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AVIATION AND MARITIME INVESTIGATION AUTHORITY
Námestie slobody 6, P.O.BOX 100
810 05 Bratislava

FINAL REPORT

on safety investigation of a serious incident
of an aircraft type **Z-142**
registration mark **OM-LNS**

Reg. No: **SKS2019002**

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The investigation of occurrence has been conducted pursuant to Art. 18 of the Act No. 143/1998 on Civil Aviation (Civil Aviation Act) and on Amendment of Certain Acts and in accordance with the Regulation (EU) No. 996/2010 of the European Parliament and of the Council on investigation and prevention of civil aviation accidents and incidents, governing the investigation of civil aviation accidents and incidents.

The final report is issued in accordance with the Regulation L 13 that is the application of the provisions of ANNEX 13 Aircraft Accident and Incident Investigation to the Convention on International Civil Aviation.

The exclusive aim of investigation is to establish causes of accident, incident and to prevent their occurrence, but not to refer to any fault or liability of persons.

This final report, its individual parts or other documents related to the investigation of occurrence in question have an informative character and can only be used as recommendation for the implementation of measures to prevent occurrence of other accidents and incidents with similar causes.

A. INTRODUCTION

Aircraft type: Z-142
Registration mark: OM-LNS



Operator/Owner: private person
Operation type: general aviation/sports and recreational flying
Take-off site: Žilina airport / LZZI
Incident site: Brezany area
Flight phase: climb
Incident location: N 49°11'13.17", E 18°39'32.76"
Incident date and time: 1 September 2019, 16:02

Note: All time data in this Report is reported in UTC time.

B. INFORMATION SUMMARY

On 1 September 2019 at 15:55 the crew took off with an aircraft type Z-142, registration mark OM-LNS (hereinafter referred to as the "aircraft") from LZZI to perform a scheduled training flight in the area of LZZI.

At 16:01 the crew heard an unusual noise from the engine compartment and the aircraft started vibrating. At that moment the crew could not identify the cause of the vibrations, decreased the engine power and then decided to make a precautionary landing into terrain on a previously selected area.

The aircraft crew did not suffer any injuries.

The aircraft sustained major damage.

The aircraft owner reported the occurrence to the Aviation and Maritime Investigation Authority of the Ministry of Transport and Construction of SR.

A committee was set up to investigate the causes of the occurrence:

Ing. Ladislav Dospiva	Chairman of the Safety Investigation Committee
Ing. Juraj Gyenes	Member of the Safety Investigation Committee

The Report has been issued by:

Aviation and Maritime Investigation Authority
of the Ministry of Transport and Construction of the Slovak Republic.

C. MAIN PART OF THE REPORT

1. FACTUAL INFORMATION
2. ANALYSIS
3. CONCLUSIONS
4. SAFETY RECOMMENDATIONS

1. FACTUAL INFORMATION

1.1 History of the flight

On the above-stated date the crew of the aircraft wanted to perform a scheduled 40-minute training flight in the LZZI airspace. The flight was planned as a VFR (visual flight rules) flight without a flight plan. Before the take-off the crew performed pre-flight preparation (checked the airframe and the engine compartment, the engine check, visually checked it for any leakages, checked the oil and the amount of fuel and its distribution in fuel tanks).

Then the crew performed an engine check, while no parameter indications were beyond operational values. No leakages were discovered in the aircraft fuel system or in the engine oil system.

At 15:55 the crew took off from the runway 24 and continued climbing to the airspace above Brezany.

According to the crew's report, six minutes after they took off from LZZI they heard a loud thud from the engine compartment, followed by strong vibrations of the aircraft.

At that moment the crew could not identify the cause of the vibrations, decreased the engine power and then decided to make a precautionary landing into terrain on a previously selected slightly inclined grass area located to the left of the direction of the flight.

The crew performed a left turn and before the landing they extended flaps, closed off the fuel supply and switched off the main source of electrical power shortly before touching down.

