

FINAL REPORT

of

the Commission for Investigation concerning the serious incident (Airprox) involving the Boeing B737-800 aircraft, registration marks OK-TVM, operated by Travel Service a. s., and the Airbus A321-200 aircraft, registration marks G-TCDG, operated by of Thomas Cook Airlines Ltd., on 23 July 2019 in the controlled air space of the Republic of Bulgaria.



Purpose of the Report and Responsibility

In accordance with Annex 13 to the Convention on International Civil Aviation of 7 December 1944, Regulation 996/2010 of the European Parliament and the Council on the investigation and prevention of accidents and incidents in civil aviation, and Ordinance 13 of 27.01.1999 of the Ministry of Transport, Information Technology and Communications, the objective of the aviation occurrence investigation is to establish the causes that have led to its realisation in order these to be eliminated and not allowed in future without apportioning blame or liability.

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01 List of Abbreviations

A/C	-	Aircraft;
AAIU	-	Air Accident Investigation Unit;
ACAS	-	Airborne Collision Avoidance System;
ACC	-	Air Control Centre;
AIRPROX	-	Aircraft Proximity;
ALT	-	Altitude;
AMRAIUD	-	Aircraft, Maritime and Railway Accident Investigation Unit Directorate;
AO	-	Aircraft Operator;
SATCAS	-	Systems for Air Traffic Control Automated Services;
ATCO	-	Air traffic controller (officer);
ATS	-	Air Traffic Service
BULATSA	-	Bulgarian Air Traffic Services Authority;
CALL SIGN	-	Call sign of the aircraft;
CPA	-	Closest Point of Approach;
DG CAA	-	Directorate General “Civil Aeronautical Administration”;
EASA	-	European Air Safety Agency
EUROCONTROL	-	European Organization for the Safety of Air Navigation
EXE ATCO	-	Radar Air Traffic Controller;
FCU	-	Flight Control Unit;
FDR	-	Flight Data Recorder;
FIR	-	Flight Information Region;
FL	-	Flight Level;
FS	-	Family Sectors;
GAT	-	General Air Traffic;
ICAO	-	International Civil Aviation Organization;
IFR	-	Instrument Flight Rules;
SIGMET	-	Information concerning en-route weather phenomena which may affect the safety of aircraft operations;
TCX1NB	-	Airbus A321-200-211 aircraft, registration marks G-TCDG of Thomas Cook Airlines Ltd AO;
M	-	Mach number;
MSN	-	Manufacturer Serial Number;
MTITC	-	Ministry of Transport, Information Technologies and Communications;
PLN ATCO	-	Planning Air Traffic Controller;
RA	-	Resolution Advisory;
VBL	-	Family Sector Varna Low;
STCA	-	Short-term conflict alert ;
TA	-	Traffic advisory;
TCAS	-	Traffic Alert and Collision Avoidance System/Airborne Collision Avoidance System;
TCP	-	Control Transfer Point;
TVS3729	-	Boeing 737-800-8FN aircraft, reg. marks OK-TVM of Travel Service a. s AO;
UTC	-	Universal Coordinated Time;
V/S	-	Vertical speed;

1 Introduction

Date and time: The serious incident occurred on 23 July 2019 at 08:36 UTC. The difference between the local and Universal Coordinated Time is +3 hours. All times in this report are in UTC.

Notified: Aircraft, Maritime and Railway Accident Investigation Unit Directorate and Civil Aircraft Administration Main Directorate at the Ministry of Transport, Information Technology and Communications of the Republic of Bulgaria (MTITC), the European Commission, the International Civil Aviation Organization (ICAO), National Bureau of Aviation Occurrences Investigation Authority of the Republic of France, European Air Safety Agency (EASA), Air Accidents Investigation Institute of the Czech Republic, Air Accidents Investigation Branch of UK and National Transportation Safety Board of USA.

On the grounds of the provisions of Article 9, para.1 of Ordinance No. 13, dated 27.01.1999, on Investigation of Aviation Accidents; the occurrence was classified as a serious incident by the Aircraft Accident Investigation Unit at the Aircraft, Maritime and Railway Accident Investigation Unit Directorate (AMRAIU) at the Ministry of Transport, Information Technology and Communications. The materials on the aviation occurrence have been filed in case No. 05/23.07.2019 in AAIU archives.

In accordance with the provisions of Article 5, para.1 of Regulation (EU) No. 996/2010 on the investigation and prevention of accidents and incidents in civil aviation, Article 142. Para. 2 of the Civil Aviation Act of the Republic of Bulgaria, dated 01.12.1972, and Article 10, para. 1 of Ordinance No. 13 of the Ministry of Transport, dated 27.01.1999, on the Investigation of Aviation Occurrences, by Order No. RD-08-365, dated 31.07.2019 of the Minister of Transport, Information Technology and Communications, a Commission is appointed for investigation of the serious incident.

Summary

On 23 July 2019, the two commercial Airbus A321-200-211 aircraft, reg. marks G-TCDG and call sign TCX1NB of Thomas Cook Airlines Ltd and Boeing 737-800-8FN aircraft, reg. marks OK-TVM and call sign TVS3729 of Travel Service a. s were cruising in the Bulgarian airspace under the control of family sector VBL of the Sofia Area Control Centre (ACC).

At 08:30:55 h UTC the flight crew of TCX1NB, performing a charter flight from EGKK (London) to LBBG (Burgas) started a descent to FL150 to point ESENA after an instruction issued by EXE ATCO from the VBL sector. At 08:31:43 h UTC the flight crew of TVS3729 of Travel Service a. s., performing a charter flight from LBWN (Varna) to LFRS (Nantes) started a climb to FL 220 to point AMTOV after an instruction issued by EXE ATCO from the same sector VBL.

At 08 31 02 h, the MTCD (Medium Term Conflict Detection) of the Automated System SATCAS detected a potential conflict of the trajectories of TCX1NB and TVS3729, which was automatically displayed as red dot in the line zero on the track label of the two aircraft on the Controller Working Position of family sector VBL.

At 08:35:50, SATCAS generated visual indication in bright red colour with sound alarm for STCA between TCX1NB crossing FL209 in a descent and TVS3729 crossing FL206 in a climb.

The EXE ATCO issued a course of delayed instructions to move aircraft away.

On board an aircraft with the call sign TCX1NB the traffic alert and collision avoidance system was engaged in RA mode and it generated a “CLIMB” command. The flight crew stopped the descent and started to climb with the necessary vertical speed for safe passing.

On board an aircraft with the call sign, TVS3729 the traffic alert and collision avoidance system was not engaged in RA mode and the flight crew executed the instructions of the EXE ATCO.

At 08:36:02 h UTC, the standard for minimum radar separation was infringed and the closest point of approach between the two aircraft was reached 2,87 NM horizontally and 800 ft vertically.

Because of the investigation, the Commission considers that the serious incident is due to the following reasons:

Immediate causes of the serious accident:

- Ineffective interaction in the EXE/PLN team;
- EXE and PLN air traffic controller did not detect the conflict in VBL sector;
- Lack of a preliminary plan for resolving potential conflicts;
- EXE and PLN air traffic controller did not react in accordance with the procedures for detecting and resolving the conflict;
- Lack of expediency of EXE and PLN air traffic controller in providing Air Traffic Services.

The main cause of the serious incident was that the EXE ATCO issued a conflict clearance for descend of the aircraft, which led to a hazardous convergence with another aircraft performing a climb after issued clearance.

The following was identified as a contributing factor to the serious incident:

The high load of the EXE and PLN air traffic controller due to switching from backup to main AATMS and change in the sector configuration.

