

Accident

Aircraft Type and Registration:	Zenair CH 601HDS, G-CHZS	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2022 (Serial no: LAA 162-15011)	
Date & Time (UTC):	22 April 2025 at 1545 hrs	
Location:	Tatenhill Airfield, Staffordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Extensive fuselage damage, prop strike, and landing gear damaged beyond economical repair	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	Unknown	
Commander's Flying Experience:	299 hours (of which 3 were on type) Last 90 days – 10 hours Last 28 days – 7 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and further investigation by the AAIB	

Synopsis

On 22 April 2025, G-CHZS suffered an engine failure while returning to Tatenhill Airfield, Staffordshire. The pilot declared a MAYDAY and attempted to glide to the airfield but, unable to reach the intended runway, carried out a forced landing on a closer runway. The aircraft landed heavily and was damaged beyond economical repair. Neither occupant was injured.

The investigation found significant contamination within the fuel system, including debris in the fuel tank and filters, and the absence of a gascolator filter screen. Faults with the left carburettor would have further degraded engine performance. The engine failure was probably caused by restricted fuel flow due to contamination, combined with carburettor inefficiency. Pre-flight fuel drain checks were not conducted, and the contamination was not detected prior to flight.

History of the flight

The accident flight was the second flight of the day, returning to Tatenhill from Sleaf Airfield. The takeoff and the initial stage of the flight were reported as uneventful. After 25 minutes, the engine started to run rough, so the pilot turned the fuel selector from MAIN to EMERG - WINGS ONLY and switched the auxiliary pump to ON as detailed on the fuel

system guide clipped to the right side of the cockpit instrument panel. The engine appeared to run normally for a brief time just before reaching Tatenhill when the rough running problem returned. The pilot switched to EMERG - ALL TANKS, but to no avail and the engine stopped.

The pilot declared a MAYDAY and attempted to glide to Tatenhill Airfield. Although the intention was to reach in-use Runway 26, the pilot realised the aircraft would not glide that far and decided to attempt to land on the closest landing strip, Runway 03 instead. Even then, the aircraft struggled to reach the runway threshold. The pilot reported that she was unable to flare fully before touchdown which resulted in a hard landing. Although the aircraft was damaged beyond economical repair, both occupants exited without injury.

Aircraft information

The aircraft was a Zenair Zodiac CH601 HDS, two seat monoplane fitted with a Rotax 912 ULS engine and a Woodcomp Klassic, three bladed propeller. It had been built by the previous owner from a partially constructed Zodiac airframe kit and had completed just over 43 flying hours before the accident. The LAA issued its Permit to Fly on 13 March 2025.

The aircraft had been purchased as a kit in 1995 and had three previous owners before it was finally completed and given a Permit to Fly in February 2023. The first owner started construction but lost interest, storing it partially constructed in a cowshed for many years. It was subsequently purchased and shipped from Dublin to Exeter where more work was undertaken to progress the build of the airframe. The incomplete aircraft was sold once again in 2010 and was transported to Brittany in France where it was stored in a cowshed converted to a workshop while the owner worked to progress construction. The owner moved to Hampshire in 2013 and transported the unfinished airframe to a workshop close to his new home. He moved once again in December 2013, this time to Lincolnshire and moved the aircraft to a farm grain store in Wispington. On the advice of an LAA inspector, who was concerned about working on the aircraft in the dusty and grimy environment in the grain store, the aircraft was moved to Wickenby in October 2022. The engine had been purchased after overhaul, having been originally fitted to a CZAW Sport Cruiser X320. It was installed into G-CHZS in June 2022.

The completed and permitted aircraft was sold to the current owner on 22 March 2025. The flight on the 22 April 2025 was the second flight on the day of the accident.

Aircraft examination

Aircraft fuel system

Examination of the main fuel tank revealed buckling of the tank structure, beach marks from sediment and the presence of larger granules of debris deposited throughout the tank's internal lower surfaces (Figure 1).

