MINISTRY FOR
INNOVATION AND TECHNOLOGY

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

2018-322-4

Accident

Pécs-Pogány Airport SW 1.8 km

31 May 2018

Magnus eFusion

HA-XEF/MG11–004

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

General information

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

- Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC,
- Act XCVII of 1995 on aviation,
- Annex 13 identified in the Appendix of Act XLVI. of 2007 on the declaration of the annexes to the Convention on International Civil Aviation signed in Chicago on 7th December 1944,
- Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as Kbvt.),
- NFM Regulation 70/2015 (XII.1) on safety investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In absence of other relevant regulation in the Kbvt., in accordance with Act CL of 2016 on the general rules of administrative authority procedure and service.

The competence of the Transportation Safety Bureau of Hungary is based on Government Regulation № 230/2016. (VII.29.) on the assignment of a transportation safety body and on the dissolution of Transportation Safety Bureau with legal succession.

Pursuant to the aforesaid laws,

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

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

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

This Final Report

was based on the draft report prepared by the IC and sent to all affected parties (as specified by the relevant regulation) for comments.

Copyright Notice

Translation

This document is the translation of the Hungarian version of the Final Report. Although efforts have been made to translate it as accurately as possible, discrepancies may occur. In this case, the Hungarian is the authentic, official version.

Table of Contents

Definitions and abbreviations

AGL	*Above Ground Level*
BFU	*Bundesstelle für Flugunfalluntersuchung (German accident investigating body)*
CRI	*Class Rating Instructor*
SW	*Southwest*
EASA	*European Union Aviation Safety Agency*
FI(A)	*Flight Instructor (Aeroplane) (KHEM Decree № 32/2009. (VI. 30.) which was in effect till 16 March 2017))*
ft.	*Feet*
GPS	*Global Positioning System*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
ITM	*Ministry for Innovation and Technology*
KBSZ	*Transportation Safety Bureau (Hungary)*
Kbvt.	*Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents*
kt.	*Knot (1 knot = 1 NM/h = 1.852 km/h) (unit of length)*
LAPL	*Light Aircraft Pilot Licence*
LT	*Local Time*
MTOM	*Maximum Take-off Mass*
NFM	*Ministry for National Development Legal Predecessor of ITM)*
NTA AA	*National Transport Authority Aviation Authority (till 31 12 2016) (Hungary)*
PPL (A)	*Private Pilot Licence (Aeroplane)*
PTE ÁOK	*Medical School, University of Pécs*
QFE	*Air pressure at the airport relative to sea level*
QNH	*Local barometric pressure relative to air pressure at sea level*
RKT	*Aerodrome Emergency Plan*
RPM	*Revolution Per Minute (unit of engine speed)*
SD card	*Secure Digital memory card*

SEP(land)	*Single Engine Piston (land) aircraft*
TMG	*Touring Motor Glider*
ULPL	*Ultralight Pilot Licence*
UTC	*Coordinated Universal Time*
VFR	*Visual Flight Rules*
Vs	*Stalling speed with retracted flaps*

Introduction

Occurrence category		Accident
Aircraft	Manufacturer	Magnus Aircraft Zrt.
	Type	Magnus eFusion
	Registration sign	HA-XEF
	Operator	Magnus Aircraft Zrt.
Occurrence	Date and time	31 May 2018, 10:02
	Location	Pécs-Pogány Airport SW 1.8 km (see Figure 1)
Number of people deceased in the accident:		2 people
Extent of damage to the aircraft involved in the occurrence:		Destroyed

Any clock-time indicated in this report is given in local time (LT). Time of the occurrence: LT= UTC+ 2 hours.

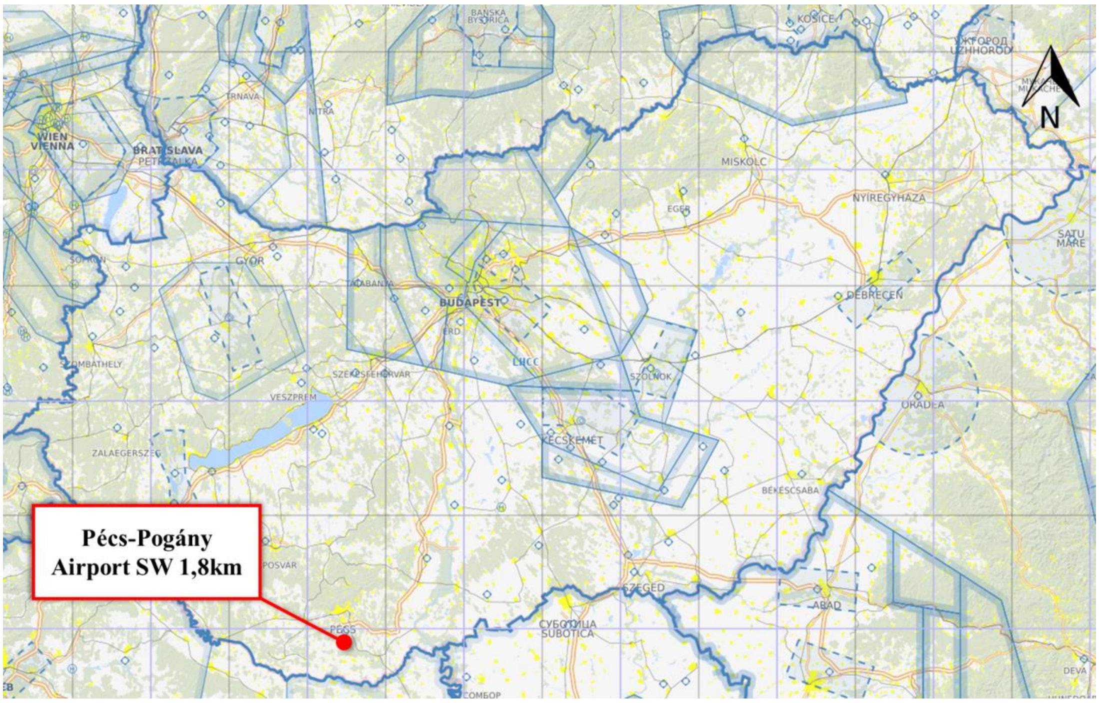


Figure 1: Location of the occurrence in Hungary

Reports and notifications

The occurrence was reported to the dispatcher of TSB by the head of Pécs-Pogány Airfield on 31 May 2018, at 10:20 am.

TSB Hungary notified:

- the investigating authority of the state of the manufacturer of the engine of the aircraft (BFU), on 31 May 2018, at 15:19.
- EASA on 31 May 2018, at 15:22.

After the notification, the following foreign organisations assigned a representative for the investigation:

- State of the manufacturer of the engine of the aircraft: Bundesstelle für Flugunfalluntersuchung (BFU)
- Other organisation affected: European Union Aviation Safety Agency (EASA)

Investigating Committee

The Head of TSB assigned the following investigating committee (hereinafter referred to as IC) to the investigation of the case:

Investigator-in-charge	**Gábor Erdősi**	Investigator
Member	**Zsuzsanna Nacsa JD**	Investigator

Overview of the investigation process

- On 31 May 2018, the IC performed a survey of the scene, during which:
  - the scene of the occurrence and the wreck of the aircraft involved was examined, and the SD card found at the scene (at the time of the survey) and the wrecks of the instruments were carried to the evidence locker of TSB,
  - witnesses were interviewed,
  - photos were taken of the scene, the wreck of the aircraft, and the documents available,
  - information and available documents relating to the preparation of the flight, to the aircraft, and to the pilots were obtained at the departure airport and from the operator of the aircraft.
- On 14 June 2018, the IC performed additional survey of the site, during which the wreck of the aircraft was inspected in a joint effort with the technical expert assigned by the police (among others), in the presence of representatives of all the parties interested.
- The IC sent BFU the SD card of the built-in camera unit (data recorder) found at the scene of the accident for the purpose of readout of data possibly saved on the card. The IC received the successfully read out data.
- In a joint effort with a representative of Siemens Zrt., TSB investigated the remnants of the instruments found at the scene of the accident.
- The IC obtained the forensic autopsy report.
- The IC had the detailed inspection of the electric engine and the inspection of the inverter found in the wreck performed by the manufacturer in the manufacturer’s workshop/lab in the presence of representatives of EASA, BFU, and all other parties interested.
- The IC obtained from the manufacturer the documents generated during the test period of the aircraft.
- On 24 July 2018, TSB issued an interim report on the accident.
- The IC obtained documents relating to the occurrence from other authorities.

