Accident

Aircraft Type and Registration:	Just SuperStol, G-SSTL
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2016 (Serial no: LAA 397-15377)
Date & Time (UTC):	4 July 2024 at 1900 hrs
Location:	Near Romsey, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Landing gear detached and airframe distortion
Commander's Licence:	PPL(A)
Commander's Age:	67 years
Commander's Flying Experience:	315 hours (of which 4 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Enquiries by the AAIB

Synopsis

The aircraft Permit to Fly had recently been revalidated after a period of non-flying and following various general husbandry tasks which included the replacement of the fuel system pipes.

The pilot had started the aircraft and taken time to bring the engine oil temperature to the correct limit before taxi and brake testing on the runway. He then took off with the intention of carrying out a couple of circuits before embarking on a short local flight. Soon after becoming airborne the engine appeared to lose power. A few seconds later it picked up and then again lost power. The pilot decided to carry out a forced landing in a field 45° to the left of the runway. As the aircraft touched down it rolled into a ditch and through a hedge. The pilot was injured, and the aircraft was severely damaged. The exact cause of the loss of power could not be determined but may have been due to a combination of fuel system installation features which did not fully conform to the aircraft and engine bay fuel system installation advice in the build manual or system recommendations more recently published in Rotax Service Bulletin 912-079-R1 (Appendix A).

History of the flight

The pilot, assisted by his friend, had removed the aircraft from its hangar at the private airstrip where it was based. The aircraft had not been flown since May 2024. The pilot's intention was to carry out a thorough pre-flight inspection followed by engine warm up checks, then a high speed taxi and brake test along the runway. If all the checks were to his satisfaction, his plan was to takeoff and fly two circuits and, if content after that, carry out a short proving flight in the local area. On completion of his pre-flight checks, he started the engine and spent approximately 15 minutes running the engine to bring the oil temperature up to the prescribed level. He then carried out a taxi and brake test on the runway. This was to his satisfaction and he indicated to his friend that he would takeoff and fly the circuits.

His friend (the only witness present) moved further along the runway and stood to the side to observe and video the takeoff. He heard the aircraft power increase and watched as the aircraft accelerated along the runway and the tail lift as normal. The aircraft became airborne and started to climb away. He then noticed that the aircraft appeared to level, the engine note changed, and the aircraft sank a small amount before appearing to climb again. The witness immediately thought that the climb was not normal. The pilot's recollection was the same, the engine power appeared to stagnate before picking up again then lose power a second time. The pilot decided to carry out a forced landing in a field to his left (Figure 1).

The witness observed the aircraft change heading before "gently floating down, wings level". It touched down at the edge of the field about two metres from a drainage ditch. It rolled down into the ditch at which point the landing gear collapsed and detached. The aircraft carried on through a hedgerow which brought it rapidly to a stop. The pilot sustained serious injuries during the accident and had to be extracted from the wreckage by the emergency services who had been called by the witness.