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The aircraft touched down on an elevated piece of terrain at higher speed and bounced to the height of 5 m. According to the crew's report the aircraft flew 130 m at such height and made a three-point hard landing with considerable overload (7g).

Time of day: Day

Flight rules: VFR

1.2 Injuries of persons

Injury	Crew	Passengers	Other persons
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
No injuries	2	-	

1.3 Damage to the aircraft

The aircraft sustained major damage during the serious incident (damaged engine - engine block pierced with a torn-off piston rod, damaged propeller, firewall, front gear, left main gear and both parts of the wing).

After its disassembly the aircraft was transported to a hangar at LZZI.



1.4 Other damage

No circumstances have been reported to the Aviation and Maritime Investigation Authority which might lead to any other claims for compensation of damage against a third party.

1.5 Personnel information

Pilot (first crew member):

Citizen of the Slovak Republic, aged 64;

holder of a private pilot license issued by the Civil Aviation Authority of SR on 14 April 2010.

Medical certificate:

class 2 with marked validity until 20 March 2020

LAPL with marked validity until 20 March 2021

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Ratings:

SEP(L) with marked validity until 30/04/2020
Night flights without restrictions

Radiotelephone operator's restricted certificate for Aeronautical Service II issued by the Telecommunications Office of SR on 11 February 2010.

Flight experience:

Total flight hours: 337 hours
Total flight hours with this type of aircraft: 277 hours
Total number of flight hours clocked in the last 90 days: 4 hours 1 minute
Total number of flight hours on this type of aircraft clocked in the last 90 days: 4 hours 1 minute
Total number of flight hours clocked in the last 30 days: 0 hours 53 minutes
Total number of flight hours on this type of aircraft clocked in the last 30 days: 0 hours 53 minutes

Pilot (second crew member):

Citizen of the Slovak Republic, aged 64;
holder of a private pilot license issued by the State Flight Inspection on 29 December 1997.

Medical certificate:

class 2 with marked validity until 09/05/2020
LAPL with marked validity until 09/05/2021

Qualifications:

SEP(L) with marked validity until 31/07/2020

Flight experience:

Total flight hours: 1052 hours
Total number of flight hours clocked in the last 90 days: 27 hours
Total number of flight hours clocked in the last 30 days: 10 hours

1.6 Aircraft information

Type: Z-142
Registration mark: OM-LNS
Serial number: 0249
Year of manufacture: 1981
Manufacturer: Moravan, a.s. Otrokovice, CR
Total flight hours: 4259 hours 38 minutes

Airworthiness Certificate No. 0288-S/5 issued by the Civil Aviation Authority on 11 September 2008.

The Airworthiness Review Certificate was issued by AIR K - Service s.r.o., the following continuing airworthiness management organization residing at Smetanova 1841, 765 02 Otrokovice, CR, on 16 November 2018 and it was marked valid until 15 November 2019.

As of the Airworthiness Review Certificate day, the aircraft had flown 4217 hours 37 minutes.

Engine

Type: M 337 AK
Serial number: 812661
Year of manufacture: 1981
Manufacturer: Avia n.p. Letňany
Last overhaul: 15 October 2005, 895 hours 30 minutes
Total engine run time since the last overhaul: 79 hours 5 minutes
Last works performed after 50 hours: 13 November 2018
Last oil change: 15 November 2018 / after 930 hours
From the last oil change date until the occurrence date the engine was in operation during 44 hours
Total engine run time: 974 hours

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1.7 Meteorological information

N/A

1.8 Aids to navigation

The aircraft was equipped for VFR flights.

1.9 Communications

The aircraft was equipped with an on-board radio station enabling bidirectional radio connection of the flight with all aeronautical stations at all times.

1.10 Aerodrome information

LZZI was the scheduled take-off and landing site. LZZI is a public international airport located 12 km to the south-west of the Žilina city.

Size of the runway 06/24 used for take-offs and landings: 1150x30 m.

