MINISTRY OF CONSTRUCTION AND TRANSPORT

TRANSPORTATION SAFETY BUREAU

FINAL REPORT

Travel Service a.s., Boeing 737-8K5, OK-TVP
Budapest Liszt Ferenc International Airport (LHBP),
23 March 2018

Accident
2018-128-4

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	The Boeing Company, USA
	Model	Boeing 737-8K5 (hereinafter: B737-800)
	Registration	OK-TVP
	Operator	Travel Service a.s., Czechia
Occurrence	Date and Time	23 March 2018, 04:23 LT
	Location	Budapest Liszt Ferenc International Airport (LHBP)
Injuries		1 person
Damage to Aircraft		No damage

The OK-TVP registered B737-800 arrived from Prague to Budapest Liszt Ferenc International Airport (LHBP) on 23 March 2018, at 03:17, to provide a relief flight for the ISR716 flight due to the crack of the windshield of the originally scheduled aircraft, OK-TSO that was planned to perform the Budapest-Tel-Aviv flight on 22 March at 19:15. Upon arrival, OK-TVP was prepared for the flight and the passengers were boarded. The push-back from gate № 33 started at 04:20 am. Shortly before the completion of the push-back, due to a technical malfunction, the pushback car (Douglas TBL-180, registration number: MG-TBT-006) began to emit heavy smoke which spread towards the aircraft's engines which were already running. The smoke was vented into the passenger cabin through the engine by the aircraft's air conditioning system. Panic developed in the rear part of the cabin, because passengers had mistakenly identified the smoke as a result of fire, which resulted in an evacuation by the flight attendants at the aft galley via the rear left evacuation slide, without informing the flight crew. During the evacuation, one passenger sustained a serious, life-threatening head injury; the aircraft was not damaged.

Figure 1: The aircraft involved in the occurrence, after the scene was changed

In the course of its investigation, the IC concluded that the direct cause of the accident was the lack of communication from the cabin crew on duty in the aft galley to the rest of the crew, and identified the panic on board caused by the misjudgement of the origin of the smoke as an indirect cause.

As contributing factors, the IC identified other human factors than those mentioned above – related to pilots and passengers and the technical failure of the pushback tug.

During the investigation of the TSB of Hungary, the Operator amended the Cabin Crew Operations Manual (CCOM).

The IC found no grounds to issue a safety recommendation.

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Definitions and abbreviations

1R	*Flight attendant on duty in the front right-hand side of the aeroplane*
2L	*Flight attendant on duty in the aft left-hand side of the aeroplane*
2R	*Flight attendant on duty in the aft right-hand side of the aeroplane*
AEP	*Airport Emergency Plan*
Aerodrome	*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;*
AMS	*Airport Medical Service*
AOCC	*Airport Operation Control Center*
APD	*Airport Police Directorate*
APU	*Auxiliary Power Unit*
ARP	*Airport Reference Point*
A-SMGCS	*Advanced Surface Movement Guidance & Control System*
ATPL	*Airline Transport Pilot Licence*
CCOM	*Cabin Crew Operations Manual*
CPL	*Commercial Pilot Licence*
Cpt	*Captain, Pilot in Command*
EASA	*European Union Aviation Safety Agency*
Flight plan	*Specified information provided to air traffic service units, relative to an intended flight or portion of flight of an aircraft;*
FO	*First Officer*
HC	*HungaroControl (Hungarian Air Navigation Services Pte. Ltd. Co.)*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
IR	*Instrument Rating*
ISR	*Israir airline, lessor*
Kbvt.	*Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*
LT	*Local Time*
MAG DTM	*Malév Ground Handling Duty Manager*
MEP(land)	*Multi Engine Piston (land)*
MTI	*Ministry of Technology and Industry*
MTOM	*Maximum Take-Off Mass*
NFM	*Ministry of National Development*
NKH LH	*National Transport Authority Aviation Authority, Hungary (until 31 December 2016)*

NNI	*National Bureau of Investigation, Hungary*
OM	*Operations Manual*
PF	*Pilot Flying*
PM	*Pilot Monitoring*
Ramp Agent	*A ground support person on duty at the time of the occurrence, who performed the process of pushing the aeroplane back and had the appropriate qualification and authorisation*
RRI	*Airport Police Department*
SCC	*Senior Cabin Crew*
SEP(land)	*Single Engine Piston (land)*
SMS	*Safety Management System*
TSB	*Transportation Safety Bureau*
TVL	*Travel Service, operator, airline*
UTC	*Coordinated Universal Time*

General information

All times indicated in this report are in local time (LT). LT at the time of the occurrence: UTC+ 1 hour.

Geographic locations throughout this document are provided in the WGS-84 standard.

The capitalised positions used throughout this document (e.g. Captain, Pilot, etc.) refer to the particular persons concerned in the event investigated.

The format and content of this report is in harmony with Chapter 6 of Annex 13 of Act XLVI of 2007 promulgating the Appendices to the Convention on International Civil Aviation, signed in Chicago on 7 December 1944. Appendix, as well as with the requirements set out in ICAO Doc 9756 Part IV.

Reports and Notifications

The occurrence was reported to TSB's call center at 04:34 on 23 March 2018, by the on-call officer of BUD AOCC.

TSB of Hungary notified the following organisations:

- Accident Investigation Authority of the State of Registry on 23 March 2018 at 10:38.
- Accident Investigation Authority of the State of Manufacture on 23 March 2018 at 10:43.
- ICAO on 23 March 2018 at 10:47.
- EASA on 23 March 2018 at 10:54.
- Accident Investigation Authority of Israel on 23 March 2018 at 11:23.

The following of the notified foreign organisations appointed an accredited representative for the investigation.

- State of Registry of the aircraft
- EASA
- Accident Investigation Authority of Israel

Investigation Committee

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

Investigator-in-Charge	Gábor Erdősi	investigator
Member	Klementina Joó	investigator

Overview of the Investigation Process

Receiving event notification, the on-duty manager of the TSB ordered an immediate dispatch to the site.

The TSB of Hungary classified the occurrence as an accident due to the extent of the injury.

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 to which Regulation (EU) 2018/1139 of the European Parliament and of the Council applies shall be the subject of a safety investigation in the Member State in which the accident or serious incident occurred.*

2. *Where an aircraft to which Regulation (EU) 2018/1139 applies and which is registered in a Member State is involved in an accident or a 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 consequences of the accident or serious incident and the lessons it expects to draw from such investigations for the improvement of aviation safety.*

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.*

5. *By way of derogation from paragraphs 1 and 2 of this Article, the responsible safety investigation authority may decide, taking into account the expected lessons to be drawn for the improvement of aviation safety, not to initiate a safety investigation when an accident or serious incident concerns an unmanned aircraft for which a certificate or declaration is not required pursuant to Article 56(1) and (5) of Regulation (EU) 2018/1139, or concerns a manned aircraft with a maximum take-off mass less than or equal to 2 250 kg, and where no person has been fatally or seriously injured.*

Based on the site survey findings, with regard to Article 5 (1) 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 site survey and the investigation the IC has taken the following steps:

- took photos;
- seized the aircraft's on-board voice recorder and had it read out with the assistance of the Czech accident investigation authority;
- obtained the following items, among other things:
  1. footage from the airport camera relevant to the accident;
  2. radio and telephone communications from HC, recorded at the time of the accident;
  3. A-SMGCS recordings of airport movements at the time of the accident from HC;
  4. documents from the Airport Police Department on-site investigation and subsequent witness interviews;
  5. the ground handling entity's servicing documents;
  6. the training syllabus for the ground handling entity's flight operations officers and aircraft ground support equipment operators, together with an extract of the related training material;
  7. training and examination documents of the ground handling organisation's employees involved in the occurrence;
  8. the ground handling organisation's initial and final report of the occurrence;
  9. documents since the time the vehicle was put into service;
  10. the aircraft operator's Operations Manual (OM Part A, B, C, D, CCOM) in force at the time of the accident;
  11. the aircraft operator's preliminary and final reports on the occurrence, including the internal action taken after the accident;

12. crew's reports;
13. the results of the forensic investigation of the defective pushback tug carried out by an expert invited by the police;
14. the Airport's final report on the case;

- interviewed people directly involved in the accident.

Investigation Principles

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

- 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 identified between safety investigators appointed to the IC. No investigator assigned with 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.

On 22 November 2022 the IC sent the Draft Report for comments – among the other parties – to the operator and asked them to forward the Draft Report for comments to the crew concerned.

Within the legal deadline in response to the Draft Report, comments from the Operator and their legal representative have been received articulating different alternative opinions.

Subsequently, on 23 March 2023, the IC held a meeting with the legal representative of the Operator in order to clarify the divergent opinions.

Following the meeting the Operator – after asked by the IC – reported, that despite the request of the IC they had not forwarded the Draft Report to the crew concerned for comments, so the IC sent them the Draft Report directly on 28 March, 2023.

The crew members that replied did not express their separate opinion, but agreed with the comments sent to the IC by the Operator in January, and also contacted the IC through the accredited representative of the Czech accident investigator branch.

The IC tried contacting the Czech accredited representative multiple times to coordinate the opinions, but did not succeed.

The IC prepared the final report by considering the opinions and comments received on the draft report as revised by parties involved.

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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

1.1.1 Before the accident

The OK-TSO registered B737-800 (flight number: ISR715) arrived at Budapest Liszt Ferenc International Airport the day before the accident at 18:48 on 22 March 2018, for the scheduled Budapest-Tel-Aviv ISR716 flight at 19:15. The crew of the arriving flight reported that the RH side sliding window of the cockpit was cracked. The maintenance staff, which was called to rectify the fault, informed the aircraft crew about the options. Based on this information, the airline representatives decided to send another aircraft from Prague to Budapest to complete the flight in order to reduce the delay. OK-TVP, the intended relief flight landed at 03:10 on 23 March 2018 and was parked at gate № 33 at 03:17. *(Passengers by this time were already waiting for more than 9 hours at the airport.)* After that, the preparation of the aircraft began, and boarding was started for the Budapest-Tel Aviv Flight: ISR716.

1.1.2 Course of the accident

The IC reconstructed the timeline of the accident from witness statements, airport camera footage, data from the aircraft's cockpit voice recorder and radio traffic data recorded by the HC (*Figure* 2). The timeline illustrates the events leading to the accident from the start of the push-back (4:20 am) until the arrival of the ambulance (4:36 am).

