MINISTRY FOR
INNOVATION AND TECHNOLOGY
TRANSPORTATION SAFETY BUREAU

FINAL REPORT

2016-004-4P

serious incident

Sofia (Bulgaria)

03 January 2016

Airbus A320-232

HA-LYP

General information

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

- Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC,
- Act XCVII of 1995 on aviation,
- Annex 13 identified in the Appendix of Act XLVI. of 2007 on the declaration of the annexes to the Convention on International Civil Aviation signed in Chicago on 7th December 1944,
- Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents (hereinafter referred to as Kbvt.),
- NFM Regulation 70/2015 (XII.1) on safety investigation of aviation accidents and incidents, as well as on detailed investigation for operators,
- In absence of other relevant regulation in the Kbvt., in accordance with Act CXL of 2004 on the general rules of administrative authority procedure and service, and, as of 1 January 2018, in accordance with Act CL on General Public Administration Procedures.

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

Pursuant to the aforesaid laws,

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

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

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

This Final Report

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

Copyright Notice

Translation

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

Table of Contents

Definitions and abbreviations

A/THR	*Auto Thrust*
AFS	*Auto Flight System*
AGL	*Above Ground Level*
Alpha Floor	*Angle-of-attack value where the stall protection function of the auto thrust system is triggered and initiates maximum (TOGA) power.*
Alpha Prot	*Angle-of-attack value where high angle-of-attack protection is triggered*
ALT	*Altitude (altitude above sea level) / Altitude hold mode*
AOA	*Angle -Of -Attack (Alpha)* *(The angle of the direction of airflow to the chord of the wing)*
ARP	*Airport Reference Point*
BEA	*Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile /* *The organisation of France for the investigation of civil aviation accidents*
CAS	*Calibrated Air Speed*
CFIT	*Controlled Flight Into Terrain*
CLIMB	*Climb (engine thrust for climbing)*
CONF FULL	*A320 configuration: Flap=40º; Slat=27º*
CONF0	*A320 configuration: Flap= 0º; Slat=0º*
CONF1	*A320 configuration: Flap= 0º; Slat=18º*
CONF1+F	*A320 configuration: Flap=10º; Slat=18º*
CONF2	*A320 configuration: Flap=15º; Slat=22º*
CONF3	*A320 configuration: Flap=20º; Slat=22º*
CVR	*Cockpit Voice Recorder*
E/WD	*Engine/Warning Display*
EASA	*European Aviation Safety Agency*
EHEH	*ICAO code of the airport of Eindhoven (Netherlands)*
EPR	*Engine Pressure Ratio*
FADEC	*Full Authority Digital Engine Control System*
FCOM	*Flight Crew Operation Manual*
FCTM	*Flight Crew Training Manual*

FCU	*Flight Control Unit*
FDR	*Flight Data Recorder*
FD Flight Director	*An instrument which gives direct flight controlling instructions to the flight crew*
FMA	*Flight Mode Annunciator*
foot	*Unit of length used in the Imperial system (1 foot = 30.48 cm)*
FPA	*Flight Path Angle*
g	*Multiple unit of load: (1 g = 9,.807 m/s^2)*
G/S+LOC	*Glideslope+Localizer mode (ILS) mode*
Green Dot (GD) speed	*Speed for best lift-to-drag ratio in clean configuration (engine-out operating speed in clean configuration)*
GPWS	*Ground Proximity Warning System*
HDG	*Heading*
IATA	*International Air Transport Association (airlines)*
IC	*Investigating Committee*
ICAO	*International Civil Aviation Organization*
ILS	*Instrument Landing System*
Kbvt.	*Act CLXXXIV of 2005 on the safety investigation of aviation, railway and marine accidents and incidents and other transportation occurrences*
knot	*Anglo-Saxon unit of speed [nautical mile /hour] (1 knot = 1.852 km/h)*
LBSF	*ICAO code of the airport of Sofia (Bulgaria)*
Mach	*Mach number (the ratio of the velocity of the aircraft and the local speed of sound)*
mbar	*millibar (unit of pressure : 1 mbar = 100 N/m^2)*
MCT	*Maximum Continuous Thrust*
MIT / ITM	*Ministry for Innovation and Technology*
MTOM	*Maximum Take-Off Mass*
NFM	*Ministry of National Development (till 18 May 2018)*
OPEN CLIMB	*Open climb mode*
PF	*Pilot flying – Crew member who controls the aircraft in a given period of time*
PM	*Pilot monitoring – Crew member who performs tasks relating to the operation*

	of the aircraft except for controlling it in a given period of time
QAR	*Quick Access Recorder*
QNH	*Atmospheric pressure converted to mean sea level, altitude above sea level*
RA	*Height above ground level as measured by radio altimeter*
sidestick	*A small stick situated next to the pilot's seat, which is used to influence turn around the longitudinal and the lateral axis*
SOF	*IATA code of the airport of Sofia (Bulgaria)*
SPD	*SPEED / managed speed mode of the auto thrust system*
Target	*A target value which the automatic system seeks to achieve / maintain*
TCAS	*Traffic Alert and Collision Avoidance System*
TLA	*Throttle Lever Angle*
TOGA	*TakeOff-GoAround*
TRK	*Track*
TSB / KBSZ	*Transportation Safety Bureau (Hungary)*
UTC	*Coordinated Universal Time*
V/S	*Vertical Speed*
$V_{ALPHA\ PROT}$	*The speed value where protection against stall is activated*
VFR	*Visual Flight Rules*
V_{LS} / VLS	*Lowest Selectable Speed*
VRTG	*Vertical Load Factor*

Summary of the occurrence

Occurrence class		serious incident
Aircraft	Manufacturer	Airbus Industrie
	Type	A320-232
	Registration	HA-LYP
	Operator	Wizz Air Hungary Ltd.
Occurrence	Date and time	03 January 2016, 16:40 UTC
	Location	Sofia Airport (Figure 1)
Fatal / serious injuries related to the occurrence:		0 / 0
Extent of damage to the aircraft involved:		Undamaged

Each time indicated in this Report is coordinated universal time (UTC).

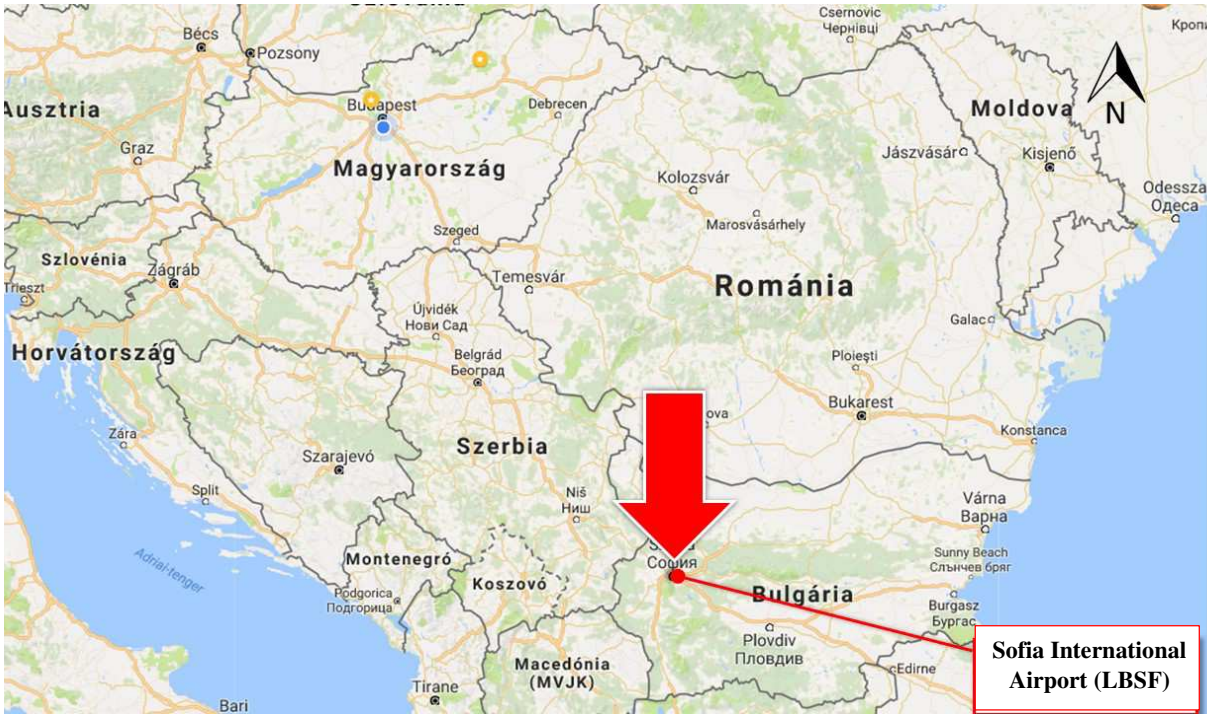


Figure 1: Location of the occurrence in Bulgaria.

Reports and notifications

The occurrence was reported to the duty service of TSB on 07 January 2016, at 21:23by the duty service of the operator.

TSB Hungary notified:

- Aviation Authority, National Transport Authority Hungary on 07 January 2016, at 23:04.
- the investigating organisation of the state of the manufacturer on 28 January 2016, at 16:11, after the occurrence had been reclassified as serious incident.
- European Aviation Safety Agency (EASA), on 28 January 2016, at 16:16.

Investigating Committee

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

Investigator-in-charge	**György HÁY**	Investigator
Member	**Ferenc KAMASZ**	Investigator
Member	**Gábor TORVAJI**	Investigator

Overview of the investigation process

As the occurrence was not treated as a serious incident at the beginning, the IC was only informed on it several days later. The Bulgarian investigating organisation stated they did not intend to investigate into the occurrence or to send a representative to take part in it. Subsequently, it was TSB that started to investigate into the occurrence. During that, TSB:

- performed primary data collecting, relying mainly on resources of the airline,
- after evaluating the information obtained, proposed that the reclassification of the occurrence from incident to serious incident,
- after reclassification, contacted the foreign organisations affected,
- asked for and received assistance from BEA, the French investigating organisation, with readout and preliminary evaluation of the data recorder containing objective information on the occurrence.
- With consent from the IC, BEA, the French investigating organisation, involved experts from Airbus (manufacturer) in data evaluation.
- The IC drafted a report on the investigation and sent it to all stakeholders for comments.
- The IC took the comments received from BEA and the operator into consideration when preparing the Final Report.

Short summary of the occurrence

On 3 January 2016, arriving from Eindhoven Airport (EHEH), the type A320 aircraft with reg. mark HA-LYP involved in the occurrence investigated, was performing ILS approach of runway 09, Sofia Airport (LBSF, Bulgaria). It was in CONF2 at an altitude of 3700 ft (above sea level) when the PF requested set to CONF3 and right after to CONF FULL, but the PM set the FLAP lever to CONF1 instead, and then, within seconds, to CONF0. The PF attempted to initiate go-around, but the flight director, which had been left ON, followed still the ILS. During the subsequent period of a couple of minutes, the flight parameters varied within the following limits, respectively: pitch angle: -8.1° to +13.2°; roll angle -43° to +18°; thrust lever positions: 5° to 45°; engine power: 33% to 87% (N1); flight speed: 198 knots to 306 knots (367 to 567 km/h); AGL: 1010 ft to 3385 ft (308 to 1032 m); vertical speed: -5100 to +5690 ft/min (-25.9 to +28.9 m/s), and the GPWS was also triggered for 3 seconds. Five minutes after initiation of go-around, the movement of the aircraft was stabilised and, after flying a left traffic circuit, it performed a safe approach and landing on runway 09.

The IC proposes that safety recommendations be issued to Wizz Air Hungary Ltd. relating to training and practice of their pilots on the one hand and to AIRBUS relating to modification of the automatic systems of the aircraft family A320 on the other.

