

FINAL REPORT

on

Investigation of a serious incident, realized on 09.09.2017 with A320-231 aircraft, registration marks LZ-LAD, operated by Bulgarian Air Charter AO Jsc, in a ferry flight from Bratislava airport to Sofia airport.



2018

Purpose of the report and level of responsibility

In accordance with Annex 13 to the Convention on International Civil Aviation of 7 December 1944, Regulation 996/2010 of the European Parliament and the Council on the investigation and prevention of accidents and incidents in civil aviation and Ordinance 13 of 27.01.1999 of the Ministry of Transport, Information Technology and Communications, the objective of the aviation occurrence investigation is to establish the causes that have led to its realisation in order these to be eliminated and not allowed in the future **without apportioning blame or liability**.

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01. LIST OF ABBREVIATIONS

A/C	- Aircraft;
A/THR	- Autothrust;
AAIU	- Air Accident Investigation Unit;
AGL	- Above Ground Level;
AIP	- Aeronautical Information Publication;
ALT	- Altitude;
AMRTAIU	- Air, Maritime and Railway Accident Investigation Unit;
AO	- Air Operator;
AP	- Autopilot;
APP	- Approach control unit or approach control service
APU	- Auxiliary Power Unit;
ATC	- Air Traffic Control;
ATC SE	- Air Traffic Control State Enterprise;
ATPL	- Airline Transport Pilot License;
ATS	- Air Traffic Services;
BEA	- National Bureau of Aviation Occurrences Investigation;
CAA	- Civil Aviation Authority;
CAS	- Computed Air Speed;
CAT	- Category;
CFDIU	- Centralized Fault Display Interface Unit;
CVR	- Cockpit Voice Recorder
DFDR	- Digital Flight Data Recorder
DG of CAA	- Directorate General of Civil Aviation Administration
DGAC	- Direction General De Aeronautical Civil
EASA	- European Air Safety Agency
ECAM	- Electronic Centralized Aircraft Monitor
EEC	- Electronic Engine Controller
EGT	- Exhaust Gas Temperature
EPR	- Engine Pressure Ratio
F/C	- Flight Crew
FADEC	- Full Authority Digital Engine Control
FCOM	- Flight Crew Operating Manual
FCTM	- Flight Crew Training Manual
FCU	- Flight Control Unit
FD	- Flight director
FDR	- Flight Data Recorder
FL	- Flight Level
FMU	- Fuel Metering Unit
FMV	- Fuel Metering Valve
FOB	- Fuel on Board
ft	- feet
GAT	- General Air Traffic
GPS	- Global Positioning System
GSPD	- Ground Speed
GW	- Gross Weight
ICAO	- International Civil Aviation Organization
ILS	- Instrumental Landing System
kg	- kilogram
kt	- knot
LBSF	- Airport Sofia

LRU	-	Line Replaceable Unit
LZIB	-	Airport Bratislava
M	-	Mach Number
METAR	-	Aviation Routine Weather Report
MTOM	-	Maximum Take-Off Mass
MSN	-	Manufacturer Serial Number
MTITC	-	Ministry of Transport, Information Technologies and Communications
NOTAM	-	A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, or hazard, the timely knowledge of which is essential of personnel concerned with flight operations
NOSIG	-	No significant change
OSV	-	Overspeed Valve
PF	-	Pilot Flying
PFR	-	Post Flight Report
PM	-	Pilot Monitoring
PN	-	Part Number
PRSOV	-	Pressure Rising and Shut-off Valve
QAR	-	Quick Access Recorder
QRH	-	Quick Reference Handbook
RALT	-	Radio Altitude
RWY	-	Runway
SCT	-	Scattered
TLB	-	Technical Logbook
TCU	-	Towering cumulus
TRE(A)	-	Type Rating Examiner (Airplane);
TRI(A)	-	Type Rating Instructor (Airplane);
UTC	-	Universal Coordinated Time

1. Introduction

Date and time of aviation occurrence: September 9th, 2017, 10:30 UTC. The difference between the local and Universal Coordinated Time is +3 hours. All times in this report are UTC.

Notified: Aircraft, Maritime and Railway Accident Investigation Unit Directorate and Civil Aircraft Administration Main Directorate at the Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria (MTITC), the European Commission; the International Civil Aviation Organization (ICAO); the National Bureau of Aviation Occurrences Investigation (BEA) of the Republic of France; European Air Safety Agency(EASA).

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 Aircraft Accident Investigation Unit at the Aircraft, Maritime and Railway Accident Investigation Unit Directorate (AMRAIU) at the Ministry of Transport, Information Technology and Communications classified the occurrence as a serious incident. The materials on the aviation occurrence have been filed in case No 06/09.09.2017 in AAIU archives.

In accordance with the provisions of Article 5, para1 of Regulation (EU) No 996/2010 on the 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 Ministry of Transport dated 27.01.1999 on the Investigation of Aviation Occurrences, by Order No RD-08-377 dated 21.09.2017 of the Minister of Transport, Information Technology and Communications, a Commission is appointed for investigation of the serious incident.

At 10:30 UTC on 09 September 2017, the flight crew of a/c Airbus A320-231 with registration LZ-LAD of "Bulgarian Air Charter" operator, while performing a ferry flight from Bratislava (Slovakia) to Sofia (Bulgaria) and shortly after leveling off at FL 330, received warning message on ECAM "ENG2 FUEL FLOW LOW". The engine motion was retarded to IDLE. After assessing the situation, the flight crew decided to continue the flight to LBSF at FL 250. While implementing approach the flight crew received new warning message on ECAM "ENG2 FADEC ALTERNATOR" with subsequent loss of indication of the rotation speed of high-pressure rotor of the No2 engine and the flight crew shut down this engine at 1100ft AGL, in a stabilized approach. The landing to the LBSF was normal, with no consequences caused to the crew and the aircraft.