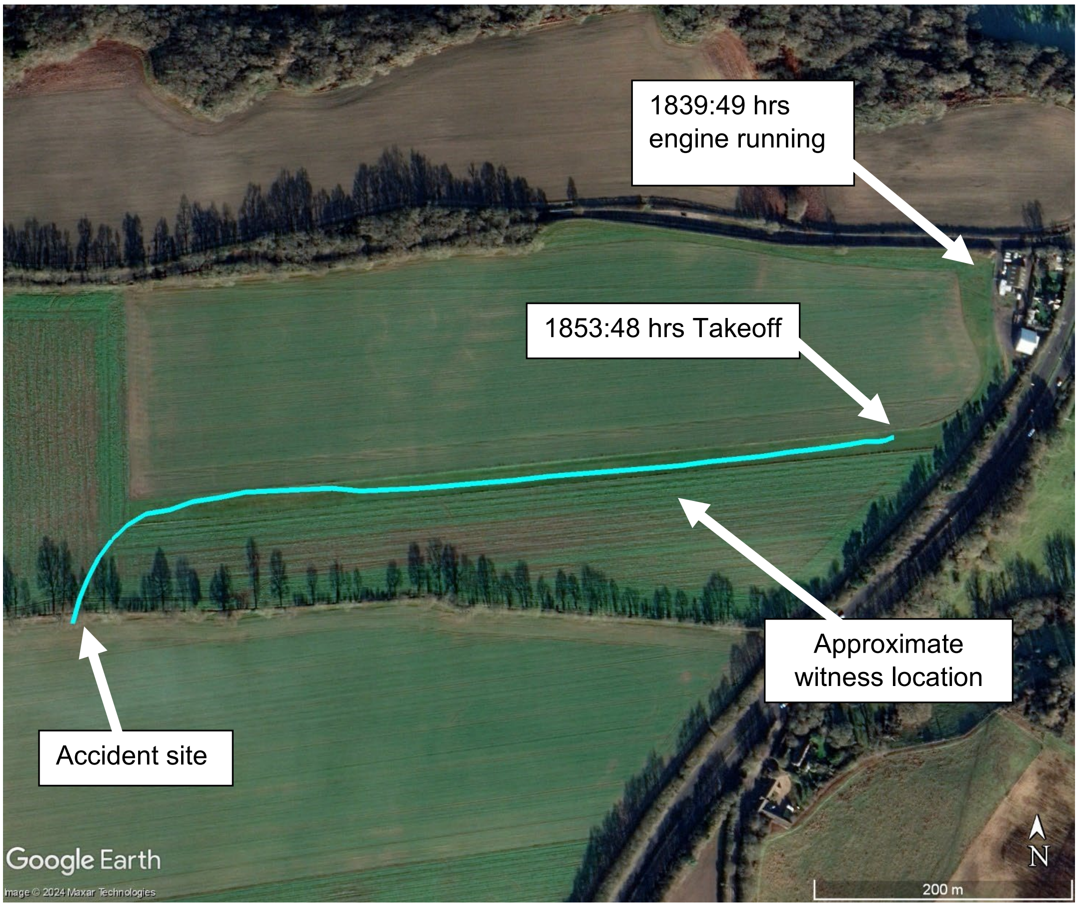

Figure 1

G-SSTL GNSS Position data

Airfield information

Pauncefoot Farm Airstrip is a private unlicensed airstrip near Romsey, Hampshire. It consists of a single grass 650 m 26/08 runway. There is a small hangar in which the accident aircraft was kept along with a supply of UL91 AVGAS held in a standard oil drum. As well as General Aviation, model and drone flying is also carried out at the airfield from two specially prepared areas on the runway. The runway was firm, well drained and the grass had been cut by the witness just prior to the takeoff.

Meteorology

The conditions at the airfield during the late afternoon and early evening were generally settled with initially no cloud below 5,000 ft, with lower patchy cloud later on. The surface wind and air temperatures were similar to those reported at Southampton Airport. This was light to moderate westerly winds with gusts to 22 kt at 1820 UTC. CAVOK[1] conditions were reported from 1620 UTC through until 1850 UTC. The temperature and dewpoint were approximately 20°C and 6°C.

Accident site

The aircraft had landed approximately 100 m from the end of the runway diagonally left of the runway centre line. A pair of wheel marks were present in a wheat crop at the edge of the field. The landing gear was partially detached and caught in the drainage ditch. During the impact the engine had been bent slightly downward in its mounts and one of the propeller blades had broken at its root and bent rearwards. The aircraft had broken through a substantial hazel bush in the hedge row denting the leading edge of the left wing and causing the aircraft to rotate through approximately 90° (Figure 2). The right wing had pivoted slightly forwards about its main spar mounting bolt. The rear spar attachment bolt had been pulled sideways out its hole.

