



## Summary report

With regard to the present serious incident, a summary investigation was carried out in accordance with Article 45 of the Ordinance on the Safety Investigation of Transport Incidents of 17 December 2014 (OSITI), status as of 1 February 2015 (SR 742.161). The sole purpose of an accident or serious incident investigation is the prevention of accidents or serious incidents. It is expressly not the purpose of the safety investigation and this report to determine fault or liability. If this report is used for purposes other than accident prevention, this fact shall be taken into account.

The Italian version of this report is the original reference version.

<b>Aircraft</b>	Diamond Aircraft Industries GmbH HK36TTC	HB-2314
<b>Operator</b>	Gruppo Volo a Vela Ticino, 6596 Gordola	
<b>Owner</b>	Gruppo Volo a Vela Ticino, 6596 Gordola	
<b>Pilot License</b>	Swiss citizen, born 1958 Private pilot license airplane (PPL(A)) according to the guidelines of the <i>European Union Aviation Safety Agency (EASA)</i> , issued by the Federal Office for Civil Aviation (FOCA)	
<b>Flight hours</b>	<b>total</b> 955:18 h <b>with the type involved</b> 12:24 h	<b>during the last 90 days</b> 49:06 h <b>during the last 90 days</b> 9:24 h
<b>Passenger License</b>	Swiss citizen, born 1952 Private pilot license airplane (PPL(A)) in accordance with the guidelines of the <i>European Union Aviation Safety Agency (EASA)</i> , issued by the Federal Office for Civil Aviation (FOCA)	
<b>Flight hours</b>	<b>total</b> 1331:49 h <b>with the type involved</b> 394:52 h	<b>during the last 90 days</b> 12:42 h <b>during the last 90 days</b> 4:10 h
<b>Location</b>	Locarno Airport (LSZL) <sup>1</sup>	
<b>Coordinates</b>	---	<b>Altitude</b> --- m/M
<b>Date and time</b>	9 July 2021, 13:52 local time (LT <sup>2</sup> = UTC <sup>3</sup> + 2 h)	
<b>Type of flight</b>	Private	
<b>Flight Rules</b>	Visual Flight Rules (VFR)	
<b>Departure</b>	Locarno Airport (LSZL)	
<b>Destination</b>	Albenga Airport (LIMG)	
<b>Flight phase</b>	Take-off and climb	
<b>Type of serious incident</b>	Smoke development in engine compartment and cockpit	
<b>Personal injuries</b>	<b>Crew</b>	<b>Passengers</b>
Not injured	2	0
<b>Damage to aircraft</b>	Slightly damaged	Turbocharger
<b>Damage to third parties</b>	None	

<sup>1</sup> Locarno Airport (LSZL) is an airport with mixed civil and military flight operations.

<sup>2</sup> LT: Local Time

<sup>3</sup> UTC: Universal Time Coordinated

## Factual information

### General Aspects

The following presentation of the course of events is based on the descriptions of the pilot, the passenger and eye-witnesses. For the reconstruction of the flight, recordings of communications with air traffic control, data recorded by the engine's Turbocompressor Control Unit (TCU) and the recording of the flight path via the pilot's tablet computer were available.

### Pre-flight history

The pilot and the passenger were both licensed and qualified for the type of aircraft involved. They also both had flying experience with aircraft equipped with the same type of engine in its different variants, the BRP-Rotax 914 F4 variant with turbocharger, which was installed in the aircraft involved in the serious incident.

The morning before the flight, they performed the usual preparations and preliminary checks before loading the motor glider for a multi-day trip to Italy. Among the various items on the checklist, they checked the engine oil level and found that the quantity was within the limits as prescribed by the manufacturer.

Then the pilot started the engine, and after taxiing to the runway holding bay he performed the run-up<sup>4</sup> without noticing any anomaly.

### Course of events

The motor glider Diamond Aircraft Industries GmbH HK36TTC, registered HB-2314 and commonly known under the commercial name "Superdimona", took off at 13:46 from the concrete runway 26R of the airport Locarno (LSZL).