1. Factual information

1.1. History of the flight

1.1.1. Summary

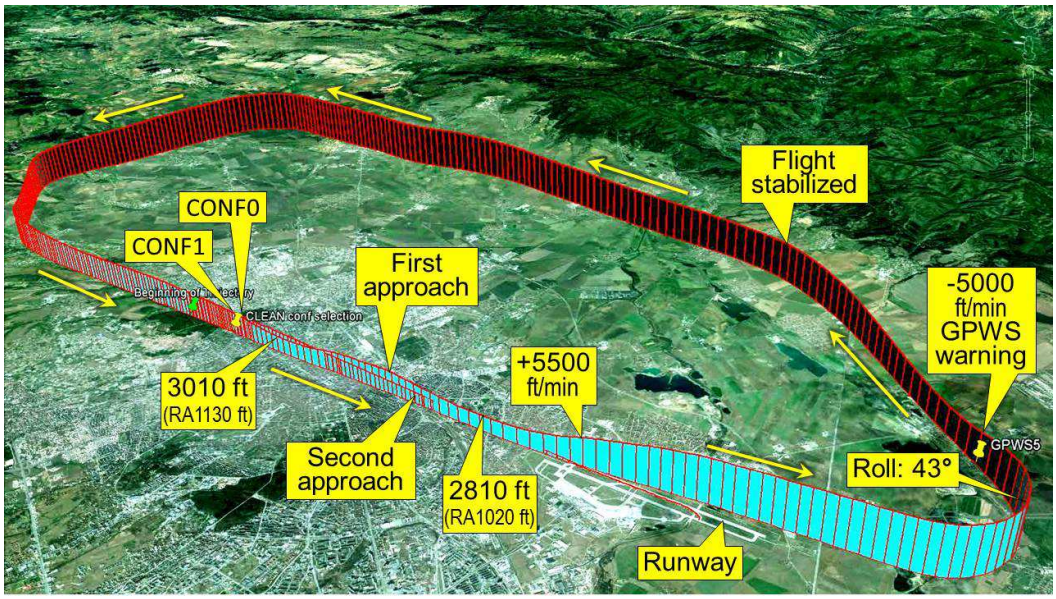


Figure 2: Aircraft trajectory and major events during the approach and go-around (Airbus Report)

On 3 January 2016, arriving from Eindhoven Airport (EHEH, Netherlands), the type A320 aircraft with reg. HA-LYP of Wizz Air Hungary Ltd. involved in the occurrence investigated, was performing ILS approach of runway 09, Sofia Airport (LBSF, Bulgaria). At that moment, the auto thrust, both autopilots and the AFCS were on, the mass of the aircraft was 59 tons, and the CG location was 28.3%.

As the aircraft was established on the ILS, just below 4000 ft (above sea level), and in CONF2, the PM positioned the flap lever to CONF0 (fully retracted) instead of CONF FULL (fully extended) as instructed by the PF. The PF pushed the sidestick forward (to descent) and put the throttle lever angle (TLA) to TOGA (take-off/go-around) position. The autopilots and the auto thrust were now voluntarily disconnected.

At 3000 ft, the sidestick was pulled back (climb), the thrust levers were pulled back to CLIMB (climb power) position and at 3400 ft, Auto pilot 1 (A/P1) was re-engaged. As the aircraft was in G/S mode but above the ILS glideslope, the aircraft immediately nosed down to reach the glideslope. Realising that, the pilots disconnected the A/P, and applied nose up inputs and TOGA thrust. Altitude began to increase.

During the climb, the AFS modes reverted from G/S LOC to V/S HDG. When 5000 ft was reached, F/D were both disengaged. A left turn was initiated at 42.9° (fairly high) maximum bank angle. During the turn, the aircraft descended at high vertical speed (maximum -5000 ft/min) which triggered a SINK RATE alert (GPWS). The minimum reached altitude was 3580 ft at that time.

Afterwards, the PF stopped the descent and began to increase altitude (using the sidestick) towards the selected value of 6000 ft. F/Ds were re-engaged, as well as all AFS, and the aircraft landed safely in 10 minutes.

1.1.2. Sequence of events in detail

Based on data extracted by AIRBUS from DFDR.

16:34:30 (at 16:34:30 UTC): crossing 3760 ft QNH (1720 ft RA), the aircraft was established on the ILS RWY 09 approach at Sofia Airport.

Configuration:
- GW: 59 tons
- CG: 28.3%
- Selected configuration : CONF2
- Landing gears: down
- Both APs and FDs engaged in G/S-LOC modes
- Selected ALT: 10 000 ft
- A/THR engaged in SPD (managed speed) mode
- target speed: 142 kt
- CAS: 142 knots

16:34:35 CONF1 and then CONF0 was selected. At that time, AOA was recorded as +8.9° and CAS as 141 kt (VLS CONF1 = 147 kt). Flaps started to retract (0° position reached at 16:34:44 UTC). The slats retracted also, but from 16:34:38 UTC remained at +18° (equivalent to CONF1; see Section 1.6.6 Slats…).

16:34:38 Pitch angle decreased to +7.8° and AOA +12° (limits: Alpha prot: 14.5°, Alpha Floor: 15°). At that time, both APs were voluntarily disengaged through the disconnect push button. A nose down stick input was applied on the captain side (up to +13.7°).

16:34:41 Pitch angle decreased sharply down to 0.7°, VRTG dropped down to +0.6 g, CAS started to increase, and AOA decreased to 8°. A nose up stick input of -6.6° was applied.

16:34:43 Thrust levers were pushed to TOGA detent (ATHR disconnected). Both flight directors remained engaged in G/S-LOC modes, despite TOGA position of the thrust levers (see Section 1.6.6 Engine…) Two seconds later, PF applied a nose down input to +4.5°. Vertical speed decreased down to -2500 ft/min. AOA increased again up to +12°.

16:34:50 Slats continued their retraction; they were fully retracted at 16:35:03.

16:35:03 Thrust levers were retarded to CLIMB detent and A/THR engaged in speed mode (speed still managed), with a target speed of 198 knots. Due to several nose up inputs initiated by the PF, from 16:34:53, the aircraft altitude started to increase after reaching a minimum of 3060 ft QNH (1130 ft RA). The CAS reached a minimum of 232 kt and then decreased.

16:35:07 Landing gears were selected up.

16:35:16 Aircraft altitude was stabilized at around 3400 ft QNH and CAS still decreased.

16:35:18 AP1 was engaged (in G/S-LOC modes), but less than 2 sec after AP1 disconnected.

16:35:27 AP1 was engaged but still in G/S-LOC modes. As a result, the AP put the aircraft in descent in order to recover the G/S. Pitch decreased to -4.2°. CAS reached a minimum of 189 knots at 16:35:30 and then increased.

16:35:33 PF voluntarily disconnected AP1 and applied a nose up stick input up to -10.5°. The thrust levers were pushed to TOGA detent.

16:35:39 Thrust levers were pulled at MCT and then 6 sec later they were selected back to TOGA.

16:35:53 Aircraft altitude reached a minimum of 2870 ft QNH (1020 ft RA), while pitch angle and CAS were increasing.

16:35:58 Thrust levers were pulled to CLIMB detent. Two seconds after, ATHR engaged in speed mode (managed speed) (GD: 198 knots). At that time, CAS reached a maximum of 306 kt before it started to decrease. Thrust decreased down to 0.92 EPR.

16:36:04 G/S-LOC modes changed to V/S-HDG modes (presumably due to leaving the coverage area of the ILS signals). At that time, the aircraft had a current V/S at about +5000 ft/min.

16:36:07 Pitch angle reached a maximum of 13°. Then the PF applied nose down stick input several times until 16:35:36.

16:36:12 OPEN CLIMB engaged and ATHR mode changed to EPR thrust. Selected ALT was 10 000 ft.

16:36:22, while the aircraft was crossing 4600 ft QNH, Selected ALT was reduced to 5000 ft, V/S mode engaged again with Selected V/S= 2500 ft/min, and ATHR mode changed to speed mode.

16:36:33 FDs engaged ALT mode.

16:36:50 Both FDs were disengaged.

16:36:52 PF initiated a left turn by applying left roll stick inputs. Selected HDG changed from 90° to 320°.

16:36:54 PF ordered several nose down inputs initiating a descent. CAS stabilized around 200 kt.

16:37:08 Nose up stick inputs were applied to 6.5° but the aircraft altitude continued to decrease. AOA and VRTG started to increase. Roll angle reached -43°.

16:37:21 While AOA was at a maximum of 7.5° and VRTG at 1.31 G, thrust levers were pushed to MCT (ATHR disengaged) and nose down stick inputs were applied. PF applied Pitch and AOA started to decrease. CAS started to increase.

16:37:29 Thrust levers were pulled between MCT (35° TLA) and CLIMB (25° TLA) detent (at around 28° TLA).

16:37:35 PF applied nose up stick inputs for 7 sec. up to -12.6°. Pitch angle reached a minimum at -8.4° before it started to increase.

16:37:37 While the aircraft was crossing 4000 ft QNH (2200 ft RA) at about -5000 ft/min, the GPWS mode 1 “SINK RATE, SINK RATE” audio signal triggered for 3 seconds. Thrust levers were pulled to near idle position.

16:37:40 Roll angle came back around 0° and HDG stabilized at about 320°.

16:37:42 CAS reached a maximum of 288 kt and began to decrease. Two seconds later, aircraft altitude reached a minimum of 3580 ft QNH (1800 ft RA) before increasing.

16:38:22 Aircraft altitude started to stabilize at around 4800 ft QNH. (Selected ALT = 5000 ft).

16:38:38 CAS which was 248 kt started to decrease, altitude increased slowly.

16:39:05 Selected altitude changed from 5000 ft to 6000.

16:40:15 FD1 then FD2 engaged in FPA-TRK modes controlled by the on-board computer.

16:40:20 AP1 engaged and 8 sec after A/THR engaged.

16:50:22 The rest of the flight was uneventful and the aircraft landed safely on RWY09.

1.2. Injuries to persons

No one was injured related to the occurrence.

1.3. Damage to aircraft

The aircraft was not damaged related to the occurrence.

1.4. Other damage

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

1.5. Personnel information

1.5.1. Data of the pilot in command ("PF")

Age, nationality, gender		49 years; Bulgarian; male
Licence data	type	ATPL(A)
	professional valid until	31/07/2016
	ratings	A320/IR (31/07/2016)
Medical class and valid until		Class I. – 11/05/2016
Flying hours/take-offs	in the previous 24 hours	5:00 / 2
	in the previous 7 days	8:57 / 4
	in the previous 90 days	145:15 / 56
	total:	16 390 hours
	on the affected type, total:	6 300 hours
Aircraft types flown:		A320
Flew / monitored the aircraft at the time of the occurrence		Flew the aircraft at the time of the occurrence
Rest period / duty time in the previous 48 hours		33:28 / 14:32
Date of recent training		Periodic simulator training: 20/12/2015
Results of recent training and mandatory and periodic checks		Simulator skill test: 19/12/2015 Line check: 31/08/2015
Knowledge and experience related to the route and airports involved		He had experience because the airport involved in the occurrence had been his usual base, so he had performed take-offs and landings there on a regular basis.

1.5.2. Data of the first officer ("PM")

Age, nationality, gender		29 years; Bulgarian; male
Licence data	type	CPL(A)
	professional valid until	31/12/2016
	ratings	A320/IR COP (31/12/2016)
Medical class and valid until		Class I – 06/03/2016
Flying hours/ take-offs	in the previous 24 hours	5:00 / 2
	in the previous 7 days	8:28 / 4
	in the previous 90 days	178:52 / 70
	total:	2 568 hours
	on the affected type, total:	2 348 hours
Aircraft types flown:		A320
Flew / monitored the aircraft at the time of the occurrence		Monitored the aircraft at the time of the occurrence
Rest period / duty time in the previous 48 hours		48:00 / 0:00
Date of recent training		Periodic simulator training: 24/12/2015

Results of recent training and mandatory and periodic checks	Simulator skill test: 23/12/2015 Line check: 22/04/2015
Knowledge and experience related to the route and airports involved	He had experience because the airport involved in the occurrence had been his usual base, so he had performed take-offs and landings there on a regular basis.