The prime cause of realization of the serious incident:

Failure of the FADEC control system of No 2 engine.

The main cause:

Fault of electrical system of the Fuel Metering Unit (FMU) caused by a short circuit or loss/interruption of the electrical signal to the Fuel Metering Valve (FMV).

2. Factual information

2.1. Flight history

2.1.1. Flight number, type of operation, last point of departure, time of departure, destination point of intended landing:

Flight number: BUC320D.

Type of operation: Ferry flight

Last point of departure: Bratislava Airport (LZIB).

Time of departure: 10:16 UTC.

Destination point of the intended landing: Sofia Airport (LBSF).

2.1.2 Preparation and description of the flight

For the execution of the BUC320D (Ferry flight after A/C painting) by the aircraft A320-231 with registration marks LZ-LAD from LZIB to LBSF, Bulgarian Air Charter Jsc Air Operator appointed a crew consisting of two instructor-pilots with a great experience on the type of A/C. The flight crew arrived at Bratislava airport around 08:30h for pre-flight preparation. At the Bratislava Airport

the flight crew received a package of documents, containing flight plan, NOTAM airspace messages, airports along the flight route, weather information for the flight, alternate aerodromes and Sofia Airport. Pre-flight preparation was completed in an extended volume for one hour and thirty minutes. The PF performed a pre-flight inspection of the airplane in accordance with the QRH and the FCOM. The airplane cockpit was prepared for flight by the crew, according to the regulatory documents. Engine start, taxiing and take-off were performed without any deviations in the airplane systems operation. During the climb to the allowed FL330 (the planned FL was 350), everything was with normal technological parameters.

The aircraft took-off from Bratislava Airport at 10:16:08 h (confirmed by the logbook entry and the start of the PFR record). During initial climb (Phase 5 - initial climb but before reaching 1500 ft AGL or 2 min after aircraft lift-off), when both engines were in take-off trust, a second level warning (Level 2 ECAM Caution) "ENG1/ENG2 FADEC" (corresponds to ATA77-11, short-time reconciling of the current EPR and the low pressure rotors reduced revolutions (N1)) was displayed in the cockpit. The warning was one-time, didn't affect the normal operation of the engines and wasn't confirmed until the end of the flight (so-called "Occurrence counter" in the PFR was missing). However at exactly the same time (10:16 h, Ph5), for No.2 Engine in EEC2 BITE and CFDIU was recorded corresponding failure message 73-22-52 FMU/HC/EEC2, which was directly linked to the problem and the occurrence.

Shortly after climbing and leveling at cruising level FL330, at 10:31 h, a warning was issued by ECAM "ENG2 FUEL CTL FAULT-ENG2 Low Fuel Flow". Seven minutes later, at 10:38 h, the FADEC system, due to its inability to maintain the set operating mode, automatically drove the engine into "Fail Safe Condition" by thrusting it to "IDLE" according to the current conditions. The corresponding failure message "ENG 2 FAIL" was issued in the cockpit.

After assessing the situation, in view of the available fuel on board the aircraft and the flight time remaining to the destination, the ACC decided to continue the flight to Sofia without shutting off No.2 Engine at FL 250, based on the requirements in QRH Para 4.05 (IN FLIGHT PERFORMANCE ONE ENGINE OUT MAX ALTITUDE). The decision to continue the flight without shutting down the engine was taken because the air bleeding from this engine (10th Stage Engine Bleed) was still possible, which would relieve the load of the healthy No1 engine during the rest of the flight.

During the approach, a new ECAM warning message "ENG 2 FADEC ALTERNATOR" was displayed at 11:29 h with the subsequent loss of N2 (indication of the rotation speed of the high pressure rotor) and an increase of EGT to a critical value. Immediately afterwards, at a radio height of 1100ft and stabilized approach, the flight crew took a decision to shut down the No2 engine. The landing at Sofia Airport was normal without consequences for the crew and the airplane.

2.1.3 Location of aviation occurrence

The serious incident occurred during a flight from the Bratislava-Sofia route.

Date and hour: 9 of September 2017, 10:18:08 h UTC

Airspace: Class C.

2.2. Injuries to persons

Injuries	Crew	Passenger	Total number of occupants	Others
Fatal	0	0	0	0
Serious	0	0	0	0
None	2	0	2	0
Total	2	0	2	0

2.3. Damages to Aircraft

No damage to the aircraft airframe was detected in the post-flight inspection. A failure was detected in the FMU.

2.4. Other damages

No other damages

2.5. Personnel information

2.5.1. Crew of AIRBUS A320-231 aircraft with registration marks LZ-LAD

2.5.1.1. Captain Pilot Flying:

Person: Bulgarian, born 1961.
Licence: Airline transport pilot licence ATPL (A)
Type: A320/IR; PIC; TRI/A/; TRE/A/
ATPL: valid till 30.04.2018;
Medical Certification: Class 1, valid till 09.04.2018 г.

Flying experience:

Total flight hours by type of A/C:

- A 320 aircraft: 7140 hrs, as a commander: 4820 hrs, as an instructor: 1115 hrs.
- Total flight hours of all types of aircraft - 19000 hrs, as commander 10 000 hrs

Information about duty time and rest:

- for the last 24 hrs: 04:25 hrs;
- for the last 30 days: 73:37 hrs;
- for the last 90 days: 250:17 hrs;

Working hours for the last 24 hrs: 4:05 hrs

Rest time before the duty time: 18:00 h.

2.5.1.2. First officer - Pilot-monitoring:

Person: Bulgarian, born 1956.
Licence: Airline transport pilot licence ATPL (A)
Type: A320/IR; PIC; TRI/A/;
ATPL: valid till 30.04.2018;
Medical Certification: Class 1, valid till 12.11.2017

Flying experience:

Total flight hours by type of A/C: A320 aircraft - 5500 hrs.

