MINISTRY FOR
INNOVATION AND TECHNOLOGY

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

2014-511-4

Accident

Near Kiskunlacháza Airport

24 December 2014

Pipistrel Virus SW

14-79

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 has been 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 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.

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 aviation 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.

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

AFIL	*A flight plan provided to an air traffic services unit by an aircraft by radio during its flight*
Ah	*Amper-hour*
air traffic service[1]	*A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service)*
ARP	*Airport Reference Point*
ASTM	*American Society for Testing and Materials International, an international standards organisation*
ATS	*Air Traffic Service*
EASA	*European Aviation Safety Agency*
Flarm	*a GPS-based collision warning system*
flight plan	*Specified information provided to air traffic service units, relative to an intended flight or portion of flight of an aircraft*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
ITM	*Ministry for Innovation and Technology*
Kbvt.	*Act CLXXXIV of 2005 on the technical investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*
$LiFePO_4$	*Chemical formula of the compound lithium iron phosphate*
LT	*Local Time*
MET	*Ministry of Economy and Transport*
MND	*Ministry of National Development*
NTA AA	*National Transport Authority Aviation Authority (till 31 12 2016) (Hungary)*
OKF	*National Directorate for Disaster Management (NDGDM)(Hungary)*
transponder	*On-board secondary radar transponder, a receiver/transmitter that transmits a response upon appropriate questioning; asking and answering take place at different frequencies*
TSB	*Transportation Safety Bureau*

[1] Implementing Regulation (EU) 2017/923 of 12 May 2017

ultralight aircraft	*The aircraft category defined in para. e) Annex 1 to Regulation (EU)№ 2018/1139 of the European Parliament and of the Council (EU)*
UTC	*Coordinated Universal Time*
VFR	*Visual Flight Rules*

Introduction

Occurrence category		accident
Aircraft	Manufacturer	Pipistrel d.o.o. Ajdovscina
	Type	Pipistrel Virus SW
	Registration sign	14-79
	Operator	private person
Occurrence	Date and time	24 December 2014, at about 12:48LT
	Location	Near Kiskunlacháza Airport (Figure 1)
Number of people severely injured in the accident:		1
Extent of damage of 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+ 1 hours.

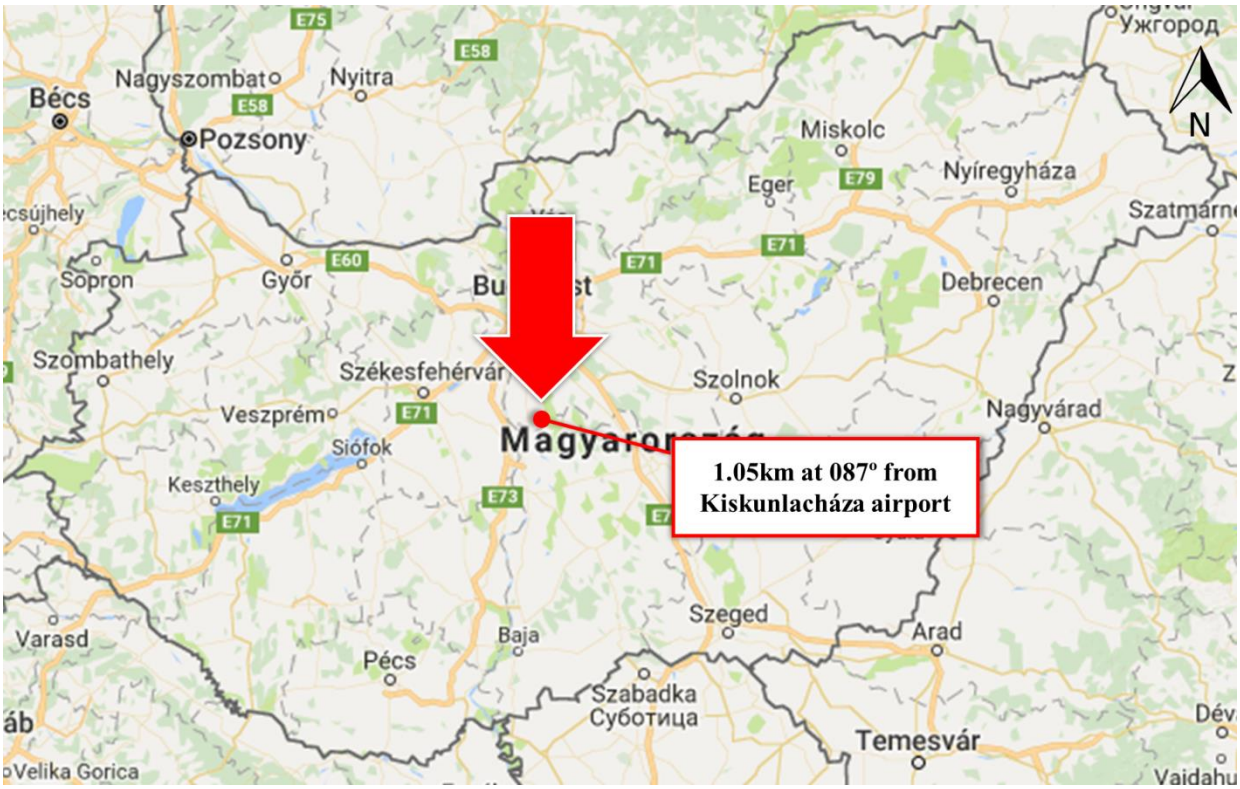


Figure 1: Location of the accident in Hungary

Reports and notifications

The occurrence was reported to the dispatcher of TSB by the duty service officer of OKF on 24 December 2014, at 14:00.

The duty service of TSB:

- notified the investigating authority of the state of the manufacturer and designer of the aircraft on 29 December 2014.

Investigating Committee

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
Member	**Gábor Erdősi**	Accident Investigator

Overview of the investigation

During the investigation, the IC:

- visited the scene and took photos there on 24 December 2014;
- took more photos and performed measurements at the scene, and removed the wreck on 25 December 2015;
- notified the manufacturer and the accident investigating authority of the country of the manufacturer of the occurrence;
- analysed the wreck in a joint effort with the manufacturer;
- received the video record of the battery overload test performed by the manufacturer during its own investigation, as well as the related test report;
- obtained a chemical expert's opinion form Hungarian Institute for Forensic Science;
- interviewed the pilot, requested information on the purchasing of the aircraft, on the pilot's prior experience with the aircraft, on the emergency situation that had emerged, and on the solution of that situation
- obtained the radar images recorded by HungaroControl Zrt. and analysed them;
- overviewed the flight manual of the affected aircraft type;
- consulted the relevant supervisory authority and the manufacturer on several occasions;
- obtained and analysed the electrical wiring diagrams of the aircraft;
- obtained the service bulletins issued by the manufacturer of the aircraft on 4 May 2017 (SB-100-004 A.01) and 12 May 2017 (SB-100-004 A.02), as well as the service bulletin issued on 27 June 2017 (SB-100-006 LSA A.00);
- obtained and overviewed the design and construction standard (ASTM) indicated by the manufacturer, relating to the electrical system;
- reviewed the data and physical properties indicated on the datasheet of the cable used for parallel connection of the batteries, and tested certain items in practice as well;
- performed a short circuit test using a battery cell which is the same type as the one involved in the occurrence;
- analysed the collected information and drew conclusions of it.

Overview of the occurrence

On 24 December 2014, during a private cross-country flight, the pilot (and owner) of the Pipistrel Virus SW aircraft (reg. mark: 14-79) (Figure 2) detected thick white smoke flowing forward from the space behind the seats in the aircraft. In the given situation, the pilot decided to perform immediate emergency landing. In an area which seemed appropriate near Kiskunlacháza airport, the pilot performed emergency landing, during which the aircraft impacted the ground hard. The pilot suffered serious injuries, and the aircraft was destroyed in the fire which started after the aircraft crashed to ground.

The IC found that malfunctioning of the on-board battery system of the aircraft was the cause of the occurrence.

The IC identified a contradiction in the legislation relating to research and rescue, and proposes that a safety recommendation be issued in order to eliminate such contradiction.

The IC identified a shortcoming in the internal procedures of the manufacturer of the aircraft, and proposes that a safety recommendation be issued in the draft report in order to eliminate such shortcoming.

The manufacturer of the aircraft has taken measures in the meantime which does not require that a safety recommendation be issued.

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

1. Factual information

1.1. History of the flight

According to his report, the pilot arrived at Tököl Airport for a cross-country flight t 10:15 on 24 December 2014. His planned route was Tököl, Csongrád, Jakabszállás Airport, and then back to Tököl Airport. The pilot filed a flight plan of the first section (Tököl to Jakabszállás) of his flight. After taking off at Tököl, he flew his route at 2500 ft, to Jakabszállás Airport, with a turning point at Csongrád. After taking a few turns above Csongrád, he landed uneventfully at Jakabszállás Airport. He asked the competent air traffic services unit to close his flight plan.

After landing, the pilot spent about 15 minutes at the airport, and then he took off again. He set out for the second section of his route toward Tököl Airport (Figure 3). He did not file a flight plan but checked in by radio with the competent air information service unit at 12:30:26. He agreed with the service unit by radio that he would continue flying toward Tököl airport without a flight plan but using the 7000 transponder code, at an altitude of 3000 ft. According to the radio communications recorded by the air traffic service, the competent service unit did not call the aircraft by radio subsequently.

According to his statement, the pilot operated all on-board electric devices (the equipment indicated in Section 1.18.3) simultaneously during the flight.

