Ministry of
Technology and Industry

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

TOMI AX-8, HA-864

Vál, Aligvári dűlő, 5 September 2020

Accident

2020-0441-4

The sole objective of a safety investigation is to find the causes and circumstances of aviation accidents or incidents and to initiate the necessary safety measures; furthermore, to make recommendations in order to prevent similar cases in the future. It is not the objective of an investigation to apportion blame or liability.

Introduction

Synopsis

Occurrence class		accident
Aircraft	manufacturer	Notheisz Balloons Hungary Kft.
	model	TOMI AX-8
	registration	HA-864
	operator	PHOENIX Hőlégballon Repülő Egylet
Occurrence	Date and time	5 September 2022, 18:52 LT
	Location	Aligvári dűlő near Vál
Fatalities / severe injuries		1 deceased / 3 severely injured
Damage to the aircraft		destroyed

On 5 September 2020, at 5:59 P.M., a TOMI AX-8 hot-air balloon – reg. mark HA-864 – took off from a grass field at the outskirts of Baracska. The pilot and three passengers were on board. At 6:52 P.M., after flying for almost an hour, the pilot attempted to land in a cultivated, but harvested field in the outskirts of Vál, in the Aligvári dűlő. At the first touchdown a sudden and intense liquid gas leak happened and the gas was ignited by the fire from the pilot flame of the burner system. The pilot and two of the passengers were able to escape from the basket of the burning balloon while it started it's ascend, the third passenger got trapped in the basket and lost her life. The escaped passengers and the pilot suffered serious, life-threatening injuries.

According to the findings of the IC, the cause of the accident was that the escaping gas caused by the fracture of an unsuitable and forbidden thread adapter got ignited. This adapter was required due to improperly used and installed fuel hose/manifold assembly, and the gas ignition was traced back to the Pilot's mishandling of the fuel tanks – due to the chaotic fuel system caused by the irregular hose routing –, his improper preparation for the landing and his behaviour during emergency. The use of a different basket and engine other than specified in the configuration list and the airworthiness certificate also contributed to the accident, and the Pilot's behaviour during emergency reduced the chance of survival for his passengers.

The IC found no grounds to issue a safety recommendation.

Figure 1: The burning balloon soaring back up
(Source of photo: National Directorate General for Disaster Management)

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Definitions and abbreviations

Aerodrome	*A defined area (including any buildings, installations and equipment) on land or water or on a fixed offshore or floating structure intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft*
AMC	*Accepted Means of Compliance*
BPL	*Balloon Pilot Licence*
CS	*Certification Specification*
EASA	*European Union Aviation Safety Agency*
FI(B)	*Balloon Flight Instructor*
Flight plan	*Specified information provided to air traffic service units, relative to an intended flight or portion of flight of an aircraft*
GM	*Guidance Material*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
Kbvt.	*Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*
LPG	*Liquefied Petroleum Gas*
LT	*Local Time*
MTI	*Ministry of Technology and Industry*
NFM	*Ministry for National Development (Legal Predecessor of MTI)*
Parachute valve line	*A rope system which reaches down in the basket and is used to remove hot air from the envelope of the hot-air balloon.*
TSB	*Transportation Safety Bureau*
UTC	*Coordinated Universal Time*
VFR	*Visual Flight Rules*

General information

All times indicated in this report are in local time (LT). LT at the time of the occurrence: UTC+2 hours.

All geographical locations throughout this document are provided in WGS-84 standard.

The content of this report is in accordance with the requirements set out in ICAO Appendix 13, Chapter 6 and ICAO Doc 9756, Chapter IV.

Reports and Notifications

The occurrence was reported to TSB's call center at 7:01 P.M. on 5 September 2020, by the on-call officer of Pest County Disaster Management Directorate.

TSB of Hungary notified the following organisations:

– EASA on 09/09/2020, at 4:37 P.M.

Investigation Committee

The Head of TSB appointed the following persons in the investigating committee (hereinafter: IC).

Investigator-in-Charge	Klementina Joó	investigator
Member	Zsuzsanna Nacsa JD	investigator

Overview of the Investigation Process

Subsequent to the notification, the on-call manager of the TSB ordered an immediate dispatch to the site.

Pursuant to Article 5 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/ECA the TSB is required to initiate an investigation in the following circumstances.

(1) *Every accident or serious incident involving aircraft other than specified in Annex II to Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency (6) shall be the subject of a safety investigation in the Member State in the territory of which the accident or serious incident occurred.*

(2) *When an aircraft, other than specified in Annex II to Regulation (EC) No 216/2008, registered in a Member State is involved in an accident or serious incident the location of which cannot be definitely established as being in the territory of any State, a safety investigation shall be conducted by the safety investigation authority of the Member State of registration.*

(3) *The extent of safety investigations referred to in paragraphs 1, 2 and 4 and the procedure to be followed in conducting such safety investigations shall be determined by the safety investigation authority, taking into account the lessons it expects to draw from such investigations for the improvement of aviation safety, including for those aircraft with a maximum take-off mass less than or equal to 2 250 kg.*

(4) *Safety investigation authorities may decide to investigate incidents other than those referred to in paragraphs 1 and 2, as well as accidents or serious incidents to other types of aircraft, in accordance with the national legislation of the Member States, when they expect to draw safety lessons from them.*

Based on the findings of the site inspection and with regard to Article 5 (4) of Regulation (EU) No 996/2010 of the European Parliament and of the Council, the head of the TSB decided that an investigation is required and will be launched.

In the course of the investigation the IC has taken the following steps:

- took photos and measurements at several locations between the first touch-down and the final landing location of the hot-air balloon,
- the IC carried out post on-site inspections on several occasions after the accident and tried to collect the scattered parts of the hot-air balloon, which was hampered by the relatively large agricultural area. The IC requested and received assistance from the auxiliary police associations,
- inspected all the wreckage found on the spot and took photos and measurements of them at an additional inspections held together with the police and technical experts. Reconstructed the fuel system used from the wreckage, assembled its components and analysed them,
- reconstructed and analysed the characteristics of the hot-air balloon basket, using another basket on the ground,
- obtained the documents of the hot-air balloon involved in the accident, and the documents of the pilot (hereinafter: “Pilot”),
- obtained copies of the documents generated during the last airworthiness review of the hot-air balloon.
- interviewed
    - the pilot of the hot-air balloon involved in the accident,
    - the assistant crew,
    - the two surviving passengers of the accident,
    - the pilot of another hot-air balloon flying nearby at the time of the accident,
    - several eye-witnesses on the ground from different locations who saw the hot-air balloon drifting with its basket on fire,
- analysed the high resolution photo series taken of the hot-air balloon flying with its basket on fire,
- analysed the photos and videos recorded by the passengers before and during the flight,
- visited the location of the aviation society involved in the accident, reviewed its other equipment and devices used for hot-air balloon flights,
- further analysed the fractured parts of the fuel system and made measurements, and examined the characteristics of the pressurised gas leaving its container at a police facility together with the police and with technical experts,
- for further analysis made a 3D model of one of the fractured joint bolts of the fuel system,
- had the fractured joint bolt of the fuel system of the balloon inspected at an accredited material testing laboratory, analysed the report received, performed calculations relating to the process of fracture and the possible causes leading to such fracture,
- obtained reports of the medical examinations of the people injured, as well as the Forensic Post-mortem Examination Report of the deceased passenger.
- Obtained weather data recorded at the time of the occurrence from the Hungarian Meteorological Service.

Principles of the investigation

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

- Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC,
- Act XCVII of 1995 on aviation,
- Annex 13 identified in the Appendix of Act XLVI. of 2007 on the declaration of the annexes to the Convention on International Civil Aviation signed in Chicago on 7th December 1944,
- Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents (referred to as Kbvt. throughout the document),
- NFM (Ministry for National Development) Regulation 70/2015 (XII.1) on safety investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In matters not covered by Kbvt., Act CL of 2016 on General Public Administration Procedures.

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

Pursuant to the aforesaid legislation,

- Transportation Safety Bureau of Hungary shall investigate aviation accidents and serious incidents.
- Transportation Safety Bureau of Hungary may investigate aviation and incidents which – in its judgement – could have led to accidents of more severe consequences in different circumstances.
- Transportation Safety Bureau of Hungary is independent of any person or entity that may have interests in conflict with the objectives of the investigating body.
- In addition to the aforementioned legislation, TSB of Hungary shall conduct safety investigations in line with ICAO Docs 9756 and 6920 Manual of Aircraft Accident Investigation.
- This Report shall not be binding, nor shall an appeal be lodged against it.
- The original of this report was written in Hungarian.

No conflict of interest has been found between safety investigators of the IC. No investigator assigned to a safety investigation has been involved as an expert in any other procedure pertaining to the same case and shall not do so in the future.

The IC shall retain all data and information having come to their knowledge in the course of the safety investigation. Furthermore, the IC shall not be obliged to make such data and information available to other authorities, whose disclosure could have been legally refused by their original owner.

This Final Report is based on the Draft Report prepared by the IC and shall be sent to all involved parties for comments, as set forth by the relevant regulations.

No comments on the Draft Report were received from the interested parties within the legal deadline.