Footnote

1 CAVOK - Ceiling and visibility OK.

Figure 2
Accident site and aircraft damage

Aircraft description

G-SSTL was a single engine high wing monoplane of steel tubular frame construction with a fabric covering. The wing form and lift augmentation devices allow low speed flight and enable it to carry out short takeoffs and landings. The landing gear was fitted with tundra 'balloon tyres' so the aircraft can be operated from uneven and unprepared surfaces. It was powered by a four cylinder normally aspirated Rotax 912 ULS engine driving a fixed pitch propellor via a reduction gearbox. The engine was fitted with two Bing variable choke carburettors. Fuel was supplied from two wing tanks feeding into a collector tank. Fuel was drawn from the collector tank via an in-line gauze filter and shut off valve and Gascolator, by a diaphragm fuel pump driven from the reduction gearbox. Excess fuel was delivered back to the collector tank via a return line. The aircraft was not fitted with an electric back -up fuel pump and so fuel delivery relies on gravity feed to the diaphragm fuel pump alone.

The aircraft instruments included two tablet displays configured to show flight and navigational information from an application. In addition, an engine display was fitted, displaying oil temperature and pressure, cylinder head temperature (CHT), manifold pressure (MAP) and engine speed in rpm. When this display is setup, it is configured for the engine type which also sets alarm and warning thresholds. When these thresholds are exceeded, the display will indicate this to the pilot.

Normal engine operating limits

The engine operating limits set out on the Pilot's Operating Handbook (POH) are as follows.

	Limits
Max take off power	100 hp
Time limit at full power	5 minutes (5,800 rpm)
Max rpm (no time limit)	5,500
Idle rpm	1,400
Maximum cylinder head temperature at pick point	150°C
Oil temperature Normal Maximum Minimum	 90 °C – 110 °C 140 °C 50 °C

The engine rpm upper alarm is set for 5,800 rpm with MAP alarm set for 27.5 InHg. When an alarm threshold is exceeded, the display background turns red. Once below the alarm threshold, the parameter will be marked with an exclamation mark to remind the pilot of the exceedance.

Recorded information

The flight planning and navigation application provided a time history of GNSS altitude and position which allowed calculation of groundspeeds. The engine display recorded to an internal memory at 5 Hz for the last 12 minutes of operation. Recorded parameters were those displayed, and no throttle position was recorded. The engine display recorded time from power on, not UTC and the two data sources were aligned using the application of takeoff power as a reference.

The engine display started recording at 1839:49 hrs, believed to be just after engine start as the oil and CHT temperatures were both low. Just over 7 minutes later, the aircraft taxied towards the westerly runway and performed a high-speed taxi up to approximately 40 kt. It then turned around and taxied back to the start of the westerly runway and waited while the engine oil temperature increased.

At 1853:48 hrs, the takeoff commenced with a recorded increase in engine rpm and MAP with oil temperature, pressure and CHT all within normal operating limits (Point A, Figure 3).