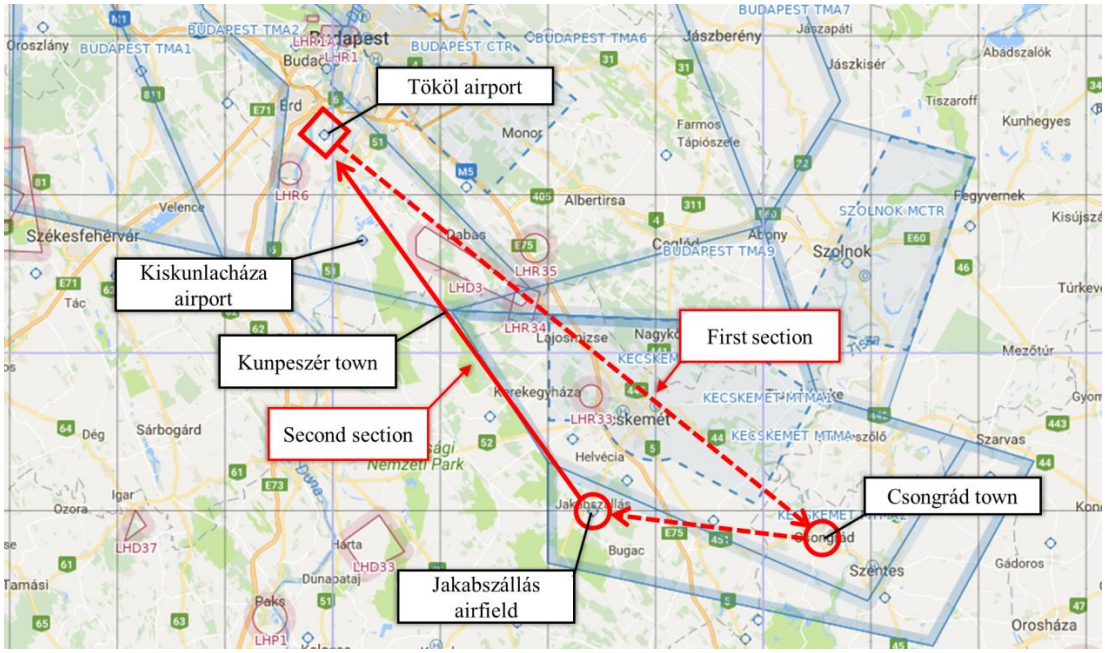


Figure 3: Planned flight of the 14-79 aircraft

Flying at cruise altitude between Kunpeszér and Kiskunlacháza Airport, the pilot heard a loud bang from behind him. Intense smoke appeared in the cabin soon after, and it was accompanied by a whistling sound. According to the pilot's statement made during his hearing, he looked at the on-board instruments and saw, among others, that the "*Battery Amper*" and "*Battery Voltage*" tell-tales were outside their respective ranges. Soon after, he stopped the engine and turned electrical power consumers off. According to his statement, he separated the battery from the electrical system by pulling the battery main switch ring, and opened the cabin door due to the thick fume, and looked for suitable terrain to land. As he thought he would not reach Kiskunlacháza Airport due to intense fume and spread of the fire, he chose an agricultural area for landing, instead of the airport (Figure 4). The pilot remembered the white smoke but could not remember the smell of the smoke or any other odour. Holding one hand on the control stick and keeping the left door of the aircraft open with the other hand, he performed emergency landing. The aircraft contacted the soft,

swampy soil rough, i.e. the terrain did not prove appropriate for a safe landing. The aircraft halted and stood still after a short run on the ground. Then the pilot released the seat belt and got out of the aircraft through the left door. After leaving the aircraft, he looked back at the front of the aircraft from a distance of 3 to 4 metres, and saw fire burning in the right hand side of the cabin (according to direction of travel).

After the emergency landing, the pilot set off to the nearby airport walking. After walking about a kilometre, he reached the fence of the airport and called the ambulance service with the help of the airport staff. The National Ambulance Service was called at 12:58 on 24 December 2014. The ambulance car carried the pilot with serious burn and shoulder injury to hospital.

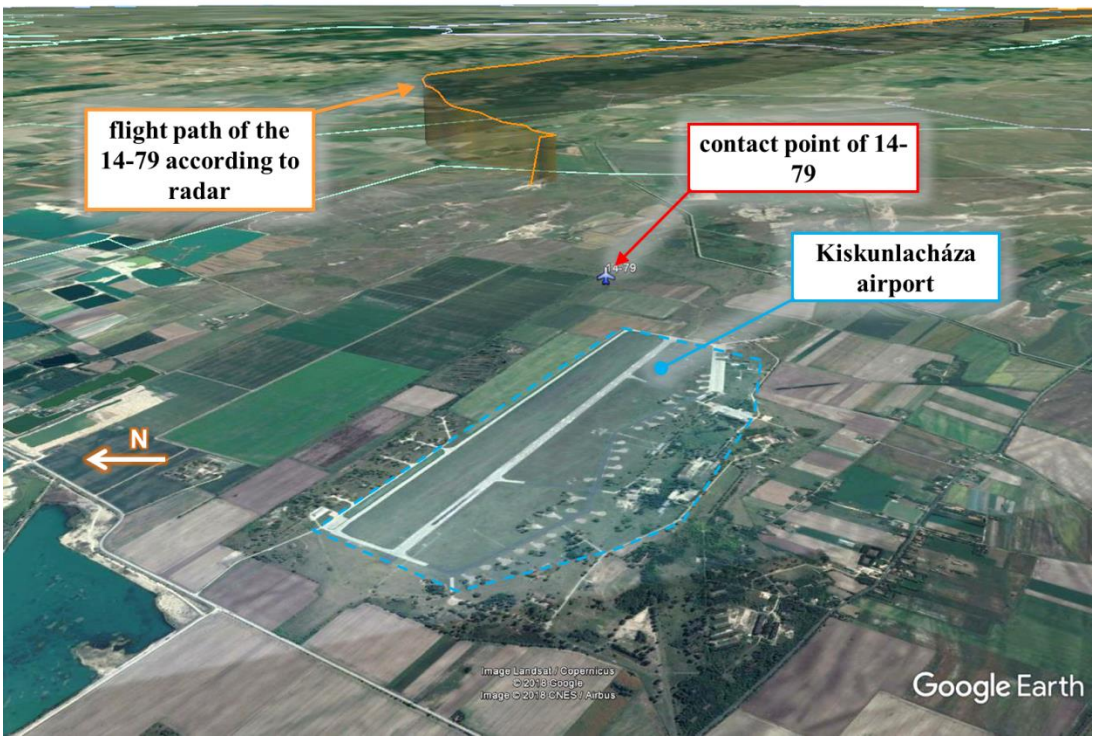


Figure 4: Actual flight path of the affected aircraft and the spot where it landed (source of map: Google Earth)

1.2. Injuries to persons

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

1.3. Damage to aircraft

The aircraft involved in the accident burnt out fully, and it was destroyed in the fire.

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		35 years, Hungarian, male
License data	Type	MKSZ pilot
	Professional validity until	10 Sep 2020
	Ratings	pilot
Certificates		pilot
Medical certificate valid until		Class II, 08/Mar/2015

The format of the document is specified by the issuing organisation and approved by the aviation authority, and it does not indicate which activities the pilot with the given pilot licence can perform.

According to the pilot's report, his flight log was destroyed in the burnt-out aircraft. The opening entry in his new flight log was 234 hours flown, on 24/12/2014.

1.6. Aircraft data

1.6.1. General data

Class	Fixed-wing ultralight aircraft
Manufacturer	Pipistrel d.o.o. Ajdovscina
Type	Pipistrel Virus SW
Year of manufacturing	2014
Serial number	669SWN100IS
Registration	14-79
State of registry	Hungary
Date of registry	28/10/2014
Owner	Private person
Operator	Private person

	Hours flown	Number of take-offs
Since manufacturing	18.1 hours*	No data
Since last periodical maintenance[2]	-	-

* According to the pilot's report, the on-board documents and the logbook were destroyed in the burnt-out aircraft. The opening in new logbook was 18.1 hours, on 24/12/2014.

1.6.2. Airworthiness

Airworthiness certificate	Date of issue	28/10/2014
	Valid until	28/10/2017
	Restrictions	None

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

Airworthiness Review Certificate	Number	12/014/2013
	Date of issue	28/10/2014
	Valid until	28/10/2017
	Date of last review	28/10/2014

1.6.3. Aircraft engine data

Class	4-stroke boxer engine
Manufacturer	BRP-Rotax GmbH
Type	Rotax 912 IS
Serial number	7703132
Hours flown / Cycles flown	
Since manufacturing	18.1 hours
Since last periodical maintenance	-

1.6.4. Aircraft loading data

Empty mass	289 kg
Fuel quantity at take-off	50 – 60 litres (36.5 – 43.8 kg)
Maximum take-off mass	472.5 kg
Maximum baggage mass	25 kg
Limits of centre of gravity position	267-375 mm behind the leading edge
Fuel type: (based on flight manual)	95 or Avgas 100LL

1.6.5. Faulty system and equipment information

The batteries of the aircraft and the luggage compartment were situated in the space behind the seats. According to the manufacturer's statement, they equipped the aircraft with two batteries, Aerovoltz make, AVO2-16 model ($LiFePO_4$). According to the manufacturer of the battery, each battery is equivalent with a lead-acid battery with a capacity of 28 Ah, producing starting currents up to 500 Amperes. The manufacturer of the aircraft connected the batteries with each other directly, applying parallel connection. The manufacturer applied no parallel connector or other electrical safety device for the parallel connection used.

The positive and negative branches of the insulated cables of the parallel connection run along each other, placed in a common plastic protective cable sock (Figure 5). The protective cable socks and the cables were fastened together by shrink sleeves at 10 cm from the cable ends.

While examining the wreck in detail, the IC found surfaces typical of metal melting, i.e. signs of electrical short circuit, on the positive and negative branches of the wires which connect the two batteries. The marks of molten metal were located ca. 10 cm from the cable poles at the assumed place of the shrink sleeve (or in its close proximity) which fastens the protective cable sock and the positive and negative cables. The position of the IC is that the short circuit developed as a consequence of the accident.