Short summary of the occurrence

On 31 May 2018, two pilots (both of them holding PPL(A) licence) were performing practicing flights in a Magnus eFusion aircraft with registration mark HA-XEF within the district of Pécs-Pogány Airport. They completed their first flight (of about 20 minutes) safely at 9:35 am, local time. Next, they took off from Runway 16, Pécs-Pogány Airport, at 10:00 am. While they were doing their second turn, the right wing of the aircraft dropped during the steep (and constantly narrowing) right turn, which was followed by quick drop of the nose of the aircraft. The pilots did not manage to recover the aircraft from that situation, as a result of which they crashed to ground at 10:02 am. Both pilots died during the ground impact. The aircraft caught fire and was destroyed following the ground impact.

During the investigation, the IC found that the occurrence can be attributed primarily to human factors on the part of the pilots.

The IC identified the low flight altitude and the unusual behaviour of the aircraft for the flight crew, and fatigue of the PIC as other risk factors contributing to the occurrence. In addition, the difference between the experience of the two pilots as flight instructors as well as between their experiences gained with the given aircraft type may have contributed to the occurrence.

During the investigation into the occurrence, the IC reviewed the activity of the Airport Rescue & Fire Service relating to the occurrence, and the Airport Emergency Plan (AEP) of Pécs-Pogány Airport. As a result, the IC found some rules which were inconsistent with the relevant regulations; the operator of the Airport eliminated such inconsistence by amending its AEP.

1. Factual information

1.1. History of the flight

1.1.1. Antecedents

On the day before the date of the occurrence, there was a celebration at the site of the manufacturer, which included a demonstration flight. During the celebration, the PIC involved in the accident flew a piston-engine version of the aircraft type (Magnus Fusion) involved in the accident. He complained of a slight sickness following his flight and of fatigue on the day after.

On the day of the accident, the pilots involved in the occurrence performed practicing flight in the Magnus eFusion aircraft with registration mark HA-XEF (see: Figure 2). According to records of the on-board camera, preparation of the aircraft for the flight, followed by engine start, was started at 09:09 am. The Pilot-in-Command involved in the accident sat in the RH seat. Take-off took place at 09:14 am. During the uneventful flight, the PIC was visibly giving instructions to the person sitting in the LH seat and flying the aircraft. During their flight, the speed of their aircraft varied between 70 and 75 kt., their altitude was 500 ft. QFE, and they performed turns with banks of about 20°. They ended the flight at 09:35 am.

Figure 2: The aircraft involved in the accident (Source: Internet)

1.1.2. The flight ending up in accident

The crew started preparation for the flight at 09:41 am, during which the technical staff replaced the discharged battery units with recharged ones, and then the pilots began to prepare the aircraft for the flight. After external visual checks, they boarded, during which the PIC occupied the RH seat again (similar to the previous flight). Then they performed the on-board part of the pre-flight process, including the engine start which was done by the pilot in the LH seat. Following the engine start, they taxied to Runway 16 of Pécs-Pogány Airport, and they started take-off at 10:00 (Annex 1). Prior to the second turn, the pilot in the LH seat operated the elevator trim switch (located on the control stick) for a fraction of a second, and then started the second turn at an altitude of 500 ft. QFE, at a speed of 70 kt., with retracted flaps. The right turn became narrower and narrower due to the steeper and steeper bank, when the aircraft suddenly dropped to right, and the aircraft started a steep fall. The pilots were not able to complete recovery of the aircraft from this presumably unintended spin situation already. As a result, the aircraft crashed to ground intensively at a flat angle and caught fire at 10:02 (see Figure 3). According to records of the on-board camera, the pilot in the LH seat was flying the aircraft all the time; there was no detectable communication between the pilots: the pilot in the RH seat was not seen to give instructions.

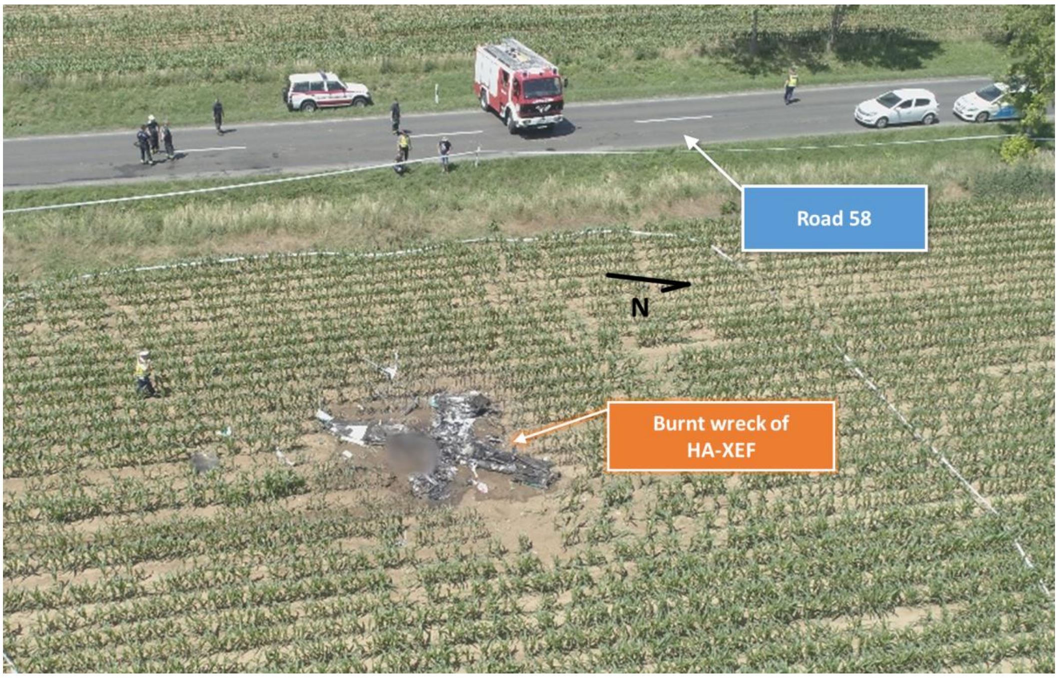


Figure 3: The scene of the accident (Source of photo: Police)

1.2. Injuries to persons

Injuries	Crew		Passengers	Other
	Pilot	Flight Attendant		
Fatal	2			
Serious				
Light				
Uninjured				

1.3. Damage to aircraft

The aircraft crashed to ground and caught fire during the accident. The fire completely destroyed the aircraft.

1.4. Other damage

The IC had got no information on other damage by the completion of the investigation.

1.5. Crew data

1.5.1. Pilot in the RH seat (Pilot-in-Command)

Age, nationality, gender		61 years old, Hungarian, male
Licence data	type	PPL(A), ULPL
	professional valid until	PPL(A) 31/01/2020 ULPL 14/12/2020
	ratings	SEP(land), TMG,
Certificates		Pilot
Medical class and valid until		2 / LAPL, 02/08/2018 / 02/08/2019
Flying hours/take-offs	in the previous 24 hours	1 hour 5 min / 3
	in the previous 7 days	7 hours 12 min / 17
	total:	over 800 hours
	on the affected type, total:	106 hours 48 min / 312
Aircraft types flown:		Jk-05 Junior, C150, C172, MS893, Magnus eFusion

1.5.2. Pilot in the LH seat

Age, nationality, gender		42 years old, Hungarian, male
Licence data	type	PPL(A)
	professional valid until	PPL(A) 30/06/2019
	ratings	SEP(land), TMG, FI(A), FI(A)/CRI(A)SE
Certificates		Pilot
Medical class and valid until		2 / LAPL, 10/07/2019 / 10/07/2019
Flying hours/take-offs	in the previous 24 hours	50 min / 2
	in the previous 7 days	11 hours 39 min/ 20
	total:	over 519 hours
	on the affected type, total:	6 hours 12 min / 14 (as pilot)
Aircraft types flown:		SF25, DA20, DA40, C172, C182,

According to the flight log, the pilot in the LH seat had flown 240 hours as flight instructor.