Copyright

Translation

This document has been translated from Hungarian. Although efforts have been made to provide a translation as accurate as possible, discrepancies between the versions might occur. In such eventuality, the Hungarian version shall prevail.

1. Factual information

1.1 Flight History

On 5 September 2020, at 5:30 P.M. in the outskirts of Baracska, the ground crew and the pilot of the TOMI AX-8 hot-air balloon registration mark HA-864 began to prepare for the planned flight. They often used this area as a start place when the wind was favourable. The crews of two other hot-air balloons were also preparing for take-off from the same area at the same time. Prior to the take-off, the assisting personnel launched small helium-filled balloons in order to assess the wind direction and intensity. The pilots of the three hot-air balloons made a collective decision that the weather conditions were suitable for flying. On completion of the preparations, the pilot and his three passengers – two young and tall women and a shorter middle-aged woman – got into the basket. In addition to the occupants, there were 4 large propane butane gas bottles (liquid phase fuel) and 2 smaller propane butane gas bottles (gaseous phase fuel for the pilot flame burner) in the basket of the balloon *(1.6.2)*. The Pilot briefed his passengers on the rules for the flight (this was confirmed by the survivor passengers), and the HA-864 hot-air balloon lifted off at 5:59 P.M.

After an uneventful flight of almost an hour, in the area of Vál village, the Pilot started preparations for the landing, and briefed his passengers on the procedures for the landing. The passengers were waiting for the touchdown as instructed: standing with their backs to the wall of the basket, legs slightly bent, and holding on the handles. In the meantime, the Pilot was holding the parachute valve line with his arm, and held both his hands on the gas burner valves, controlling the vertical speed of the balloon.

According to the passenger reports, the first ground impact was quite intense. The right front corner of the basket in the direction of travel hit the ground first and then, after a short ascent, it drew an about 4-5 m long and 20-25 cm deep hole in the ground. Almost at the same time as the first touchdown, liquefied gas unexpectedly erupted from behind Passenger2 and soon flooded the basket with a white mist. The pilot reported that he released the balloon unloading rope, pushed the passenger away and tried to close the right front fuel tank to close to the liquid gas flow, but found this tank to be already closed. Meanwhile, the vapour of the liquefied gas reached the pilot flame and ignited.

As the pilot and passengers began to evacuate the basket, the sudden, significant decrease in the weight of the basket, as well as the balloon heated by intense burning, the basket began to rise at a sudden, accelerating pace. The pilot and one of the young passengers (hereinafter: Passenger1) jumped out almost simultaneously, followed by the other young passenger (hereinafter: Passenger2), who reported that she already jumped from a height of almost 2 m.

The third, shorter passenger ('Passenger3') was unable to escape from the basket in time. After the ascent, the hot-air balloon that was heated by a fire fed by the gas flow – according to eyewitnesses – rose to a height of about 300 meters and travelled more than 2,500 meters before reaching the ground and coming to rest. During the uncontrolled flight, one of the fuel tanks and at least one of the pilot flame tanks exploded from the heat of the fire.

Passenger3 got trapped in the basket and lost her life during the accident, the balloon was destroyed.

1.2 Injury to Persons

	Flight Crew	Passengers	On the Aircraft	Others
Fatal	0	1	1	0
Serious	1	2	3	0
Minor	0	0	0	0
Not injured	0	0	0	
Summary	**1**	**3**	**4**	

1.3 Aircraft Damage

The aircraft was destroyed in the accident. For more detailed description see chapter '*1.12 - Wreckage and Impact Information*'.

1.4 Other Damage

Trample damage occurred in the cornfield during the inspection of the crash site. No other damage was reported to the IC before the closure of this investigation.

1.5 Personnel Information

1.5.1 Pilot-in-Command

Age, nationality, gender		63 years old, Hungarian, male
Licence data	type	BPL
	professional valid until	Until withdrawal
	ratings	FI(B) / 30 Nov 2020
Medical class and valid until		Class 2, 05 Sep 2021 LAPL, 05 Sep 2022
Flight hours / take-offs	in the preceding 24 hours	53 minutes / 1 take-off
	in the preceding 7 days	53 minutes / 1 take-off
	in the preceding 90 days	1 hour 53 minutes / 2 take-offs
	total:	743 hours / 650 take-offs
Aircraft types flown:		TOMI AX-8

1.6 Aircraft Information

1.6.1 General Information

A hot-air balloon as an aircraft consists of three main components, such as the envelope (the registration mark is visible on this part), the basket, and the engine (the gas burner system with the fuel tanks and the hoses).
Manufacturers generally make a one-piece rectangular basket for the AX-8 hot-air balloon sub-class. The maximum recommended crew for the Notheisz TOMI AX-8 category, 3000 m^3 volume hot-air balloon involved in the accident is 1 pilot + 3 passengers.

Class	Lighter-than-air aircraft, hot-air balloon
Manufacturer	Notheisz Balloons Hungary Kft.

Model	TOMI AX-8	
Envelope capacity	3000 m^3	
Year of manufacture; Serial nr	1996; 27/96	
Registration mark	HA-864	
State of registry	Hungary	
Date of registry	06 June 1996	
Owner	Private person	
User operator	SUP-AIR Ballon Egyesület	
Operator	PHOENIX Hőlégballon Repülő Egylet	
	Flight hours	Take-offs
Since manufacture	746 hours	651
Since last periodical maintenance	28 hours 10 minutes	31

1.6.2 Accessories of the aircraft

The HA-864 registered balloon was equipped with 4 high-pressure liquid-phase propane-butane fuel tanks (with dip tube), 23 kg each, to supply the main burners, and two gas-phase fuel-tanks, 2 kg each, to supply the 2 pilot flame burners.

Fuel tanks	
Fuel tank 1	
Type	MAL ALU 23 kg
Serial number	B38186 (exploded; found near the basket) *(Figure 4)*
Fuel tank 2	
Type	MAL ALU 23 kg
Serial number	A54141 (found in the cornfield on 11 Nov 2020) *(*Figure 4*)*
Fuel tank 3	
Type	MAL ALU 23 kg
Serial number	A69308 (found in the elderberry field) *(*Figure 4*)*
Fuel tank 4	
Type	MAL ALU 23 kg
Serial number	A69242 (found in the elderberry field) *(*Figure 4*)*

Pilot flame gas tanks	
Type	2 kg, alum.
Serial number	13472 (exploded; found near the basket) *(*Figure 4*)*
Type	2 kg, alum.
Serial number	(gas tank not found)

Gas burners		
	Certified configuration	Installed configuration
Type	KÖGÁZ III-2-1, or KÖGÁZ II	Schroeder Optima IV.
Serial number	29/89	2.260-1/1992

	02/87	
Basket		
Type	Notheisz	Schroeder IV/5 (145*115)
Serial number	008/1996	(Data plate not found)

1.6.3 Airworthiness Certificate

The envelope, the basket and the engine are inspected by the authority as a whole configuration. The certificate of airworthiness is issued accordingly and it has to be operated as certified.

Airworthiness Certificate	Number	FD/LD/NS/A/3770/1/2014
	Date of issue	13 Dec 2014
	Valid until	Until withdrawal
	Restrictions	None
Airworthiness Review Certificate	Number	HU.MG.0151
	Date of issue	29 Jun 2019
	Valid until	17 Jun 2021

A component may only be replaced with another component if such part is approved by the manufacturer and has been inspected as a configuration and the civil aviation authority documents it.

At the time of the accident the Airworthiness Review Certificate of the HA-864 TOMI AX-8 was approved with the following configuration:

- Envelope serial number: 27/1996,
- Notheisz basket serial number: 008/1996
- KÖGÁZ III-2-1 burner serial number 29/89 or KÖGÁZ II burner serial number 02/87
- MAL ALU 23 kg fuel tanks serial numbers: A69308, A54141, A61646, A69242, and A38186.

The certified configuration did not include a fuel hose/manifold assembly, therefore the use of such hose is not permitted. According to the documentation of the balloon the thread of the fuel hose and of the fuel tank were the same, no thread adapters were required for connecting them – the use of such converters is also prohibited.

On the site the remains of a Schroeder burner (serial number: 2.260-1/1992) and the remains of a Schroeder basket with an unreadable serial number were found.

Prior to the flight ending in the accident, the crew assembled the aircraft for the flight in a different configuration than certified, therefore the aircraft did not have a valid airworthiness review certificate for the assembled configuration. The pilot did not submit any technical or maintenance documentation of the destroyed basket or burners to the IC during the investigation.

In the configuration found at the scene, the threads of the gas burner hose and the fuel tank did not match therefore a thread adapter was used to connect them. The gas hoses used were manufactured in 2009, the maximum lifespan specified by the manufacturer for the gas hoses was 10 years.