2 Factual information

2.1 Flight history

2.1.1 Flight number, type of operation, last point of departure, destination point of the involved aircraft

2.1.1.1 Aircraft with registration mark- OK-TVM

Radio call sign	TVS3729
Flight rules	Instrument flight rules (IFR)
Type of operation	Commercial Air Transport-Passenger-Airline
Departure point	Bulgaria-Varna (LBWN)
Destination point	France Nantes Atlantique Airport (LFRS)

2.1.1.2 Aircraft with registration mark G-TCDG

Radio call sign	TCX1NB
Flight rules	Instrument flight rules (IFR)
Type of operation	Commercial Air Transport-Passenger-Airline
Departure point	United Kingdom - London Gatwick Airport (EGKK)
Destination point	Bulgaria-Burgas (LBBG)

2.1.1.3 ATS units

Sofia Area Control Centre	
Family Control Sector	Varna Bravo Low (LBVNL3)
Airspace class	C

Closest point of approach between the two aircraft: 2,87 NM and vertical separation of 800 ft.

AIRPROX ICAO category A - The Risk Analysis Tool used to define the risk showed high risk of collision.

Minimum separation 5 NM horizontally or 1000 ft vertically.

2.1.2 Flight preparation, description of the flight and events leading to the serious incident

On 23 July 2019, the Boeing 737-800-8FN aircraft, registration marks OK-TVM and call sign TVS3729 of Travel Service a.s., performing flight from LBWN (Varna) to LFRS (Nantes). According the flight plan, the aircraft took off from Varna (LBWN) to point TOTKA, after that flown the N605 one-way track, to point GOL and left the serviced airspace of Republic of Bulgaria through DOLAP TCP at FL360.

The Airbus A321-200-211 aircraft, registration marks G-TCDG and call sign TCX1NB of Thomas Cook Airlines Ltd., performing flight from EGKK (London) to LBBG (Burgas). According the flight plan, the aircraft entered the Republic of Bulgaria airspace through BULEN TCP to fly one way track L742 to point ESENA for landing to LBBG (Burgas).

According to an approved schedule by the Director of ACC – Sofia, on 23 July 2019, at 06:00, a shift of ATCO, consisting of EXE ATCO and PLN ATCO took over, assuming responsibility for air traffic control of family sector VBL in ACC – Sofia.



Fig.1

At 05:35, The Airbus A321-200-211 aircraft, registration marks G-TCDG and call sign “Thomas Cook one november bravo” (TCX1NB) took off from London Gatwick Airport (EGKK) on a charter flight to Burgas (LBBG).

At 08:20, the Boeing 737-800-8FN aircraft, registration marks OK-TVM and call sign “Skytravel tree seven two nimmer” took off from Varna (LBWN) on a charter flight to Nantes Atlantique Airport (LFRS).

At 08:25:06, the crew reported to Sofia ACC VBL as follows “TCX1NB reaching FL310”. The air traffic controller PLN ATCO acknowledged the call as follows: “Kestrel Hello Sofia identified continue descend FL250. (“Kestrel” instead of “Thomas Cook”)

At 08:25:20, the flight crew of TCX1NB confirmed the instruction “Descend FL250 TCX1NB”.

The radio communication is conducted by the EXE, after adjusting the display of the ODS after switching to the system SATCAS V3DL – main AATMS.

At 08:30:50 EXE ATCO issued instruction to TCX1NB “Kestrel descend FL150. (“Kestrel” instead of “Thomas Cook”)

At 08:30:55, the flight crew of TCX1NB confirmed the instruction “Descend FL150 TCX1NB”.

At 08:31:02, Automated ATM System SATCAS generated warning for MTCDD between A/C TCX1NB and A/C TVS3729. The potential conflict was displayed on the Controller Working Position of family sector VBL. The distance between the two aircraft is 66 NM (Fig.2).

At 08:31:31, the flight crew of TVS3729 established radio communication with EXE ATCO and reported “Varna Good morning TVS3729 climbing FL160”.

At 08:31:38, EXE ATCO identified the aircraft as TVS3729 and issued instruction for climbing to FL220. “Kestrel Sofia Control identified climb FL220” (Kestrel instead of “Skytravel).

At moment, EXE ATCO and PLN ATCO did not notice the warning for MTCDD between A/C TCX1NB and A/C TVS3729. The distance between the two aircraft is 59 NM (Fig.3).



Fig.2

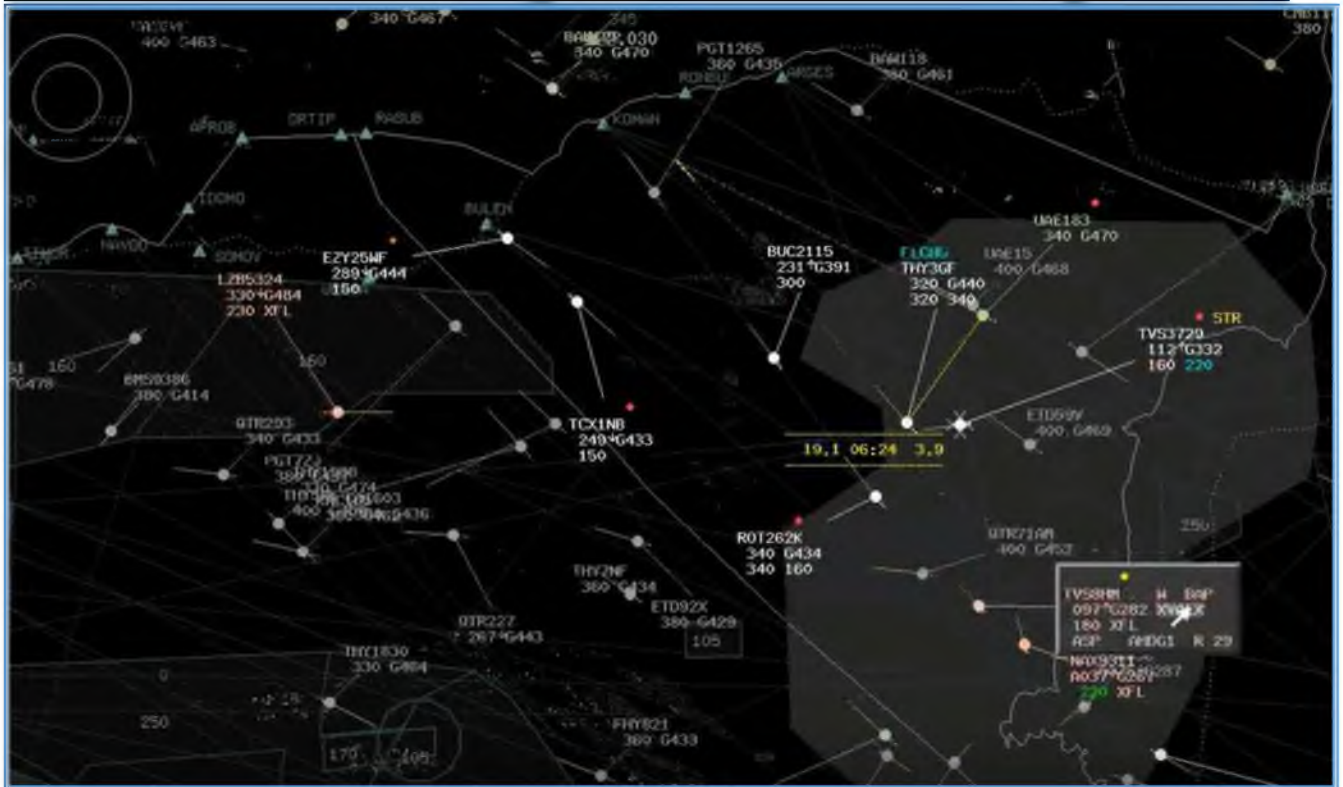


Fig.3

At 08:31:43, the flight crew of TVS3729 confirmed correctly the instruction “*Climbing FL220 TVS3729*”.