According to the pre-flight checklist, the pilot in the LH seat had spent 11 hours and 29 minutes as observer in the aircraft with registration mark HA-XEF during 46 take-offs.

The pilot in the LH seat boarded upon assignment by the owner of the aircraft, and submission of his application to the aviation authorities was pending relating to flying the affected aircraft type on his own.

The IC did not experience, and has no information of, any attitude of the pilot flying the aircraft which would have influenced the flight concerned, nor of a sign of any tension or rivalry between the two pilots involved.

1.6. Aircraft data

1.6.1. General

Class	Fixed wing aircraft (MTOM < 5700kg) (experimental aircraft)
Manufacturer	Magnus Aircraft Zrt.
Type	Magnus eFusion
Year of manufacture	2016
Serial number	MG 11-004
Registration marks	HA-XEF
State of registry	Hungary
Date of registry	18/03/2016
Name of the owner	Siemens Zrt.
Name of the operator	Magnus Aircraft Zrt.

	Hours flown	Number of take-offs
Since manufacturing	217:38	723
Since last overhaul	No overhaul yet	No overhaul yet
Since last periodical maintenance	32:27	90

Aircraft design

To the knowledge of the IC, and according to the opinion of the expert assigned by the police, the aircraft involved in the accident has symmetrical airfoil (Eppler 472 TE), which provides favourable characteristics for aerobatics, but its characteristics for lower speed flights are less favourable, and its stalling (flow separation) is more sudden, rough and unpleasant than with similar aircraft having wings with thicker, cambered airfoil. The initial type certifications of the aircraft were performed by the German DULV (Deutscher Ultraleightverband e.V.), pursuant to the LTF UL-2003 requirements accepted in the EU. As a result, the German type certificate 937-14 1 Musterzulassung was issued for the piston engine versions of the Magnus Fusion aircraft in 2014, and that certificate served as basis for the Type Certificate (issued under number UL-05-2014) in the exchange process (“naturalisation”). Then the development of the electrical version of the type began. Due to increased MTOM (maximum take-off mass) of 630 kg, the aerodynamic and strength calculations for the modified version were revised, pursuant to the requirements CS-23 and CS-VLA, respectively. Electrical experimental flights with the aircraft were started in 2016.

1.6.2. Notes relating to airworthiness of the aircraft

<table>
<tr><td rowspan="4">Airworthiness Certificate</td><td>Number</td><td>LFH/12741-1/2018-NFM</td></tr>
<tr><td>Date of issue</td><td>15/02/2018</td></tr>
<tr><td>Valid until</td><td>Until validated completion of the planned flights with the conditions specified in the certificate, or till 19 October 2018.</td></tr>
<tr><td>Restrictions</td><td>Flights shall be carried out in accordance with the procedures and restrictions specified in eFusion Pilot’s Operating Handbook (Rev. 00, 05.04.2016.) and in the Flight Test Program (MAG-EN-50-001-A). Flights shall be carried out in the airspace of Hungary only, and in accordance with VFR day flight rules.</td></tr>
</table>

1.6.3. Aircraft engine data

Class	Electrical	
Manufacturer	Siemens Zrt.	
Type	E-motor SP45D-V9	
Serial number	008	
Hours Flown / Take-offs		
Since manufacturing	217:38	723

SP45D-V9 is a permanent magnet 3-phase synchronous electric motor, specially developed for flight applications by Siemens, and is powered by an inverter.
The Electric Propulsion Unit (see Figure 4) is the unit responsible for generating controlled power from the batteries to the propeller. The battery DC power is converted in the inverter into the proper three-phase AC power for the permanent magnet synchronous motor, type SP45Dv9, that turns the propeller directly. The operation of the system requires appropriate regulation which is the task of the control unit of the vehicle (Vehicle Control Master). That unit monitors operation-related parameters on a continuous basis, calculates new regulation values and sends such values to the necessary places. The Vehicle Control Master communicates with other elements of the system through a digital data channel which includes also a number of sensors integrated in the system. An indispensable element of the operation of the system is the Thrust Lever Sensor. It too uses a digital data channel to send information on the performance level expected by the pilots to the Vehicle Control Master, which requests the level of torque from the inverter necessary for the set power level. Based on that, the inverter will transform the direct current of the batteries into alternating current for the permanent magnet synchronous motor which drives the propeller directly.

Propulsion unit parameters and possible error messages are displayed on the dedicated cockpit display.

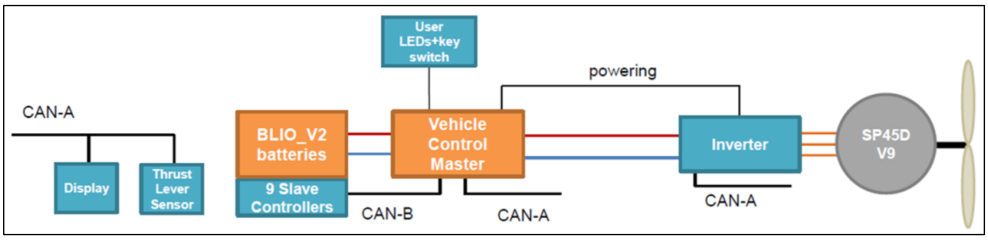


Figure 4: Schematic drawing of the propulsion system

CAN-A: Controller Area Network, Channel A
CAN-B: Controller Area Network, Channel B
Display: a central display which displays propulsion system data, and error messages.
Thrust Lever sensor: digital position sensor of the thrust lever
BLIO_V2 batteries: the batteries which provide energy for the propulsion system
9 Slave Controllers: sensor and controlling circuit in the 9 battery modules
UserLEDs+keyswitch: the dashboard main switch and indicator lights
Vehicle Control Master: the main control unit for the propulsion system
Inverter: inverter
SP45DV9: a type SP45Dv9 permanent magnet synchronous motor
Powering: power control signal between the Vehicle Control Master and the inverter

Engine power data on the basis of the flight manual relating to the aircraft involved:
Maximum engine power: 78 kW (3000 RPM)
Maximum take-off power: 78 kW (3000 RPM)
Maximum continuous power: 45 kW (2500 RPM)

Fully recharged battery modules integrated in the aircraft provide energy for a flight of 15 to 25 minutes.

1.6.4. Engine-mounted propeller

According to the Aircraft Flight Manual, three different kinds of propeller can be mounted on the aircraft.

- Type DUC INCONAL FLASH 2-blade propeller, adjustable on the ground only
- Type MTV-34-1-A/164-200 3-blade propeller, adjustable on the ground only
- Type HEWLX H 50 F 1,65 R-SI-XX-3 3-blade propeller, fixed (cannot be adjusted).

According to the service worksheets obtained, the propellers were replaced relatively often, in such manner that the variable-pitch propellers were set for different pitch angles on the ground several times.

According to the service worksheets, the type DUC INCONAL FLASH 2-blade propeller (which can be adjusted on the ground only) was mounted on the aircraft, with a 20° setting.

No other propeller data influenced the course of the occurrence therefore it needs no discussion in detail.

1.6.5. Aircraft loading data

Empty mass	455 kg
Payload (maximum)	175 kg
Maximum take-off mass	630 kg

According to aeromedical information, the relevant entry in the aeromedical evaluation of 2017 was "*body weight: 88 kg*" for the pilot in the LH seat, and "*body weight: 91 kg*" for the PIC in the RH seat. Taking these values into account, the payload of the aircraft, and thus its take-off mass, may have exceeded the maximum limit by 4 kg. The IC has no information on the aircrew's body weight at the time of the accident.

1.6.6. Description of malfunctioned equipment; equipment data

No information emerged during the investigation on malfunction of the structure or any system of the aircraft prior to the occurrence, thus contributing to the occurrence or influencing the course of events.