The PM was on holiday for six days preceding the date of the occurrence. According to information of the IC, the PM did not sleep well at the night preceding the occurrence, and he only woke up 50 to 55 minutes before the time scheduled for him to report for duty. He had to hurry to catch up on his delay. Between the time of reporting for duty and the time of the occurrence, he performed his duty (which was planned to include the four phases of the flight) as usual.

1.6. Aircraft information

1.6.1. General information

Class	Fixed wing aircraft MTOM>5700kg
Manufacturer	AIRBUS
Model	A 320-232
Year of manufacture	2015
Serial number	06589
Nationality and registration marks	HA-LYP
State of registry	Hungary
Date of registry	13 May 2015
Name of the owner	ARCADIA MSN 6589 Limited
Name of the operator	Wizz Air Hungary Ltd.
Airline company	Wizz Air Hungary Ltd.
Call sign during the given flight	W6 4328

	Flight hours	Take-offs
Since manufacture	2 770 hours	1 262
Since last inspection	2 152 hours	1 011

1.6.2. Airworthiness Certificate

Airworthiness Certificate	Number	FD/LD/NS/A/1843/3/2015
	Date of issue	13/05/2015
	Valid until	Until withdrawal
	Restrictions	None

Airworthiness Review Certificate	Number	FD/LD/NS/A/1843/4/2015
	Date of issue	13/05/2015
	Valid until	13/05/2016
	Date of latest review	13/05/2015

1.6.3. Engines

Category	High bypass ratio turbofan engine	
Engine manufacturer	International Aero Engines (IAE)	
Type	V2527-A5	
Position on the aircraft	Engine 1	Engine 2
Serial number	V17715	V17730
Date of installation in this position	02 April 2015	02 April 2015
Flight Hours	2 769:38	2 769:38
Take-offs	1 262	1 262

1.6.4. Aircraft loading data

Empty mass	40 780 kg
Fuel on board	~3 000 kg
Payload	15 000 kg
Maximum take-off mass	71 500 kg
Maximum landing mass	64 500 kg
Airplane mass at the of the occurrence	59 000 kg
Centre of gravity location at the time of take-off	28.3%
Permissible centre of gravity location	23 – 45%
Type of fuel	Jet A-1

1.6.5. Description of the systems affected

(based on the report prepared by Airbus)

Protective function of the slats (Alpha/Speed Lock Slats)

The function of the two flaps per wing and five slats per wing is to increase lift.

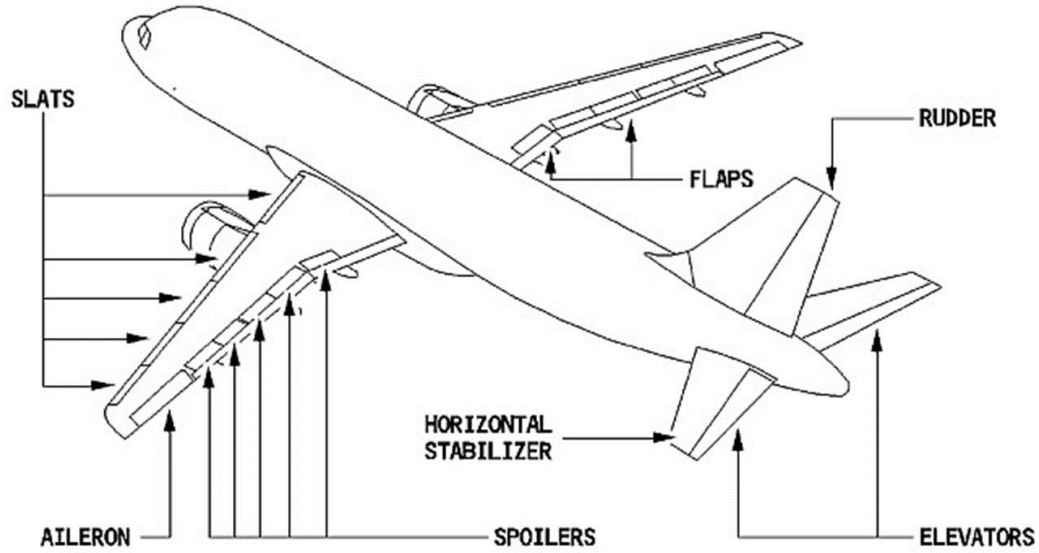


Figure 3: Controllable aerodynamic surfaces of the A320 aircraft (Operation Manual)

The Alpha/Speed Lock function inhibits slat retraction at high angles-of-attack (alpha) and/or low speeds. If alpha exceeds 8.5° or the airspeed goes below 148 knots, retraction from position 1 to position 0 is inhibited. Inhibition is removed when alpha goes below 7.6° and, when the speed exceeds 154 kt. This protective function is not active if the aircraft is on the ground, and its speed is less than 60 kt., or, during flight if alpha exceeds 8.5° or the airspeed goes below 148 kt, after the flight crew has moved the lever to 0.

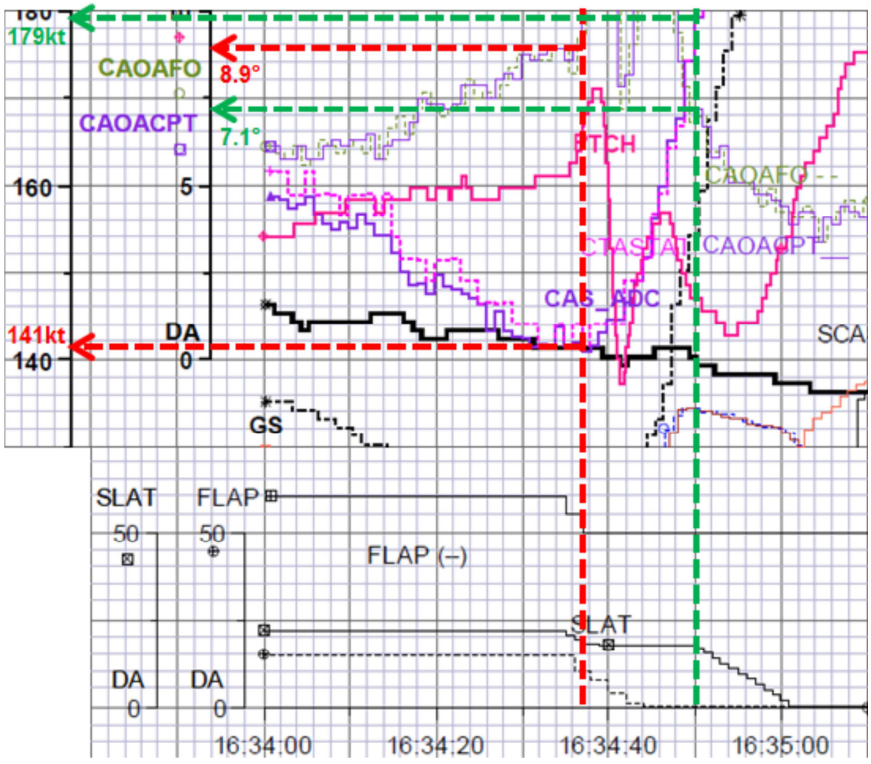


Figure 4: Inhibition of retraction of slats (red arrow) and removal of such inhibition (green arrow) (source: Airbus Report)

Engine control – Thrust levers

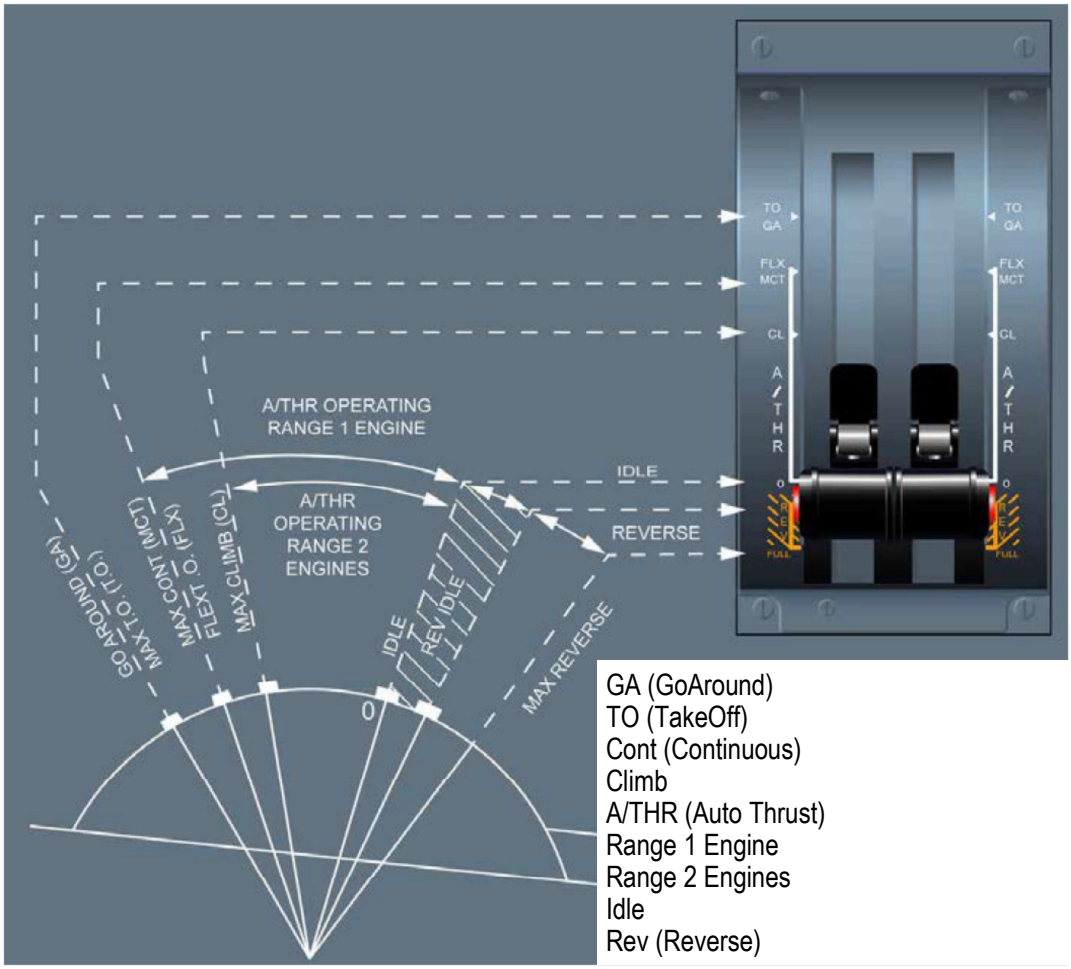


Figure 5: Operating range of thrust levers of the A320 aircraft (source: Airbus Operation Manual)

Engine thrust, in full range, is controlled by the FADEC system. Thrust levers can only be moved manually (in contrast with those types where thrust levers are moved automatically, too). FADEC controls the operation of the engines with regard to the positions of thrust levers. The following is a largely simplified description of its basic operation principle:

- In TOGA position of the thrust levers, FADEC drives the engines to the maximum take-off thrust available in the given circumstances, regardless of the operation of other automatic systems.
- In MCT position of the thrust levers, FADEC drives the engines to the highest thrust they can endure at length, regardless of the operation of other automatic systems.
- In the A/THR range (A/THR armed), FADEC sets engine thrust to the value required by the automatic systems, within the maximum determined by thrust lever positions.
- In the REVERSE range, after resetting thrust-reversers of the engines, FADEC adjusts engine thrust to values determined by thrust lever positions.

