MINISTRY FOR
INNOVATION AND TECHNOLOGY
TRANSPORTATION SAFETY BUREAU

FINAL REPORT

2015-227-4
Accident

Balatonberény District
25 July 2015

Pipistrel Virus
35-22

The sole objective of the technical investigation is to reveal the causes and circumstances of aviation accidents and incidents, 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 apportion blame or liability.

General information

This investigation was carried out 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 technical investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as: Kbvt.),
- Decree № 123/2005. (XII. 29.) of the Minister of Economy and Transport on the rules of technical investigation of aviation accidents and incidents and other occurrences,
- NFM Regulation 70/2015 (XII.1) on technical investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In absence of other related regulation of the Kbvt., the Transportation Safety Bureau of Hungary conducted the investigation in accordance with Act CXL of 2004

on the general rules of administrative authority procedure and service.

The competence of the Transportation Safety Bureau of Hungary is based on Government Decree № 278/2006 (XII. 23.), and, as from 01 September 2016, on Government Decree № 230/2016. (VII.29.) 23) on assignment of a transportation safety body and on the dissolution of Transportation Safety Bureau with legal succession.

Pursuant to the aforesaid laws

- The Transportation Safety Bureau of Hungary shall investigate aviation accidents and serious aviation incidents.
- The Transportation Safety Bureau of Hungary may investigate railway accidents and incidents which – in its judgement – could have led to more accidents with more serious consequences in other circumstances.
- The Transportation Safety Bureau of 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 version of this Report was written in the Hungarian language.

Incompatibility did not stand against the members of the IC. The persons participating in the technical 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 technical 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.

Simultaneously with the distribution of the draft final report, the head of TSB Hungary informed the people involved on the date of the closing meeting, and also invited them and their organisations to such meeting.

The pilot in charge attended the closing meeting of 12 March 2018; the Hungarian representative of the manufacturer communicated their comments relating to the Draft Report orally, on an occasion other than the closing meeting.

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*
AMSL	*Above Mean Sea Level*
ARP	*Airport Reference Point*
Crankcase gas	*A mixture of fuel and air flowing from the combustion chamber into the crankcase of an internal combustion engine.*
GKM	*Ministry of Economy and Transport*
GS	*Ground speed*
hPa	*hectopascal*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
Kbvt.	*Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*
L/D ratio	*Lift per drag ratio. An aerodynamic parameter which refers to the gliding performance of an aircraft. It is a number without dimension.*
LT	*Local Time*
MIT	*Ministry for Innovation and Technology*
NFM	*Ministry of National Development*
NKH LH	*National Transport Authority Aviation Authority (till 31 12 2016) (Hungary)*
QNH	*Local atmospheric pressure value adjusted to sea level, given in hPa*
SEP(land)	*Single Engine Piston (land)*
TMG	*Touring Motor Glider*
TSB	*Transportation Safety Bureau of Hungary*
UL	*Ultralight aircraft*
UL A2	*Abbreviation used to designate ultralight aircraft*
Ultralight aircraft	*Aircraft with maximum 2 seats, with a stalling speed in a landing configuration or with a minimum speed in the landing configuration during steady flight not exceeding 35 knots (65 km/h) CAS (Calibrated Air Speed), and (in the case of two-seated land aircraft equipped with an airframe mounted total recovery parachute system) with a maximum take-off weight not more than 472.5 kg.*[1]
UTC	*Coordinated Universal Time*
VFR	*Visual Flight Rules*

[1] Excerpt from KHEM Regulation 32/2009. (VI. 30.) on the training and licensing of flight crew.

Introduction

Event category		accident
Aircraft	Manufacturer	PIPISTREL d.o.o. Ajdovščina
	Type	Virus 912
	Registration sign	35-22
	Operator	private people
Event	Date and time	25 July 2015, 14:05
	Location	Balatonberény district (Figure 1)
Number of people fatally / severely injured in the accident:		0 / 0
Extent of damage of the aircraft involved in the occurrence:		It was damaged significantly.

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

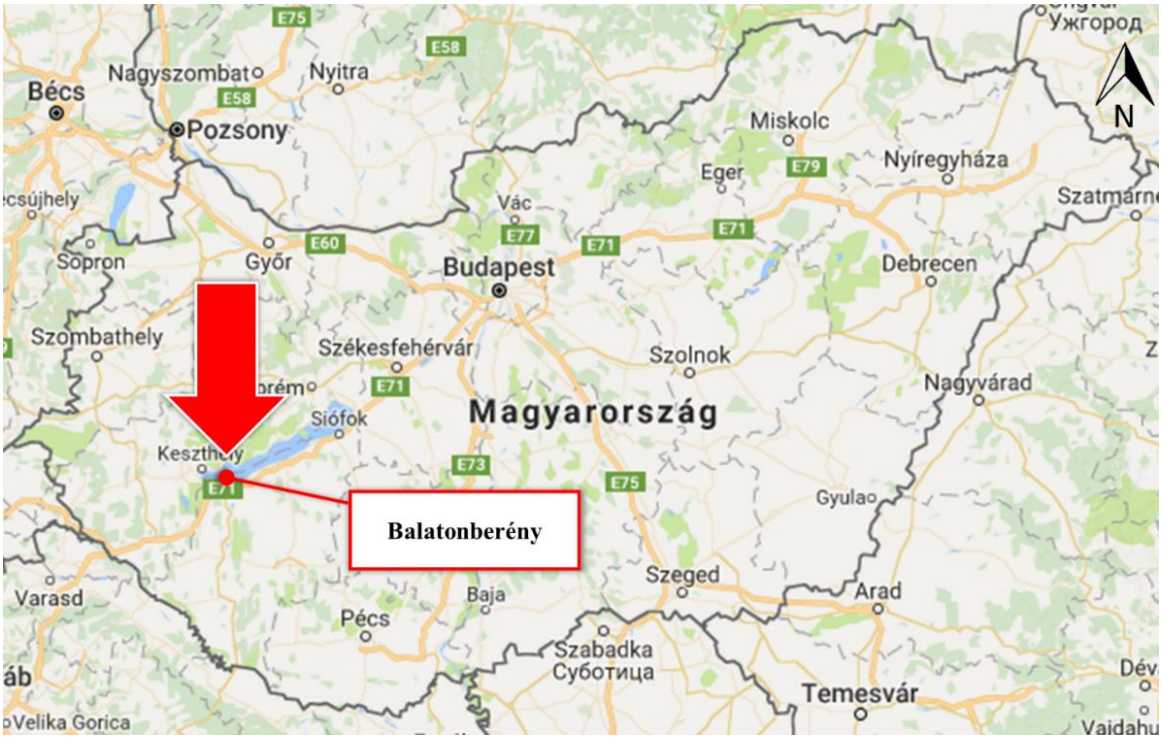

Figure 1: Location of the accident in Hungary

Reports and notifications

The occurrence was reported to the dispatcher of TSB by the duty service officer of the competent police unit on 25 July 2015, at 14:27.