1.7. Meteorological information

Anticyclone influence was prevailing in Hungary on the day of the event, with a lot of sunshine with little cirrostratus and cumulonimbus cloud formation due to descending movement of the air. Daytime maximum temperatures varied between 28°C and 33°C. According to the METAR telegram valid for Pécs-Pogány Airport at the time of the occurrence, the wind blew from 90° and the wind speed was 4 knots. Visibility exceeded 10 km; the cloud base was over 1500 m. The temperature was 25°C and the dew point was 13°C. The local atmospheric pressure converted to seal level was 1018 hPa.

METAR LHPP 310815Z 09004KT CAVOK 25/13 Q1018=

The accident took place at daytime, in good visibility conditions.

1.8. Aids to navigation

The navigation equipment did not influence the course of events, so it needs no detailed discussion.

1.9. Communications

The communication equipment did not influence the course of events, so it needs no detailed discussion.

1.10. Aerodrome information

The take-off took place from Pécs-Pogány Airport at 10:00 a.m. on 31 May 2018.

The scheduled destination aerodrome was also Pécs-Pogány Airfield.

The airport involved in the occurrence had a valid operation licence.

Name of aerodrome	Pécs-Pogány Airport
ICAO code of aerodrome	LHPP
Elevation above sea level	198 m
Runway orientation	16 / 34

The parameters of the airport did not influence the course of events, so they need no detailed discussion.
Airport Rescue & Fire Service was in place at the time of the occurrence, and the Airport had an approved Airport Emergency Plan (AEP).

1.11. Flight data recorders

A small-size device, capable of recording data, audio and visual information, was mounted on the rear wall of the aircraft, in between the pilots (see Figure 5). The device was positioned in such manner that its recordings showed the instrument panel in front of the pilots almost fully, the sight out of the aircraft partially, and the movement of the controls partially.

The data recording system installed on the aircraft was serviceable and the data recorded by them was evaluable, except for on-board voice.

Flight recorder	Manufacturer	APPAREO SYSTEMS INC
	Type	Appareo Vision 1000
	Place of readout	Germany – BFU
	Location when found, state of repair	Occurrence scene; Damaged

Figure 5: Appareo Vision 1000
(Source: https://www.appareo.com/aviation/flight-data-monitoring/vision-1000)

The device was able to record and store the following major data types, among others:

- video and audio information in the flight cabin,
- GPS coordinates,
- Time data,
- Aircraft orientation data (roll, pitch, direction... etc.).

The device stores the aforesaid information on an SD card which is able to fall out of the housing of the device in case of an accident, which largely reduces the possibility of data loss.
The IC sent the SD card found at the scene to BFU for data recovery.

BFU successfully downloaded data which provided useful information for the investigation, except for on-board audio information. Processing of the video information offers the following findings:

During the flight leading to the accident:

- video recording is interrupted soon before the start of the second turn;
- subsequently, the camera recorded the flight in 46 frames (approx. 11.5 sec.) as far as the last moments immediately preceding ground impact;
- the video records available show neither smoke nor any sign of on-board fire (within the visual field of the camera);
- the displays related to the electric propulsion system reflected normal operation until the ground impact;
- the large on-board multifunctional flight data display was in operation, as well as the on-board barometric instruments; those seen on the camera record were legible;
- there was no information relating to malfunction in the flight control systems;
- there was no sign of technical malfunction of the airframe structure.
- At 480 ft. QFE altitude, during a constantly narrowing right turn performed with increasing bank angle, the aircraft dropped to right intensively when the bank angle reached 68-70° and the overload reached 2.7[1] (speed: 82-83 knots).

1.12. Wreckage and impact information

The wreck of the aircraft was found on the spot with geographical coordinates N45.97551° E018.23002°, approx. 1.8 km of Pécs-Pogány Airport, approx. 4.8 km of the point of the second turn of the specified traffic circuit. The situation of the wreck and its damages suggest that the aircraft impacted the ground at large vertical speed, at a small angle, and with its wings in almost horizontal position. The positions of the parts parting upon impact and the impact marks in the ground suggest that the aircraft had been rotating to the right around its vertical axis (see *Figure 6*). The aircraft caught fire upon ground impact, and then the fire spread to the airframe made of composite.

The remains of the data recorder and the instruments found at the scene were seized by the IC for further investigation.

The wreck of the aircraft was seized by the police and carried to a lockable storage place, assigned by them, for further investigation.

[1] Ratio of the upward lift and the vertical force (based on the mass).

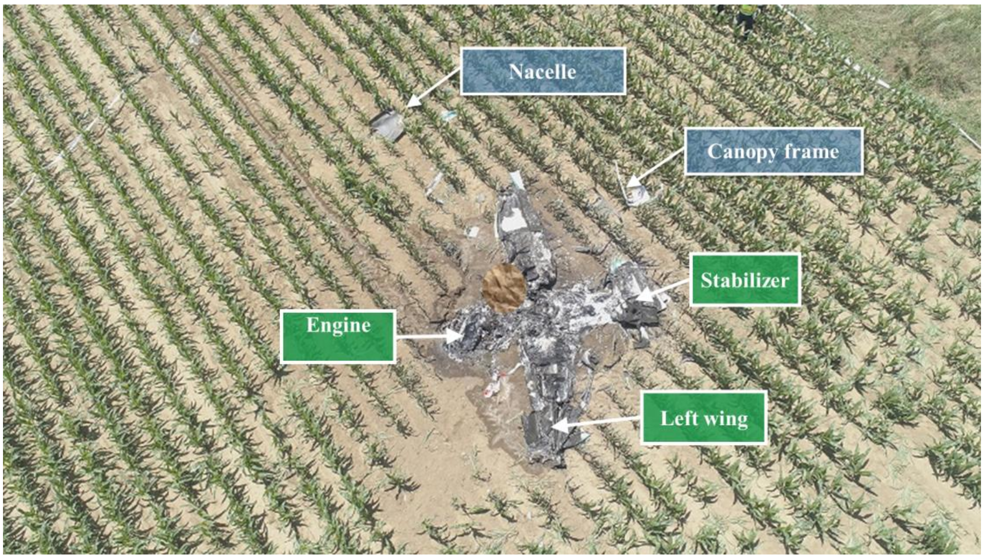


Figure 6*: The burnt wreck of the aircraft*

1.13. Medical and pathological information

The autopsy of the pilots involved in the accident took place at Institute of Forensic Medicine UP Medical School on 05 June 2018.

According to the expert forensic report, the direct cause of their death was the crashing of the aircraft to ground, during which they suffered so severe, unsurvivable injuries that their lives could not have been saved even by immediate and proficient medical care, and:

- their *"burns occurred due to post-mortem flame impingement."* Both autopsy and toxicological examination excluded smoke inhalation;
- the possibility of the crew's suffering fatal electrical shock prior to ground impact can be excluded;
- *"at the time of death, they were not under the influence of alcohol drug or any medicine which would have adversely influenced their ability to fly an aircraft";*
- *"The autopsy found no visceral lesion which would have adversely influenced the flight crew's capability for perception or action."*

1.14. Fire

The position of the IC is that in consequence of the impact following the fall the 9 battery modules of the aircraft were damaged to such extent (see Figure 7) that short circuit and overtemperature may have occurred in their cell units. Due to the damage, the heat increase in the cells was too fast to be compensated by the heat exchange with their environment, which was even worsened by the short circuit causing strong current. A fire started during that irreversible process, and rapid spread of the fire was supported by the composite airframe of the aircraft which was fully burnt in the fire. The fire was so intense that those parts of the aircraft which had not departed during the ground impact and were found as part of the wreck were either fully burnt or showed marks of intense fire.

Those parts which separated and spread upon the ground impact (nacelle, a piece of the canopy, a broken piece of the Plexiglas of the canopy) show no sign of in-flight internal fire, smoke or overheating.

