

FINAL REPORT

from

Investigation of a serious incident, realized on 14.08.2019 by Cessna 172N airplane, registration marks LZ-SPB, operated by Air Operator Avio Detachment Varna Ltd on Lesново Airfield, District of Sofia



2020 г.

Purpose of this report and level of responsibility

In accordance with Annex 13 of Chicago Civil Aviation Convention from December 7,1944, Regulation 996 / October 20, 2010 of European Parliament and of Council for Investigation and Prevention of Accidents and Incidents in Civil Aviation and Ordinance No. 13 from January 27, 1999 of MT (last edition from January 22,2016), the purpose of this incident investigation is to identify the reasons which have led to its implementation in order to be eliminated and prevented in the future **without identifying any guilty or responsibility**

CONTENTS

01. LIST OF ABBREVIATIONS	4
1. Introduction	5
2. Factual information.....	5
2.1. Flight History	5
2.1.1. Flight number and type, the last point of departure and time, and planned destination point	5
2.1.2. Flight preparation and description of the flight	5
2.1.3. Location of aviation occurrence	6
2.2. Injuries to persons	6
2.3. Damage to aircraft.....	6
2.4. Other damages.....	6
2.5. Personnel information:	6
2.5.1. Commander	6
2.5.2. Trainee pilot	7
2.6. Aircraft Information	7
2.6.1. Airworthiness Information	7
2.6.2. Aircraft characteristics	8
2.6.3. Information on the used fuel.	8
2.7. Meteorological information	8
2.8. Navigation systems.....	9
2.9. Communication systems.....	9
2.10. Aerodrome information	9
2.11. Flight recorders	9
2.12. Information about the impact and the debris	9
2.13. Medical and pathological information.....	10
2.14. Fire.....	10
2.15. Survival Aspects.....	10
2.16. Testing and research.....	10
2.17. Additional information	11
3. Analysis.....	12
4. Conclusion.....	13
4.1. Findings	13
4.2. Causes.....	14
5. Safety Recommendations:.....	14
ANNEX 1.....	16

01. LIST OF ABBREVIATIONS

AC	-	Aircraft;
DG CAA	-	Directorate General of Civil Aviation Authority;
SG	-	State Gazette;
CAA	-	Civil Aviation Authority;
AMRTAIU	-	Air, Maritime and Railway Accident Investigation Unit;
MT	-	Ministry of Transport;
MTITC	-	Ministry of Transport, Information Technologies and Communications;
CAMO	-	Continuing Airworthiness Management Organization
RWY	-	Runway;
MP	-	Maintenance program;
AOM	-	Aircraft Operation Manual;
AAIU	-	Air Accident Investigation Unit;
SOP	-	Standard Operating Procedures;
TLB	-	Technical Logbook;
CRS	-	Certificate of Realis to Service;
EASA	-	European Air Safety Agency;
FAA	-	Federal Aviation Administration;
ICAO	-	International Civil Aviation Organization;
NTSB	-	National Transportation Safety Board;
SSP	-	Special Service Publication;
UTC	-	Coordinated Universal Time.

1. Introduction

Date and time of air occurrence: 14.08.2019, 10:50 AM local time (7:50 UTC). Notified: Directory of Aircraft, Maritime and Railway Accident Investigation (AMRAIU), Directorate General of Civil Aviation Administration (DG of CAA) at the Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria (MTITC), the European Aviation Safety Agency (EASA) and European Commission, the National Transport Safety Board of the USA (NTSB), Bureau of Investigation and Analysis of Republic of France, the International Civil Aviation Organization (ICAO)

On the grounds of the provisions of Article 9, para.1 of Ordinance No 13 dated 27.01.1999 on Investigation of Aviation Accidents; the occurrence was classified as a serious incident by the Aircraft Accident Investigation Unit (AAIU) at AMRAIU Directorate at the MTITC. The materials on the aviation occurrence have been filed in case No 07/14.08.2019 in AAIU archives.

In accordance with the provisions of Article 5, Para1 of Regulation (EU) No 996/2010 on investigation and prevention of accidents and incidents in civil aviation, Article 142, Para2 of the Civil Aviation Act of the Republic of Bulgaria dated 01.12.1972 and Article 10, Para1 of Ordinance No 13 of the MT dated 27.01.1999 on the Investigation of Aviation Occurrences, by Order No RD-08-389/20.08.2019 of the Minister of MTITC, a Commission was appointed for investigation of the serious incident.

The difference between the local and Universal Coordinated Time is +3 hours. All times in this report are local.

On 14.08.2019, a Cessna F172 N aircraft, registration marks LZ-SPB, took off from Lesnovo airfield to perform a training flight in the training flying area above the Iskar Dam. A few minutes after take-off at an altitude of 3600 ft, the trainee pilot noticed appearance of fumes (smoke) from the left side of the dashboard. The instructor decided to terminate the flight, return and land back at the Lesnovo airfield. During the return flight, vibrations occurred and the engine shut down just before the threshold of RWY10. The aircraft landed successfully without further damages and without injury to the crew.