Setting at least one thrust lever to the TOGA detent, automatic control systems will switch to go-around mode, provided that the flaps lever is at least in positon 1, and the aircraft is in flight, or the aircraft has been on ground for less than 30 seconds. Flight Directors (FDs) switch to go-around modes, i.e. Speed Reference System (SRS) for longitudinal and G/A track (GA TRK) for lateral, which is reflected by the Flight Mode Annunciator (FMA).

Events which trigger auto pilot disengagement (above 400 ft flight altitude):

- The flight crew pushes the takeover pushbutton on the sidestick
- The flight crew pushes the corresponding AP pushbutton on the FCU
- The flight crew pushes on the sidestick or rudder harder than a defined threshold,
- The flight crew moves the pitch trim wheel beyond a defined threshold,
- The other AP is engaged, except when localizer/glideslope modes are armed or engaged, or when go-around mode is engaged,
- Both thrust levers are set above the MCT detent and the aircraft is on ground, or
- One of the engagement conditions is lost.

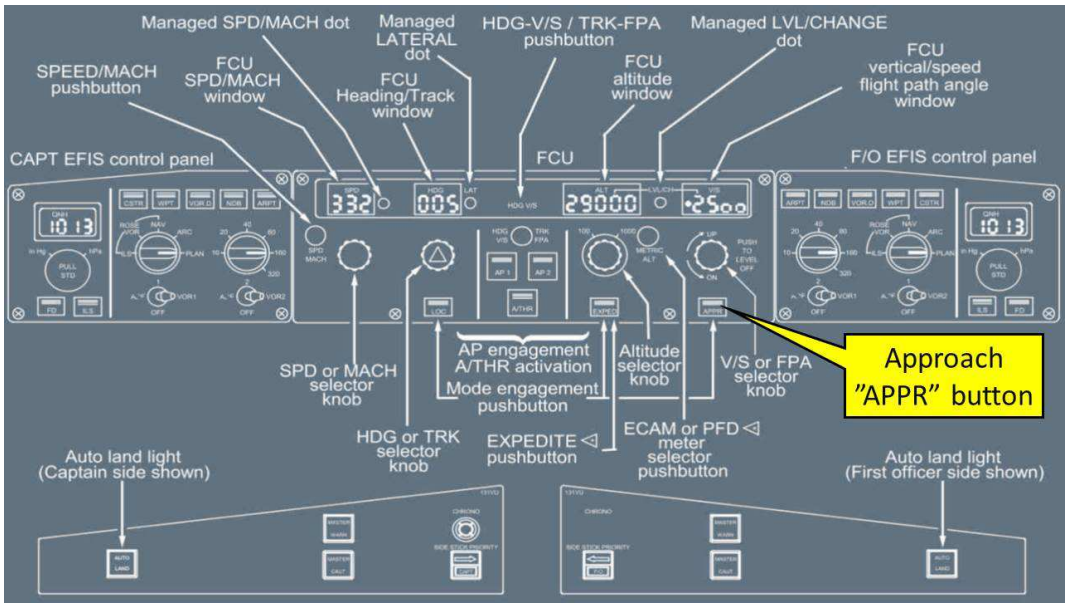


Figure 6: Flight Control Unit (FCU) (source: Airbus Report)

Disengagement conditions of G/S-LOC and G/S modes:

- The APPR pushbutton is pressed (Figure 6), or
- The LOC pushbutton is pressed (G/S mode disconnects, LOC remains active), or
- The HDG/TRK knob is pulled out, or
- The go-around mode is engaged, or
- Another approach is selected. HDG-V/S or TRK-FPA modes engage.
- When the LOC or G/S signal has been lost for 7 s or more above 200 ft RA.

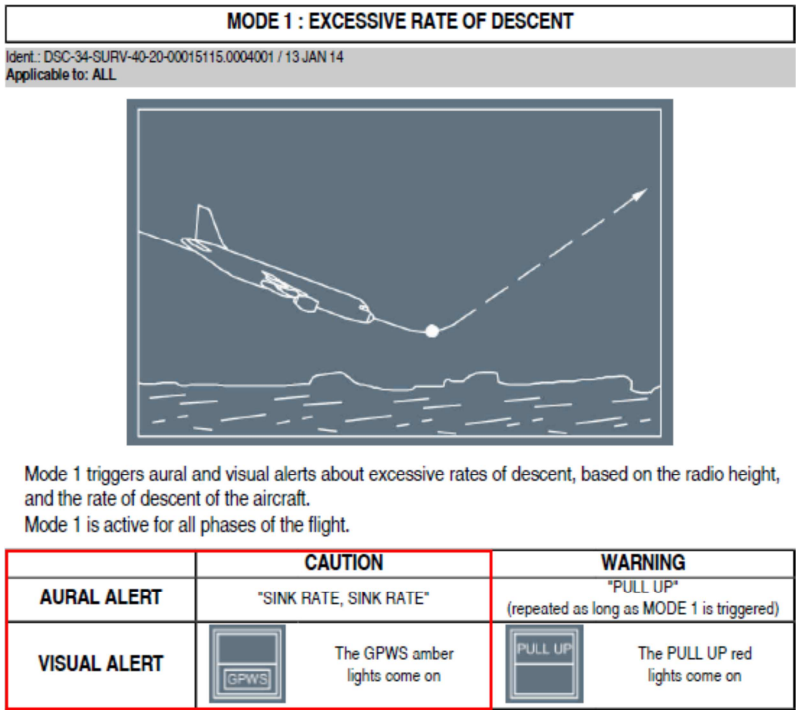
1.6.6. On-board warning systems

The aircraft was equipped with transponder, traffic alert and collision avoidance system (TCAS) and ground proximity warning system (GPWS). Such systems worked according to the requirements, the IC made or received no comment relating to their operation.

GPWS – ground proximity warning system

The function of the system is to warn the flight crew in the case that the current flight trajectory threats with collision with the ground or an obstacle. It may give a warning, among others, if:

- descent of the aircraft or approaching of the ground is excessive compared to the flight altitude, or
- there is loss of altitude after take-off or go-around, or
- the aircraft gets too close to the ground in a situation other than landing configuration, or
- the aircraft descends significantly below the glideslope during ILS approach.



MODE 1 : EXCESSIVE RATE OF DESCENT

Ident.: DSC-34-SURV-40-20-00015115.0004001 / 13 JAN 14
Applicable to: ALL

Mode 1 triggers aural and visual alerts about excessive rates of descent, based on the radio height, and the rate of descent of the aircraft.
Mode 1 is active for all phases of the flight.

	CAUTION	WARNING
AURAL ALERT	"SINK RATE, SINK RATE"	"PULL UP" (repeated as long as MODE 1 is triggered)
VISUAL ALERT	GPWS — The GPWS amber lights come on	PULL UP — The PULL UP red lights come on

Figure 7: How alert triggered by excessive rate of descent works (source: Airbus Report)

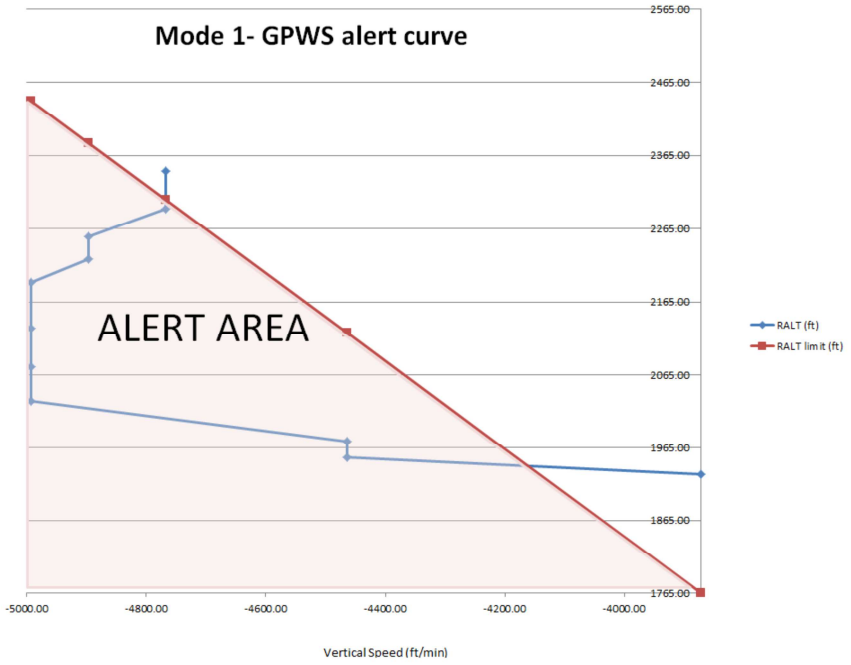


Figure 8: Flight parameters which triggered SINK RATE alert in the case (Airbus Report)

1.7. Meteorological information

The event took place at dusk, in satisfactory visibility conditions.

At the time of the occurrence, the weather conditions at Sofia were as follows (METAR report):

„…09016KT 3500 -SN FEW026 OVC034 M08/M10 Q1011…NOSIG="

That is: East wind of 16 knots (30 km/h). Visibility is 3500 m. It is snowing lightly. Sparse clouds at 2600 ft (800 m) and overcast at 3400 ft (1040 m) altitudes. Temperature: -8°C, dew point: -10°C. Air pressure (QNH): 1011 mbar. No significant change is expected.

1.8. Aids to navigation

The equipment items specified in the airworthiness certificate were installed on the aircraft, and the IC made or received no comment relating to irregularity of their operation. The IC made or received no comment relating to irregularity of the operation of the ground-based equipment items. Navigation equipment did not influence the course of events, so it needs no detailed discussion.

1.9. Communications

The equipment items specified in the airworthiness certificate were installed on the aircraft, and the IC made or received no comment relating to irregularity of their operation. The IC made or received no comment relating to irregularity of the operation of the ground-based equipment items, they proved to be fit for their functions.

1.10. Airports information

Take-off was performed from Eindhoven Airport (EHEH/EIN), Netherlands.

The scheduled destination was Sofia Airport (LBSF/SOF), Bulgaria. Landing took place on 3 January 2016, at 16:49.

Name of airport	Sofia (Bulgaria)
ICAO code of airport	LBSF
Airport operator	Sofia Airport EAD
Reference point (ARP)	N42°41'42" E023°24'30"
Elevation	1742 ft (531 m)
Runway identification	091° / 271°
Runway dimensions	3 600 x 45 m
Runway surface	Asphalt

1.11. Flight recorders

The data recording systems required for the air traffic management equipment and for the aircraft were serviceable. The IC made or received no comment relating to irregularity of the operation of such systems. As for a few days the event had been classified as minor incident, FDR data and CVR audio data was overwritten in the meantime, so it was not available for the investigation. Data recorded by the quick access recorder (QAR) was available for download, thus reconstruction of the event was primarily based on such data (Figure 9).

