5 It is recommended that pilots fly with a flying helmet and fire-protective gear on at all times in the interest of safety and the protection of human lives.

10. Appendices

10.1 Annexure A (Airframe fuel system as described in the POH)
10.2 Annexure B (Rotax 912 Fuel System, BRP-Powertrain Installation Manual)
10.3 Annexure C (Safety Information, Engine operation, www.flyrotax.com)

This report is issued by:
Accident and Incident Investigation Division (AIID)
South African Civil Aviation Authority
Republic of South Africa

8.6 Fuel system

The fuel system (see **Fig. 3**) includes two wing fuel tanks 1 (each 45 l capacity, 57 l fuel tanks are optional) with filler inlets 2 and fuel lines 9 connecting the tanks to each other and to the engine fuel pump 6 (that is feeding fuel to the engine carburetors 10) via two fuel valves 3, mud box 11 and fuel filter 5. Fuel can be drained from the tanks using the drain valve 4. The fuel tanks are connected with the atmosphere via the vent lines 8 in inlet covers 2.

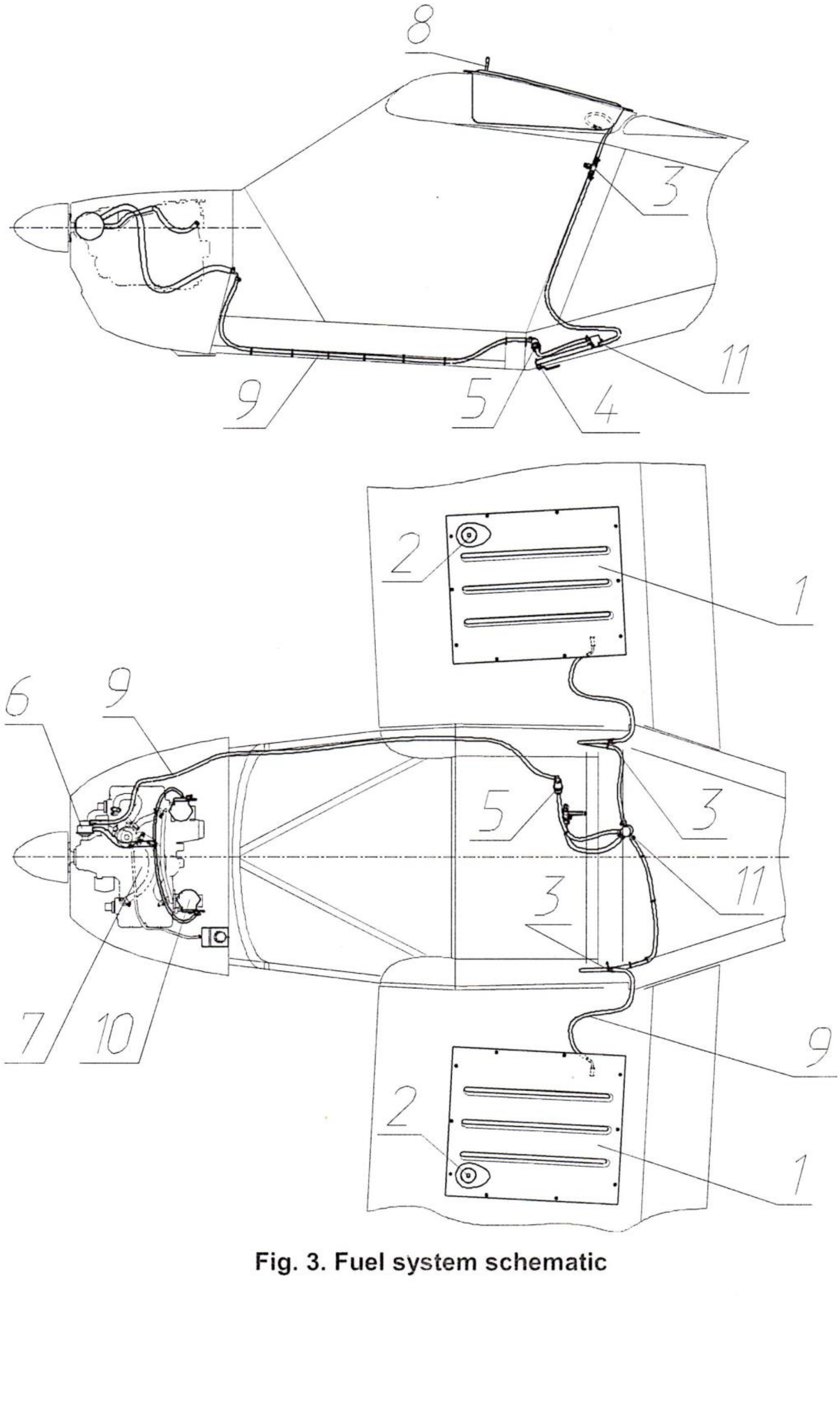


Fig. 3. Fuel system schematic

- NOTE: When both tanks are full, fuel may flow from one tank to the other (e.g. due to the lateral forces during side slipping or when wings are not level on parking or during taxiing), overfill it and spill out through the vent line. To prevent this close one of the fuel valves.