Total flight hours of all types of aircraft – 20 000 hrs;

Information about duty time and rest:

- for the last 24 hrs: 02:30 hrs;
- for the last 30 days: 80:07 hrs;
- for the last 90 days: 247:04 hrs;

Working hours for the last 24 h: 6:00 hrs;

Rest time before the duty time: 18:00 h.

The flight crew of A320-231 aircraft with registration marks LZ-LAD possessed the required qualification and medical certification to carry out their duties. All the available information indicates that the flight crew was rested when he came on duty. There are no indications that fatigue played a part at the time of the incident.

2.6. Aircraft Information

There are no data about technical failures of the on-board systems neither in the flight crew's reports nor in the analysis of the FDR readouts.

2.6.1. Airworthiness information

A320-213 aircraft, registration marks LZ-LAD, serial number 00353, was produced by AIRBUS INDUSTRIES on October 8, 1992. The aircraft is owned by Bulgarian Air Charter Jsc, with address City of Sofia, Gorublyane, 35 Pavel Krasnov str. The data for the approved by the CAA organization are: BG.145.0004; BG.MG.0006 (Ref AOCBG06).

There is an Export Certificate for the aircraft No. 18397/08.10.1992 by the CAA of the Republic of France. History of the registration status of the aircraft for the period from October 1992 to November 2016:

- Last issued Airworthiness Certificate, valid until 20.06.2011;
- Last flight for MEXICANA AIRLINES executed on 28.08.2010, with total flight time since new 63 165:36 hours and 29425 cycles);
- In September 2016 the aircraft was purchased by JETTRAN LLC and its registration was changed. The change was related to a change of ownership - from government to private company (contract of 30.09.2016) of DGAC MEXICO;
- On 09.11.2016 the aircraft was purchased by Bulgarian Air Charter Jsc;
- On 09.11.2016 a document for reception of the aircraft was signed by a representative of Bulgarian Air Charter Jsc;
- On 11.11.2016 DGAC MEXICO issued a certificate No. E2016157-SPECIAL CERTIFICATE OF AIRWORTHINESS for a FERRY FLIGHT of the aircraft from Mexico to Sofia. The flight was completed on 12/13.11.2016;
- The Mexican registration was canceled on 18.11.2016;
- On 21.11. 2016, DG of CAA assigned a 24-bit S-mode code of the aircraft.
- DG of CAA issued following documents for the aircraft on 09.12.2016 after an inspection (the copies were delivered on 11.09.2017):
 1. Certificate of Registration No 2656 of 09.12.2016;
 2. Aircraft Noise Certificate No 45-0116 of 09.12.2016;
 3. Aircraft Radio Certificate No BF(RS)-0487 of 09.12.2016;

The C Check was carried out by the previous operator on 30.06.2012 at a flight time since new of 62 660 hours and 29 221 cycles. After the ferry flight to Sofia Airport on 12/13.11.2016, the Maintenance Organization of Bulgarian Air Charter Jsc according to the manufacturer's Maintenance Manual preserved the aircraft for a long period of storage. According an order No.5984-A-17 for maintenance, a planned form of maintenance 12Y Check was performed on 01.06.2017

A total flight time of 63 184:03 hours and 29 431 cycles was recorded in the airplane form since new until the date of the occurrence (09.09.2017).

The aircraft is equipped with two V-2500-A1 gas turbine engines with serial numbers V0167 (No.1) and V0175 (No.2). The engine flight time since new of Engine No.1 was 46 250 hrs/ 21 815 cycles, and for Engine No.2 was respectively 55 430 hrs/ 26 033 cycles.

During the flight in which the occurrence was realized, the aircraft was airworthy and prepared for the execution of the flight.

The maintenance of the aircraft was carried out according the Continuing Airworthiness Program, approved by GD of CAA.

2.6.2. Aircraft information

A320 is a narrow-body medium range passenger airplane. The A320-231 Airplane Serial No.0053 was manufactured on October 8, 1992. At the time of the occurrence the aircraft was in configuration of 182 seats (all tourist), including those for the cabin crew. The initial Type Certificate of Airworthiness was issued on 08.10.1992 under a reference number AI/EA-AS No.413/3030/92. The aircraft was equipped with two IAE V2500-A1 type gas turbine engines type, set to a maximum take-off thrust of 24800lbf each.

The Maximum Take-Off mass of the airplane is 73500 kg. The Maximum Landing Mass is 64500 kg. For the flight in which the air occurrence was realized, according to the aircraft logbook information, the Maximum Take-Off Mass was 51800 kg and the Maximum Landing Mass at Sofia Airport was 48600 kg and respectively:

- mass of the planned fuel before the flight - 6192 kg (minimum required fuel for the flight);
- Total Fuel Mass on Airplane Before Flight (Total FOB) - 9100 kg;
- mass of residual fuel on board the aircraft after landing - 5740 kg;
- the fuel spent for the flight (BTS-SOF) was 3360 kg (planned fuel consumption to the destination - 3143 kg).
- In the AIRCRAFT SYSTEM ENGINES section of FCOM (Flight Crew Operating Manual) the following EGT LIMIT is given for the A320 aircraft.
- the maximum EGT:
 - during the engine start sequence on ground (635°C);
 - in all other cases (610°C).

According to the entry Flight Data in the Technical Log, there were no deviations of the masses and balance of allowable norms.

Typical speeds:

- Never exceed speed (V_{mo}): 350 kt CAS;
- limiting Mach number M = 0.82;
- recommended landing approach speed at a mass of 60000 kg: 134 kt;
- maximum admissible tail-on wind at take-off and landing: 10 kt.

The technical characteristics of the aircraft are irrelevant to the realized air occurrence.