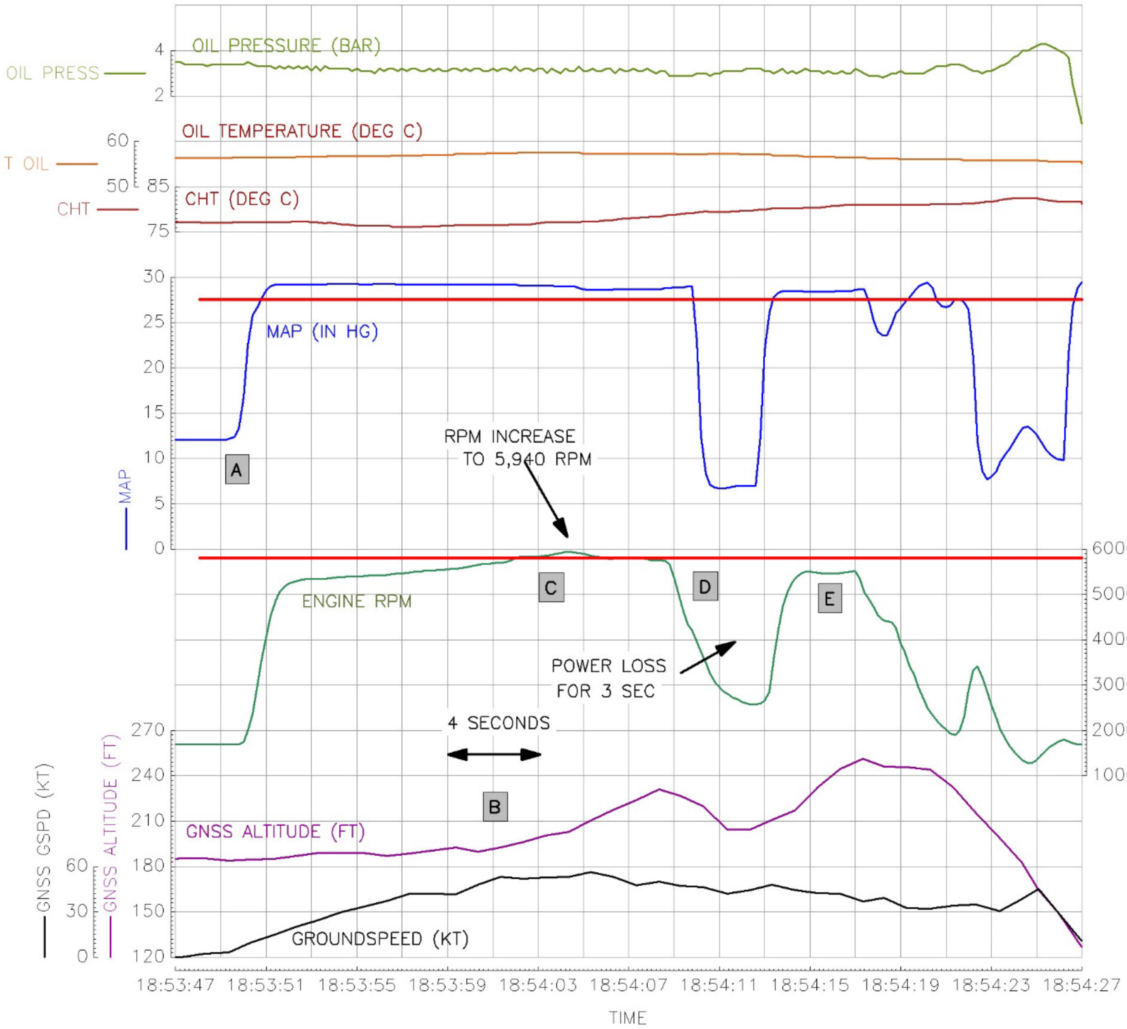

Figure 3

G-SSTL flight and engine data

The MAP rose to approximately 29 InHg, above the alarm threshold of 27.5 InHg for the engine display. The aircraft accelerated to a groundspeed of approximately 53 kt and started to climb (Point B). At the same time, the engine rpm increased and then exceeded the upper warning limit of 5,800 rpm (Point C). Maximum recorded rpm was 5,940 rpm after which a rapid decrease in engine rpm and MAP was recorded (Point D). This lasted for three seconds before power was restored for a further four seconds (Point E). After this point, there was a reduction in engine power with reducing / fluctuating rpm and MAP. The aircraft descended and hit the ground at approximately 1854:27 hrs.

A previous takeoff was identified in the engine display recorded data. At the application of full power, MAP rose to 29.8 InHg and rpm to approximately 5,800 rpm.

Maintenance history

The aircraft was built in 2016 operated under a Light Aircraft Association (LAA) Permit to Fly and had undergone a permit revalidation inspection on 3 May 2024. As part of that inspection several maintenance tasks had been carried out. The fuel pipes were replaced throughout, and this was followed by carburettor setting and balancing. At the same time a non-return valve was fitted in the return line to prevent fuel from syphoning out of the header tank. The aircraft had not been flown since that work was carried out.