1.11 Flight recorders

The aircraft was not equipped with any flight recorder to record flight parameters or other recording devices.

1.12 Wreckage and impact information

Coordinates of the incident site:

N 49°11'13.17"

E 18°39'32.76"



1.13 Medical and pathological information

N/A

1.14 Fire

None.

1.15 Survival aspects

It was not necessary to perform any search or rescue with SAR equipment.

1.16 Tests and research

Samples of operating fluids were examined:

- AVGAS 100LL aviation fuel sample:
sent to a testing laboratory at VÚRUP, a.s.;
diagnostics result: the AVGAS 100LL aviation fuel sample meets the requirements of the ASTM D 910 standard in all parameters tested;
- TOTAL D 100 engine oil sample:
sent to a testing laboratory at MOL-LUB s.r.o., a company specializing in production, distribution and service of lubricants;
diagnostics result: **low oil viscosity.**
The viscosity and additives do not correspond to the type of oil specified in the engine log book.

Damaged piston rod with the piston:

sent to the Institute of Forensic Science of the Slovak Police for expert examination.

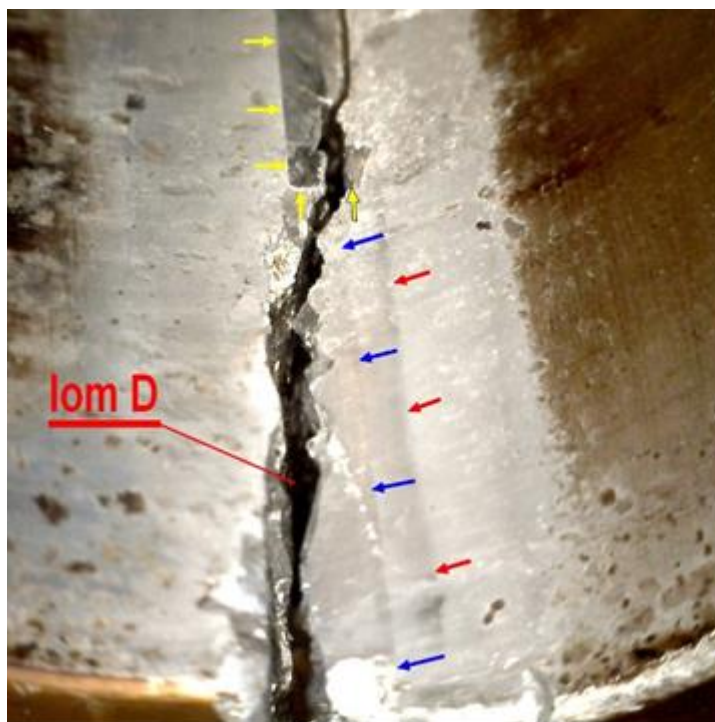
The examined piston rod was broken into seven parts. To make the description of the damaged piston rod clearer, the individual fractures are identified with letters A to G.



It was obvious from the layout and the direction of the fractures that the longitudinal fracture D in the connecting rod shank originated earlier than longitudinal fractures E, F and G – the positions of E and F did not correspond (such fractures were not connected, i.e. the connecting rod shank must have already been longitudinally divided by D at the time when E and F originated).

The fracture D originated as a result of intrusion of a solid object into the connecting rod shank in the direction from the inner wall of the connecting-rod eye. Several local material imprints originated at the place when the fracture D initiated (see the lines of such imprints marked with arrows), indicating that G could not have existed at that time, and that at the time when D originated the gudgeon pin was not pushing correctly to the lower part of the connecting-rod eye, i.e. that the upper connecting-rod eye must have been damaged at that time.

