FINAL REPORT

ACCIDENT

Occurrence No.: 2374/16

Aircraft: Hummingbird 300 LS helicopter, SP-YLN

6 September 2016

Rzeszów-Jasionka aerodrome (EPRZ)

This Report is a document presenting the position of the State Commission on Aircraft Accidents Investigation concerning circumstances of the air occurrence, its causes and safety recommendations. The Report was drawn up on the basis of information available on the date of its completion.

The investigation process can not be considered as finally closed. The investigation may be reopened if new information becomes available or new investigation techniques are applied, which may affect the wording related to the causes, circumstances and safety recommendations contained in the Report.

Investigations into air occurrences are carried out in accordance with the applicable international, European Union and domestic legal provisions for prevention purposes only. The investigation was carried out without the need of application of the legal evidential procedures, applicable for proceedings of other authorities required to take action in connection with an air occurrence.

The Commission does not apportion blame or liability.

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For the above reasons, any use of this Report for any purpose other than air accidents and incidents prevention, can lead to wrong conclusions and interpretations.

This Report was drawn up in the Polish language. Other language versions may be drawn up for information purposes only.

WARSAW 2018

TABLE OF CONTENTS

GENERAL INFORMATION

Occurrence reference number:	***2374/16***			
Type of occurrence :	***ACCIDENT***			
Date of occurrence:	***6 September 2016***			
Place of occurrence	***EPRZ aerodrome***			
Type and model of aircraft:	***Hummingbird 300 LS helicopter***			
Aircraft registration marks:	***SP-YLN***			
Aircraft User/Operator:	***Private***			
Aircraft Commander:	***CPL(H) holder, test pilot***			
Number of victims/injuries	***Fatal***	***Serious***	***Minor***	***None***
	-	***-***	***-***	***1***
Investigator-in-Charge:	***Mieczysław Wyszogrodzki***			
Investigating authority:	***SCAAI Investigation Team***			
Composition of the Investigation Team:	***Dariusz Frątczak – SCAAI Member/Expert*** ***Tomasz Makowski - SCAAI Member*** ***Roman Kamiński - SCAAI Member*** ***Eligiusz Starzyński – SCAAI Expert*** ***Dariusz Baranowski - SCAAI Expert*** ***Paweł Zembrzycki – User Representative***			
Document containing results:	***SCAAI Final Report***			
Recommendations:	***Yes***			
Addressees of the recommendations:	**Vertical Aviation Technologies, Inc. USA**			
Date of completion of the investigation:	***TBD***			

SYNOPSIS

On 6 September 2016 at 13:25 hrs LMT, (local time) during post-assembly tests, when cooling engine on the ground after completing a hover, the engine compartment of Hummingbird 300LS helicopter, SP-YLN, caught fire.

Despite of an immediate firefighting action by the maintenance personnel and the Airport Fire Brigade, the helicopter was significantly damaged.

The pilot and the maintenance personnel did not suffer any injuries.

1. FACTUAL INFORMATION

1.1. History of the flight

On 25 August 2016 the test pilot began to carry out post-assembly tests of Hummingbird 300 LS helicopter, registration marks SP-YLN, in accordance with item D.2.1. of the "Flight Test Program" approved by the Civil Aviation Authority.

The tests were observed by four maintenance persons located at a safe distance from the helicopter.

During the first test the following failures were found:

- inoperative engine speed regulator;
- incorrect tracking of main rotor blades, blade fluctuation was about 5 to 10 centimeters;
- incorrect indication of the engine oil temperature.

After removing the failures, on 6 September 2016 further ground tests were carried out, followed by flight tests.

Following arrangements with EPRZ TWR, the tests were carried out on TWY G. When the engine was started and the take-off parameters were reached, the pilot checked the helicopter during taxiing, and then proceeded to check in a hover at a height of 1,5 to 3 meters. All tests were carried out over TWY G. When in a hover the pilot checked the helicopter during sideways movements and in turns around its vertical axis by 90º to the left and right.

During the maneuvers, the pilot observed an increase in the oil temperature close to the maximum permissible values, i.e. 275 F (135° C). Due to that fact the pilot decided to land to cool the engine oil. Upon reaching the recommended oil temperature (176F ÷ 266F) - (80ºC ÷ 130ºC) the pilot took off again, performing hover maneuvers at a height of about 1,5 to 3 m.

After over a dozen minutes, the pilot again observed an increase in engine oil temperature (the oil pressure was normal) therefore, he decided to land, cool the oil to the recommended values and suspend the flight tests until the causes of the high oil temperature have been found.

While cooling the engine the pilot heard a "thud" in the back of the fuselage. A short time after that (3 to 5 seconds), the engine stopped, which was confirmed by illumination of a red light on instrument board. TWR informed the pilot by the radio about fire in the aft part of the fuselage, which was confirmed by maintenance personnel who started a firefighting action, giving the pilot signals to evacuate.

The pilot, seeing that the ground personnel action was unsuccessful, asked TWR for Airport Fire Brigade to extinguish the fire. Neither the pilot nor other personnel involved in the firefighting action suffered any injuries.

1.2. Injuries to persons

Injuries	Crew	Passengers	Others
None	1	-	-

1.3. Damage to aircraft:

- burnt engine compartment;
- destroyed transmission system from engine to main rotor gearbox;
- destroyed tail beam;
- destroyed and singed main rotor blades (two of three);
- singed tires of the left wheel of the main landing gear;
- damaged engine controller;
- damaged systems in the engine compartment (fuel, oil, electric).

Photos of the helicopter damage are presented in Album of Illustrations (Annex 1).

1.4. Other damage

None.