Aircraft examination

The aircraft sustained severe damage during the accident. There was no fire and no fluid leakage. The pilot had been wearing a four-point harness which had been cut by the emergency services. The pilot's seat(left) seat pan and sub frame was distorted. Despite the damage to the aircraft, it was in a very good almost 'new' condition.

Fuel was present in both tanks and the fuel valve was set to ON and fuel was present in the pump, its supply and return lines and the carburettor float bowls. The choke was off and push/pull throttle handle was fully forward at full power. However, during the impact the engine mounting frame had been distorted, and the engine had moved forward and downwards. This had put the throttle cables under enough tension to pull them from the throttle linkage pinch bolts. The right carburettor had been dislodged from its rubber inlet manifold flange adaptor. The engine instrument wiring loom had been put under tension and several wires had been pulled from their terminal connectors.

The fuel suction pipe was routed from the Gascolator upwards along the top of the engine block to the pump. Figure 4 shows the fuel pipe location looking from above. There was no thermal insulation on the fuel pipes.

The lower part of the suction pipe near the fire wall was found to be in proximity to the right rear cylinder exhaust down pipe and was attached to part of the engine bearer frame by a cable tie and rubber collar. There was also evidence that the cable tie contacted the down pipe whilst it was hot. However, this may have occurred during the impact sequence as the engine mounting frame distorted. Measurements taken between the fuel pipe and the exhaust downpipe accounting for the distortion, suggest an original clearance of approximately 30 mm (Figure 5).