Cause of realization of the serious incident

Tearing of the engine oil filter from the adapter plate for its attachment to the engine crankcase, caused by plastic deformations in the mounting sleeve related to violations of technology of repair and/or maintenance.

2. Factual information

The factual background information on the flight history, its preparation and execution, as well as the occurrence of the aviation event itself, was obtained by the Commission from interviews and written evidence from witnesses and data from DG CAA.

The aircraft does not have a system for recording flight parameters.

2.1. Flight History

2.1.1. Flight number and type, the last point of departure and time, and planned destination point

Flight Number: Registration marks of the aircraft LZ-SPB.

Type of flight: Training flight.

Last point of departure: Lesnovo airfield.

Take-off time: 09:50 h.

Planned destination point: Lesnovo airfield.

2.1.2. Flight preparation and description of the flight

On 14.08.2019, a Cessna F172N aircraft, registration marks LZ-SPB, based on Lesnovo airfield, was planned to perform a training flight in the training flying area above the Iskar Dam. The crew consisted of commander-instructor and trainee pilot. Preflight check of the aircraft was conducted according the requirements of Section 4, Normal Procedures of Pilot's Operating Handbook. 41 US gallons of fuel and 5.3 quarters of oil were found on board according the engine oil level measuring line. No leaks of fuel and working fluids from aircraft systems were established during the examination of the aircraft. The preflight check was performed by the trainee pilot and it was recorded in the Aircraft Technical Logbook. The takeoff was at 10:47 AM according the logbook. During climbing at about 3600 ft (QNH), smoke (fumes) appeared from the left side of the cockpit. This smoke was noticed

firstly by the trainee pilot, who was seated in the left-hand seat. He reported this to the instructor and the latter decided to abort the task and return to the Lesnovo airfield. At the instructor's command, the trainee pilot began a right-hand turn. At starting the turn vibrations occurred in the engine area. The instructor took the controls. During the approach for force landing on RWY10 at Lesnovo airfield, the engine shut down 3...4s before touch down. After the touch down, the crew switched off the master switch, ignition, mixture enrichment and fuel tap. The landing was successful, without any consequences for the aircraft and crew. The landing was recorded in the Technical Log Book as 10:55 AM. The duration of flight was 8 min. After stopping, the crew leaved the aircraft and found out that the aircraft fuselage was spilled with oil. The aircraft was towed to aircraft maintenance hangar of Avio Detachment Varna Ltd. as shown in Fig. 1 and 2 of Appendix 1, where it was found that the engine oil filter was disconnected from the crankcase, the adapter plate was broken and the filter was attached to the engine by locking wire only.

2.1.3. Location of aviation occurrence

The force landing was realized on Lesnovo airfield with geographic coordinates of the reference point of the runway 42°38'4" N and 023°38'47" E. The elevation of the airfield reference point is 556 m (1824 ft).

The event was realized at daylight.

2.2. Injuries to persons

Injuries	Crew	Passengers	Total persons on board	Other persons
Fatal	0	0	0	0
Serious	0	0	0	0
Absent	0	0	0	0
Total	2	0	2	0

2.3. Damage to aircraft

The During the inspection of the aircraft after realization of air occurrence the following damages were found:

- There were traces of oil leakage under the airplane and all over the lower surface of the airframe;
- The oil filter was torn from the adapter plate and attached by the locking wire only, as shown on Fig. 10 of Annex 1;
- Destruction of mounting assembly of the adapter plate at the crankcase, Fig. 11 and 12 of Annex 1;
- Demolition of the valve lifter housing of the outlet valve of fourth cylinder, shown on Fig.13 of Annex 1;
- The mark on the dipstick for controlling the actual amount of oil shown in Fig. 9 of Appendix 1, evidenced of complete leakage of oil, and 200 ml of oil were drained from the crankcase.

2.4. Other damages

No other damages.

2.5. Personnel information:

2.5.1. Commander

Man of 68.

License: CPL (A). Date of first issuing: 20.05.2014. Valid qualification class SEP (land) (last check 15.05.2019, valid till 31.05.2021), instructor: SEP (land) FI (A) (last check 23.04.2017, valid till 31.05.2020).

The aircraft commander possesses medical certification Class 1, issued on 08.04.2019, valid till 08.02.2018. The medical certification was valid at the moment of realization of air occurrence.

Flight experience:

Total flight time about 15 000 hrs;

Information about duty time and rest:

8 hrs rest in the night before the flights.

The Commission accepts that the aircraft commander possesses the necessary training and experience for his functions.

2.5.2. Trainee pilot

Training Course - PPL (A), currently nearing the end of the flight training program, with 21 hours of flying time over 2 months.