1.5. Personnel information (crew data)

Pilot - male, aged 62, holder of:

- flight crew licence;
- CPL(H), issued by CAA on 20 May 2016, valid for undefined period;
- TR for R44 valid until 31 July 2017;
- TR for R66 valid until 31 July 2017;

- TR for SW4 valid until 30 September 2017;
- TR for W3 Sokół valid until 31 May 2017;
- FTI valid until 30 November 2019;
- IR valid until 31 May 2017;
- Rating of a helicopter test pilot Cat I;
- General Radiotelephone Operator's Certificate issued by President of Authority of Electronic Communications on 21 May 2007, valid for undefined period.

Medical examination effected 24 June 2016, obtained Class 1 Medical Certificate valid until 24 December 2016 and Class 2 valid until 24 June 2017, LAPL with VNL limitation valid until 24 June 2018.

Flight experience (based on the pilot flight book):

- total flight time – 5008 h;
- flight time as instructor – 1824 h;
- flight time over last 90 days – 80 h;
- flight time over last 24 h – 0,5 h on Mi-2 helicopter.

According to the aircraft log from 25 August to 6 September 2016 the pilot performed on the accident helicopter the following tests and flights:

- on 25 August - ground tests during 1h;
- on 6 September - tracking of main rotor blades during 55 minutes;
- on 6 September - flight test in hovering during 35 minutes.

The pilot had an appropriate rest time over the last 24 hours prior to the occurrence.

1.6. Aircraft information

Airframe:

Manufactured by Vertical Aviation Technologies, Inc. USA, type Hummingbird 300 LS, serial number HB300LS-1. The helicopter was purchased as a set of parts and assembled by a private company, which was the aircraft operator for the time of assembling and tests.

The Hummingbird 300 LS helicopter has a classic configuration with a 3-blade main rotor and a 2-blade tail rotor. The helicopter fuselage is mostly metal, riveted, partly made of composite materials. The cabin provides space for four persons (including pilot). The helicopter is equipped with a 4-point wheel landing gear.

Figure 1. General view of Hummingbird 300 LS helicopter (photo: Operator)

The rotor hub was constructed in a classic system with three pivot points (horizontal, vertical and angular). The control is effected by a control disc with pushers.

Single-spar metal blades of the main rotor have a rectangular contour with end fairing. The tail rotor metal blades have a triangular contour.

The drive system consists of:

- 8-cylinder LS7 liquid-cooled gasoline V-engine;
- main rotor gearbox, intermediate gearbox and tail rotor gearbox;
- tail rotor drive shaft on 6 support bearings.

Working time since new: 2 hours 30 minutes.

Number of cycles since new: 2 flights lasting 35 minutes.

The helicopter had valid third party liability insurance.

Engine

Piston V-engine, fuel B95 or B89 gasoline.

The engine was installed on the helicopter on 23 August 2016.

Model LS7	Vertical Aviation Technologies, Inc.
Power	280 BHP at 3200 RPM
Number of cylinders	8
Cylinder bore	4.130''
Piston stroke	4.000''
Displacement	7.0 cubic decimetres
Compression ratio	10.8 : 1
Year of manufacture	2013
Serial number	LS7-001
Working time since new	2 hrs 30 minutes

Helicopter weights (according to the manufacturer):

- Maximum Take-off Weight (MTOW): 1270 kg;
- Maximum Zero Fuel Weight (MZFW): 902 kg;
- Maximum load weight (including fuel) 368 kg.

After the accident about 130 litres of fuel remained in the helicopter. The fuel was protected as evidence.

Ballast used for solo flights was placed and tied down on the front passenger seat in accordance with the Flight Manual

The helicopter weight and location of its center of gravity was within the limits specified in the Flight Manual.

The helicopter was maintained in accordance with regulations applicable in the assembling organization.

The helicopter records were maintained correctly.

1.7. Meteorological information

The flight was performed in daylight. Weather conditions on the day of the accident on EPRZ were as follow:

METAR EPRZ 061200Z 05010 kt 020V080 9999 BKN21 22/16 Q1022.

Weather did not have an impact on the accident.

The meteorological information was obtained from publicly available archive data of Institute of Meteorology and Water Management.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The helicopter was equipped with a radio transceiver operating in the frequency range of 118,00 – 136,75 MHz. During the flight the pilot maintained a two-way radio communication with EPRZ TWR at the frequency of 126,80 MHz.