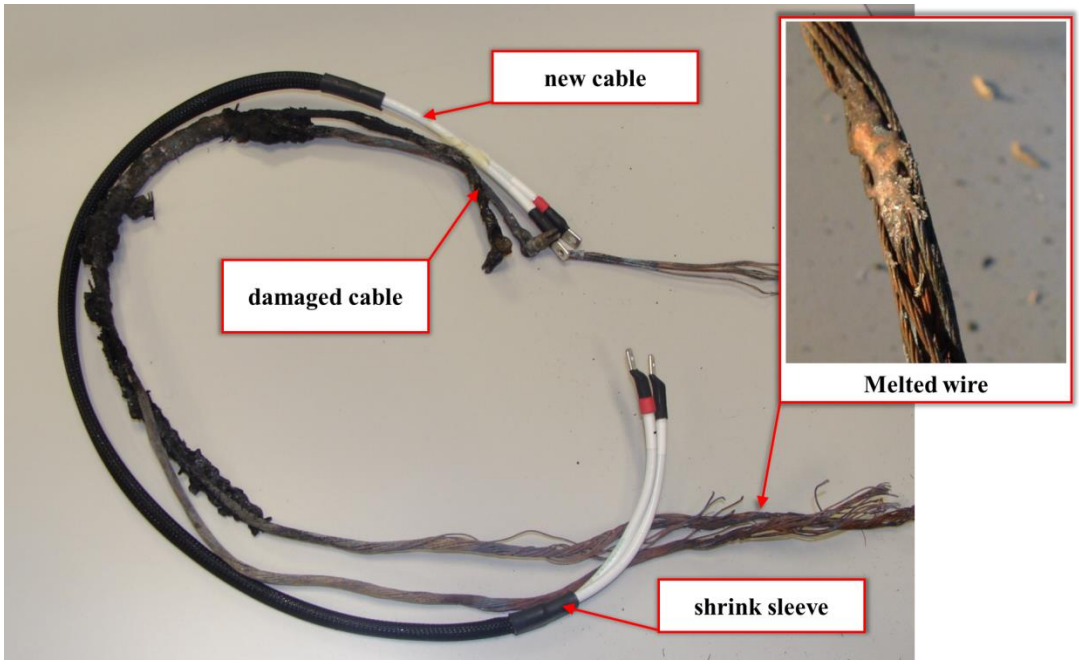


Figure 5: The pair of cables damaged in the accident vs. a new one

1.7. Meteorological information

The weather was clear and dry on the day of the occurrence, with patches of fog in the Transdanubian area in the morning, which then cleared during the day. South-west wind became strong from time to time in the area of the Great Plain and Budapest. The peak temperatures were between 6°C and 15°C.

On 24 December 2014, at 12:30pm LT, the wind direction was 210, with a wind speed of 9 knots, according to the weather report published at Budapest Liszt Ferenc International Airport. Visibility was over 10 kilometres, the temperature of the air was 9°C, and its dew point was 4°C.

1.8. Aids to navigation

The navigation equipment had no effect on the course of events so it needs no further discussion.

1.9. Communications

During flight, the pilot maintained two-way radio contact with the competent aviation information service. The communication equipment had no effect to the occurrence therefore detailing them is not relevant.

1.10. Aerodrome information

The planned destination airport of the second section (Figure 3) of the route was Tököl Airport. The take-off directly preceding the occurrence took place at about 12:45 on 24 December 2014. According to the pilot's statement, he spent 10 to 15 minutes at Jakabszállás airport after landing then he took off again.

Actual landing took place near Kiskunlacháza airport, at about 12:48 on 24 December 2014.

Aerodrome parameters had no effect on the occurrence, so detailing them is not relevant.

1.11. Data recorders

There was no data recorder on-board the aircraft; it is not required for the given aircraft type.

The aircraft was equipped with transponder equipment which was in operation during the occurrence until the pilot turned electricity off. The IC obtained and used the radar image recorded by the air traffic management service.

1.12. Wreckage and impact information

The wreck of the aircraft was found at the location with coordinates N47.16886° and E019.09895°. The area of the emergency landing is a boggy terrain with swampy surface, partly covered with water. The wreck was found in the 302° direction as seen from the point of landing, at a distance of ca. 49 metres. The marks in the terrain show that the aircraft hit the ground with high energy, which is supported by the fact that the nose gear broke out. In its still position, the direction of the aircraft deviated 90° to the left from the direction of landing (Figure 6 and Annex 1).

The burnt-out composite material of the airframe of the aircraft made it extremely difficult to perform further investigation to comprehensively assess the mechanical damage suffered by the aircraft as a consequence of the landing.

On the basis of the investigation of the scene and the detailed analysis of the wreck performed in January 2015, the IC found that the source of the fire was not in the engine compartment. In addition, it was also found that the area most exposed to fire was the space behind the pilot's seat.

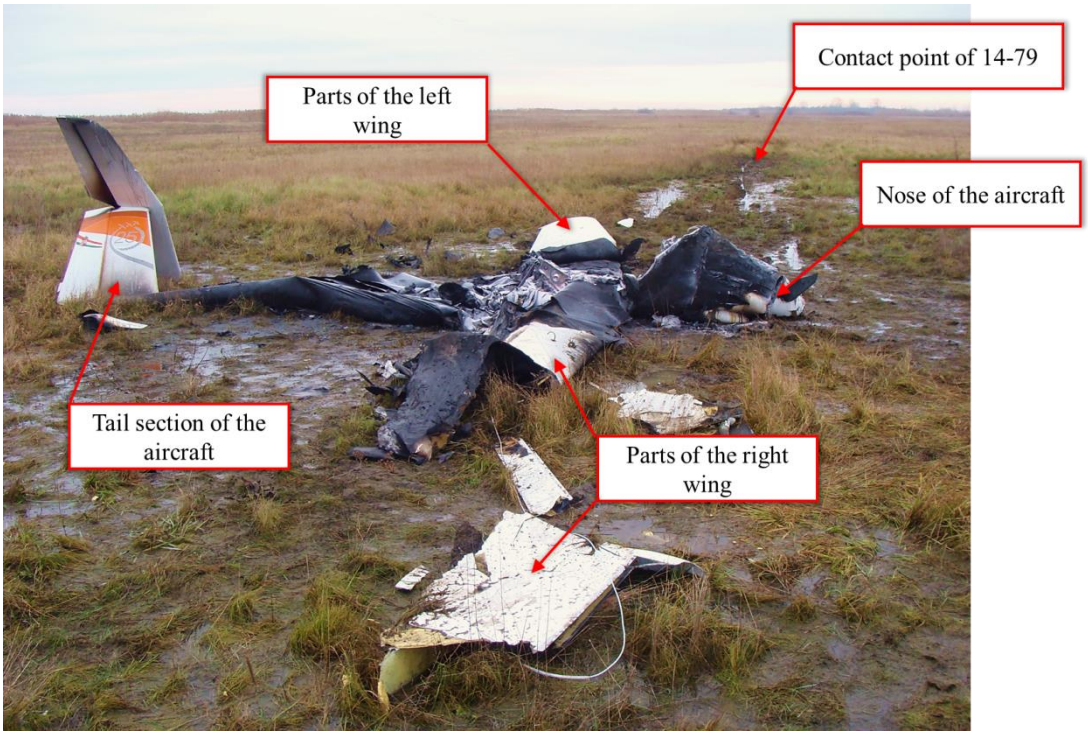


Figure 6: The wreck and the area where it landed

1.12.1. Damage to fuel system

The electrical fuel pump is situated behind the right seat of the aircraft; it is fastened to the bottom of the airframe. During the investigation of the scene, the IC found the fuel pump which was exposed to higher thermal load at the side where the fuel lines connect to it than the opposite side.

The opinion of the IC is that, due to hard landing, leakage developed in that section of the fuel system which is behind the seat. Ignition of the small amount of fuel which leaked into the airframe caused further damage to the fuel system. The larger amount of fuel that spilt subsequently ignited all combustible parts of the aircraft.

1.13. Forensic information

On the basis of the chemical expert opinion received from Hungarian Institute for Forensic Science, the pilot's blood and urine sample showed 0.00 g/l ethanol concentration. According to the discharge note issued on completion of the pilot's hospitalisation, the back of the pilot's right hand suffered serious burn, his right ear and the adjacent area got singed, and his left shoulder got dislocated in the accident. No burn in the respiratory tract was suspected when he was hospitalised, and he had no airway complaints during his stay in hospital.

1.14. Fire

During the flight, the pilot heard a loud bang and then a whistling sound, which was followed by intense white fume in the cabin; the smoke came from the space behind his seat, so he opened the cabin door.

The aircraft burnt out fully after landing (Figure 6).

1.15. Survival aspects

Due to the thick fume and the rise in temperature, the pilot decided to perform emergency landing. In the given situation, he did not know how much time he had before he would get incapacitated or before the suspected on-board fire would cause structural damage that excludes further flight.

According to the pilot's report, he was wearing overall made for air pilots at the time of the accident. Injured in the accident, he walked to Kiskunlacháza Airport, which was about 1 kilometre away, and made an emergency call using a cell phone borrowed from the airport staff.

1.16. Tests and research

During the safety investigation of TSB, the manufacturer of the aircraft performed an overload test of a battery of the type which is used in aircraft similar to that destroyed in the accident, took a video record of it, and made the video available to the IC of TSB. Prior to the test, the manufacturer measured the terminal voltage of the battery used for the test, which was 14.36 V. According to the manufacturer's information the battery used for the test prior to and during the test was fully charged and its temperature was 18-25°C. During the test, the battery was shorted using a cable (silicone-insulated)) which was thicker than the battery linkage cables installed in the aircraft. The battery emitted a considerable amount of smoke at high speed during the test (Figure 7). According to the video record, smoke generation was accompanied by a whistling sound. The shorted battery did not catch fire, nor did its plastic housing crack.