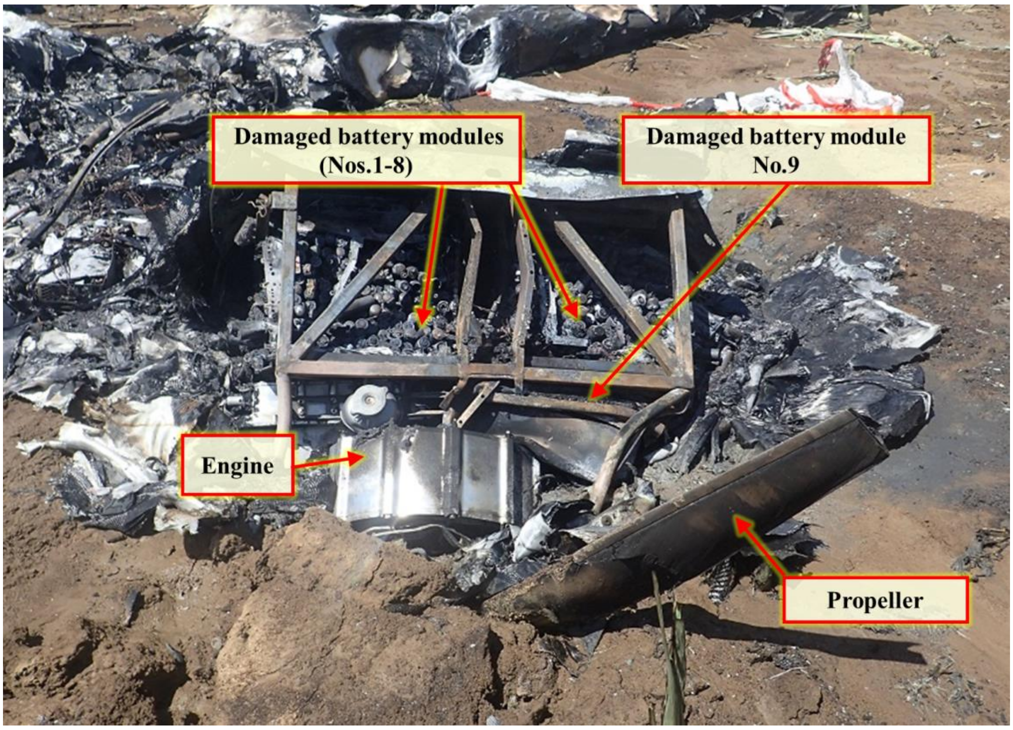


Figure 7*: Location of the start of the fire*

1.15. Survival aspects

The accident was not survivable. Both occupants of the aircraft suffered lethal injuries at the moment of the ground impact; their lives could not have been saved even by immediate and proficient medical intervention.

The aircraft was equipped with a Junkers Magnum recovery parachute system which was set to operation mode (ready for use) prior to the take-off concerned, but was not activated during the flight.

The squib of the recovery parachute system was activated as an effect of the fire on the ground; however, the packed parachute, which was badly deformed by the ground impact, was not fully pulled out; only a part of the pilot chute was found around the wreck.

1.16. Tests and research

1.16.1. 14 June 2018 – additional survey

The Investigating Committee of TSB performed an additional survey in Pécs in presence of representatives from each stakeholder.
It was found during the additional survey that the fire had started after the ground impact.

1.16.2. 18 and 19 July 2018 – additional survey, investigation

On 18/07/2018, the Investigating Committee of TSB Hungary had the remaining parts of the electric motor and the inverter, among others, dismounted (in the presence of representative of the owner of the aircraft) from the wreck (seized in the city of Pécs), for further inspections to be made. According to on-site visual assessment, the condition of the dismounted units was fit for further inspection. The units were transported to the aircraft owner's workshop/laboratory for such inspection, where the items were placed in a box, locked by TSB Hungary, for the inspection to be performed on the subsequent day.
On 19/07/2018, the electric motor and the inverter found in the wreck were inspected in

detail at the owner's workshop/laboratory, in presence of representatives from EASA, BFU, and all stakeholders.

a.) After disassembly of the permanent magnet 3-phase synchronous motor type SP45Dv9, the IC makes the following major comments:

- After disassembling the motor we could not observe any sign (mechanical, electrical or thermal) at the electric machine side which could be the reason of operational malfunction,
- The damages of the motor clearly appear due to mechanical impact and subsequent external fire.

Figure 8: The electric motor of the aircraft (front view and rear view)

b.) Investigation of the inverter:

- Based on observations/measurements, no short-circuit occurred inside the inverter which could cause the immediate stop and blocking the motor rotation.
- The heat, which melted the grey material and detached the parts inside the inverter, was coming from an external heat source.
- The damage of the inverter was caused by the ground impact and the external heat after the impact.

Figure 9: The inverter of the aircraft

1.17. Organisational and management information

1.17.1. Airport rules

According to Section 1.22. of the Airport Rules in effect at the time of the occurrence, the flight altitude along the traffic circuit is QNH 1600 ft., and AGL 1000 ft. according to the map of the Hungarian AIP AD 2-LHPP-VAC-1[2] (07DEC2017), and the elevation of Pécs-Pogány Airport above sea level is 198 m (648 ft.) according to the Airport Rules as well as the AIP.

1.17.2. Activity of the Airport Rescue & Fire Service

According to information available to the IC, the Airport Rescue & Fire Service was not dispatched to the scene of the occurrence and did not intervene.

The Aerodrome Emergency Plan ("RKT") of Pécs-Pogány Airport:

- The RKT and the procedures therein are based on relevant ICAO requirements (which is also mentioned, among others, in the Introduction to RKT) in addition to domestic legislation;
- According to point p) of the Introduction to the RKT:

  "The firefighting service operated at the airport is not entitled (has no legal grounds) to perform intervention outside the airport, but, notwithstanding the aforesaid, it shall provide help, to the extent possible, within a distance of 200 to 500 metres from the area of the airport (where there is a chance to save lives) during an aviation accident."

- According to the last sentence in the first paragraph of RKT point 3 Classification of Occurrences, Definitions:

  "In the case of an alarm, the necessary forces shall be dispatched to the given scene, and they have to make sure of the authenticity of the alarm at the scene in each case (except for Section 3.5[3])."

- According to point b) of RKT 3.7.2.3, the person currently in charge of the Airport Rescue & Fire Service ("RTSZ"[4]):

  "shall assist the help of the firefighting service by all of his firefighting vehicles, equipment and expertise."

- According to paragraph n), Section 2 of the RKT:

  "Review of the RKT shall be performed as necessary, but always after an emergency drill or an emergency situation, and at least biennially (within the framework of the full emergency drill)."

Besides the aforesaid, the IC found that the definitions of concepts and tasks in the aforesaid RKT are mixed up or vague in certain cases.

According to ICAO Doc 9137-AN/898 Part 8 Airport Operational Services:

- That part of *The Airport Emergency Plan*[5] which discusses the action range of the airport rescue and fire service says that, taking into account the barriers to access (e.g.: railway, river, etc.), there may be locations where the boundary of the action range is only 2 to 3 kilometres from the boundary of the airport, while in other instances it may extend to approx. 8 kilometres.

[2] AIP AD 2-LHPP-VAC-1 - Aeronautical Information Publication Aerodrome 2-Pécs-Pogány- Visual Approach Chart-1
[3] Section 3.5: "Standby state"
[4] "RTSZ" – presumably stands for 'Airport Rescue and Fire Service' (The RKT contains no applicable definition).
[5] ICAO Doc 9137-AN/898 Part 8 Chapter 15 The Airport Emergency Plan

- The aforesaid shall also be taken into account according to that part which applies to the operation requirements of airport rescue and firefighting services[6].

During the investigation period, the operator reviewed the Airport Emergency Plan of Pécs-Pogány Airport in a joint effort with members of the Airport Security Committee, within the framework of a corrective action. Such revision and the amended Airport Emergency Plan were approved by the Aviation Authority by its Decision of 5 December 2019.

The IC found that, by such amendment of the Airport Emergency Plan, the operator had eliminated the inconsistencies objected by the IC.