1.6.4 Aircraft Loading Data

Empty Weight	215 kg
Fuel on board	140 kg
Take-off weight	675 kg (estimated value)

1.6.5 Malfunctioning System or Equipment

The hot-air balloon was equipped with a double gas burner. The fuel tanks were placed in the four corners of the basket, the tanks were connected two-by-two along the long side of the basket with fuel hose/manifold assembly *(Figure 2)* that were connected to the burner. The site surveys found that the hoses used were unnecessarily long and the fuel hose/manifold assembly connecting the fuel tanks was of unknown origin. None of the used thread adapters had specific markings or identification number or were part of the certified configuration. Their layout did not meet the professional standards or EU norms. One part of the fractured thread adapter connected to Fuel tank 3 *(Figure 2)* was found inside the flare nut of the joint hose, and the other in the connector of the fuel tank. Due to the location of the fractured part in the fuel system and the fracture surface, the IC ordered further analysis of the material *(1.16)*. There was also another broken T-connector in the fuel system, which was analysed by experts during a material test ordered by the police.

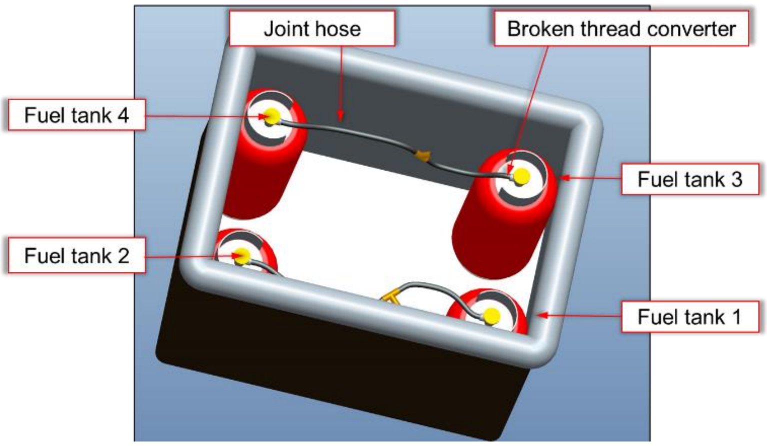

Figure 2: Arrangement of the fuel tanks in the basket

1.7 Weather information

The accident happened in daytime in good visibility conditions. According to information from Aviation Meteorology Department, Hungarian Meteorological Service, an anticyclone was above Hungary, then the front of a cold front approaching form north-west arrived during the day. The weather at the location of the accident was undisturbed, clear and dry at the time of the accident. According to data recorded at the meteorological measurement station located nearest to the scene (measurement station № 35418, Martonvásár), the temperature had fallen from 27°C to 25°C during the flight, the wind near the ground blew from the 130°-150° direction at moderate speeds decreasing (5.75 to 3.6 km/h), with gusts of 9 to 6.48 km/h. Visibility exceeded 10 kilometres.

The pilot involved in the accident reported that together with the two other pilots requested weather information from the Hungarian Meteorological Service before the flight. They launched several meteorological balloons prior to the flight in order to assess the current near-ground wind speed and direction. According to data obtained by the pilots, the wind speed varied between 8-10 km/h, the weather was suitable for hot-air balloon flights.

1.8 Aids to Navigation

Navigation equipment had no influence on the course of events.

1.9 Communication

Pursuant to Subsection (1) § 65 of NFM Regulation 56/2016. (XII. 22.) on the rules of flights in the airspace of and at aerodromes in Hungary, hot-air balloons shall be equipped with radio equipment if the hot-air balloon is operated in uncontrolled airspaces between the altitudes 4000 feet (1200 m) and 9500 feet (2900 m) AMSL. Accordingly, it was not mandatory to equip the hot-air balloon with radio equipment for the given flight path and altitudes.

The pilot of the hot air balloon with an application maintained constant contact with ground crew following the balloon's journey during the flight to help them locate the landing site.

Communication equipment had no influence on the course of events.

1.10 Locations of take-off and landing

The aircraft took off from a grass hay land (47°14’49.30”N 18°47’48,17”E) outside Baracska on the 5 September 2020, at 5:59 PM. The area chosen for the take-off proved suitable for the task. According to the notification, the first touch-down of the balloon happened at 6:50 PM, near Vál (47°20’55.44”N 18°42’38,89”K).

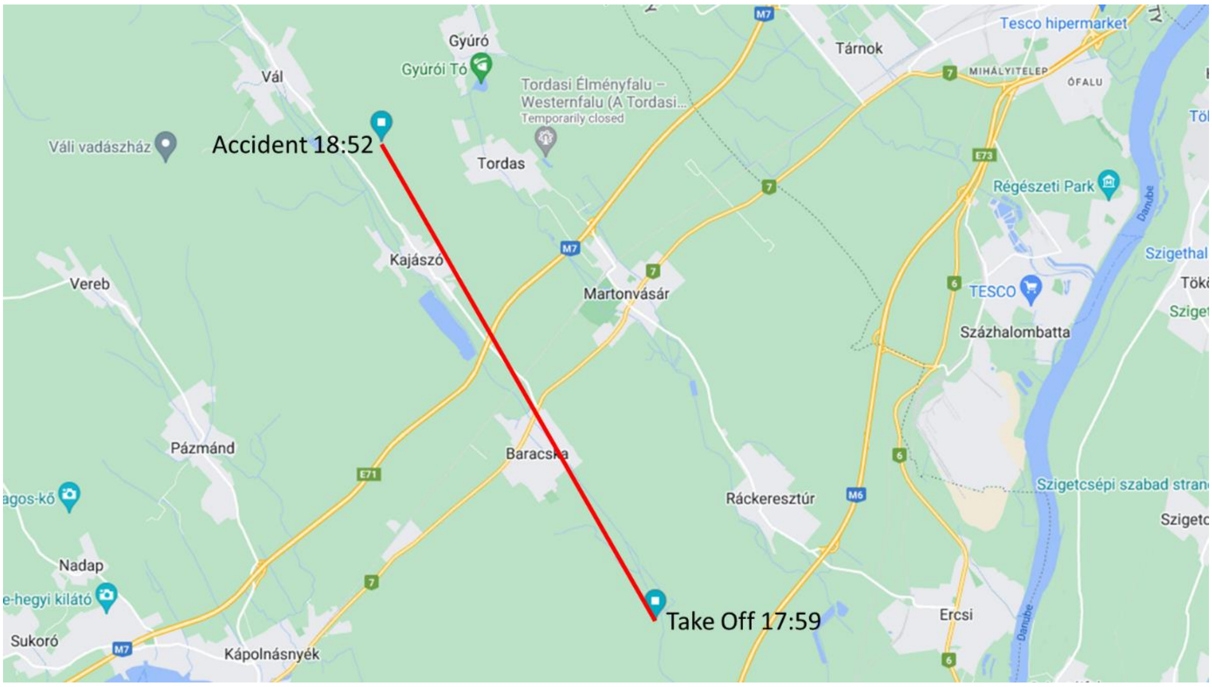

Figure 3: Locations of the take-off and the accident

1.11 Data recorders

The flight path of the hot-air balloon was recorded by the ground-crew using a telephone app. No flight data recorder was installed on the aircraft – it is not required for the aircraft type concerned.

Before and during the flight, the passengers of the hot-air balloon took photos and videos which they made available to the IC. Passengers’ videos recorded the inner arrangement of the basket, as well as the heating up of the balloon, during the pre-flight activity.

1.12 Wreckage and Impact Information

Based on locations of the scattered parts and components of the hot-air balloon, the IC identified three main scenes.

I. The first ground impact of the balloon HA-864 happened next to Vál, on an agricultural land 47°20’55,44”N 18°42’38,89”E. According to the marks on the ground, the basket got blocked during landing, and then lifted in the air again and travelled approx. 2 metres. Then it touched down again, and carved a trench of 4-5 m length and 20-25 cm depth into the soil. This is where the gas leaked, caught fire, and where the injured occupants left the burning basket. The fastening bracket of a fuel tank, the data plate of the envelope, and a couple of minor burnt pieces of the envelope were found a few metres away.

II. The body of the fatally injured passenger and two 23 kg fuel tanks (Fuel tank 3 and 4, Serial numbers: A69308, A60242) were found in an elderberry field.

III. The envelope (about one fifth of it had burnt out) with the gas burner, and the remains of the basket dragged by it, as well as a 2-kg pilot flame fuel tank (serial number: 13472) and a 23-kg fuel tank (Fuel tank 1, serial number: B38186) – both tanks exploded – landed here in the corn field 47°22’11.36”N 18°41’46.60”E.

Another 23-kg fuel bottle (Bottle 2, serial number: A54141), which was found last (for a long time regarded as lost) had fallen to the ground roughly halfway between scenes I and II. It was finally found during harvest on 12 October 2020 in a filled state.