Investigating Committee

On 26 August 2015, the Head of TSB assigned the following Investigating Committee (hereinafter: IC) for the investigation of the occurrence:

Investigator-in-Charge	**Zsigmond Nagy**	Accident Investigator
Member	**Miklós Ferenci**	Accident Investigator

Overview of the investigation

During the investigation, the IC:

- inspected the scene on 25 July 2015;
- interviewed the pilot;
- obtained and analysed the radar images recorded by HungaroControl Zrt.;
- overviewed the flight manual of the affected aircraft type;
- consulted the relevant supervisory authority on several occasions;
- got familiar with reports from the police unit which acted at the scene and from the expert invited by the police.
- consulted the representative of the manufacturer of the aircraft.

Pursuant to relevant legislation, the IC sent the Draft Report to the all stakeholders on 10 January 2018, and the IC took the comments received into consideration when elaborating this Final Report.

Overview of the occurrence

After take-off from Balatonkeresztúr, the aircraft, occupied by the pilot and a passenger was flying towards Keszthely, according to the submitted flight plan, when the pilot detected high oil temperature, so he shut the engine of the aircraft off. When the pilot found they would not be able to glide from their given position as far as the departure airport with the engine shut off, he triggered the parachute system of the aircraft above the surface of the lake Balaton. After the aircraft descended into the water, the pilot and the passenger were rescued by a nearby boat.

During the assessment of the scene, the police seized the aircraft as well as the pilot's personal navigation device. The police did not notify TSB Hungary of the place and date of the posterior assessment following the occurrence, and thus, the IC got familiar with the findings of such assessment from the report of the expert invited by the police.

The investigation attributed the cause of the occurrence to the pilot's erroneous decisions resulting from incorrect evaluation of the situation.

The IC identified several procedural and operating factors which increased the likelihood of the occurrence. The IC proposes that safety recommendations be issued in order to eliminate the shortcomings revealed.

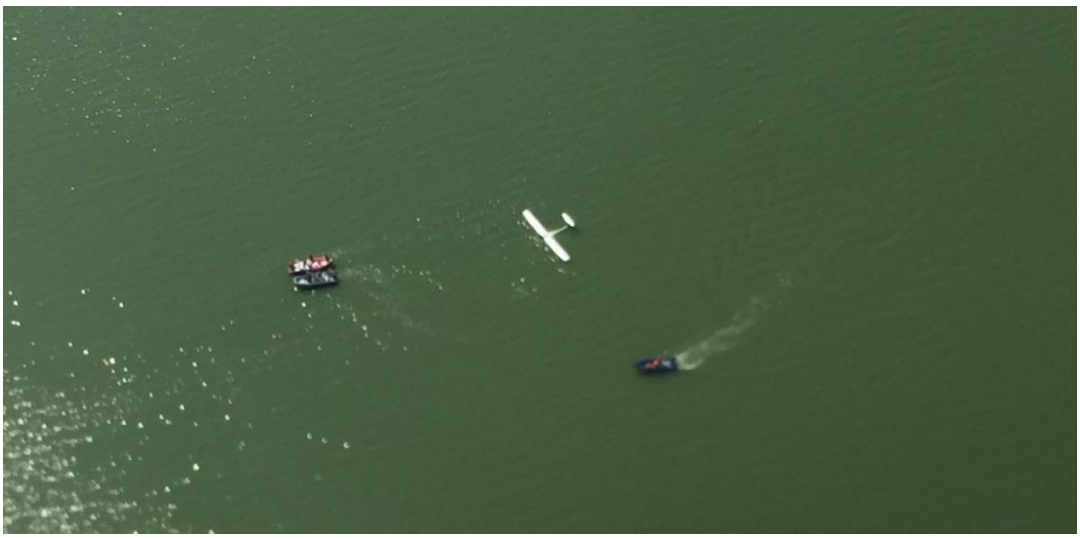

Figure 2: The aircraft after ditching
(Source of the photo: Hungarian Air Ambulance Nonprofit Ltd.**)**

1. Factual information

1.1. History of the flight

On 25 July 2015, prior to the occurrence, several pilots flew the affected aircraft, including the pilot involved in the occurrence. No technical malfunctions or signs of disorder were detected in connection with the aircraft by the pilots during such flights.

According to report by the pilot involved in the occurrence, he performed a check according to the Flight Manual and Maintenance Manual, and topped up fuel to a total of 20 litres for the planned flight. On the basis of the flight plan submitted, he intended to fly on a route through the settlements Balatonkeresztúr, Balatonberény, Keszthely, Tapolca, Fonyód, and Balatonkeresztúr, at an altitude of 2500 ft according to QNH.

The aircraft with the pilot and a passenger on board took off from the Balatonkeresztúr airfield at about 13:50:31 (Section 1, Annex 1), and was heading to Balatonberény, according to plan. The pilot contacted the competent air traffic management service, and turned on the on-board secondary transponder soon after, as a result of which the radar signal of the aircraft appeared on the screen of the competent air traffic management service (Section 2, Annex 1).

After reaching the cruising altitude (Section 3, Annex 1) the pilot set up the cruising parameters, and, according to his report, it was then that he had first detected an increase on the oil temperature on the indicators. He continued the flight along the route planned, and found that, with all other parameters within the normal operating range, the oil temperature reached 120°C. Then he reduced engine power to idle, and began to descend in order to increase aircraft speed, hoping that oil temperature would decrease (Section 4, Annex 1). According to the pilot's report, soon after starting descent he found that the oil temperature still was 120°C, he turned ignition off in order to prevent further damage to the engine. However, the engine did not stop, but continued idle running according to the throttle position. 1 minute and 24 seconds after starting descent, the pilot turned off electricity to the aircraft, as a result of which supply to electric devices was sopped, and the engine also stopped, according to the pilot's report. At that time, the aircraft was ca. 850 metres of the western coast of the lake Balaton and 371 metres (1171 ft) above the water surface (Section 5, Annex 1).

