Short summary of the occurrence

On 31 March 2017, the pilot of the type DV-20 Katana (Figure 1) aircraft with registration mark HA-DAL detected loss of engine power during the climb after take-off, so he interrupted his flight task and returned to the airport. An eye-witness saw smoke leave the exhaust pipe of the engine of the aircraft during landing. Landing was performed safely, and none of the people on board was injured, and the aircraft was not damaged either. Smoking stopped upon stopping of the engine.

Figure 1: The aircraft (Source: Internet)

According to the position of the Investigating Committee (hereinafter: IC) of TSB, the occurrence was caused by the fracture of the piston and associated piston rings in Cylinder 1.

The IC found no circumstance which would warrant a safety recommendation.

Factual information

Occurrence category:	Serious incident			
Date of occurrence:	31/03/2017, 18:32LT			
Location of occurrence:	Tököl non-public take-off and landing ground (LHTL), Hungary			
Type and registration of aircraft:	DV-20 KATANA, HA-DAL			
Year of manufacture, serial number:	1995, 20135			
Type of engine:	Rotax 912 S3			
Purpose of flight:	Private, cross-country			
	Crew	**Passenger**	**Other**	
People **Number:**	1	1	-	
People **Injured:**	0	0	-	
Damage to property:	**Aircraft:** Undamaged **3rd party:** --			
Licence and ratings of PIC:	PPL(A)[1], SEP(Land)[2], TMG[3], FI(A)[4]/CRI(A)[5]			
Age and citizenship of PIC:	49 years old, Hungarian			
Flight experience of PIC:	**Total**	**On the type**	**Last 90 days**	**Last 7 days**
Flying hours:	ca. 240	ca. 150	N/A	N/A
Sources of information:	Report, on-site investigation, witness interviews			

[1] Private Pilot Licence
[2] Single Engine Piston (Land)
[3] Touring Motor Glider
[4] Flight Instructor
[5] Class Rating Instructor

History of the flight

In 2017 DV-20 Katana HA-DAL and a passenger took off for a sightseeing flight from Tököl non-public take-off and landing ground. The pilot chose the 140° runway direction for the take-off, for which he had to taxi along the available runway, then turn round and take off in the opposite direction. The engine test, the taxiing and the take-off run took place as usual, as compared to the 150 hours of experience gained by the pilot flying this aircraft type. However, according to his report, the pilot found during the climb following the take-off that the engine was louder than usual, and it gradually began to vibrate, while its power became lower than usual. According to his position, the pilot found that he could not land safely continuing the straight direction of his take-off already, so he decided to fly a shorter round along the traffic circuit. Because he felt smoke penetrating the flight cabin while he was making the first turn, he changed his mind and decided to turn round and land in the 320° direction, i.e. opposite the direction of his take-off. During his approach, the smoke was visible from the control tower as well, according to a witness. Apart from that, the approach was trouble-free, as well as landing. After leaving the runway and stopping, the pilot shut the engine down and de-energized the aircraft. When the engine was stopped, the smoke also stopped. The occupants of the aircraft were not injured during the occurrence, and the aircraft did not suffer damage other than the engine malfunction.

The scene and the wrecks

No wreck was generated in connection with the occurrence.

The aircraft

The aircraft involved in the occurrence is a two-seat, low-wing aircraft with T-tail. It is powered by one type Rotax 912 S3 carburetted, water-cooled, four-cylinder, four-stroke, reciprocating aircraft engine, which drives the adjustable-pitch, two-blade propeller through a reducer.

The aircraft was airworthy prior to the occurrence, and it was maintained in compliance with the requirements.

Aerodrome

Tököl Airport is a non-public take-off and landing ground, with 14/32 traffic pattern, and with a concrete runway sized 799 x 60 m. Its elevation (above sea level) is 100 m / 328 feet.

Malfunctioned equipment

At the posterior inspection, the IC found that both compression rings as well as the oil control ring broke in Cylinder 1 of the engine of the type Rotax 912 S3. The piston shows burn marks at the ring grooves, and it even burnt through in an area of a few square millimetres at the groove for the oil control ring. The piston surface contacting with the combustion chamber shows the signs of damage caused by loose pieces of metal, and there is aluminium (missing from the material of the damaged piston) smeared on the cylinder walls (Figure 2).