2.6. Aircraft Information

2.6.1. Airworthiness Information

An Cessna F172N aircraft, registration marks LZ-SPB, was manufactured in 1979 by Reims Aviation Cessna, Republic of France. The serial number, written on the identification plate of the aircraft, shown on Fig. 3 of Annex 1, is F17201817. The airplane possesses a Certificate of Registration No.2523 issued by the Directory General of Civil Aviation Administration of the Republic of Bulgaria on 07.10.2014 and in this certificate the serial number is written as F172-1817. The aircraft is owned by Avio Detachment Varna Ltd with office address V. Varnenchik residential complex, block 401, entrance 17, ap. 288, Varna, Republic of Bulgaria. Aircraft operator is Avio Detachment Varna Ltd with office address Vladislav Varnenchik residential complex, block 401, entrance 17, apartment 228, Varna 9023, Republic of Bulgaria.

The aircraft has a Certificate of Airworthiness No. 25-0054, issued by DG CAA on 07.11.2014.

Airworthiness Review Certificate No.BG-ARC- 2385 is issued by Avio Detachment Varna Ltd, approval ref. No.BG.MG.0443, from 15.05.2018, valid till 20.05.2019 On 13.05.2019 the validity of this certificate was extended till 19.05.2020 In this certificate Cessna Aircraft Company USA is written as a manufactured and the serial number of the aircraft is cited as F172-01817.

At the time of the occurrence, the aircraft had a valid Certificate of Airworthiness and a valid Airworthiness Review Certificate, in which the above mentioned inconsistencies with the Certificate of Registration should be corrected.

An Aircraft Noise Certificate No 45-0055 was issued for the aircraft. The certificate was issued by DG CAA on 07.11.2014. In this certificate the serial number of the aircraft is written as F172-1817.

Total flying time since new to the day of air occurrence the aircraft has flown 9137:36 hrs.

The continuing airworthiness of the airplane was maintained in accordance with Cessna/Reims Cessna 172/F142 Airplane Maintenance Program, operated by Air Operator – Air Detachment Varna Ltd and approved by DG CAA on 01.04.2016.

On the basis of this document, a total technical resource of 30 000 flying hours for the airframe was established without a calendar limitation provided that certain conditions, given in the Program, were met.

The aircraft features a Lycoming O-320-H2AD aviation piston engine, serial No. L-1787-76T. At the time of air occurrence the engine has accumulated 1333:12 hrs, with 2000 hours time-between-overhaul or 12 years. The engine was mounted on the aircraft on 21.08. 2017.

The aircraft is fitted with a McCauley 1C160/DTM 7557M1 propeller with JB02D series blades. Until the moment of air occurrence the propeller has accumulated 1603:36 hrs, with 2000 hours time-between-overhaul or 72 months. The propeller was installed on 02.05.2017.

Documents relating to the history of the airplane do not contain any information related to the maintenance of the airplane from the year of production until June 2014. The manner in which the documentation was kept permits replacement of data, which is inadmissible.

At the time of execution of the flight the aircraft was provided with the necessary resource.

A Technical Log Book with a number 1910067 was completed for the flight. A pre-flight inspection by the trainee pilot under supervision of the instructor was performed and the amount of fuel and oil loaded on board were noted in the logbook. During the aircraft pre-flight inspection no malfunctions detected and eliminated were recorded. For the previous flight a Technical Log Book No. 1910066 was completed. There are no records in this logbook related to the abnormal operation of the

aircraft during the flight and at post-flight inspection.

Taking into account information in this paragraph, the Commission accepted that before the last flight was made, the aircraft was prepared in accordance with the continuing airworthiness requirements and was loaded with enough fuel to carry it out.

2.6.2. Aircraft characteristics

The Cessna 172N is an all-metal, four-seat, high-mounted wing, single-engine with non-retractable tricycle landing gear designed for general aviation.

The maximum take-off mass of Cessna 172N airplane, serial number F172-1817, LZ-SPB registration marks, according to the Aircraft Noise Certificate issued by the CAA No 45-0055 is 1043 kg. Standard empty weight of the aircraft is 683 kg, according the weighting protocol dated 21.03.2018 issued by the Air Detachment Varna Ltd. Maintenance Organization.

At the moment of landing there were about 108 kg of fuel on board, by readings of fuel meters. There are two people on board, a trainee pilot and an instructor. Provided the crew on board had a mass of 160 kg, the landing mass of the airplane was 951 kg.

The maximum landing mass of the airplane is 1043 kg.

Some typical speeds and limitations are given below in accordance with the Cessna 172N Aircraft Operation Manual.

Speed Limitations

	Speed	KIAS
V _{NE}	Never exceed speed	160
V _{NO}	Maximum structural cruising speed	128
V _A	Maneuvering speed	89
V _{FE}	Maximum extended flap speedup to 10 ⁰	110
	10 ⁰ – 40 ⁰	85

Stall speed, flaps up - 50 kt

Stall speed, flaps down - 44 kt

Landing ground roll - 158 m

Total landing distance over 50ft standard obstacle - 381 m

Maximum permissible g-load

- with flaps up +3,8, -1,52;

- with flaps down +3,0.