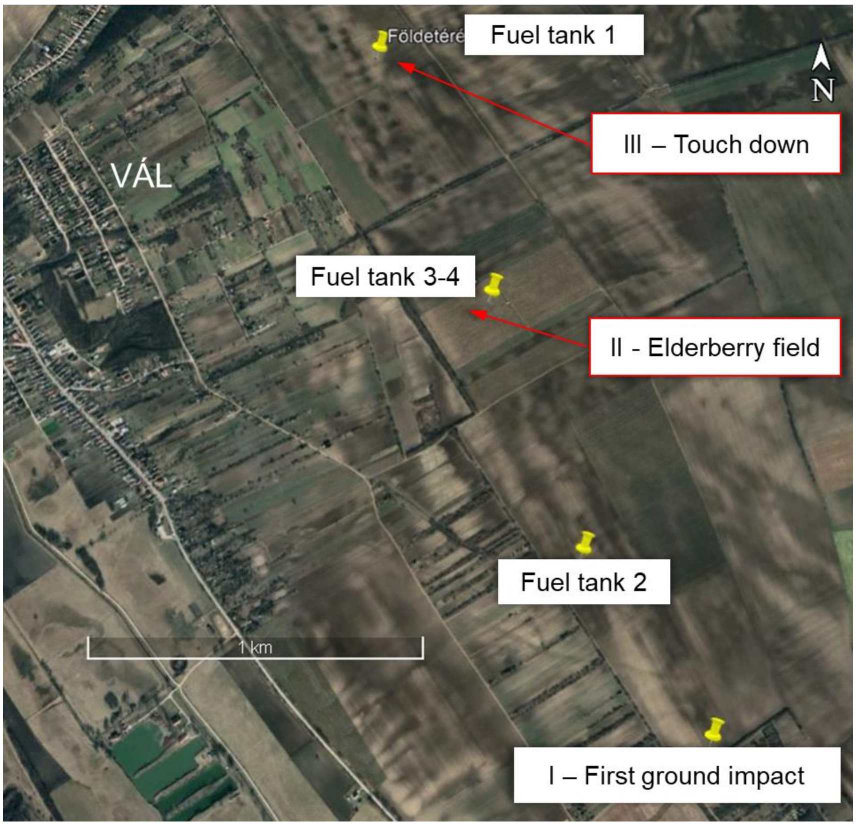

Figure 4: Locations of the touch-down, the gas bottles, and the burnt-out wreck

1.13 Medical and Pathological Information

The pilot of the hot air balloon sustained burns to his head and hands. There was no evidence that his ability to act was affected by physiological factors or other impediments.

Passenger1 acted quickly after the fuel exploded and had the opportunity to jump out of the basket immediately after the pilot, sustaining burns while fleeing. Her face, tip of her nose, limbs and belly were injured. His hands and fingers were also injured. No respiratory injury developed, ambulances transported her to hospital with stable life functions.

Passenger2 was also able to jump out of the burning aircraft, leaving the burning basket slightly higher (nearly 2 meters high). As a result of the severe fire, she suffered second-degree burns to his head, back, left arm, and both forearms, as well as both legs. As a result of facial burns, her eyes also needed treatment.

Passenger3 was trapped in a basket of burning hot air balloons, his entire body was characterized by a quarter of severe burns. He suffered burns and traumatic injuries that were incompatible with his life as a result of the accident.

Passenger 3 got trapped in the burning basket of the hot-air balloon; her body showed severe, fourth-degree burn injuries. As a result of the accident she suffered burns and traumatic injuries that were incompatible with life.

1.14 Fire

Intensive leakage of liquid gas occurred suddenly in the fuel system during the landing; the leaking gas caught fire when its vapour reached the pilot flame and then the burning gas set the inside and the cane wicker of the basket on fire. The burning hot-air balloon ascended again, and the heat accumulated in the basket caused several gas-filled fuel bottles to explode.

The balloon and its burnt-out basket landed in a cornfield where the fire was prevented from spreading.

Figure 5: Burnt remnants of the hot-air balloon

1.15 Survival Aspects

While approaching the ground, the pilot opened the deflation valve of the envelope in order to reduce lift, as part of the usual process. After a rough touch-down, right at the moment when gas leakage started, he let the parachute valve line go, thus preventing hot air from leaving the envelope. The intense fire further heated the hot air trapped in the envelope. After the three people jumped out, the aircraft began to lift faster and faster due to the significant weight loss and continuous heating. The third trapped passenger had no chance of survival.

1.16 Tests and Research

On October 2, 2020, one of the operators of a hot air balloon in Hungary presented the opening of a full fuel tank in the yard of the Székesfehérvár police station. The purpose of the study was to determine the form in which an outflow of pressurized gas escaping from a tank or an open system would flow without a constriction without obstruction to the outflow. The high-pressure liquid-phase gas could flow freely in full cross-section through the tap of the tank. As a result of the sudden pressure drop, the liquid immediately turned to gas and formed a dense, compact, white mist that one could not see *(Figure 6)*.

Figure 6: Gas flowing out of the bottle with the valve open

The IC examined the characteristic (theoretical) structural dimensions of the fuel tank fuel hose/manifold assembly and the fuel tanks quick release connector, using computer component modelling. A thread adapter with an external thread size of G3 / 8 and a thread of G1 / 4 on the inside was installed between the quick coupling and the attached hose. With the help of the modelling program, the smallest distance between the outer and inner trenches was measurable *(Figure 7).* Construction suggests that the smallest theoretical wall thickness is less than 1 mm.

According to the calculations of the IC, in the case of a copper alloy component with such a wall thickness, if the characteristic load (e.g. external force) is concentrated on a 100mm lever arm, the component may break under a load of 105N (~ 10.5kg). The flexible hose fastened onto the quick-release coupling applied can be connected to the quick-release coupling, through a joint bolt, with a threaded hose end embedded in a rigid armature. The distance between the fractured surface and the rigid hose end was almost 100 mm.

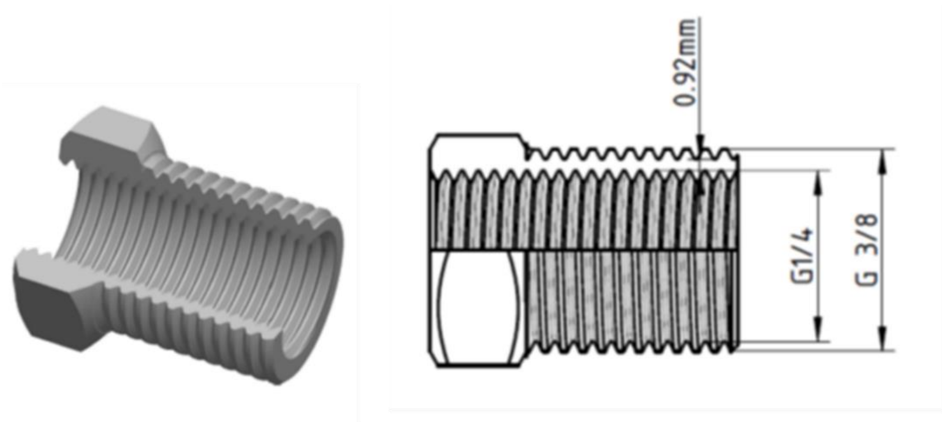

Figure 7: Section drawing of the fractured joint bolt

The IC ordered metallurgical examination of the fractured thread adapter used with the hose which connected the fuel tanks (*Figure 9).* While the bronze types typically used in the manufacturing of machine parts are copper alloys with 6% to 10% tin content, the test found that the thread adapter was made of brass-lead alloy. This alloy is typically used as base material in bearings, owing particularly to its good gliding properties.

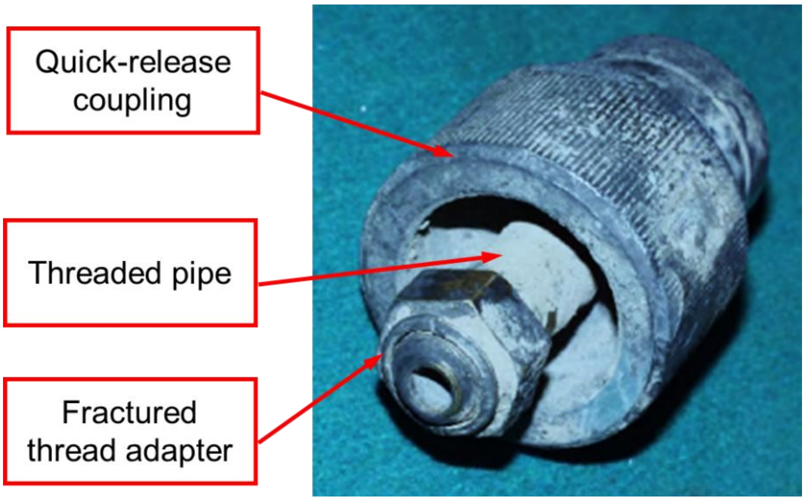

Figure 8: The quick-release coupling with the fractured joint bolt

The material testing demonstrated neither macroscopic nor microscopic material defect in or around the fractured surface of the joint bolt. However, the thickness of the fracture surface varied significantly, between 0.3 mm and 0.8 mm. A possible cause of the formation of an asymmetric fracture surface is that the axes of symmetry of the external and internal threads are not identical, which may as well refer to a possible error of manufacturing. The analysis shows that the fracture of the joint bolt was not preceded by significant plastic strain: the pattern of the fracture surface suggests that a brittle-type fracture occurred (*Figure 9*). Hardness measurement showed noticeable hardening in the location where the fracture started.