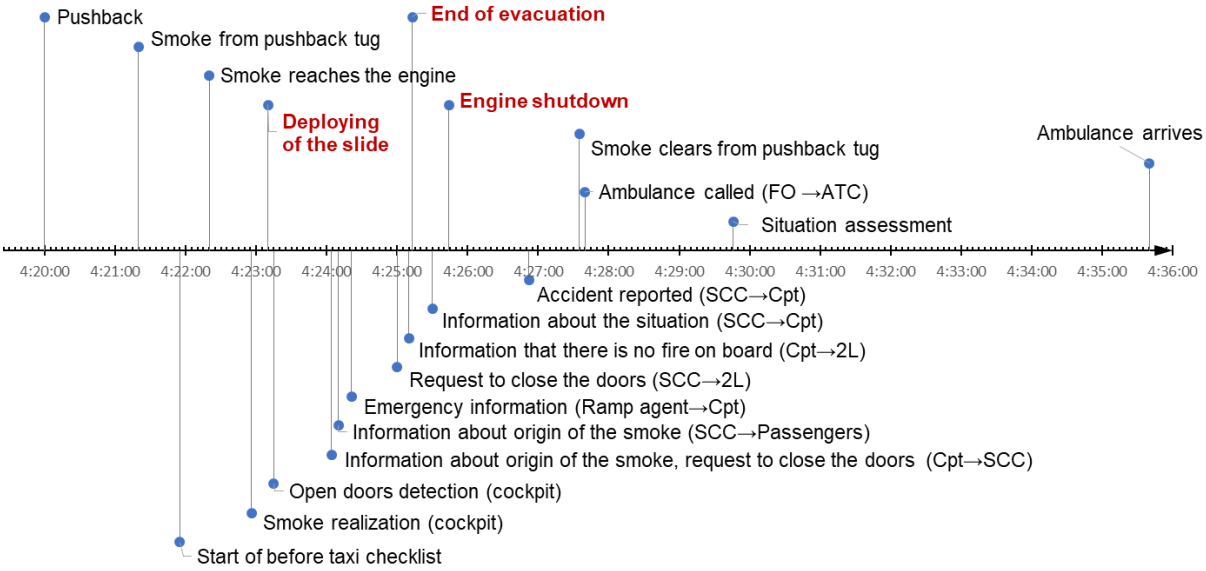


Figure 2: Timeline of the accident

After boarding, at approximately 04:15 on 23 March 2018, the aircraft was connected to the pushback tug (which later failed during the accident) operated by the ground handling organization, and was authorised to start push-back from gate № 33 at 04:20. Following the start of the push-back, the flight crew started the right (N°2) engine, after which, according to the camera footage, a light smoke stream was seen to come from the pushback tug. Almost at the end of the push-back procedure (pull phase), and during the start-up of the other engine (N°1), the amount of smoke emitted by the tug increased considerably and was flowing towards the aircraft with the already working engines. Meanwhile, the pilots were carrying out their before taxi checklist as required when they noticed the mentioned malfunction of the pushback tug. When the smoke from the tug reached the engines that

were already running the smoke was transferred to the passenger cabin through the switched on air conditioning system. As a result, the passengers at the rear of the cabin, mistakenly identifying the smoke as a result of fire, panicked got up from their seats, started crowding towards the aft exits and demanded that the cabin crew (2L and 2R) at the rear to allow them to leave the aircraft as soon as possible. The aft flight attendants also saw and smelled the presence of smoke, which – influenced by the passengers – they also mistakenly identified as a result of fire. In the panic that ensued, the aft doors on both sides were opened by the flight attendants without consulting with or informing the pilots and, after assessing the external environment, they decided to block the right side exit and began the evacuation on the aft left evacuation slide with both engines running.

In the cockpit, the pilots realised the open position of the two aft doors, due to the caution signals. The Captain informed the flight attendants in the front galley of the open condition/indication of the aft doors via the Interphone and asked them to close the doors. The Ramp Agent, in order to save time, first tried to signal to the pilots by hand to stop the engines, and after an unsuccessful attempt, informed the pilots by radio (reconnected headset) that both aft evacuation slides were open and there were passengers on the ground and firmly asked them twice to shut down the engines, this was confirmed by the captain. After the confirmation the pilots first started the APU and then shut down the engines after the APU started providing electric power. The shutdown of the engines took place about 2.5 minutes after the opening of the slides. In the meantime, the driver of the malfunctioning pushback tug moved away from the aircraft towards the safety zone of gate № 34. The emergency shutdown of the tug did not work, but after two minutes it stopped automatically, which reduced the amount of smoke. Following the Ramp Agent's information, the Captain announced the cabin crew in a firm tone that there was no fire on board and told that everyone should take their seats. The evacuation was stopped by 2L and 2R only after the announcement. During the evacuation, approximately 40 people, including the deadhead crew, were evacuated via the slide. During the evacuation, 1 passenger suffered life-threatening injuries. The accident was reported to the pilots almost 4 minutes after the opening of the slides, after the report an ambulance was immediately requested from air traffic control. The ambulance arrived on the scene approximately 8 minutes after the request from the First Officer (PM). After the preliminary medical examination, the injured passenger was taken to the Trauma Care Unit of the Merényi Hospital at 5:20 am, with injuries that were expected to heal after 8 days. The airport fire service also attended the scene, but their intervention was not necessary.

1.2 Injury to Persons

	Crew		Passengers	**Summary**	Others
	Flight Crew	Cabin Crew			
Fatal	-	-	-	-	-
Serious	-	-	1	1	-
Minor	-	-	-	-	-
Not injured	2	4	160	166	
Summary	**2**	**4**	**161**	**167**	

1.3 Aircraft Damage

The aircraft was not damaged related to the accident, but the LH side evacuation slide was damaged during the evacuation of the passengers, with a 5 mm long tear on the outside of the left inflatable tube.

1.4 Other Damage

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

1.5 Personnel Information

1.5.1 Pilot-in-Command

Age, nationality, gender		64 years, Czech, male
Licence data	type	ATPL (A)
	professional valid until	28 February 2019
	ratings	IR
Certificates		B737 300-900, A320, A310, ATR
Medical class and valid until		Class 1, 13 April 2018
Flight hours / take-offs	in the preceding 24 hours	1 hour 8 minutes / 1
	in the preceding 7 days	1 hour 8 minutes / 1
	in the preceding 90 days	153 hours / 26
	total:	over 17,000 hours
	total on this type:	1076 hours
Aircraft types flown:		B737 300-900, A320
Person flying / providing ground service for the aircraft at the time of the occurrence		Pilot Flying (PF)
In the preceding 48 hours		rest period: 36 hours 30 minutes duty time: 1 hour 8 minutes
Date of most recent training		January 2018
Results of most recent training, mandatory and periodic checks		06 January 2018, passed

1.5.2 First Officer

Age, nationality, gender		29 years, Czech, male
Licence data	type	CPL (A)
	professional valid until	30 September 2018
	ratings	IR (SE, ME)
Certificates		B737 300-900, SEP (land), MEP (land)
Medical class and valid until		Class 1, 01 June 2018
Flight hours / take-offs	in the preceding 24 hours	1 hour 8 minutes / 0
	in the preceding 7 days	7 hours 13 minutes / 1
	in the preceding 90 days	107 hours 51 minutes / 14
	total:	1226 hours
	total on this type:	806 hours
Aircraft types flown:		B737 300-900

Person flying / providing ground service for the aircraft at the time of the occurrence	Pilot Monitoring (PM)
In the preceding 48 hours	rest period: 48 hours duty time: 1 hour 8 minutes
Date of most recent training	02 February 2018
Results of most recent training, mandatory and periodic checks	02 February 2018, passed

1.5.3 Flight Attendants

Senior Cabin Crew (SCC) data

Age, nationality, gender		50 years, Hungarian, female
Licence data	type	Flight Attendant
	professional valid since	15 May 2015
	on the type involved	26 June 2017
Flight hours / take-offs	in the preceding 24 hours	did not fly
	in the preceding 7 days	did not fly
	in the preceding 90 days	98 hours 16 minutes

Cabin Crew Member (1R)

Age, nationality, gender		26 years, Czech, female
Licence data	type	Flight Attendant
	on the type involved	29 May 2017
Flight hours / take-offs	in the preceding 24 hours	1 hour 8 minutes
	in the preceding 7 days	12 hours 24 minutes
	in the preceding 90 days	150 hours 24 minutes

Cabin Crew Member (2L)

Age, nationality, gender		43 years, Czech, female
Licence data	type	Flight Attendant
	on the type involved	14 May 2017
Flight hours / take-offs	in the preceding 24 hours	1 hour 8 minutes
	in the preceding 7 days	1 hour 8 minutes
	in the preceding 90 days	190 hours 34 minutes

Cabin Crew Member (2R)

Age, nationality, gender		30 years, Czech, female
Licence data	type	Flight Attendant
	professional valid since	01 June 2013

	on the type involved	19 June 2017
Flight hours / take-offs	in the preceding 24 hours	1 hour 8 minutes
	in the preceding 7 days	1 hour 8 minutes
	in the preceding 90 days	122 hours 5 minutes

1.5.4 Ground Personnel

Age, nationality, gender		44 years, Hungarian, male
Licence data	type	Flight Operations Officer licence
	professional valid until	04 August 2019
	ratings	Turnaround Coordinator, Load Control Officer
Categories and ratings		Ramp Agent, Tow Supervisor
In the preceding 48 hours		rest period: 48 hours duty period: on 21/03/2018: from 11:00 to 23:30, on 22/03/2018: from 18:00 to 06:30
Date of most recent training		10/10/2017
Experience in the given position		~ 10 years

1.5.5 Ground Support Equipment Operator's data

Age, nationality, gender		30 years, Hungarian, male
Licence data	type	Ground Support Equipment Operator
	professional valid until	08 August 2018
	ratings	Basic de-icing training
Categories and ratings		Ramp Agent, Tow Supervisor
In the preceding 48 hours		rest period: 48 hours duty period: on 21/03/2018: from 05:15 to 18:00 on 22/03/2018: from 18:00 to 06:45
Date of most recent training		16/11/2017
Experience in the given position		6 months

1.6 Aircraft Information

1.6.1 General Information

Class	Fixed wing aircraft (MTOM > 5700kg)
Manufacturer	The Boeing Company
Model	Boeing B737- 8K5
Year of manufacture	2002
Serial number	32907
Nationality and registration	OK-TVP

marks

State of registry	Czechia
Date of registry	16/05/2017
Owner	DCAL 5 Leasing Limited, Ireland
Operator	Travel Service a.s., Czechia

	Flight hours	Take-offs
Since manufacture	54265	20716
Since last inspection	1 hour 07 minutes	1

1.6.2 Airworthiness Certificate

Airworthiness Certificate	Number	6225
	Date of issue	17/05/2017
	Valid until	until withdrawal
	Restrictions	none

Airworthiness Review Certificate	Number	6225
	Date of issue	17/05/2017
	Valid until	16/05/2018
	Date of latest review	17/05/2017

In the course of the inspection no indication was found concerning any failure of a structural element or any aircraft systems prior to the occurrence with effect to the outcome of the event.