At 08:34:30, EXE ATCO issued instruction to TCX1NB to stop climb at FL200 at a time when the flight crew is performing a descent “*TCX1NB stop climb at level 200 due to traffic*”

At 08:34:35, the flight crew of TCX1NB informed the EXE ATCO that stopped the descent at FL 200: “*Stop descend FL200, TCX1NB*”

Follows a double call from the LRB5324 crew for further descend to which the EXE Sofia Control, did not answer.

At 08:34:35, the Mode S downlink message showed that the aircraft TVS3729 was climbing through FL 188 with a rate of 1800ft/min, while the aircraft TCX1NB was descending through FL219 with a rate of 1000ft/min.

At 08:35:03, EXE ATCO issues instruction to TVS3729 “*TVS3729 stop climb at FL190*”.

At 08:35:11, EXE ATCO issues instruction again to TVS3729 “*TVS3729 stop climb and return to FL190*”.

At 08:35:20, the flight crew of TVS3729 addressed to EXE ATCO “*Are you cleared us before to FL220 so we stop the climb now to 190?*”.

At 08:35:25 EXE ATCO issued instruction to the flight crew of TCX1NB “*TCX1NB stop descend immediately, maintain FL210*”.

At 08:35:33 the flight crew of TCX1NB: “*Descend now TCX1NB*”.

At 08:35:34 the flight crew of TVS3729 “*Sofia, TVS3729, do you confirm we descend now to FL190*”.

At 08:35:39 based on the simulation conducted by InCAS v4.2.3 (Interactive Collision Avoidance Simulator), both aircraft received Traffic Advisory.

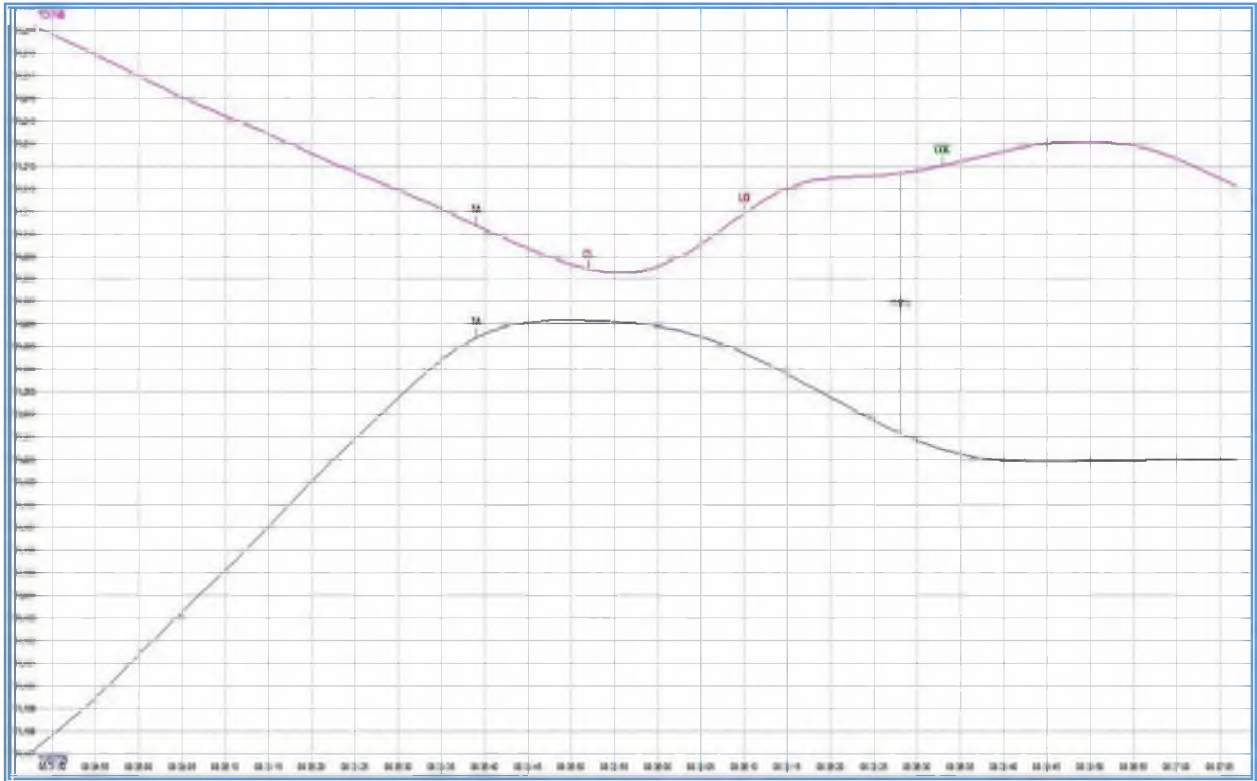


Fig.4

At 08:35:40, EXE ATCO confirmed the instruction *“TVS3729 Stop climb immediately and descend back to FL200”*

At 08:35:45 the flight crew of TVS3729: *“We descend FL200 and you’ve cleared us to FL220.”*

Follows a call from EZY25WF crew whether to maintain the descending speed, to which EXE does not answer.

At 08:35:47 according to downlinked radar data, a Climb Resolution Advisory was issued for the aircraft TCX1NB. The aircraft TCX1NB complied with RA and started to increase its vertical speed to the required 1500ft/min. At the time when the RA was issued TCX1NB was levelling off.

No Resolution Advisory has been downlinked for TVS3729 as the aircraft operated in the *“TA-Only”* mode.

At 08:35:50, Automated ATM System SATCAS generated visual indication in bright red colour with sound alarm for STCA between A/C TCX1NB and A/C TVS3729, which is displayed at both the working positions of VBL sector. At the present moment TCX1NB crossing FL209 in a descent and TVS3729 crossing FL206 in a climb. The distance between the two aircraft is 7,9 NM (fig 5)

At 08:35:57 was issued a subsequent resolution advisory (Level Off) for TCX1NB. At the time of RA, its vertical rate was 200ft/min.

At 08:35:58 EXE ATCO issued instruction to flight crew of TCX1NB immediately to turn left *“Kestrel immediately 20 degrees to the left”*

At 08:36:03, the flight crew of TCX1NB reported *“Roger TCX1NB, TCAS RA”*



Fig.5

At 08:36:13, EXE ATCO: “Sofia Control”.

At 08:36:25, the flight crew of TCX1NB reported “TCX1NB we are cleared of traffic what level would you like to maintain and what heading would you like?”.

At 08:36:32 EXE ATCO issued instruction to flight crew of TCX1NB “TCX1NB maintain Level210”.

At 08:36:38, RA downlink information indicated that the TCX1NB RA terminated.

At 08:36:37, the flight crew of TCX1NB confirmed the instruction “Maintain FL 210 TCX1NB”.

At 08:36:37 h RA downlink message indicated, that A/C TCX1NB received indication RA Terminated (Clear of Conflict).

At 08:37:23 EXE ATCO issued instruction to flight crew of TCX1NB to descend “TCX1NB descend FL150 contact Burgas 125.1”.

The PLN ATCO is changed.

At 08:37:31, the flight crew of TCX1NB confirmed the instruction “Descend FL 150 and contact Burgas 125.1 TCX1NB”.

At 08:37:34 EXE ATCO issued instruction to flight crew of TVS3729 to establish a contact to Sofia Control next sector: “TVS3729 contact Sofia Next Sector 129.1, goodbye”.

At 08:36:37, the flight crew of TVS3729 confirmed the instruction “129.1 TVS3729”.

Both aircraft continued to their destination without further incident both aircraft continued to their destination points.

2.1.3 Location of aviation occurrence

Position 60 NM West of Varna Airport (Over waypoint ALIVI).

Date and time: 23 July 2019, 08:36:01 UTC

Lighting conditions: Daylight

Altitude FL 210

2.2 Injuries to persons

No injuries of crews, passengers or other persons because of the occurrence.

2.3 Damage to Aircraft

No damages to the aircraft.