The IC performed detailed inspection of the wreck at the factory in Slovenia, during which a set of socket wrenches, a first aid kit and 7 small Lithium ion batteries (type 18650) were found. According to the pilot's report, the latter were accessories to a handheld electrical screw driver. According to the pilot's report he really stored these items in the luggage compartment. He said he had kept the socket wrench set and the wireless electrical screwdriver so that he could remove and put back the cover plates of the wheels when servicing the landing gear. Each of the batteries found had a nominal capacity of 24.Ah. In its report issued on 26 January 2016, the manufacturer assumes that these batteries might have played a role in the starting of the fire.

The small Lithium ion batteries of the handheld screwdriver were tested for short circuit on 5 March 2018. The test procedure was as follows: the IC created a short circuit involving one battery, and then continuously measured the terminal voltage and the temperature of the battery. The highest temperature thus measured was 96.9°C. The battery did not catch fire during the short circuit, and neither smoke nor acoustic effect was detected. The energy

stored in the battery was consumed in 1.5 to 2 minutes. During the period of load, its terminal voltage dropped so much that it could not be measured. The terminal voltage of the battery measured after the test was 0.17V, i.e. dropped largely as compared to the initial value of 3.6V.

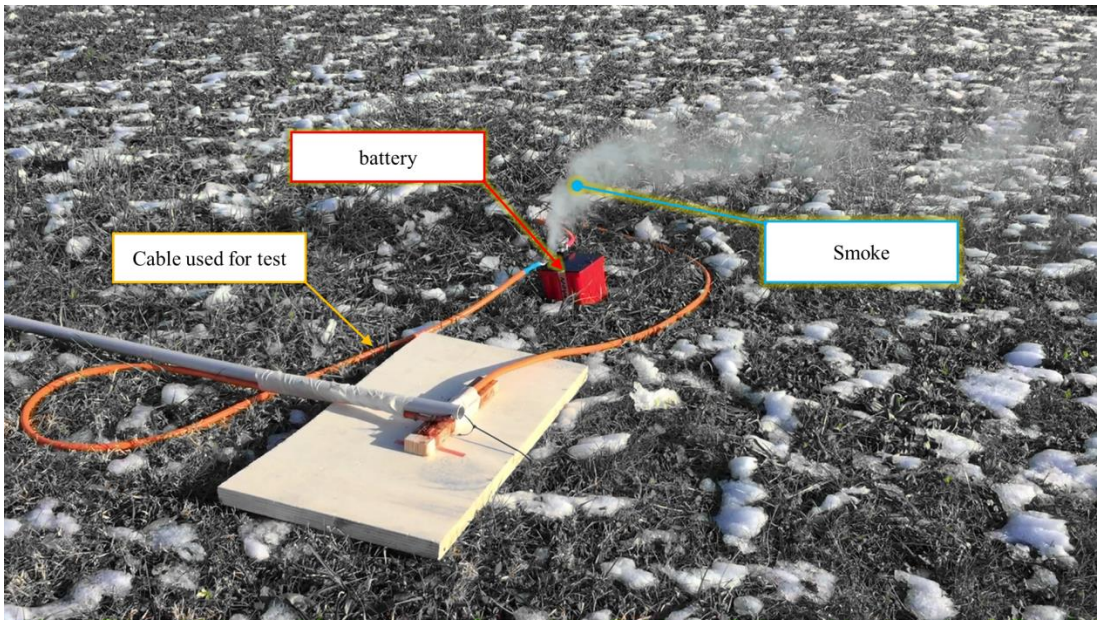


Figure 7: Smoke was emitted by the battery after an electrical short circuit

On 25 August 2018, the IC performed a heat shock test a piece of cable of the same type as the one used to connect the batteries. The test procedure was as follows: a piece of cable was placed, for 2 hours, into an oven pre-heated to 210°C. After the sample was cooled to room temperature, no change was seen, neither by naked eye, nor under a magnifying glass. Its mechanical properties showed no change either, as compared to the initial state. When the cable was pushed into gas flame from the side, its insulation disappeared at the surface which contacted the flame, but no self-sustaining fire was started in the insulation material. The results of the test performed by the IC did not differ significantly from the test values published by the manufacturer. See published data in Annex 3 below.

1.17. Organisational and management information

When visiting the manufacturer, the IC was informed that the manufacturer had no elaborated and approved procedure in place relating to the framework and limits of fulfilling customer needs. According to oral information, the quantity of installation of optional instruments and on-board equipment is limited only by the physical dimensions of the aircraft. Also, they have no procedure relating to the number or array of batteries to be used for given quantities of instruments. In the case of aircraft layouts which differ from default instrumentation the electrical network is designed with individual solutions of which no wiring diagram is drawn up that would be valid for the aircraft of the given serial number. That process was followed also in the case of the aircraft destroyed in the fire.

During the safety investigation, the IC asked the manufacturer for information and data relating to the electrical system of the aircraft, but some of the questions had not been answered by the closing of the investigation.

1.18. Additional information

1.18.1. The cable used between batteries

The cable used to connect the batteries provided for the IC by the manufacturer was type M22759/16-6. The diameter of this cable is ca. 6mm (insulation included), and consists of multi-stranded tinned copper wires and ETFE (ethylene-tetrafluoroethylene) insulation. Its

usual temperature range of operation is between -55°C and 150°C. Its insulation resists mechanical and chemical impacts very well and also has good fire resistance capability.

1.18.2. Parallel connection of batteries

The aircraft destroyed in the accident was manufactured in the Slovenian factor where it was equipped with two type Aerovoltz AVO2-16 batteries, each with a capacity equalling that of a 28 Ah lead-acid battery, producing up to 500 Ampere starting current, and the batteries were connected in parallel, without a control/protection unit.

The batteries need to be connected in parallel if the amperage of the output current must be increased. The combined amperage of the output current of the batteries connected in this manner equals the total of the added up ampere values of the output current of each battery.

When applying connection in parallel, care must be taken to connect batteries with the same characteristics (identical physical and electrical properties), and to install a control/protection unit between them. Otherwise connection will cause damage.

According to the manufacturer's declaration and the wiring diagram sent, the manufacturer installed no protection against overload or any other protection between the batteries connected in parallel.

During the safety investigation, the manufacturer did not tell the IC which of the aircraft manufactured by them had an electrical system containing batteries connected in parallel.

1.18.3. Aircraft equipment

When buying the aircraft, the owner requested the manufacturer to install extra on-board equipment in addition to the standard items. Table 1 shows the list of the optional electric power consumers installed accordingly. The manufacturer added an additional battery to the electrical system, placing it at the right hand side of the space behind the pilot.

Table 1

Electrical equipment	**Type**
2 x Dynon Skyview	SV-D1000 T
Auto Pilot Servo1	Dynon Sv32
Auto Pilot Servo2	Dynon Sv42
GPS Skyview	SV-GPS-250
AdaHRS Skyview	Sv-Adahrs-200
Flarm – ADBS	Garrecht TRX-2000
Dynon Modul	SV-EMS-221
Transponder	Dynon SV-xpndr-281
Radio	Funke ATR 833

1.18.4. Electrical feedback of on-board instruments

According to the User Guide of the SkyView Touch (SV-D1000 T) on-board instrument,[3] the instrument indicates the voltage and amperage of the electrical system on a continuous basis. Should any parameter value go outside the limits, the equipment will give an acoustic signal and display a caution with the appropriate label: "*Electrical Current HIGH*" or "*Electrical Current LOW*" or "*Voltage HIGH*" or "*Voltage LOW*".

[3] SkyView Touch Pilot's User Guide, Document 101321-025, Revision Z

1.18.5. Prior flights

The owner had his aircraft transported in disassembled state. Prior to the accident, he did not perform any flight lasting longer than about half an hour. His first longer flight was the one which ended up in an accident, and all the items of the electrical equipment on-board the aircraft were in operation simultaneously.

1.18.6. Construction standard applied with the aircraft

According to the manufacturer, they applied the Standard № ASTM2639 for the electrical systems during manufacture. According to that standard,

Power Feeder

They shall be given special protection to prevent potential chafing against other wiring aircraft structure, or components.

9.7.1.1 Philosophy of Aircraft Circuit Protection—For reliable circuit protection, the design shall provide automatic protection that will limit a fault to single circuit and more importantly minimize the danger of smoke and fire not only to the component but also the conductors (or cables) leading to and from the component. The primary consideration shall be the protection of the conductors or cables. Furthermore, the protection shall be capable isolating the fault from the power source so that nonfaulted circuits can be kept functioning in a normal manner. This is an essential safety of flight requirement. These objectives may not always be achieved by a single protective device, but by a combination of devices, wire size, and routing. Circuit designers shall use every means available to accomplish optimum protection. For example, correct sizing of wire and safe routing shall contribute to the overall circuit protection philosophy. Considerations for maintenance, inspection, and continued airworthiness shall be an integral part of the design philosophy.

Circuit protection devices shall be sized to supply open circuit capability. Proper selection should normally result in a protective device with the lowest standard rating that will not open inadvertently. It shall interrupt the fault or overload current by disconnecting the faulted line from the power distribution system before wire fusing, insulation damage, or other system damage occurs. Conventional circuit breakers shall be of the push-pull type to facilitate periodic cycling the breakers to remove contaminants from the contacts.

III. Electrical systems and equipment

LTF-UL 1365 Electric cables and equipment

1. Each electric connecting cable must be of adequate capacity and correctly routed, attached and connected so as to minimize the probability of short circuits and fire hazards.

1.18.7. Aircraft flight manual

According to the emergency chapter of the Flight manual and Maintenance manual [4] in effect at the time of the occurrence:

Smoke in cockpit

Smoke in cockpit is usually a consequence of electrical wiring malfunction. As it is most definitely caused by a short circuit it is required from the pilot to react as follows:

1. Master switch to I (key in central position) - or Avionics OFF. This enables unobstructed engine operation while at the same time disconnects all other electrical devices from the circuit. Verify that the 12 V and Pitot heat are OFF as well.