1.6.3 Aircraft loading data

Aircraft data had no influence on the course of events.

1.6.4 Malfunctioned pushback tug

Name of the malfunctioned equipment	Douglas TBL 180, pushback tug
Registration plate №	MG-PBT-006
Manufacture date	1999
Model	Tugmaster TBL 180
Manufacturer	Douglas Equipment Limited Cheltenham, (United Kingdom)
Identification number	DK 2352/TBL 180/N 4669
Make and type of engine	Perkins 1004.40T
Layout	in-line, 4-cylinder, Diesel
Performance	80.5 kW/2400 r/min

According to its maintenance documents, the pushback tug manufactured in 1999 underwent continuous servicing and mandatory (250 operating hours) maintenance.

Prior to the occurrence, the last inspection of the tug was on 19/03/2018. During the last maintenance, the air filter, windscreen wiper and oil were changed and the antifreeze was refilled. The vehicle was returned to service on 22/03/2018, the day before the accident.

The pushback tug was seized by the police after the accident and a forensic expert was appointed to assess its technical condition and determine any technical problems. The follow-up inspection with the forensic expert was carried out without informing the IC, and its results were made known to the IC through the material provided by the police. The forensic investigation revealed a fracture of the tug's turbo shaft which resulted in releasing a large amount of oil from the engine into the exhaust system and into the combustion chamber. For a detailed description see chapter (1.17.2.2 *Pushback tug maintenance*).

1.6.5 On-board Warning Systems

The aircraft was equipped with a transponder, on-board traffic alert and collision avoidance system (TCAS), and enhanced ground proximity warning system (EGPWS).

The systems worked in compliance with the requirements, and the IC made or received no comment relating to the irregularity of their operation.

1.7 Weather Information

The event occurred in the early hours of the morning, just before sunrise. The ambient light at the apron was characterised by the darkness of dawn and the artificial yellowish lights. At Budapest Liszt Ferenc International Airport, the METAR at the time of the event was:

LHBP 230330Z 32004KT CAVOK M02/M05 Q1007 NOSIG
LHBP 230400Z 32004KT CAVOK M02/M05 Q1007 NOSIG

On 23 March 2018, between 03:30 and 04:00 UTC, the outside temperature was cool -2°C, matching the early spring morning weather, accompanied by a light north-westerly 320 degrees wind at 4 knots. The dew point was -5°C and the air pressure was 1007 hPa.

1.8 Aids to Navigation

The equipment items specified in the type certificate were installed on the aircraft, and the IC made or received no comment relating to the irregularity of their operation.

The IC made or received no comment relating to the irregularity of the operation of the ground-based equipment items.

Navigation equipment had no influence on the course of events.

1.9 Communication

The equipment items specified in the type certificate were installed on the aircraft, and the IC made or received no comment relating to the irregularity of their operation.

The IC made or received no comment relating to the irregularity of the operation of the ground-based equipment items which proved to be serviceable.

The handheld radio communication systems of the air traffic control and airport services were operable.

1.9.1 On-board communication

Communication on board an aircraft can take place in two ways: verbal communication between crew members on duty next to each other, and with the Interphone between different locations.

The on-board communication system of the Boeing 737-800 aircraft includes the cockpit communication system (Flight Interphone), the common communication system for cockpit - passenger area - ground handling (Service Interphone) and the passenger information system (Passenger Address).

The elements of the communication system are interconnected in such a way that any station can be reached directly from the cockpit. By using the appropriate control devices communication can be established between pilots and air traffic control, cabin crew passengers or ground personnel.

Flight attendants can communicate with each other and with the cockpit using handsets located at the front and end of the cabin (or even at other locations in the cabin on certain aircraft types). The flight crew and the cabin crew can initiate communication with each other by calling each other. The passenger address system can be accessed from any station directly via the handsets by selecting the appropriate button.

The IC reconstructed the communication channels during the accident, based on the on-board voice recorder and witness reports, which is demonstrated in *Figure 3.*

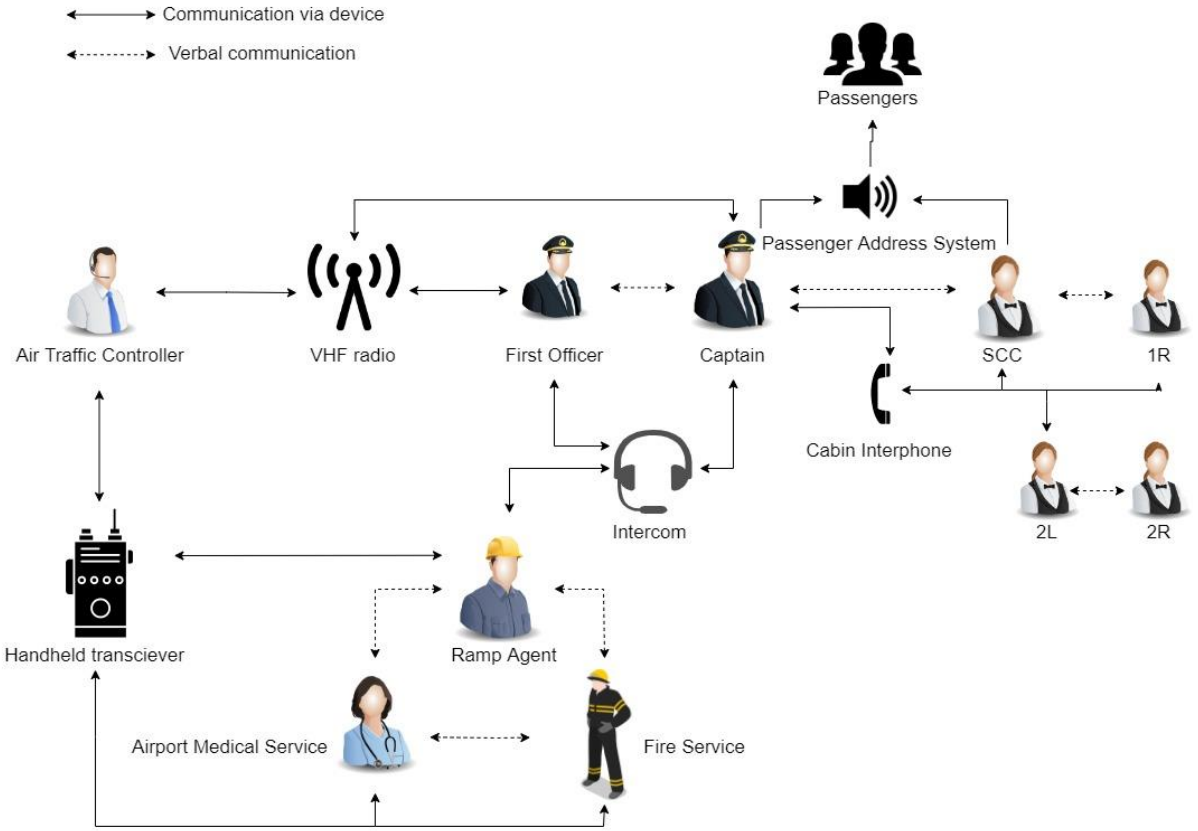


Figure 3: Major channels of communication established during the accident

During the on-board radio communication, the pilots were in contact with the Tower by radio (‘*VHF radio’)*. The Ramp Agent was connected to the cockpit communication system (Flight Interphone) via a headset connected to an external communication point of the aircraft and communicated with the cockpit crew via this system.

The Captain communicated with the flight attendants via the aircraft’s communication system, and passengers were also informed via that system.

On-board verbal communication took place as follows:

- Captain – First Officer;
- Captain – Senior Cabin Crew (SCC);
- Cabin Crew on duty in the front galley (SCC-1R);

- Cabin crew on duty in the aft galley (2L-2R).

1.9.2 Ground based communication

The services at Budapest Liszt Ferenc International Airport (e.g., air traffic control – Tower, startup control, apron guide, fire service, security, technical staff, etc.) communicate with each other via a handheld radio.

The Service Interphone allows two-way communication that is necessary for aircraft preparation and maintenance. This communication device is used by a headset connected to the aircraft. It is operational only on the ground; communication with the aircraft Operator is achieved by linking the Service Interphone to the Flight Interphone.

During the accident, the Ramp Agent was in contact with the Captain via the cockpit communication system (Flight Interphone) until the completion of the pushback. After disconnecting his headset, he attempted to communicate with the pilots by hand signals as he realised the emergency. When that was unsuccessful, he reconnected his headset to the cockpit communication system (Flight Interphone) and informed the Captain of the situation. He said that the evacuation slides had been deployed and some passengers were on the ground, while he firmly requested the pilots, twice, to shut down the engines immediately. The Ramp Agent said that he had been communicating with the flight crew via that same headset until the push-back of the aircraft was completed.

The Ramp Agent used a hand-held radio to communicate with his head of service, as it is stated in their procedures, and informed him about the accident, when the ambulance and the fire service team arrived, they communicated verbally.

1.9.3 Safety-critical - Emergency communication

Communication between crew members happens via the handset by selecting the buttons below. For normal communication:

cabin crew – cabin crew: 5

cabin crew – flight crew: 2

In an emergency situation, it is sufficient for flight attendants to use a specific combination of numbers on the handset, which allows “blind communication” to inform pilots of an emergency.

According to relevant rules and regulation, flight attendants must brief the pilots on the situation and request further instructions. At the time of the accident, the aft cabin crew member (2L) was holding the handset, but ultimately neither the Captain nor the SCC was informed of the presence of smoke, nor of the development of a panic.

The SCC was informed of the open position of the aft doors by the Captain. The communication between the SCC and the Captain stated the origin of the smoke and it had been correctly identified. The Captain had asked the SCC to close the aft doors, despite the fact that the doors were already in the armed position before the pushback started, that the flight attendants must report to the pilots ("*All doors in armed positon and crosscheck"*). Based on the information received, the SCC informed the passengers about the origin of the smoke via the passenger address system (PA). In the meantime, the Ramp Agent also informed the flight crew of the emergency.

The evacuation lasted several minutes, during which approximately 40 people were reported evacuated to the IC. The evacuation was stopped after the Captain informed the aft cabin crew that there was no fire on board. The audio recording shows the voice of the aft cabin attendant (2L) in full panic and desperation, as well as the shouting of the passengers.

After that, the Captain used the PA to get passengers to remain in their seats and informed them that there was no fire.

According to the recorded radio, the First Officer notified the tower of the accident 48 seconds after he became aware of the accident, and requested the alerting of the rescue units.

1.10 Aerodrome Information

The event occurred during the push-back from gate 33 at Budapest Liszt Ferenc International Airport at 04:23 LT on 23 March 2018. The intended destination airport was Tel Aviv, Israel (LLBG).