CAUTION! At all times during the flight ensure fuel coming to the engine by opening the valve(s) of the tank(s) WITH fuel. If one of the tanks is empty, close its valve to prevent air getting into the fuel line and causing engine malfunction or even failure.

Capacity of tanks: 2×45 l (2x11.9 US gal)
Total fuel capacity: 90 l (23.8 US gal)
Total usable fuel: 89 l (23.5 US gal)
Non-usable fuel: 1 l (0.3 US gal)
Fuel: unleaded avgas with RON 95 or above

ANNEXURE B

1) Fuel system

1.1) Description of system

General note

See Fig. 2.

NOTE: The fuel system from tank to the inlet of engine-driven fuel pump has to be installed by the aircraft manufacturer.

Fuel

The fuel flows from the tank (1) via a coarse filter and fire cock (3) continue to water trap/fine (4) to the mechanical fuel pump (5), from the pumps fuel passes on via the fuel manifold (6) to the two carburetors.

Fuel lines

Depending on the configuration of the engine the fuel lines from fuel pump to the carburetors are already installed by the manufacturer (optional on some engine).

Only the following connections per Fig. 2 have to be established:

- Feeding lines to suction side of the mechanical fuel pump (5).
- Lines from pressure side of the mechanical fuel pump to inlet of fuel manifold (6).
- Returnline from fuel pressure control to fuel tank.

Return line

Via the return line (5) surplus fuel flows back to the fuel tank and suction side of fuel system.

NOTE: The return line prevents malfunctions caused by the formation of vapor lock.

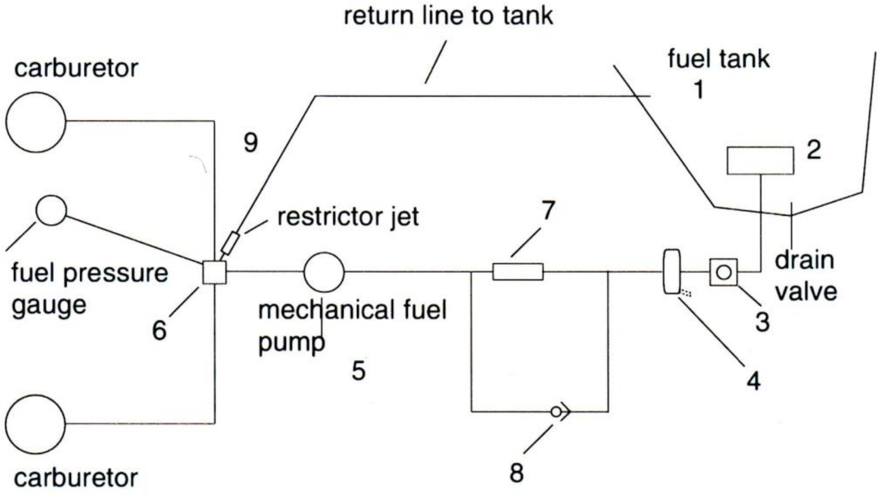
Components

The fuel system includes the following items:

- Tank
- Coarse filter
- Fine filter/water trap
- Fuel shut off valve
- Electrical fuel pump
- Manometer
- Return line from engine to tank (with integrated adapter sleeve)

as well as the required fuel lines and connections.

Graphic Fuel system



Part	Function
1	Fuel tank
2	Coarse filter
3	Fire cock
4	Fine filter/water trap
5	Mechanical fuel pump*
6	Fuel pressure control*
7	Electrical fuel pump
8	1x check valve
9	Return line from engine to tank (with integrated adapter sleeve)
	* Standard version

Fig. 2 07306

1.2) Operating limits

General note

NOTICE The design and layout of the entire fuel system must ensure engine operation within the specified operating limits.

See 912 Series Operators Manual, section 2.1) Operating Limits.

1.2.1) Fuel pressure

General note

See Fig. 3.

⚠WARNING Non-compliance can result in serious injuries or death! Fuel pressure in excess of stated limit can lead to an override of the float valve with subsequent engine stop.

NOTE: Readings of the fuel pressure are taken at the pressure gauge connection on the fuel distributor piece (standard for ROTAX 912 F and 912 S, optional for other series).

Operating limits

Fuel pressure:

Max.	0.4 bar (5.8 psi) (0.5 bar (7.26 psi))*
Min.	0.15 bar (2.2 psi)

* applicable only for fuel pump from S/N 11.0036.