2.6.2.1 Fuel Metering Unit (FMU) of IAE V2500-A1/A5 engine. Brief description and operation

1. Location

Bolted onto the body of Fuel Pumps Unit at the rear left side of the engine accessories drive gearbox at 7:00 o'clock position (See Fig. 1 and Fig. 3)

FMU shares only liquid connections with Fuel Pumps Unit, no any mechanical rotational input is provided or required. It just needs servo fuel pressure and electrical control signals for proper operation.

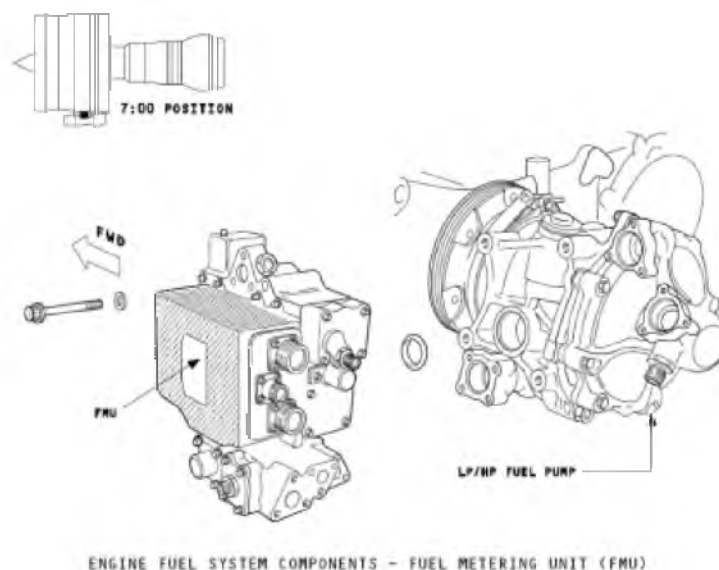


Fig. 1

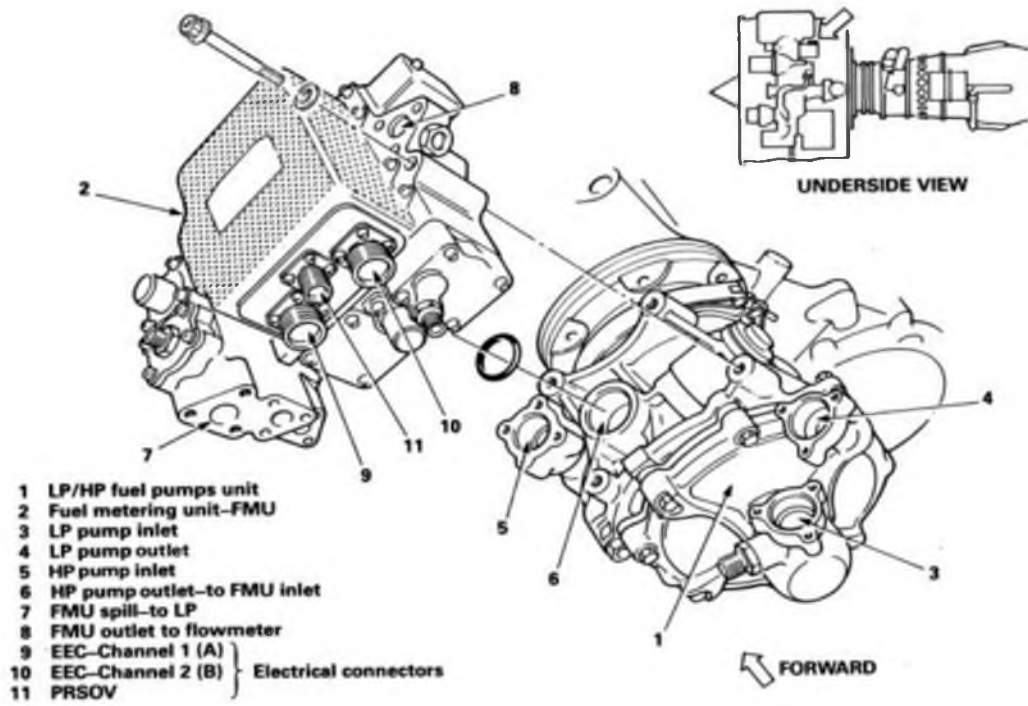


Fig. 2

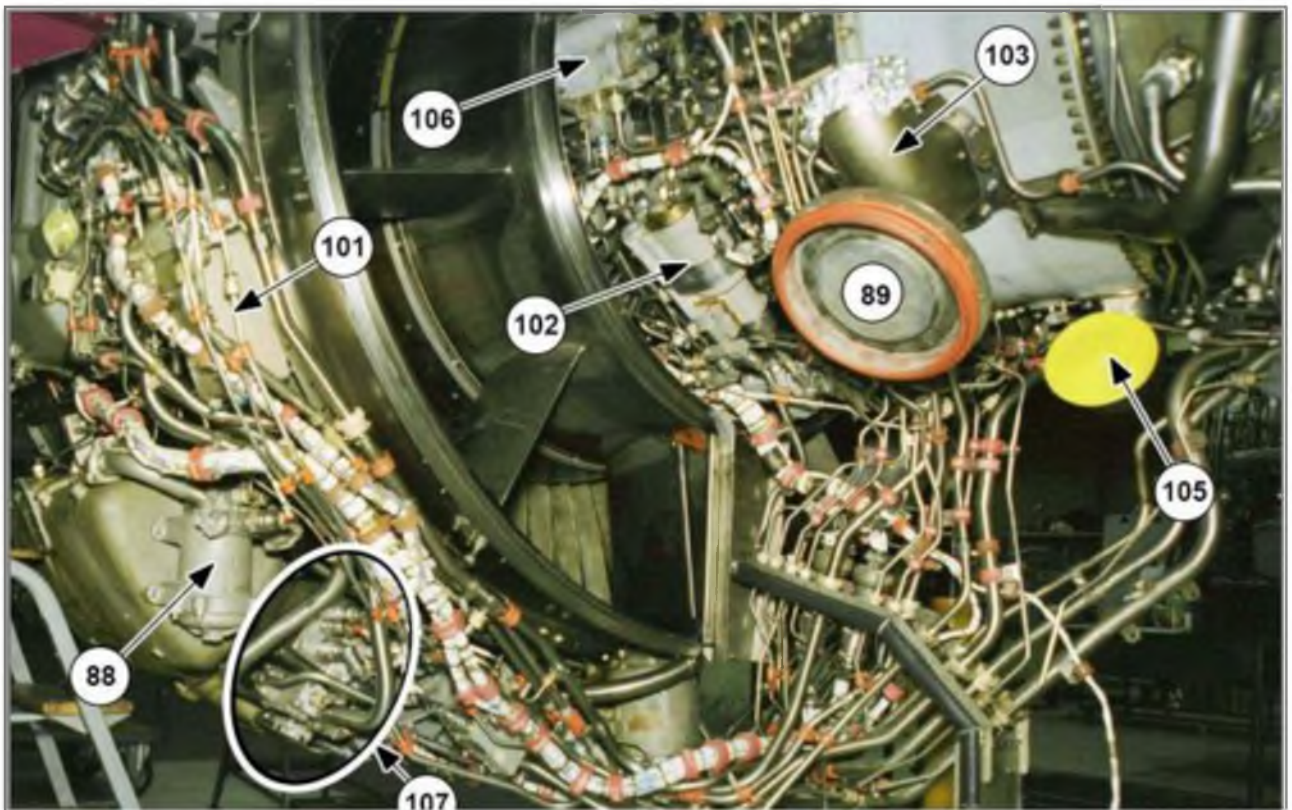


Fig. 3

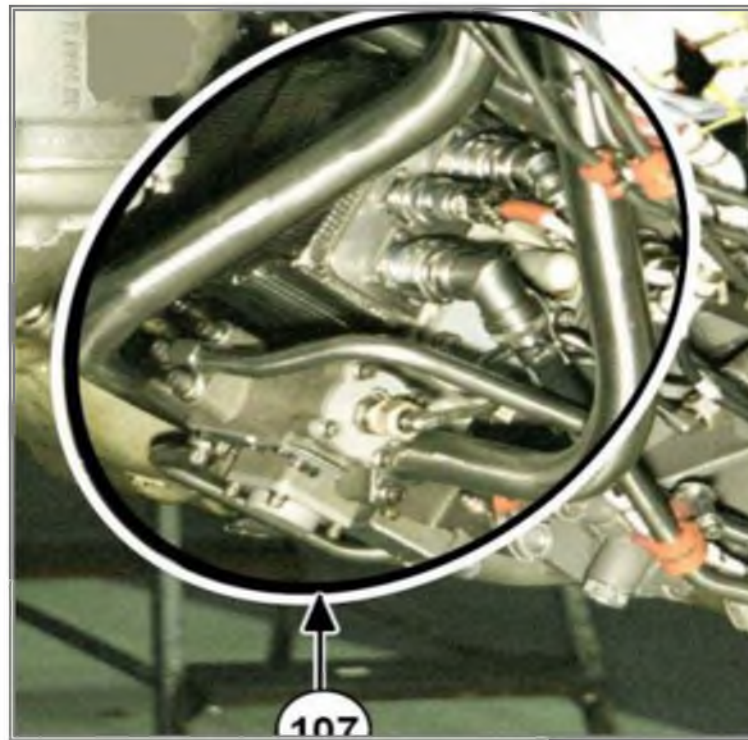


Fig. 4

On the Fig. 4 the position 107 was shown, with the three electrical connectors.

2. Operation of FMU.

FMU primary components include Fuel Metering Valve, Overspeed Valve (OSV) and Pressure Rising and Shut-off Valve (PRSOV) situated in series on the main fuel stream inside. All these three valves are Torque Motor operated (no solenoid valves installed in this unit). The FMU has dual windings modulating torque motor, while the OSV and PRSOV are equipped with discrete open-close ones. The other two valves inside FMU, servo fuel regulating valve and the spill valve play also significant role, but for the purpose of that short explanation they will be deliberately omitted. (See Fig. 2)

Fuel Metering Valve - as the name suggests, the necessary for combustion fuel is dosed by it for all engine modes. It consists of a pilot control valve with a paired electromagnetic part (one set for each EEC (Electronic Engine Controller) channel, a double feedback system and a separate servo-hydro-mechanical activating power device, which performs the action itself. It is controlled directly and by the EEC only.

Overspeed Valve – prevents LP or HP rotor from over-speed and normally stays open at all engine operating states. If the preset rpm threshold is reached ($N1 > 105\%$ or $N2 > 103,5\%$), the EEC will electrically command immediate closure of the OSV. When OSV is closed, a small calibrated orifice will still allow the engine to operate at some fixed idle, i.e., the engine will not be automatically shut down. Further control over that engine is irreversibly lost to the end of flight. When OSV closes, it is hydraulically latched by the delivered upstream fuel servo pressure. To reset the valve back to open, a nearly full upstream pressure drop is required, which is possible only on the ground (even the engine is shut down in flight, the N2 windmilling will keep yet some pressure delivery to the FMU).

Pressure Rising and Shut-off Valve – this is the valve which sets the fuel flow to “run” or “shutoff” during engine start and shut-down procedures. EEC has no any authority over the PRSOV; it is controlled directly from the Engine Master Switch in the cockpit. By default, at switch “ON” the PRSOV is de-energized to open, and at switch “OFF” the PRSOV is energized to close (fail-safe logic). When commanded open, it will do so only if the upstream fuel pressure is enough

for the proper operation of the fuel spray nozzles in the combustor (hence the name “pressure rising”).