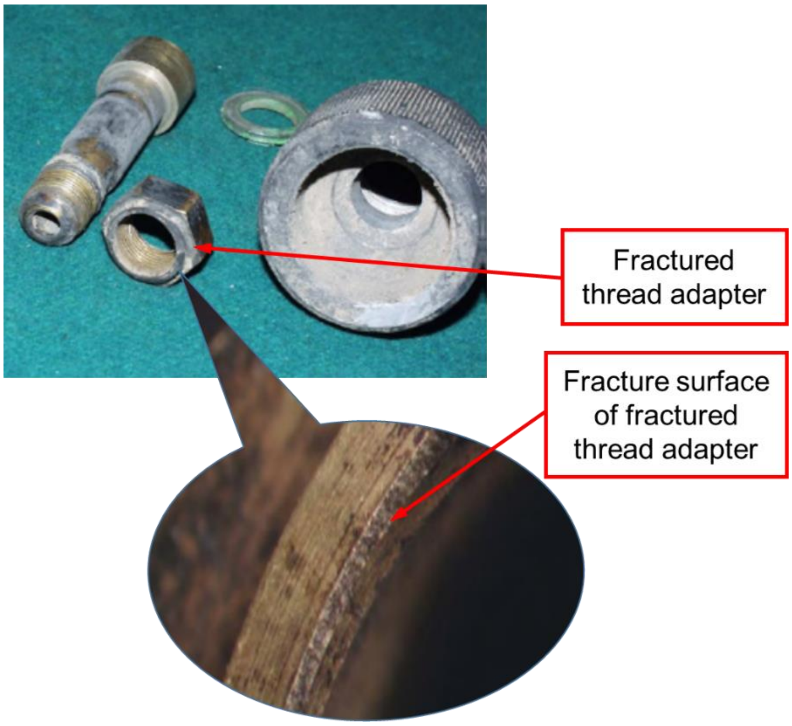

Figure 9: The joint bolt with fractured surface

Material testing of the fractured T-piece was ordered by the Police. The analysis showed neither material defect nor fatigue. A T-piece of the same make was put to a crash test which demonstrated that the T-piece cannot be broken by human force with the given lever arm.

1.17 Organizational and Management information

The HA-864 aircraft is owned and operated by Phoenix Hot-Air Balloon Flying Association (hereinafter: Phoenix HRE), the exclusive responsible representative of which is the pilot involved in the accident.

The pilot stated that flying passengers is almost his only source of income – in addition to possible amounts from pilot training and advertisements – to compensate the fairly high costs of operating a hot-air balloon.

According to the Civil Aviation Authority's records at the time of the accident Phoenix HRE did not have a licence to perform commercial activities and, according to information available to the IC, the Pilot did not have a commercial pilot licence either. The pilot used the HA-864 hot-air balloon to fly passengers with a permit issued to himself by himself in the name of the association.

1.18 Additional Information

1.18.1 The layout of the hot-air balloon

Hot-air balloons perform static flights, during which the necessary lift is provided by the difference between the specific weight of the air enclosed in the envelope and the ambient air by reducing the density of the air inside the envelope by heat. Descent can be achieved by either pausing the heating or by venting and deflating the envelope with the valve situated at the top of the envelope, (i.e. letting some hot air out). The valve can be operated from the basket, using the valve line via pulleys *(Figure 10)*.

The air in the envelope is heated by burners installed on a frame above the basket. These days the burners are fuelled almost exclusively with liquefied propane-butane gas.

1.18.2 Fuel

The air in the envelope is heated by burning liquefied gas (LPG = Liquefied Petroleum Gas). The gas is a mixture of propane and butane that burn cleanly without harmful side effects.

The boiling point of propane is -42°C and butane is -1°C. At low temperatures, gas phase extraction would increase the butane concentration of the liquefied gas, and the resulting pressure drop would make gas extraction impossible.

The propane is present in the tank in a mixed state, the pressure varies from 2 to 10 bar at ambient temperature. At low temperatures and pressure, the pressure in the tank is increased with the use of inert gas (nitrogen) just before take-off.

If the liquefied gas is released into the open in a liquid state, it immediately begins to evaporate. During evaporation, its volume increases about 230-fold while its environment is significantly cooled. In a short time, a large amount of gas escapes in the form of a cold mist, which can cause frostbite in its immediate vicinity.

The propane-butane gas used to heat the hot-air balloon is extremely flammable. Flammability concentrations in the air range from 1.6 to 9.5% by volume, so even in the case of small leaks, a large amount of flammable mixture is formed.

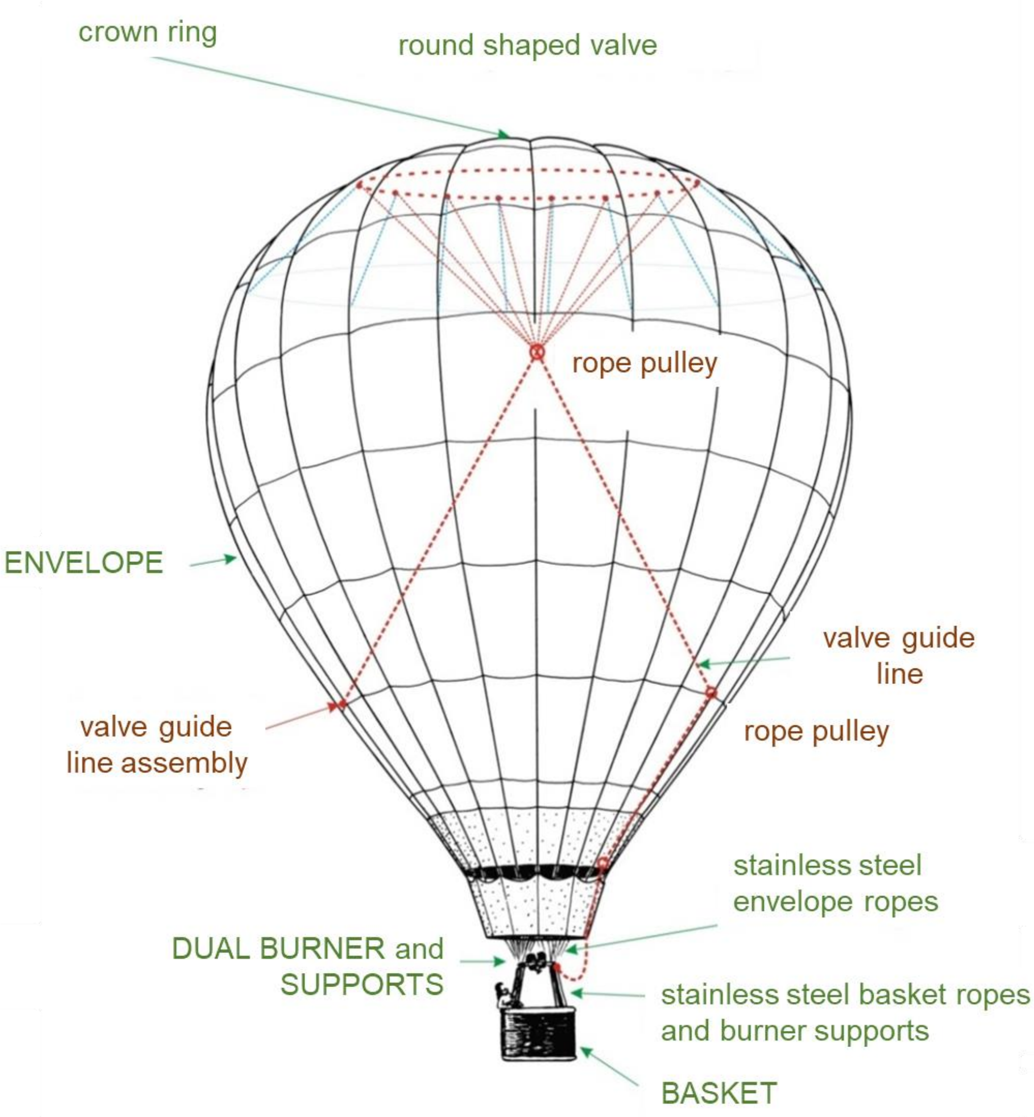

Figure 10: The layout of the hot-air balloon

1.18.3 Engine (Gas burner system and fuel supply)

Depending on the size of the envelope, gas burner system may consist of one or more gas burners. The TOMI AX-8 hot-air balloon has a system of two gas burners. The gas burner produces the thermal energy needed to lift the hot-air balloon. With the help of vaporizing coils, the burner preheats and vaporises the liquefied gas which then mixes with the air. This is ignited by the pilot flame and directs the flame directly into the envelope.

The pilot flame burner is a constantly burning ignition source fuelled by a 2-kg gas bottle providing gas in gaseous state.

The burner system is mounted on a frame that can be turned in two directions, using a handle.

Since the end of the 1970s, hot-air balloons were installed with a dual burner system (each of which can be operated independently of the other) all over the world. Hot-air balloons in Hungary were made exclusively with dual burner systems. In normal operation, the hot-air balloon flies with one burner, while the other is in reserve, so the pilot can switch to it at any time. The combined outputs of both burners working simultaneously can also be applied as necessary.