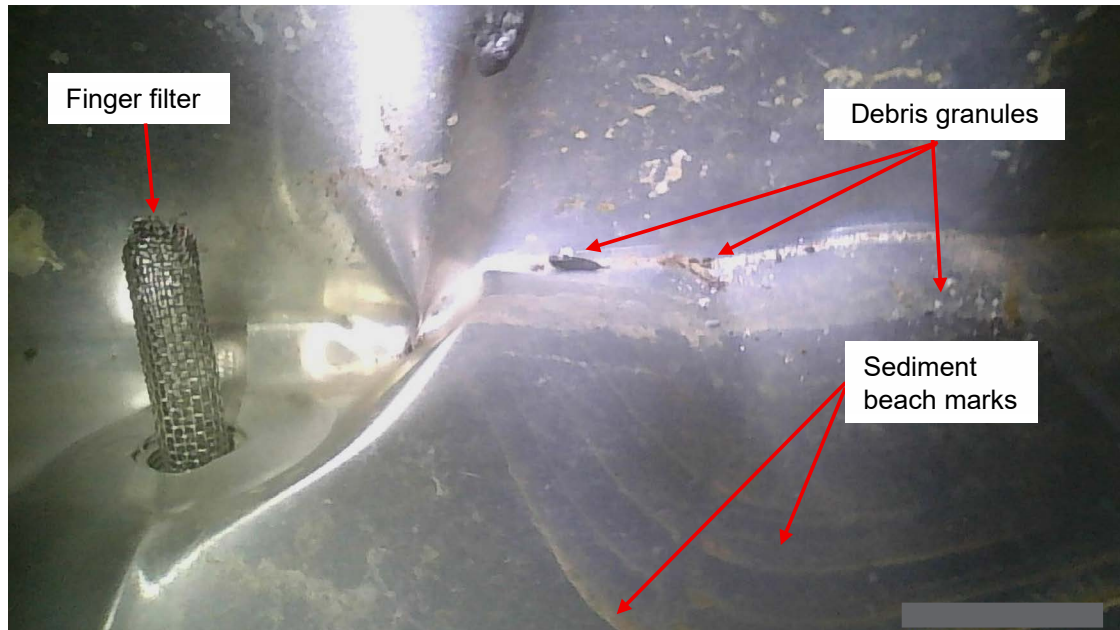


Figure 1

View inside the buckled main fuel tank showing sediment marks, debris, and finger filter

When the gascolator bowl was removed, the fine debris filter screen and rubber gasket were missing (Figure 2, left). The screen removes particles from the fuel whilst the gasket seals the bowl to the lid of the gascolator.

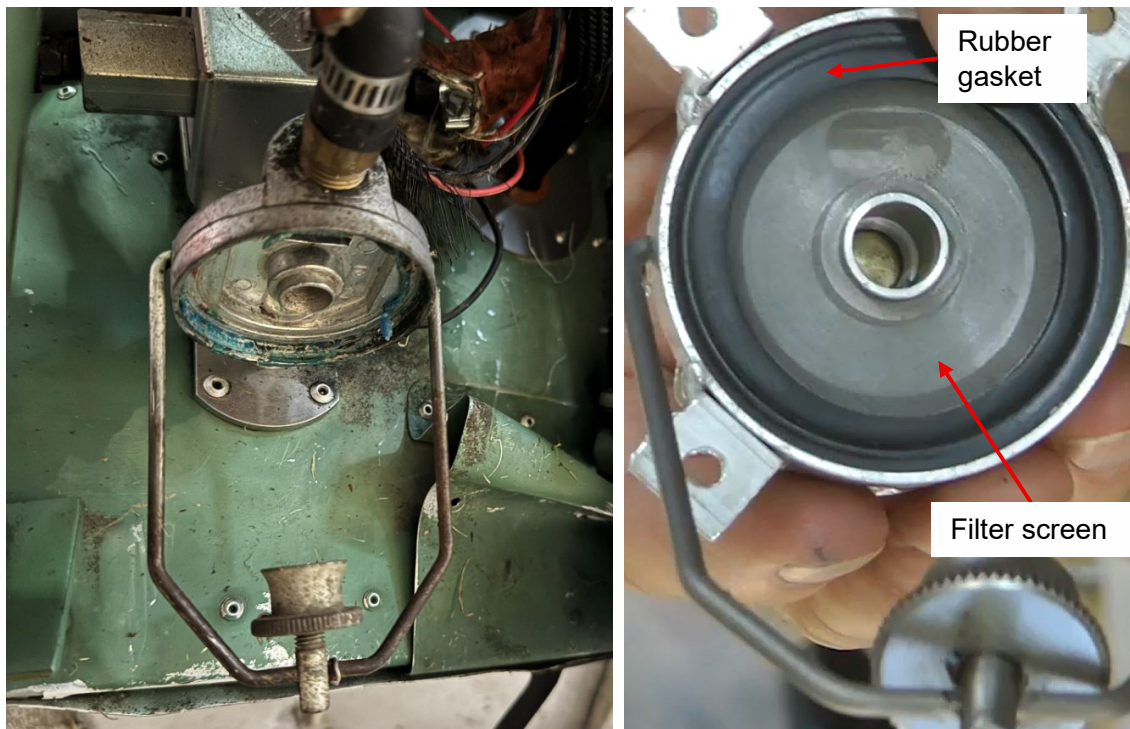


Figure 2

Gascolator lid showing filter and rubber gasket missing (left) and an example with the filter screen and rubber gasket fitted (right)

Inside the bowl, there was evidence of debris like that found in the main fuel tank, and blue gasket jointing sealant was found around the edge of the lid, the edge of the bowl and inside the bowl. The blue sealant appeared to have been used to seal between the bowl and the lid of the gascolator in place of the rubber gasket (Figure 3).