2. Disconnect the battery from the circuit (pull battery disconnection ring on the instrument panel's switch column)

3. Land as soon as possible.

[4] Flight manual and Maintenance manual, REV. 3 (28 September, 2010)

In case you have trouble breathing or the visibility out of the cockpit has degraded severely due to the smoke, open the cabin door and leave it hanging freely. Flying with the door open, do not, under any circumstances exceed 90 km/h (50 kts).

Flight manual and Maintenance manual[5] of the aircraft requires the following procedure for emergency landing:

Emergency landing / Landing out

1. Shut both fuel valves

2. Master switch OFF.

3. Approach and land with extreme caution, maintaining proper airspeed.

4. After having landed abandon the aircraft immediately.

The landing out manoeuvre MUST be performed with regard to all normal flight parameters.

According to the service and maintenance chapter of the Flight manual and Maintenance manual[5], the owner is entitled to service and replace the batteries. The Flight manual and Maintenance manual specifies 12V and 11Ah values for the batteries.

1.18.8. De-energising the aircraft

The electrical system of the type Pipistrel Virus SW aircraft was designed in such manner that the powers supply to all electrical power consumers can be shut off by pulling a ring located on the instrument panel.

1.18.9. Research and rescue

According to the Decree № 16/2000 (XI. 22.) KöViM in effect at the time of the occurrence:

4.1.2. Alerting service shall be provided for:

a) all aircraft provided with air traffic control service;

b) all aircraft having filed a flight plan, after receiving information on their operation, until their closing of their respective flight plans;

c) all known aircraft participating in the traffic of airports with an AFIS unit; and for

d) any aircraft known or believed to be the subject of unlawful interference.

Note: Detailed rules of providing alert services by ATS units are specified in Chapter 9 of Annex 2 to this Decree.

Pursuant to SERA.10001 Section 10 Annex to Commission Implementing Regulation EU No 923/2012 (hereinafter: "SERA") in effect at the time of the closing of the investigation:

(a) Alerting service shall be provided by the air traffic services units:

(1) for all aircraft provided with air traffic control service;

*(2) in so far as practicable, to all other aircraft having filed a flight plan or otherwise known to the **air traffic services**; and*

(3) to any aircraft known or believed to be the subject of unlawful interference.

[5] Flight manual and Maintenance manual, REV. 3 (28 September, 2010)

According to Article 2 of SERA:

*'**air traffic service (ATS)**' means a generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service);*

Subsection (2), Section 18 of Decree № 56/2016 (XII. 22.) NFM on the Rules of the Air within the Aerodromes of Hungary in effect at the time of the closing of the investigation says:

"Air traffic service, including taking the actions necessary when an aircraft is in emergency or lost as well as starting search and rescue as soon as possible, shall be provided for the aircraft if it filed a flight plan to the ATS unit previously.

1.18.10. Burning of the fuel and of structures made of composite

According to a document addressing the burning of aircraft structures made of composite material,[6] Epoxy plastics resist an ignition temperature of 400°C. It may be stated in general that most of the epoxy plastics used in the aviation industry have good thermal insulation properties, and that they emit thick, black and highly toxic fumes when burning.

When kerosene is ignited in the open air, first its vapour burns. This burn is fast, produces a lot of heat, and produces hardly any fume. Soot will float in the air after the fire is out. Next, the emitted vapour will burn on the surface of the kerosene puddle. The amount of the fume depends on the amount of available oxygen; its fume is dark and occasionally contains a considerable amount of soot.

1.18.11. Service bulletins issued by the manufacturer

In its Service Bulletin № SB-100-004 A.02 issued on 12 May 2017, the manufacturer of the aircraft provides for mandatory disconnection or removal of the second battery (See Annex 4) for all Virus SW aircraft if such aircraft is equipped with two $LiFePO_4$ batteries connected in parallel.

On 27 June 2017, the manufacturer of the aircraft issued a non-mandatory service bulletin (№SB-100-006 LSA A.00, see Annex 5) for the aircraft specified in the aforesaid Service Bulletin № SB-100-004 A.02. In the case that two batteries need to be installed in the aircraft, the manufacturer requires installation of a specific battery type (selected by the manufacturer) which contains appropriate protective elements.

1.19. Useful or effective investigation methods

TSB started a safety investigation under № 2011-160-4P to reveal the cause of the aviation accident which took place on 3 August 2011. The investigation revealed that divergence can be seen between the texts of Chapter 4 Alerting Service in Annex 1 to Decree № 16/2000 (XI. 22.) KöViM on the Rules of the Air within the Aerodromes of Hungary and Chapter 5 Alerting Service in Annex 11 Air Traffic Services 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. In order to exclude diverging provisions, TSB issued a safety recommendation under № BA2011-160-4P-1 on 10 September 2013.

[6] COMPOSITE MATERIAL FIRE FIGHTING, Federal Aviation Administration – US, 2009

2. Analysis

2.1. Possibility of electrical fire

In a set of two batteries connected in parallel if the charge level or capacity of the one is different from the other, then the battery which is in better state will work in charge equalisation mode. Added to the power uptake of all electrical consumers connected and turned on, this process may generate a significant extra load which may exceed the ratings of the system.

On the basis of the contents of Chapters 1.16 and 1.18.1, the IC excluded the possibility that the cables running parallel (and providing parallel connection of the batteries) could have been damaged by friction caused by rubbing of the cables with each other or with the airframe, and accordingly, the possibility of short circuit due to damage by friction as well. According to information presented in Chapter 1.6.5, the electrical short circuit (melt) occurred either at the assumed location of the shrink sleeve on the cables connecting the two on-board batteries or in its close proximity. During the experiments performed by the IC with the electrical cable which connects the two batteries, the insulation of the cable was only damaged as an effect of naked flame (see Chapter 1.16 above).

The position of the IC is that, during the flight leading to the accident, one of the two batteries connected in parallel behaved like the battery which was exposed to short circuit during the short circuit test (see Chapter 1.16 above) performed by the manufacturer of the aircraft.

According to the pilot's report, he only detected white fume during the flight, which allowed the IC to conclude that the composite structure of the aircraft was not on fire in that period. On the basis of the pilot's report, the conclusion drawn by the IC, and those presented above, the battery system which malfunctioned in the occurrence could not deliver sufficient amount of thermal energy to ignite the composite structural elements of the aircraft.

The arc discharge found on the cables used for parallel connection (Chapter 1.6.5) might have occurred as an effect of considerable external heat, during which the insulation of the cable was damaged. According to the opinion of the IC, such considerable external (i.e. not coming from an electricity malfunction) heat was provided by the burning fuel. The safety investigation brought no clear evidence relating to how the fuel system of the aircraft had got leaked as a consequence of the high-energy impact with the ground and how the powered section of the electrical system had ignited spilt fuel.

During the investigation, the IC excluded the possibility that (in the case of a possible short circuit) the batteries of the handheld screwdriver on-board at the time of the occurrence (see Chapter 1.16) could have provided sufficient heat to damage the structure of the aircraft.

2.2. Pilot activity and survival aspects

According to radar information obtained, the pilot was flying from Jakabszállás toward Tököl at an altitude of 2900 ft. Radar data shows that, when approaching Kiskunlacháza Airport, the pilot began to descend at 12:45:21, and simultaneously, he turned left of the direction of flight and flew in the direction of Kiskunlacháza Airport (Figure 8).

The position of the IC is that the intense spread of the fume distracted the pilot from controlling the aircraft to such extent that he could not pay sufficient attention to the landing manoeuvre. This and the unsuitable terrain chosen for landing caused the primary damages to the structural elements of the aircraft.

The pilot's shoulder injuries suffered in the accident support that he was holding the open door at the moment of touch down. Relying on forensic data, the IC supposes that the pilot suffered his burn injuries after touch down, during his leaving the aircraft. The burn injuries behind the pilot's right ear support the supposition of the IC that the pilot was not wearing his headset already when the blaze started. Due to the injury of his left shoulder, the pilot

was able to use his right hand only to leave the aircraft; accordingly, his right hand was probably more exposed to the fire. According to the position of the IC, the pilot would have left the aircraft with injury to his respiratory tract if the aircraft had been blazing fiercely already in the air or right after touch down.

The legal contradiction between the regulations mentioned in Chapter 1.18.9 and in the safety recommendation (BA2011-160-4P-1) in Chapter 1.19 relating to the initiation of search and rescue action existed before and at the time of the occurrence, and had not been resolved by the time of the closing of the investigation.

With reference to the SERA paragraph presented in Chapter 1.18.9, the position of the IC is that, due to the fact that the pilot contacted the competent air traffic services unit, such unit took notice of the aircraft, and thus, they should have provided alerting service for such aircraft. The time which elapsed between notification to the rescue units and the start of the radio contact was not sufficient to evoke the commencing of alert on the part of the air traffic services.

On the basis of the facts that the pilot turned his aircraft in the direction of the nearby airport and did not start emergency landing after detecting smoke, and that he de-energised the aircraft one minute after detecting smoke, the IC concludes that the situation was worsening gradually as compared to the initial moment of the occurrence.

The pilot's chances for survival were reduced by low temperatures of the atmosphere and the water covering the swamp and by his having to walk on his own a relatively long distance to get help.

The pilot's chances for survival were increased by the fact that his injuries did not prevent him from leaving the aircraft and getting help on his own.