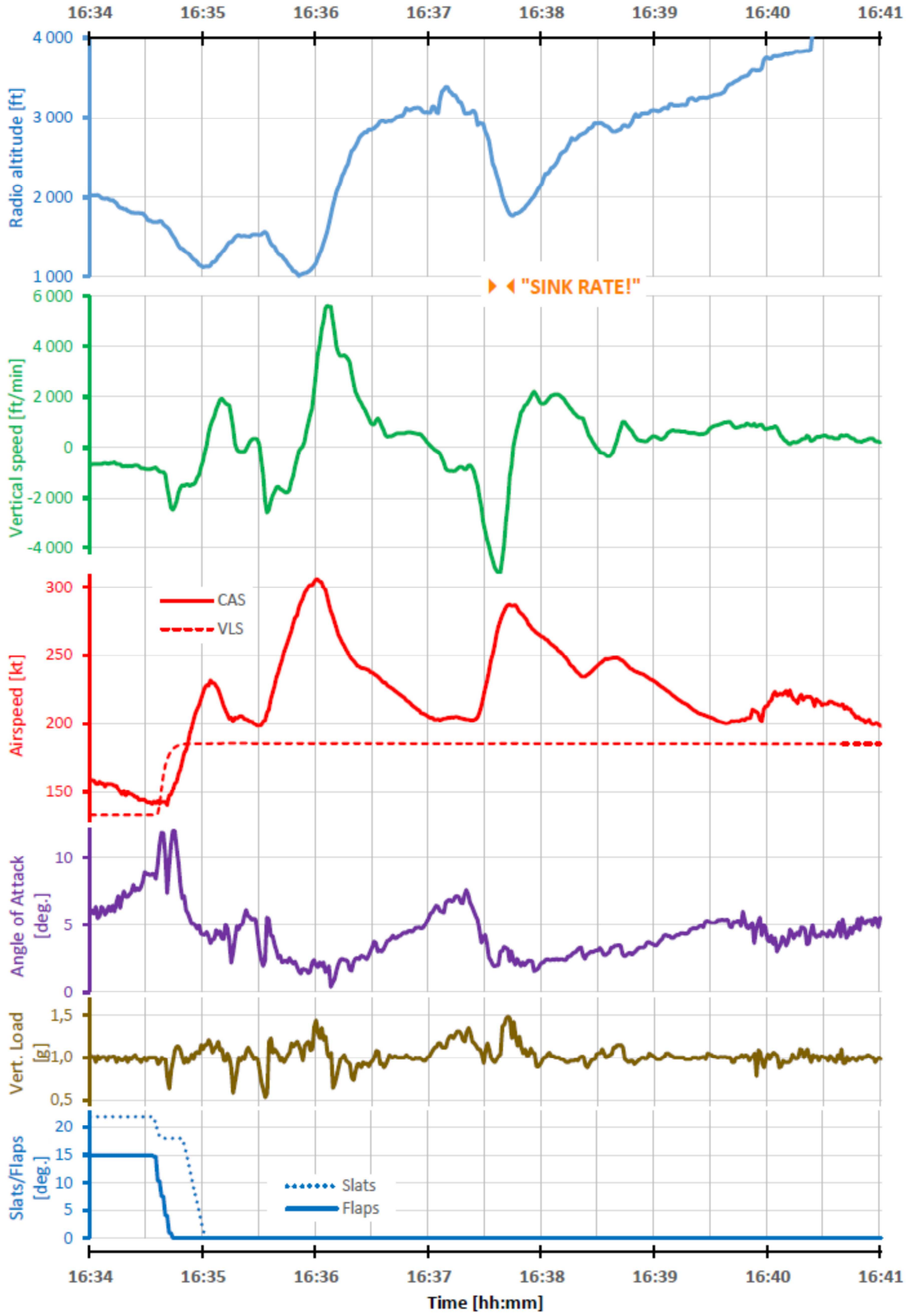


Figure 9: Flight parameters as per data from the QAR (TSB)

1.12. Wreckage and impact information

There was no wreckage.

1.13. Medical and pathological information

There was no evidence that physiological factors or other impediments had affected the legal capacity of the personnel concerned.

1.14. Fire

There was no fire.

1.15. Survival aspects

No one was injured.

1.16. Tests and research

The IC performed or ordered no tests or examinations.

1.17. Organizational and management information

1.17.1. Required procedure of slats/flaps deployment

In approach upon the verbal instruction *"FLAPS 1/2/3/FULL"* from the PF the PM shall check first whether the airspeed of the aircraft is below the VFE of the configuration requested and decelerating, and then confirms it using the expression "*Speed checked* ". Then the PM selects the requested Flaps lever position and replies „*FLAPS 1/2/3/FULL*" after checking the blue number of the flaps position displayed on the ECAM Upper Display to confirm that the correct selection has been made.

1.17.2. Use of flight director with disengaged auto pilot (FCTM)

If the flight crew do not follow flight director instructions then the flight directors should be disengaged. If the flight director is engaged then it will give instructions for vertical and lateral steering for flight according to the selected mode. Manual control should be in such manner that the indicators of the flight director should possibly remain in the middle position.

1.17.3. Recommended procedure for engaging the auto pilot

Before engaging the auto pilot, pilots should:

- manoeuvre the aircraft along the desired flight path
- check if the flight director is engaged and set in the desired mode (FMA)
- steer the aircraft in such manner that the indicators of the flight director should be in middle position.

(If, at the time of engagement of the auto pilot, there is too big difference between the intended and the actual flight path then the aircraft controlled by the auto pilot may run out of the desired vertical and/or lateral target, which may surprise the flight crew, due to the resulting large pitch/roll changes and thrust variations.)

1.18. Additional information

Sensory illusion: In case of a sudden forward linear acceleration during level flight the pilot perceives the illusion that the nose of the aircraft is pitching up. The pilot's response to this illusion would be to push the sidestick forward to pitch the nose of the aircraft down.

1.19. Useful or effective investigation techniques

A verbal information obtained by the IC, which demonstrated that some proportion of active pilots are not aware that setting the thrust lever(s) to the TOGA position with the FLAP lever in a position lower than CONF1 (FLAP lever at "0" position) will not trigger go-around mode activation by its design logic.

2. Analysis

2.1. Flight control

After the instruction to deploy flaps, when the PM set the control lever to CONF0, the PF saw on his instrument that the lowest selectable speed (V_{LS}) value was rapidly growing and reaching a value above the current airspeed. The immediate danger of stalling was eliminated by the action of the protective system of the aircraft which did not allow full retraction of the slats immediately because of low airspeed and high angle of attack. In order to eliminate the problem, the PF disconnected the auto pilots, initiated steeper descent, and then set the thrust levers to maximum thrust (TOGA). Despite the fact that the thrust levers were now in TOGA position, the aircraft control did not switch from approach mode to go-around mode because the CONF0 position of the flaps lever inhibited that process according the AFS logic.

At the cost of a loss of altitude of ca. 500 ft, airspeed reached a safe value of 220 kt, after which the slats were retracted fully. The aircraft started to climb, and PF pulled the thrust back to CLIMB position. The landing gears were retracted. In response to the thrust lever position, the A/THR engaged, and, in accordance with the still active approach mode, it tried to reduce airspeed to Green Dot speed (198 kt). As at this time the current aircraft speed was 230 kt, the A/THR reduced engine thrust (to a level near idle).

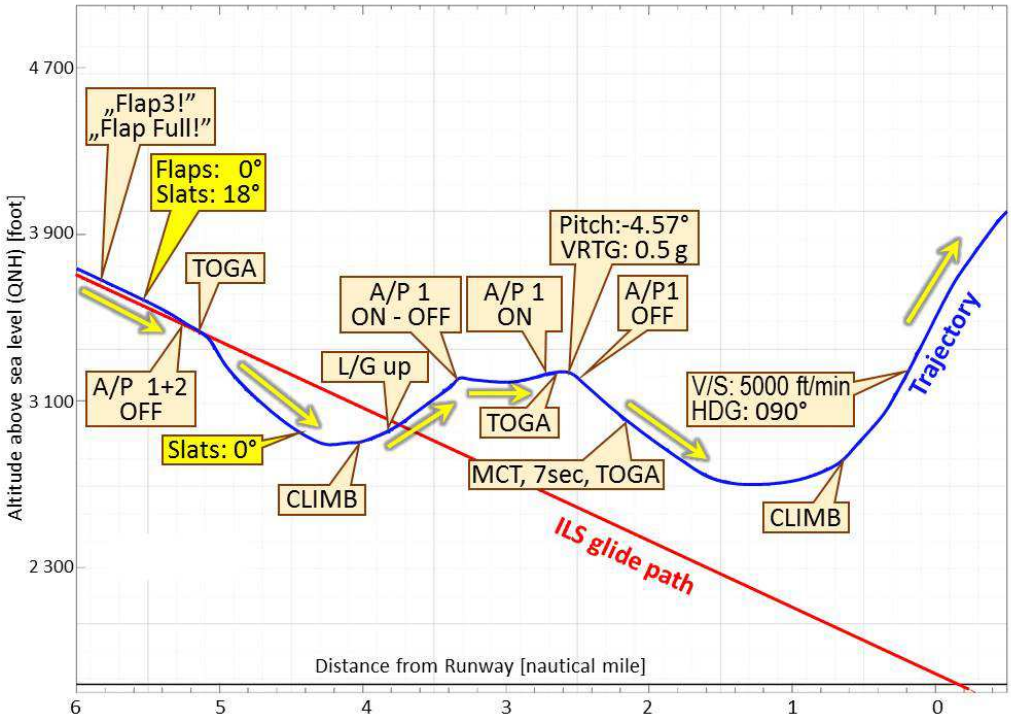


Figure 10: Moments of the interruption of the ILS approach, side view (source: BEA)

After normalising the speed and descent situation, the PF tried again to activate automatic modes. He reconnected AP1 which had still beenworking in approach mode and trying to follow the ILS glide path and localiser. As the aircraft was already above the glide path, the auto pilot initiated steep descent and then six seconds after engagement was disconnected by the flight crew. As both speed and altitude were decreasing, the PF pushed the thrust levers to TOGA position again. As a combined effect of increased thrust and steep descent, airspeed also increased quickly to exceed 300 knots, although the position of the thrust levers decreased to MCT value for a short time. The flight crew was able to stop descent, by pulling the sidestick backward, only at an altitude of 1133 ft above ground level. Climb started, the PF pulled thrust levers back to CLIMB position, and as an effect, the auto thrust set the engines to idle in order to reduce airspeed, because it had still been in approach mode.

With the engine thrust close to IDLE, the speed of the aircraft in steep climb was decreasing fast. The automatic control finally quitted approach modes (most likely due to the loss of one of the ILS signals, LOC or G/S signal) and then about 45 seconds after both flight directors were disengaged by the flight crew. Stopping climb at 5000 ft, the PF initiated a left turn upon instruction from the air traffic control. The PF, who was overloaded by the unusual, unexpected and frightening situation with series of information that he did not understand, initiated a left turn that finally reached a roll angle of 42.9° value. The PF pushed the thrust levers to MCT position again. The IC assumes that the sudden acceleration with longitudinal direction caused by thrust increase might have caused a sensory illusion to the pilot who might have had the false perception of steep climb, as an effect of which he initiated a steep descent. The sink rate of the aircraft reached the -5000 ft/min value, which made the ground proximity warning system give the audio warning SINK RATE for a short time.

Descent was stopped at 1750 ft (533 m) thanks to nose up inputs ordered on the captain sidestick. Then, relying on the flight control system, AP1 and the auto-thrust, the flight crew normalized the flight gradually, managing to reach and maintain the direction of 270° and flight altitude of 6000 ft as permitted by the Air Traffic Control. The flight crew might have realized at that point the cause of the unusual behaviour of the aircraft, i.e. the fully retracted position of the slats/flats system. After that, the aircraft finished the traffic circuit and landed safely on Runway 09.

2.2. Protection of the slats/flaps mechanism

At the moment the slats and flaps were inadvertently retracted, the airspeed (141 knots) was lower than the minimum speed required by the protection of the slats (148 knots). As a result, the retraction process halted at 18°, and was finished only after the sufficient speed was reached. The system worked in accordance with its design purpose, i.e. it managed to prevent a dangerously high angle of attack (Section 1.6.6).

2.3. Switch to go-around mode

When the thrust levers were set in TOGA position, the slats/flaps configuration was already CONF0, so the automatic systems did not switch from approach mode to go-around mode. As the flight directors remained engaged after disconnection of the auto pilots, the ILS approach mode also remained active when the PF performed go-around. When reconnected, the auto pilot began to work in ILS approach (LOC+G/S) mode which was still active and, contrary to the PF's intention, attempted to perform the landing procedure, which resulted in intensive descent.