The aerodromes involved in the occurrence had valid operation licences.

Name of aerodrome	Budapest Liszt Ferenc International Airport
Location indicator	LHBP
Airport operator	Budapest Airport Zrt.
Reference point (ARP)	47°26'22N 19°15'43E
Elevation	151 metres
Runway identification	13L-31R 13R-31L
Runway length	3707x45 metres, 3010x45 metres
Runway surface	Concrete

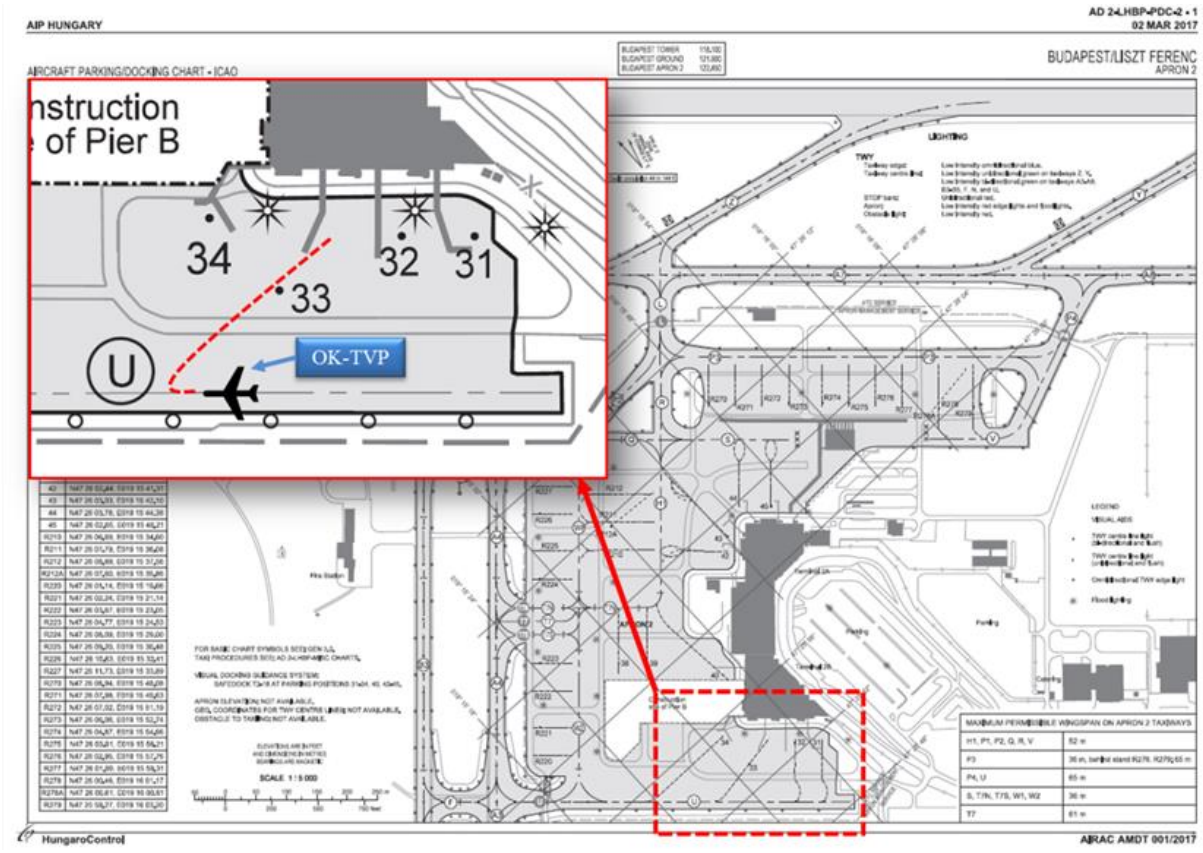


Figure 4: Location of the accident (Source of map: AIP)

The parameters of the airport did not affect the accident, further details are not required.

1.11 Data Recorders

The data recording systems required for the air traffic management equipment and for the aircraft were serviceable and the data recorded by them were evaluable.

The handheld transceiver radio communication recording systems of the air traffic control and airport services were operational, and the IC received, evaluated and used the data recorded by them. The footage from the airport's fixed-position camera were received, evaluated and used by the IC.

The aircraft had the data recorder(s) specified in the type certificate in place.

CVR cockpit voice recorder	Manufacturer	Honeywell International Inc.
	Model	Cockpit voice recorder
	Part Number	980-6022-001
	Location of the readout	Prague
	Could recorded data be used?	Yes

The IC seized the cockpit voice recorder, and the audio recorded on it was evaluable and its contents were used in the investigation.

The IC did not seize the flight data recorder on the spot but asked the Operator for its contents. According to information provided by the Operator, the recorder did not record any data of the event.

On the occurrence timeline illustrated in *Figure 2*, the IC took the initial time as the start of the slide opening (as shown by the airport camera footage) and the time of the opening of the aft service door as realised by the First Officer (as reflected in the on-board voice recording), and reconstructed the sequence of events on this basis.

1.12 Wreckage and Impact Information

There was no wreckage in connection with the occurrence.

1.13 Medical and Pathological Information

During the evacuation, one of the passengers suffered serious head injuries. Following the accident, the injured person was treated by the Airport Medical Services (AMS) staff. They were able to stabilise the passenger's state at the airport, afterwards she was taken to hospital. According to information available to the IC later on she was transported to Israel.

The IC requested information on the condition of the injured passenger multiple times from the parties involved in the accident, but no information was provided until the finalization of this report, so the IC has no detailed information on the medical condition of the injured passenger.

1.14 Fire

The pushback tug began to emit heavy smoke, which stopped after its engine was shut down. There was no fire in the accident.

1.15 Survival Aspects

The evacuation was initiated with the engines operating, using the aft left evacuation slide of the aircraft. The video recorded by the airport's CCTV shows only the emergency slide on the right side, which was continuously unstable due to the operating engine until the right engine

was stopped. During the evacuation, the slide on the left side was also flattering like the one on the right because of the jet blast of the operating engine so it became unstable, while several passengers were leaving the flight deck with it. Multiple passengers who had used this slide reported, that it was unstable ("The slide they came down on was not stable, it bounced"). During evacuation one passenger – under unclear circumstances – fell from the slide and suffered a serious head injury. Approximately 2.5 minutes passed from the opening of the slide to the shutdown of the engines.

According to information obtained by the IC, several flight attendants were travelling as deadhead crew in the aft cabin, two of whom were among the first to leave the aircraft. They were the first to attempt to assist the passenger who fell during the evacuation.

The Airport Medical Service (AMS) was notified by the AOCC at 4:30 am, and they arrived 6 minutes later. The medical personnel on the scene immediately started treating the casualty and stabilized her condition. Meanwhile, the driver of the AMS service called the National Ambulance Service, to whom they handed the passenger over at 4:50 am, and she was taken to the trauma unit of the hospital on duty.

According to the opinion of the AMS doctor they were notified late about the accident, which made them arrive at the scene after many other services, while in most cases they are the first to respond.

Fire services were also notified, they arrived at the scene, but their intervention was not required.

1.16 Tests and Research

The scene was changed, which will be detailed in the chapter *1.17.3 Airport*.

In a joint effort with the RRI and the NNI, the TSB moved the aircraft to its original position during the accident. In order to reconstruct the scene a training slide was installed and used on the left aft door.

The slide is connected to the threshold of the aft door of the aircraft, it’s height from the ground is between 2.97 and 3.12 metres, depending on the load.

As shown in *Figure 5:* the slide is in line with the direct jet blast of the left engine.

Figure 5: The reconstructed scene

Several documents highlight the danger zones of the operating engines. In the area behind the engine, not only the speed and mass of the exhaust air, but also the temperature of the jet blast is dangerous to the health of the people who are standing there.

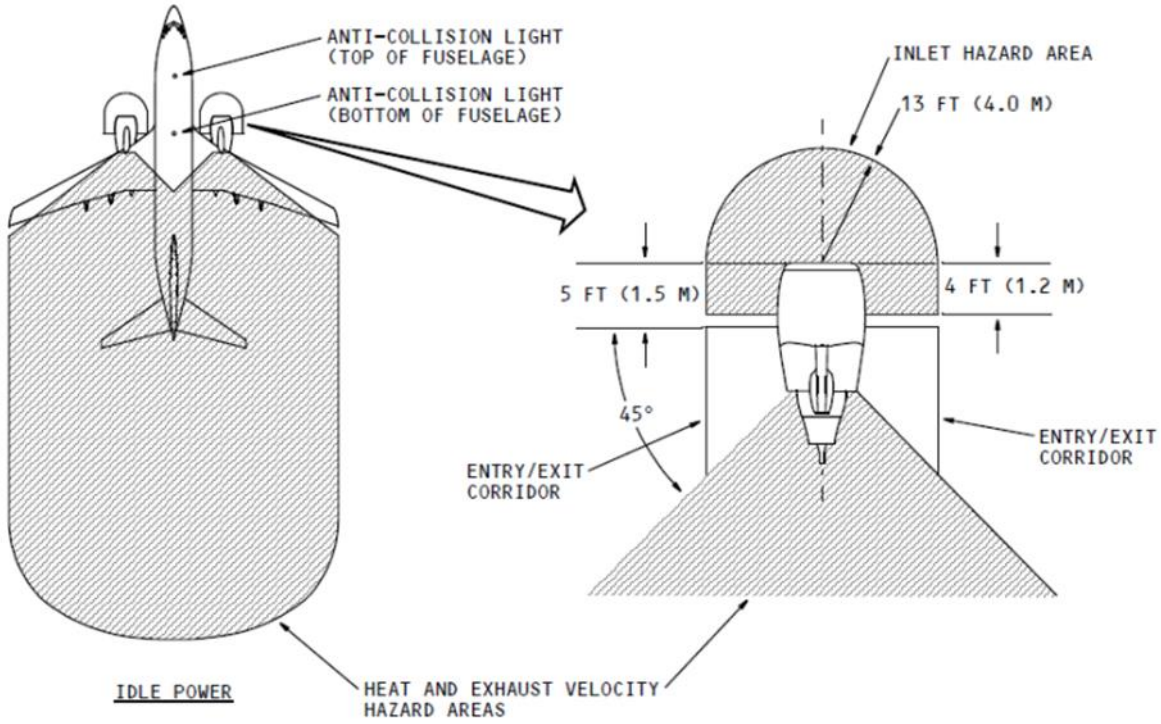


Figure 6: Danger zones of an engine operating on idle
(Source: http://www.aviationlearning.net/files/B737%20NG%20REFRESHER.pdf)

1.17 Organisational and Management information

1.17.1 Operator

1.17.1.1 Final report prepared by the Operator in relation to the accident

The IC requested the final report from the Operator, which was received under *Final Report 2/2018, OK-TVP accident, revision 0.* Based on the Operator's opinion, the evacuation was most likely inevitable due to the combination of the early morning hours, smoke density and the short reaction time. In addition, the most critical problem was identified as information sharing, where the Ramp Agent first only tried to signal the situation to the flight crew with hand signals and only connected to the communication system after. Furthermore, not only the wrong choice of communication channel, but also the content of the communication was considered to be a serious reason.