In Section 3 "Emergency Procedures" of the Aircraft Operation Manual on page 3-16, in the section "Rough Engine Operation or Loss of Power" it is written:

„ ... If a total loss of oil pressure is accompanied by a rise in oil temperature there is a good reason to suspect an engine failure is imminent. Reduce engine power immediately and select a suitable forced landing field. Use only the minimum power required to reach the desired touchdown spot.”

2.6.3. Information on the used fuel.

According the Technical Log Book record No1910067, completed before the flight, in which the air occurrence was realized, the aircraft was refuelled with 41 US gallons 100LL aviation gasoline. Upon inspection of the aircraft after the occurrence it was found that the available fuel was 40 US gallons.

A picture of the fuel indicators are shown on Fig. 5 of Annex 1; the total fuel quantity was 108 kg

The fuel quantity and its condition are not relevant to the occurrence realized.

2.7. Meteorological information

Meteorological conditions during landing - wind direction 100° and wind speed 3m/s, CAVOK, QNH 1019.

There are no meteorological phenomena to influence the occurrence.

2.8. Navigation systems

Standard aids to navigation of the aircraft.

2.9. Communication systems

ULA standard communication equipment.

2.10. Aerodrome information

Upon realization of the aviation occurrence the aircraft took off and then forcibly landed on Lesnovo airfield.

The RWY of the airfield is with asphalt concrete pavement. The RWY directions are 103°/283° (magnetic heading). The length of RWY is 910 m, the width is 24 m. The geographical coordinates of RWY referent point are (LAT/ LONG) 42° 38' 4,2" N; 023° 38' 47,2" E. The elevation is 556 m (1827 ft).

2.11. Flight recorders

The plane has no flight recorders.

2.12. Information about the impact and the debris

The serious incident is not related to the impact of the aircraft on the ground. The aircraft made a forced landing on the Lesnovo airfield, from which it took off. After landing, the aircraft was parked in front of the hangar of Avio Detachment Varna Ltd, as shown in Fig. 1 and 2 of Annex 1. There were traces of oil leakage under the airplane and all over the lower surface of the airframe. A tray for collecting of oil leakage was placed under the nose section of the aircraft. From the drainage tap of the coarse fuel filter of the airplane was drained 1 liter in a bottle for testing as needed. No more than 200 ml of oil was drained from the engine crankcase. During the inspection of the airframe no additional damages were found. In the picture Fig. 3, Annex 1, the identification plate of the aircraft is shown.

An inspection of the cockpit was carried out, taking pictures of the position of the engine controls, the instrument panel and the position of the various switches, shown in pictures Fig. 4 to 7 of Annex 1. The instruments on the dashboard were in off position as the main switch was turned off when at crew leaving the aircraft, other switches also were off, including ignition, fuel buster pump, throttle control lever was in position of full throttling, the engine mixture control lever was in lean mixture position, fuel valve was in closed position. The integrated clock into the engine speed indicator shows 7165.1 hours of operation. At switching on the battery, the fuel indicators in the left and right fuel tanks indicated nearly full level; both pointers were above the 20-gallon line. The pointers of all other instruments indicated electrical zero.

After the cabin inspection, the engine compartment was inspected. During the inspection, it was established that the oil filter was torn from the adapter plate and attached to the engine by the locking wire only, as shown on Fig. 10 of Annex 1. There were traces of oil leakage, Fig. 8 and 11 of Annex 1. The location of the oil filter tearing off from the engine housing, the adapter plate to the housing, is shown in Fig. 12 of Annex 1. The inspection of the engine housing also revealed the demolition of the exhaust valve lifter housing of the fourth cylinder, shown in Fig. 13 of Annex 1.

Upon inspection of the detached filter assembly from the engine, it was found that the adapter sleeve of the filter adapter plate to the adapter housing was broken, Fig. 14 and 15 of Appendix 1.

The connection plate is clamped to the adapter housing by means of a stud with an internal opening, through which the oil flows from the interior of the filter. This plate is sealed to the

11

adapter housing by means of an annular seal. For tightening of the stud a hexagon is formed for a wrench in the middle of stud and the tightening force should be up to 50...60 ft-lb. In Fig. 17 to 24 in Appendix 1 the photos of the elements of the detached filter assembly after its disassembly are shown.

There is a thread in the adapter sleeve for screwing the stud. The thread is formed by a steel helical spring. A consultation with a manufacturer's representative shows that the manufacturer has approved this design of the adapter sleeve.

In the scheme on Fig. 16 taken from SSP-885-1 ENGINE MOUNTED OIL FILTER KITS AND REPLACEMENT FILTERS OF TEXTRON LYCOMING, dated from April 1986., it is shown, that the seal of adapter plate shall be replaced at major overhaul. In the same diagram, the steel helical spring is not shown as an element of the adapter arrangement.