The pilot turned the aircraft, with the engine shut off, from its given position to the direction of Balatonkeresztúr Airport, the aerodrome of departure. According to his statement, the pilot did not feather the propeller.

While gliding with inactive engine, the pilot found that the gliding performance of the aircraft did not make it possible to reach the departure airport. As reported by the pilot, he activated the parachute of the aircraft at a height of ca. 100m above the water. After pulling the control lever, the canopy of the recovery parachute opened normally, the aircraft reached the water surface very soon after deployment of the parachute, at a low speed in the forward direction.

After the aircraft descended into the water, the pilot and his passenger left it on their own, and then, clinging to the wings of the floating aircraft, they waited for the boats to come to their rescue. The boats arriving to the floating aircraft began to tow it to the shore. Upon arrival, the water police unit recorded the geographical coordinates of the location, and took over the technical rescuing of the aircraft (Section 6, Annex 1). The aircraft was towed to the free beach at Balatonberény, where the IC began its inspection.

1.2. Injuries to persons

Injuries	Crew		Passengers	Other persons
	Pilot	Flight Attendant		
Fatal	-	-	-	-
Serious	-	-	-	-
Light	-	-	1	
Uninjured	-	-	-	

1.3. Damage to aircraft

It was found during the inspection of the scene that the windshield, nose cone and nose wheel of the aircraft had been damaged (Figure **Hiba! A hivatkozási forrás nem alálható.**).

According to information received by the IC, the plastic structure of the aircraft was saturated with water to such extent during its stay in water and during subsequent storage that it became unfit for flight. After release of the aircraft from seizure by the police, the manufacturer destroyed it, according to its record of 28 April 2016, with the consent of the owners.

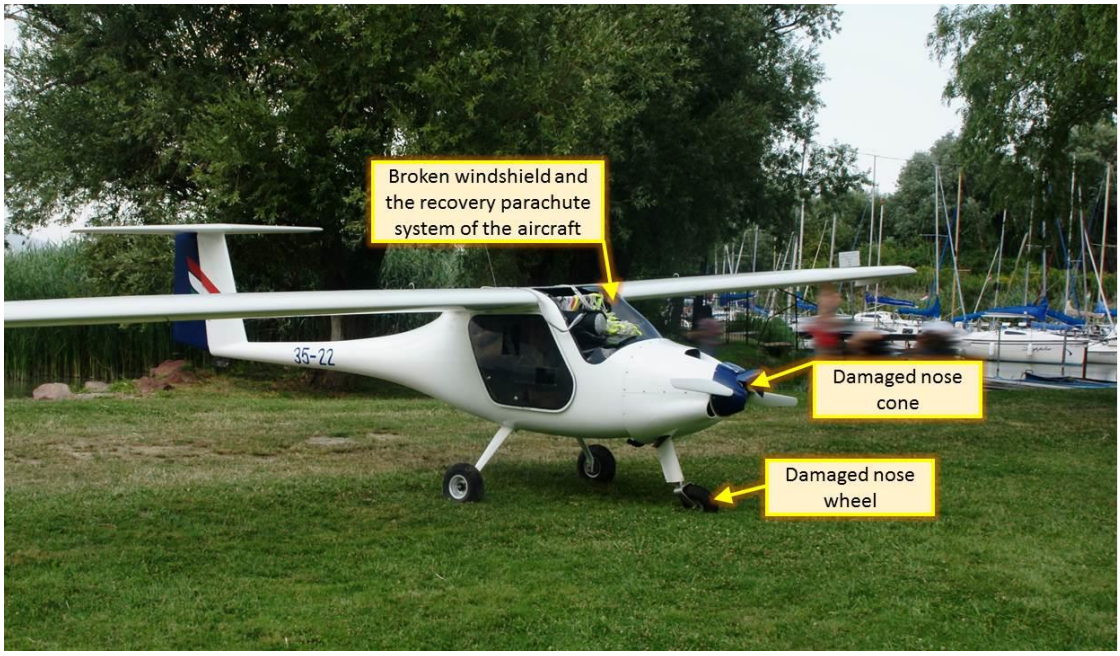

Figure Hiba! A hivatkozási forrás nem található.**: Damages of the aircraft after after its escue from the lake (photo taken at Balatonberény Beach)**

1.4. Other damage

The IC had no information on any other damage during the investigation.

1.5. Crew data

1.5.1. Data of the pilot-in-charge

Age, citizenship, gender		62 years, Hungarian, male
License data	Type	UL A2 pilot
	Professional validity until	14/03/2016
	Ratings	SEP (land), TMG, UL A2
Certificates		UL A2 pilot
Medical certificate valid until		18/02/2016
Hours flown / Cycles flown	in previous 24 hours	00 hours 51 minutes / 2
	in previous 90 days	11 hours 52 minutes / 11
	Total:	283 hours 48 minutes / 587
	On the aircraft type involved, total:	105 hours 45 minutes / 257

1.6. Aircraft data

1.6.1. General data

Class	Fixed-wing ultralight aircraft
Manufacturer	Pipistrel d.o.o. Ajdovščina
Type	Virus 912
Year of manufacturing	2002
Serial number	085R1V912 1102
Registration	35-22
State of registry	Hungary
Date of registry	03 Nov 2014
Owner	Private persons
Operator	Private persons

	Hours flown	Number of take-offs
Since manufacturing	1426 hours	2498
Since last periodical maintenance[2]	11 hours	18

1.6.2. Airworthiness

Airworthiness certificate	Number	None
	Date of issue	03 Nov 2014
	Valid until	03 Nov 2017
	Restrictions	None

[2] 50-hour care performed on 16/06/2015

The aircraft was subjected to:

- 100-hour and yearly maintenance on 17/03/2015;
- 50-hour care on 16/06/2015.

1.6.3. Aircraft engine data

Class	4-stroke boxer engine
Manufacturer	BRP-Rotax GmbH & Co KG
Type	Rotax 912 UL
Serial number	4405000
Hours flown / Cycles flown	
Since manufacturing	1487 hours
Since last periodical maintenance	12 hours

1.6.4. Aircraft loading data

Empty mass	284 kg
Fuel mass	15.1 kg
Maximum take-off mass	472.5 kg
Fuel type:	95 octane petrol

The take-off mass of the aircraft cannot be determined.

1.6.5. Faulty system and equipment information

According to the documents available, the maintenance technician completed the yearly care of the engine of the aircraft on 17 March 2015, and the 50-hour care on 16 June 2015. Engine oil and the oil filter were replaced during such care according to the specification. According to the entries in the maintenance document, the inspection of the magnetic plugs of the oil system found no disorder.