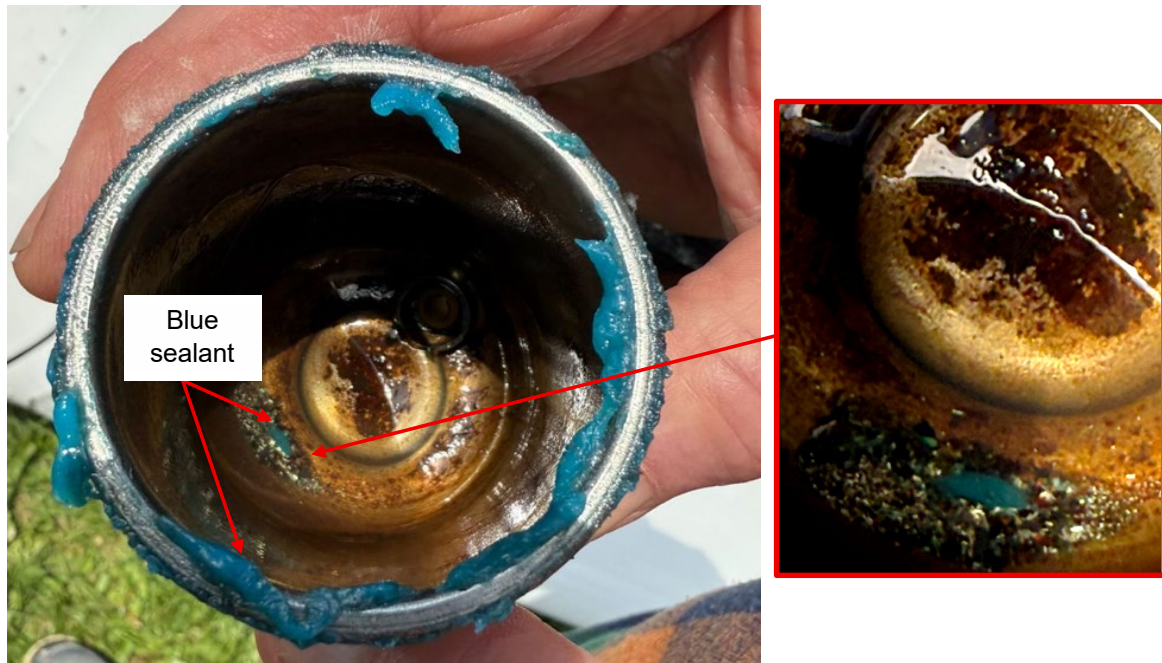


Figure 3

Gascolator bowl showing blue sealant and debris in the bowl

Engine fuel system

Examination of the in-line fuel filter revealed significant debris was present (Figure 4) which included clusters of granules (Figure 5).



Figure 4

Debris present within the in-line fuel filter

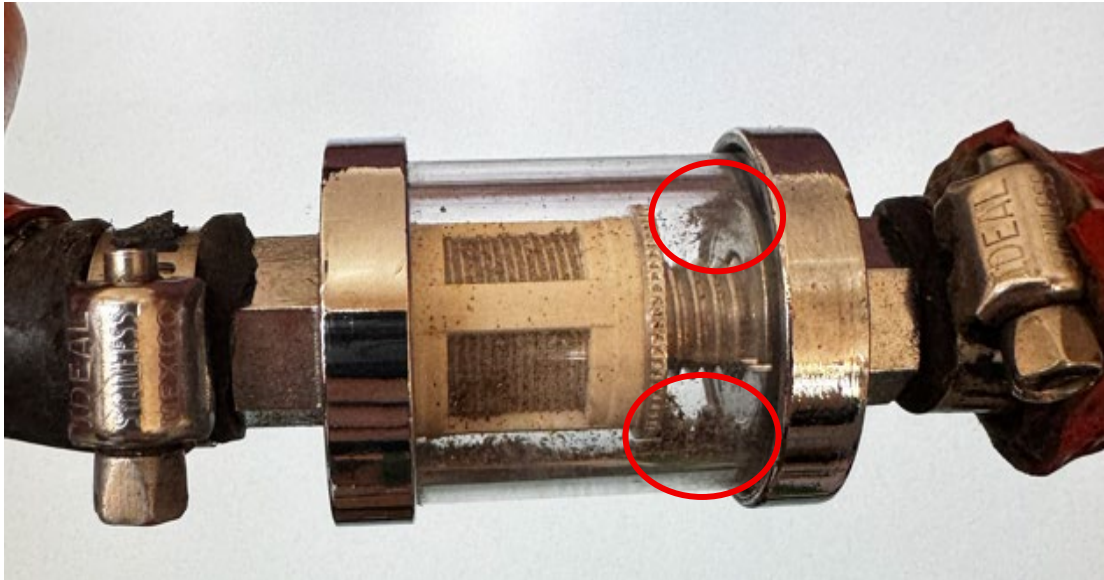


Figure 5

In-line fuel filter showing clusters of debris

Carburettors

Constant Depression Carburettors

The Rotax 912ULS engine fitted to this aircraft employed twin Constant Depression (CD) Carburettors to supply the appropriate fuel-air ratio, pressure and flow rate needed for combustion.