After a few minutes the occupants noticed a strange smell during the initial climb. An initial scan of the engine instruments did not reveal any anomalies. About thirty seconds later, a curtain of smoke began to appear in the cockpit, which is configured with side-by-side seating. The smoke appeared to be coming from the baggage area which is located behind the occupants' heads. The pilot requested an immediate return to landing due to a rapid increase in smoke density, despite the fact that both canopy windows were open. The engine was kept running as the instruments indicated no abnormalities.

For a brief moment, the occupants considered dropping the canopy because of the significant reduction in visibility. They decided otherwise and proceeded with the approach for an emergency landing.

In the meantime, the air traffic controllers observed a thick trail of white smoke coming from the engine area of the aircraft and alerted the fire brigade of the military air base, which immediately intervened with fire-fighting vehicles.

The aircraft landed six minutes after takeoff on the grass runway 08R after a straight-in approach.

The pilot immediately shut down the engine and the occupants evacuated the aircraft. The smoke development stopped instantly and inspection of the engine compartment, from which the cowlings had meanwhile been removed, revealed no signs of a fire in progress.

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<sup>4</sup> Run-up is the term commonly used in aviation to indicate the test procedures and verification of engine parameters before take-off. In particular, engine speed, operating pressures and temperatures, indications and control lights, ignition circuits and idle maintenance are checked.

Findings

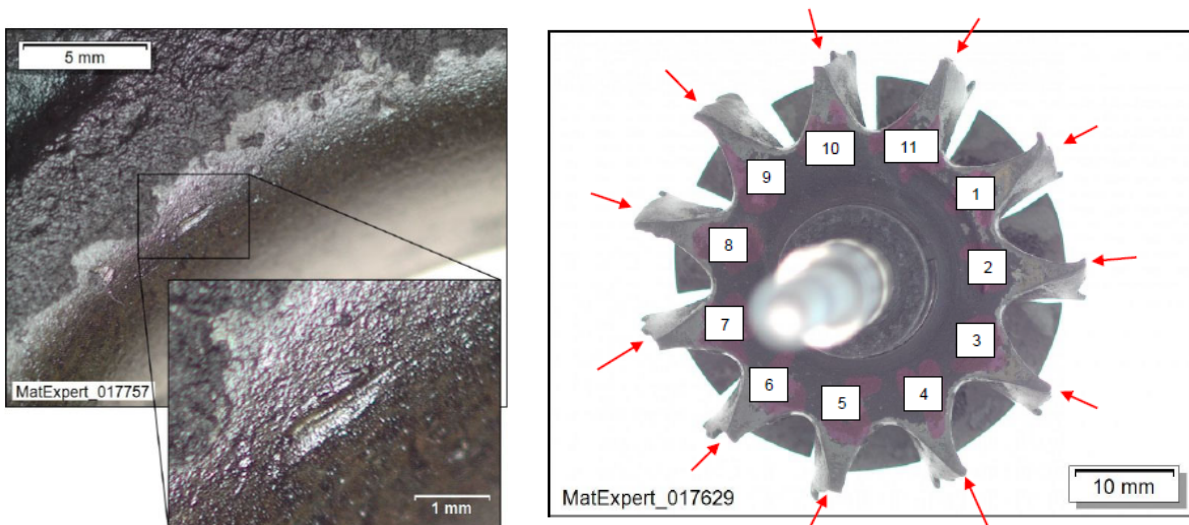
Turbocharger

Immediately after landing, black oil was seen dripping from the exhaust pipe, while the oil tank with a maximum content of 3 liters was practically empty. Oily soot was visible in the lower right corner of the engine compartment, in the region of the hot section of the Turbocharger (see Figure 1).



**Figure 1:** Front engine cowling after removal with evident oily soot deposit on the lower right part, in the region of the hot section of the turbocharger (yellow ellipse)

Subsequent inspection, in particular of the turbocharger, revealed significant foreign object damage (FOD) on the impeller on the exhaust side. All impeller vanes were damaged, as well as the impeller housing (see Figure 2). The metallographic analysis showed that the FOD had persisted for an undetermined period of time, but in any case, had not occurred only immediately before the serious failure.