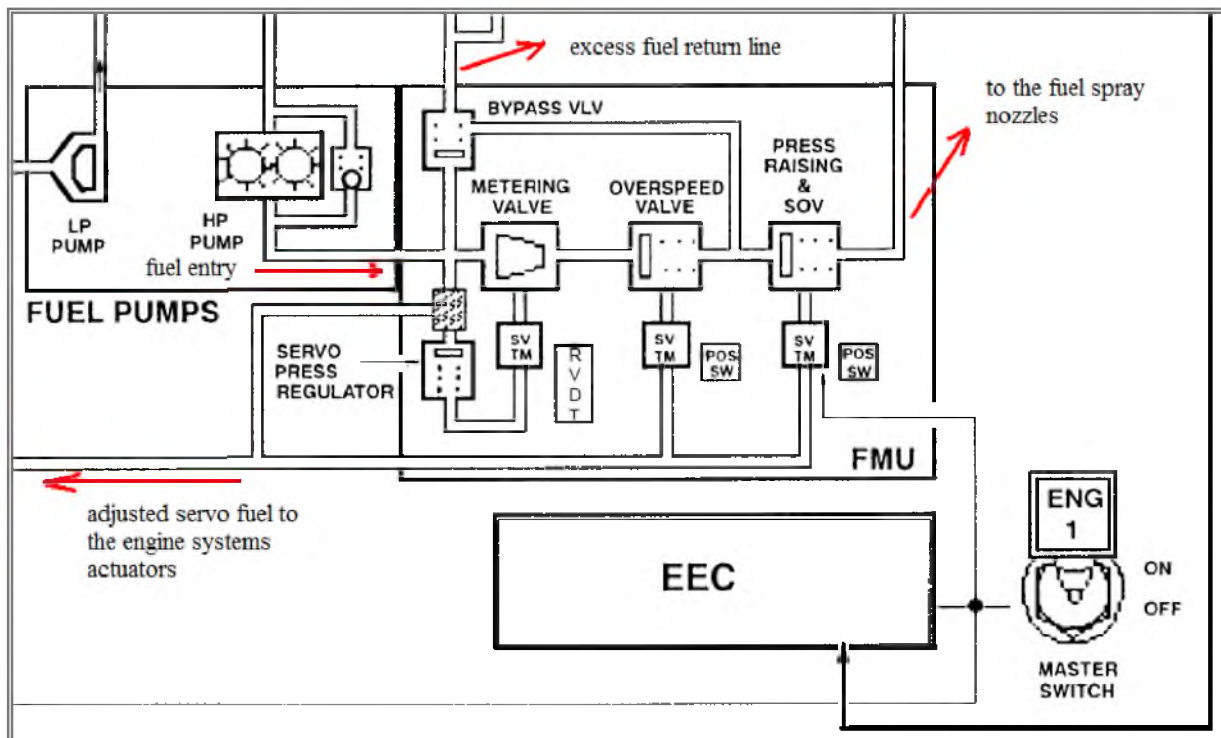


Fig. 5

2.6.3. Fuel

According to the technical log (aircraft technical log) No.102563 dated 09.09.2017, the A320 airplane with LZ-LAD registration marks was fuelled with 9100 kg of JET A-1 kerosene at the Bratislava airport before the flight to Sofia. The planned fuel consumption for the Bratislava-Sofia flight was 6192 kg.

The fuel was enough to carry out the flight.

2.7. Meteorological Information

Weather conditions in the area of Sofia Airport for the period from 10:00 to 12:00 UTC on 09.09.2017

Bulgaria was in the south-eastern periphery of a large cyclone with a center above the North Sea. A process of formation of shallow depression was observed above the Aegean Sea, which determines the conditions for the development of clustered convective cells, accompanied by thunder activity and short-lasting rainfall over southwest Bulgaria after 09:00 UTC.

METAR weather information broadcasted for Sofia airport for the period 10:00-12:00 UTC:

LBSF **091000Z** 22011KT 180V250 9999 SCT066 28/11 Q1012 NOSIG=

LBSF **091030Z** 21013KT 130V250 9999 SCT066 29/10 Q1011

LBSF **091100Z** 22018KT 9999 SCT066 30/10 Q1011 NOSIG=

LBSF **091130Z** 22017KT 9999 FEW040TCU SCT065 30/11 Q1011 TEMPO TSRA FEW033CB=

LBSF **091200Z** 19011KT 140V230 9999 FEW040TCU SCT065 30/12 Q1011 NOSIG=

The meteorological conditions at the moment of the aviation occurrence realization were of no effect of the serious incident.

2.8. Navigation

Standard aids to navigation of the A-320 aircraft. No malfunction of aircraft navigation aids were registered.

The approach of BUC320D flight to RWY27 at Sofia Airport was carried out using the ILS instrument landing system, which is Cat.1, as described in the Aeronautical Information and Publication (AIP) of the Republic of Bulgaria.

2.9. Communications

The crew maintained a two-way radio communication with the Approach ATC and Tower ATC at Sofia Airport. The two-way radio was free of interference.

2.10. Aerodrome information

The reference point of Sofia Airport is with the following coordinates (RWY center): N42°41'42" and E 023°24'30". Elevation 531m. The direction of the runway is 091°/271° (designated as 09/27), 3600m long and 45m wide.

2.11. Flight data recorders

The record of DFDR of LZ-LAD aircraft for the BUC320D/09.09.2017 flight started at 10:05:12 UTC. The engines were started in sequence - right-hand engine at 10:07 and left-hand engine at 10:09 UTC. The engine start was normal, and the maximum temperatures were EGT2=524°C и EGT1=525°C. The maximum registered vibrations were on N2 и they were respectively VIBN22=0.4 and VIBN21=1.0.