A carburettor piston which is suspended from a rubber diaphragm, is seated inside a venturi in the body of the carburettor, (Figure 6). During engine operation, when the pilot opens the throttle, it in turn, opens the throttle valve. The volume of fuel-air mixture drawn in by the engine is determined by the cross-sectional area of the venturi. When the throttle valve opens, the airflow in the venturi increases and causes a vacuum build up at the outlet of the jet needle. The vacuum in the venturi also acts on the top side of the diaphragm via the topside bore in the carburettor piston and lifts the piston against its own weight and the piston spring. Attached to the piston is the jet needle and as the piston rises the needle lifts out of the jet, the annular opening increases and more fuel is drawn up from the float chamber by the increased suction caused by the vacuum at the jet needle outlet. Lifting the piston also increases the area of the venturi, which in turn reduces both the vacuum pressure and the air flow restriction until a balanced fuel-air flow rate is achieved at the new throttle setting. The adjusting piston causes the pressure drop to remain almost constant (hence the term 'constant depression'). The reference pressure for the piston is created by ambient air which is applied to the underside of the diaphragm via the bottom side bore.

On its way from the float chamber to the venturi, fuel passes through the main jet, the mixing tube, and the jet needle. The fuel is pre-mixed with air, brought in via the air duct and the atomizer, in the diffuser tube creating an annular flow around the needle jet. The air flow assists the atomizing process and fuel distribution into the inlet manifold.

When fuel is drawn out of the float chamber, the fuel level in the chamber decreases. As a result, the floats open the needle valve via the float bracket allowing an increase in fuel flow to refill the chamber. When the chamber fuel level increases again, the floats rise and the needle reduces flow into the chamber. Once the fuel level is restored, fuel flowing into the chamber is shut off by the valve.