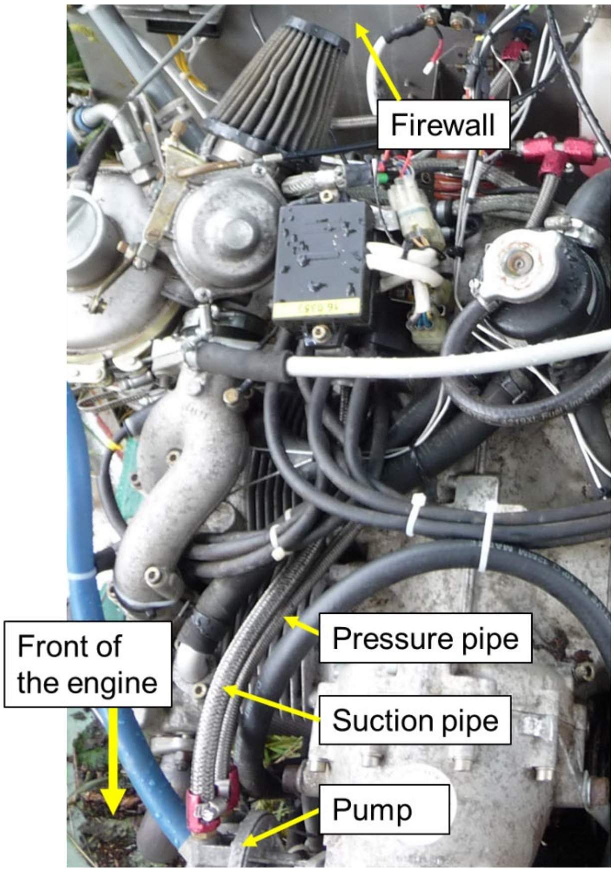

Figure 4
Fuel suction and pressure pipe location

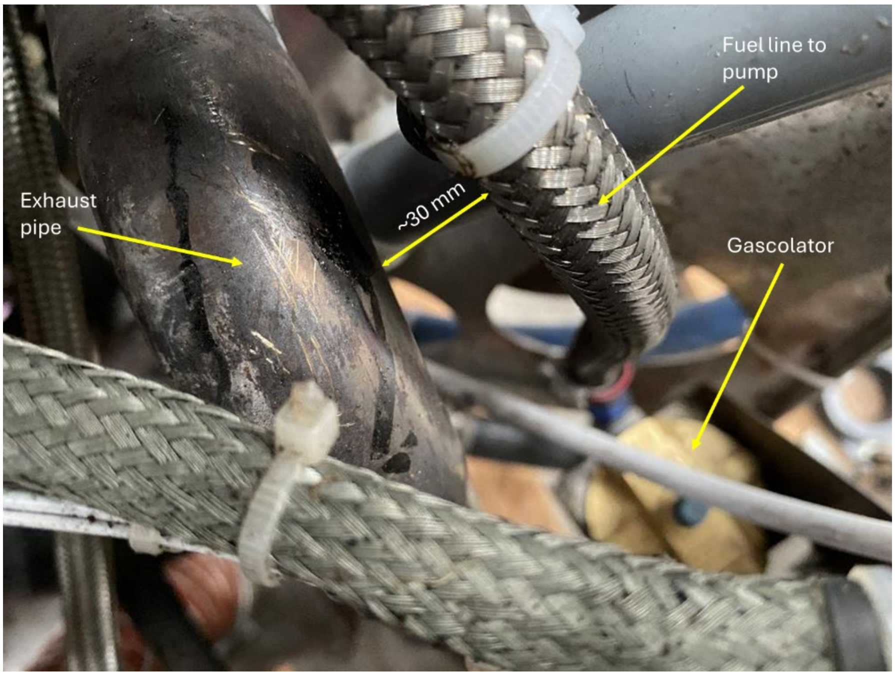

Figure 5

Suction pipe position in relation to exhaust downpipe

Tests and research

Both carburettor float bowls were removed and the internal components examined. The fuel valves operated correctly and were clear; the floats were of the type annotated 'R' introduced under mandatory Rotax SB-912-074. The needle valve and carrier pistons operated correctly and the fuel jet was clear. The spark plugs were examined and indicated normal combustion.

The recently replaced fuel lines were examined. The pipes, filter and non-return valve within the airframe were in an as new condition as was the braided fuel pipe assembly between the pump and carburettors. However, the suction pipe from the Gascolator to the gearbox driven pump was discoloured grey rather than bright silver braiding. The tube within the braiding showed signs of degradation and appeared to be leaching through and between the braiding weave. Figure 6 shows the apparent pipe degradation.

Figure 6
Suction pipe condition

The degradation of the rubber compound within the braided pipe between the Gascolator and the pumps appears to be evidence that this pipe was externally heated. However, experiments were carried out to establish the effect of heat on the pipes. Blown air heating raised the surface temperature on the sample pipes to between 150°C to 160°C and this was found to have no lasting effect.

The diaphragm fuel pump was also examined and tested and operated correctly. Of note in this aircraft there is no electrical back-up fuel pump, so the system relies on gravity feed to the diaphragm pump alone. Vacuum testing was also carried out on the suction pipe with no effect apparent.

Other information

The engine installation manual refers to the installation of the fuel system in the following extract;

> **ATTENTION**
>
> **For prevention of vapor 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 vapor formation) the fuel lines could be routed in a hose with cold air flow.

Discussions with the LAA and other owners of Rotax powered aircraft of similar types suggest the fuel pipe routing within compact engine bays can lead to fuel flow problems. This is more so with MOGAS fuelled aircraft rather than UL 91 fuelled aircraft. However, no gasoline fuels are completely immune from vaporisation or the formation of cavitation bubbles on fuel lines which are in a hot area. The engine manufacturer recently published a revised Service Bulletin, SB-912-079 R1 dated 22 November 2024. It is a compendium of essential information regarding the installation, operation and maintenance for Rotax 912 (Series) aircraft engines and is annotated as 'Highly Recommended'. There are several specific requirements for the aircraft fuel system design set out in section 3.2 of the SB. A copy of which is at Appendix A. G-SSTL did not conform to the build advice or to some of the guidance points set out in the SB as follows:

- The SB states that fuel pipe routing within the engine bay should be away from heat sources and thermally insulated. In this aircraft, the suction line from the Gascolator to the diaphragm fuel pump is routed within 30 mm of the right rear cylinder exhaust down pipe. From there it lies under the right inlet manifold across the block lying on top of the pump outlet pressure line to the carburettors. There is no thermal insulation around the engine bay fuel lines.