2.4 Other damages

No other damages.

2.5 Personnel information**2.5.1 Crew of TCX1NB****2.5.1.1 Commander**

Not available.

2.5.1.2 Co-pilot

Not available.

2.5.2 Crew of TVS3729**2.5.2.1 Commander**

Not available

2.5.2.2 Co-pilot

Not available

2.5.3 Air traffic control personnel**2.5.3.1 EXE ATCO:**

Gender:	Male
Age:	31 Years
Year of birth:	1987
ATCL BGR.ATCL:	Certificate ATCL
Rating :	Permissions FS Varna ACS – RAD valid until 03.05.2020
ENGLISH:	LEVEL5 valid until 11.03.2020
Medical Certification:	valid until 08.04.2022
Check:	Check of Competence of ATCO on working position in ACC-Sofia “Control” (Family sector of Varna) on 08.04.2019.

2.5.3.2 PLN ATCO:

Gender:	Male
Age:	43 Years
Year of birth:	1976
ATCL BGR.ATCL:	Certificate ATCL
Rating:	Permissions FS Varna ACS – RAD valid until 27.05.2020
	Permissions FS Sofia ACS – RAD valid until 30.09.2019

ENGLISH:	LEVEL 5 valid until 18.12.2021
Medical Certification:	valid until 25.09.2019
Check:	Check of Competence of ATCO on working position in ACC-Sofia "Control" (Family sector of Sofia/Varna) on 23.04.2019.

At the time of realization of this aviation occurrence, PLN ATCO was involved in realizing of 1 serious incident on 12.08.2018.

The PLN ATCO in 2018 and 2019, when reissuing an aviation medical certificate, did not inform the Commission for Aeromedical Certification that it was a participant in realizing of a serious incident.

When reissuing an aviation medical certificate for the confirmation of a certificate of competence - ATCL in 2018 and 2019, BULATSA and the General Directorate 'Civil Aviation Administration' have not notified the Commission for Aeromedical Certification that the PLN ATCO is a participant in realizing of serious incidents.

2.6 Aircraft Information

There are no data about technical failures of the on-board systems in the reports of the flight crew.

2.6.1 TCX1NB Aircraft

Registration:	G-TCDG;
Manufacturer:	The Airbus SE, France;
Type of aircraft:	Airbus A321-200-211;
Factory serial number:	6122;
Manufactured:	May 2014;
State of Registry:	United Kingdom;
Air Operator:	Thomas Cook Airlines Ltd;
Relevant equipment:	Honeywell TCAS II, Version 7.1.

2.6.2 TVS3729 Aircraft

Registration:	OK-TVM;
Manufacturer:	The Boeing Company, USA;
Type of aircraft:	Boeing 737-800-8FN;
Factory serial number:	37077;
Manufactured:	January 2010;
State of Registry:	Czech Republic;
Air Operator:	Travel Service a. s.;
Relevant equipment:	Honeywell TCAS II, Version 7.1;

Status as of 23.7.2019: TCAS computer model TPA-100B, P/N 940-0351-001, S/N TPA08280, manufacturer Honeywell. History of unscheduled removals: Last removal 27.9.2018 due to "TCAS Fail".

2.7 Meteorological Information

On 23.07.2019, unstable and humid air mass is advected over central and east Bulgaria with favorable conditions for convective clouds and thunderstorm developing after 03-06 UTC. Most active areas are above north Black sea coast and east part of Bulgaria after 10:00 UTC.

Analysis of radar and satellite data, for the period 08:00-09:00 UTC, showed no significant convective clouds in area of 15 NM around waypoint ALIVI. After 08:00 UTC in the vicinity of waypoint GONGO, convective clouds are developing, with cloud top FL 200-220 and movement to the east. At 08:30 UTC this cloud is about 3NM to the east from waypoint GONGO and is dissipating.

Significant convective clouds, reaching FL350-410 and active thunderstorm area during this period is observed to the northeast, above Kaliakra cape and to the northeast of town Shumen and Dobrich.

The meteorological conditions at the time of the air occurrence were of no effect to the serious incident.



Fig.6

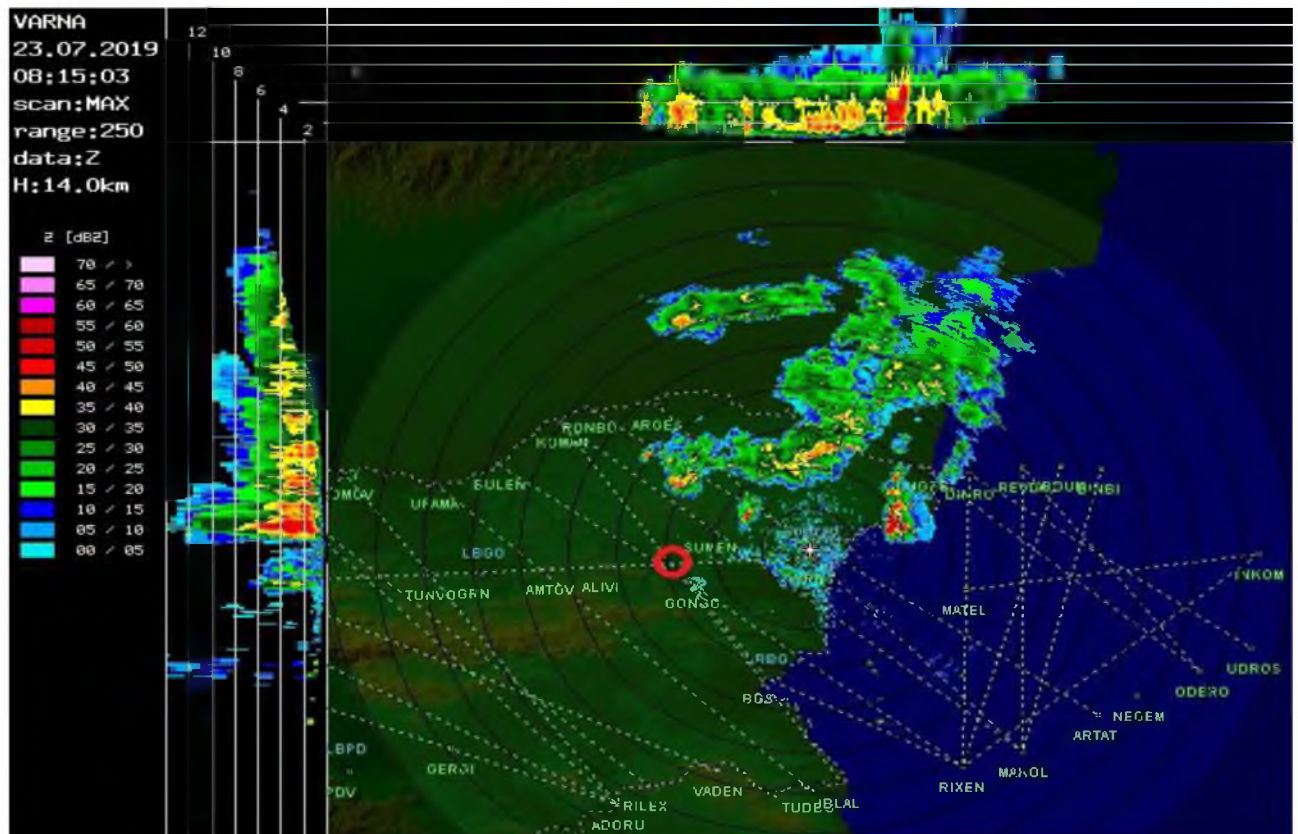


Fig.7

2.8 Navigation

Both aircraft performed the flights with the standard navigation equipment for the types of aircraft.

There are no reported technical failures of the navigation equipment of the aircraft.

The flights of the two aircraft were carried out in air space of Bulgaria, under the conditions of zonal navigation and in conformity with the Instrument Flight Rules.