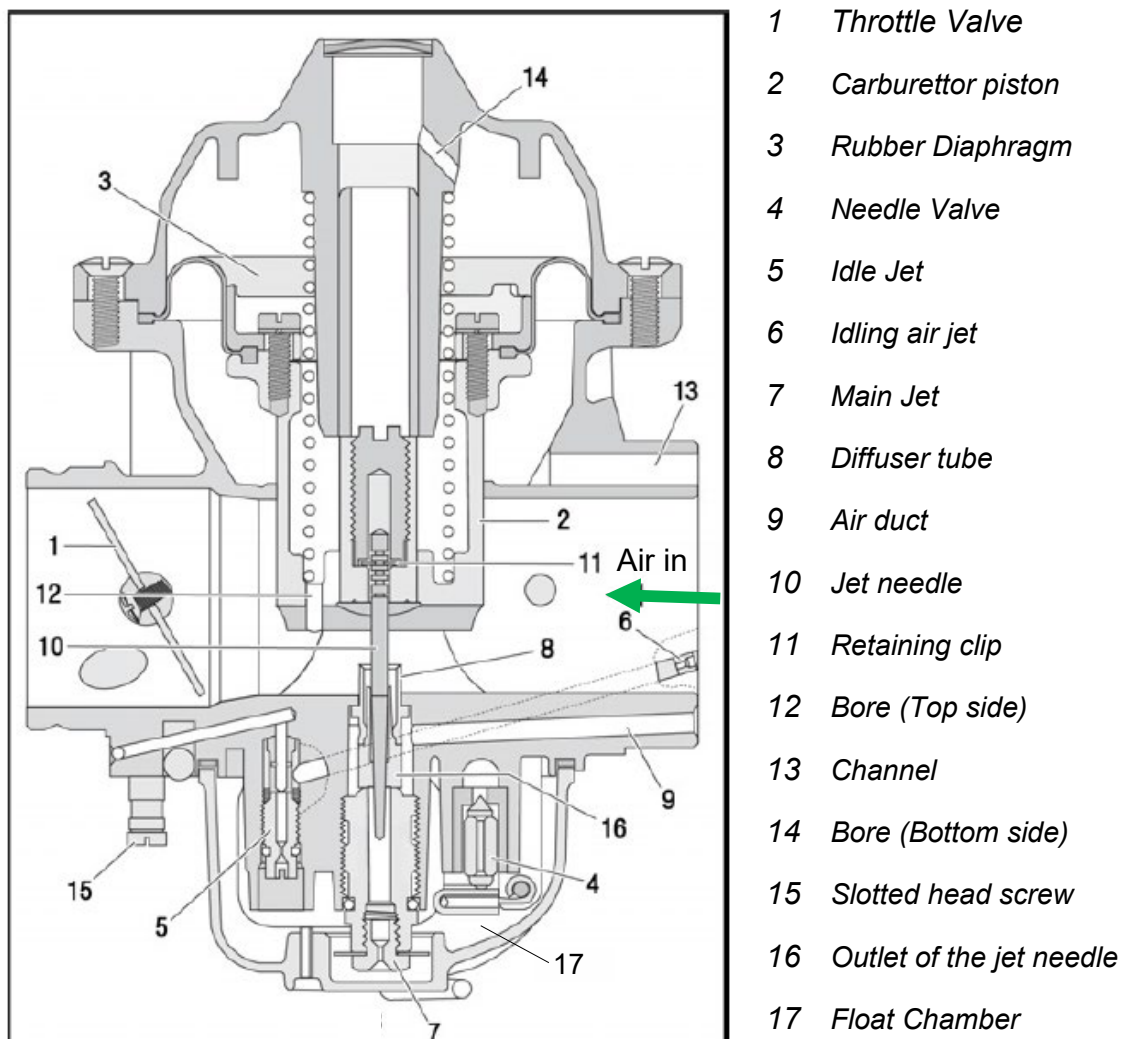


Figure 6

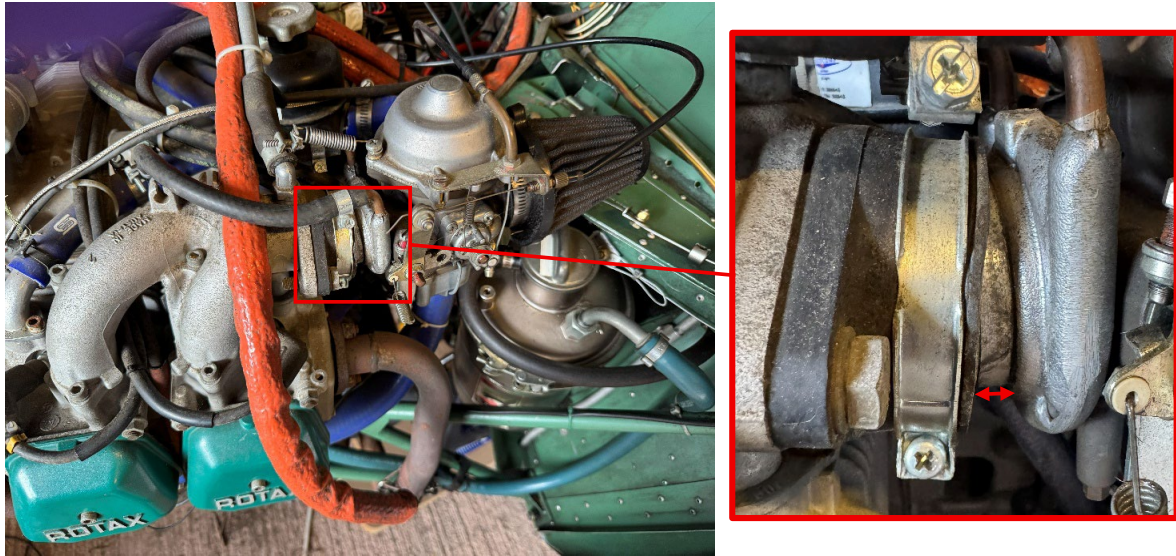
Carburettor cross-section diagram¹

Examination of the left carburettor

The left carburettor was not tightly secured to the engine inlet manifold (Figure 7) and appeared dislodged. It was not difficult to pull the carburettor away from the manifold because the securing buckle was loose. The right carburettor by comparison, was tightly secured. Air leaking at the inlet manifold can cause the engine to run with a lean fuel/air mixture.

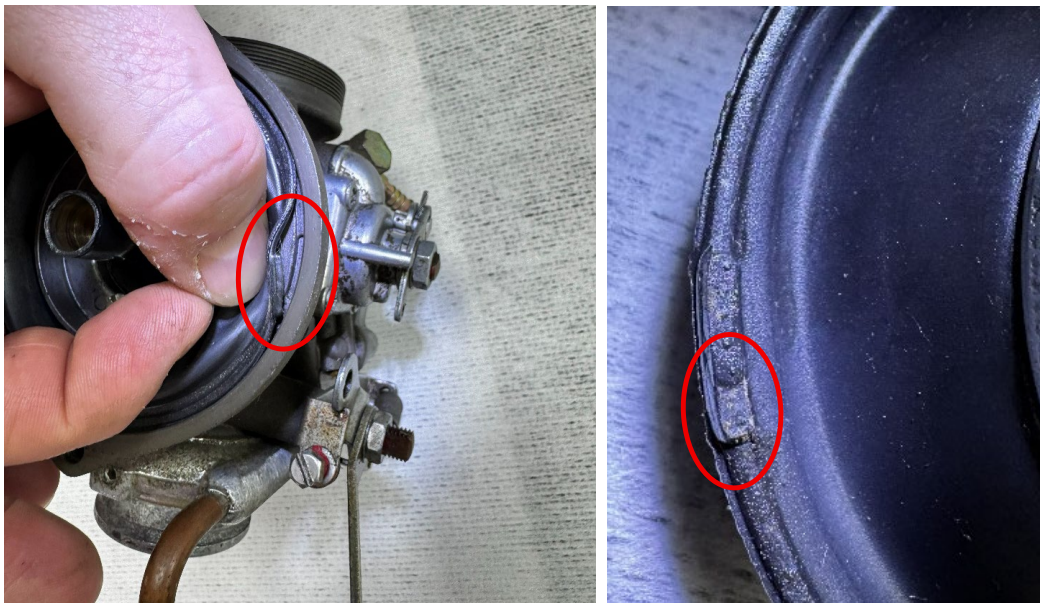
Footnote

¹ Rotax Maintenance Manual for Rotax Engine Type 912 and 914 Series Edition 2/September 2022 Chapter 73-00-10 page 5, Figure 13.4 'Carburettor overview'.