1.7. Meteorological information

The occurrence took place at daytime, in good visibility conditions, without any mentionable meteorological phenomena. According to the data issued at the airports of Pápa and Sármellék, the air temperature near the ground was 32ºC. The speed of the wind from the south-southeast was 3 m/s.

On the basis of the International Standard Atmosphere, the air temperature at the actual flight altitude of the aircraft was about 28 to 29 ºC.

The weather conditions had no effect on the course of events, therefore weather needs no further analysis.

1.8. Navigation aids

The items indicated in the type certificate were installed in the aircraft; the IC found no problem with and received no comment regarding to the functioning of such items.

During the on-site investigation, the IC found a personal navigation device with the pilot which was able to record the flight route as well; the device was seized by the competent police unit.

During posterior investigations, the expert invited by the police could not recover data from the device.

The IC was able to reconstruct certain sections of the flight path on the basis of the radar image recorded by the aeronautical information service provider.

1.9. Communications

The items indicated in the type certificate were installed in the aircraft; the IC found no problem with and received no comment regarding to the functioning of such items. The communication equipment had no effect on the occurrence therefore detailing them is not relevant.

After take-off, the pilot of the aircraft contacted the competent unit of the aeronautical information service provider.

After being notified of an aircraft which crashed into water, the aeronautical service called the aircraft with registration 35-22 on the radio several times, but they were not able to contact the pilot. Simultaneously, the service unit took the required alert state actions.

1.10. Airport data

The aircraft took off from Balatonkeresztúr Airport on 25 July 2015, at about 13:50, local time.

Name of airport	Balatonkeresztúr Airport
ICAO code of the airport	LHBK
Airport coordinates (ARP)	N46°41'44" E017°23'40"
Altitude above sea level	110 m (361 ft)
Runway dimensions	650m x 50m
Runway cover	Grass

Airport parameters had no effect on the course of events, therefore their further analysis is irrelevant.

1.11. Data recorders

The aircraft had no data recorder in place; it is not required for the aircraft type affected.

1.12. Wreckage and impact information

According to information from the water police, the coordinates of the place where they found the immersed aircraft were: N46°43'31.14", E017°19'19.92".

According to the pilot's statement, the extra air pressure generated by the propelling rocket after activating the parachute ripped the windshield out, and opened the doors. Then, after the parachute opened, they touched the water *"relatively soon"*. According to judgement by the pilot, the aircraft still had a minimal horizontal speed when touching the water surface, that is why the nose cone fractured.

During the investigation, the IC found that only the drag chute of the recovery parachute opened (Figure 3) (the task of the drag chute is to pull the main parachute out of its container). See Section 1.18.5 for a description of the recovery parachute system.

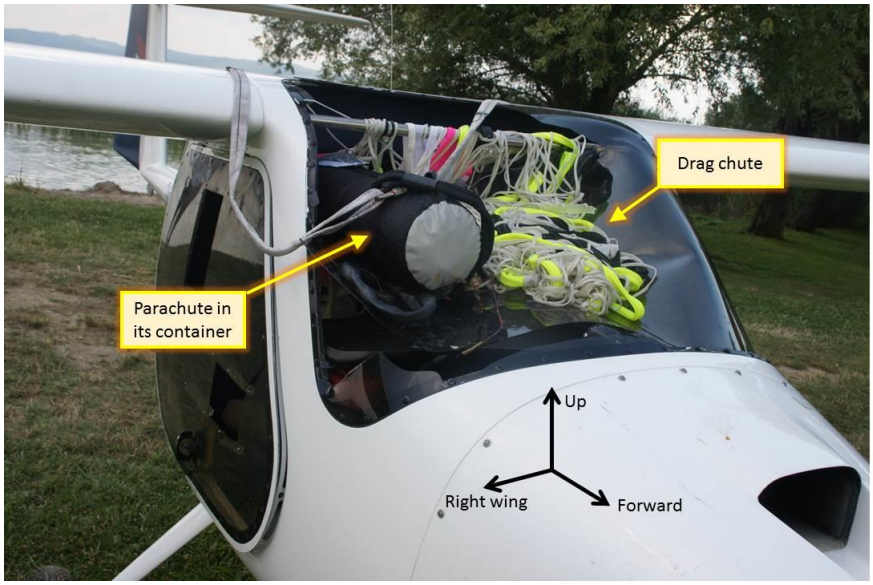

Figure 3: The main parachute in the container and the drag chute

1.13. Forensic information

There was no evidence of any influence of physiological factors or other impediment on the capacity of the flight crew.

1.14. Fire

No sign of fire was detected during flight or after the crash.

1.15. Survival aspects

The position of the IC is that the use of the onboard recovery parachute largely increased the chances of survival in the context of crash-landing into water.

The rescue units were notified after the aircraft crashed in the water.

According to his report, the pilot directed the aircraft and activated the parachute over an area where he saw boats nearby. According to the report obtained from the police, the witnesses said the boat staying near the spot of the occurrence started the rescue of the pilot and the passenger with no delay.

1.16. Tests and research

During the technical investigation, the IC received the report of the court expert invited by the police on the posterior inspection of the aircraft. According to such report:

> *"The expert inspection revealed no installation disorder or any fault which would have led to the accident."*

1.17. Organisational and management information

1.17.1. Airworthiness certificate

Aircraft not subject to the effect of Regulation (EC) № 216/2008 of the European Parliament and of the Council may only be operated of it holds an airworthiness certificate according issued by the air transport authority pursuant to the regulation on the requirements for the airworthiness of aircraft, the examination of airworthiness, and the airworthiness certificate.

Pursuant to NFM Regulation № 21/2015. (V. 4.) on the manufacturing, construction and airworthiness of aircraft, airworthiness certificates for aircraft not subject to the effect of Regulation (EC) № 216/2008 of the European Parliament and of the Council may also be

issued by an airworthiness management organisation approved by the transport authority. Pursuant to Subsection (1) Section 102 of the NFM Regulation № 21/2015. (V. 4.), during the airworthiness review of aircraft, the certifying authority shall ensure that the flight manual applies to the given aircraft configuration, and complies with the state indicated during the last review.