There is no information about technical failures of the navigation system of the Bulgarian Air Traffic Services Authority (BULATSA), which could cause the occurrence.

All facilities included in the national net for course navigation operated normally.

In the daily briefing statement of the ACC Sofia, no failures of technical means were recorded, which might directly affect the operational ability at the time of the occurrence.

Shortly before occurrence planned prophylactic switching from SATCAS V3MS - backup Automated ATM System (AATMS), to SATCAS V3DL (main AATMS) has been performed.

During the investigation it was identified an overlay of images from SATCAS V3MS and SATCAS V3DL for about 2 minutes from the actual moment of switching from backup to main AATMS in the recorded information from the radar screen of the EXE.

The overlay was a result from incorrect function of “Grabber” - device from the Audio information and operation displays recording and reporting system VSRRS – Jotron, and did not affected the information visualized on the EXE screen during the occurrence.

2.9 Communications

Both aircraft performed the flights with the standard communication equipment for the types of aircraft.

The air-ground radio communication in the FS VBL and the aircraft serviced was carried out at the frequency of 134.700 MHz in English.

The Bulgarian Air Traffic Services Authority provided a transcript of the radio-communication of Sofia Control, FS VBL, at frequencies 134.700 MHz, as well as telephone communications between PLN ATCO and the adjacent ATC sectors before, during and after the time of the aviation occurrence.

After hearing the radio conversations at the operating frequencies of FS VBL, the Investigation Commission found that there had been no loss of radio communication and that there were no interruptions and disturbances during the radio broadcasting with not a single aircraft in the sector.

2.10 Aerodrome information

The occurrence is not realized at an aerodrome.

2.11 Flight data recorders

Data were used from the flight data recorders of the Common National Air Traffic Control Centre (CNATCC) of the Bulgarian Air Traffic Services Authority (BULATSA) in regards to the radar picture and radio communications, as well as records of the telephone communication of the Planning Air Traffic Controller with the other sectors.

The records have been enclosed to the investigation materials in case No. 05/23.07.2019.

2.12 Wreckage and Impact Information

The occurrence was not related to the aircraft destruction.

2.13 Medical and Pathological Information

Because of the nature of the aviation occurrence, medical and pathological research was not performed.

2.14 Fire

No fire was started during the occurrence.

2.15 Survival Aspects

No survival equipment was used by the passengers and the crew.

2.16 Tests and Research

For the purpose of investigation in connection with safety, the Commission carried out and conducted the following activities:

- Collecting, documentation, studying, listening to and analysis of the radar picture recordings, radio communications, the telephone communications between the work position Sofia - Control – VBL sector and the neighboring ATS sectors;

- Listening, documentation and analyzing of voice exchange records in the VBL sector;

- Discussions with EXE ATCO, PLN ATCO and Air Traffic Controller – Supervisor who performed the air traffic control during the serious incident;

- Analysis of the actions of ATCO at VBL sector;

- Analysis of the actions of flight crew of both aircraft during the aviation occurrence;

The Commission also requested, discussed and analyzed the data from:

- The flight crew report of Airbus-321-200-100 aircraft crew with a call sign TCX1NB;

- The flight crew report of Boeing 737-800-8FN aircraft with a call sign TVS3729;

- Flight simulation of a Boeing 737-800-8FN aircraft on a flight simulator - B737NG- TCAS II equipment, 7.1;

To determine the reasons for triggering of the TCAS as well as the actions of the crews of the aircraft, the Commission for safety investigation coordinated with the EUROCONTROL and a simulation of the event was implemented on InCAS v4.2.3 (Interactive Collision Avoidance Simulator). The simulation results are given in Annex 1.

The commission requested from AO Smartwings FDR data of a Boeing 737-800-8FN aircraft with a call sign TVS3729. However, the relevant data was no longer available.

The Commission requested from the BULATSA, but did not receive the ambient workplace recordings at the working positions of VBL sector.

2.17 Organizational and management information

A major document specifying the rules, procedures, instructions and information on the performance of Air Traffic Servicing by the air traffic servicing authorities at the RC for ATS-Sofia is the Manual on air traffic servicing of BULATSA.

2.17.1 Organization of ACC-Sofia

Sofia Control provides air traffic services in its area of responsibility and consists of the following sectoral groups:

- a) Family sectors (FS) Sofia;
- b) Family sectors (FV) Varna).

Each sector group consists of one or more sectors.

Each of the two control sectors (FS Sofia - FV Varna) in the upper airspace (FL 245 - FL 600) of the Sofia Area Control Centre (ACC) has two working positions for air traffic controllers:

- a) One working position for the Executive ATCO;
- b) One working position for the Planner ATCO.

2.17.2 Service operation organization for the Sofia Area Control Centre

The Air traffic controller - Supervisor is responsible for service operation organization in the Sofia ACC:

- ”... ”
- Upon taking up duty, he accepts all responsibility for the performance of the tasks and responsibilities specified in the normative documents for this position.
 - Assumes responsibility for coordinating the operational activities of ACC Sofia.
 - Assess the capacity of the ACC and, depending on the situation and the composition available, change the sectoral configuration in the order described in paragraph 8 in the performance of the tasks of the pre-tactical and tactical phase of air traffic flow management.
-

.....
Air traffic controller - Supervisor decides to switch from the main to the backup SATCAS (scheduled or emergency).

”... ”

2.17.3 Air traffic capacity analysis

The Supervisor changes the sector configuration for Sofia Control Unit, FS Varna, and FS Sofia in order to avoid exceeding of the declared sectors’ values. Fig.8 shows the traffic data for sector LBNL3 (VBL).

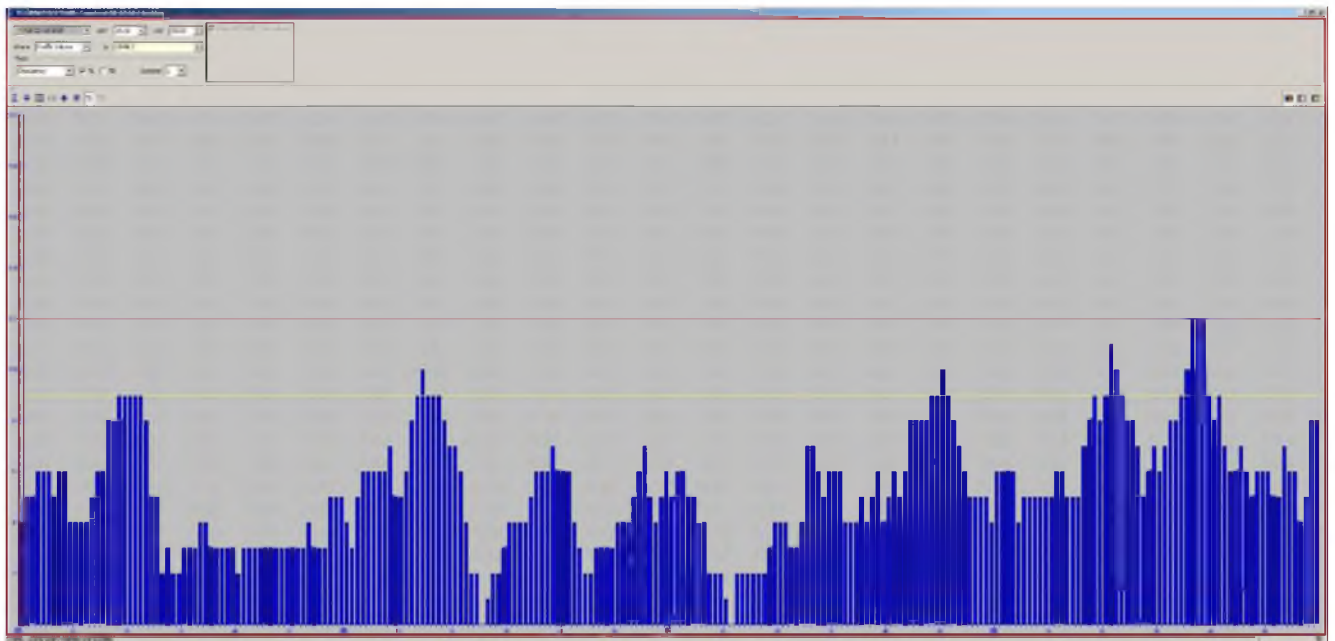


Fig.8

Supervisor has arranged appropriate time for the planned prophylactic activities performed by technical sector SFDPS for SATCAS V3DL (main AATMS) which has imposed temporally switching and ATS provision at Sofia Control Unit to be performed through ODS SATCAS V3MS and then switching back to the main AATMS – ODS SATCAS V3DL.