The safety measures defined by the Operator mainly concerned the clarification of the communication at the ground handling organisation regarding the handling of the aircraft, especially in emergency situations.

The Operator's planned safety recommendations include the following:

- Auditing the ground handling organisation at Budapest Liszt Ferenc International Airport with regard to equipment maintenance records;
- Checking the English proficiency of employees in the ground handling organisation;

- "Include the requirement to count the number of rows of seats visible from CC stations to easily assess the conditions during any non-standard situation"

The IC requested the Operator for information on the implementation of the measures in the *"Corrective actions and safety recommendations"* section of the Operator's final report. In response, the Operator sent the same document with a different content, but under the same reference number mentioned above. The "new final report" missed information regarding the disclosure of facts and the investigation part, which contained relevant information about the activities of the crew (APU start-up, communication failures, etc.) and their influence on the accident. In addition, many of the safety recommendations issued for themselves were also missing from the new document. The Operator also gave "safety recommendations" to the other lessor (Israir) in these documents.

1.17.1.2 CCOM

Chapters 2-3 of the Operations Manual *(CCOM version 9)* for cabin crew issued by the Operator and valid at the time of the accident contain the preventive measures and procedures to be followed in various emergency situations as follows:

Original text

Cabin Crew Operations Manual

- *CCOM (rev.9. Chapter 2-3)*

2.11. PRECAUTIONARY DISEMBARKATION

There can be a non-standard situation when it is necessary to disembark PAX out of A/C as soon as

- *possible as a precautionary measure (e.g., in case of fire in the vicinity of our A/C). Cpt informs CC via interphone*

3. CHAPTER 3 – EMERGENCY PROCEDURES

3.1. EMERGENCY SITUATIONS

Land

The Captain has the prime responsibility for initiating an evacuation. If Cabin Crew considers evacuation necessary, they shall attempt to advise Captain of the situation and await his instructions.

If there is no contact with the flight crew only then will Cabin Crew assume responsibility for initiating evacuation.

There are three types of abnormal situations:

1.Unprepared Emergencies*: on land or water, or on ground – during boarding and taxi before takeoff or after landing*

Note: Cabin Crew can initiate evacuation independently only ***after the aircraft has stopped*** *and Flight Deck Crew don't respond even to Alert call. If time allows the Emergency Entry Code should be used. When the aircraft is damaged and fuselage is separated or fire and/or smoke on board is present, Cabin Crew will initiate evacuation immediately.*

According to *paragraph 3.1, CCOM Chapter 3,* cabin crew can initiate an evacuation only after the airplane has stopped, and only if the pilots do not respond to alert call or if fire and/or smoke is detected.

On the contrary, according to *point 3.2, Chapter 3 of the* Operator's *CCOM*, cabin crew must always contact the flight crew in the case of fire and smoke.

The CCOM Rev.9 *"Chapter 00 Introduction 00.4. Terms and Meanings"* chapter explains the meaning of SHALL according to which the application of a rule, regulation or procedure is MANDATORY.

„SHALL

Means that the application of a rule, regulation or procedure is MANDATORY."

Changes to the CCOM affecting flight attendants

Since the accident, the following change was introduced in the *Emergency Procedures* chapter: in all emergency situations, the pilot must be contacted, except ditching, when evacuation is immediately necessary.

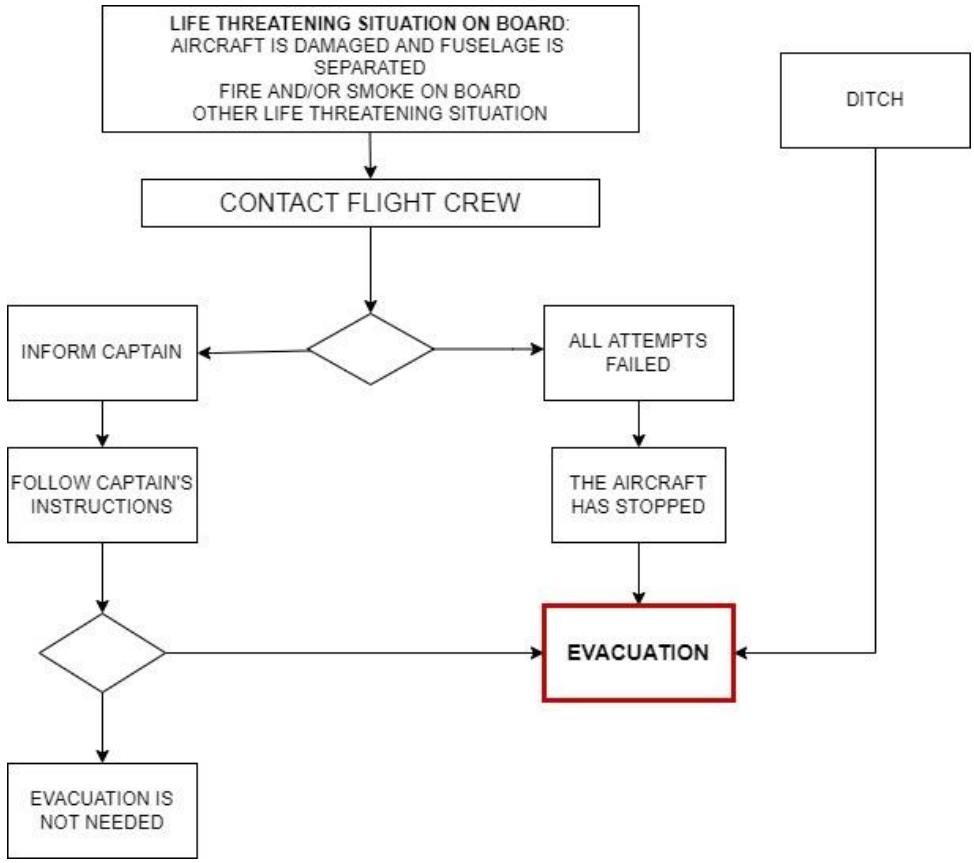


Figure 7: CCOM Chapter 3 – Emergency procedures/16.01.2019 Rev.0/

1.17.1.3 Rest periods

In the CCOM in force at the time of the accident *(CCOM Part A 7.1.4 -7.1.6 Fatigue risk management),* the duty time requirements were given in hours, depending on the time of the day, so the details of duty and rest times in the investigation only cover the period of the occurrence.

The original departure time was in the evening hours, in which case, in accordance with the procedures, the duty time normally cannot exceed 11 hours, but may be extended by maximum 1 hour in special cases. The crew on the original flight would have exceeded the maximum permitted duty time due to the malfunction of the aircraft. The duty period includes the time of waiting for repair the aircraft as well (OM[1] 7.1.4.1 Flight Duty Period). Due to the uncertain repair time of the aircraft, the Operator decided to operate the flight with another aircraft and with the standby crew.

[1] *Operations Manual Part A – Flight Time Limitations rev. 53. (01 July 2017)*

According to their documentation, the flight crew involved in the accident had not flown more than 100 hours in 28 days, as required by the regulations, and the rest period was not less than the minimum required 12 hours.

1.17.2 Ground Handling Organisation

1.17.2.1 Final report of the ground handling organisation

Following the accident, the ground handling organisation sent their final report to the IC, which included technical, procedural and training tasks. Based on their final report, the Organisation ordered an immediate inspection of all pushback tugs of the same type.

The internal investigation determined the direct cause of the occurrence to be a technical failure of the pushback tug during operation, as regards the ground handling incident.

Based on the lessons learned from the event, the Organisation has revised its training syllabuses, especially regarding emergency procedures, and incorporated those lessons into its SMS training.

1.17.2.2 Pushback tug maintenance

Prior to the accident, there were no technical faults reported with the pushback tug involved. During the pushback of the aircraft the operator became aware of the thick smoke coming from the engine of the tug. Although the vehicle remained operational, the pushback tug driver noticed a loss of power and increasing smoke from the engine. At the end of the pushback the pushback tug driver disconnected his vehicle and moved away from the aircraft.

Based on forensic expert appointed by the Police:

The appointed forensic expert was able to trace the maintenance history of the pushback tug back to 2011. The maintenance history, which can be found in the *"Vehicle history"* document, is difficult to trace back as the operating hours contain contradictions. It includes operating hours that the machine had not even reached by the time of the accident.

According to the representative of the organisation, the machine undergoes a mandatory service every 250 hours of operation, as confirmed by the maintenance booklet. The operations indicated on the basis of the last maintenance were performed correctly based on the inspection.

According to the tug driver and the police investigation, the smoke was coming from the exhaust system, caused by the combustion of the engine oil and leakage in the oil system. This could be concluded based on the engine oil leaking from the exhaust pipe.

After disassembling the pushback tug, the fault of the turbo charger became clear.

During the investigation, the expert established that prior to the failure, the wear (rotating) parts of the turbo charger had significantly been worn out, resulting in a gradual loss of balance of the turbo shaft, which then led to breakage of the turbo shaft.

For a driver with average technical knowledge, the wear that led to the fracture is not necessarily detectable.

The engine contained 8 to 9 litres of oil based on the last service, of which about 1 litre remained after the failure, which means that 7 to 8 litres of oil had burnt or leaked.

According to the forensic expert, the smoke could have been avoided with proper maintenance of the tug.

1.17.2.3 Procedures for the Ramp Agent

The aircraft pushback procedure is detailed in the Budapest Liszt Ferenc International Airport Rules and the Ground Handling Organisation's work technology. In "*FKT 100/03 Traffic Servicing Technologies",* the pushback procedure is defined as follows:

'Push-back procedure' means a procedure performed using a conventional tug with a towbar or a towbarless tug on departure/arrival of an airplane when it cannot turn onto a taxiway or stationary axis line with its own engines and when the following conditions are met:

- *the movement takes place on the apron;*
- *the cockpit is occupied by the flight crew;*
- *the gear lock pins are not in place;*
- *the aircraft is performing a flight."*

The procedure for the pushback covers the preparation of the tug, the execution of the pushback, and the communication techniques to be used. After the pushback has been completed, non-verbal communication shall be carried out after disconnection from the communication system, using the conventional hand signals recommended by the IATA Airport Handling Manual between the ground crew and the flight crew.

Communication during and after the pushback and its options are contained in the *Operations Manual part A-8 Ground Handling Instructions (rev.53.),* which states that after disconnecting from the aircraft communication system, the ground handling crew shall communicate with the flight crew exclusively by hand signals.