1.10. Place of occurrence information

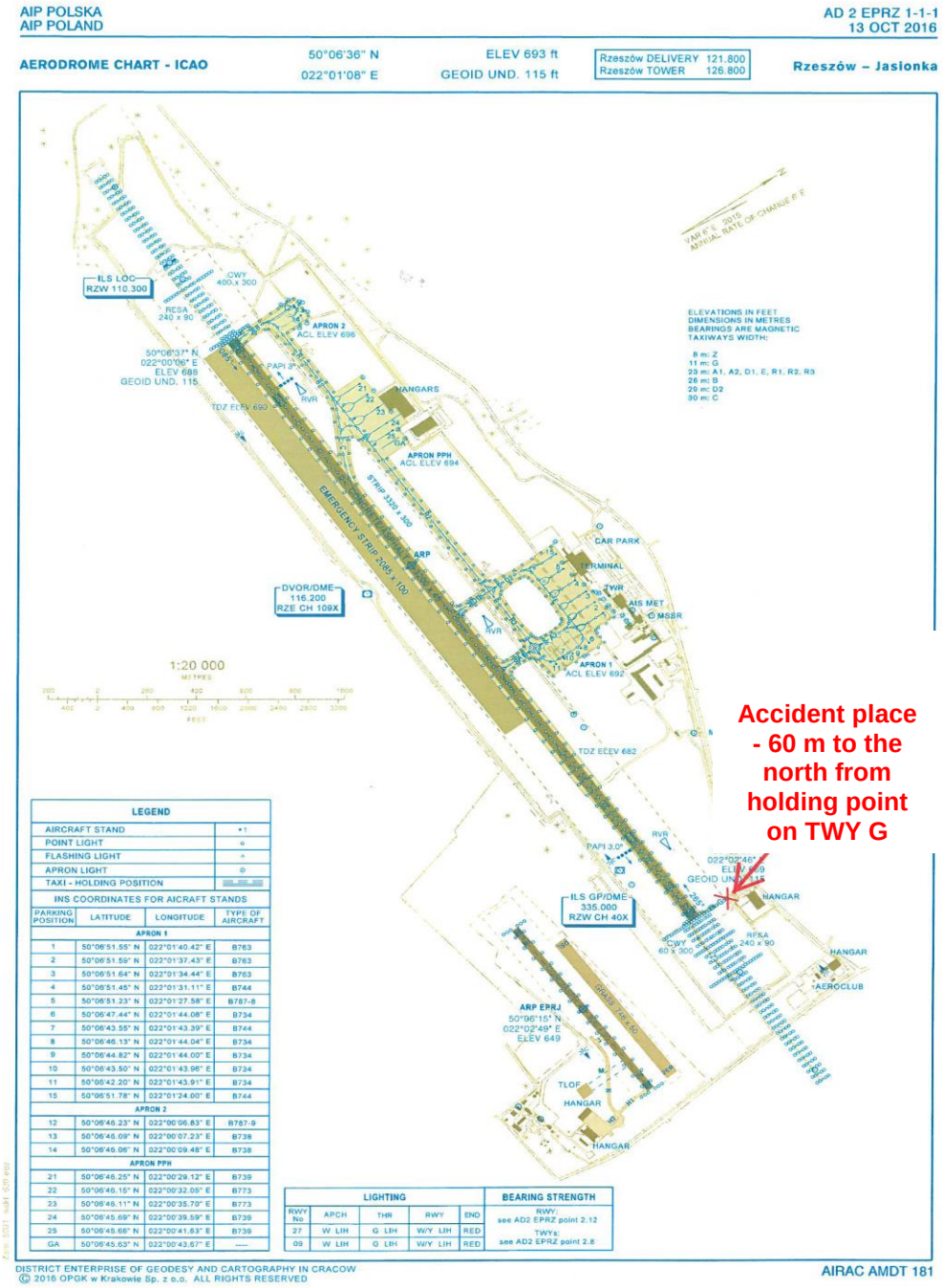

Figure 2. Accident place on EPRZ layout (AIP Poland)

Figure 3. The helicopter during the tests on TWY G (photo: Operator)

1.11. Flight recorders

The helicopter was not equipped with typical flight recorders. However, it was equipped with ECM for LS7 and the MGL Avionics Stratomasteri EFIS Challenger.

Memory cards of the aforementioned devices allow to record flight parameters and operation of powerplant.

1.12. Wreckage and impact information

The fire zone included the rear part of the fuselage, engine compartment, main rotor gearbox, main rotor blades, tail beam and the left rear wheel of the landing gear. The fire caused melting of the fuselage skin, destruction and separation of the tail beam and partial evaporating or change into slag some elements of the engine. The fuel tank and the front part of the helicopter fuselage were outside the fire zone.

Figure 4. Helicopter after firefighting action of Airport Fire Brigade (photo: Operator)

1.13. Medical and pathological information

The pilot did not suffer any injuries as a result of the accident.

At the time of the accident, the pilot was not under the influence of alcohol or psychoactive substances.

1.14. Fire

Figure 5. Beginning of the helicopter fire (photo from Operator surveillance camera)

In the course of the engine cooling the engine compartment caught fire. In the initial phase of the fire portable extinguishers located in the area of tests were used. There was 215 liters of gas on board before take-off.

The pilot, assessing that the action with portable extinguishers would not be successful, asked EPRZ TWR to activate Airport Fire Brigade. After about 2 minutes three vehicles of the Airport Fire Brigade arrived and extinguished the fire in a short time.

After the firefighting action 130 liters of gasoline remained in the helicopter tank.

Figure 6. Firefighting action by maintenance personnel, prior to arrival of Airport Fire Brigade (photo from Operator surveillance camera)

1.15. Survival aspects

The situation in which the fire occurred (helicopter on the ground, information about the fire from TWR and presence of maintenance personnel urging the pilot to leave the helicopter) gave the pilot a chance to survive.

The pilot had his seatbelts fastened and there were portable extinguishers at hand, which were used prior to arrival of the Airport Fire Brigade. The pilot left the aircraft unaided.

1.16. Tests and research

After arrival of SCAAI representatives at the scene the following actions were immediately taken:

- the helicopter wreckage was inspected visually and protected for further investigation;
- photographic documentation of the scene and the wreckage was made;
- available documentation regarding flights in "special" category was protected;
- detailed inspections of the fuel and oil systems were carried out;
- ECM of LS7 engine and MGL Avionics Stratomasteri EFIS Challenger were protected for further testing;
- continuity of kinematic connections of the control system was inspected;
- pilot's records were protected;
- weather conditions on the accident day were analyzed;
- witnesses were interviewed;
- technical documentation related to the helicopter assembly was acquired and secured;
- documentation from CAA related to permits for test flights was acquired;
- photos and videos from airport cameras and the Operator's surveillance system as well as recordings of radio and telephone communication from EPRZ TWR were protected.

Analyzes and specialist examinations:

- specialist examinations of the fuel and oil systems and ECU of LS7 were carried out;
- specialist examinations by State Fire Service representatives acting as SCAAI experts were commissioned to determine causes of the fire.

1.17. Organizational and management information

The organization assembling the helicopter met all requirements resulting from the applicable Aviation Law.

The preparation of the crew for the tests and flights, air traffic service and meteorological service actions were carried out in accordance with the applicable regulations.