After instructions to all ATCOs from Sofia Control Unit for transition to the main AATMS – SATCAS V3DL, Ops Supervisor has not received information from EXE/PLN Sofia Control, FS Varna, sector VBL, that they had not switched the both radar displays (ODS) to the main AATMS – SATCAS V3DL.

The switching process consists of two sequential and consistent switching – at first of PLN and in consequence of EXE, which impose additional adjustment of the ODS, adding of all required neighbouring operational frequencies and additional aircraft radar identification.

The reported information from sector SFDPS related to the performed planned and prophylactic activities is as follows:

„SATCAS - Information #28950

Full restart of the system SATCAS DL

23.07.2019 08:57 – (the rapporteur's name has been deleted)

Status: Completed

Priority: Normal

Start [UTC]: 23.07.2019 03:20

Actions taken: Completed procedure for restart of the main system

End [UTC]: 23.07.2019 11:30

Effect: no

Reason: Planned restart according to technological instruction 93-00-2998/07.03.2017

Category: Other

Description: In accordance with technological instruction 93-00-2998/07.03.2017 a full restart of the system SATCAS DL has been performed

From 03:20 till 11:30 the operations are performed by the system SATCAS V3 MS. “

2.17.4 OM - procedures for RA crew response

8.3.6.5. RA Crew Response

- 1) The PF shall respond immediately by following the RA as indicated, unless doing so would jeopardise the safety of the aeroplane.
- 2) The PF shall follow the commands as closely as possible with respect to aeroplane capabilities.
- 3) If a climb RA is generated at maximum operating altitude commence a climb or at least maintain present altitude. Do not descend opposite to the RA. Maximum altitude usually permits a 200 fpm capability which is sufficient for ACAS of conflicting traffic to confirm "Descent/Increase Descent" RA. The other traffic is then able to ensure safe separation based solely on its descent.
- 4) NEVER manoeuvre in a direction opposite to the RA command.
- 5) PF shall follow the RA even if there is a conflict between the RA and an ATC instruction to manoeuvre. PM checks the traffic display and monitor the response to the RA according procedures, initiated in respective OM-B.
- 6) PM as soon as possible, as permitted by flight crew workload, shall notify the appropriate ATC unit of any RA which requires a deviation from the current ATC instruction or clearance (see RA reporting).
- 7) PF promptly complies with any modified RA
- 8) PF shall limit the alternations of the flight path to the minimum extent necessary to comply with the RA

- 9) When the conflict is resolved, the PF maneuvers to promptly return to the terms of ATC instruction or clearance.
- 10) PM notifies ATC when returning to the current clearance.
- 11) When the conflict is resolved, the PF promptly returns to the current ATC clearance, unless otherwise directed by ATC.
- 12) When reaching the cleared level, undesirable ACAS RA signalling may occur due to high vertical speed, if the adjacent flight level is occupied or being reached by another aircraft.

Table 8.3-16

In order to prevent such undesirable RA, it is necessary to reduce the vertical speed to less than 1000ft/min for the last 1000ft before the cleared level. Circumstances	Phraseology
RA requires deviation from clearance or instruction	TCAS RA
after ACAS "Clear of Conflict" announcement (Pilot and controller interchange)	CLEAR OF CONFLICT, RETURNING TO (assigned clearance)
after returning to clearance after responding to an ACAS resolution advisory (Pilot and controller interchange)	CLEAR OF CONFLICT (assigned clearance) RESUMED
when unable to comply with an ATC clearance because of an ACAS resolution advisory (Pilot and controller interchange)	UNABLE, TCAS RA

The commander is responsible for submitting following written reports (see 11.2):

- 1) EFA Flight Report
- 2) TCAS RA report

2.18 Additional information

2.18.1 Activated warning systems and activation procedure

2.18.1.1 Information on transponder operating modes

Mode	Description
STANDBY	The transponder system is energized but does not transmit.
ALT-OFF	The transponder system transmits the reply in Mode A and Mode S, but it does not transmit the altitude data. The TCAS does not operate.
XPNDR(ALT-ON)	The transponder system transmits the reply in Mode S, and exchanges data with the ground systems and board systems of aircraft. The TCAS does not operate – TCAS OFF.
TA	The transponder system transmits the reply in Mode S, The TCAS will operate normally, exchanges data, and perform all tracking functions TCAS will only issue TAs; RAs will be inhibited. TA ONLY TFC
TA/RA	The transponder system transmits the reply in Mode S. The TCAS will operate normally, exchanges data, and perform all tracking functions TCAS will issue TAs and RAs when appropriate. TFC

2.18.1.2 Airborne Collision Avoidance System – ACAS/TCAS

Both commercial aircraft involved in the serious incident were equipped with a traffic alert and collision avoidance system (TCAS, version 7.1).

The automated system for the avoidance of dangerous approach or collision of an aircraft in flight with another aircraft operates on the principle of the secondary radiolocation and uses data from on board transponders. Via a directed antenna, assembled on each aircraft, and data exchange between the transponders of aircraft, TCAS monitors for the availability of aircraft flying in dangerous proximity and, where requested, the automated system for avoidance of collision on board of the two aircraft performs data exchange and synchronizes rendering of differentiated commands for manoeuvring on the vertical, aimed at avoiding of potential conflicts.

The Traffic advisory Mode is activated in case the system detects an aircraft, which may come into conflict with the relevant aircraft in a short-term plan. After the activation of this Mode, the system displays on board a radar sign in yellow and its spatial location versus the relevant aircraft. The visual indication is accompanied by an audible warning signal for dangerous approach of an aircraft, though the repetition of the word "Traffic".

Where the aircraft continues its movement following a conflicting trajectory or, in violation of the specified norms on normal separation, enters in a predetermined radio area around the conflicting traffic, the system reports the dynamic parameters of the flight of the aircraft under surveillance and analyses the data received from the estimated data exchange with the opposite on board transponder.

Where the analysis shows that the two aircraft move on conflicting routes, the norms on minimum separation being violated, and there is a real danger for direct collision, the system generates a command for fulfilment of vertical manoeuvring on the part of the flight crew, aimed at solving the existing conflict and avoidance of collision with the aircraft under surveillance. The flight crew of the aircraft, found under surveillance by TCAS, also receives a command for fulfilment of vertical manoeuvre. The two commands have differentiated instructions, as the TCAS system harmonizes the generated and rendered commands between the two aircraft, to ensure the performance of opposite manoeuvres. After switching of the system to RA Mode, the flight crews of the two aircraft receive commands for the fulfilment of a vertical manoeuvre, respectively CLIMB for the one aircraft and DESCEND for the other aircraft, or vice versa.

In case of an activated RA Mode and timely performance of the rendered commands on the part of the flight crews of the two aircraft, after solving of the conflict and avoiding of the collision, on board of the two aircraft the system announces conflict free overcoming of the dangerous approach through an audible message "Clear of traffic".

According to the results of the simulation of InCAS v4.2.3, the TCAS on board of TCX1NB which was at FL206, generated the RA "*Climb, climb!*", and weakening "*Level Off*".