During the inspection performed by the manufacturer with full disassembly, signs of damage caused by circulation of metallic particles in the intake system at cylinder head 3 were also detected.

Figure 2: The damaged piston

Weather and visibility

The serious incident took place by daytime, in good visibility conditions. The barometric pressure converted to sea level was 1022 hPa, and wind speed was 4 m/s from 180°.

Additional information

- Abnormal burns in the cylinder of the engine:
  - Knock combustion occurs when burning spreads not from molecule to molecule but at a much higher speed than that. It is very harmful to the structural elements of the engine. It increases heat transfer to the piston and the walls on the one hand, and the fluctuation of pressure increases the stress of the structural elements on the other.
  - In the case of burning by auto-ignition, burning is not started by the spark of the plug but by a local overheated point or points where the temperature reaches the ignition temperature of the fuel mix. Such points may be generated by the heat load of the engine or if deposits (e.g. coke, soot) occur within the combustion chamber due to incomplete burn, or the spark plug heat range is not correct or perhaps the air-fuel mixture ratio is not appropriate, or the octane number in the fuel is lower than the specified value.
- The engine manufacturer's recommendations for the operating settings of the engine (especially valid when coolant temperature is higher than 120°C (248°F) and pressure altitude is below approximately 1000 metres (3500ft.) are as follows:
  - Engine speed over 5500 rpm is restricted to 5 min maximum,
  - Take-off RPM at WOT (wide open throttle) should not be below 5200 rpm to avoid loading the engine,
  - Continuous use of engine speed below 5200 rpm with WOT should be avoided, and, at pressure altitudes below 3500 ft., continuous use of engine speed below 5200 rpm must follow the graph below (Figure 3):

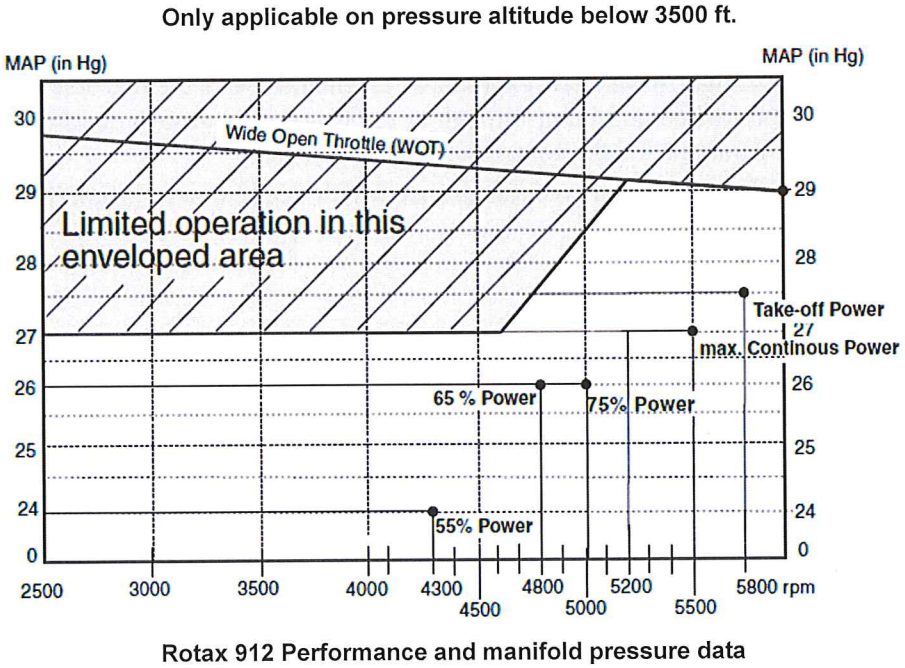

Figure 3: Operating range below 3500 ft. (Source: Service Letter SL-912-016R1)

- According to the manufacturer's inspection of the damaged engine, the damage symptoms at the piston of cylinders are the result of knocking combustion.

