

Field Notes

Date of accident: November 27th 2024
Location of the accident: Ocean Isle Beach, SC
Aircraft registration: N814B
Aircraft type: AR BOT JOURNEY
Engine type and S/N: Rotax 912ULS2, S/N 5647261
NTSB file number: ERA25LA062
Date of Report: January 27th 2025
File number: 2024-051

Original Accident Location:

Ocean Isle Beach, SC

Location and date of on-site investigation:

Inspection carried out at: Hanger at K60J Airport, Ocean Isle Beach, NC

Date of inspection: January 27th, 2025

Persons in attendance

- FAA Aviation Safety Inspector – Shane Graham
- Rotech Flight Safety – Jordan Paskevich

ENGINE

Rotax Engine Model Number: Rotax 912ULS2

Rotax engine serial number: 5647261

Manufacturing Date: 06.10.2006

Initial condition of the engine as presented before the inspection

The aircraft wreckage was stored outdoors, with the fuselage covered by a tarp. However, the firewall and engine were uncovered and exposed to the elements. The aircraft sustained substantial impact damage, with the firewall and engine separated from the fuselage.

- The propeller was an E-Prop ground-adjustable 3-blade design. Two blades were broken off at the hub, and the third blade was fractured approximately 6 inches from the hub.
- The exhaust muffler and pipes were aftermarket, non-Rotax components, and sustained impact damage. The #1 and #2 exhaust pipes were separated from the muffler assembly.
- The oil cooler and coolant radiator were damaged from the impact, resulting in breaches in both systems.
- The ignition modules were aftermarket, non-Rotax brand, and had been relocated behind the firewall using a modified extended wiring harness.

Detailed Engine Inspection

The engine and firewall were moved to a hangar to facilitate the detailed examination.

Ignition System

The Rotax 912ULS ignition system consists of 4 ignition coils, 2 ignition modules, 8 ignition cables (leads), 8 spark plug connectors (caps), and 8 spark plugs.

- The ignition modules were aftermarket, non-Rotax brand, and had been relocated behind the firewall using a modified extended wiring harness.
- A physical inspection revealed all components to be in good condition, with no visible damage. The condition of the spark plugs suggested that the ignition system was functioning correctly; however, a functional test of the ignition system was not performed.

Spark Plugs & Spark Plug Connectors

- All 8 spark plug caps remained securely attached to the spark plugs.
- The 8 spark plugs were securely tightened when removed from the cylinder heads. After removal, they were placed in a holding tray for inspection.
- The spark plugs were identified as NGK DCPR8E.
- The #1, #3, and #4 top and bottom spark plugs had white insulators with no wear on the ground electrodes, indicating recent replacement. The #2 top and bottom spark plugs had dark tan insulators, suggesting a richer fuel-to-air mixture, but the lack of wear on the ground electrodes indicates they were also recently replaced.
- **Fuel System inspection:**

The Rotax 912ULS fuel system normally consists of fuel lines (including a fuel return line), a mechanical fuel pump, and two Constant Depression Carburetors.

- The fuel lines were covered with orange-colored fire sleeves and found securely connected to the inlet and outlet of the mechanical fuel pump and the carburetor inlets. The fuel system did not include the mandatory return line as per the Rotax installation manual instructions. All fuel lines were in good condition and clear of obstructions.
- The mechanical BCD pump (P/N 893115, S/N 23.1014) was damaged at the mounting base.
- The inlet and outlet fuel lines were removed from the fuel pump, and the mechanical fuel pump was removed from the reduction gearbox. When the fuel pump plunger was manually actuated, no fuel was expelled from the outlet port. However, the fuel pump had been previously activated during hand rotation of the propeller shaft which likely sent any fuel contained within it to the carburetor float bowls.
- The 1/3 carburetor was still attached and secured to its respective intake manifold. It was externally inspected and found to be in good condition. The 2/4 carburetor was slightly pulled away from its respective manifold due to impact but was also observed to be in good physical condition.
- Both the 1/3 and 2/4 carburetors were removed from the engine and placed on a table for internal condition inspection.