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G, F, E, C and B had similar surface morphology (Details of the fracture surfaces on the piston rod)



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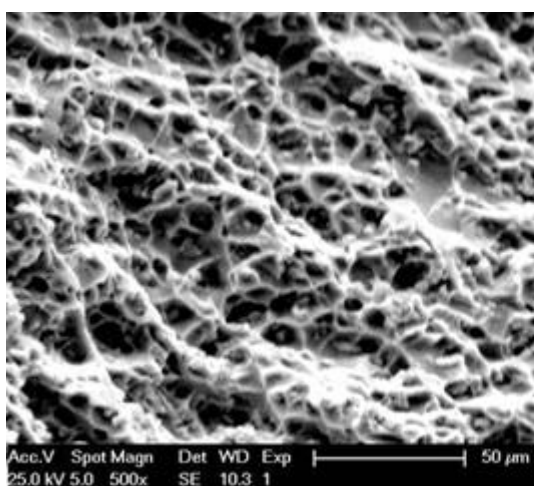
Fracture D had an obviously different morphology and secondarily imprinted surface. Since it has been proved that it originated only when the upper connecting-rod eye was already damaged, such fracture was not examined further in detail.



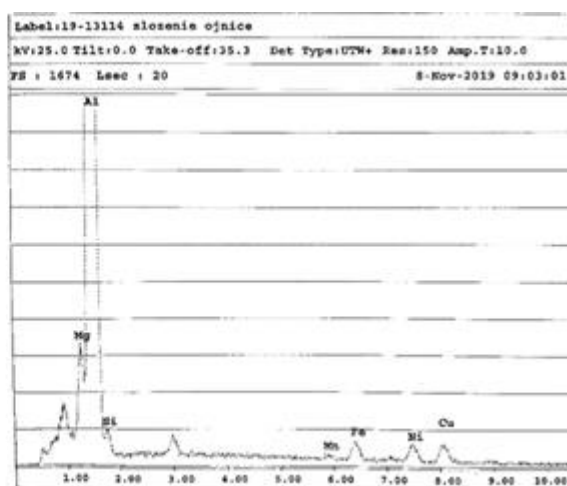
It was discovered from F that the fracture had a nature of a ductile fracture with obvious cup morphology and that the piston rod was made of an aluminium alloy.

Traces of magnesium, copper, nickel, ferrum, manganese and silicium were discovered on the fracture surface (see the spectrogram).

The piston rod was thus made of an alloy type Al-Cu-Mg. Such alloys are commonly used in aviation. Nickel further increases their firmness at higher temperatures - this corresponds fully to the use of such material for production of piston rods in aircraft engines.

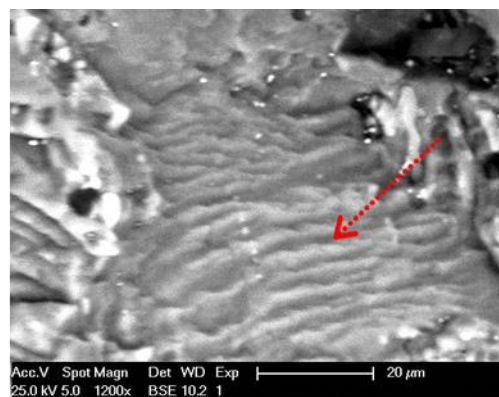
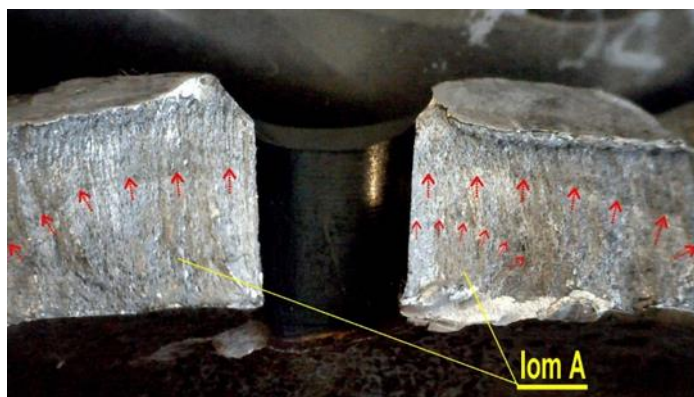