**Figure 7**

Left carburettor dislodged from inlet manifold

Both carburettors were removed from the engine and sent to a Rotax specialist workshop for examination. The results revealed that the left carburettor diaphragm was not correctly positioned because the locator tab, which fits into the recess in the rim of the carburettor housing, was displaced (Figure 8). The tab was partially compressed indicating that it had been damaged when the chamber top was refitted. As a result, it was possible there was a small gap between the top and bottom of the diaphragm. This may have affected the pressure differential across the top of the piston which can result in the piston not lifting correctly, restricting the cross-sectional area of the venturi. The amount of mixture drawn in by the engine and, therefore, its performance is determined by this cross-sectional area.

**Figure 8**

Misplaced diaphragm (Left) and damaged locator tab (right)

The carburettor piston was found slightly rotated (Figure 9) which would also have affected the cross-sectional area of the venturi.

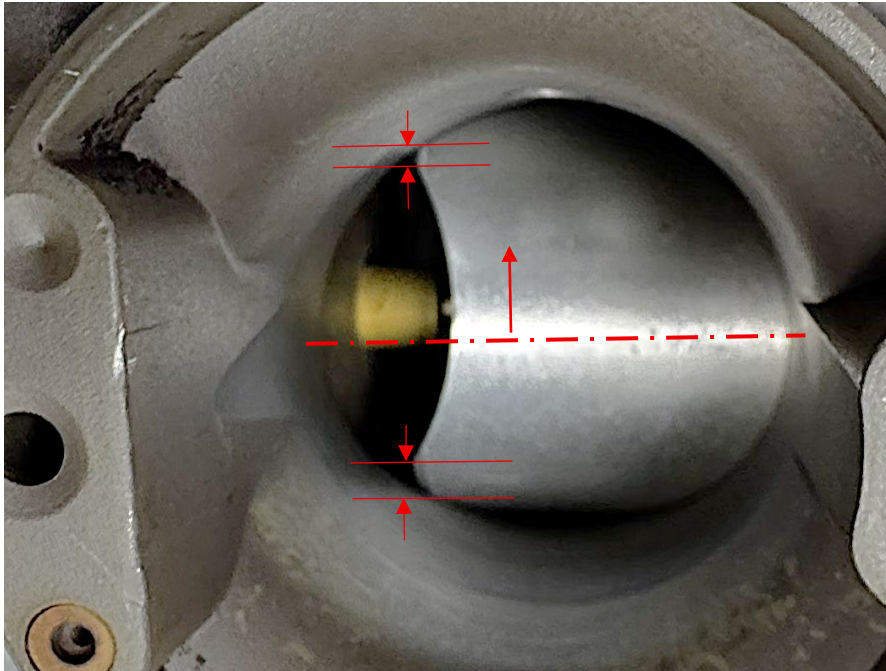


Figure 9

Carburettor piston rotated

The carburettor float needle valve was leak tested in accordance with the BRP Rotax Maintenance Manual Heavy (MMH)-912². The pressure reading did not hold for the required 5 seconds and started to dissipate immediately when pressure was applied, (Figure 10). This fault causes an increase in the fuel ratio resulting in a rich running engine. According to the maintenance manual, *'the pressure drop indicates leakage which may cause fuel overflow and in consequence engine damage due to hydraulic shock.'* Often this fault is caused by wear on the surface of the needle valve. It can also be caused by debris caught between the needle valve and the valve wall if the fuel is contaminated.

Footnote

² BRP Rotax MMH-912 / MMH-914 Edition 2/September 2022 Chapter 73-00-10 page 12.



Figure 10

Pressure test of the left carburettor float chamber needle valve (Figure 11)



Figure 11

Left carburettor float bowl needle valve

Other information

The walk around list provided with the aircraft paperwork (Figure 12) was the previous owner's mind-map of the pre-flight checks he needed to conduct. It did not reflect the Zenair CH 601 Pilot's Operating Handbook pre-flight inspection 'walk around' (Figure 13) and omitted the requirement to check the fuel drains and gascolator for the presence of water.