1/3 Carburetor: The carburetor float bowl was removed and internally inspected. It contained a small amount of yellow-colored liquid with an odor consistent with old automotive fuel. No contamination was observed in the fuel or at the bottom of the float bowl.

The floats were removed, inspected, and in good condition. They were of the updated style, marked with the letter "R" stamped on the side. The floats were weighed on a scale and were within the allowable limit of 7 grams. The main jet was inspected and found to be clear of any obstructions. The piston slide was examined in situ and operated normally; when manually actuated, it slid up the bore of the carburetor body with ease.

The chamber top of the carburetor was removed, and the piston slide, rubber diaphragm, and chamber top were separated, examined, and found in good condition. The throttle lever along with the attached throttle plate rotated through its full range of motion and operated as expected.

No anomalies were observed with the 1/3 carburetor or its internal components.

2/4 Carburetor: The carburetor float bowl was removed and internally inspected. The float bowl was absent of liquid, and no contamination was observed in the fuel or at the bottom of the float bowl.

The floats were removed, inspected, and in good condition. They were of the updated style, marked with the letter "R" stamped on the side. The floats were weighed on a scale and were within the allowable limit of 7 grams. The main jet was inspected and found to be clear of any obstructions. The piston slide was examined in situ, but it was seized in the fully down (idle) position and did not travel up the bore of the carburetor body when actuated.

The chamber top of the carburetor was removed, and the piston slide and rubber diaphragm were separated from the carburetor body. However, the piston slide was seized within the chamber top and could neither be separated nor rotated. While the piston slide and diaphragm were in good physical condition, the piston slide did not function properly. The throttle lever with the attached throttle plate rotated through its full range of motion and operated as expected.

The 1/3 and 2/4 carburetors were loosely reassembled and placed in a bag. FAA Aviation Safety Inspector Shane Graham took custody of the carburetors.

Lubrication system

The Rotax 912ULS engine incorporates a dry sump forced lubrication system, which includes a main oil pump with an integrated pressure regulator. The standard configuration of the oil system consists of an external oil tank, oil feed, and return lines, an oil cooler, an oil pump, and an oil filter.

Oil was observed throughout the engine's internals, including the reduction gearbox. All internal components showed signs of proper lubrication, with no excessive heat signatures, bluing, scoring, or metal transfer observed during the partial disassembly.

The oil pump and filter were externally examined and in good physical condition.

Cooling system

The Rotax 912ULS engine's cooling system is designed to provide liquid cooling for the cylinder heads and ram-air cooling for the cylinders. The cylinder head cooling system operates as a closed circuit with an expansion tank. Coolant is circulated by a water pump driven by the camshaft, moving coolant from the radiator to the cylinder heads. The accident aircraft was equipped with a carburetor heat system integrated into the engine coolant system, routing engine coolant through a series of coolant lines into an aluminum block mounted between the intake manifolds and carburetor sockets.

The Rotax 912ULS cooling system typically consists of coolant lines, a coolant radiator, a water pump, an expansion tank, and an overflow tank.

Coolant system breach: The coolant system was breached because of impact damage to the coolant radiator. The expansion tank cap was removed and found to be empty.

Coolant lines condition: The coolant lines were in good physical condition. However, several coolant lines were found detached from their connection points due to the impact, resulting in the coolant system being drained and void of coolant.

Overflow tank: The coolant overflow tank was no longer attached to the firewall and was disconnected from the coolant line leading from the expansion tank. The overflow tank was unavailable for inspection.

Cylinder head inspection: The rocker arm shafts in each cylinder head rotated and moved freely, indicating adequate cooling and no evidence of overheating in the cylinder heads.

Exhaust system

The Rotax 912ULS exhaust system typically consists of four exhaust pipes, a muffler, and an exhaust elbow.

The exhaust muffler and pipes were aftermarket, non-Rotax components, and sustained impact damage. The #1 and #2 exhaust pipes were separated from the muffler assembly.