1.18. Additional information

Change of Investigator-in-Charge (IIC): until 13 November 2016 SCAAI member Dariusz Frątczak was IIC for this accident and from 13 November 2016 SCAAI member Mieczysław Wyszogrodzki was nominated for this position.

After reviewing the collected evidence, the prosecutor's office abandoned their proceedings.

During a meeting held on 17 July 2017 the SCAAI Investigation Team decided to re-examine the wreckage with particular attention paid to the engine oil system.

1.19. Useful or effective investigation techniques

Standard investigation techniques were applied during the investigation.

2. TECHNICAL ANALYSIS

The helicopter fuel and oil systems were examined in detail and an attempt was made to recover data from the engine ECM and MGL Avionics Stratomasteri EFIS Challenger.

2.1. Fuel system

During a visual inspection special attention was paid to the technical condition of the quick connector P/N 640850 in the fuel line supplying fuel to the engine injection rail.

It was found that a plastic insert designed to prevent the connector from disconnection was missing. Following the finding, the Commission decided to conduct a thermal test of the quick connector on a test stand. New connectors P/N 640850 purchased from manufacturer were used for the thermal tests.

Figure 7. Disconnected fuel line supplying the injection rail is indicated by red arrow (photo: SCAAI)

The female connector was joined with a connection pipe (P/N 640940). The connection pipe was identical, (geometrically and materially) with the one used to feed the LS7 fuel injection rail. The complete connector was placed on the test bench allowing to simulate the working pressure in the fuel system.

Figure 8. The tested connector. From the left: a connection pipe of 3/8 inch, plastic insert preventing disconnection of the coupling, 3/8 inch female connector (photo: SCAAI)

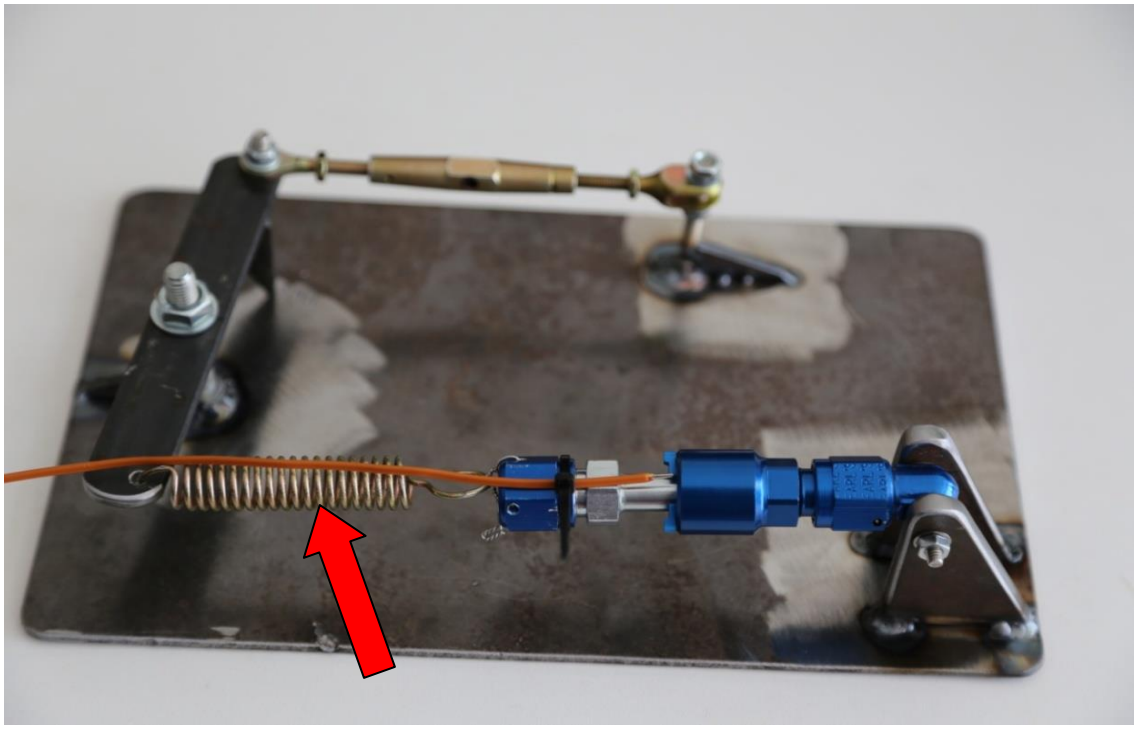

Figure 9. The connector prepared for the test with a thermocouple (photo: SCAAI)

Three tests were carried out. The tested connectors were placed in a heating device to create the temperature conditions similar to those in the helicopter engine compartment at the time of the occurrence.

The first connector was gradually heated, starting from 31,6°C. **At the temperature of 212°C melting and flow of the plastic insert** preventing the connector from being disconnected was observed (Figure 11).

Then the second test was carried out on a new connector. It was placed at the temperature of 117,3°C and then it was subjected to further heating. **After reaching the temperature of 275°C, the tested quick connector disconnected.**

In the next test, the third connector was placed on the test stand and it was gradually heated starting from the temperature of 21°C. The connector was preheated to 120°C and then the temperature was increased by 20°C every 10 minutes. At the temperature of 167°C the beginning of softening of the plastic insert was observed. **At the temperature of 192,6°C, the tested quick connector was completely disconnected.**