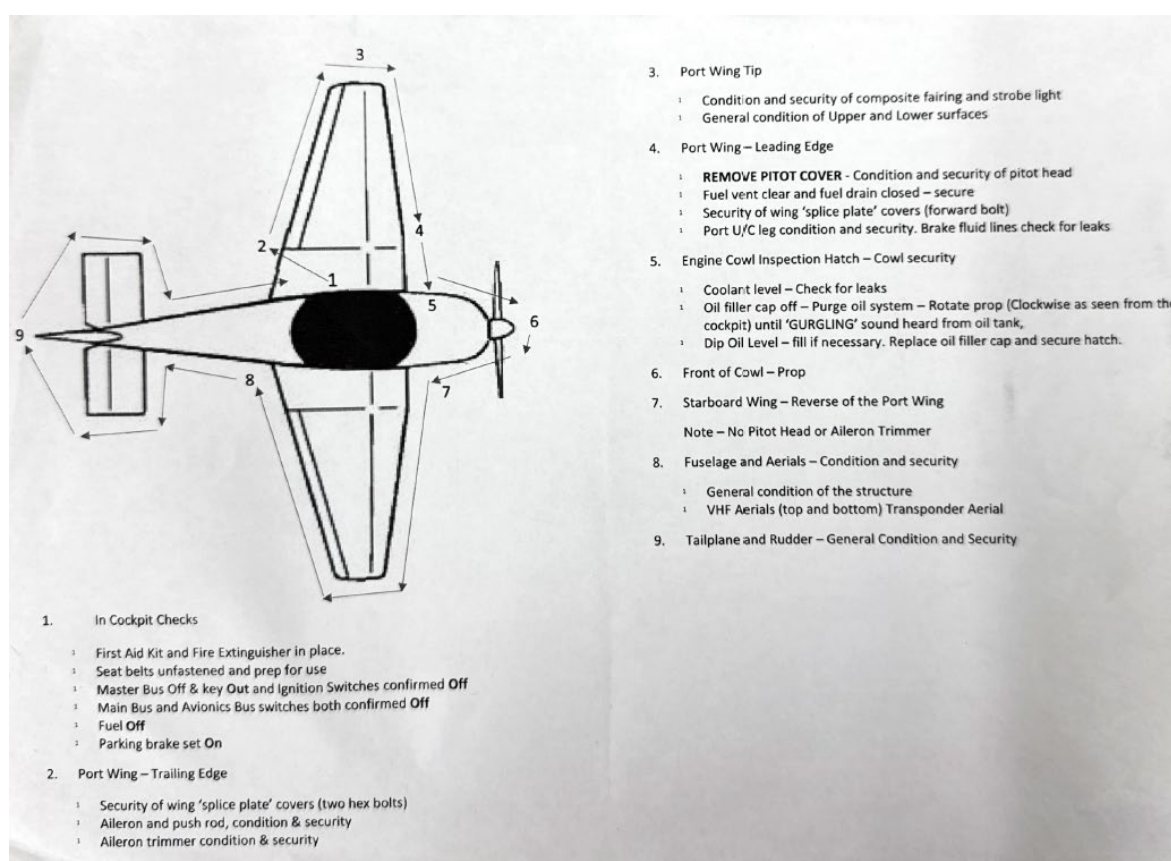


Figure 12

Bespoke pre-flight checklist intended for personal use only

The new owner was unaware of the gascolator, its function, its location in the engine bay and the requirement for one of the pre-flight checks to include looking for fuel contamination via this device.

PRE-FLIGHT INSPECTION: "walk around" before each flight

1. Ignition switch off, fuel open, elevator free.
2. Drain gascolator and all drain valves to ensure that no water is in the fuel lines, check cowl fasteners for looseness, check spinner and prop. You may want to remove the cowl to check the exhaust and general engine condition for safety. Check fuel quantity as well as coolant level and oil
3. Check pitot tube. Clean bugs and check full length of wing leading edge. Inspect wing tip, wing cover strip and make sure baggage locker doors are secure (remove tie-down).
4. Check general condition of ailerons; inspect hinge area over its entire length, aileron control attachment.
5. Landing gear condition, wheel and tires, brake s, bottom of wings and fuselage
6. Stabilator attachments, elevator and rudder hinges, cables and attachments, control stops (remove rear tie down).

Continue walk around in reverse order.

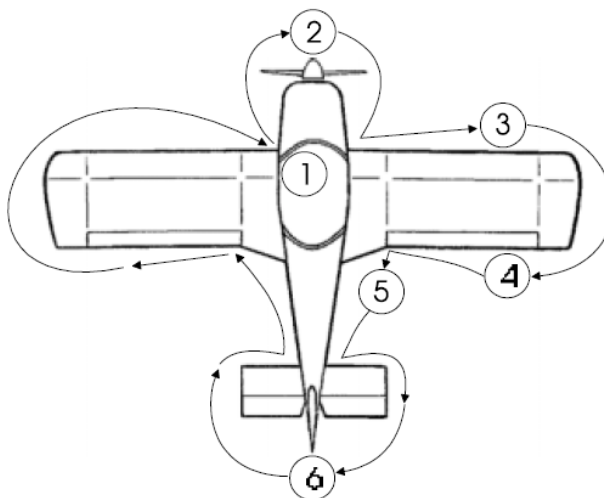


Figure 13

Zenair CH 601 Pilots Operating Handbook walk round guide

The Permit to Fly generic maintenance schedule for the aircraft (Figure 14) details the fuel system checks that should be carried out and there were signatures present on the aircraft documentation to confirm that the checks had been completed on 9 March 2025 prior to the sale of the aircraft.

 Light Aircraft Association	PERMIT TO FLY GENERIC MAINTENANCE SCHEDULE 12 MONTH/150 HOUR INSPECTION		FORM LAA/GMS/12/150
			Issue 2 April 2022

Fuel System		
Check filters for cleanliness and tank vents unobstructed. Drain samples from all drain points and check for presence of water, foreign matter and correct colour.		
Inspect tanks, filler caps, selector valves, pumps, pipelines, hoses, carburettor, injector systems, throttle, mixture control, fuel selector control, filler point placard.		