1.18. Additional information

1.18.1. The engine and the propeller of the aircraft

According to Chapter VI Emergency Situations of the aircraft flight manual (written in Hungarian language) intended for the aircraft involved in the occurrence:

> *"The engine in the Virus 912 UL ultralight aircraft is an auxiliary engine, i.e. not a rated aircraft engine. Its stall in any phase of the flight does not represent an aviation incident. Landing the aircraft on open terrain is also as natural as in the case of a glider. An important rule: the pilot of the aircraft must always choose the path and the altitude of the flight in such manner that they could reach the previously selected, suitable landing spot safely even in the case that the engine stalls."*

The above note indicated in the Hungarian aircraft flight manual is not included in the Flight manual and Maintenance manual issued by the manufacturer.

The affected aircraft is equipped with a VARIO propeller. Its design allows the feathering the propeller after the engine is shut off inflight, i.e. the propeller blades get in a position where their drag is minimal. This system increases the gliding performance of the aircraft. Propeller feathering[3] should be performed after the engine has stopped, and airspeed has been reduced to 90 km/h (48 kts).

1.18.2. Engine oil system and cooling

The type Rotax 912 engine is equipped with a complex cooling system. The entire surface of the engine and the cylinders are cooled with ram-air flowing through the engine compartment, while the cylinder heads are designed for liquid cooling.

The engine oil system is a closed system designed for pressure lubrication. The oil flows from the oil tank through the radiator, the oil pump, the filter and the pressure-control valve to the lubrication spots of the engine. The draining oil is accumulated in the oil sump, from where the crankcase gases push it back into the oil tank. The oil temperature sensor is situated on the outlet branch of the oil sump.

According to the Flight manual and Maintenance manual[4] issued by the manufacturer, the standard operating oil temperatures range from 90 to 110°C. The highest permitted oil temperature is 140°C.

1.18.3. Flight manual and Maintenance manual

According to the Flight manual and Maintenance manual[5] issued by the manufacturer, the RPM of the engine must be reduced after take-off, and airspeed must be increased as necessary in order to cool the engine. The Flight manual requires an airspeed of 115 km/h (62 kts) above the altitude of 100 m for the climb after lift-off.

In the case of in-flight engine failure, according to the Flight manual[6]:

> *"First ensure proper airspeed by reducing angle of attack, then start analysing terrain underneath and choose in your opinion the most appropriate site for landing out."*

[3] Pipistrel Virus 912 Flight manual and Maintenance manual (Rev. 2, 28 September, 2010) / Power plant and propeller / Propeller feathering
[4] Pipistrel Virus 912 Flight manual and Maintenance manual (Rev. 2, 28 September, 2010) / Limitations / Engine, Fuel, Oil
[5] Pipistrel Virus 912 Flight manual and Maintenance manual (Rev. 2, 28 September, 2010) / Normal procedures / Initial climb
[6] Pipistrel Virus 912 Flight manual and Maintenance manual (Rev. 2, 28 September, 2010) / Emergency procedures

According to the Flight manual,[7] the actions to be taken in the case of in-flight engine failure are as follows:

"Make sure the master switch is in the ON position (key full right), magneto switches both set to ON and both fuel valves OPEN.

Should the propeller not be spinning (motor blocked!), the engine is probably seriously damaged. In this case DO NOT attempt to restart the engine. Instead begin with the landing out procedure immediately.

Should the propeller be spinned by air current freely, fuel or electrical system is probably malfunctioning. Verify on-board fuel quantity and make sure both fuel valves are open and magneto switches set to ON. Restart the engine."

The "Appendix / Aircraft familiarisation / Climb" chapter of the Flight manual and Maintenance manual issued by the manufacturer says:

"A comfortable setting for climb is flaps in neutral position, speed of 115 km/h (62 kts) at some 5000 RPM. In summer time or when outside temperature exceeds 30°C you should consider climbing at some 130 km/h (70 kts) to provide more airflow to the engine radiators. Trim the aircraft for comfortable stick forces."

The owners of the aircraft involved in the occurrence used a Hungarian aircraft flight manual approved by *Aviation Authority, National Transport Authority* (hereinafter: "NKH LH") under № 522543/04. Such Hungarian aircraft flight manual approved by NKH LH says the following relating to the management of engine overheating:

"Failure to observe the required RPM limits may lead to overheating of the engine. Engine overheating is indicated by the coolant temperature indicators and the oil temperature indicator. The maximum permitted cooling water temperature is 96ºC. Should the temperature exceed that value, glide to cool down the engine at 3000 RPM, and then continue normal flight."

The "Normal Procedures / Normal procedures and recommended speeds" chapter of the Flight manual and Maintenance manual issued by the manufacturer contains the following parts:

- Engine start-up
  - Before engine start-up
  - Engine start-up
  - Engine warm-up procedure
- Taxi
- Take-off and initial climb
  - Initial climb
- Cruise
- Descent and final approach
- Roundout and touchdown
  - Crosswind approach and roundout
- Parking
- Restarting the engine in flight

1.18.4. Flight altitudes

Pursuant to Decree 14/2000. (XI. 14.) of the Minister of Transport and Water Management on the Rules of the Air within the Airspace and the Aerodromes of the Republic of Hungary, in effect at the time of the occurrence:

"2.1.2. Minimum flight levels

[7] Pipistrel Virus 912 Flight manual and Maintenance manual (Rev. 2, 28 September, 2010) / Emergency procedures / Engine failure in flight

Except for the cases of take-off and landing, or except by permission from the aviation authority, aircraft shall not be flown over the congested areas of cities, towns or settlements or over an open-air assembly of persons, unless at such a height as will permit, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface."

"3.4. Flight altitudes

3.4.1. Except for the cases of take-off and landing, aerial work, special flight tasks performed by state aircraft, and flights related to patient transport and life-saving, VFR flight shall not be performed:

a) over the congested areas of cities, towns or settlements or over an open-air assembly of persons, or lower than 100 ft (300 m) over the highest obstacle situated within a circle of 600 metres radius with the aircraft in the centre of the circle;

b) lower than 55 ft AGL (150 m) over the ground or water level when over areas not specified in Paragraph a), except for flights subject to special permits, balloon flights, glider or hang glider flights."

1.18.5. Operation of the recovery parachute system of the aircraft

The built-in recovery parachute of the aircraft is a rocket engine activated rescue system serving the primary purpose of saving the lives of the people on board.

The system consists of a parachute unit fixed into the luggage compartment, an operating rocket engine, and a handle for activating the system. When the person on board triggers the system by pulling the handle, the rocket engine shoots the parachute (which is fixed to the airframe) as far as 18 m of the aircraft (Figure 5). According to the manufacturer's specification, the time required from activation to full opening of the parachute is 3.2 seconds. The manufacturer guarantees that the device works safely at a height of 90 to 120 m, provided that the airspeed of the aircraft is over 60 km/h.