The oil filter is mounted by tightening it by hand to the other end of the stud with an internal opening and sealing the adapter housing by seal built into the filter. After tightening the filter by hand, an additional crewing force of 16... 18ft-lb should be applied. The instructions for installation of the filter are written on its housing, Fig. 10 of Annex 1;

When disassembling the detached filter assembly, it was found the following:

1. Traces of spreading over the adapter plate seal holder with some screed for fixing when securing it or for improving the seal due to possible leakage, Fig. 14 and 15 of Annex 1;
2. Significant residual deformation (flatten) on the adapter plate, Fig. 15 and 18 of Annex 1.
3. Traces of impacts with a solid metal, notches, on both surfaces of the adapter plate at the locations of the oil passage openings, Fig. 18, 29 and 22 of Annex 1.
4. Traces of corrosion of the material on the sleeve, in which helical spring is mounted.
5. Unscrewing the adapter plate from the filter was made by attaching it in a vice and using a device for unscrewing, made of a tooth chain; considerable force was applied, but it was not measured due to the absence of a torque measuring device.
6. Considerable force was also applied to unscrew the stud from the adapter plate.

There are no signs of fire during the oil leakage. The measuring line is shown on Fig. 9 of Annex 1 indicates for complete leakage of the oil.

2.13. Medical and pathological information

There is no information about the consequences for the pilot resulting from the occurrence, and therefore medical and pathological researches weren't performed.

There is no information that physiological factors or loss of capacity have influenced the pilots' capacity for work.

2.14. Fire

No fire occurred.

2.15. Survival Aspects

At leaving the aircraft, the piloting pilot turned off the fuel cock, ignition and the battery. There was no need the airfield emergency rescue group to take any actions.

2.16. Testing and research

For the purposes of the safety investigation the following was done:

1. Inspection of Cessna 172N aircraft, registration marks LZ-SPB, after the air occurrence realized;
2. Inspection of the detached filter assembly from the engine;
3. Interview with witnesses to the air occurrence;
4. Investigation and analysis of operational documentation of the AC;
5. Research and analysis of documents related to aircraft registration and airworthiness;
6. Evaluation of the flight and operational performance of the AC;
7. Fractography of the broken fragment of the oil filter assembly fixation to the engine;
8. Consultations with representatives of NTSB and engine manufacturer TEXTRON LYCOMING;
9. Logical-probabilistic analysis of possible causes of air occurrence.

For Item 1, the results of the aircraft inspection after the air occurrence are given in Para 2.3 & 2.12.

For Item 2, the results of the inspection of the assembly detached are given in Para 2.12.

For Item 3, the results of interviews with the instructor, trainee pilot, air operator's officials and airfield officials are reflected in Para 2.1.2 & 2.6.1.

For Item 4, the results of the study and analysis of the operational and technological information of the aircraft are reflected in Para 2.6.1, 2.6.2 & 2.6.3.

For Item 5 the study and analysis of documents related to aircraft registration and airworthiness are reflected in Para 2.6.1.

For Item 6 the results of evaluation of the aircraft flight and operational performance, related to the air occurrence realized are given in Para 2.6.2.

For Item 7 a fractography of the broken fragment of the oil filter assembly fixation to the engine was made in Mechanical Tests and Control Laboratory of Sofia University.

The results of the study carried out are set in Protocol No. 104/3108 attached to the investigation materials.

Sheet 2 of the minutes reads as follows:

"2. A fractography of broken fragment was made, where the following was visible:

- Expressed texture of the torn material caused by unacceptable loading;

- No cracks were identified;

- Destruction was caused by extreme loading;

- Probable scheme of unacceptable loading corresponds to general bending and shearing, confirmed by the texture of the broken fragment of the filter and thread element.

- The destruction of the filter was likely to have started as a plastic fracture by force normal to sleeve cross section to about 50% and after that the final breakage was a brittle fracture.

3. The plastic deformation of the specimen is due to a loss of structural stability and subsequent loading."

For Item 8, the results of consultations with representatives of the NTSB and with the engine manufacturer TEXTRON LYCOMING are set out in paragraph 2.17. 13

Logical and probabilistic analysis of the possible causes of the serious air occurrence has been made in Chapter 3 of this Report.

2.17. Additional information

Upon receipt of the notification of the occurrence, the NTSB appointed an accredited representative for assistance in investigation. From the correspondence with him it became clear that the NTSB has a database of about 60 events with Lycoming O-320-H2AD engine. One of these events was related with engine oil filter. We received the database of events from accredited representative by e-mail and namely a report on oil filter case. Although it was not related to the destruction of the filter attachment plate, the report aided the investigation, both with the circumstances described in the case therein and with reference to SSP-885-1. Information on other documents concerning the use of the Lycoming O-320-H2AD engine was also sent later. It was stated that the FAA's certification office had no information regarding such type of failures in the last 20 years. A recommendation has been made to look for the reasons for the failure of the filter attachment assembly in engine maintenance.

At the time of the occurrence, the engine, as it was noted in para 2.6.1, had operating time of 1333:12 hrs after overhaul and was installed on the aircraft on 21.08.2017. The overhaul was performed by NORVIC AERO ENGINES LTD, UNITED KINGDOM, for which there was EASA FORM 1 issued, No NAE 4073.