Cup morphology of the fracture F



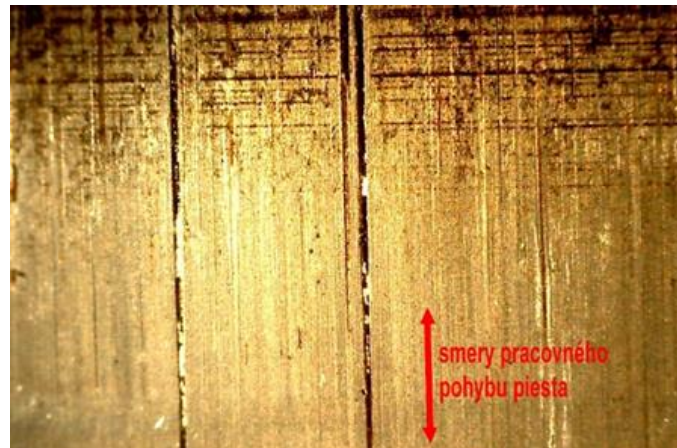
Spectrogram - material composition of the piston rod discovered on the surface of the fracture F

Fracture A located in the upper part of the connecting-rod eye directly at the lubrication aperture demonstrated less obvious signs of a certain staged damage to the material. Presence of the so-called growth striations was discovered during examination, confirming the fatigue mechanism of damage to the material in this part of the piston rod.



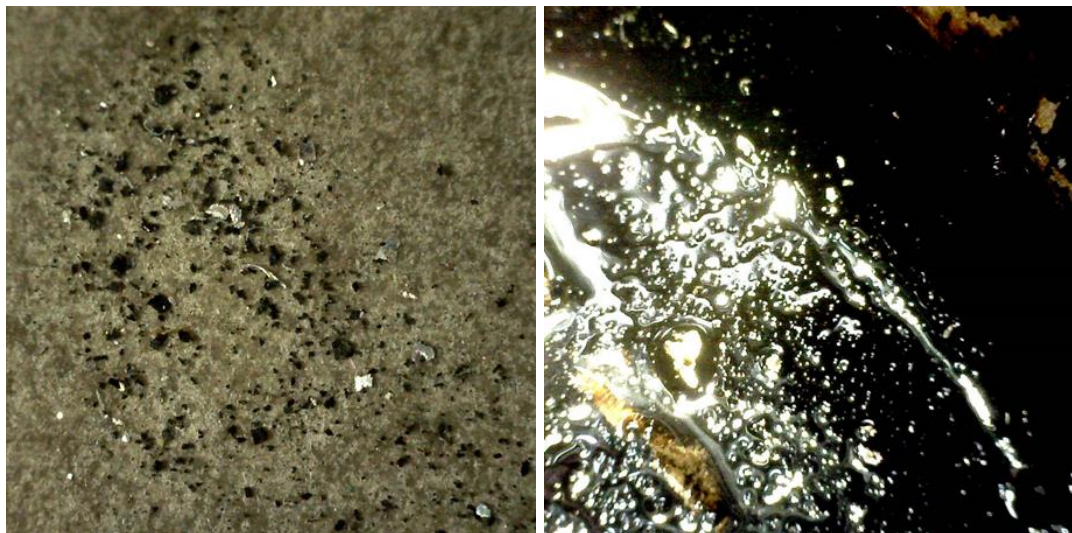
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Piston rings of the piston which worked together with the examined damaged piston rod were not damaged. Longitudinal dents resulting from light rubbing of the piston in the cylinder liner were found on the piston side wall; it was due to presence of mechanical impurities located in the working space between the piston and the liner.



Directions of the working movement of the piston

The remaining oil found in the piston cavity contained mechanical impurities. Analysis of such impurities using the scanning electron microscopy method confirmed two types of impurities or particles: particles based on magnesium with aluminium addition and particles based on lead with bromine addition.