At 10:10:00 flaps at 15° were extended and at 10:10:25 the aircraft started taxiing to the standing start with an average speed of 10 kt. No anomalies in engine operation were registered during the taxiing. The temperatures were EGT1=470÷480°C и EGT2=450÷460°C. The average fuel consumption was respectively F1=390 kg/h и Fuel F2=385 kg/h.

The LZ-LAD aircraft took-off from Bratislava RWY13 at 10:16:08 UTC. At RALT=500 ft the landing gear was retracted and the autopilot was turned on (AP2). During the initial climb the ECAM display was set to the "Engine" page. At 10:16:48 at a RALT=2000 ft, a message "Door" appeared on the ECAM display for 5 seconds.

At 10:17:02 at RALT=2480 ft and speed of CAS=170 kt the flaps were retracted to 10°, and after 20 seconds at RALT=3000ft и CAS=201 kt the flaps were retracted to 0° и and the "Door" page appeared again on the ECAM display for 9 seconds. At 10:17:29 at RALT=3250 ft the ECAM display was set to "Cruise" page.

No engine deviations were registered during the take-off and initial climb. The maximum temperatures reached were EGT1=572°C and EGT2=566°C. The maximum registered vibration were for N1 and were respectively VIBN11=0.8 and VIBN12=1.4.

At 10:19:28 at ALT=11150 ft the page "Door" was again put on the ECAM. Till 10:23:00 at an ALT=21000 ft the pages "Door", "Status" и "Press" have changed 3 times more.

At 10:23:03 the page "Cruise" was put on the ECAM display.

At 10:30:00 the aircraft reached ALT=33000ft in heading of 135° and at speed of CAS=279 kt.

At 10:31:12 the page "Fuel" appeared on the ECAM display for 11 seconds. The current fuel consumption at this point was Fuel F1 = 1100kg/h and Fuel F2 = 1118 kg/h respectively. From 10:31:45 the current fuel consumption of the right-hand engine started to reduce and in 10 seconds it reached Fuel F2 = 127 kg/h. At 10:32:09 the throttle of right-hand engine was put on "Idle" position, and the left-hand engine mode was increased from EPR=1.20 to EPR=1.48.

At 10:33:25 the aircraft started to descent in heading of 135° and at 10:42:00 reached an ALT=25000 ft. The flight continues at this altitude, and the average values of the right-hand engine parameters were: EPR=0.79; N2 = 41%; EGT=340°C; Fuel F2=130 kg/h.

At 11:12:30, the aircraft started to descent for landing at Sofia Airport at a heading of 150°. During the descent, a gradual change of some of the parameters of the right engine began. N2 engine revs began to decrease on average by 0.1% in 3 seconds, and the temperature (EGT) starts to increase on average by 1°C in 3 seconds.

In a heading of 150° the aircraft was descending with an average speed of CAS=260kt and reached ALT=8000 ft at 11:26 h. At 11:26:50 in a heading of 187° and with a speed of CAS=260 kt the landing gear was extended. At 11:27:25 the flaps were extended to 15° at CAS=176 kt.

At 11:28:55 the landing heading of 270° was established at RALT=3200 ft and after 50 seconds more the flaps were extended to 40° at RALT=1800 ft and CAS=145 kt

Meanwhile N2 and EGT on the right-hand engine have already reached unusual values with F2 Fuel Consumption = 130 kg/h. At a RALT=1400ft N2=10.2%, and EGT2=600°C at EGT1=506°C of the normally running left-hand engine. At 11:29:45 at a RALT=1100 ft the right-hand engine was shut down, and the maximum of the temperature reached was EGT = 624°C.

At 11:30:49 at a RALT=340 ft and CAS=126 the AP2 was switched off. The aircraft landed at 11:31:19 on RWY27 at a speed CAS=127 and overload of Ny=1.25 g. The aircraft mass at touch-down was GW=48700kg. During landing run the left-hand engine reverser was activated and at GSPD = 110 kt it was turned off. Using the brakes, the speed was reduced to GSPD = 15 kt. The aircraft was taxiing with an average speed of 10 kt till 11:36:30 UTC, when in a heading of 159° the left engine was shut down.

2.12. Wreckage and Impact Information

There was no impact on the aircraft during the occurrence and the structural integrity of the aircraft was not compromised.

2.13. Medical and Pathological Information

There are no consequences for the aircraft crew when occurrence was realized, and no medical and pathological researches were performed.

2.14. Fire

The occurrence was not related to the emergence of fire.

2.15. Survival Aspects

The occurrence was not related to the need of performing of emergency and rescue actions.

2.16. Tests and Research

During the investigation process, the following actions were carried out:

1. Conversations with the staff performing maintenance on the airplane.
2. Review of crewmembers reports on the occurrence.
3. Review of aircraft operating documentation.
4. The Fuel Metering Unit (FMU) No.2 was sent for functional test to ACCEL AVIATION (USA), which found that channel "B" of the Fuel Metering Unit with PN: FMU 500 MK4 and serial No.B318 was non-functional. The identified failure of the FMU was documented by "Accel Aviation" by Work Order No.23608 of 26.10.2017.

2.17. Organization and Management Information

The aviation occurrence was realized by the ACC with an A-320 aircraft on a FERRY FLIGHT along the Bratislava-Sofia route after aircraft painting. The aircraft is operated by Bulgarian Air Charter Jsc AO with an approved an Air Operator Certificate No.BG 06 issued by DG CAA.

The organization and management of Bulgarian Air Charter Jsc AO are set out in Parts A, B, C and D of the Flight Operation Manual, provided by the AO to the Investigation Commission, in order to use the necessary information for the purposes of the investigation.

2.18. Additional information

AO has replaced the failed unit, and the results of flaw detection of the failed unit (FMU) were reflected in Para2.16.

3. Analysis

In view of stated in paragraphs 2.1.2; 2.3; 2.11 and 2.16, it could be concluded that the prime cause of the serious incident was a failure in the FADEC electronic control system of engine No.2, associated with an internal failure in the electrical system of the FMU fuel dosing unit.