- All the fuel hoses must also be sufficiently supported in order to avoid excessive vibration. The pressure and suction lines in G-SSTL lay across and were in contact the engine block which may have made them susceptible to vibration.

- In order to reduce the pressure drop along the fuel line, the use of sharp angled adapters and banjo connectors should be avoided as much as possible. G-SSTL has three right angle connectors and a banjo union in the system in the gravity feed suction side of the system.

Analysis

The start up and warm up runs appeared to have been normal with no adverse characteristics. However, the data shows that after the throttle was opened to full power for the takeoff run the engine over sped for a period of three seconds before settling down to maximum normal rpm. After 4 seconds the engine rpm and power decreased before picking up again, which was as described by the pilot. The engine power reduced for a second time at which point the pilot prepared to carry out a forced landing.

Of note there were several features in the fuel system installation which did not conform to the build advice or the guidance set out in SB 912-079-R1. It is possible the combination of these features and fuel being drawn under gravity caused intermittent fuel starvation during the high demand required for takeoff. The slight exceedance in rpm, 5,940 vs 5,800, may be indicative of a leaning of the mixture as the fuel levels in the carburettor float bowls dropped and was a precursor to further leaning and to the loss in engine power.

The possibility of carburettor icing was considered. The temperature and dewpoint at the time of day in the general area, suggested a moderate risk and the warmup running at low power followed by taxiing on a grass strip in the early evening could have increased the risk further. However, the very compact engine bay in this aircraft and the heat generated by the engine beneath the two carburettors suggests carburettor icing was unlikely.

Conclusion

The engine started and ran without any problems as the pilot went through his checks and paused to allow the oil temperature to increase to the minimum required level. However, as the demands on the fuel supply system increased for takeoff, it is possible that the fuel system features in this aircraft, which did not fully conform to the build manual or some of the advice in the SB, may have combined and resulted in a partial fuel starvation that led to engine power loss.

General observation

The fuel system components had been replaced as part of the work carried out prior to the renewal of the aircraft permit to fly. It was assumed by the person carrying out the work, that the assembly, location and routing of the original pipes and associated components was correct. They had no reason to assume otherwise as the aircraft appeared to have been flown since it was built without any problems. They are now of the opinion, "that when taking over a used kit build aircraft (or even commercially produced), not to assume everything has been installed in accordance with best practice when completing maintenance and replacing like for like rather than reviewing and questioning further".

Safety Action

During the test and research for this investigation it became apparent that there may be other Rotax powered aircraft that may not fully conform to the some of the requirements of SB 912-079-R1 regarding fuel systems. The Light Aircraft Association (LAA) has concluded that it would be useful to draw attention to this SB to other aircraft owners and LAA inspectors. Therefore, the LAA has carried out the following Safety Action:

> The LAA has published an article in the March 2025 edition of their monthly magazine highlighting the fuel system installation issues found on G-SSTL and drawing attention to the guidance set out in SB 912-079-R1.

Appendix A

Extract from Rotax SB 912-079-R1

3.2) Fuel system

3.2.1) Background information

Requirements of the fuel system:

The fuel system is a complex and important subsystem of an aircraft engine installation. The fuel system must be designed to ensure that the engine is supplied with sufficient fuel at the correct pressure in every operational situation. Any deviation from the installation manual and maintenance manual may result in a non-standard operation.

Carburettor synchronization and maintenance:

Regular synchronization of the carburettors greatly improves smoothness of engine operation.