The safety investigation commission verified when the filter was replaced and what technology was used to replace it. It was found that the replacement of the filter was carried out at the next 50-hour inspection on 03.08.2019 at 1330:24 hrs operating time, following the technology described on the housing of the filter itself, Fig. 25 of Annex 1. An inspection of all records made in the aircraft's logbooks from the date of installation of the engine of the aircraft, 21.08.2017, till the date of the event, 14.08.2019, was made. No records were found for performing any works during the line maintenance,

related to the removal of oil filter from the engine and to the engine oil system in general. For the period from the last overhaul to the occurrence realization, 50 periodic aircraft inspections were carried out in accordance with the maintenance program. No records were found in the inspection documentation, related to presence and removal of oil leaks.

The Safety Investigation Commission expresses its gratitude for the assistance of the NTSB accredited representative.

3. Analysis

From the foregoing in paragraph 2.1.2, it is evident that the serious incident occurred as a result of destruction of oil filter assembly for attachment the oil filter to the adapter plate. After the destruction of this assembly, the engine oil leaked out and, when getting in contact with hot parts of the engine, some of it evaporates and entered in the cockpit in the form of vapor. This vapor was observed by the crew and they took measures to abort the flight and make a forced landing at Lesnovo Airfield. Due to vibrations associated with friction in absence of lubrication, the exhaust valve body of the fourth cylinder was destroyed and the engine stopped just before touchdown.

It was necessary to clarify what was the reason for destruction of the sleeve of filter connecting plate to the adapter. For this purpose, a fractography was made of the broken fragment of the oil filter attachment assembly to the engine in Mechanical Tests and Control Laboratory of Technical University in Sofia and a thorough inspection of the detached filter assembly from the engine. The results and findings are set out in paragraphs 2.16 and 2.12.

The fractographic analysis has shown that the destruction of the filter was likely to have started as a plastic fracture in the cross section of the adapter sleeve about 50% and the final breakage was a brittle fragile. On the Fig. 10, 11, 12, 14, 15, 18 и 23 are shown pictures of this destruction. Para2.12 states the findings after disassembling of the detached filter assembly. When considering the outcome of the fractographic analysis and the findings made during disassembly, several possible scenarios related to the destruction of the assembly might be identified. For each of them there is a certain effect of reducing to some extent the area of the bearing cross section of the sleeve, associated with the insertion of the helical spring to form the inner thread of the sleeve. As it was indicated in para2.12, such a spring may be fitted during the engine overhaul.

The sleeve is mainly loaded by the tightening force of the stud, shown in Fig. 19 of Appendix 1, by the force caused by tightening of the filter on the stud, by vibrations of engine running and the vibrations of the aircraft when moving on runway.

As stated in paragraph 2.12, the stud tension must be 50... 60 ft-lb. This stud should not be dismantled during the aircraft operation. On the Fig. 16 of Appendix 1 it is shown, that the disassembly of the stud may only be required when replacing the adapter plate gasket, which shall be made at overhaul.

In the findings made when disassembling the assembly of the detached filter, it was stated that traces of spreading of some kind of paste on the bed of the adapter plate seal have been found, Fig. 14, 15, 18 and 21 of Annex 1. Such kind of spreading might be made in order to fix the seal at installation or to improve the sealing in case of leakage. In the first case it is not related to the load on the assembly, but in the second one it may be related to the additional tension of the sleeve in order to stop leakage. It is more likely, that this was done during the overhaul when the gasket was replaced, but the possibility that it was made in operating conditions should not be excluded; however, there are no entries for this in the technical documentation kept by the operator. Under all conditions, tightening of the sleeve or filter may cause plastic deformation observed in the fractography of the fracture. It is also possible to have a complex effect of tightening, combined with a reduced cross section from the threaded spring installation. Further fracture, brittle one, can be caused also by vibrations.

In connection with the above, considerable residual deformation (flatten) of the adapter plate gasket can also be considered, which can be a result of considerable tension.

Reduction of the bearing capacity of the sleeve also might be a result from corrosion, as noted in the inspection findings.

The Commission cannot categorically determine at which stage of operation the plastic deformation occurred. The final destruction of the sleeve most likely occurred as a result of vibrations

upon aircraft takeoff run. The flight time was 8 min; the time of climb to 3600 ft (QNH) altitude was about 4 min and at that time most of the oil in the crankcase was drained; during the next four minutes for maneuvering and reaching the runway at Lesnovo airfield the engine was run at a reduced rpm and high vibrations, and the engine stopped 3...4s before the touchdown.

The Commission failed to explain the reason for traces made by a solid metal, described in para 2.12 on the both surfaces of the adapter plate at the locations of the technological opening for oil passage, fig. 18, 21 and 22 of Annex 1.

In view of the foregoing, the occurrence of the serious incident was due to the tearing of the engine oil filter from the adapter plate, attaching it to the crankcase, caused by plastic deformations in the mounting sleeve, related to violation of technology during repair and/or maintenance.