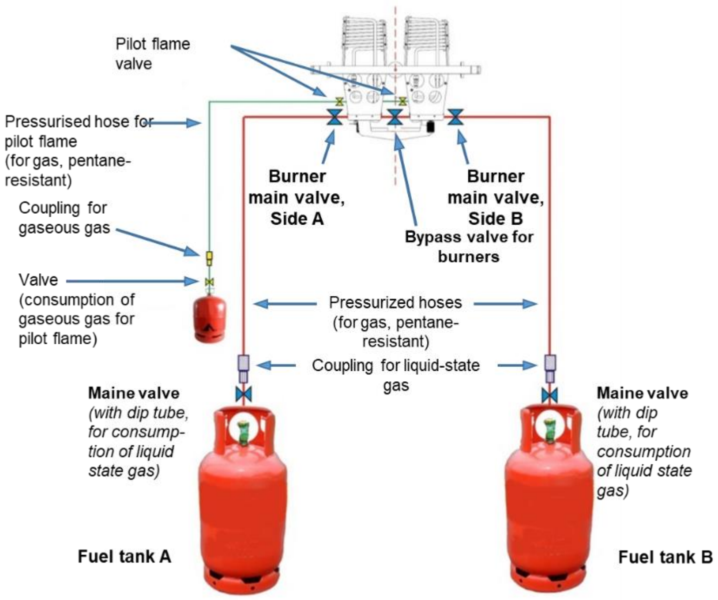

Figure 11: Schematic diagram of a dual gas burner system with fuel bottles and a pilot flame gas bottle.

A possible method of fuel supply of hot-air balloons of this size is to use a direct feed system, i.e. without joint hoses. This system is equipped with one quick-release coupling for each tank, i.e. with only one possible source of malfunction *(Figure 12).*

Another option is to use a fuel hose/manifold assembly where more than one tanks are connected to the system through a fuel hose T-joint. In that case, replacement of a tank consists of simply shutting the empty tank and opening the full tank. However, that system contains three or more quick-release couplings, which entails three or more sources of malfunction *(Figure 13)*.

The hoses and connectors are regarded as parts of the propulsion unit and therefore their technical control is part of the airworthiness certification and, for reason of traceability, those parts must also be identified. In order to keep sources of malfunction to a minimum, the use of joint bolts (thread adapters) is forbidden.

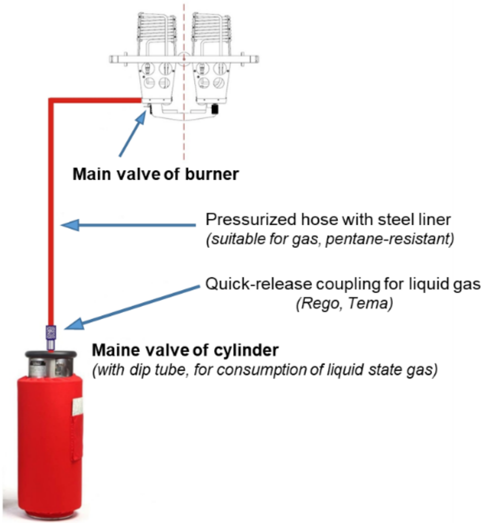

Figure 12: Direct feed

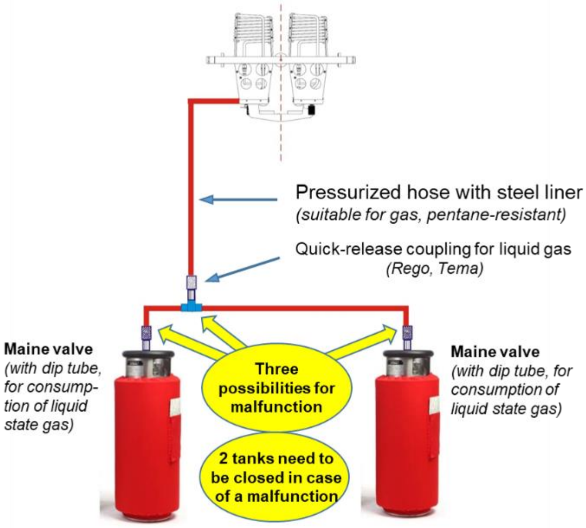

Figure 13: Use of a joint hose

1.18.4 Arrangement of the fuel hoses

The hot-air balloon was equipped with a Schroeder basket instead of the certified Notheisz basket included in the airworthiness review certificate of the hot-air balloon. According to the relevant flight manual (Schroeder Flight Manual Edition 2016 /Revision 4):

"Fuel line manifolds are used to connect two or three fuel cylinders with the burner. Master fuel cylinders as well as slave fuel cylinders can be connected. It is very important to meet the following condition:

1. *All parts of the fuel system must be original Schroeder fire balloons parts.*
2. *There must only be one fuel cylinder opened at a time! Never open two cylinders at the same time connected to one T-piece Manifold! In case two cylinders are opened at one T-Manifold, overfilling of one of the two can occur. Liquefied gas can flow from the cylinder with higher pressure into the cylinder with lower pressure. The safety volume of the cylinder will vanish if gas flows into a filled cylinder and represent a great danger.*
3. *If less fuel cylinders are used, the not connected couplings must be secured using original blanking fittings. This is necessary to avoid gas leaking if the non-return valve of a coupling should fail.*
4. *The hoses are to be routed and fastened below the basket top frame in a way that they do not project into the passenger area and therefore minimising the danger of hose rupture during a hard landing.*
5. *The SCHROEDER fire balloons operation information plate must be glued to every fuel cylinder.*
6. *The manufacturer's serial number of the balloons must be embossed into the t-piece."*

According to the manufacturer's specifications, the lengths of the pressurised fuel hoses routed in the soft protective cover of the rods holding the burners are sized to reach the tanks by the shorter side, they should never reach other tanks situated by the longer side. The tank connections should face the shorter wall, i.e. they must be protected from inadvertent contact with either the crew or passengers. The hoses should be routed below the top frame of the basket, possibly in such manner that they should not project into the passenger space, thus minimising the risk of anyone bumping into a hose *(Figure 16).*

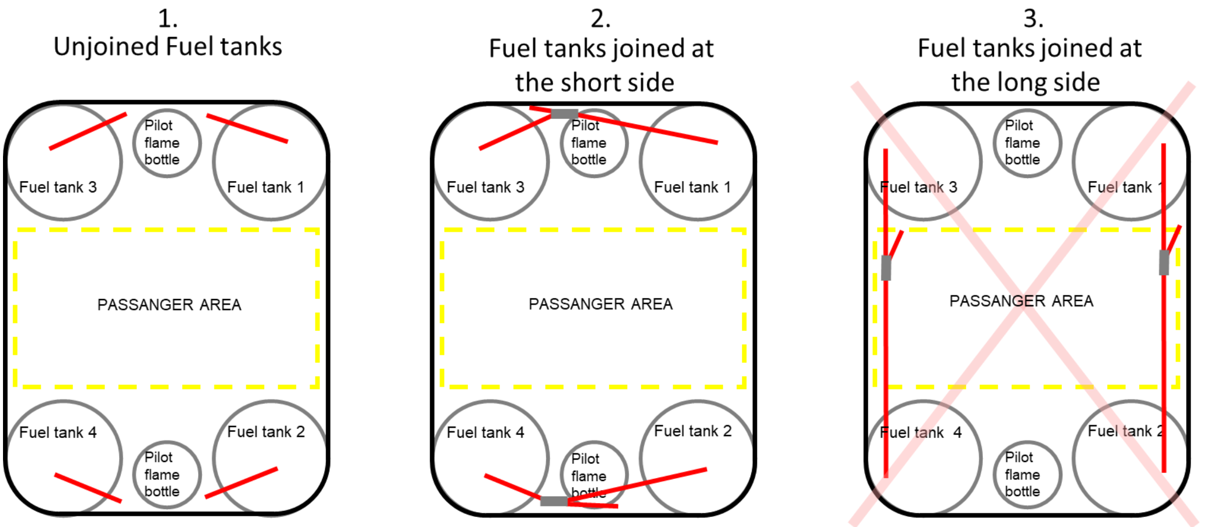

Figure 14: Fuel tank connection layouts

As a general rule, if a pilot uses a T-piece, the pilot may connect it at the short side, and never at the long side. This is also ensured by the short size of the fuel hose/manifold assembly *(Figure 14 2., Figure 15*Figure 14: Fuel tank connection layouts*)*. If any fuel manifolds are used (although their use is optional) they must be inspected and tested against the same standards as fuel hoses.

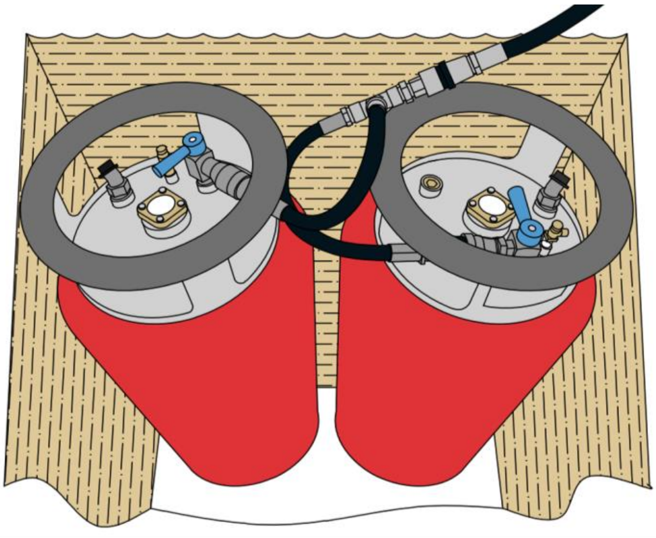

Figure 15: Application of a fuel hose/manifold assembly (Source: Schroeder Flight Manual)

1.18.5 EASA regulation – Certification Specification for Hot-air balloons

EASA publishes important up-to-date regulation relevant to specific areas in the form of a series of e-rules. They include the text of the current rule, the relevant AMC (Accepted Means of Compliance) and GM (Guidance Material), as well as CS (Certification Specification) standards.