Graphic

Fuel pressure

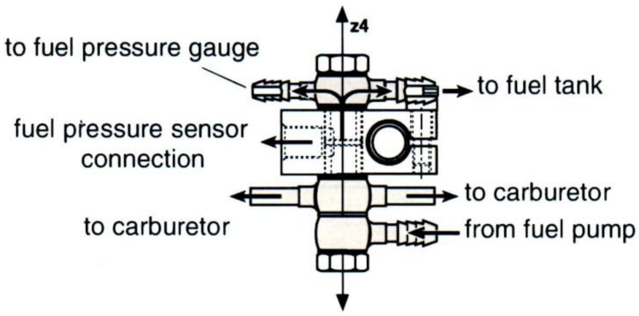


Fig. 3 09139

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1.2.2) Electrical fuel pump

General note

The engine manufacturer requests the use of an electrical auxiliary fuel pump.

The electrical auxiliary fuel pump is not just required in case of a malfunction or defect of the mechanical fuel pump, but also provides required fuel supply e.g. in case of vapour formation at high altitudes and temperatures.

Operating limits

NOTE: If an electrical auxiliary fuel pump is installed, the whole fuel system has to be designed to warrant engine operation within the specified pressure limits.

NOTICE The fuel pressure of an additional auxiliary fuel pump should not exceed 0.3 bar (4.4 psi).

1.3) Requirements of the fuel system

Delivery rate

Electric or mechanical fuel pump:

- Min. 35 l/h (8.2 US gal/h).

Fuel lines

See Fig. 2.

NOTICE Fuel lines have to be established to the latest requirements such as FAR or EASA by the aircraft manufacturer.

NOTICE For prevention of vapour locks, all the fuel lines on the suction side of the fuel pump have to be insulated against heat in the engine compartment and routed at distance from hot engine components, without kinks and protected appropriately.

At very critical conditions e.g. problems with vapour formation the fuel lines could be routed in a hose with cold air flow.

Secure fuel hoses with suitable screw clamps or by crimp connection.

Fuel return line

NOTICE The installation of a fuel return line is mandatory.
If the fuel distributor piece with regulator from ROTAX is not available, the fuel pressure must be regulated by a restriction in the fuel return line, which ensures that the fuel pressure is under all operating conditions within the operating limits specified by ROTAX.

Fuel filter

See Fig. 2.

Fuel filter	
Coarse filter	On fuel tank as per valid certification.
Fine filter	In the feed line from tank to the fuel pumps an additional fine filter with **meshsize** 0.1 mm (.004 in.) has to be provided. The filter has to be controllable for service. A combination of filter/water-trap (gascolator) is recommended.

Water trap

A suitable water trap must be installed at the lowest point of the fuel feed line.

Fuel temperature

To avoid vapour locks keep the temperature of the fuel lines, float chamber and related deviced below 45 °C (113 °F).

If you should encounter problems in this respect during the test period, than the affected components such as the supply line to the fuel pumps have to be cooled.

1.4) Connecting dimensions, location of joints and directives for installation

1.4.1) Fuel manifold

Return line

See Fig. 4.

Return line (1) to tank:

Outside dia.	7 mm (.28 in.)
Slip-on length	Max. 17 mm (.67 in.)

Pressure gauge

Pressure gauge connection (2):

Outside dia.	6 mm (.24 in.)
Slip-on length	Max. 17 mm (.67 in.)

Fuel pressure switch

Fuel pressure switch connection (3):

Thread	M10
Thread length	Max. 9 mm (.35 in.)
Tightening torque	15 Nm (135 in.lb) und LOCTITE 221

Banjo bolt

NOTICE At loosening or tightening of the banjo bolt (4) (tightening torque 10 Nm = 90 in.lb) support the fuel manifold appropriately.

Connection nipple

NOTE: The connection nipple (5) is furnished with an orifice (6) essential for operation of the fuel system.

If the pressure gauge connection (2) is not used and a hose nipple (7) installed, the banjo bolt assy. (4) marked with a color dot or marked "FUEL" is furnished with an orifice (8). This is essential for operation of the fuel system as it prevent a loss in fuel pressure.