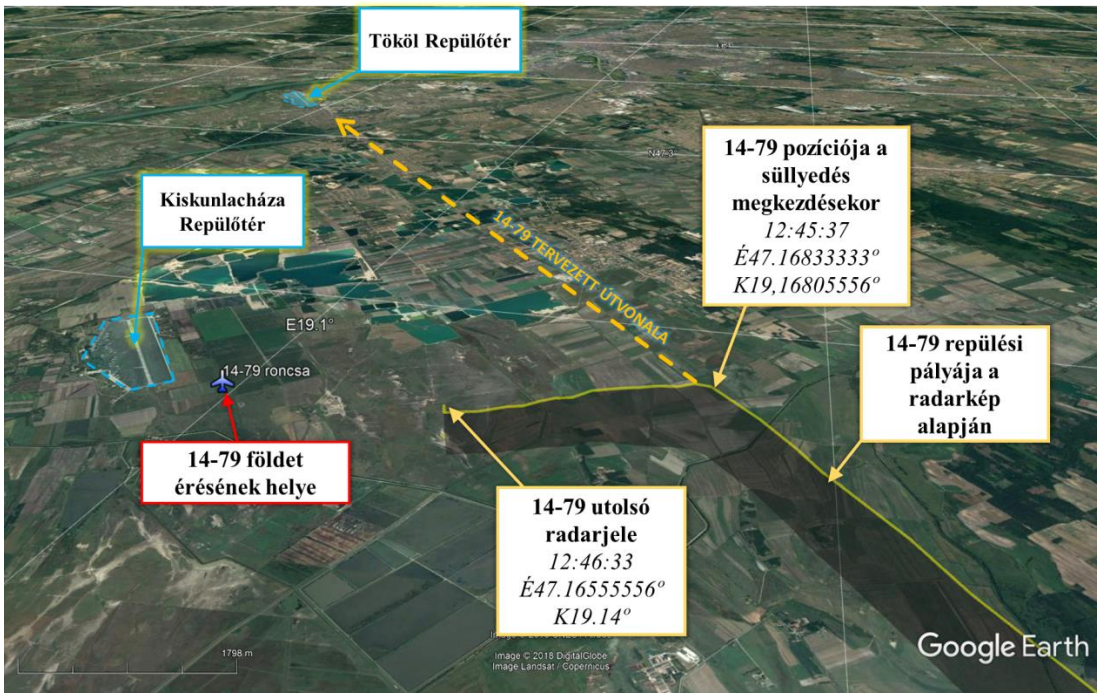


Figure 8: The last section of the flight path of the aircraft with reg. mark 14-79 on the basis of the radar image (source of map: Google Earth)

2.3. The process of development of the fire

According to the hypothesis of the IC, which is based on the information gathered during the investigation, the process of destruction of the aircraft with reg. mark 14-79 took place as follows:

- Malfunction of a battery cell was detected as noise and smoke, and interpreted as a starting on-board fire, by the pilot;
- The pilot modified his flight by turning in the direction of Kiskunlacháza Airport, and decided to perform emergency landing when the smoke began to get thicker, and landed as soon as possible in an area which seemed appropriate;
- The IC does not know the extent of damage caused by the landing to the aircraft but it was significant on the basis of the traces;
- Structural damage to the aircraft was accompanied by a minor leakage of the fuel system;
- As a result of leakage, a small amount of fuel spilt in the behind the pilot's seat where the pair of batteries, connected in parallel, were also situated. The system, which was isolated from all on-board electrical systems but contained a malfunctioned battery in configuration of parallel connection, ignited the vapour of the fuel spilt in its proximity. This is also supported by the pilot's burn injuries suffered in the accident. According to the IC's opinion, the pilot was injured either right before or during his leaving the aircraft.
- The fire of the ignited fuel further damaged the structural elements of the aircraft as well as the insulation of the cable pair connecting the batteries in parallel;
- The cables connecting the batteries were heated and part of their insulation melted;
- In the case of the cables of opposite polarity running immediately along each other, the insulation, which melted at a point, lost its isolating function and allowed an electric arc to occur. That caused the damage, typically the mark of short circuit, in the pair of cables of the parallel connection (see Chapter 1.6.5).
- The heat of the fuel which leaked from the fuel system and began to burn ignited the composite airframe.

2.4. Layout of the electrical system of the aircraft

According to the pilot's statement, when he detected the thick fume and saw the warnings on the on-board instruments, he de-energised the aircraft. Shut-off of the electrical system does not isolate the two batteries from each other, i.e. the risk of a short circuit is still there.

In the opinion of the IC, if a circuit protection device had been installed between the two batteries, which were connected to each other directly, then the risk of malfunction of the batteries and formation of a short circuit would have decreased considerably.

In the opinion of the IC, batteries connected in parallel without circuit protection are not safe, which is also supported by the standard (referred to in Chapter 1.18.6) followed by the manufacturer.

In order to assist assembly, the factory provides assemblers with a set of wiring diagrams for the standard equipment of its aircraft, which does not include a process of selecting a standard wiring diagram adjusted to specific equipment demand.

3. Conclusions

3.1. Factual statements

The occurrence was evoked by malfunction of one of the batteries installed behind the pilot's seat.

Ignition of the airframe did not occur in flight.

Damage to the airframe was caused by high-energy impact with the terrain.

The airframe was ignited by the burn of spilt fuel.

The most intense fire occurred in the space behind the seats.

The pilot suffered burn injuries after the aircraft hit the ground.

The pilot had appropriate licence and ratings and sufficient experience for the given flight task at the time of the occurrence.

During the pre-flight inspection on the ground, the aircraft was found airworthy. The aircraft had a valid airworthiness certificate.

The take-off weight of the aircraft was within limits. The aircraft was fuelled sufficiently for the flight.

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

During the investigation, the IC found electric cables which connected the two batteries, and the cable surfaces showed a molten area which was a consequence of the fire which had started before.

According to the manufacturer's statement, the second batter installed in the aircraft was connected in a parallel configuration. The manufacturer applied no parallel connector or other safety device when connecting the two batteries. The whole electrical system of the aircraft did not comply with the standard the manufacturer referred to.

The batteries of the handheld electrical screwdriver did not contribute to the occurrence.

The manufacturer did not have a procedure in place which would clearly specify the layout of the electrical system.

3.2. Causes of the accident

As an outcome of the investigation, the IC concludes that the cause of the occurrence was that smoke was formed in the aircraft due malfunction of the battery system, which the pilot interpreted as fire on board.

4. Safety recommendations

4.1. Actions taken by the manufacturer during the safety investigation

Relating to on-board batteries, the manufacturer of the aircraft issued the service bulletins mentioned in Chapter 1.18.11.

The manufacturer of the aircraft, upon receiving the draft report, informed the IC that Standard Practice for Design, Alteration and Certification of Aircraft Electrical Wiring System manual was developed which was issued on 18 March 2019.

By its letter of 20 March 2019, the manufacturer of the aircraft informed the IC that an electrical load analysis should be performed for each aircraft leaving production in order to verify power consumption and generation balance.

After evaluation of the manufacturer's action, the IC withdraws its Safety Recommendation № BA2014-511-4-2 included in the Draft Report sent by the IC.

4.2. Safety recommendation issued after the investigation

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

BA2014-511-4-1: *During its safety investigation, the Investigating Committee of Transportation Safety Bureau found that there is contradiction between the respective paragraphs relating to search and rescue of aircraft in* Commission Implementing Regulation EU No 923/2012 and Decree № 56/2016 (XII. 22.) NFM. *For this reason:*

> **Transportation Safety Bureau recommends the Minister for Innovation and Technology, as the minister responsible for transport, to consider amendment of the national regulations to ensure harmonisation of legislation.**

The opinion of the IC is that, in the case of accepting and implementing this recommendation, the text in the relevant regulations would become unambiguous and offer one interpretation only.

Budapest, 10 April 2019

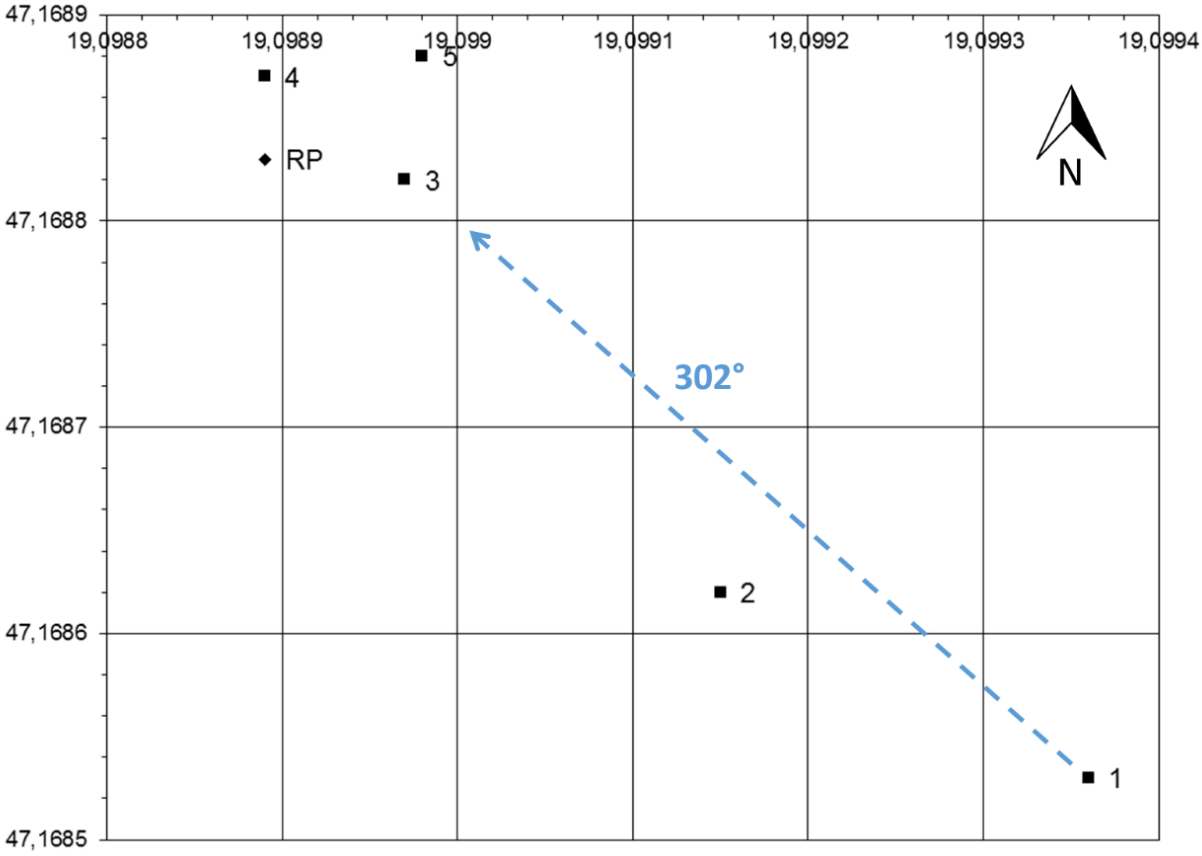
.....
Zsigmond Nagy
Investigator-in-charge