1.18. Additional information

1.18.1. Permit to fly

The aircraft involved in the accident was classified as experimental aircraft therefore it was subject to the scope of section 28 (1) of NFM Decree № 21/2015. (V.4.) on the manufacture, construction and technical suitability of aircraft: "*An individual flight permit is required to perform a flight in an aircraft for research, experimental or scientific purposes, including flight tests*". The last individual flight permit (№ LFH/12741-1/2018-NFM), which was in force at the time of the occurrence as well, had been issued by the competent authority on 15 February 2018. Issuance of such permit took place pursuant to NFM Decree № 21/2015. (V.4.), Point FCL.830 of Annex I to Regulation (EU) 1178/2011 and Part A of Appendix XII to (Part 21 of) Regulation (EU) 748/2012. Of the persons involved in the occurrence, only the pilot in command is indicated by name in that permit as a person who is entitled to fly the plane on his own. That permit also specifies that in each case, the person assigned (in writing) by the quality manager of the owner or operator is entitled to stay as an observer on-board the aircraft.

1.18.2. Information relating to the Pilot Operating Handbook

(a) Stalling speed of the aircraft;

According to the pilot operating handbook for the aircraft, the stall speed of the aircraft in normal operating circumstances (with maximum take-off mass, at sea level) with not flaps (V_s) is 52 kt. (96 km/h).

According to relevant section of the pilot operating handbook:

- The airplane is an experimental aircraft,
- All aerobatic manoeuvres, including spins, are prohibited.

(b) Expected pilot activity in the case of inadvertent spin

According to Section 3.3. of the Pilot Operating Handbook for the aircraft, the following steps need to be taken in the case of an inadvertent spin:

- THROTTLE……………………IDLE,
- RUDDER………………………FULL in opposite direction of rotation,
- CONTROL STICK…………….Ease forward,
- RUDDER………………………NEUTRAL after stopping rotation,
- ELEVATOR………………….. PULL cautiously to stop descent.

[6] ICAO Doc 9137-AN/898 Part 8 Chapter 17 Rescue and Fire Fighting Services

Section 3.3 of the Pilot Operating Handbook for the aircraft also provides, emphasized by a red WARNING sign, that “If controlled flight cannot be maintained deploy the rescue system!”

(c) Pilot activity following the stall of the aircraft

According to the camera record of the period following the drop of the nose of the aircraft:

- No attempt to reduce engine power can be identified. The engine speed values displayed are around 2400 RPM on a continuous basis, which reflects the maximum sustainable continuous power,
- Moving of the rudder pedal fully opposite the direction of rotation cannot be identified either,
- No attempt to activate the rescue system (recovery parachute) can be identified.

1.18.3. Flight test program of the aircraft

Section 4 of the flight test program of the aircraft includes investigation of the stalling characteristics, which is attached as Annex 2 to this Draft Report.

1.19. Useful or effective investigation techniques

The investigation did not require techniques differing from the conventional approach.

2. Analysis

2.1. Flight characteristics of the Aircraft

Stalling is a flight situation where the airflow separates from the wing, which causes dramatic drop in upward lift and an increase in air drag. Separation of the airflow is a consequence of reaching critical angle of attack during increase of the angle of attack. The value of critical angle of attack is constant for a given airfoil. The speed where stall occurs in given circumstances is called stalling speed. However, the speed at which stall actually occurs is not constant, as its value depends on several factors. One of them is the extent of load which may change during flight manoeuvres. For instance, both the load and the stall speed increase during a turn with steep bank angle. Accordingly, in the case of a possible increased load, the stalling of the aircraft may occur at a speed which is well over the V_s speed given by the manufacturer for horizontal flight. For instance, in the case of a bank of 70°, the overload is 2.9 to 3.0, which causes a cca. +70% increase of the speed compared to V_s. In addition, stall will occur asymmetrically in the case of a turn: it will occur first on the wing which is at the side of the bank. Such asymmetrical stall will cause a sudden drop of the wing, which is the start position of a spin. Depending on the shape of the airfoil and the design of the aircraft in general (wing twist, stabilizers, control surfaces, centre of gravity, etc.), stalling may be rougher (more intense, more sudden) or softer, easier to manage.

With regard to the symmetric airfoil, it may be established that the stall characteristics of the aircraft concerned are more unpleasant: its stall (airflow separation) is more unexpected and rougher than that of similar aircraft with arched, thicker airfoil.

According to the Pilot Operating Handbook of the aircraft concerned, the stalling speed of the aircraft in normal circumstances (V_s) (with maximum take-off mass, at sea level, with no flaps) is 52 knots (96 km/h). On the basis of the records of the on-board camera, it was found that the flaps of the aircraft had been in retracted position during the wing drop and the subsequent manoeuvre of the aircraft. However, the stall speed increased substantially (by +64%, to 85 kt. according to calculations by the IC) due to increased load (overload factor: 2.7) during the turn with steep bank (68-70°) therefore the aircraft stalled at a speed of 82-83 kt. According to the camera records, the stall was intense, with no preceding sign (1.11).

Taking data of the pilots' aeromedical evaluation of 2017 into account, the payload of the aircraft, and thus its take-off mass, may have exceeded the maximum limit by 4 kg. (1.6.5). The IC has no information on the aircrew's body weight at the time of the accident.

The IC does not suppose that the possible exceeding of the maximum take-off mass of the aircraft by 4 kg played any role in the occurrence.

As regards the flight characteristics of the aircraft, the IC wishes to note that the given type was still in an experimental phase therefore its characteristics might have changed from time to time, which had to be monitored on a continuous basis by the manufacturer as well as the pilots.

2.2. The pilots' experience level

According to information available to the IC (1.5.), the PIC had substantial experience with the aircraft concerned as well as with other aircraft types. Both his flight log and the *"Pre-flight Check-lists"* of the aircraft suggest that the number of his flight hours in the aircraft as PIC since August 2017 was among the highest. However, on the basis of his pilot licence, he had no flight instructor licence therefore the IC supposes that he had no experience as practical flight instructor either.

The IC's opinion is that, with his flight experience of over 500 hours (1.5) the pilot in the LH seat could have been regarded as an experienced pilot. The 11 hours and 30 minutes time spent as observer on-board the aircraft type concerned and the documented 6 hours and 12 minutes of flying the same aircraft type may be regarded as little experience. According to his pilot licence, however, he had had a flight instructor rating for the aircraft type concerned since 07 December 2017, and had spent over 240 hours flight instructor in other aircraft types. The IC's opinion is that this number of flight hours as flight instructor provided significant experience for the pilot.

According to information available to the IC, neither pilot had aerobatic rating or aerobatic experience.

2.3. The pilots' activity

The pilots were performing practicing flights on the day of the occurrence. The records taken by the built-in video camera suggest that the two pilots performed the flight at 500 ft. QFE altitude and at a speed of 70-75 kt. preceding the accident. They applied bank angles of ca. 20° during the turns. In the course of that flight, both during the taxiing and afterwards, the PIC in the RH seat was visibly giving instructions to the pilot sitting in the LH seat and flying the aircraft. Notwithstanding the lack of voice recording, the IC thinks that, relying on visual information only, the pilot in the RH seat (who did not hold flight instructor rating) was probably providing practical training during that flight.

Based on those above, the IC concluded that such a situation might have occurred on-board the aircraft where a person without experience as practical flight instructor instructed a person who had little flight experience on the given aircraft type but had substantial experience as flight instructor on other aircraft types. The IC's position is that this situation implies the possibility of misunderstanding or gap of understanding. With regard to that, the IC identified this situation as a risk factor which impairs flight safety.

During the investigation, the IC did not find or receive any information which would refer to any attitude of the pilot flying (PF) which would have adversely affected the flight (i.e. tension or rivalry) (1.5.2). Therefore, the IC excluded any tension between the pilots as contributing risk factor besides the possibility of misunderstanding described above.

During the flight ending up in accident, however, the typical instruction situation mentioned above was not seen at all. The IC perceived no activity resembling communication or giving instructions from the pilot in the RH seat.