1.17.3 Airport

On 17.02.2022, the IC received the Safety Investigation Report № BUD 07/2018 of BUD Airport Zrt.

The investigation report concluded that the airport operations of BUD Airport Zrt. had not played a direct role in the occurrence. However, BUD Airport Zrt. did take safety measures directly related to the lessons learned from the accident, including the initiation of an automatic, digital-based technical upgrade of the airport emergency alert system. The evaluation of the accident and the application of the Airport Emergency Plan was carried out by the training of the services.

BUD AOCC was first notified of the accident by MAGH DTM (04:27 LT), who then notified the relevant airport operational medical rescue and firefighter services. Following the chain of notification, the aircraft was towed from the original scene to a remote gate (№ 39), before to the arrival of the accident investigators of the TSB. The changing of the scene was authorised by the AOCC with the approval of the NNI and RRI, without informing the TSB. The location was changed due to traffic conditions.

Pursuant to Subsections (1) and (7) Section 11 of the Kbvt., the scene of the occurrence shall be secured and left unchanged , except:

> *"The preservation of the site of the incident in its original state may be waived only if indispensable immediate actions are required in the interest of personal safety, safety of life or elimination of a catastrophe or if they are justified by urgent proceedings…"*

In addition, Chapter III of the Airport Rules *(RR_Version 15 in force at the time of the incident)* also requires that the accident scene be left unchanged and secured in accordance with the requirements to be followed in the event of an accident.

1.18 Additional information

1.18.1 Crew activities

Action by the cabin crew during the unprepared emergency

Before the panic occurred, the aft cabin crew performed the taxi out duties as usual after the safety briefing. Upon completion of the cabin check, they became aware of shouting as they entered the aft galley. According to the rear flight attendants, at this time the 2L picked up the handset to alert the pilots, which alert did not happen at the end. By this time, the

passengers in the rear part of the cabin had left their seats, panicked, and were trying to exit via the aft emergency exits, pushing the flight attendants to the aft galley. The rear cabin crew, seeing and hearing the passengers approaching them shouting 'FIRE', also panicked according to the tone of their voice on the CVR, and they decided to evacuate the aircraft. According to the flight attendants' report, they checked the external environment, and then began the evacuation by opening the aft doors, as trained and in accordance with the relevant procedure. After opening both exits, the flight attendant on duty at the right aft door decided to block the right door after seeing the increasingly dense smoke outside the aircraft. This meant that passengers could only leave the aircraft through the left aft door. They reported that they continued the evacuation until they discovered the original cause of the smoke themselves. Despite their report the evacuation was suspended by 2L after communicating with the SCC and the Captain via the PA, and the Captain informed them on the real cause of the smoke and that there was no fire on board (1.9.3).

Flight crew activities

After starting the engines and connecting the generators to the electrical system, the pilots – in accordance with the procedures – cut off radio communication with the Ramp Agent. The pilots then performed the before taxi checklist until the accident occurred. As the pushback tug was moving away, they detected that smoke was coming from it, but did not think it was important. Seeing the caution signals on the instrument panels while performing the check, they realised that the aft doors were open. At this point the Captain informed the SCC on the open position of the aft doors and asked for them to be closed despite the fact that in this phase of the flight the doors are armed and the slides deploy during opening, which prevents the normal closing of the doors. The pilots reported that at that time they had not observed any indication of an emergency. The SCC and the Captain discussed that the smoke coming into the cabin was coming from the pushback tug. The aft flight attendants did not inform them of the panic in the aft cabin. Their first information of the emergency was received from the Ramp Agent who told them that both aft evacuation slides were open and that there were passengers on the ground next to the aircraft. The Ramp Agent asked them to shut down the engines, which the pilots did only after almost one and a half minutes. This was due to the time required to start the APU and connect it to the electrical bus, despite the fact that they already confirmed the engine shut down to the ramp agent. According to the audio recordings the flight crew communicated in a cool and calm manner until they became aware of the evacuation, after which they changed from calm to a more firm tone. Only after that they made contact with the passengers on board via the PA, and inform the ATC. They were informed of the accident and the seriousness of it by the Senior Cabin Crew member so they requested emergency assistance.

1.18.2 Operation of the Evacuation slide

The B737-800 is equipped with evacuation slides at all four exits. It is the responsibility of the cabin crew to arm the slides by securing a girt bar before the aircraft starts moving from a parked position. When the door is opened, the fixed girt bar automatically ensures the slide inflation, that takes about 5 to 6 seconds.

1.18.3 EASA requirements for evacuation

The B737-800 aircraft complies with the EASA Large Aeroplanes design standard[2] which requires that the design of the aeroplane shall allow the maximum seating capacity to be evacuated from the aircraft to the ground under simulated conditions within 90 seconds.

EASA requires the aircraft Operator to ensure the development and implementation of evacuation procedures.

[2] EASA Easy Access Rules for Large Aeroplanes (CS-25.810), Emergency egress assisting means and escape routes, Subpart D, Amdt 27, Aug 2022.

1.18.4 Passenger questionnaire

After the accident and before boarding for the relief flight, members of the TSB's go team handed out 50 passenger questionnaire forms to the passengers involved in the event, asking them to fill them and return them to the address provided in order to facilitate the safety investigation. Until the closing of this investigation no completed questionnaires were returned by the passengers.

1.18.5 AMS and fire service requirements in an emergency

An Airport Emergency Plan *(hereinafter referred to as* "AEP"*)*, version 10, dated 19/02/2018, was in force at LHBP airport and was reviewed at regular intervals. The AEP contains the procedures to be followed in case of an emergency and provides instructions for the coordination of the organisations to be involved in case of an emergency. The AEP includes the availability and coordination of emergency services to respond adequately to emergencies. The approach and departure areas for emergencies are located within 1000 metres of the runway threshold.

At Budapest Liszt Ferenc International Airport, rescue (AMS) and fire service personnel are on duty 24 hours a day to provide life-saving and fire-fighting services in the event of an aviation-related accident or incident at the airport or in its immediate surroundings. In such cases, the main objective is to create and maintain conditions for survival, to provide escape routes for passengers/airport staff and to rescue people who cannot escape without direct assistance.

1.19 Useful or Effective Investigation Techniques

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

2 Analysis

2.1 Evacuation

2.1.1 Passenger behaviour

The accident occurred in the early hours of 23 March 2018, after nearly 10 hours of waiting at the airport, which made the passengers not only tired but also exhausted. This may have contributed to the development of the panic.

In the experience of the IC, wrong or erroneous decisions are more often based rather on emotion than on an objective assessment of the circumstances. This is especially true in case of mentally and/or physically tired individuals, where an external stimulus that induces fear in the individual can easily generate uncontrollable panic. In general, some individuals react in unpredictable ways to a panic situation, in which their reaction may endanger the physical safety of others. In addition, people in panic can also affect their environment, triggering a process in which people no longer react to the stimulus that triggers the panic, but to the behaviour of panicked people.

This is exactly what was observed in this case, where the behaviour of some passengers influenced other passengers in such way that panic developed, which was combined with poor situational awareness.

The passengers panicked when they saw the smoke entering the aft passenger cabin and their only goal was to leave the aircraft. The IC's opinion is that the sight and smell of smoke inside and outside of the aircraft, combined with the artificial yellowish exterior lighting at the apron frightened several passengers, which mistakenly confirmed the presence of fire for them. The word 'FIRE' shouted by several passengers also created panic in the other passengers, which might have been greatly exacerbated by the fact that they were in a crowded and narrow place and were also limited in their ability to leave the aircraft. Passengers tried to leave the aircraft as quickly as possible by moving towards the aft emergency exits.

2.1.2 Cabin crew activity

The rest time of the flight attendants complied with the rules and regulation, with no active duty in the last 48 hours preceding the accident. Their working hours started 4-6 hours before the accident on the given day and although they were called in from standby, the IC's opinion is that this should not have had any influence on their activity or on the handling of the situation.

According to the IC, the passengers' unexpected panic reaction limited the decision-making abilities of the cabin crew and the created time pressure contributed to their inaccurate assessment of the situation and led to inappropriate decisions. As audible on the CVR recording the aft flight attendants also panicked, that – according to the IC's opinion – resulted in not following the procedures in all detail that they shall follow in the event of an unprepared emergency. Due to their own mental state they were also unable to calm the passengers.

Neither of the two aft flight attendants informed the SCC or the flight crew of the panic and the detection of smoke and smell of fumes while the PA was already in the hand of the 2L. In the IC's point of view they would have had the opportunity and limited time to inform the SSC or the pilots when smoke was realised, even by using the code on the PA for emergencies. The evacuation was solely the cabin crew's decision. Provided that the Captain was in a state to make decisions and was available only he could have initiated the evacuation in such situation.

According to the report of the aft cabin crew, the emergency was handled in accordance with the procedures and the evacuation was interrupted based on their assessment of the situation. They checked the external environment and the armed position of the slides before the doors were opened, but the IC's opinion is that their assessment of the external environment was wrong. As a result of that misjudgement seeing the intensifying smoke outside the aircraft after opening the 2R decided to block the right aft service door. As a consequence of the blocked right aft door, evacuation happened only via the slide of the left aft door, with the engines running, which was also the result of a situational awareness issue in the IC's opinion. As the running engine endangers the stability of the evacuation slide and therefore the safety of the passengers, the use of these emergency exits is dangerous and should be avoided. According to the aft flight attendants report they identified the source of the smoke on their own during the evacuation and stopped the evacuation afterwards. The IC's opinion differs from what the cabin crew reported because according to the audio recovered from the voice recorders the evacuation was stopped after the captain informed them. The rear flight attendants became aware of the passenger lying near the slide after the evacuation was stopped. The passenger suffered a serious head injury.

The procedures in the CCOM do not provide clear guidance for dealing with unexpected situations, which can lead to misunderstandings. The manual states that the cabin crew should report all emergencies to the flight crew, but notes separately that in the event of smoke and/or fire, if the aircraft came to a full stop, the cabin crew may decide individually to initiate an evacuation (1.17.1). If only this note is taken into account about the initiation of an evacuation, then the cabin crew could have legitimately opened the aft door. However, the descriptions and the train of thought in the manual states that the Captain should always be aware of everything during the flight. This is supported by the *'Smoke and fire on board*' chapter in the manual, which specifically deals with what cabin crew should do in such situations. On this basis, pilots **shall** be informed of the origin, smell and colour of the smoke/fire. The IC's opinion is that if the cabin crew had interpreted the manual as allowing them to initiate an evacuation in the event of smoke/fire, according to the chapter *"Smoke and fire on board"* they should have informed the pilots all times.

In the IC's opinion, the amendment of the CCOM as presented in point *1.17.1.2 CCOM* eliminated the above-mentioned ambiguity.