The damaged piston rod and its piston was submitted together with an intact piston rod and its piston for comparison. Mechanical impurities of risky dimensions were discovered in the cavity of such piston as well. No similar longitudinal dents on the surface of such piston were discovered.



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For a fatigue-caused fracture to occur in the upper part of the connecting-rod eye, changeable material pull stress in such cross-section of the connecting-rod eye and some tension concentrator (dent or material defect) needed to be present and the so-called fatigue limit needed to be exceeded. In such case the function of the concentrator was performed by the lubrication aperture in the upper part of the connecting-rod eye. Changeable material pull stress in the connecting-rod eye was caused by inertia forces which are related to a high speed of sliding masses of the piston and the gudgeon pin, while such load peaked in the initial phase of the sucking working stroke. When the piston was also being braked by rubbing of impurities jammed between the piston and the cylinder liner during such movement, the fatigue limit could have been exceeded and the fatigue-caused damage to the connecting-rod eye may have started.

1.17 Organizational and management information

N/A

1.18 Additional information

On 11 September 2019 the Safety Committee dismantled and visually inspected the engine type M 337 AK, serial number 812661 at LZZI.

Conclusion from the visual inspection:

- the piston rod of the piston 5 was destroyed during the occurrence; it pierced the engine block and its remains were found in the engine;



- when the oil filter was disassembled and checked, an undefined amount of water was found in oil;
- no damage was discovered on the walls of the dismantled cylinders 4 and 5 which would indicate engine rubbing; however, their significant carbonization was discovered.



1.19 Useful or effective investigation techniques

Common investigation methods were applied.

2. ANALYSIS

2.1. Crew activity

After the crew heard a loud thud from the engine compartment and felt subsequent unusual aircraft vibration, they assessed the situation as an emergency situation which required an immediate decision to make a precautionary landing into terrain on a suitable area.

During the precautionary landing the crew performed all actions and measures according to the Flight Manual of the aircraft in question (In the case of any unusual vibration of the aircraft, it is necessary to set the engine revolutions at the lowest possible level for the flight and to make a precautionary landing into terrain with the engine running and flaps as necessary. If vibrations continue increasing enormously, it is necessary to shut down the engine and make an emergency landing.).

The safety of a landing into terrain depends on the pilot's decision according to their experience, suitability of the terrain and other circumstances. During the final landing the crew touched down on an uneven terrain at a higher landing speed what caused the aircraft to bounce 5 m above the ground and after further 130 m of flight the crew performed three-point hard landing (with 7g), causing damage to the aircraft.

2.2. Conclusion from the expert examination of the Institute of Forensic Science of the Slovak Police

Destruction of the piston rod of the piston 5 was caused by development of a **fatigue-caused fracture** in the upper part of the connecting-rod eye. Exceeding the so-called fatigue limit could have been related to rubbing of mechanical impurities between the piston and the cylinder liner in such part of the engine.

3. CONCLUSIONS / Cause of the serious incident

3.1 Findings

- the crew had valid licenses to perform flights with the particular aircraft category;
- at the time of the occurrence the crew was not under the influence of alcohol or narcotic drugs which could have reduced their attention during the flight and when dealing with the critical situation;
- the aircraft met airworthiness conditions before the critical flight according to the available documentation;
- the aircraft fuel system contained a sufficient amount of fuel of suitable quality;
- the aircraft oil system contained a sufficient amount of oil of **unsuitable** quality;
- On 6 April 2018, AERO DM 15W50 oil was used during oil change in the engine oil system. Such oil is not included in the list of oils suitable for permanent operation of the engine in the Technical Description and the Engine Manual.

3.2 Causes of the serious incident

- destruction of the piston rod No 5;
- landing into uneven terrain.

4. SAFETY RECOMMENDATIONS

The Final Report on safety investigation of the serious incident does not contain any recommendations.

In Bratislava, 06/12/2019