Coordinates

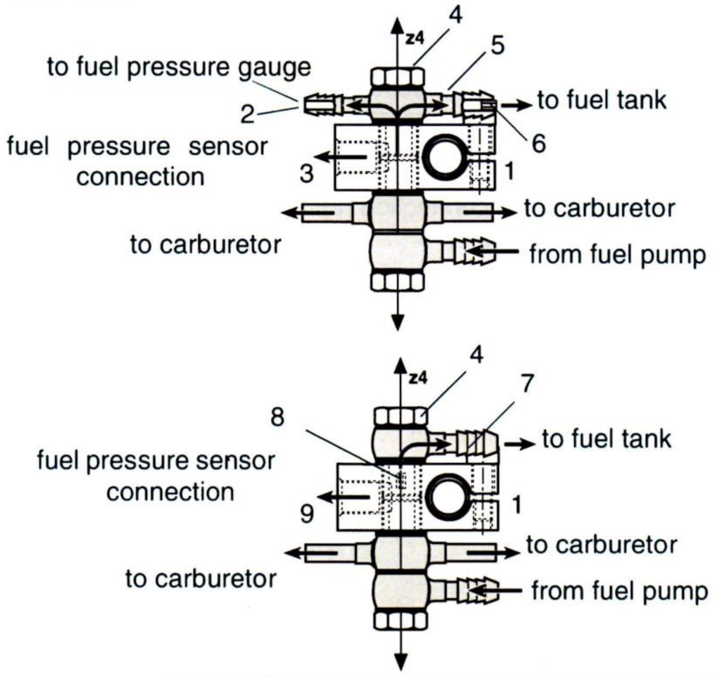
Position of z4 axis of the fuel manifold:

NOTE: Dimensions always from point of reference (P).

	Coordinates [mm]		
	x-axis	y-axis	z-axis
Fuel distributor piece	-385.0 mm (-15.16 in.)	-50.0 mm (-1.97 in.)	approx 110 mm (4.33 in.)

Graphic

Fuel manifold



Part	Function
1	Fuel manifold
2	Pressure gauge connection
3	Fuel pressure switch connection
4	Banjo bolt

d06102.fm

Use for intended purpose

⚠ WARNING
Non-compliance can result in serious injuries or death! Never fly the aircraft equipped with this engine at locations, air speeds, altitudes or in other situations which do not allow a successful no-power landing after sudden engine stoppage.

- This engine is not suitable for acrobatics (inverted flight, etc.). Flight attitudes outside the permissible limits are not allowed.
- This engine shall not be used on rotorcrafts with an in-flight driven rotor (e.g. helicopters).
- It should be clearly understood that the choice, selection and use of this particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler and owner/user.
- Due to the varying designs, equipment and types of aircraft, BRP-Rotax grants no warranty on the suitability of its engines use on any particular aircraft. Further, BRP-Rotax grants no warranty on this engines suitability with any other part, components or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application.

⚠ WARNING
Non-compliance can result in serious injuries or death! For each use of DAY VFR, NIGHT VFR or IFR in an aircraft the applicable legal requirements and other existing must be adhered to.

- Certain areas, altitudes and conditions present greater risk than others. The engine may require humidity or dust/sand preventative equipment, or additional maintenance may be required.
- You should be aware that any engine may seize or stall at any time. This could lead to a crash landing and possible severe injury or death. For this reason, we recommend strict compliance with the maintenance and operation and any additional information which may be given to you by your dealer.

Training

- Whether you are a qualified pilot or a novice, complete knowledge of the aircraft, its controls and operation is mandatory before a solo flight. Flying any type of aircraft involves a certain amount of risk. Be informed and prepared for any situation or hazard associated with flying.

- A recognized training program and continued education for piloting an aircraft is absolutely necessary for all aircraft pilots. Make sure you also obtain as much information as possible about your aircraft, its maintenance and operation from your dealer.
- Engine-specific training courses are provided by the authorized distributors according to manufacturer specifications (iRMT).

Regulations

- Respect all legal requirements or local rules pertaining to flight operation in your flying area. Only fly when and where conditions, topography, and airspeeds are safest.
- Consult your aircraft dealer or manufacturer and obtain the necessary information, especially before flying in new areas.

Instrumentation

- Select and use proper aircraft instrumentation. This instrumentation is not included in the ROTAX® engine package. Verification to the latest regulations such as FAR or EASA has to be conducted by the aircraft manufacturer.

Engine log book

- Keep an engine log book and respect engine and aircraft maintenance schedules. Keep the engine in top operating condition at all times. Do not operate any aircraft which is not properly maintained or has engine operating irregularities which have not been corrected.

Maintenance (iRMT)

- Since special training, tools and equipment are required, engine servicing shall only be performed by an authorized ROTAX® aircraft engine distributor or their independent service center. BRP-Rotax requires that any service or maintenance work carried out and verified by a technician that has a current iRMT rating.
- When the engine will not be operated for a longer period protect the engine and fuel system from contamination and environmental exposure.

Engine operation

- Never operate the engine without sufficient quantities of operating fluids (oil, coolant, fuel).
- Never exceed the maximum permitted operational limits.
- In the interest of safety, the aircraft must not be left unattended while the engine is running.
- To eliminate the risk of injury or damage, ensure any loose equipment or tools are properly secured before starting the engine.