Based on analysis of those records of the on-board camera which show the course of the flight from the start of the second turn to the last moment preceding the ground impact, it can be established that:

- according to the altimeter of the aircraft, the maximum flight altitude reached by the aircraft during the flight ending up in accident was 500 ft. QFE,
- prior to the stall of the aircraft, neither the PIC nor the pilot flying demonstrated any identifiable activity which would have targeted prevention/avoidance of the stall,
- the right turn started by the pilot flying was more and more intense due to the increasingly growing bank, and as a result of pulling the control stick (when reaching the parameter values discussed in detail in Sections 1.11 and 2.1) the right wing finally dropped,
- the stall occurred intensively, i.e. the aircraft showed no signs of a threatening stall (no preceding sign),

- neither the PIC nor the pilot flying showed any identifiable activity aimed at eliminating the intense drop of the nose or the resulting spin, i.e. at attempting to recover the aircraft from the critical flight situation,
- the operation of the flight controls showed no disorder,
- the rescue system (recovery parachute) was not activated.

On the basis of those above, as well as those in section 1.17, it may be stated that the aircraft did not follow the path of the required traffic circuit and was below the altitude expected there.

It may also be stated that the operations specified in the Pilot Operating Handbook for recovery from unintended spin (1.18.2(b)) could not be identified in the pilots' activity.

According to the IC, it may also be stated on the basis of the records of the on-board camera and the contents of Sections 1.6.6, 1.11, and 1.16 that there was no fire, engine failure, technical or structural malfunction during the accident (prior to ground impact). Therefore the IC excluded the contribution of such factors to the accident or to the pilot activities discussed above.

According to data available, neither pilot had substantial experience in aerobatics or with an aircraft demonstrating harsher stall characteristics. According to the Pilot Operating Handbook (1.18.2), it is forbidden to perform any aerobatic manoeuvres, including spin, with the aircraft. And, according to the Flight Test Program of the aircraft, the stall characteristics of the aircraft had to be tested only with stalls performed with the wings in horizontal position. According to the documentation, during such tests "*the aircraft indicated stall by vibration of the control stick, soon before the stall actually occurred"* and the aircraft demonstrated no proneness to spinning (Annex 2). The IC's position is that proneness to spin may be different in flight conditions that are not "sterile" (in turns, at different engine power levels etc.).

Accordingly, the IC concluded that, with the aircraft type involved, the pilots could only have acquired experience with the starting and managing of stalls performed with the wings in horizontal position.

Based on that, it may be assumed that the pilots had not experienced the (potentially harsher) stalling and spinning characteristics which the given aircraft demonstrated in turns. Therefore the pilots were not prepared to expect an intensive stall which occurred without any warning sign, at normal flight speed, in a steep bank.

The IC therefore concluded that the PIC and the pilot in the LH seat started a manoeuvre which fell outside the set of safe flight elements provided their earlier experience. The IC identified the lack of recognizing the hazards implied in the manoeuvres performed as loss of situation awareness.

According to the IC, the fact that the records of the on-board video camera do not show even an identifiable motion aimed at activating the rescue system (recovery parachute) raises the possibility that the pilots had no adequate knowledge relating to the possibilities and usage of that system.

In addition, the opinion of the IC is that the PIC's fatigue mentioned on the day of the occurrence (1.1.1) might have had a negative effect on his mental performance as well, which the IC also regarded a contributing factor.

2.4. Airport Rescue & Fire Service

On the basis of those discussed in Section 1.17.2, the Airport Rescue & Fire Service was not dispatched to the scene of the occurrence and did not intervene there. That process partly complied with the Airport Emergency Plan of Pécs-Pogány Airport which says that they only provide help (within the limits of their capabilities) with accidents within 200 to 500 metres from the area of the airport.

However, the IC's position is that that the procedure and the process do not comply with the relevant ICAO requirements cited in Section 1.17.2 which specify such intervention range as 2 to 8 km, taking into account the obstacles to access the scene.

The IC's position is that the above procedure and process are inconsistent with the provisions of the Airport Emergency Plan cited in Section 1.17.2, which says as follows:

- *"In the case of an alarm, the necessary forces shall be dispatched to the given scene, and they have to make sure of the authenticity of the alarm at the scene in each case (except for Section 3.5[7])."*
- the person currently in charge of the Airport Rescue & Fire Service ("RTSZ"[8]) *"shall assist the help of the firefighting service by all of his firefighting vehicles, equipment and expertise.*

The above process and procedure did not contribute to the occurrence or to its consequences. The IC thinks, however, that in other circumstances, a quick intervention, possibly including special capabilities, may significantly contribute to the mitigation of an aviation occurrence or to the saving of lives of people involved in such an occurrence.

The operating organisation reviewed and amended the Airport Emergency Plan of Pécs-Pogány Airport during the investigation. The IC found that, during the amendment of the RKT, the operator of the Airport had eliminated the inconsistencies objected by the IC.

In addition to those above, the IC wishes to emphasize that, according to those discussed in detail in Section 1.13, the lives of the pilot could not have been saved even by immediate help following the accident under investigation.

[7] Section 3.5: "Standby state"
[8] "RTSZ" – presumably stands for 'Airport Rescue and Fire Service' (The RKT contains no applicable definition).

3. Conclusions

3.1. Findings

The Pilot-in-Command had valid pilot licence and medical certificate at the time of the occurrence.

The Pilot-in-Command had great experience in flying the aircraft involved in the occurrence.

The Pilot-in-Command had no flight instructor rating. (1.5.1, 2.2)

The pilot in the LH seat boarded upon assignment by the owner of the aircraft, and submission of his application to the aviation authorities was pending relating to flying the affected aircraft type on his own. (1.5.2, 2.2.)

According to his licence, the pilot in the left hand seat had valid licence and rating for the given aircraft type at the time of the occurrence, but, on the given aircraft, he had little experience for the flight task which led to the accident. (1.5.2, 2.2.)

The pilot in the left seat had a flight instructor rating. (1.5.2, 2.2.)

The aircraft was airworthy. The aircraft had a valid airworthiness certificate. According to its documents, it was equipped and maintained in compliance with the requirements in effect and with the accepted procedures. (1.6, 2.1)

The aircraft started its flight with fully charged battery units. (1.1.2)

During the flight ending up in accident, the aircraft – while performing the second turn at a speed of 82 to 83 kt., at 500 ft. QFE, which is different from the right traffic circuit of Pécs-Pogány Airport, – stalled and crashed to the ground. (1.17.1, 1.11, 2.3)

The activity PIC sitting in the right hand seat reflected no communication or giving instructions during the flight ending up in accident. (1.1.2, 2.3)

Neither pilot demonstrated any identifiable activity aimed at solving the critical flight situation. (1.18.2, 2.3)

After ground impact, the aircraft caught fire and was destroyed. (1.1.2, 1.3, 1.12)

The pilots died in the accident.

According to data from the aeromedical evaluation of 2017 of the pilots, their body weights were 88 kg and 91 kg, respectively. (1.6.5, 2.1)

The IC has no information on the aircrew's body weights at the time of the accident. (1.6.5, 2.1)

The mass of the aircraft was close to the maximum value during the accident. (1.6.5, 2.1)

The pilots performed the flight at altitudes lower than that of the traffic circle specified in the Airport Rules of Pécs-Pogány Airport. (1.1.2, 1.17.1, 2.3)

A non-statutory camera unit was installed in the aircraft; it recorded visual data only, and saved it on an SD memory card. Recorded data was evaluable. (1.11)

Neither smoke nor any sign of on-board fire was seen in the field of view of the camera. (1.11)

The displays pertaining to electric propulsion indicated normal operation. (1.11)

Both the large multifunctional on-board display and the on-board barometric instruments were serviceable. (1.11)

No sign of any malfunction in the steering controls was detected. (1.11)

No sign of any technical defect of the airframe was detected. (1.11)

The damages of the engine were clearly due to mechanical impact and subsequent external fire. (1.16.2)

Ground impact and the external heat after the impact caused the damage of the inverter. (1.16.2)

The flight took place at daytime, in good visibility conditions. (1.7)

An Airport Rescue & Fire Service was in place at Pécs-Pogány Airport at the time of the occurrence, and the Airport had an approved Airport Emergency Plan (1.10, 2.4)

According to information available to the IC, the Airport Rescue & Fire Service was not dispatched to the scene of the occurrence and did not intervene. (1.17.2)

The procedure in the Airport Emergency Plan of Pécs-Pogány Airport and the processes based on it did not comply with the relevant ICAO requirements. (2.4)

The operating organisation amended the Airport Emergency Plan of Pécs-Pogány Airport during the investigation. (1.17, 2.4)

No information emerged on the activity of the air traffic management service, the support staff or the characteristics of the aerodrome which could be associated with the occurrence.