In the opinion of the IC, the risk of the irregular flight situation occurring due to retraction of slats and flaps was worsened by the fact that the automatic system did not support the flight crew's intention to go-around, and the flight crew were not aware of this fact for minutes.

2.4. Engine control

During the event, the engine powers varied between extreme values. Indeed, when the PF found current airspeed dangerously low or dangerously decreasing and set the thrust levers to higher position than the functional range of the auto-thrust, then the engines began to work at a high thrust level corresponding to the thrust lever position. But when the PF pulled the thrust levers back to the functional range of the A/THR, then the A/THR set an engine thrust to the adequate level to reach and maintain the speed target (Green Dot speed). During the event, it happened that the automatic system lowered the engine thrust close to IDLE in order to reach such target speed (because at that time the actual aircraft speed was well above this target).

In the opinion of the IC, the fact that on this aircraft type the auto-thrust system changes engine thrust without changing the position of the thrust levers might have effect on flight crew's awareness concerning the set engine thrust during unexpected and unusual situation, because crew were able to primarily rely on indirect in-formation from the instruments relating to actual engine function.

2.5. Trigger of the GPWS aural warnings

The purpose of the ground proximity warning system (GPWS) is to prevent dangerous approach of terrain (or controlled flight into terrain in extreme cases) by warning the flight crew on time. In the case involved, the "SINK RATE!" warning of the system triggered when the sink rate reached 5000 ft/min (25.4m/s) at only 2200 ft (670 m) RA, which sink rate, if maintained, would have resulted in ground impact in 26 seconds. The system worked in accordance with its design purpose, i.e. it managed to prevent dangerous approach of terrain, although the PF had already initiated a climbing manoeuvre before hearing the GPWS warning alert, but deflection of the sidestick significantly increased after the warning.

2.6. Human factor evaluation using the SHELL model

The SHELL model may be of help for the analysis of the PF's activity. The model classifies the factors influencing the acts of the individual into four major groups:

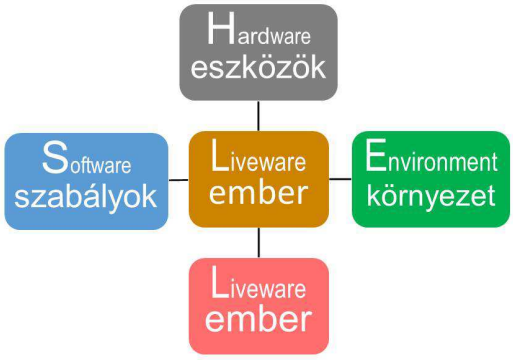


Figure 11: The SHELL Model used for evaluation of the human factor (TSB)

2.6.1. Liveware (co-operation of the flight crew):

Under the influence of a week off before the occurrence and a night of disturbed rest, the 29-year-old PM who had 2600 hours of flight experience, set the slats/flaps control lever to a position which resulted in full retraction of the flaps and slats instead of deploying them according to the instruction received. The IC could not clearly identify the specific cause of the error.

2.6.2. Environment:

Visibility conditions were adversely influenced by dusk and snowing. The geomorphology conditions dominated by high mountains around Sofia Airport increased the load of the PF. As it was his base airport, he had to be aware of the disadvantageous terrain, which might have increased his psychological stress.

2.6.3. Hardware:

Some of the features of the controls of the A320 Airbus model (Sections 1.6.5, 2.1, 2.3) did not make it easy for the PF to realise and manage the unexpected and unnatural flight situation. After the thrust levers were pushed to the TOGA position, the automatic systems still did not switch to the go-around mode. When the thrust levers were moved just a few centimetres, the engine power altered between near-maximum and near-minimum values.

2.6.4. Software (rules):

In addition to inadvertent retraction of the slats and flaps, the flight crew did not follow the company standard operating procedure (disregarding E/WD and FMA displays, failing to disengage the flight director, etc.), which made it even more difficult for them to identify and manage the situation. Their failing to disengage the flight director kept the ILS (G/S and LOC) approach mode active. When the auto pilot was reconnected in a hurry, it took the aircraft into a manoeuvre which made the situation even worse.

2.6.5. General analysis of the PF's reactions

Continuous, detailed overviewing and full understanding of the operation of such heavily automated systems like an Airbus A320 aircraft typically exceeds the possibilities of an average operator. Practical operation of such systems is based on practising those procedures which are used on a daily basis. An unexpected, substantial difference from the usual procedures may mean a serious challenge to the person operating the system. It is particularly typical of the situation of the flight crew whose mental load is further increased by strong time constraint and their awareness of potential serious consequences of a possible mistake.

Right before the serious incident occurred, the PF might have reasonably expected that a routine approach and landing procedure was to follow. But to the contrary, the unusual error made by the PM who retracted the slats and flaps instead of fully deploying them changed the situation fundamentally, situation which was difficult for the PF to understand at that time. In the first moments, the most important information for him was that the airspeed had become lower than the lowest selectable airspeed (V_{LS}), which implied the danger of getting too close to the stalling speed, and might require activation of further automatic protective functions in order to maintain safe controllability of the aircraft. The PF eliminated immediate danger by available means (descending manoeuvre and increasing of engine thrust) but he was not aware of the origin of the problem.

The next decision was the abortion of the approach procedure and performing go-around, as stabilization of the flight of the aircraft within acceptable period of time did not seem possible. In general practice, setting the thrust levers to the TOGA position will switch the systems of the aircraft to go-around mode, but in this case it did not happen because the slats/flaps lever was in CONF0 position. Safe management of the situation was hindered largely by the fact that, for several minutes, the flight crew's intention was to abort the approach while the automatic systems of the aircraft were still in approach modes.

2.6.6. Training for pilots for managing extraordinary situations

During the investigation, the IC found that, although pilots learn during their training that, in CONF0 position of the slats/flaps lever the automatic systems do not switch to go-around mode despite the throttle levers are set to TOGA position in aircraft of the A320 family of Airbus, but that knowledge fades out with time, because pilots do not face that situation during their work or recurrent training. This deficiency can be eliminated by changing this feature of the aircraft or by further development of training.

3. Conclusions

3.1. Findings

Members of the flight crew had the appropriate licences and ratings and sufficient experience for the given flight task. Until the unjustified retraction of the flaps and slats, the flight crew had performed the flight in compliance with relevant requirements.

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

The mass and the centre of gravity of the aircraft were within the specified limits. The aircraft was filled up with fuel of sufficient quantity and appropriate quality for the flight.

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

The flight took place in satisfactory visibility conditions, in the twilight period, according to the flight plan, until reaching the altitude of 4000 ft during ILS approach.

During the approach, following the command from the PF to set FLAP 3 and FLAP FULL, the PM initiated retraction of the slats/flaps instead of extending them by setting the FLAP lever to “0” position. However due to the aircraft protection system, which worked as per design prevented the slat to fully retract. When realizing the unexpected and unusual situation, the PF attempted to abort the approach and to initiate go-around by setting the thrust levers to TOGA position. In line with their design, the automatic systems of the aircraft did not switch to the go-around mode because the FLAP lever was in “0” position. When attempting to start the go-around, the flight crew disconnected autopilots. Both flight directors remained ON, which was still following the approach mode (G/S and LOC).

During the go-around, the PF took the aircraft into a left turn, upon instruction from the air traffic control. During the manoeuvre, the bank angle reached 43 degrees. During the turn, the vertical speed almost reached -5000 ft/min and, at 2200 ft (670 m) RA, the aural warning of the GPWS system sounded for 3 seconds.

During the 5 minutes between the start of the go-around and the stabilization of aircraft movement, the pitch angle varied between -8.1 and +13.2 degrees, the thrust lever positions between 5 and 45 degrees, and engine thrust values between 33 and 87% (N1), CAS between 198 and 306 knots (367 and 567 km/h), RA between 1010 and 3385 ft (308 and 1032 m), and vertical speed between -5100 and +5690 ft/min. (-25.9 and +28.9 m/s).

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

3.2. Causes

The IC concluded during the investigation that the cause of the occurrence was:

- that the PM retracted the slats/flaps in contrast to the PF’s instruction which was to further extend them.

In addition to the above, the IC presumes the following probable causes:

- the flight crew did not follow the company standard operating procedure in regards of go-around flow, callouts and check/review of SLAT/FLAP movement when setting the flap lever to a different position;
- late disconnection of automation and reverting to “basic modes” when its operation causes confusion to flight crew or things do not go as expected;
- the automated systems did not help the pilots in performing the go-around manoeuvre.

4. Safety recommendations

4.1. Actions taken by the operator/authority during the investigation

After the occurrence was understood, the airline Wizz Air communicated the lessons learnt from the case to their pilots in writing, and later on, within the framework of annual training, such learnings were also integrated in the operation manual and in the program of the simulator training.

4.2. Safety recommendation(s) issued during the investigation

TSB issued no safety recommendation during the investigation.

4.3. Safety recommendation(s) issued on completion of the investigation

The Investigating Committee of TSB proposes the following safety recommendations as the closing of the investigation:

BA2016-004-4-1: *During the investigation, the Investigating Committee of Transportation Safety Bureau found that, when in an unusual situation occurring unexpectedly, the flight crew had not followed the relevant procedures fully. Therefore*

> **MIT Transportation Safety Bureau recommends Wizz Air Hungary Ltd. to consider elaborating a program for improving the training for their pilots in order to enhance safer managing of unusual situations occurring unexpectedly.**

The opinion of the Investigating Committee is that in the case of acceptance and expected implementation of the recommendation, unusual situations occurring unexpectedly would entail lower risk.

BA2016-004-4-2: *During the investigation, the Investigating Committee of Transportation Safety Bureau found that it had resulted in a situation difficult to understand and manage that, without their knowledge, the automated system did not switch to go-around mode despite the TOGA setting of the thrust levers. Therefore*

> **MIT Transportation Safety Bureau recommends AIRBUS to study the feasibility of the activation of Go-Around Modes in Clean Configuration during the Approach Phase.**

The opinion of the Investigating Committee is that in the case of acceptance and expected implementation of the recommendation, the performing of go-around would cause fewer problems to the flight crew in the case that slats/flaps were in retracted position.

Budapest, 2020.02.20.