2.1.3 Flight crew activity

When the event occurred, the pilots were performing the before taxi procedure while the MASTER CAUTION light along with the two aft door lights started to illuminate. The Captain informed the front cabin crew of the open position of the aft doors. In the IC's opinion, and based on the audio recordings, the calm tone of the pilots' concludes that they did not realise that the panel indication of the two aft door lights at this stage of the flight were not a false signal but an indication of an actual open state, which results in the inflation of the slides due to the armed doors.

The pilots initially did not detect the emergency nor the smoke entering the cabin that was caused by the failure of the pushback tug although they knew about the smoke as they had established its source together with the SCC. Due to the operating engines smoke reached the rear of the cabin through the air conditioning system, causing panic for both passengers and the aft cabin crew. The pilots were first informed about the deployed slides and passenger positions by the Ramp Agent. The Ramp Agent first tried to communicate by hand signals and then spoke to the pilots via the reconnected headset. However, being aware that passengers were on the ground, the pilots only shut down the engines after the APU was started and connected to the electric system of the aircraft, which took one and half extra minutes. Based on the audio recordings, the IC's opinion is that the flight crew could only have become aware of the seriousness of the situation in the seconds before the shutdown of the engines. In the event that the flight crew is instructed by the Ramp Agent to shut down the engines, it must be carried out without delay after being briefly informed on a justifiable

reason. The information to shut down the engines (two aft doors are open, slides are deployed, there are passengers on the ground) was received by the flight crew from the Ramp Agent via the headset, but the engine shutdown was delayed for one and a half minutes, which caused the slides to be in an unstable position for several minutes – this was supported by the account of multiple passengers. In the IC's opinion, in this situation, i.e., after receiving and evaluating the engine shutdown information, the shutdown of the engine should have been performed instead of starting the APU, even though only emergency lighting would have been available on the aircraft as a result of an immediate engine shutdown. The pilots received detailed information about the injured passenger only after speaking to the flight attendants via the PA.

The impact of the delayed engine shutdown on the accident is discussed in detail in the chapter *2.6 Survival Aspects / AMS and Fire Service*.

2.1.4 Ramp Agent activity

The training syllabus and topics of the ground handling organisation for the training and refresher of a Ramp Agent licence include the push-back procedures and frequent problems encountered during push-back, as well as operational and inter-process malfunctions of equipment. The Ramp Agent involved had more than ten years of experience at the time of the accident. In the IC's opinion, during this time the Ramp Agent must have encountered abnormal situations as well.

On the basis of the video footage and the voice recorder, the IC analysed the Ramp Agent's activity – regarding the possibility of interrupting the push-back process (*Figure 8*) from the time of the first appearance of noticeable smoke flowing from the tug towards the aircraft.

The timeline below illustrates the activities between the start-up and idle of engine N°2 to the shutdown of both engines, from the perspectives of the flight crew and the Ramp Agent. The time shown on the timeline represents the actual time of the event, based on the timestamp of the airport surveillance camera.

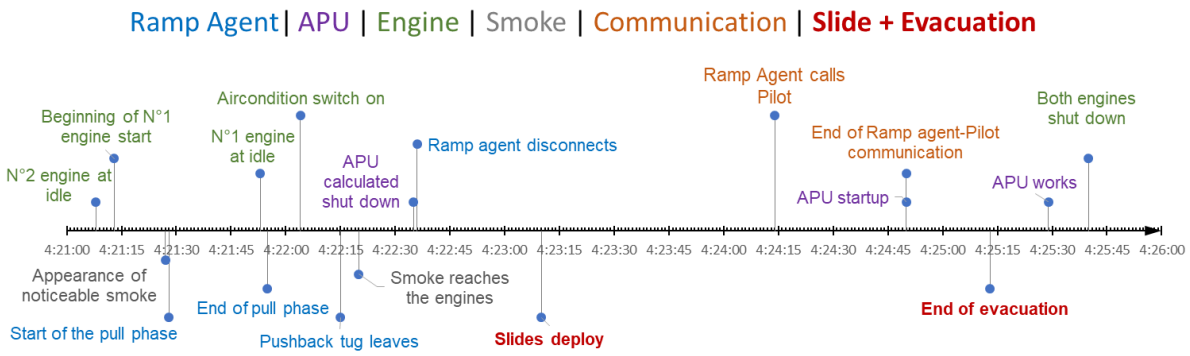


Figure 8: Timeline related to the Ramp agent

Based on the timeline:

- the appearance of the smoke and the start of the pull part of the push-back procedure roughly happened at the same time (04:21:27), while medium dense smoke was already flowing towards the right engine (N°2) of the aircraft, which had been running for about 20 seconds,
- approximately 26 seconds passed between the start of the pull part of the push-back procedure (4:21:28) and the full stop of the aircraft (4:21:54),
- the generators being switched on and the characteristic sound of the air conditioning system being switched on can be recognized on the audio recordings (04:22:04),
- after the full stop the tug gets disconnected as the final phase of the pushback, and then the tug leaves the aircraft (04:22:17) when more dense smoke appears,

- large amount of smoke reaches the running engines with the already operational air conditioning system resulting in smoke entering the cabin (04:22:20),
- in accordance with the standard procedures the Ramp Agent's radio communication with the flight crew ends when the pushback is completed and the pilot confirms the separation, afterwards the Ramp Agent can disconnect from the airplane's communication system (04:22:36),
- approximately 50 seconds pass between the smoke entering the cabin and the deployment of the slides,
- after the unsuccessful communication attempt with hand signals, the Ramp Agent, re-connected to the communication system (04:24:14) to report the emergency, and after an approximately 36 seconds long discussion, the content of the verbal information given by the Ramp Agent mistakenly triggers the flight crew to initiate a normal engine shutdown action, that is preceded by connecting the APU to the electrical system. As a result, the actual engine shutdown happened with a delay (04:25:40).

Based on the IC's experience and the information above, the IC's opinion is that if the Ramp agent had decided to abort the push-back when the smoke first appeared, the time needed to communicate the abnormal situation and to start the disconnecting of the tug would have taken approximately the same time (30-40 seconds) as needed to complete the normal pushback.

According to the IC, standard communication – which means the exchange of general and usual information – lasts about 10-20 seconds, while abnormal situation communication takes about 40 seconds, as the information that needs to be transferred is more than the usual. This suggests that, from the point of view of the accident, the interruption of the pushback would not have resulted in a better outcome regarding time, so it would not have had a positive effect on the course of events.

After preparing the aircraft for taxi, the Ramp Agent disconnected from the communication system as usual, which finished the direct contact with the flight crew. While moving away from the aircraft, he noticed the increasing smoke from the pushback tug and not much later the aft evacuation slides inflated. In the IC's opinion, the Ramp Agent tried to re-establish the communication with the flight crew because he recognized the dangers of evacuation with the operating engines, regardless of the fact that he had no information about the panic situation on board the aircraft. The Ramp Agent also applied the sequence of communication channels in accordance with the rules and regulation/procedures as communication after disconnecting from the communication system can also be non-verbal. In the IC's opinion, the Ramp Agent performed the pushback procedure as required in the Ground Handling Organisation's work technology.

2.2 The role of communication

Effective, fast and accurate communication is essential in both normal and emergency situations, this greatly influences the appropriate response in an unexpected situation. In the IC's opinion, the event that was caused by an unexpected situation, reveals the lack of appropriate communication. Not only is there no effective communication, but there is also no information flow from the cabin crew in the aft galley to the rest of the crew; thus, not giving the rest of the crew the opportunity to recognise and react to the unexpected situation in time. In the IC's opinion, the lack of communication of cabin crew members 2L and 2R was a result of panic caused by the misjudgement of the situation, and this is confirmed by both the content and the tone of 2L heard on the audio recording during the evacuation.

2.3 Operator - Travel Service

The IC compared and analysed the final reports submitted by the Operator mentioned in the chapter *1.17.1 Operator*. The two reports have the same revision number and the same date, and does not have any markings of the changes by the company. This can be misleading, because it may appear to everyone that the revised version is the original final report. The date when the new document was issued could not be identified by the IC because the date was not changed in the new document.

In the Operators' second submission of their final report the IC discovered missing sentences and rewritten parts compared to the first submission. Both reports also contain statements that do not reflect the reality, despite the fact that the Operator also had the objective evidence necessary to carry out the investigation.

In the upcoming chapters the IC lists some of the contradictory parts, as well as relevant information that is missing from the second submission but was included in first submission of the final report by the Operator:

2.3.1 APU start-up before engine shutdown

The first submission states that the flight crew started the APU in order to avoid a bigger panic. They claimed that shutting down the engines without having the APU running could have resulted in an even bigger panic due to the change of interior lighting conditions (only the emergency lights would have worked).

Figure 2 that was made based on the audio recordings shows that the Captain informed the SCC and then the SCC informed the passengers of the situation and the origin of the smoke before receiving information from the Ramp Agent.

After informing the passengers, and despite the Ramp Agent's request to the flight crew to stop the engines, the engines continued to operate for approximately 2 more minutes, so the slides remained in an unstable state.

The time spent starting and connecting the APU to the electric system in the IC's opinion caused delay in the safe handling of the situation. The immediate shut down of the engines would have resulted in a more safe solution from the passengers' point of view (no jet blast destabilizing the slides) than the starting of the APU and connecting it to the electric system to ensure normal light conditions and avoid a potential panic.

2.3.2 Lack of communication

In the conclusion section of the second submission, the section that details the lack of initiated on-board communication by the cabin crew in the aft galley was removed. As described in this report, none of the aft cabin crew members informed the rest of the crew about the situation.

In the IC's opinion is that the lack of the flight attendants' communication contributed to the case. The Operator's second submission of their final report did not go into detail of investigating this.

2.3.3 Realization of the external environment by the cabin crew

The investigation part of the second submission lacks the finding that was included in the first submission, that the flight attendants were aware of the operation of the left engine and that the jet blast caused an unstable evacuation slide.

In the IC's opinion, the Operator removed information relevant to the case, and the report instead of assisting in the full understanding of the activities of the cabin crew lacks information on all of the contributing factors that could be linked to the case.

2.3.4 Safety measures

In the safety measures section of the Operator's first submission includes a total of 6 measures for themselves with deadlines. Despite this, in the second submission 5 of these measures were removed, and the IC has no information about the reason behind that.

The IC found contradictory parts regarding the Ramp Agent's communication as well. In the description of the event (with times), that briefly explains the chronology of the events based on the voice recordings, the Operator illustrates the Ramp Agent's actions and the information given to the flight crew, in which the content of the information (request to stop the engines, passengers on the ground, both slides deployed) is also mentioned. In contrast to that, they claim in the conclusions that the Ramp Agent's communication was deficient and he requested the shutdown of the engines without specifying the reasons.