An integral part of the fuel metering unit FMU is the Fuel Metering Valve (FMV). In the fuel stream after Fuel Metering Valve two more electronic valves are installed, respectively an Overspeed Valve and Pressurizing and Shut Off Valve (PRSOV), which definitely have worked normally. The whole unit is of a closed type, no set points, adjustments, and it works on the principal "As is"; in case of problem it shall be explicitly removed and replaced as a whole (LRU - Line Replaceable Unit), which excludes the possibility of any human interference by the technical staff. The failure is internal, purely technical.

The take off and climbing of the aircraft up to an altitude of 33000ft passed without any deviation in the parameters of the two engines. After leveling off at FL330, the crew received a warning message on the ECAM display: „ENG2 FUEL FLOW LOW“ and the No.2 engine remained operational at “IDLE” mode with normal parameters and minimum fuel supply. The flight crew reported to the ATS for the minimum trust of one engine. The flight crew started up APU and descended (in coordination with Budapest ATC) to FL250. The APU was started up in order to ensure a backup source of electrical power and air in case of possible escalating of the problem to a complete loss of power of this engine. After discussing the situation, weather conditions along the route and the main and alternate airports, available fuel on board, and the available and required length of the RWY with one engine, the flight crew decided to continue the flight to Sofia. The A/C commander said if the operational parameters of No.2 engine would go close to the limits, the engine would be shut off. After overfly of navigation point GOL the ATCO-APP vectored the crew for an ILS approach for RWY 27. The approach of the aircraft to Sofia Airport was stabilized at an altitude of about 1500ft. Subsequently the flight crew received a new warning message on the ECAM display "ENG 2 FADEC ALTERNATOR". The PM reported for disappearance of the N1 and N2 readings of engine No2 and increasing of the temperature of the exhaust gas (EGT) to critical values. Upon reaching EGT = 624°C, by a command of the A/C commander No.2 engine was shut down by the PM. The descent was performed according to the criteria of stabilized approach, the landing was normal, with registered vertical overload $N_y = 1.25 g$.

In view of the above, the Safety Investigation Commission accepted the actions of the crew at the time of the occurrence were correct.

4. Conclusion

4.1. Findings

As a result of the investigation, the Commission concluded:

1. A320-231 aircraft, serial No 00353, with registration marks LZ-LAD, was manufactured in 1992 by AIRBUS INDUSTRIES, Republic of France.
2. The airplane has Certificate of Registration No. 22656 issued by Directorate General of Civil Aviation Administration of the Republic of Bulgaria on 09.12.2016.
3. The aircraft is owned by Bulgarian Air Charter Jsc, with address: City of Sofia, Gorublyane, 35 Pavel Krasov str.

4. A total flight time of 63 184:03 hours and 29 431 cycles was recorded in the airplane log book since new until the date of the occurrence (09.09.2017).
5. After the Ferry flight to Sofia Airport on 12/13.11.2016, the aircraft was preserved for a long period of storage by the Maintenance Organization of Bulgarian Air Charter Jsc according to the manufacturer's Maintenance Manual.
6. According an order No.5984-A-17 for maintenance a planned form of maintenance 12Y Check was performed on 01.06.2017.
7. The C Check was carried out by the previous operator on 30.06.2012 at a flight time of 62 660 hours and 29 221 cycles.
8. The aircraft is equipped with two V-2500-A1 gas turbine engines with serial numbers V0167 (No.1) and V0175 (No.2). The engine flight time since new of Engine No.1 was 46 250 hrs/ 21 815 cycles, and for Engine No.2 was respectively 55 430 hrs/ 26 033 cycles.
9. When performing the flight, in which the investigated occurrence was realized, the aircraft, engines and equipment had the necessary resources.
10. There is no information that any physiological factors or loss of capacity has influenced the pilot's capacity for work.
11. The weather conditions have no direct impact on the realization of the air occurrence.

4.2. Causes

On the base of the investigation, the Commission considers that the serious incident is due to the following reasons:

The prime cause:

Failure of the FADEC control system of No 2 engine.

The main cause:

Fault of electrical system of the Fuel Metering Unit (FMU) caused by a short circuit or loss/interruption of the electrical signal to the Fuel Metering Valve (FMV).

5. Safety recommendations:

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-2017/06/01. At the earliest opportunity, the AO shall perform the FADEC SYSTEM Operational Test on the Ground (Ref. MM 73-22-00, §.501) of all operational V 2500-A1 engines. The records of the test itself and the entries in the GROUND SCANNING Menu and the Scheduled Maintenance Report shall be reviewed, and if there are, any malfunctions detected, to remove them immediately according to the established TROUBLESHOOTING procedures until the test under item 1 is received without any records of malfunctions. The test performed shall be recorded in the Aircraft Technical Log;

BG.SIA-2017/06/02. At discretion of the AO Quality Management System, the A-320 Series Aircraft Maintenance Program (IAE V2500) to be supplemented with FADEC SYSTEM Operational Test on the Ground. This test should be run when the aircraft is parked in Flight Ready Condition for more than 15 calendar days in low temperature and high humidity conditions.

On the grounds of Art.18, § 5 of Regulation 996/2010, the safety measures instructed shall be recorded in the centralized European System of Safety Measures (SRIS).

The Investigation Commission reminds all organizations to which safety measures have been sent, that on the basis of Article 18 of Regulation 996/2010 on Investigation and Prevention of Accidents and Incidents in Civil Aviation and Art.19, Para7 of Ordinance No. 13 for investigation of aviation accidents, they are obliged to notify in writing the AMRAIU Directorate of MIITC on the actions taken according the safety measures made.

30 July 2018

BULGARIAN AIRCRAFT ACCIDENT INVESTIGATION UNIT