4. Conclusion

4.1. Findings

As a result of the investigation, the Commission concluded:

1. Cessna F172N aircraft, serial number F17201817, registration marks LZ-SPB, was manufactured in 1979 by Reims Aviation Cessna, Republic of France.
2. The airplane possesses a Certificate of Registration No.2523 issued by the Directory General of Civil Aviation Administration of the Republic of Bulgaria on 07.10.2014 and in this certificate the serial number is written as F172-1817.
3. The aircraft is owned by Avio Detachment Varna Ltd with office address: V. Varnenchik residential complex, block 401, entrance 17, ap. 288, Varna, Republic of Bulgaria.
4. Aircraft operator is Avio Detachment Varna Ltd with office address: Vladislav Varnenchik residential complex, block 401, entrance 17, ap. 228, Varna 9023, Republic of Bulgaria.
5. There is a Certificate of Airworthiness No 25-054 of the aircraft, issued by DG CAA on 17.11.2014.
6. An Airworthiness Review Certificate of the aircraft No BG-ARC - 2385 was issued on 15.05.2018 with validity till 20.05.2019. On 13.05.2019 the validity of this certificate was extended till 19.05.2020.
7. Cessna Aircraft Company USA is written as manufacturer in the Airworthiness Review Certificate and the serial number of the aircraft is written as F172-01817.
8. An Aircraft Noise Certificate No 45-0055 was issued for the aircraft. The certificate was issued by DG CAA on 07.11.32014. In this certificate the serial number of the aircraft is written as F172-1817.
9. Total flying time since new to the day of air occurrence the aircraft has flown 9137:36hrs.
10. The continuing airworthiness of the airplane was maintained in accordance with Cessna/Reims Cessna 172/F142 Airplane Maintenance Program, operated by Air Operator Avio Detachment Varna Ltd and approved by DG CAA on 01.04.2016.
11. A total technical resource of 30 000 flying hours for the airframe was established without a calendar limitation provided that certain conditions, given in the Program, were met.
12. The aircraft features a Lycoming O-320-H2AD aviation piston engine, serial No. L-1787- 76T. Until the moment of air occurrence, the engine has accumulated 1333:12 hrs, with 2000 hours time-between-overhaul or 12 years. The engine was mounted on the aircraft on 21.08. 2017.
13. The aircraft is fitted with a McCauley 1C160/DTM 7557M1 propeller with JB02D series blades. Until the moment of air occurrence, the propeller has accumulated 1603:36 hrs, with 2000 hours time-between-overhaul or 72 months. The propeller was installed on 02.05.2017.
14. On August 3, 2018, 50-hrs servicing of the aircraft was performed and the engine oil filter was replaced. The replacement was performed according the technology written on the filter itself.
15. At the time of execution of the flight the aircraft was provided with the necessary resource.
16. A technical logbook with a serial number 1910067 was completed for the flight. During the aircraft pre-flight inspection no malfunctions detected and eliminated were recorded. 16

17. For the previous flight the technical logbook No.1910066 was completed. There are no records in this logbook related to the abnormal operation of the aircraft during the flight and at post-flight inspection.
18. The Commission accepted that before the last flight was made, the aircraft was prepared in accordance with the continuing airworthiness requirements and was loaded with enough fuel to carry it out.
19. During flight the mass and balance of the aircraft were within the permissible limits.
20. After take-off, smoke (fumes) appeared from the left side of the dashboard during climbing at about 3600 ft (QNH).
21. A decision for abortion the flight and landing back at the Lesново airfield was taken.
22. During the landing approach, engine vibration occurred and the engine stopped just before touchdown.
23. The force landing was performed without any consequences for the aircraft and crew.
24. After stopping, the crew leaved the aircraft and found out that the aircraft fuselage was spilled with oil.
25. The aircraft was towed in front of the aircraft maintenance hangar of Avio Detachment- Varna Ltd., where it was found that the engine oil filter was detached from the crankcase, the connecting assembly was destroyed and the filter was attached only by the locking wire.
26. No fire occurred during the event.
27. The weather conditions have no direct impact on the realization of the air occurrence.
28. The aircraft commander-instructor possesses the necessary training and experience for his functions.

4.2. Causes

On the basis of the circumstances set out in this report and the analysis performed, the Commission pointed out as a cause of realization of the serious incident:

Tearing of the engine oil filter from the adapter plate for its attachment to the engine crankcase, caused by plastic deformations in the mounting sleeve related to violations of technology of repair and/or maintenance

5. Safety Recommendations:

Immediately after the occurrence, the Directorate of the AMRAIU sent an email to DG CAA with the following content:

"In connection with an incident on 14.08.2019 with a CESSNA F172N aircraft with registration marks LZ-SPB, owned by Avio Detachment - Varna, related to oil leakage and engine shutdown during a training flight and on grounds of Art.17, para.1 and para.2 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of civil aviation accidents and incidents, I recommend you the following immediate safety measures to be taken:

1. DG CAA to ground all CESSNA 172 aircraft entered in the Civil Aviation Register of the Republic of Bulgaria until execution of the following:
 - check the condition of attachment of the oil filter and the factual amount of oil in the engine oil system;
 - engine test, paying attention for presence of oil leakage and the parameters of the oil system (pressure and temperature).
2. Checks must be recorded on the aircraft and engine log books.