Air-to-fuel ratio:

The air-to-fuel ratio (mixture) heavily influences the whole combustion process. Especially lean conditions may have negative effects and can be caused by various factors. Several occurrences of vibrations and power losses have been identified to be caused by restricted fuel supply (e.g. contamination, vapor lock, etc.) and/or inadequate ventilation of the carburettors

(e.g. blocked, inadequately routed venting lines).

3.2.2) OEM requirements

Requirements of the fuel system:

Make sure to comply with the fuel system requirements outlined in the installation manual in particular:

Fuel flow:	min. 35 l/h (9.25 gal/h).
Fuel pressure: (relative to ambient pressure)	0.15 - 0.5 bar (2.18 - 7.25 psi)
Fuel lines:	Inlet line inner diameter: min. 7.5 mm (0.3 in.) (AN-6 or 3/8").

NOTE:

- Due to the technical design and installation conditions (construction of the return line, etc.) pressure fluctuations at the fuel pump are possible. These pressure fluctuations within the specified operating limits are not considered a problem.

  Low fuel pressure indications are also possible and allowed, but the pressure must stabilize to the operating limit within 10 seconds. However, low pressure indications below 0.08 bar (1.16 psi) may only last a maximum of 1 second. If not, the cause must be determined and rectified.
- It is also advisable to route the fuel line as far away from heat source as possible and to add thermal isolation around the fuel lines, especially within the engine compartment.
- The electrical fuel pump must be positioned in order to be gravity fed from the fuel (catch) tank and the hoses between the electrical fuel pump and fuel tank must be self bleeding (No airtrap).
- Fuel line should also be routed with sufficient bending radius (Follow manufacturer recommendation) in order to prevent the pipe from kinking.
- In order to reduce the pressure drop along the fuel line, the use of sharp angled adapters or banjo connectors should be avoided as much as possible.
- The fuel hose on the suction side must be collapse resistant.
- All the fuel hoses must also be sufficiently supported in order to avoid excessive vibration of the hose, which would increase the risk of vapor lock.
- When installing other "devices" than the one specified in the Rotax installation manual on the suction side of the fuel pump, their effect on the fuel system pressure drop must be carefully investigated at all operating conditions.
- Use appropriate fuel filter (coarse/fine) and water separator/gascolator.
- For prevention of vapor locks: The length of the fuel line on the suction side of the electrical / mechanical fuel pump (between the fuel tank and the fuel pump) must be kept as short as possible to minimize vapor formation at high altitudes and high temperatures. High engine compartment temperatures increase fuel temperature and therefore facilitate vapor forma- tion of the fuel.
- Fuel temperature: The fuel system must be designed considering vapor lock depending on the ambient conditions (e.g. pressure and temperature) and the used fuel types (vapor pressure class). Should problems occur during the test period, the affected components, e.g. the sup- ply line to the fuel pumps, must be cooled. To avoid too much fuel heating at the fuel pump inlet, it is obligatory to route the fuel return line from the engine to the main fuel tank, and not to the electrical fuel pump inlet or header tank, see latest Installation Manual (IM), Chapter 73-00-00.
- Install check valves with appropriate specification (e.g. with sufficient cross section, opening pressure etc.) parallel to the electrical fuel pumps as indicated in the latest Installation Man- ual (IM), Chapter 73-00-00.
- Venting lines: The carburetor float chamber venting lines have to be routed into a ram-air and vacuum free zone or into the GENUINE ROTAX® airbox, according to the requirements and release of BRP-Rotax GmbH & Co KG. These lines must not be routed into the slipstream. If the drainage lines of the airbox are connected with the drainage lines of the drip trays or the carburetors by a T-piece, these lines must not be routed down the firewall (drainage lines of the airbox separately are allowed).
- At first installation or when doing extensive work on the fuel system or replacing fuel line, the complete fuel system should be flushed in order to remove all potential contaminant.