According, statement to the flight crew and the conducted simulation the TCAS of TVS3729 on board, did not generate "*Traffic Traffic*" nor RA warning.

2.18.1.3 Simulation of the flight on flight simulator B737NG (Boeing 737-800W), equipment TCAS II, 7.1

TCAS/transponder control panel– the operational mode of the TCAS system is set by the pilot from the control panel.

Control panel on flight simulator – B737NG- equipment TCAS II, 7.1



Fig.9

Flight simulations depending on the selected TCAS/transponder control panel mode by the flight crew.

BOEING 737- 700/800 - CHECKLIST-BEFORE TAKE OFF

TAXI CHECKLIST	
TAXI to assigned runwaySPEED Max. 20 knots	
BRKS/GYRO/TURN COORDINATOR.. CHECK during taxi	
BEFORE TAKE-OFF CHECKLIST	
PARKING BRAKE	SET
FUEL FLOW	RESET, then RATE
C FUEL PUMPS	AS REQUIRED
DE-ICE	AS REQUIRED
CABIN LIGHTS	AS REQUIRED
FLIGHT INSTRUMENTS	CHECK
ENGINE INSTRUMENTS	CHECK
TAKE-OFF DATA	(V1, VR, V2) CHECK
NAV EQUIPMENT	CHECK
<i>Request Takeoff Clearance</i>	
LANDING LIGHTS	ON
STROBE LIGHT	ON
TAXI LIGHTS	OFF
TRANSPONDER	TA/RA
TFC	PUSH ON
CLOCK	START

Fig.10

- Before take off from LBWN runway the flight crew set the system to the „TA ONLY“ position

In this mode, the symbols “TFC“, “TA ONLY” were displayed on both navigation displays (ND).

After take off from LBWN the flight crew started to climb to FL 220.

After flying over TOTKA point TCAS detected an intruder.

On FL 204 the TCAS was activated in mode TA, as a result on both navigation displays appeared a radar sign at 02 O'clock in yellow, the visual indication „TRAFFIC” and an audible warning signal for dangerous approach of an aircraft, thought the repetition of the word „TRAFFIC TRAFFIC“. TCAS did not active in mode RA, because of a prohibition.



fig.10



Fig.11

- Before take off from LBWN runway the flight crew set the system to the „TA/RA“ position

In this mode, the symbol “TFC“ was displayed on both navigation pilot displays (ND). After take off from LBWN the flight crew started to climb to FL 220.

After flying over TOTKA point TCAS detected an intruder. After take off from LBWN the flight crew started to climb to FL 220.

After flying over TOTKA point TCAS detected an intruder.

The TCAS is activated in mode TA as a result on both navigation displays appeared a radar sign at 02 O'clock a radar sign at 02 O'clock in yellow, the visual indication „TRAFFIC“ and an audible warning signal for dangerous approach of an aircraft, thought the repetition of the word „TRAFFIC TRAFFIC“.

When the norms on minimum separation was violated, that the two aircraft move on conflicting routes, and there was real danger for direct collision, the TCAS is activated in mode RA, generated a command for fulfilment of vertical maneuvering “DESCEND DESCEND“ and weakening LEVEL OFF .

The flight crew immediately executed the issued commands and the conflict was resolved.

After solving of the conflict and avoiding of the collision, the system announces conflict free overcoming of the dangerous approach through an audible message “CLEAR OF CONFLICT”.



Fig.12

- Before take off from LBWN runway the flight crew set the system to the „XPNDR(ALT-ON)“ position

On both navigation, pilot displays (ND) were appeared the symbol **TCAS OFF**. This is an indication that TCAS had not provided surveillance and control in the surrounding air space. In the present case this led to the fact that the flight crew visually detected the conflict traffic.



Fig.13



Fig. 14

2.18.1.4 Ground-based warning systems

Medium Term Conflict Detection (MTCD)

The automated Medium Term Conflict Detection (MTCD) function will assist the controllers in monitoring the air situation continuously by providing conflict data through HMI.

MTCD shall support conflict detection for all flights for which a system trajectory is available.

MTCD will start conflict detection for a flight when it is a pre-defined time from entering the area of operation (i.e. when the flight turns its state to ACTIVE), and continue conflict detection for this flight until it leaves this area.

MTCD are forecasted, where forthcoming simultaneous loss of horizontal and vertical separation between two aircraft may be detected based on the aircraft's systemic trajectories. Such forecast is made for a period of 20 minutes ahead. It uses the data from the systemic flight plans for building of systemic trajectories.

MTCD functionality generates warning in case of a forecast is produced that two or more aircraft will be in conflict within the prognosticated period of time established (up to 20 min). Upon automatic detection of conflict in the trajectories of aircraft, which are found in a potentially dangerous situation, a warning at the ATCO's working position is received.

The detected conflict is automatically displayed as a red dot on the zero line of the aircraft's label and additionally in the Conflict Display Window (CDW), with information about the conflict and the call signs of the aircraft found in a conflict situation.

In the present case, the MTCD generated a warning between TCX1NB and TVS3729 at 08:31:02 UTC; this continued to be displayed until 08:35:50 UTC on the work position of VBL sector.

The MTCD therefore gives an adequate warning time, which is designed to leave the ATCO sufficient time for an appropriate response.

SHORT TERM CONFLICT ALERT (STCA)

STCA are detected conflicts with time horizon of up to 5 min (typically 2 min).

The last barrier to aircraft collision are the on-board automated ACAS, which function within a time horizon of less than 2 min (typically 40 s).

The STCA functionality generates visual and audible warning (alarm), if two or more aircraft are already in conflict (an existing conflict), or it is forecasted that they will be in conflict within the pre-set forecast time (2 min).

In the present case, the STCA generated a warning between TCX1NB and TVS3729 at 08:35:50 UTC this continued to be displayed until 08:36:18 UTC on the work position of VBL sector.

2.18.1.5 ATS Manual, part Two, Sofia ATCC, Chapter III, Section VII, p. 5:

“ ...

6. ATCO's actions in case of switching between main and backup SATCAS system

6.1. The switching to the backup system incl. the switching of the keyboard, the mouse and the monitor is performed by a combination of keys „Ctrl and F1”.

6.2. The switching to a main system incl. the switching of the keyboard, the mouse and the monitor, is performed by a combination of keys „Ctrl and F3”.

6.3. At switching to the backup system, the EXE identifies all aircraft located in the respective sector.

6.4 The PLN submits calculations and corrections to the neighboring ATS units/sectors until the recovery of the normal operation of OLDI connections to the backup system.”

...”

3 Analysis

To establish the causes for the realized serious incident, the following aspects were reviewed:

- Technical failure;
- Errors of the crews of TVS3729 and/or TCX1NB, related to the operation of the aircraft;
- Inefficient implementation of procedures by ATCO.

The first aspect is related to the technical failure of SATCAS or the aircraft systems. On the ground of the information received, the Commission established that the SATCAS worked without interruption of its functionalities. From the information obtained, it was established that:

- STCA and MTC D functionalities of the SATCAS Safety Nets subsystem generated a warning in accordance with the parameters set in the subsystem specifications.

- The MTC D generated a warning between TCX1NB and TVS3729, which was automatically displayed as red dot in line zero on the track label of the two aircraft on the Controller Working Position of family sector VBL.

- SATCAS generated the STCA a warning between TCX1NB and TVS3729 which is displayed at both the working positions of VBL sector.

During the investigation, the Commission did not find any information about irregularity in the aircraft systems of TCX1NB and it was established that on board of TCX1NB the TCAS system generated the RA "CLIMB, CLIMB", and weakening "LEVEL OFF".

Upon the simulation using InCAS v4.2.3 performed at EUROCONTROL covering the period of conflict the TCAS system of TVS3729 was operating in TA ONLY mode.