- According to the Service Letter № SL-912-016R1 published by the engine manufacturer on 30 December 2016, the causes of knocking combustion may be as follows:
  - Excessively high intake air temperature (due to improper use of carburettor heat),
  - Incorrect ignition timing (Incorrect spark plug grade/ heat range),
  - Excessively high engine load with low RPM (incorrect propeller pitch setting),
  - Lean fuel/air mixture (incorrect carburettor setting),
  - Poor fuel quality.

Analysis

When realising power loss of the aircraft engine, the pilot evaluated the situation correctly, and, owing to his decision, it was possible to avoid a more serious occurrence.

Compression in Cylinder 1 decreased due to piston ring fractures and to burn of the piston, which led to power loss and vibration of the engine. Particles of the fractured parts caused additional mechanical damages within the rotating engine. The fume of the oil leaking into and burning in the combustion chamber left through the exhaust pipe, which the witness saw, too.

During the investigation, the IC found no evidence which would prove that the engine malfunction was caused by shortcomings of maintenance or the use of inappropriate fuel.

According to information available to the IC, the aircraft involved in the occurrence was typically used for the training of student pilots. As a result, it may have been occurred that its engine was used – for shorter or longer periods – outside the optimum parameters specified by the manufacturer in the Service Letter № SL-912-016R1. This could have been caused by possible switched-on state of carburettor heating during a take-off following a go-around, and/or improper propeller pitch setting in various phases of the flight. A situation where the engine was operated at engine speed over 5500 rpm during climb following take-off may have occurred during student pilots' independent flights. The IC's position is that the breakdown of the engine was the result of a longer process during which the pistons and cylinders of the engine might have been exposed to mechanical and thermal loads in excess of the design values occasionally. The piston melted and burnt through at the piston ring groove due to excessive heat load which might have occurred during operation, and the compression rings fractured.

During the investigation, the IC found no circumstance which would warrant a safety recommendation.

Gábor Torvaji
Investigator-in-charge

József Mezei
IC Member

The sole objective of the safety investigation is to reveal the causes and circumstances of aviation accidents or incidents and to initiate the necessary technical measures and make recommendations in order to prevent similar cases in the future. It is not the purpose of this activity to investigate or apportion blame or liability.

General information

This investigation is being carried out by Transportation Safety Bureau on the basis of

- Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC,
- Act XCVII of 1995 on aviation,
- Annex 13 identified in the Appendix of Act XLVI. of 2007 on the declaration of the annexes to the Convention on International Civil Aviation signed in Chicago on 7th December 1944,
- Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as Kbvt.),
- NFM [6] Regulation 70/2015 (XII.1) on safety investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In absence of other relevant regulation in the Kbvt., in accordance with Act CL of 2016 on General Public Administration Procedures.
- The competence of the Transportation Safety Bureau of Hungary is based on Government Regulation № 230/2016. (VII.29.) on the assignment of a transportation safety body and on the dissolution of Transportation Safety Bureau with legal succession.

Pursuant to the aforesaid laws,

- Transportation Safety Bureau Hungary shall investigate aviation accidents and serious incidents.
- Transportation Safety Bureau Hungary may investigate aviation and incidents which – in its judgement – could have led to more accidents with more serious consequences in other circumstances.
- Transportation Safety Bureau Hungary is independent of any person or entity which may have interests conflicting with the tasks of the investigating body.
- In addition to the aforementioned laws, the ICAO Doc 9756 and the ICAO DOC 6920 Manual of Aircraft Accident Investigation are also applicable.
- This Report shall not be binding, nor shall an appeal be lodged against it.
- The original of this report was written in the Hungarian language.

Incompatibility did not stand against the members of the IC. The persons participating in the safety investigation did not act as experts in other procedures concerning the same case and shall not do so in the future.

The IC shall safekeep the data having come to their knowledge in the course of the safety investigation. Furthermore, the IC shall not be obliged to make the data – regarding which the owner of the data could have refused its disclosure pursuant to the relevant act – available for other authorities.

[6] Ministry of National Development