Neither version of the final report is the joint final report of the lessor and the Operator, but only the Operator's own report, so the IC does not understand the risk mitigation measures that the Operator gave to the lessor airline (ISR) as safety recommendations.

The IC cannot find the reason why the Operator has changed the original final report in such manner that its versions are not identifiable and its content is shorter.

2.4 Ground Handling Organisation

The Ground Handling Organisation investigated the accident as a ground handling incident for its own organisation. According to the IC's opinion, the scope of the investigation was sufficient and the direct cause in their final report – technical failure of the tug – was correctly identified.

The IC analysed the documentation relating to the servicing of the pushback tug and agrees with the opinion of the forensic expert appointed by the police. The documentation of the servicing of the tug reveals contradictory information, which suggests that the quality of the service was not always sufficient. The IC identifies the failure of the tug as a contributing factor.

2.5 Airport

Airport operations did not play a direct role in the development of the accident. The change of the site after the accident for traffic reasons reduced the possibility of an exact exploration of the course of events and circumstances of the accident.

2.6 Survival Aspects / AMS and Fire Service

The circumstances of the accident are unclear, but the IC's opinion is that the injury of the passenger could have been caused by the floating of the evacuation slide, caused by the jet blast of the engine and/or by an accidental push from another passenger. During the investigation, the IC received no additional information that would confirm or exclude either of these possibilities.

Based on the camera footage and the interviews, the AMS and Fire Service were notified by the AOCC. Upon their arrival, the AMS stabilized the condition of the passenger and handed her over to the staff of the National Ambulance Service (OMSZ).

Pursuant to the chapter *1.18.5 AMS and fire service requirements in* an emergency, *"the main goal is to create and maintain the survival conditions"* in an emergency. In the IC's opinion, the AMS team, although notified late, fulfilled the above-mentioned main goal.

2.7 Weather

The external environment, including visibility, plays a significant role in recognizing a situation. The accident took place in the early hours of the morning, which significantly affected the visibility conditions. In addition to the darkness, the artificial yellowish lights of the lamps and the sight of smoke could have been realized as fire both by the passengers' and the aft cabin crew's eyes.

The direction of the wind (320 degrees) was also decisive, because the smoke from the tug was blowing right towards the running engine of the aircraft. In the IC's opinion, the external light conditions and the wind blowing towards the engines were decisive from the aspect of the case.

2.8 Situational awareness – CRM

Flight safety and the occurrence of errors depend on several factors, in which the human factor occupies a prominent place, as it contributes to a significant part of the incidents and accidents that occur in aviation. In the IC's point of view, the human factor played a significant role in this accident as one of the causes.

Situational awareness is one of the most important aspects in preventing an accident when an unexpected event happens. Good situational awareness can be influenced by several factors. The IC considers the identification of the origin of the smoke perceived by passengers and the aft flight attendants and its misperception as fire to be a contributing factor, and also identifies the lack of communication by the frightened aft cabin crew as a direct cause, in which the development of their own panic may have played a significant role. In addition, the late shutdown of the engine could also have contributed to the accident, which the IC attributed to the pilots loss of situational awareness.

2.9 Passenger questionnaire

Until completion of this final report, none of the 50 passenger questionnaires (referred to in the chapter *1.18.4 Passenger questionnaire,* and distributed to obtain information on the circumstances of the accident) had been returned to the IC. In the absence of this, the IC was unable to gain a detailed understanding of the accident from the passengers' point of view and to analyse the mechanism of their decisions.

3 Conclusions

3.1 Findings

3.1.1 Aircraft

The aircraft had a valid airworthiness certificate. (1.6.2)

It is documented as being equipped in line with the regulations in force and the agreed procedures. (1.6)

The aircraft was not damaged in the accident. (1.3)

The investigation did not reveal any information that the aircraft structure or any of its systems had failed prior to the event, thereby contributing to or influencing the occurrence of the incident. (1.6.5)

The aircraft was fitted with the equipment described in the type certificate and – apart from the flight data recorder – no comments were made by or reported to the IC regarding its operation. (1.8, 1.9)

Engine N°2 was started at the beginning of the push-back procedure. (1.1.2, 2.1.3, 2.1.4)

Smoke from the malfunctioned tug was vented into the cabin through the operating air conditioning system. (1.1.2, 2.1.3, 2.1.4)

Prior to the accident, the two aft doors were opened, causing the associated slides to inflate. (1.1.2, 1.17.1, 2.1.2, 2.1.3)

The engines were running throughout the evacuation. (1.1.2, 2.1.1, 2.1.2, 2.1.3)

The slides were in an unstable condition during the evacuation. (1.15, 2.1.3, 2.3)

The left-hand side slide was slightly damaged in the accident. (1.3, 1.18.1)

3.1.2 Meteorological information

The accident took place in the early morning light conditions. (1.7)

The wind direction was decisive from the aspect of the case. (2.7)

3.1.3 Crew

The flight crew and the cabin crew members were properly licenced and rated at the time of the accident and had the appropriate experience for the given flight task. (1.5)

The pilots performed the before taxi checklist prior to the accident. (1.1.2, 1.17.1, 2.1.3)

The pilots detected no emergency. (1.1.2, 1.17.1, 2.1.3)

The pilots shut down the engines only after starting the APU. (1.1.2, 1.17.1, 2.1.3)

According to the rules, the rest time of the cabin crew was adequate, they were not on active duty in the last 48 hours before the accident. (1.17.1)

The passengers' behaviour in the panic contributed to the misjudgement of the unexpected situation by the cabin crew, which resulted in erroneous decision-making. (2.1.2)

None of the rear cabin crew members informed the pilots on the existence of the panic and on the detection of smoke and the smell of burning. (1.9.3, 2.1.2)

The decision to initiate an evacuation was made by the cabin crew on duty in the aft galley. (1.1.2, 2.1.2)

After opening the rear doors, the flight attendant 2R decided to block the right aft door, so evacuation was performed using the left aft slide only. (1.1.2, 1.17, 2.1.2)

The cabin crew on duty in the aft galley did not handle the panic in accordance with the procedures. (2.1.2)

The evacuation was aborted after the captain was informed. (1.1.2, 2.1.2)

3.1.4 Ramp Agent / Pushback tug operator

The Ramp Agent had more than ten years of experience. (1.5.4, 2.1.4)

The Ramp Agent disconnected from the radio communication system as required after the aircraft had been prepared for taxi. (1.9.2, 2.1.4)

Upon noticing the occurrence, the Ramp Agent first tried to communicate with the pilots by hand signals and then reconnected to the communication system. (1.1.2, 1.17.1, 2.1.3, 2.1.4)

The Ramp Agent gave the pilots detailed information on the situation (both slides open, passengers on the ground). (1.9.2, 2.1.3, 2.1.4)

During the communication, he firmly and repeatedly asked the pilots to stop the engines. (1.9.2)

From the aspect of the occurrence, the interruption of the push-back process would not have led to a more favourable outcome in terms of time. (2.1.4)

The Ramp Agent acted in accordance with the requirements in handling the situation. (2.1.4)

The operator of the pushback tug was duly licensed and rated, with only 6 months' experience at the time of the accident. (1.5.5)

3.1.5 Passengers

Passengers were not only tired but even exhausted due to waiting for nearly 10 hours, which had a significant impact on the panic. (1.1.1, 2.1.1)

The smoke entering the passenger cabin was erroneously identified as a fire. (1.1.2, 2.1.1, 2.8)

One passenger suffered a serious head injury during the evacuation. (1.15)

3.1.6 Air operations

The aircraft's mass and balance were within the specified limits. The aircraft was refilled sufficiently for the flight. (1.6.3)

3.1.7 Operator

The CCOM issued by the Operator contained ambiguous guidance relating to the event. (1.17.1, 2.3)

The Operator amended the section on emergency procedures in the CCOM after the occurrence. (1.17.1, 2.3)

The Operator submitted two final reports to the IC under the same reference number and with the same date, 2 years apart. (1.17.1, 2.3)

The traceability of final reports is not ensured. (1.17.1, 2.3)

In the amended report received from the Operator, the parts concerning personnel have been removed and safety measures were missing. (1.17.1, 2.3)

The Operator issued a safety recommendation to the lessor airline (Israir). (1.17.1, 2.3)

3.1.8 Ground handling organisation

The ground handling organisation investigated the occurrence as a ground event. (1.17.2.1, 2.1.4)

From the perspective of the ground handling organisation, the cause of the ground event was identified as a tug failure. (1.17.2.1, 2.4)

The driver of the pushback tug had no means of detecting the failure in advance. (1.17.2.2)

3.1.9 Air traffic services / airport

No comments on the operation of the ground-based navigation equipment were made by or reported to the IC. (1.8)

No comments were made by or reported to the IC regarding the ground-based radio communication equipment: it was found to be fit for purpose. (1.8)

The airport involved had a valid operating licence. (1.10)

The airport operations of BUD Airport Zrt. did not play a direct role in the occurrence. (1.17.3, 2.5)

Due to traffic reasons, the scene of the accident was changed before the arrival of TSB's go team. (1.17.3, 2.5)

3.1.10 Data recorders

As regards to the air traffic control equipment, the required data recording systems were operational and the data they recorded could be evaluated. (1.11)

The airport data and image recording equipment, air traffic control equipment and other required data recording systems were operational and the data they recorded was evaluable. (1.11)

The flight data recorder recorded no data relevant to the occurrence. (1.11)

The cockpit voice recorder was operational and the data recorded could be evaluated. (1.11)

3.1.11 Medical examinations

The condition of the passenger with a serious head injury was stabilised. (1.13)

3.1.12 Survival aspects

The possibility of survival was not delayed by the arrival of the rescue and ambulance units. (2.6)

3.2 Causes

In the course of its investigation, the IC concluded that the direct cause of the accident was the lack of communication from the cabin crew on duty in the aft galley to the rest of the crew, and identified the presence of the panic on board as an indirect cause, which was caused by the misjudgement of the origin of the smoke.

In addition to those above, the IC presumes the following contributing factors:

– passengers' fatigue;

– malfunction of the pushback tug;

– ambiguity of the emergency procedures;

– initiation of an evacuation without approval;

– late reaction of the flight crew to the situation.

4 Safety Recommendations

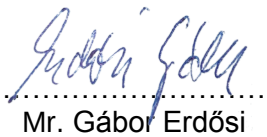
4.1 Actions Taken by the Operator/Authority During the Investigation

During the safety investigation, the Operator amended the part of the CCOM concerning the emergency evacuation procedures to clarify that the cockpit crew must be contacted in all emergency situations except for ditching.

4.2 Concluding Safety Recommendation(s)

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

Dated in Budapest, on 28/06/2023



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