3.2. Causes

The IC concluded during the investigation that the cause of the occurrence was that the pilots had lost their situation awareness.

The IC identified low flight altitude, unusual behaviour of the aircraft for the aircrew, and the PIC’s fatigue as factors which contributed to the occurrence. In addition, the differences in the pilots’ levels of experience gained as flight instructor and as pilot for the given aircraft may also have contributed to the occurrence.

4. Safety recommendations

4.1. Actions taken by the operator of the airport during the investigation

During the investigation period, the operator reviewed the Airport Emergency Plan of Pécs-Pogány Airport in a joint effort with members of the Airport Security Committee, within the framework of a corrective action. Such revision and the amended Airport Emergency Plan were approved by the Competent Authority by its Decision of 5 December 2019.

The IC found that, during the amendment of the RKT, the operator of the Airport had eliminated the inconsistencies objected by the IC.

4.2. Safety recommendation issued during the investigation

TSB issued no safety recommendation during the investigation.

4.3. Safety recommendation issued on completion of the investigation

The Investigating Committee of TSB identified no circumstance which would warrant issuance of a safety recommendation.

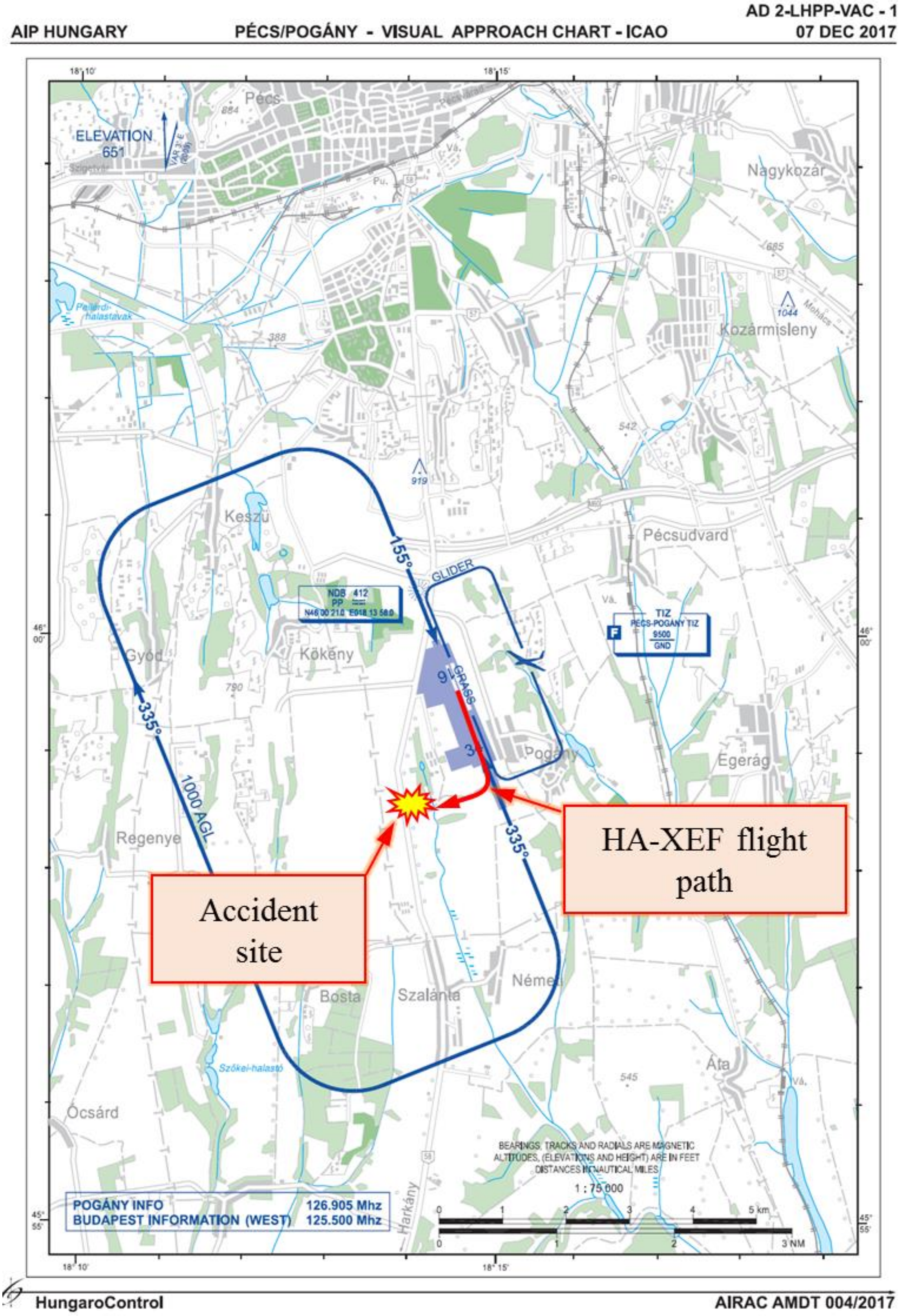
Budapest, "30" November. 2020

Gábor Erdősi
Investigator-in-charge

Zsuzsanna Nacsa JD
Member of IC

Annexes

Annex 1: Visual Approach Chart, Pécs –Pogány Airport



Annex 2: Magnus eFusion Flight Test Program and its findings (excerpt)

MAGNUS® AIRCRAFT

4. Átesési tulajdonságok vizsgálata

Emelkedjen iskolakörről kisorolva 1000 m fölé, és vizsgálja meg az átesési tulajdonságokat. Amennyiben nem jelentkezik dugóhúzóhajlam, 600 méteren lehet folytatni a repülési feladatot. Az átesési vizsgálatokat úgy kell végrehajtani, hogy egyenes vonalú vízszintes repülésből kb. I,8-2 km/ó másodpercenkénti ütemben csökkenjen a sebesség mindaddig, amíg vagy bekövetkezik az átesés, amit egy azonnal nem korrigálható lefelé irányuló bólintó mozgás, vagy egy lefelé irányuló bólintó és billenő mozgás jelez, vagy a kereszttengely körüli kormány a szélső helyzetébe ért.

A hossz- és függőleges tengely körüli elmozdulásokat ki kell tudni korrigálni a kormányok nem ellentétes értelmű alkalmazásával mindaddig, amíg az átesés be nem következik.
Átesés előtt a repülőgépnek egyértelműen jeleznie kell. A repülőgép akkor is megfelelőnek minősíthető, ha az áteséshez közeledve nem ad jelzést, de amikor az átesés egyenes repülésből következik be, korrigálni lehet a lebillenést csak a hossztengely el körüli kormánnyal, semleges helyzetben tartva a függőleges tengely körüli kormányt, és nem jelentkezik számottevő szárny lebillenés semleges helyzetben tartott függőleges tengely körüli kormány mellett sem.

Elvárt értékek:	Mért értékek:
Vso= 45 csomó Nem jelentkezhet dugóhúzó hajlam Felvétel közben a kormányok normális alkalmazásával meg kell tudni gátolni 20°-nál nagyobb lebillenést.	A légijármű a magassági kormány remegésével jelezte az átesést, röviddel annak bekövetkezése előtt. A repülőgép 45 csomós sebességnél esik át. A gépen nem jelentkezik dugóhúzó hajlam, áteséskor az orrát adja le legelőször.
Kiértékelés	Nem jelentkezik dugóhúzó hajlam. Átesése a várt értékeknek megfelelő. Magatartása jóindulatú.

11

The aircraft indicated stall by vibration of the control stick, soon before the stall actually occurred.
The aircraft stalls at 45 kt. speed. No proneness to spin occurs; the nose drops first during stalling.