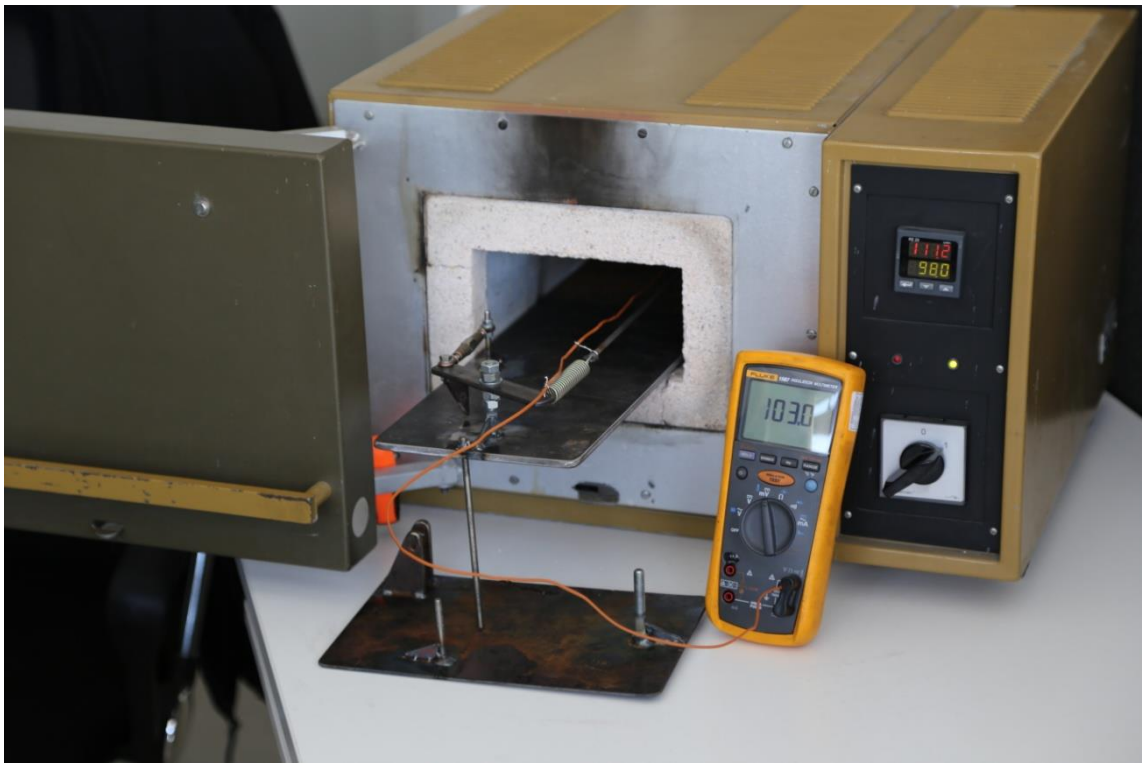

Figure 10. The stand for testing the impact of temperature on the connector (photo: SCAAI)

Figure 11. The plastic insert after the first test (photo: SCAAI)

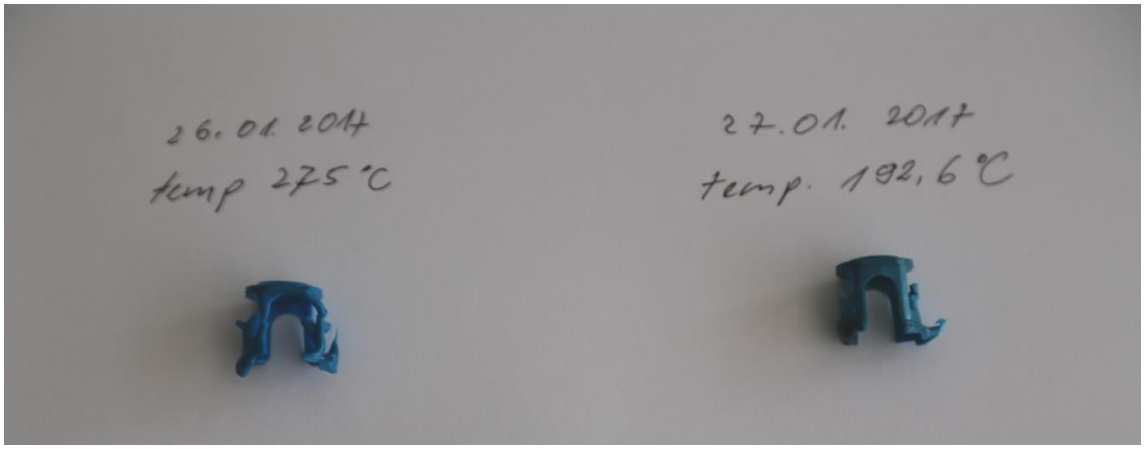

Figure 12. The plastic inserts after the second and the third test (photo: SCAAI)

As a result of the thermal tests of the quick connectors used in the fuel system of the LS7 engine, the following observations were made:

- partial melting (deformation) of the plastic insert designed to prevent the connector from disconnection;
- no signs of temperature impact on the metal elements of the connector (connection pipe and female part of the connector).

2.2. Oil system

Then, the disassembly and inspection of the components of the engine oil system was carried out:

- oil lines
- threaded connections
- oil filter.