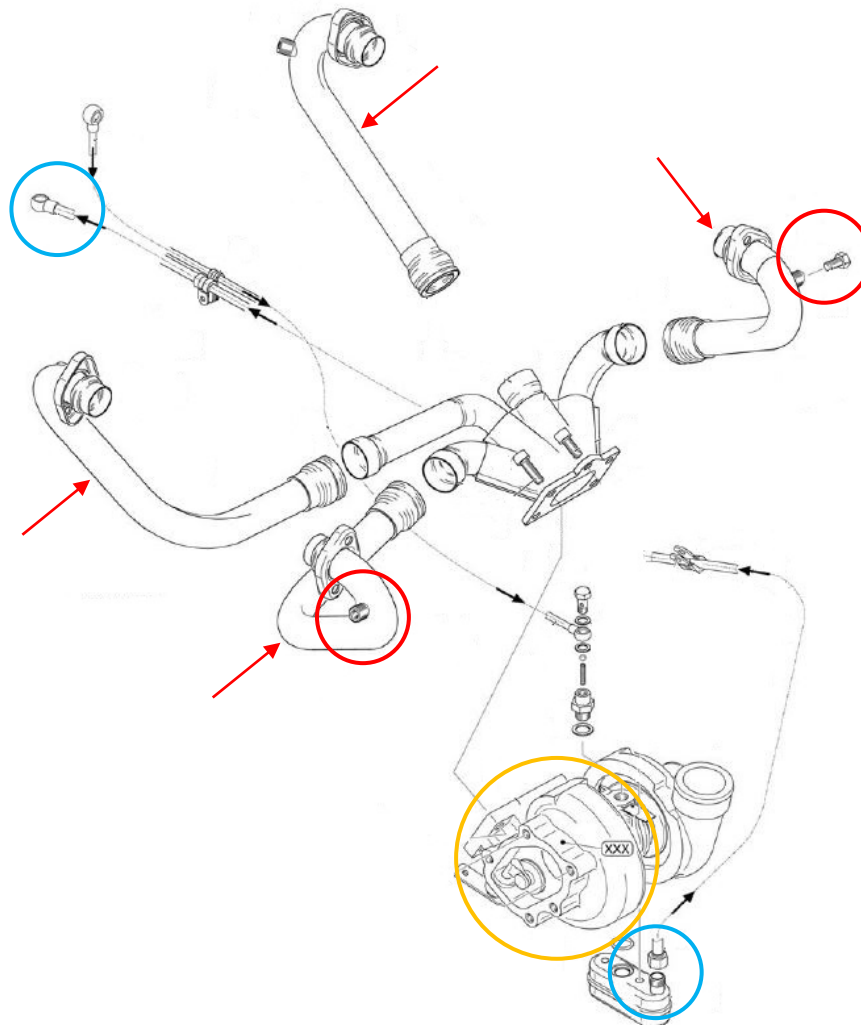
**Figure 2:** The left image shows FOD on the crankcase, the right image shows all 11 vanes also damaged at their outer ends

During a subsequent inspection a broken exhaust gas temperature sensor (see Figure 3) was discovered, located upstream of the turbocharger impeller inside the exhaust manifold.



**Figure 3:** Exhaust gas temperature probe. The missing part of the damaged probe (above) is highlighted by comparing the damaged probe to an undamaged probe (below).

In addition, in the turbocharger oil return line and in the turbocharger oil sump there were significant accumulations of carbonized material, which prevented the oil pump from sucking in the lubricant and returning it to the reservoir (see Figure 4).



**Figure 4:** Exhaust manifolds (red arrows), exhaust gas temperature probes (red circles), return oil line from the turbocharger and the relative pipe header (blue circles). The hot part of the turbocharger is circled in orange. Source: illustrated catalogue of the parts of the BRP Rotax 914 F4 engine, edited by STSB

The motor glider HB-2314 was normally fueled with 98 octane green (unleaded) automotive gasoline, occasionally aviation fuel of the AVGAS 100LL type (containing lead) had been used.

### Engine oil

The oil used by the operator on the recommendation of an authorized workshop was EVVA Oil C52 Airmax+ 10W40.