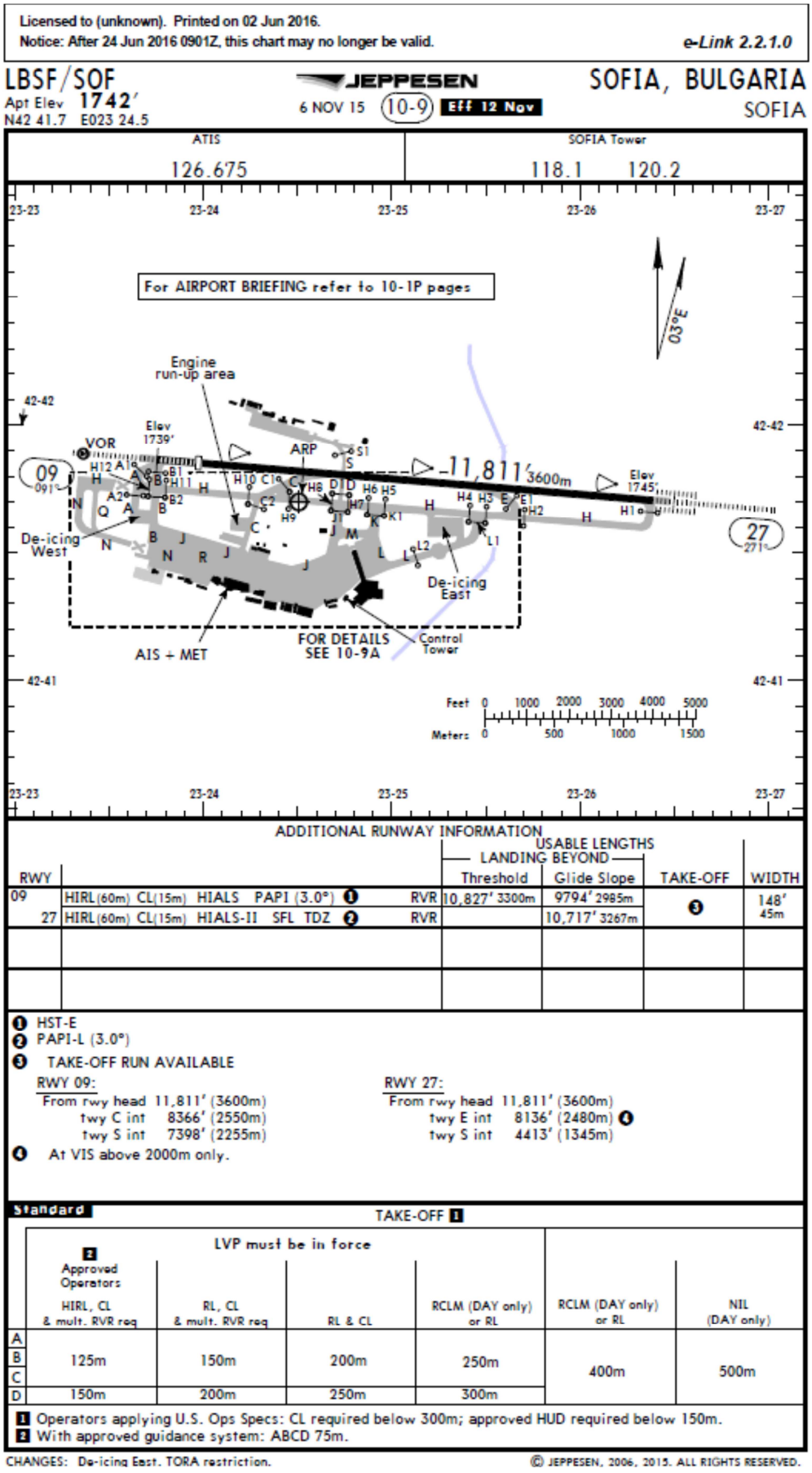
György Háy
Investigator-in-charge

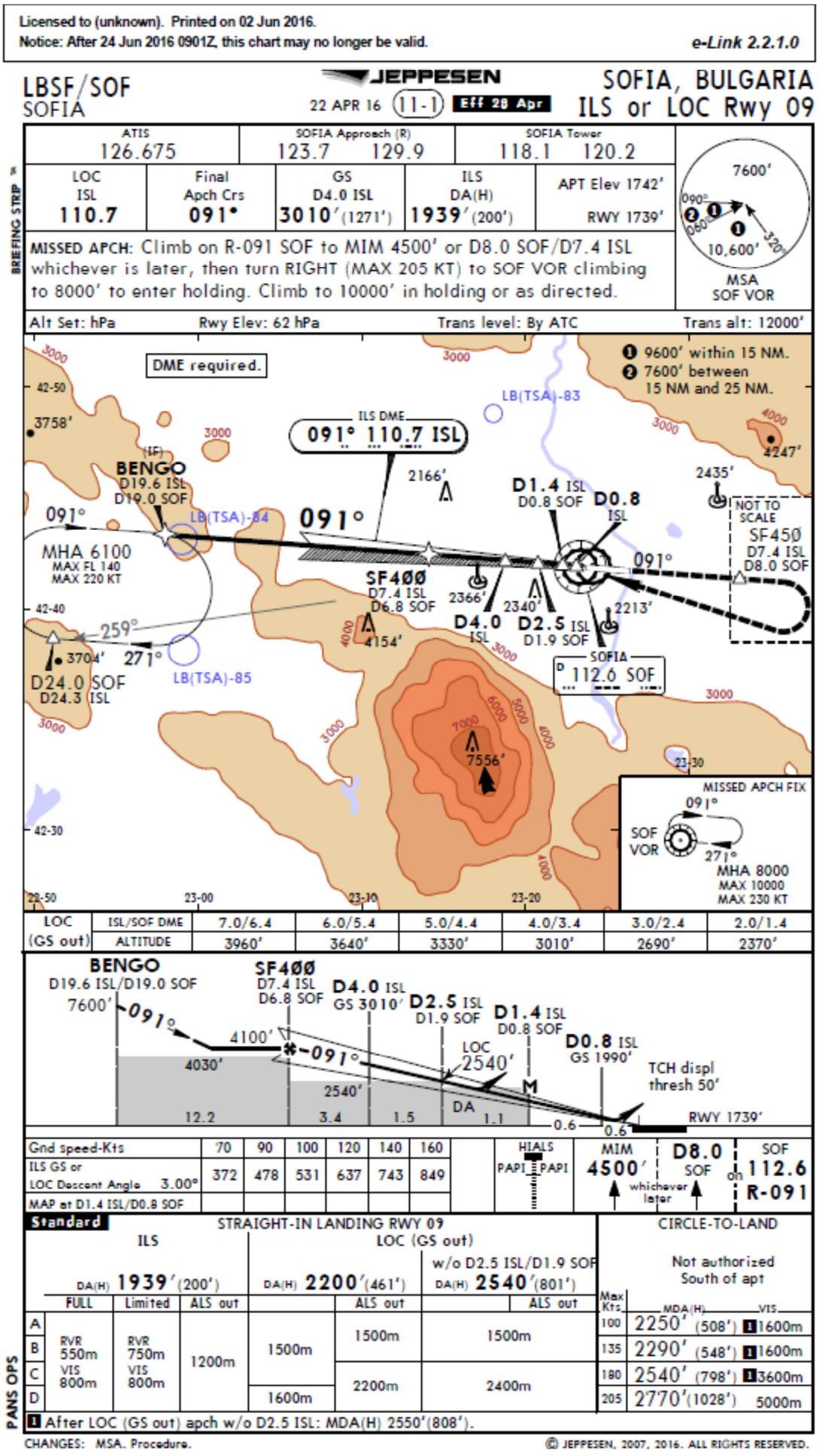
Ferenc Kamasz
IC Member

Gábor Torvaji
IC Member

Annexes

Annex 1: Maps of Sofia Airport (Airbus Report)

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e-Link 2.2.1.0
LBSF/SOF
SOFIA
JEPPESEN
22 APR 16
11-1
Eff 28 Apr
SOFIA, BULGARIA
ILS or LOC Rwy 09
ATIS 126.675
SOFIA Approach (R) 123.7 129.9
SOFIA Tower 118.1 120.2
LOC ISL 110.7
Final Apch Crs 091°
GS D4.0 ISL 3010′ (1271′)
ILS DA(H) 1939′ (200′)
APT Elev 1742′
RWY 1739′
MISSED APCH: Climb on R-091 SOF to MIM 4500′ or D8.0 SOF/D7.4 ISL whichever is later, then turn RIGHT (MAX 205 KT) to SOF VOR climbing to 8000′ to enter holding. Climb to 10000′ in holding or as directed.
7600′
10,600′
MSA
SOF VOR
BRIEFING STRIP
Alt Set: hPa
Rwy Elev: 62 hPa
Trans level: By ATC
Trans alt: 12000′
DME required.
1 9600′ within 15 NM.
2 7600′ between 15 NM and 25 NM.
ILS DME
091° 110.7 ISL
BENGO
D19.6 ISL
D19.0 SOF
MHA 6100
MAX FL 140
MAX 220 KT
SF400
D7.4 ISL
D6.8 SOF
D4.0 ISL
D2.5 ISL
D1.9 SOF
D1.4 ISL
D0.8 SOF
D0.8 ISL
SF450
D7.4 ISL
D8.0 SOF
NOT TO SCALE
SOFIA
112.6 SOF
D24.0 SOF
D24.3 ISL
LB(TSA)-83
LB(TSA)-84
LB(TSA)-85
3758′
4247′
2435′
2166′
2366′
2340′
2213′
4154′
3704′
7556′
MISSED APCH FIX
091°
271°
SOF VOR
MHA 8000
MAX 10000
MAX 230 KT
LOC (GS out)
ISL/SOF DME
ALTITUDE
7.0/6.4 6960′
6.0/5.4 3640′
5.0/4.4 3330′
4.0/3.4 3010′
3.0/2.4 2690′
2.0/1.4 2370′
BENGO
D19.6 ISL/D19.0 SOF
7600′
091°
4100′
4030′
SF400
D7.4 ISL
D6.8 SOF
D4.0 ISL
GS 3010′
D2.5 ISL
D1.9 SOF
D1.4 ISL
D0.8 SOF
LOC 2540′
D0.8 ISL
GS 1990′
TCH displ thresh 50′
2540′
DA
RWY 1739′
12.2
3.4
1.5
1.1
0.6
0.6
Gnd speed-Kts 70 90 100 120 140 160
ILS GS or LOC Descent Angle 3.00° 372 478 531 637 743 849
MAP at D1.4 ISL/D0.8 SOF
HIALS
PAPI PAPI
MIM 4500′ whichever later
D8.0 SOF on 112.6 R-091
Standard
STRAIGHT-IN LANDING RWY 09
ILS
DA(H) 1939′ (200′)
FULL
Limited
ALS out
RVR 550m VIS 800m
RVR 750m VIS 800m
1200m
LOC (GS out)
DA(H) 2200′ (461′)
1500m
1600m
ALS out
1500m
2200m
w/o D2.5 ISL/D1.9 SOF
DA(H) 2540′ (801′)
ALS out
1500m
2400m
CIRCLE-TO-LAND
Not authorized South of apt
Max Kts
MDA(H)
VIS
100 2250′ (508′) 1600m
135 2290′ (548′) 1600m
180 2540′ (798′) 3600m
205 2770′ (1028′) 5000m
1 After LOC (GS out) apch w/o D2.5 ISL: MDA(H) 2550′(808′).
PANS OPS
CHANGES: MSA. Procedure.
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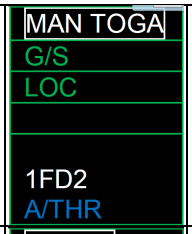
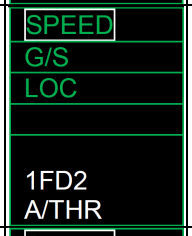
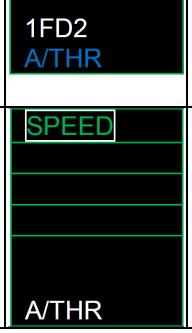
Annex 2: Sequence of events in detail

(Between 16:27:46 and 16:42:07, according to analysis by BEA)

UTC time	Modes FMA	Altitude	Speed	Heading	Remark
16:27:46	SPEED V/S -1900 ALT NAV AP1+2 1FD2 A/THR	FL102↓	226 knots	137°	Altitude target: **6000 ft**
16:29:31	„	7776'↓	233 knots	140°	Speed managed
16:29:38	„	7708'↓	232 knots	141°	Selected speed: **220 knots** *(due to ATC instructions)*
16:29:58	THR IDLE OP DES G/S LOC* AP1+2 1FD2 A/THR	7552'↓	226 knots	122° Left turn	
16:30:03	THR IDLE OP DES G/S LOC* AP1+2 1FD2 A/THR	7488'↓	224 knots	108° Left turn	Speed managed A/P2 engaged (16:30:02)
16:30:16	THR IDLE OP DES G/S LOC AP1+2 1FD2 A/THR	7400'↓	218 knots	198°	
16:30:23	THR IDLE OP DES G/S LOC AP1+2 1FD2 A/THR	7376'↓	221 knots	096°	CONF1
16:30:45	„	7148'↓	203 knots	099°	Selected speed: **180 knots** (Since 16:32:19: **160 knots**)
16:30:58	SPEED G/S* LOC AP1+2 1FD2 A/THR	7056'↓	197 knots	100°	