Figure 14

LAA generic maintenance schedule – completed 9 Mar 25 for G-CHZS

Analysis

Fuel contamination

The presence of sediment and debris in the main fuel tank and gascolator, showed that the aircraft side of the fuel system was contaminated. The first opportunity to screen out these particles would have been the finger filter located in the fuel tank; however, this filter may not have been fine enough to prevent some of the debris from migrating to filters downstream. A filter screen in the gascolator should have provided a second barrier but it was missing, allowing debris to continue travelling through the fuel system. The presence of blue sealant around the rim of the bowl which had also migrated inside the bowl, may also have resulted in some of the material flowing into the fuel pipes, increasing the potential of a fuel blockage.

Downstream, the substantial number of granules found in the in-line filter could have caused a fuel blockage before fuel could even reach the carburettors. The considerable number of granules attached to the filter element could have reduced fuel flow below the amount the engine needed to keep running, particularly during high fuel flow demand.

It is probable that the debris was introduced into the fuel system during transport, storage, and construction of the aircraft within multiple dusty and grimy environments over the 28 years it took to build it.

Carburettor issues

If ambient air was able to leak through the loose seal between the carburettor and the manifold during engine vibrations, this could have affected the pressure in the manifold and resulted in a lean fuel mixture. This could have contributed to the engine failure.

The rotated carburettor piston would have adversely affected the venturi cross-sectional area, reducing the efficiency of the carburettor. The potential compromise of the seal between the upper and lower surfaces of the diaphragm could have also affected the piston operation and only increased the carburettor's inefficiency. The leaking float bowl needle valve would have increased fuel flowing into the venturi causing a rich fuel mixture thereby reducing the engine performance even more.

The difference between the efficiency of the right carburettor, which was operating correctly, and the left may have mechanically unbalanced the engine, caused vibration, and reduced engine power. Whilst not immediately catastrophic, the imbalance can become safety critical when combined with carburettor internal faults, induction leaks, and high power settings.

Fuel drain checks

The new owner stated that fuel drain checks had not been conducted before both flights on the day of the accident. Even if the owner had used the walk-round guide provided with the aircraft when it was purchased, there was no entry requiring fuel drain checks. Had the pilot located the Zenair CH 601 operating handbook and found the walkaround guide, the checklist may have prompted her to ask where the gascolator and its fuel drain were located to allow the check to be undertaken.

The necessity for fuel drain checks prior to flight cannot be overstated. They are required before the first flight of the day, which is not only stated in the owners' manual but paragraph 18 of CAA Safety Sense Leaflet '1e, *Good Airmanship*³, which refers to the need to check the fuel drains for water and other contaminants. This necessity is also featured in the sample and testing section of CAA Safety Sense Leaflet 28⁴, '*Fuel Handling and Storage*', which states that sampling fuel for water and other contaminants is a '*vital part of any aircraft pre-flight.*'

Potential cause of the engine failure

Whilst the precise cause of the engine failure could not be positively determined, the migration of debris throughout the fuel system, exacerbated by the lack of one of the key filters, may have resulted in a fuel blockage causing the engine to stop. Even if a complete fuel blockage did not occur, the debris may have significantly reduced fuel flow to the carburettor which, when combined with the inefficiency of the left carburettor, could have been a significant factor in the engine failure.

Basic engine and aircraft checks

Whenever purchasing an aircraft, it would be prudent to have an appropriate aviation experienced engineer who is familiar with the aircraft type to check its basic condition, including such things as fuel samples. These additional checks may provide early warnings of latent issues that could adversely affect the correct functioning of the aircraft and the engine.

Conclusion

The engine failure was probably caused by restricted fuel flow due to contamination within the aircraft's fuel system, combined with the degraded performance of the left carburettor. The contamination, consisting of sediment and debris present throughout the fuel system, was able to migrate downstream due to the absence of a gascolator filter screen. Granules of debris accumulated within the in-line filter, which may have restricted fuel flow to the engine.

The left carburettor was found to have multiple faults, including a loose inlet manifold mounting, a misaligned diaphragm and a leaking float needle valve, which would have adversely affected fuel metering and engine efficiency. These faults likely contributed to reduced engine performance and increased susceptibility to fuel flow restrictions.

The aircraft had been constructed over a prolonged period in varied storage conditions, which undoubtedly contributed to the introduction of debris into the fuel system. In addition, pre-flight fuel drain checks were not carried out on the day of the accident, and the pilot was unaware of the gascolator and its function. Consequently, an opportunity to detect the contamination prior to flight was missed.

Footnote

³ <https://www.caa.co.uk/media/do4h50i0/20130121ssl01.pdf>.

⁴ <https://www.caa.co.uk/data-and-publications/publications/documents/content/safety-sense-leaflet-28/>.

This accident highlights the importance of effective fuel system filtration, thorough pre-flight inspection - particularly fuel drain checks - and the value of independent technical oversight when bringing newly acquired aircraft into use.