On 28 May 2021 the engine manufacturer published the Service Instruction SI914019R12, specifying the operating fluids allowed for operation with the Rotax 914 F4 engine. In this Service Instruction, which is also referenced in the corresponding Type Certificate Data Sheet (TCDS) EASA.E.122 and therefore an integral part of the engine certification, EVVA Oil C52 Airmax+ 10W40 is not covered. This type of oil had been removed from the corresponding Service Instruction since revision R7 published on 16 April 2015.

The engine manufacturer clearly specifies in the same Service Instruction that failure to observe the provisions contained therein may result in engine damage.

The oil sample taken immediately after the serious incident was analyzed at a specialized laboratory. The oil had been changed 83 hours before the serious incident. The analysis showed lead and copper contamination, as well as increased traces of fuel with a resulting decrease in viscosity.

## Analysis

### Technical aspects

The turbocharger impeller and crankcase showed clear signs of FOD. In the light of the finding of the exhaust gas temperature probe broken further upstream in the exhaust manifold, it is probable that fragments of the probe, thrown by the exhaust gas flow against the blades of the impeller, was the cause of the damage to the impeller and the crankcase.

The damage certainly caused a significant imbalance in the impeller, resulting in a suboptimal rotation of the impeller, which caused abrasion of material typically used in the construction of bushings and found inside the oil. A further undesired effect could be identified in the increase of the operating temperature of the turbocharger due to friction.

Due to the high rotational speed of a turbocharger impeller, the sealing joint separating the lubricating oil from the exhaust gases is a piston ring type one and very delicate.

The unbalanced rotation of the impeller most likely allowed the very hot exhaust gases to come into contact with the lubricating oil, creating charred residue that clogged the oil return pipe between the turbocharger and the oil pump. Once this pipe was completely clogged, the delivery pressure of the "fresh" oil found no other way to discharge than to force the lubricant into the impeller from the exhaust gas side, causing the typical white trail caused by unburned and vaporized oil.

Considering the oil tank content of about 3 liters and the volumetric flow rate of the lubrication circuit of about 2.6 liters per minute, it is evident how quickly the lubricant will be completely dispersed.

The use of a type of lubricating oil that is not specified in the manufacturer's operating instructions is to be avoided, even if this is not relevant in this case. The problem of the use of non-approved lubricating oils was the subject of an FOCA study, which has been published with the [SAND<sup>5</sup> 2022-001 recommendation](#).

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<sup>5</sup> SAND is an acronym for "Safety Awareness Notification Data" used by the Federal Office of Civil Aviation (FOCA) to denote safety-related information that provides instructions and recommendations to the civil aviation community.

The shape of the fuselage creates certain areas of low pressure which can cause suction of outside air. In the present case, air contaminated by vaporized oil was sucked in and created visible smoke in the cabin.

### **Operational aspects**

The pilot's decision to immediately turn back to the airport and declare an emergency was appropriate in terms of safety considering the proximity of the departure airport, which was able to provide all necessary assistance. The quick reaction also allowed to limit the damage to the engine as lubricating oil was still present, even if in limited quantity only. Any hesitation would certainly have led to the complete leakage of the lubricating oil, with potentially severe consequences.

### **Conclusions**

The serious incident in which a Diamond Aircraft Industries HK36TTC "Superdimona" type motor glider was forced to make an emergency landing due to the development of smoke in the engine compartment and cabin was caused by engine oil spilling and vaporizing into the exhaust pipe.

The oil leakage was caused by the clogging of the oil return line from the turbocharger as a result of the creation of carbonization residue generated by contact from the hot exhaust gases that entered the oil circuit through the seal, which in turn was damaged by the unbalanced rotation of the turbocharger impeller, which had most probably previously been struck by a fragment of the exhaust gas temperature probe.

In view of these results, the Swiss Transportation Safety Investigation Board comes to the conclusion that with regard to the serious incident investigated here, no further results are to be expected that would be useful for the prevention of such an incident. Therefore, based on Art. 45 OSITI, the STSB refrains from further investigative actions and closes the investigation with the present summary report.

Bern, 17 January 2023

Swiss Safety Investigation Service