16:31:13	SPEED G/S* LOC AP1+2 1FD2 A/THR	6876’↓	191 knots	099°	CONF2
16:31:16	SPEED G/S ALT LOC AP1+2 1FD2 A/THR	6824’↓	190 knots	099°	selected altitude: **10 000 ft** (22 seconds later)
16:33:58	SPEED G/S LOC AP1+2 1FD2 A/THR	4108’↓	161 knots	094°	Speed managed
16:34:12	SPEED G/S LOC AP1+2 1FD2 A/THR	3960’↓	154 knots	094°	L/G selector down
16:34:35	„	3676’↓	142 knots	094°	PF: „Flap3!” „Flap Full!” Flap lever: **1** Pitch increased (up to **7.7**° **at** 16:34:39)
16:34:37	„	3664’↓	141 knots	094°	Flap/slat control lever: **0** Flaps:**0**°, Slats: **18**°(lock) IAS (at 16:34:37-kor): **140.6 knots** Lowest selectable speed (VLS):**147 knots**
16:34:38	SPEED G/S LOC 1FD2 A/THR	3628’↓	143 knots	095°	As the VLS was increasing, the PF pitched down, A/P1 and A/P2 were voluntarily disconnected, but FD1/2 remained displayed. *(At this moment the crew is startled, and doesn’t understand the situation.)* Pitch minimum (at 16:34:41):**-0.7**°
16:34:44	MAN TOGA G/S LOC 1FD2 A/THR	3472’↓	151 knots	095°	TLA were set to **TOGA** detent, ATS were disconnected (N1 = **85%** at 16:34:47.7) ATC instruction: Climb to **5000 ft**!
16:35:02	MAN THR G/S LOC 1FD2 A/THR	3060’↑	230 knots		Minimum altitude, PF pitched up (at16:35:01) TLA pulled back to **CLIMB** detent (16:35:13)

16:35:03	SPEED G/S LOC 1FD2 A/THR	3068’↑	229 knots		ATHR activated. Speed managed mode, target: **198 knots**
16:35:07	„	3132’↑	226 knots		L/G selector is up
16:35:19	SPEED G/S LOC AP1 1FD2 A/THR	3392’	205 knots		A/P1 engaged, but involuntarily disconnected. AP1 appeared on FMA, but then disappeared
16:35:28	SPEED G/S LOC AP1 1FD2 A/THR	3416’	198 knots		A/P1 engaged Vertical speed: **352 ft/ min** Pitch angle: **+6**° *The crew intended to go around*
16:35:32	MAN TOGA G/S LOC AP1 1FD2 A/THR	3416’	204 knots		TLA were set to TOGA, and ATHR disconnected Pitch angle: **-2.1**° Deviation from ILS glide: **319 mA** *(When the TLA were set to CLIMB position (at 16:35:03), thrust was close to idle because the target speed was significantly lower that the CAS.)*
16:35:33	MAN TOGA G/S LOC 1FD2 A/THR	3392’	204 knots		Pitch angle: **-4.57**° PF’s nose down sidestick input: **-10.55**°. VRTG: **0.5 g** Vertical speed: **-2576 ft/min** A/P1 is voluntarily disconnected *(The AP is disconnected because the aircraft was too high above the glide and tried to catch it.)*
16:35:39	MAN MCT G/S LOC 1FD2 A/THR	3172’↓	235 knots		TLA were set to MCT and to **TOGA** 7 seconds later.
16:35:48	MAN TOGA G/S LOC 1FD2 A/THR	2900’	276 knots		Descent was stopped around **2900 ft** QNH.

16:35:56		2904’↑	301 knots		Pitch angle: **+3.87°.**
16:35:58		2952’	305 knots		TLA were set to **CLIMB,** which reengaged the A/THR in **SPEED** mode (target speed: **198 knots** Max CAS: **306 knots** (at 16:36:00)
16:36:04					Selected V/S: **5000 ft/min** Selected heading: **090**° A/Ps are OFF, F/Ds are ON
16:36:12		4056’↑	265 knots		A/Ps are OFF A/THR: in **THRUST** mode (TLA lever in **CLB** detent) Target speed: **250 kt** Target altitude: **10 000 ft**
16:36:20		4552’↑	245 knots		A/Ps are off Selected vertical speed: **2500 ft/min** altitude: **5000 ft** A/THR: in **SPEED** mode (TLA levers in **CLB** detent)
16:36:33		4836’↑	234 knots		
16:36:45		4916’↑	221 knots		TLAs were moved from **CLB** to **MCT** and rolled back during 1s *(The PF had previously experienced the speed decreasing, not understanding why and not wanting it. Therefore, he moved the throttled forward to avoid a speed decay.)*
16:36:50 16:36:51		~5000’	213 knots		Both flight directors were voluntarily disengaged.

16:37:00	SPEED A/THR	5000’↓	204 knots	083°	PF engaged left turn During the turn: Roll value reached: **42.9**° NZ values reached: **1.33g** **V/Z** values reached: **-4992 ft/min** *(PF’s sensual illusion in IMC situation is suspected.)*
16:37:21	MAN MCT A/THR	4780’↓	203 knots		Roll: **left, 38**° Pitch: **+3,5**° V/Z: **-700 ft/min**
16:37:31	MAN THR A/THR	4480’↓	234 knots		The PF’s roll sidestick inputs: **leftwards 10.9**°, nose down sidestick inputs**: 4**° Roll: **36.9**° **left** Pitch: **-5.62**° V/Z: **-3680 ft/min**
16:37:37	SPEED LVR CLB A/THR	3992’↓	273 knots	319°	EGPWS warning V/Z: **-4992 ft/min** Pitch: **-8**° Roll: **8°, left** LVR CLB flashes
16:37:38		3872’↓	277 knots		A/THR was no longer armed, nor active.
16:37:44	„	3580’	286 knots	318°	Minimum altitude (RA) reached: **1750**’ Roll: **3.9**° **right,** Pitch: **+2.8**°
16:38:29	„	4824’	242 knots	296°	Engine thrust (N1): **71%** Aircraft levelled off (from 16:38:39)
16:39:05	„	4948’↑	225 knots	280°	Selected altitude: **6000 ft** *(upon instruction from ATC)*
16:40:16 16:40:19	 V/S +0 ALT HDG 1FD2	5764’↑	219 knots	266°	F/D1 engaged, which engaged TRACK/FPA followed by HDG/V/S modes. Selected heading: **270**° Selected V/S: **0 ft/ min** F/D2 engaged (16:40:19)
16:40:21	 V/S +400 ALT HDG AP1 1FD2	5784’	221 knots	271°	A/P1 engaged Selected heading: **270**° Selected V/S: **400 ft/ min**

16:40:29	SPEED V/S +400 ALT HDG AP1 1FD2 A/THR	5844’	216 knots	274°	A/THR armed in SPEED mode TLA in CLB detent (16:40:33)
16:40:54	SPEED ALT* HDG AP1 1FD2 A/THR	6016’	202 knots	269°	
16:40:58	SPEED ALT HDG AP1 1FD2 A/THR	6036’	198 knots	269°	*(Perhaps the crew might have realized at this moment that the flaps were fully retracted.)*
16:41:02	SPEED ALT HDG AP1 1FD2 A/THR	6056’	199 knots	268°	Selected heading decreased to **190**°
16:41:14	SPEED ALT HDG AP1 1FD2 A/THR	6052’	196 knots	254°	Speed mode was selected. Selected speed: **196 knots**, which rapidly changed to **205 knots**.
16:41:38	SPEED ALT HDG AP1 1FD2 A/THR	6052’	205 knots	201°	Speed was managed Target speed: **198 knots**
16:41:49	SPEED ALT HDG AP1 1FD2	6060’	200 knots	190	Flaps/slats configuration: CONF1 Target speed: **185 knots**
16:42:07	THR IDLE OP DES ALT HDG AP1 1FD2 A/THR	6064’			Selected altitude: **5000 ft**

Annex 3: BEA main comments

#	Section	Page	Extract of the report	Comment	Proposed changes	Response
1.	Short summary	9	The PF initiated go-around	Not accurate. The PF did not initiate a go-around as per the SOP. He first initiated a descent and set the thrust to TOGA to reach a safe speed. Therefore he did not follow the GA procedure.		Accepted
2.	2.1 Flight control	24	The PF, who was overloaded by the unusual, hazardous situations and the series of information difficult to understand or seeming even contradictory sometimes, and the roll angle initiated by him finally reached the 42.9° value, as an effect of which the lowest selectable speed grew almost to the current airspeed.	The aircraft speed actually decreased below VLS but thanks to the Alpha Speed Lock function, remained well above the Valpha prot and therefore the aircraft was far from a stall situation. Therefore, the situation was clearly unusual and unexpected but not hazardous before the GPWS alert. In addition, information provided by the systems to the flight crew was consistent with the actually state of these systems. Therefore, it was not contradictory. Finally, the lowest selectable speed (VLS) does not change in case of roll. The aircraft speed decreased down to 200kt because it was the speed targeted (Green Dot) by the A/THR.	The PF, who was overloaded by the unusual and unexpected situation with series of information that he did not understand, initiated a left turn that finally reached a roll angle of 42.9° value.	Mainly accepted
3.	2.6.4 Software	26	Their failing to disengage the flight director kept the ILS approach mode active and gave them misleading signals.	As already mentioned, the systems did not give misleading information: AP/FD engaged modes were clearly indicated on the FMA. The PF did not understand the aircraft behaviour when he reengaged the AP because he did not check, by reading the FMA (as per SOP), which modes were actually engaged but the information provided by the FMA was correct.	Their failing to disengage the flight director kept the ILS approach mode active.	Accepted
4.	2.6.5 General analysis of PF's reaction	26	Continuous, detailed overviewing and understanding the operation of such heavily automated systems like an Airbus A320 aircraft typically exceeds the possibilities of an average operator."	Acquiring the good knowledge and skill to fly an Airbus aircraft is typically the purpose of the Type Rating and Recurrent Training that every pilot must follow. These trainings are approved by the Certification Authorities. Besides, as per regulation, the whole aircraft certification is done taking into account the knowledge and skills of an average pilot. Therefore, we propose to remove this sentence.	N/A	Partly accepted
5.	2.6.5 General analysis of PF's reaction	26	But to the contrary, the unusual error made by the PM who retracted the slats and flaps instead of fully deploying them changed the situation fundamentally, without giving the PF a chance to understand the point of such change.	We do not agree that there was no chance for the PF to understand the PM error. Indeed, the increase of the aircraft pitch could have been an indication for the PF of a Flaps retraction and the information of the aircraft configuration was indicated on the E/WD.	But to the contrary, the unusual error made by the PM who retracted the slats and flaps instead of fully deploying them changed the situation fundamentally, situation which was difficult for the PF to understand at that time.	Accepted
6.	2.6.5 General analysis of PF's reaction	26	Safe management of the situation was hindered largely by the fact that, for several minutes, the flight crew were acting according to the go- around procedure while the automatic systems of the aircraft were following the approach procedure.	As already mentioned, the PF did not applied the G/A procedure as per SOP but was clearly with the intension to abort the approach whereas the automatic systems were still in approach mode.	Safe management of the situation was hindered largely by the fact that, for several minutes, the flight crew intension was to abort the approach while the automatic systems of the aircraft were still in approach modes.	Accepted
7.	3.2 Causes	27	The automated systems did not follow the pilot's intent to go-around.	The Automated Systems cannot guess the pilot intent. It is up to the pilot to set correctly the automated system in order for the aircraft to fly the desired flight path.	The automated systems did not help the pilot's in performing the go-around manoeuvre.	Accepted