After recording the checks in the log books, flights might be allowed."

Taking into account the causes of the serious incident and the deficiencies found during the investigation, the Commission recommends the following safety measures to be implemented:

BG.SIA-2019/08/01. Engine manufacturer TEXTRON LYCOMING in another newsletter to inform Lycoming O-320-H2AD engine users on the circumstances related with the serious incident.

BG.SIA-2019/08/02. DG CAA to reissue the Registration Certificate, Certificate of Airworthiness Review and Noise Certificate of CESSNA F172 N aircraft with registration marks LZ-SPB, eliminating the inconsistencies mentioned in points 2, 7 and 8 of para 4.1.

BG.SIA-2019/08/03. The air operator Avio Detachment Varna Ltd. should provide technology of keeping the technical documentation of its aircraft, which will not allow for data exchange.

Follows: Annex 1, which is an integral part of this Report.

On the grounds of Article 18, §5 of Regulation (EU) 996/2010, the safety recommendation issued will be recorded in the centralized European system SRIS (Safety Recommendations Information System).

The Investigation Commission reminds all organizations, to which flight safety recommendations are sent that, on the grounds of Article 18 of Regulation (EU) 996/2010 on Investigation and Prevention of Accidents and Incidents in Civil Aviation and Article 19, paragraph 7 of Ordinance No. 13 on the Investigation of Aviation Accidents are obliged to notify the Directorate of the AAIU to the MTTC in writing of the action taken on the recommendations made.

Chairman of the Commission:

Stefan Petrov

ANNEX 1



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.



Fig. 12.



Fig. 13.



Fig. 14.



Fig. 15.

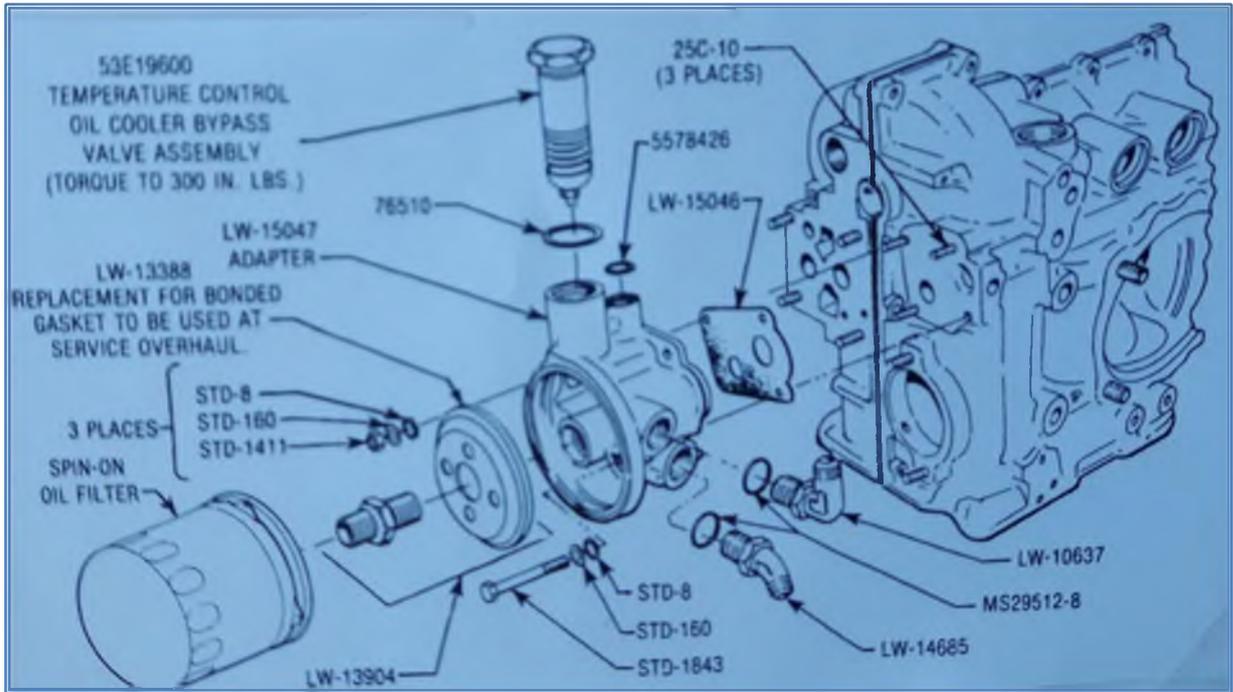


Fig. 16.



Fig. 17.



Fig. 18.



Fig. 19.



Fig. 20.



Fig. 21.



Fig. 22.



Fig. 23.



Fig. 24.



Fig. 25.