The emergency operation chapter of the aircraft flight manual issued by the manufacturer of the aircraft does not mention the operation or use of the recovery parachute.

The annex to the aircraft flight manual issued by the manufacturer provides information on the use and maintenance of the parachute system.

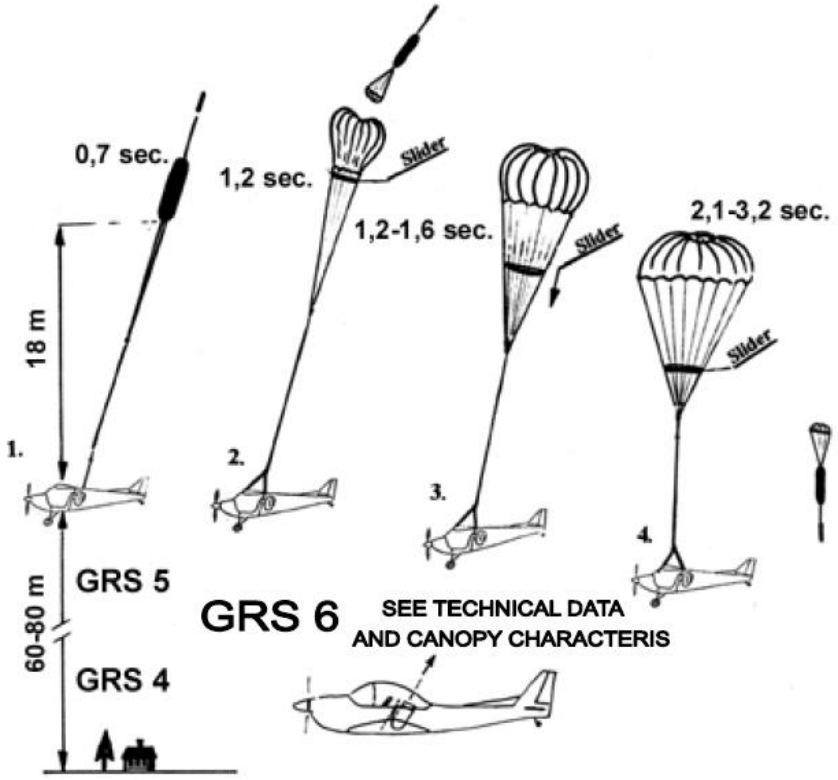

Figure 5: Operation of the total recovery parachute system according to the manufacturer
(Source of the photo: Instruction Manual for Assembly and Use, Galaxy High Technology s.r.o. of Liberec**)**

1.19. Useful or effective investigation methods

The investigation required no non-standard methods.

2. Analysis

The analysis performed by the IC is based on experiences gained at the scene, on the radar images, on the instructions in the flight manual, on studying the reports sent by the police, and on literature relating to human factors[8].

2.1. Aircraft flight manual

In the context of the occurrence, the IC analysed both the aircraft flight manual (written in Hungarian) supplied to the aircraft and approved by Aviation Authority, National Transport Authority and the aircraft flight manual (written in English) issued by the manufacturer. Such analysis revealed that the two flight manuals coming from different sources are different in several points. The Hungarian version requires certain procedures that are not included in the original manual. During the investigation, the IC acquired no information which would explain the cause of such differences.

The Type Certificate issued by Aviation Authority, National Transport Authority under № UL-04-2016 on 6 June 2016, i.e. after the occurrence, refers to the use of manuals published by the manufacturer and approved by the competent authority of the country of the manufacturer. The manufacturer guarantees airworthiness of the type Pipistrel Virus 912 aircraft on condition that the requirements specified in the Type Certificate are met. The aircraft flight manual is one of the sources of the specification of such requirements, and the position of the IC is that it is forbidden to disregard the aircraft flight manual without approval from the manufacturer and the competent authority.

With reference to Chapter 1.18.3, the manufacturer's aircraft flight manual specifies that, if the ambient air temperature is over 30°C, the aircraft requires a speed of 130 km/h (70 kts) to climb. The IC finds this information important from the aspect of flight safety. However, this part is found in the annex to the aircraft flight manual, and there is nothing to warn the user of the flight manual of the importance of the issue, and it is not connected in any form to the chapter on operation in the manual. The procedures relating to the use of the recovery parachute of the aircraft are also found in the annex to the aircraft flight manual. The chapter on emergency situations in the manual does not mention the use of the recovery parachute despite the fact that it requires the use of the system in the case of emergency. The IC regards the procedures relating to prevention of engine overheating and the use of the recovery parachute as high risk from the aspect of flight safety in the current layout, i.e. because they are indicated in the annex, separated from the main chapters of the manual.

The manufacturer recommends the aircraft for navigation practice flights, and for gliding with the engine shut off due to its gliding performance. The chapter on normal procedures in the flight manual issued for the aircraft deals with in-flight engine restart (Chapter 1.18.3), but does not cover in-flight engine shut-off. The position of the IC is that the gaps existing in the procedure of the aircraft flight manual may create circumstances where the pilot needs to apply an ad-hoc procedure to shut the engine off inflight, which implies high risk as regards flight safety.

2.2. Analysis of the operation of the engine

It is known from the pilot's report that the engine did not stop after the ignition was turned off. According to the IC, the reason for this is that engines tend to run on when shut off at operating temperatures, especially when apparent wind reduces propeller load.

The IC analysed the systems of the engine of the aircraft involved in the occurrence, including the operation of such systems. The pilot's report and the radar image revealed that, in order to cool the engine, the pilot set engine power to idle at 12:03:28 UTC, and started to increase the speed of the aircraft by descent. Then, realising that oil temperature had not

[8] Handbook of Aviation Human Factors SECOND EDITION, John A. Wise, V. David Hopkin, Daniel J. Garland, 2010, and Errors in Aviation Decision Making, Judith Orasanu Lynne Martin, NASA-Ames Research Center

changed (120ºC), he turned the battery main switch off. One minute and 28 seconds elapsed between the two interventions. According to the aircraft flight manual, the oil temperature limit is 140ºC. The IC concluded that, in the case investigated, the time provided for the cooling of the engine is not sufficient to change to the oil temperature substantially (with ambient temperatures of 29ºC to 32ºC).

The IC finds that the pilot's action to manage the rise of engine oil temperature, as well as shutting the engine off at the given location, was based on inappropriate assessment of the situation.