.....
Miklós Ferenci
IC Member

.....
Gábor Erdősi
IC Member

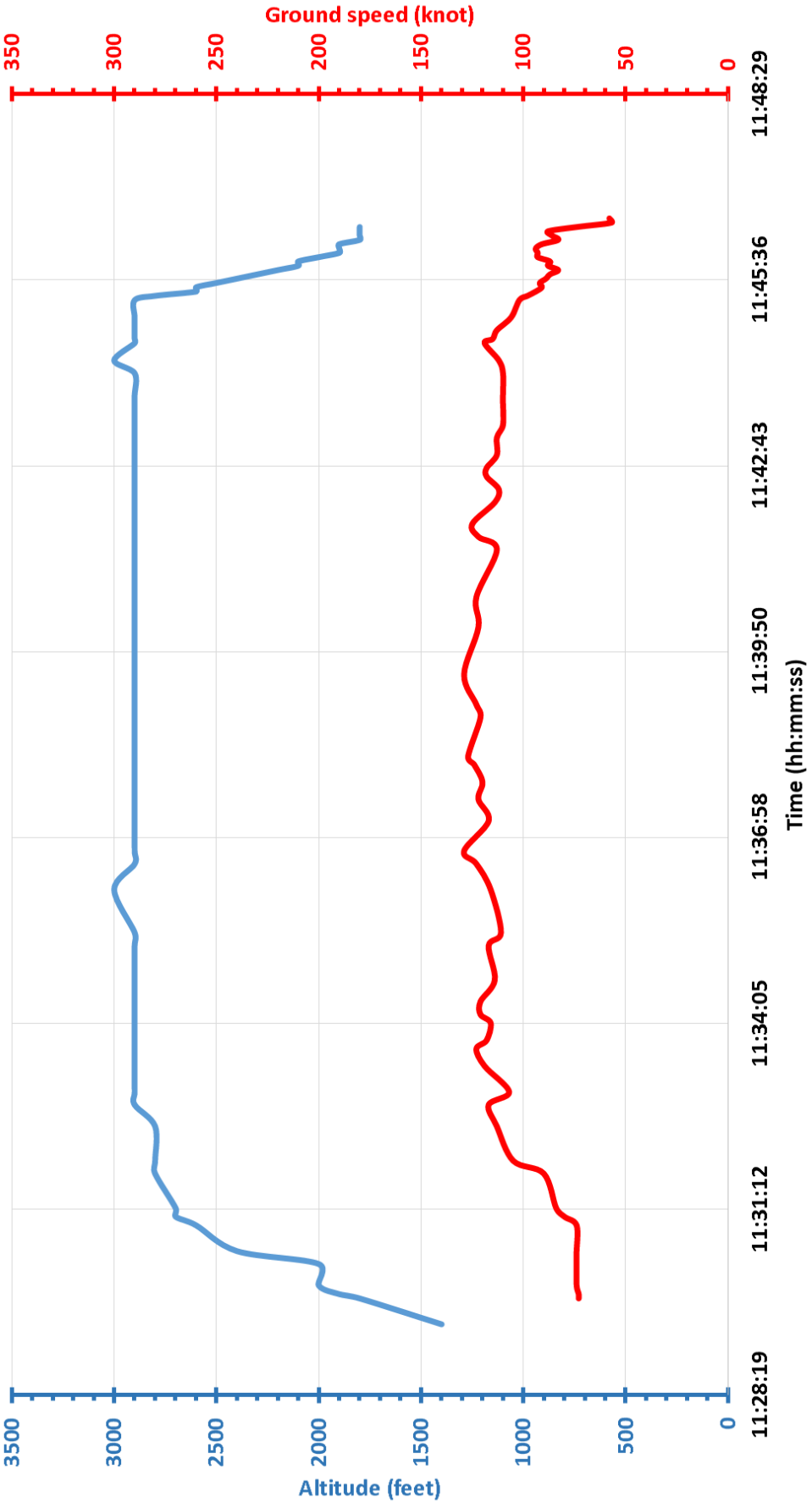
ANNEXES

Annex 1: Diagram of the scene



(RP – aircraft heading, 1 – traces of landing, 2 – spot where nose gear was found, 3 – left wing tip, 4 – right wing tip, 5 – tail piece)

Annex 2: Flight data recorded by radar



Annex 3: Test data of the cable of Serial № M22759/16

Source: www.glenair.com

Table II: Test Data	
Temperature Rating	150° C (302° F) max conductor temperature
Voltage Rating	600 volts (rms) at sea level
Short Term Thermal Stability	7 hours at 230 ± 2° C (446 ± 3.6° F). Quality conformance test, group II; test procedures and requirements as in life cycle test except for time and temperature of oven exposure.
Spark Test of Primary Insulation	not required
Impulse Dielectric Test	100% test, 8.0 kilovolts (peak)
Insulation Resistance, Initial	24 AWG through 14 AWG: 5,000 megohms for 1000 ft (min) 12 AWG through 6: 3,000 megohms for 1000 ft (min) 4 AWG through 00: 2,000 megohms for 1000 ft (min)
Wrap Test	"wrap back" test required, no cracking. Oven temperature: 200 ± 2°C (392 ± 3.6° F)
Blocking	200 ± 2° C (392 ± 3.6°F)
Shrinkage	0.125 inch max at 200 ± 2° C (392 ± 3.6° F)
Wicking	no requirement
Low Temperature (Cold Bend)	bend temperature: -65° ± 2° C (-85 ± 3.6° F) dielectric test: 2,200 volts (rms), 60 Hz
Thermal Shock	oven temperature: 150 ± 2° C (302 ± 3.6° F) max change in measurement: 24 AWG through 12 AWG: 0.060 inch 10 AWG through 8 AWG: 0.100 inch 6 AWG through 00 AWG: 0.125 inch
Flammability	vertical flame test; 2 seconds (max) after-flame, 5.50 in (max) burn length. Post-flame dielectric test not required.
Life Cycle	oven temperature 200 ± 2° C (392 ± 3.6° F) dielectric test: 2,200 volts (rms), 60 Hz
Dielectric Test After Immersion	2,200 volts (rms), 60 Hz
Acid Resistance	no requirement
Conductor Strand Adhesion Requirements	shall be in accordance with 3.6.11 of MIL-W-22759
Abrasion Resistance After Immersion	no requirement
Humidity Resistance	after humidity exposure, wire shall meet the requirements for initial insulation resistance.
Surface Resistance	24 AWG through 12 AWG: 500 megohm-inches (min) initial and final readings 10 AWG through 00 AWG: no requirement
Smoke	200° C (392° F)
Color	in accordance with MIL-STD-104, class 1; white preferred
Color Striping or Banding Durability	125 cycles (250 strokes) minimum, 500 grams weight
Identification of Product	Required
Identification Durability	125 cycles (250 strokes) minimum, 500 grams weight
Wire Length Requirements	schedule A

Annex 4: Service Bulletin № SB-100-004 A.02

PIPISTREL SLO.DOA.002	Service Bulletin	Document-No.: SB-100-004
	Service Bulletin No.: SB-100-004	Issue: A.02
	Disconnection of all second LiFePO4 batteries	Page: 1 of 4

Disconnection of all second LiFePO4 batteries

Category: MANDATORY

Subject: Disconnection of all second LiFePO4 batteries

Affected Aircraft s.n.: All Sinus, Virus, Virus SW and ALPHA trainer aircraft that have two LiFePO4 batteries installed

Time of Compliance: Immediate.

Reason: To prevent any chance of a short circuit occurring and causing potentially dangerous current surges

Actions: Disconnect the second LiFePO4 battery and, if desired, remove it

Documents: N/A

Required Material: N/A

Mass and Balance: Must be redetermined only if the second battery is removed from the aircraft

Required Records: Compliance with this Service Bulletin must be recorded in the aircraft's documentation and confirmed by submitting the provided and completed Service Bulletin Compliance Sheet (Attachment) to Pipistrel.

Revision history:

Issue	Alteration	Affected Pages	Date
A.01	Initial Issue	All	04.05.2017
A.02	Third battery configuration added, accomplishment instructions amended	All	12.05.2017

Verified and approved under the authority of DOA-No.: SLO.DOA.002

Date: 12.05.2017

PIPISTREL d.o.o. AJDOVŠČINA

Head of Airworthiness
Design Organisation SLO.DOA.002

Date: 12.05.2017

Reason:

Concern has been raised about the use of two LiFePO4 batteries on Pipistrel aircraft. Instances of abnormal behavior and testing indicate that short circuits can occur and cause potentially dangerous current surges, if any of the batteries individual cells self-discharge to sufficiently low levels.

Accomplishment instructions:

To prevent any potentially dangerous battery failures, immediate disconnection of the second LiFePO4 battery is required.

NOTE: Disable the batteries using the switch/pin found at the bottom of the switch panel before carrying out any of the work outlined below.

There are three different battery configurations that this Service Bulletin applies to.