Pursuant to AMC 31HB.46(b), the commercially available copper couplings, fittings or joint bolts used in conventional gas systems must not be used in hot-air balloon systems such because such parts do not meet the level of strength (robust layout) required in aviation.

The parts which connect fuel tanks such as manifolds (including T-pieces) and hoses should be designed in such manner that they should not be exposed to tensile load even in the case of significant deformation of the basket during a hard landing. Stiff extensions should possibly be avoided during planning. If stiff extension is used, and it may fracture upon a collision, appropriate protection must be provided. Such extreme forces must also be taken into account as a passenger grabbing the fuel hose during landing or abrasion to the fuel hose caused by another line. Hoses should be protected (e.g. with steel braid) to make them resistant to such effects.

It should be taken into account that those elements of the fuel system which are outside the protected areas of the load frame and the basket may bump to obstacles or be exposed to other extreme loads.

1.18.6 Pilot flame tanks

With rare exceptions, hot-air balloons use a single pilot flame tank, with only one coupling to the pilot flame burner. Such connection is done using a special self-locking quick-release coupling (specifically designed for this purpose) which can be disconnected with a quick movement, thus putting the flame out.

The Schroeder burner used in the hot-air balloon accident had two pilot flame connections (instead of the special self-locking quick-release coupling) with a high throughput service coupling type REGO.

1.18.7 Inner arrangement of the hot-air balloon

Figure 16: Arrangement in the basket involved in the occurrence, right before the take-off

The photos taken by the passengers right before the take-off show that the gas hoses in the basket of the aircraft sagged deeply into the passenger area *(Figure 16).* The gas bottle outlets were not turned in towards the basket wall and the gas hoses were also tied to the basket walls occasionally with plastic cable ties only. The hose of a pilot flame bottle was not secured in the basket and its lowest point was situated within stepping height (from the bottom of the basket). Thus, there was the possibility that occupants grab it or bump into it with a foot.

1.18.8 Passengers' locations in the basket

Figure 17 shows the positions of the passengers and the pilot in the basket during landing. According to information available to the IC, the passengers were standing facing the inside of the basket; therefore, during landing, Passenger 1 was facing backwards, while the two other passengers were facing side wards relative to the direction of the landing. Passenger 2 (situated on the pilot's right) was squatting, while the other two passengers were waiting for the touchdown with their knees bent. The fuel hoses placed inside the basket were located in close proximity to the occupants, in unsecured or partly secured state, while the couplings on the fuel bottles were not pointing to the basket walls but typically to the inside of the basket. Neither the fittings nor the hoses located close to the passengers were separated from the passengers therefore there was the chance that such items be close at hand, even if inadvertently. Fuel tank № 3 was behind the back of Passenger 2 (squatting on the pilot's right) where the thread adapter broke.

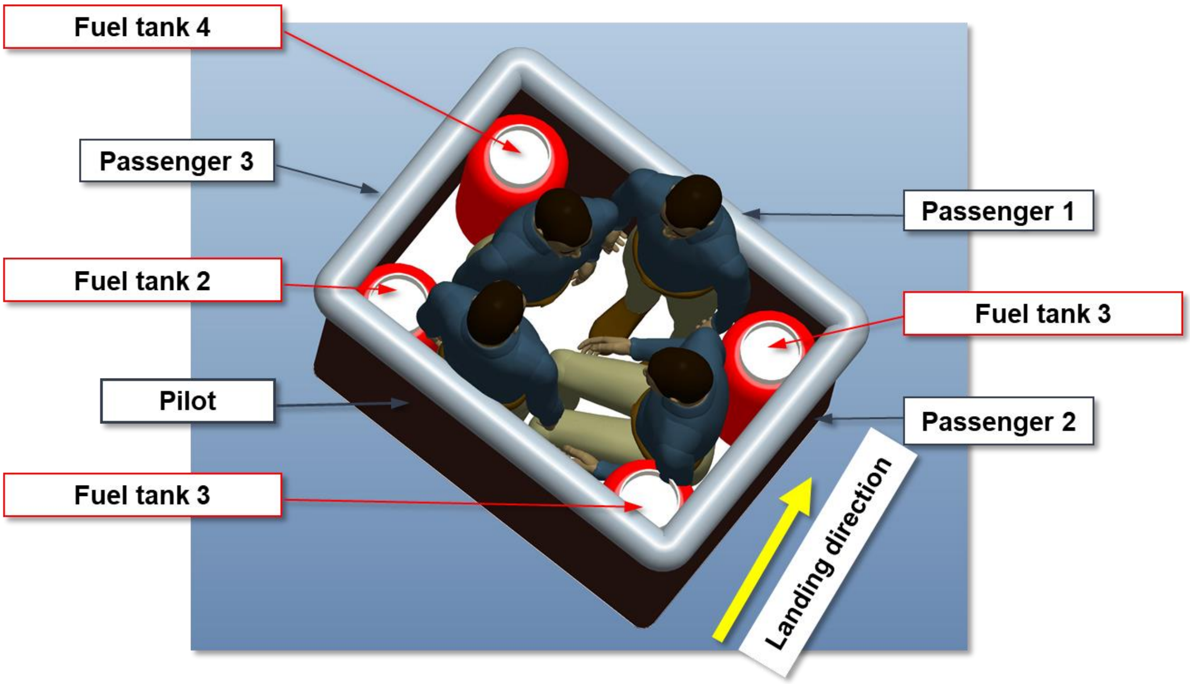

Figure 17.: Locations of the occupants in the basket during the landing

1.18.9 Legislation regarding the pilots' responsibility

Pursuant to Point 1.c Annex IV, Regulation EC no 216/2008: *"The pilot-in-command must be responsible for the operation and safety of the aircraft and for the safety of all crew members, passengers and cargo on board."*

1.18.10 Training environment

According to information available to the IC, there is no officially approved, current training material for hot-air balloon pilot training. The latest relevant textbook (which is still in use) is the one called *Tansegédlet Hőlégballonrepülők Részére* (Guidance Material for Hot-air balloon Pilots), issued in 1983 by the former *Magyar Honvédelmi Szövetség Országos Központjának Repülőfőnöksége* (Aviation Agency of the National Center of Hungarian Defense Association).

According to the above-mentioned Guidance Material:

"Touch-down:

…

- *Put out the pilot flame and shut the gas valves off – if you have the time;*

…

Fire

…

"The procedure to follow in case of fire shall start with fire extinguishing and preventing fire from spreading. Fire shall be extinguished using the fire extinguisher (part of the equipment) and other available means.

…

The next step is to stop any fire and flame in the balloon, i.e. shut the burner off, shut the gas line off, and start landing.

Landing must be started even if fire extinguishing fails: open the parachute valve or keep it open, depending on the flight altitude. Do not forget that the fire will give extra heat to the *envelope, i.e. lift may increase and the aircraft may start ascending. Therefore, in the case of a fire which started on or near the ground, any delay in action may result in climbing to such heights where occupants cannot safely leave the aircraft without parachutes.*

It is advisable to consider the following instead of the above activities:

- *jump out of the basket (if the fire occurred on or near the ground), up to heights of 20-30 metres, in such manner that you hold the parachute valve line firmly, because that will moderate ground impact and deflate the envelope. (Supposing that the parachute valve line is in good state, possibly has a steel core, and does not run through the fire);*
- *jumping out of the basket and free fall (i.e. without holding the line) from a height of 10 metres: probable fractures of bones upon ground impact, while the same jump from about 20 metres or more results in fatal injuries;*

…

- *the pilot in command may only leave the basket before other occupants if he/she can provide the possibility to escape for others, i.e. if he/she can clearly provide the evacuation or descent of the hot-air balloon by jumping out.*
- *if the fire is extensive (damaged gas bottle) and fire extinguishing seems impossible and the balloon starts to climb then occupants should risk jumping out even if it entails severe injuries."*

Chapter II 6.4 of the manual issued to and approved for the original configuration of the hot-air balloon included a description of the approach and landing, which also requires that the pilot flame and the bottled should be shut off prior to landing.

1.19 Useful or Effective Investigation Techniques

Passengers took photos and videos of the pre-flight preparations as well as of the flight. Relying on such objective data, the IC was able to reconstruct the pre-flight layout of the basket as well as the flight activity.