On the basis of the aircraft flight manual, the summary opinion of the IC is that the pilot shut the engine off unnecessarily when the oil temperature reached 120ºC.

The investigation performed by the expert invited by the police did not cover all of the auxiliary equipment of the engine, in absence of which the IC does not take any position on the serviceable condition of the engine.

2.3. Flight path and pilot activity

The IC used radar data and weather information to determine the speed of the aircraft during its climb. Based on radar data, the pilot kept ground speeds of 57 to 70 kts (64.6 kts on average) during most of the climb.

According to the IC, the speed chosen by the pilot during climb did not provide the extent of engine cooling which the pilot had been used to.

According to the aircraft flight manual issued in Hungarian language, the flight path must always be selected in such manner that the pilot should be able to land the aircraft on suitable terrain even in the case of unexpected engine stall. This implies flight over an area where landing is possible or choosing a flight altitude which allows the pilot to find a suitable landing area by gliding. It is the aircraft flight manual approved by the competent authority that should be applied to the operation of the aircraft. Considering all this, pilots must observe the requirements specified in the aircraft flight manual issued in Hungarian language and approved by the competent authority.

Turning the main battery switch of the aircraft off will cut power supply to all electrical consumers, including the on-board secondary transponder as well. The IC got aware of the time of switching off of electricity on the aircraft and the resulting engine shut-off from the pilot's oral report and the recorded radar image. At the given time (12:04:52 UTC) (Annex 2), the aircraft was at an altitude of 1500 ft AMSL, about 850 m of the west coast of the lake Balaton (coordinates: N 46°44'58" E 17°15'24") and 357 m above the water level.

Based on witness reports, the IC supposes that the geographical coordinates recorded by the water police unit as the location of finding the aircraft is not identical with the location where the aircraft hit the water because towing of the aircraft ashore was started before the water police arrived. Accordingly, the IC cannot determine the spot where the aircraft hit the water.

According to the aircraft flight manual, the maximum fineness ratio of the aircraft with feathered propeller is 24. As the IC has no recorded data of the flight path, the gliding path following the engine shut-off is not known either, which prevents us from determining the actual fineness ratio. If we take the position of the aircraft at the time of the engine shut-off and assume a gliding performance of the aircraft based on its maximum theoretical fineness ratio, the aircraft could have reached the aerodrome of departure from an altitude of 2530 ft (770 m) AMSL, i.e. 670 m above the water surface as a minimum. The IC's calculations took into account that the flight route was over inhabited areas, thus the altitude where the aircraft should arrive at the airport was determined as 150 m AGL, for safety reasons. Practical experience shows that actual performance of gliding aircraft falls far below the value of the theoretical fineness ratio. It may be concluded on the basis of data available that, following the engine shut-down, the gliding performance of the aircraft would not have allowed safe return to the aerodrome of departure. Even if the actual gliding performance of

the aircraft in the given circumstances allows return to the aerodrome theoretically, the manoeuvre could have implied high flight safety risk according to the opinion of the IC, because the last section of the scheduled route ran over a densely populated settlement. Instructions relating to safe flight altitudes are included in Chapter 1.18.4.

According to the opinion of the IC, the pilot's decision to select an aerodrome which at a distance beyond the gliding performance of the given aircraft after the engine shut-down, as well as the fact that, starting from the west coast of the lake Balaton, the pilot selected a flight path for gliding which ran over open water surface, i.e. moving away from the shore, implied high risk. According to the position of the IC, the cause of making high-risk decisions by the pilot in order to resolve the situation was his inadequate assessment of the situation.

The IC reviewed the flight plan submitted to the competent air traffic management service prior to the flight. The cruise height indicated in the flight plan was 2500 ft QNH. According to the position of the IC, the combination of the planned route and the flight altitude did not comply to the limits specified in the aircraft flight manual (written in Hungarian) for non-certified aircraft engine, and did not comply with the relevant legislation either. I.e. the possibility to land the aircraft on suitable terrain in the case of unexpected engine shut-off was not available at each point of the planned route.

On the basis of the facts presented in Sections 1.12 and 1.18.5, the IC concluded that the pilot had activated the recovery parachute system of the aircraft 1.2 seconds at earliest before touching the water surface.

2.4. Airworthiness review certificate

During the investigation, the IC also reviewed the airworthiness review procedures of the organisation which managed the airworthiness of the aircraft involved in the occurrence. The result showed that the airworthiness review procedure performed by the airworthiness managing organisation in 2014 relating to the aircraft with reg. number 35-22 did not reveal the contradictions between the aircraft flight manuals. The IC reviewed the "*Inspection Report*" of the airworthiness managing organisation approved by the competent authority, which does not indicate the documentation or the applicable manuals on the list of the items to be inspected. According to the position of the IC, this gap does not only influence flight safety in the case of this aircraft but, the same may also apply directly or indirectly to all other aircraft reviewed by this organisation.

3. Conclusions

3.1. Factual statements

The flight crew had appropriate license and qualification as well as adequate experience for the given flight task at the time of the occurrence.

The aircraft had a valid airworthiness certificate. According to its documents, the aircraft was equipped and maintained in compliance with the requirements in effect and with the approved procedures.

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

No information has been acquired in relation to the activities of the air traffic management service or the ground personnel or to the characteristics of the aerodrome which could be related to the occurrence.

The aircraft flight manual issued by the manufacturer and the one (written in Hungarian) approved by the competent authority show differences at several points.

The airworthiness review procedures of the organisation managing the airworthiness of the aircraft involved in the occurrence lack the inspection of the aircraft flight manual specified in the relevant statute of law.

As a consequence of erroneous assessment of the situation, the pilot shut the engine off within the specified oil temperature range.

The gliding performance of the aircraft did not allow it to reach the aerodrome of departure after the engine shut-off.

The location where the aircraft descended into the water cannot be determined.

The pilot activated the recovery parachute system at a point of time which was too late for its effective operation.

3.2. Causes of the accident

The investigation performed by the IC has concluded that the occurrence was caused by the pilot’s inadequate situation assessment and erroneous decisions.

The IC identified route planning with insufficient care as the precondition of the immediate cause of the occurrence.