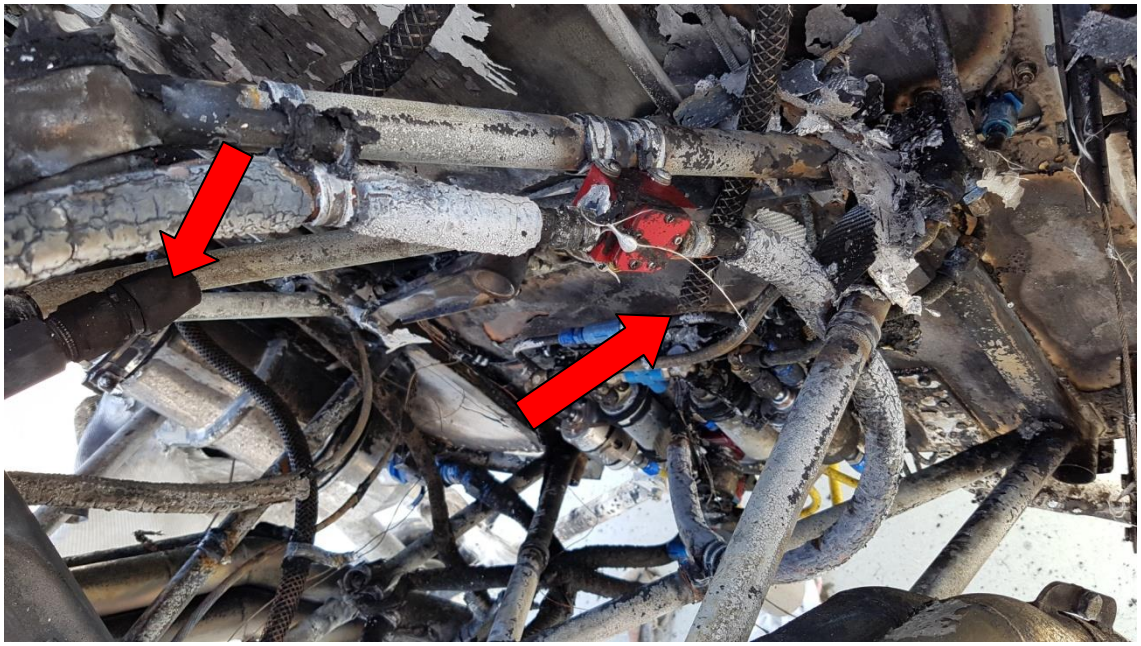

Figure 13. Damaged oil line separated from the engine block connection pipe (the pipe marked with the red arrow on the left). The end of the separated line indicated by the arrow on the right. The other end of the line (invisible on the photo) is connected to the oil filter (photo: SCAAI)

Figure 14. Damaged oil line, connection pipe removed from the engine block and oil filter (photo: SCAAI)

Figure 15. Disassembled oil filter – in the bottle oil from the filter (photo: SCAAI)

Visual inspection of the oil system showed:

- effects of high temperature on all surfaces - traces of charring and melting. It was found that the connection of the oil line with the oil filter was continuous and the oil line was not connected with the engine block;
- no abnormalities were found in the tested elements of the oil filter, such as: filter cartridge, internal seals, springs and engine oil residues.

The Commission assumed that the fire resulting from unsealing of the oil system was unlikely, because the observed discontinuity of the oil line would have led to a drop in the oil pressure which had not been observed by the pilot prior to the engine stop.

According to the Commission, disconnecting of the oil line should not have caused the engine to stop immediately. Probably, after oil leak, the engine would run until its seizure.

In view of the above, the Commission considered that the observed failure (discontinuity) of the oil line had a secondary nature and was caused by fire or the fire-fighting action.

Based on the tests of quick connectors used in the fuel system of LS7-001 engines, the Commission concluded that disconnection of such connector may result from a high temperature in the engine compartment. High temperature causes melting the plastic

insert which would have prevented disconnection in lower temperature. Vibrations generated by the helicopter and a pressure in the fuel system are factors contributing to the disconnection. When a connector disconnects, the fuel under pressure leaks and creates a high probability of a fire.

2.3. Attempt to read out parameters

The Commission attempted to read out the ECM from the LS7 engine installed on the helicopter. Since no data from the ECM could be retrieved, its housing was removed and it was found that its electronic components were separated from the main board. Loose elements (due to melted solder connections) were protected.

The course of the read out and disassembly of ECM were documented by video recording and photos.

The Commission also verified the hypothesis that the ECM had shut down the engine due to a drop in oil pressure. To this end, ECM software was analyzed.

The analysis showed that the ECM did not have a function shutting down the engine in the case of a drop in oil pressure.