Disconnecting the second LiFePO4 battery: one aft battery, one forward battery and tandem switch installed

In those aircraft that have one battery located in the cabin behind the instrument panel, one in the luggage compartment and a tandem switch installed, the positive and negative cables need to be disconnected from the AFT battery. Once disconnected, they must be fastened to something with tape or plastic ties, to prevent them from shifting and/or moving around during aircraft operation. More importantly, the cable terminals, as well as the battery terminals, must be thoroughly insulated/protected to prevent them from touching components/installations nearby. After the cable is disconnected, the second battery can either be left where it is or removed. Only the later requires redetermining the aircraft's weight and balance.

NOTE: For this configuration the tandem switch MUST be left ON at all times subsequent to the implementation of this SB. When gliding, aircraft operators must pay special attention to voltage levels to ensure restarting the engine is always possible.

Disconnecting the second LiFePO4 battery: one aft battery and one forward battery installed WITHOUT tandem switch

In those aircraft that have one battery located in the cabin behind the instrument panel, one in the luggage compartment and NO tandem switch installed, the positive and negative cables need to be disconnected from the AFT battery. Once disconnected, they must be fastened to something with tape or plastic ties, to prevent them from shifting and/or moving around during aircraft operation. More importantly, the cable terminals, as well as the battery terminals, must be thoroughly insulated/protected to prevent them from touching components/installations nearby. After the cable is disconnected, the second battery can either be left where it is or removed. Only the later requires redetermining the aircraft's weight and balance.

Disconnecting the second LiFePO4 battery: dual aft battery configuration

In those aircraft that have both batteries located in the luggage compartment, the positive and negative cables need to be disconnected from the second battery (see Figure 1). Once disconnected, they must be fastened to something with tape or plastic ties, to prevent them from shifting and/or moving around during aircraft operation. More importantly, the cable terminals, as well as the battery terminals, must be thoroughly insulated/protected to prevent them from touching components/installations nearby. After the cable is disconnected, the second battery can either be left where it is or removed. Only the later requires redetermining the aircraft's weight and balance.

Figure 1

Personnell and site requirements:

Personnell: No special requirements, can be accomplished by owner, who is also a licensed pilot

Other publications: N/A

Manhour estimation: 1 hour.

Additional Questions?

Pipistrel is currently exploring its options as to how to restore the dual-battery configuration. Until a solution is found, all questions relating to this SB can be forwarded to Pipistrel Maintenence department via telephone: +386 5 364 38 83 or email: leon.brecelj@pipistrel.si

END OF SERVICE BULLETIN.

Prepared:	Verified:	Approved:	Replaces issue:
A. B. Horvat	T. Tomazic	V. Plevnik	A.01

PIPISTREL	Service Bulletin	Document-No.: SB-100-004
	Service Bulletin No.: SB-100-004	Issue: A.02
SLO.DOA.002	Disconnection of all second LiFePO4 batteries	Page: 4 of 4

Service Bulletin Compliance Sheet

Please complete this page and send it to Pipistrel

The Service Bulletin mentioned above was incorporated:

Date:

Aircraft S/N:

Registration:

Owner:

Comments (Difficulties encountered, deviations, recommendations, etc.):

Prepared:	Verified:	Approved:	Replaces issue:
A. B. Horvat	T. Tomazic	V. Plevnik	A.01

Annex 5: Service Bulletin № SB-100-006 LSA A.00

PIPISTREL	Service Bulletin	Document Number
		SB-100-006 LSA
		Issue: A.00
Pipistrel LSA s.r.l. Via Aquileia 75 34170 Gorizia, Italy, EU www.pipistrel.eu Phone: 0481 522000	Battery installation recommendations	Supersedes Doc. Number
		N/A
		Page 1 of 5

Aircraft make	Aircraft model	Affected serial numbers
PIPISTREL	**Sinus, Virus, Virus SW and ALPHA trainer**	**See cover page**
Date of issue	Date of effect	Date of required corrective action
27 June 2017	27 June 2017	N/A

Battery installation recommendations

Category: INFORMATION/RECOMMENDATION

Subject: Battery installation recommendations for all Sinus, Virus, Virus SW and ALPHA trainer aircraft, especially those affected by SB-100-004 LSA A02

Applies to: Alpha Trainer: all.
Sinus, Virus, Virus SW: all

Time of Compliance: N/A

Reason: See SB-100-004 LSA A02

Actions: Battery upgrade/replacement

Documents: ETX Lithium Battery User's Manual 111017_R

Required Material: N/A

Mass and Balance: Insignificant effect

Required Records: Installation of ETX 680 C to be logged in the aircraft's documentation.

Verified and approved under the

authority of DOA-No.: SLO.DOA.002 Digitally signed by Tine Tomazic

Head of Airworthiness

Design Organisation SLO.DOA.002

Digitally signed by Vid Plevnik

PIPISTREL	Service Bulletin	Document Number SB-100-006 LSA Issue: A.00
Pipistrel LSA s.r.l. Via Aquileia 75 34170 Gorizia, Italy, EU www.pipistrel.eu Phone: 0481 522000	Battery installation recommendations	Supersedes Doc. Number N/A Page 2 of 5

Aircraft make	Aircraft model	Affected serial numbers
PIPISTREL	**Sinus, Virus, Virus SW and ALPHA trainer**	**See cover page**
Date of issue	Date of effect	Date of required corrective action
27 June 2017	27 June 2017	N/A

Reason:

Since releasing SB-100-004 LSA A02, Pipistrel has determined that the **EarthX ETX 680 C LiFePO4** battery is a suitable replacement for the **Aliant LiFePO4** batteries found in its aircraft. The ETX 680 C's integrated battery management system protects it from over discharge, over charge and short circuit. It incorporates thermal protection and cell balancing. Lastly, it fits nicely into Pipistrel's battery holders/boxes for Aliant LiFePO4 batteries, making it a drop-in replacement.

NOTE: The contents of this SI DO NOT apply to aircraft with Aerovoltz LiFePO4 batteries or a tandem switch installed.

Any operators that wish to replace their single (aft or fore) battery OR restore dual battery configuration (dual aft or one aft/one fore) with the ETX 680 C, can to do so following the *ETX Lithium Battery User's Manual 111017_R* and the accomplishment instructions found in this SI.

NOTE: The EarthX ETX 680 C is currently the only battery approved by Pipistrel d.o.o Ajdovščina for use in dual LiFePO4 battery configurations. All aircraft with dual LiFePO4 battery configurations that incorporate a battery OTHER THAN the EarthX ETX 680 C must adhere to SB-100-004 LSA A02.

Accomplishment instructions:

NOTE: Disable the batteries using the switch/pin found at the bottom of the switch panel before carrying out any of the work outlined below.

NOTE: Please refer to the ETX Lithium Battery User's Manual 111017_R for additional installation guidance/instructions.

PIPISTREL	Service Bulletin	Document Number
		SB-100-006 LSA
		Issue: A.00
Pipistrel LSA s.r.l. Via Aquileia 75 34170 Gorizia, Italy, EU www.pipistrel.eu Phone: 0481 522000	Battery installation recommendations	Supersedes Doc. Number
		N/A
		Page 3 of 5

Aircraft make	Aircraft model	Affected serial numbers
PIPISTREL	**Sinus, Virus, Virus SW and ALPHA trainer**	**See cover page**
Date of issue	Date of effect	Date of required corrective action
27 June 2017	27 June 2017	N/A

Replacing the aft battery/batteries

a.) Remove Velco strap holding the battery in place.
b.) Remove cable bolt caps.
c.) Remove bolts, washers and cables.
d.) Slide battery out of the box and replace it with ETX 680 C.
e.) Fasten the positive cable (marked with red shrink sleeve or "+" sticker) to the positive terminal and the negative cable to the negative terminal (see Figure 1) using the fastening material that came with the ETX 680 C.
f.) Torque according to the *ETX Lithium Battery User's Manual 111017_R.*
g.) Install cable bolt caps.
h.) Fasten battery in place with Velcro strap.
i.) Remove/install second aft battery in the same fashion if necessary.

Figure 1: Aft battery installation

Replacing the fore battery

a.) Remove cable bolt caps.

PIPISTREL	Service Bulletin	Document Number
		SB-100-006 LSA
		Issue: A.00
Pipistrel LSA s.r.l. Via Aquileia 75 34170 Gorizia, Italy, EU www.pipistrel.eu Phone: 0481 522000	Battery installation recommendations	Supersedes Doc. Number
		N/A
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Aircraft make	Aircraft model	Affected serial numbers
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Date of issue	Date of effect	Date of required corrective action
27 June 2017	27 June 2017	N/A

b.) Remove bolts, washers and cables.
c.) Grab the strap's loose end as seen in Figure 2. Tear it away from the base strap (i.e. it's bonded to it). Remove strap.
d.) Slide battery out of brace and replace it with ETX 680 C.
e.) Fasten/tighten in place with strap.
f.) Apply a little glue to the loose end of the strap, so that it bonds to the base strap and doesn't hang freely.
g.) Fasten the positive cable (marked with red shrink sleeve or "+" sticker) to the positive terminal and the negative cable to the negative terminal using the fastening material that came with the ETX 680 C.
j.) Torque according to the *ETX Lithium Battery User's Manual 111017_R.*
h.) Install cable bolt caps.

Figure 2: Fore battery installation – tearing away the strap's loose end

Installing the ETX's fault monitoring system

The ETX 680 C has a discrete output that can be used to monitor any battery faults that may occur. Please refer the *ETX Lithium Battery User's Manual 111017_R* for installation instructions.

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Personnel and site requirements: No special requirements, can be accomplished by owner, who is also a licensed pilot

Other publications: N/A

Manhour estimation: 0.5 – 1.5 hours (depends on configuration)

Additional Questions?

Contact Pipistrel Maintenance department via telephone: +386 5 364 38 83 or email: leon.brecelj@pipistrel.si

END OF SERVICE INFORMATION.