4. Safety recommendations

4.1. Safety recommendation issued after the investigation

As a conclusion of the technical investigation, the IC finds it necessary to issue the following safety recommendations:

BA2015-227-4-1: *During its technical investigation, the Investigating Committee of Transportation Safety Bureau concluded that the normal operation procedure in the aircraft flight manual issued by the manufacturer to the ultralight aircraft Pipistrel Virus 912 does not include the procedure of in-flight engine shut-off despite the fact that such aircraft flight manual allows the use of the aircraft as a glider as well. For this reason:*

> **Transportation Safety Bureau recommends the PIPISTREL d.o.o. Ajdovščina Factory to adjust the contents of the chapter on normal operation in the Pipistrel Virus 912 Flight manual and Maintenance manual with the proposed modes of use of the aircraft designed and manufactured by such Company.**

The opinion of the IC is that, in the case of accepting and implementing this recommendation, the flight safety risks arising from the gaps in the procedures in the aircraft flight manual may decrease.

BA2015-227-4-2: *During its technical investigation, the Investigating Committee of Transportation Safety Bureau concluded that the annexes to the aircraft flight manual issued by the manufacturer to the ultralight aircraft Pipistrel Virus 912 contain some procedures which are related to normal operation and emergency situations. Further, such procedures are not referenced in the relevant chapters. For this reason:*

> **Transportation Safety Bureau recommends the PIPISTREL d.o.o. Ajdovščina Factory to transfer those procedures and information which are relevant from the aspect of flight safety from the Annexes to the Pipistrel Virus 912 Flight manual and Maintenance manual into the relevant chapters of such manual.**

The opinion of the IC is that, in the case of accepting and implementing this recommendation, the flight safety risks arising from compartmentalisation of the aircraft flight manual will decrease.

BA2015-227-4-3: *During its technical investigation, the Investigating Committee of Transportation Safety Bureau concluded that the procedures of the airworthiness management organisation approved by the relevant Authority do not comply with the requirements in the applicable legal requirements. For this reason:*

> **Transportation Safety Bureau recommends Deputy State Secretary for Transport Authority Affairs, Ministry of National Development, which is in charge of the administrative supervision of aviation related activities, to review the manuals of the airworthiness management organisations for Hungarian aircraft not covered by the Regulation (EC) № 216/2008.**

The opinion of the IC is that, in the case of accepting and implementing this recommendation, the procedures of the airworthiness management organisations involved in the issuing of airworthiness certificates for Hungarian aircraft not covered by the Regulation (EC) № 216/2008 will comply with the relevant legal provisions.

Budapest, 03 December 2018

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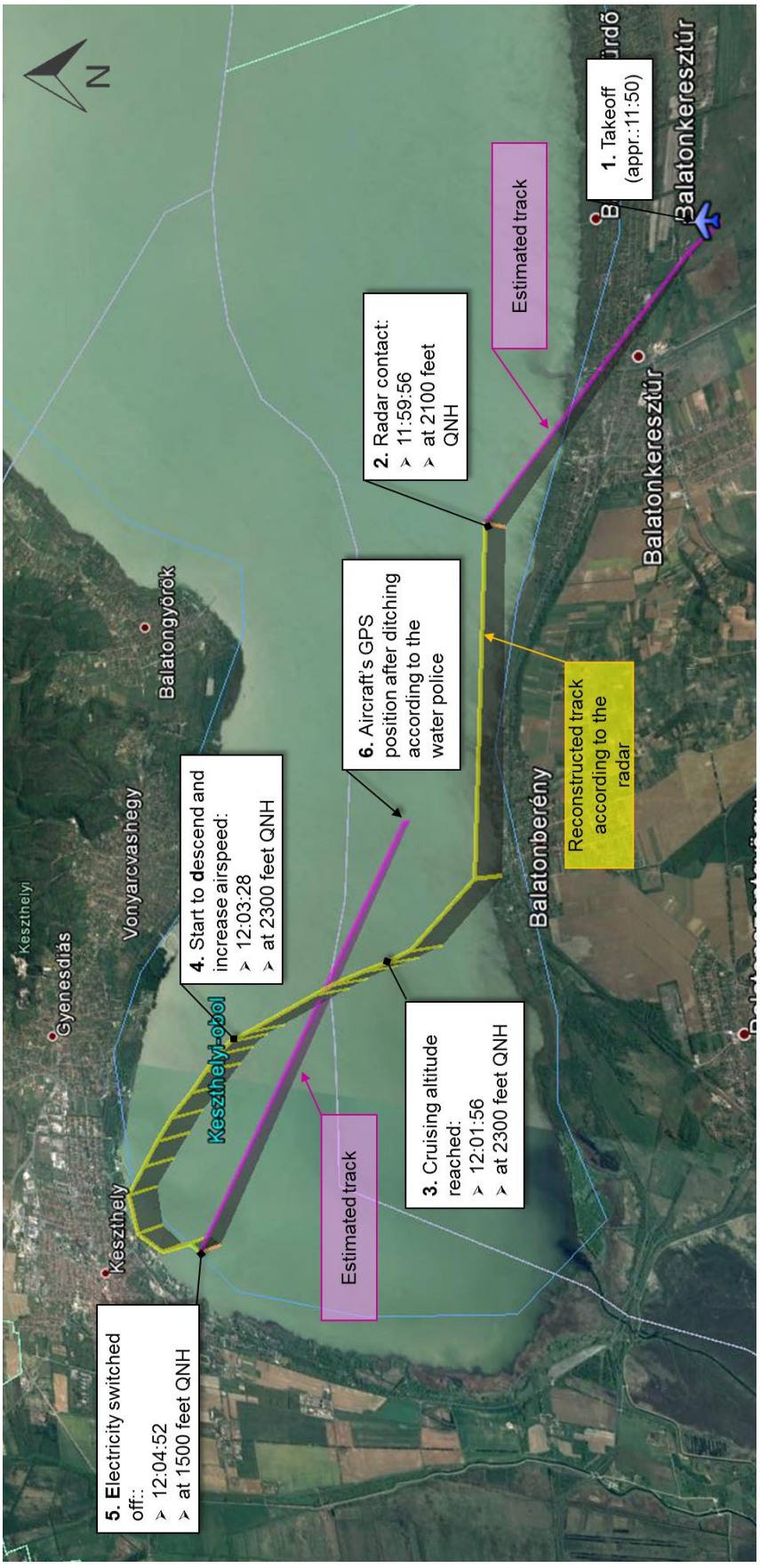
Zsigmond Nagy	Miklós Ferenci
Investigator-in-Charge	IC Member

ANNEXES

Annex 1: Route of the aircraft (Source of the map: Google Earth)



Annex 2: The flight parameters as recorded by the radar of the air traffic management service