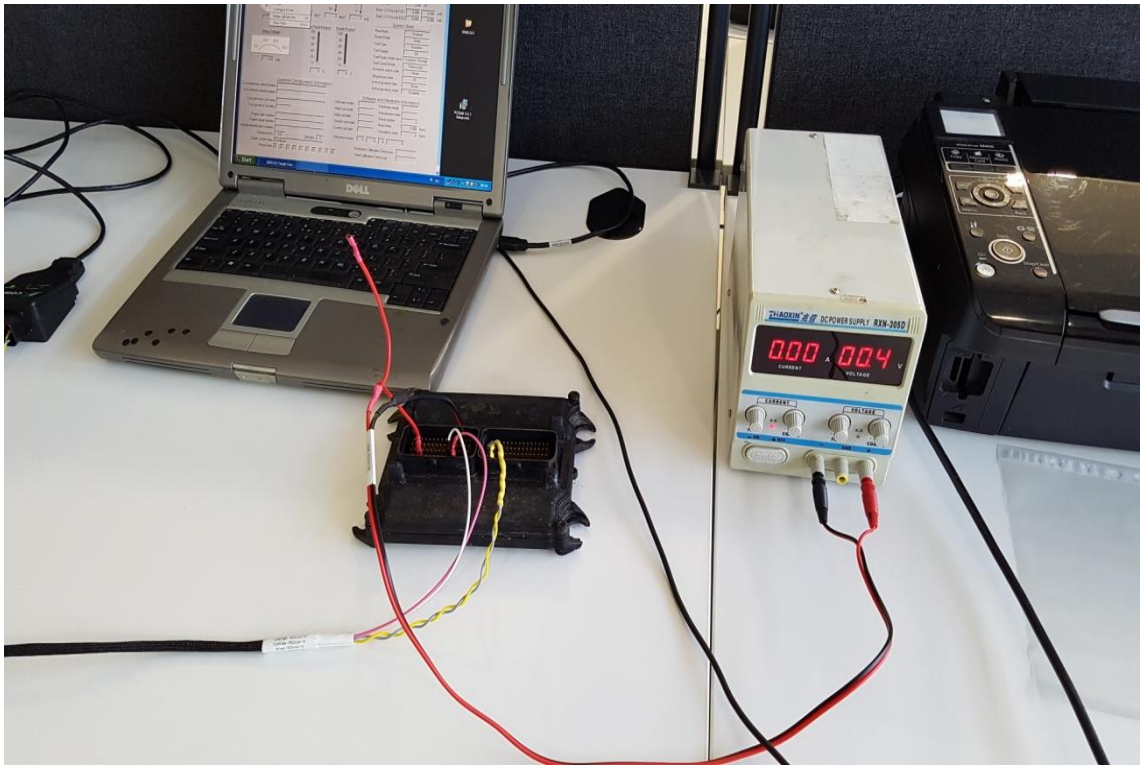

Figure 16. Measuring stand prepared to read out data from the ECM of LS7 engine (photo: SCAAI)

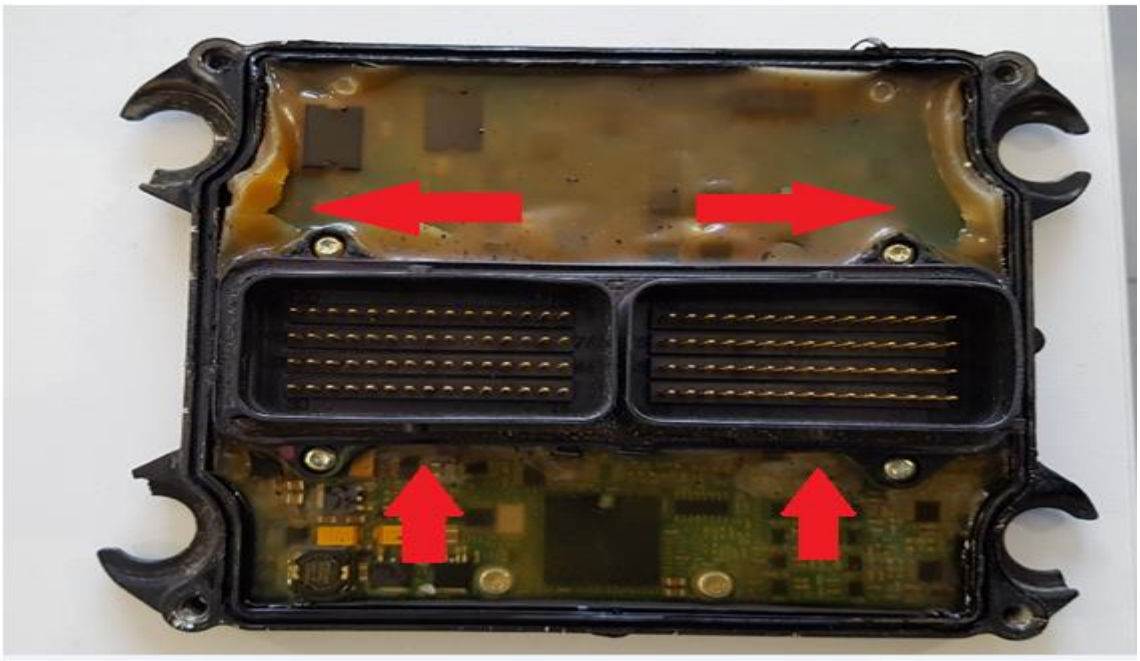

Figure 17. Opened ECU of LS7 engine. The red arrows show the parts damaged by high temperature (photo: SCAAI)

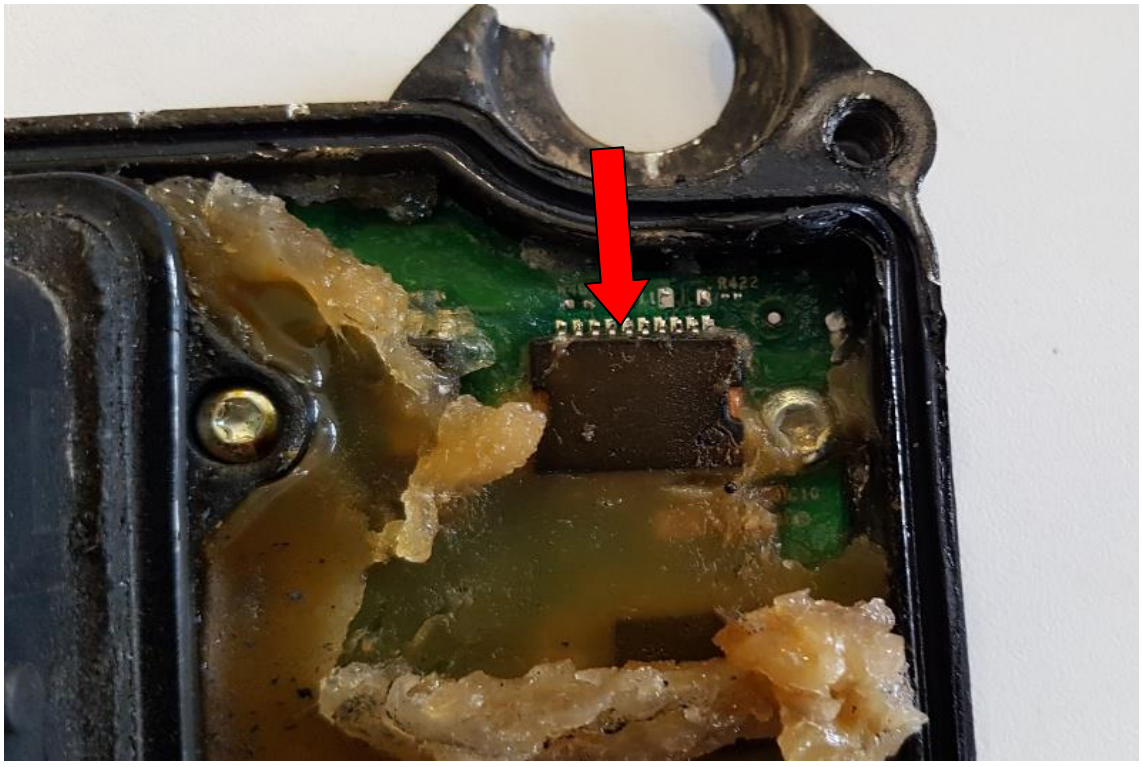

Figure 18. Part of ECM after removing protecting gel. The red arrow indicates place where electronic elements were soldered prior to the accident (photo: SCAAI)