Reduction Gearbox

The Rotax 912ULS has a reduction gearbox designed to reduce the engine's rotation speed to match the propeller's operational requirements. The gearbox features a propeller shaft, a gearset with a 2.43:1 reduction ratio, axial springs, a dog hub, an eccentric mechanism for actuating the mechanical fuel pump, and an overload clutch. It is lubricated with the same oil as the engine.

The reduction gearbox installed on the accident engine was a Version 2 configuration, designed for use with a fixed-pitch, ground-adjustable, or electrically controlled constant-speed propeller.

The gearbox was inspected and found to be undamaged, in good condition, and adequately lubricated. Hand rotation of the propeller shaft revealed no unusual noises, roughness, or resistance, and it rotated freely.

Cylinder heads, Cylinders and Pistons

The Rotax 912ULS engine has four liquid-cooled cylinder heads, air-cooled cylinders, and aluminum pistons.

The cylinder heads were found to be in good physical condition, and valve train continuity was confirmed during the manual rotation of the propeller shaft. The cylinder heads were removed from the cylinders, and no anomalies were observed with the cylinder heads or their components, including the valves, rocker arms, and valve springs.

The air-cooled cylinders were also found to be in good physical condition. After being removed from the engine and inspected, no signs of overheating, metal transfer, or scoring were observed. All the cylinder walls displayed good cross-hatching, and adequate oil lubrication was evident.

The pistons were examined and in good condition, with no signs of detonation or pre-ignition. The piston rings were free within their land grooves, and no indications of overheating or damage were observed.

Air Filters

The air filters appeared to have been properly serviced, with the pleats adequately oiled and clean, and no obstructions observed. Both air filters were securely attached to their respective carburetors. However, the air filter for the #2/4 carburetor sustained damage from the impact.

Crankshaft

The Rotax 912ULS crankshaft is a multi-piece, pressed-together assembly made of high-strength steel. It features splined ends for secure connections to the propeller gearbox and accessories, integrated counterweights for balance, and internal oil passages for efficient lubrication. The crankshaft incorporates four connecting rods, specifically designed for the horizontally opposed 4-cylinder layout.

A continuity check was performed during the manual rotation of the propeller shaft. The crankshaft rotated easily and smoothly, with no unusual noises or roughness detected. All four pistons moved equally and independently, indicating the crankshaft was not twisted or damaged.

The crankshaft was visually inspected through the piston bores on the crankcase and appeared to be in good condition. No bluing or excessive heat signatures were observed, indicating proper oil lubrication.

Camshaft and Valve Train

The Rotax 912ULS camshaft is positioned below and parallel to the crankshaft within the crankcase. It is a single-piece steel-alloy construction with eight lobes that activate the intake and exhaust hydraulic lifters. These lifters are connected to pushrod tubes that actuate rocker arms in the cylinder heads, which open and close the intake and exhaust valves. Each cylinder has one intake, and one exhaust valve, equaling a total of eight valves. The camshaft is gear-driven and connected to the crankshaft via a gear set located at the rear (aft) of the engine behind the ignition housing. Additionally, the camshaft drives the engine oil pump.

A continuity check was performed during the manual rotation of the propeller shaft. The camshaft rotated easily and smoothly, with no unusual noises or roughness detected. A thumb compression check was also conducted on each cylinder, confirming proper valve operation indicating that the camshaft was rotating and functioning as expected.

Summary

The investigation of the Rotax 912ULS engine revealed that, despite significant impact damage to the airframe and external systems, the majority of the engine's internal and external components were in good condition, with no anomalies observed. Detailed inspections confirmed that despite a breach in the oil system, sufficient lubrication was evident throughout the engine, with no signs of overheating, scoring, or excessive wear. Similarly, while the cooling system was breached due to impact damage, there were no indications of overheating in the cylinder heads.

A significant anomaly was identified in the 2/4 carburetor, where the piston slide was seized within the chamber top and prevented normal movement. This issue could lead to reduced engine performance, rough running conditions, or improper fuel delivery to the affected cylinders. While no contamination or visible damage was observed in the carburetor's internal or external components, the seized piston slide remains a critical finding.

Both the 1/3 and 2/4 carburetors have been sent to the NTSB lab for further analysis to determine the cause of the seizure.