A fairly large area had to be searched in order to make the parts and accessories of the hot-air balloon available to the IC. Owing to a joint effort with the police and to their specific search device, the coupling snapped off from the fuel tank № 3 was found as well as its fittings. Search activity was difficult because most of the area concerned was covered with corn in its vegetation period. The parts fallen in the high-grown vegetation could only be identified from close range only. Another significant part of the area was covered with elderberry shrubs, which was also difficult for the team to search. Due to complexity of the search work and the size of the area, the IC asked Fejér County Auxiliary Police Association for help. The size of the area searched in joint effort with the Auxiliary Police was about 30 hectares. The missing fuel bottle № 2 was finally found upon completion of the harvest works.

The IC applied computer-aided part modelling to study the characteristic dimensions of the pipe coupling of the hoses connecting the fuel tanks and those of the quick-release coupling applied.

2. Analysis

2.1 The PIC's rating and the airworthiness of the hot-air balloon

The PIC of the hot-air balloon had a valid licence for private flight and as balloon flight instructor, and had a valid medical certificate. He had significant experience with flying hot-air balloons, but he had no licence to perform commercial activity.

The PIC of the hot-air balloon did not fully comply with the mandatory requirements either as the chairperson of the association or as the pilot of the aircraft. He flew the aircraft with a configuration which was different from the configuration approved in the airworthiness certificate, and the elements of the fuel system did not meet the manufacturer's specifications described in Chapter 1.18.5 (neither the parts used, nor their arrangement).

2.2 Relevant flight parameters

According to data obtained during the safety investigation, the total flight time was 53 minutes and the distant covered was approximately 12 km. The average speed of the hot-air balloon was 13.85 km/h, which roughly equals the average wind speed, due to the nature of the flight.

2.3 Fuel system

The couplings of the outlets of the fuel tanks were not turned towards the basket walls. The fuel hoses, which were too long compared to the size of the basket and only partially secured, as well as the unsecured hoses (placed within stepping height from the bottom of the basket) of the pilot flame bottles (1.18.8) made it possible for occupants to grab or tread on, thus exposing such items to potential extreme loads. In addition, the fracture of the improperly applied low grade thread adapter could have occurred upon load from a concentrated force of 105N (approx. 10.5 kg) on the given load, according to the IC's calculations. Taking into account the body mass of an average adult and the grasping force applied, the given system of the fuel bottles, quick-release couplings and hoses implied significant flight safety risks.

2.4 Landing

During landing, passengers turned facing the inside of the basket, following the Pilot's instructions, i.e. the passengers at the touch-down side were facing backwards (*Figure 17*). The IC supposes that, as an effect of the jolt, which was sudden and more intense than expected according to their account, the passengers instinctively tried to get a grip. Presumably, one of the passengers fell back against the incorrectly routed hose of the fuel bottle № 3, which resulted in fracture of the thread adapter, or she inadvertently grabbed the hose itself, and the resulting pull might have caused the adapter to break. According to the IC, when the hose are properly routed and fastened (short wall jointing in case of jointing), passengers cannot grab / step on them, so extreme loads cannot occur and, if used proper and robust material is used, the otherwise improperly installed adapter will not break even when a greater force is applied. .

According relevant instructions in the aircraft's flight manual and the Guidance Material *(1.18.10)* the gas bottles should have been shut and the pilot flame put out during landing. By failing to observe the instructions in the aircraft's flight manual, the pilot endangered flight safety. In the IC's opinion, the accident could most likely have been avoided by observing the instructions in the aircraft's flight manual.

The liquid fuel gas, which began to flow freely out due to facture of the improperly used thread adapter evaporated (turned gaseous) as an effect of the sudden pressure fall. This process extracted significant heat from the environment, which was concentrated behind Passenger 2, which might have caused frostbite to her back, which is similar to burn injuries.

The outflowing gas quickly formed an opaque fog in the basket *(1.16)*. Due to the T-piece used, the fuel bottles and hoses constituted a system that was difficult to oversee and manage, because the two fuel bottles were connected along the long and not along the short side of the basket *(1.18.5)*.

By mistake, the pilot attempted to stop the gas flow by shutting off the valve (which was in off position anyway) of the tank № 3 connected to the jointed line, while the gas was actually flowing out of the tank № 4 through the T-joint *(1.1, Figure 4, Figure 15)*. In the case of a less complicated system with no joint hoses, the supply to the flame could have been stopped by shutting the appropriate gas bottle.

Quick shutting off of the pilot flame was not a viable option, because the pilot flame connections included high-throughput service couplings (for liquefied gas) REGO instead of the quick-release coupling installed and approved by the company Schroeder. As soon as the outflowing gas had filled the basket (within a few seconds) and formed a large quantity of flammable mixture, the pilot flame ignited it. In the PC's opinion, if a standard pilot flame quick-release coupling had been used, there would have been a chance to prevent the fire.

After his unsuccessful effort to stop the gas flow, the pilot made no further attempt to extinguish the fire or shut the gas line. The complicated layout of the system and the ignition of the gas mixture had probably made it impossible it by then. Then the pilot decided to leave the basket in flames immediately, but he did not give any instruction to other occupants of the basket.

According to the IC's position, if the pilot had managed to grab and hold the parachute valve line and jump out of the basket, thus deflating the envelope, then he could significantly have reduced the lift generated by the fire. That would have delayed the repeated ascending of the hot-air balloon, leaving more time for the emergency evacuation of the basket.

2.5 Survival aspects and methods

When the pilot let the parachute valve line go during the attempt to stop the gas leak, the hot air could not leave at the top of the envelope anymore. In the meantime, the continuously fed intense flame further heated the air in the envelope, thus increasing lift. As a result of the occupants' escaping, the total mass of the basket decreased quickly and significantly, which, in addition to the increased lift, led to a sudden climb of the hot-air balloon at an accelerated rate.

The IC's position is that in the circumstances given, occupants had only a couple of seconds to escape, and the escape of each occupant significantly reduced the survival chances of the occupants remaining in the basket. According to his experience with hot-air balloons, the pilot identified the dangerous situation sooner and, despite relevant requirements *(1.18.9, 1.18.10)* – he was the first to leave the basket, leaving his passengers behind.

Seeing the pilot escape, the two taller and younger passengers were still able to follow him; owing to their body heights, they probably were able to reach the frame which helped them leave the burning aircraft. But subsequently, due to the basket's even faster climb, the third passenger had no time left to escape.

3. Conclusions

3.1 Findings

3.1.1 Aircraft

According to its documents, the aircraft was equipped according to the rules and regulations in effect as well as to accepted procedures, but the remains showed that it was not operated according to the configuration list approved as per the last airworthiness review. As regards the fuel system, neither the parts used nor the design of their installation met the specifications given in the flight manual *(1.6.3)*.

3.1.2 Pilot in command

The pilot held a Balloon Pilot Licence at the time of the accident, but had no licence to pursue commercial activities *(1.5.1)*.

3.1.3 Air operations

The take-off mass of the hot-air balloon was within the specified limit *(1.6.4; 1.18.5)*.

The aircraft was sufficiently refuelled for the flight *(1.1)*.

The flight took place according to the flight plan, at daytime, in good visibility conditions. *(1.7)*

The Phoenix HRE association held no licence to perform commercial activities at the time of the accident *(1.17)*.

3.1.4 Medical and pathological information

There was no evidence that physiological factors or other impediments had affected the legal capacity of the Pilot *(1.13).*

3.1.5 Chances of survival

After the pilot and two passengers jumped out, the aircraft became much lighter, and began an intensive climb with its basket on fire. As a result, the third passenger had no chance to escape anymore *(1.15)*.

3.2 Causes

During the safety investigation, the IC concluded that the direct cause of the accident was the ignition of the escaping gas due to the fracture of the thread adapter of fuel tank № 3.

Furthermore, the IC identified the following indirect causes and contributing factors:

3.2.1 Causes leading to the fracture of the adapter:

- use of an unauthorized fuel hose/manifold assembly and a thread adapter;
- the possibility of extreme stress on the hose assemblies due to the irregular routing and fastening of the hose. (unintentionally clinging to or stepping on the hose);

3.2.2 Causes leading to the gas ignition:

- the pilot flame valve and the fuel valves were not shut off in the last phase of the landing.
- incorrect tank handling due to chaotic fuel system caused by the fuel hose/manifold assembly application and irregular routing;

3.2.3 Contributing factors leading to the accident and influencing its outcome:

- using a different basket and burner than specified in the configuration list and airworthiness certificate;
- the Pilot, by releasing the balloon unloading rope and leaving the aircraft first, did not do everything possible to ensure that the passengers of the hot air balloon could leave the basket safely.

4. Safety Recommendations

4.1 Actions Taken by the Operator/Authority During the Investigation

Neither the operator nor the regulatory authority took action relating to the accident during the investigation performed by TSB.

4.2 Interim Safety Recommendation(s)

The IC of the TSB found no grounds to issue an interim safety recommendation.

4.3 Concluding Safety Recommendation(s)

Such cases can be avoided by complying with the relevant rules and regulation. The IC of the TSB found no grounds to issue a safety recommendation.

Budapest, 20 September, 2022

…………………………
Klementina Joó
Investigator-in-Charge

…………………………
Zsuzsanna Nacsa JD
IC Member