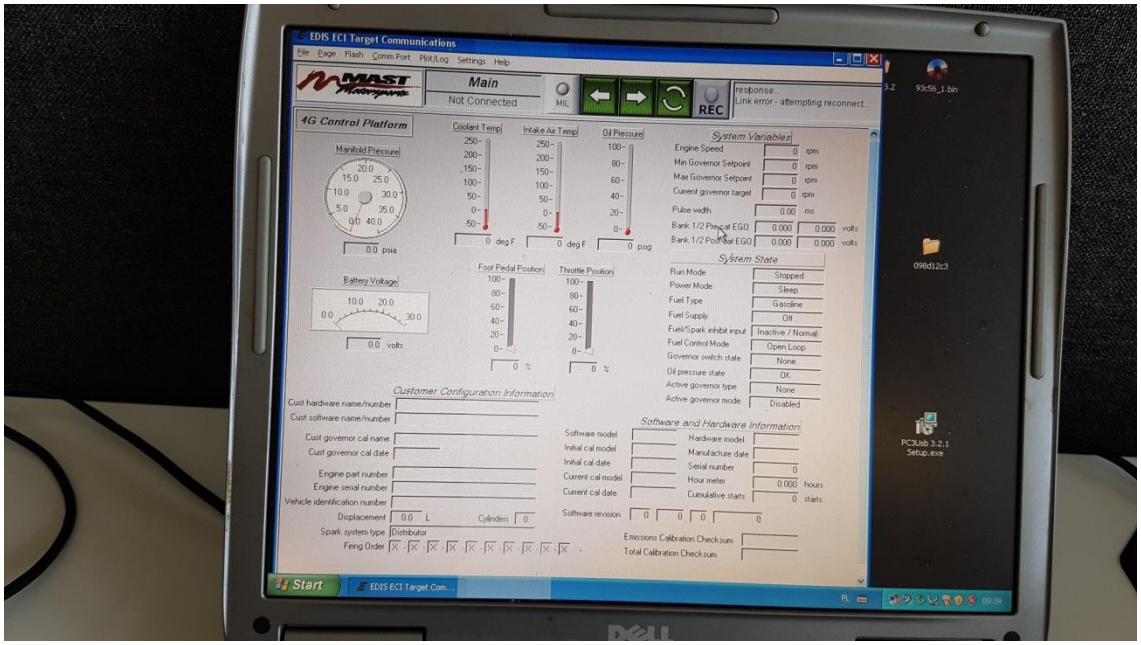

Figure 19. Screen of the measuring apparatus (photo: SCAAI)

The MGL Avionics Stratomasteri EFIS Challenger did not record any data because no memory card was installed in it.

2.4. Analysis of flight tests organization

The helicopter tests on the ground and in flight were organized in accordance with the President of the Civil Aviation Authority decision No. 086/2016 of 6 September, 2016, related to Special Permit to Fly No. SZL-DLR-M/027/2016. Validity period of the permit: from 6 September to 6 October 2016.

Ballast used for "solo" flights (in accordance with the Flight Manual) was placed and tied down on the front passenger seat.

The helicopter weight and location of its center of gravity were within the limits specified in the Flight Manual.

Prior to the flight on 6 September 2016 the pilot agreed with Operator all details relevant to post-assembly tests of the helicopter.

After taking place in the cockpit the pilot established communication with EPRZ TWR and when cleared, proceeded to perform planned flights.

The Commission did not find any irregularities regarding organization of the flight tests.

3. CONCLUSIONS

3.1. Commission findings

1. The pilot had valid ratings, valid General Radiotelephone Operator's Certificate and valid medical certificate.
2. The helicopter was built in accordance with the regulations applicable to aircraft used in SPECIAL category, and its documentation was maintained correctly.
3. Until the accident the helicopter was airworthy and had a valid Airworthiness Review Certificate in SPECIAL category.
4. Weather conditions did not affect the course of the occurrence.
5. Two-way radio communication was ensured during the tests.
6. At the time of the accident the pilot was not under the influence of alcohol or psychoactive substances.
7. During visual inspection of the helicopter wreckage, except for other damage, the disconnected quick connector of the fuel line near the injection rail and the lack of continuity of the oil line between the oil filter and the engine block were found.
8. Attempts to read data from ECU and MGL Avionics Stratomasteri EFIS Challenger ended in failure.
9. No irregularities were found in relation to the organization of the flight tests.

3.2. Cause of the accident

The most probable cause of the accident was unsealing of the quick connector in the fuel system which led to a fire.

4. SAFETY RECOMMENDATIONS

1. The Commission recommends that the Manufacturer considers measures aimed at replacing quick connectors in the fuel system of all Hummingbird 300LS helicopters with connectors resistant to disconnection.
2. The Commission recommends that the Manufacturer considers introducing fire alarm system in engine compartment of Hummingbird 300LS helicopter.

5. ANNEXES

5.1. Album of Illustrations

THE END

Investigator-in-Charge