AO Smartwings provided information that there were no recorded reports of defects and/or deficiencies in the operation of the TCAS system of the aircraft before the realization of the aviation occurrence.

According to Honeywell's expert assessment, in order to determine the selected mode of the TCAS control panel in the TA Auto position or the TA Only position, it is necessary to the Event History of the TCAS unit from the Boeing 737 (which was a Honeywell unit, TPA-100B)

Unfortunately, the information from FDR and TCAS Event History on aircraft with call sign TVS3729 was no available, therefore it is not possible to determine whether this was due to a technical malfunction or incorrect operation of the crew when selecting TCAS mode before departure from LBWN.

Considering the contents of paragraphs 2.1.2, 2.6, 2.8 and 2.18 above, the Commission declined the possibility that the event has resulted from a technical failure of SATCAS or a technical failure on board systems of aircraft with call sign TCX1NB.

The Commission could not establish whether the operation of the TCAS system in TA / RA mode on an aircraft with the call sign TVS3729 was the result of a technical malfunction or a breach of the procedure by the flight crew.

The Commission associates the second aspect with the possible errors made by the crews of TCX1NB and/or TVS3729 in the aircraft operating.

With regard to the flight of TCX1NB

According to the information received from BULATSA, the explanations of the flight crew of TCX1NB and the one set out in paragraph 2.1.2 during the flight in the controlled airspace of Sofia Control, VBL sector, the aircraft executed correctly the instructions of EXE ATCO for descent to FL150 to LBBG.

During descent, EXE ATCO issued a follow-up instruction to stop the descent at FL 210.

At this time, the flight crew identified on TCAS oncoming aircraft 3000 feet below and climbing.

The flight crew heard two calls to the TVS3729 aircraft to maintain FL190, but the aircraft continued to climb altitude.

At that time, the EXE ATCO issued an instruction to the flight crew of TCX1NB immediately stop the descent at FL200. The next moment, on board of TCX1NB the TCAS system generated the RA "CLIMB".

The flight crew of TCX1NB reacted to the visual indication and aural resolution advisories (RAs) of their traffic alert and collision avoidance systems (TCASs) without delay and in accordance with the procedures prescribed by their aviation operator.

Their actions were prevented the escalation of the conflict.

With regard to the flight of TVS3729

According to the information received from BULATSA, the explanations of the flight crew of TVS3729 and the one set out in paragraph 2.1.2 during the flight in the controlled airspace of Sofia Control, VBL sector, the aircraft executed correctly the instructions of EXE ATCO to climb to FL220 after took off from LBSF.

When passing FL200, the EXE ATCO an instruction for immediate descent to FL190. The flight crew of TVS3729 selected ALT HOLD, changed FL down to FL180 and LVCHG.

In this conflict situation, the flight crew did not receive an indication of TCAS “TRAFFIC TRAFFIC” or “RA”.

It is not possible to unambiguously determine whether a momentary technical failure has occurred or an error made by the flight crew in a procedure prescribed their aviation operator when selecting the transponder mode (TCAS has been set in TA ONLY – as a human factor - non-rotation of the selector to the TA / RA position).

In view of the second aspect above, the following conclusions can be drawn:

The actions of the flight crew of TCX1NB during the conflict situation were accurate and correct, which prevented the escalation of the conflict.

Incorrect actions of the flight crew of TVS3729 in selecting a transponder mode before the conflict situation may have contributed to their TCAS system did not generate the RA.

Their subsequent actions to the implementation of the EXE ATCO instructions were adequate and did not contributed to complicate the conflict situation.

The third aspect is related to the ineffective implementation of procedures by ATCO.

During the period of the occurrence, 12 aircraft were serviced simultaneously in SBL.

Due to not providing the ambient workplace recordings at the working positions of VBL sector, the Commission does not dispose complete information about the plan elaborated by PLN ATCO from VBL sector, what clearances he has agreed with the EXE ATCO and how the plan has been amended in respect for the purpose of avoiding a potential conflict between A/C TVS3729 and A/C TCX1NB.

At the start of work at 08 00 h UTC of sector VBL after an instruction issued by the Supervisor, EXE and PLN began to switch the display from backup to main AATMS – ODS SATCAS V3 DL.

The switching process consists of two sequential and consistent switching – at first of PLN and in consequence of EXE, which impose additional adjustment of the ODS, adding of all required neighboring operational frequencies and additional aircraft radar identification.

The PLN ATCO was adjusted its display approximately for about 2 minutes. After the end of the process, PLN ATCO did not inform the EXE ATCO that the process was completed and that it is possible for the EXE ATCO to start the process of display switching to the main AATMS.

At that time the Supervisor changed the sector configuration for Sofia ACC, FS Varna, and FS Sofia division level 355 in order to avoid exceeding of the declared sectors’ values.

About 15 minutes after the real completion of the switching from backup to main AATMS by PLN ATCO, the EXE ATCO started his own switching of ODS to SATCAS DL. EXE ATCO turned on maps settings, grouping the tables, introducing filters, FL and working frequencies of neighboring sectors and ATCCs.

This takes about 7 minutes, during which period PLN Atco performed radio communication with the aircrafts.

After completing, the switching to the main AATMS the EXE ATCO started again communication with the aircrafts.

When transferring the radio communication to the EXE ATCO again, there were already changes in the PLN's air situation plan because the latter had given permissions and instructions to the respective aircraft in his area of responsibility.

It should be noted that at this time there has been no effective discussion with the EXE ATCO about all potential conflicts, because of lack of time.

In this situation at 08:30:50 UTC the EXE ATCO issued a conflict clearance for descend to aircraft TCX1NB to FL150 in despite that the departing from Varna aircraft TVS3729 has received permission to climb FL 160 after adopted coordination by PLN ATCO.

At 08:31:02, Automated ATM System SATCAS generated warning for MTCD between A/C TCX1NB and A/C TVS3729.

At 08:31:38, EXE ATCO identified the aircraft as TVS3729 and issued instruction for climbing to FL220, regardless of the MTCD's indication of a conflict between TCX1NB and TVS3729.

It should be noted that the conflict remains undetected until information about it is received from ATCO from the neighboring sector.

After noticing a conflict situation between TCX1NB and TVS3729 the EXE immediately issued instructions to stop descend to FL200, because of traffic of aircraft TCX1NB and delay with about 30 s to issue instructions to aircraft TVS3729 to stop climb to FL190.

In this situation aircraft, TVS3729 has already passed over FL194 climbing to FL220 and execution of the instructions was impossible. The EXE does not use the necessary phraseology – “immediately”/” due traffic”/”for separation”, as well as does not issue “essential traffic information” to the crew of aircraft TVS3729.

In fact the EXE ATCO did not use the necessary phraseology – “immediately”/” due traffic”/”for separation”, as well as did not issue “essential traffic information” to the crew of aircraft TVS3729. Consequently, the EXE ATCO issued corrective instructions to the crew of aircraft TCX1NB to stop descend to FL210 and issued instructions to the crew of aircraft TVS3729 to stop climb and to descent to FL200.

At 08:35:58, the EXE issued instructions for turning left with 20 degrees to the crew of aircraft TCX1NB, but the crew responds that they are performing TCAS RA.

In accordance with the third aspect of the possible inefficient implementation of procedures by ATCO, the inefficient performance of procedures upon providing Air Traffic Services lead to infringement of the minimum norms for safe separation between aircraft, which makes the situation grow from complicated flight conditions to a situation threatening the safety of flight.

In view of stated so far, conclusion may be made that the serious incident investigated is predetermined by dominating factors related to the third aspect:

- Issuing of a conflict clearance by EXE air traffic controller;
- Ineffective interaction in the EXE/PLN team;
- EXE and PLN air traffic controller did not detect the conflict in VBL sector;

- Lack of a preliminary plan for resolving potential conflicts;
- EXE and PLN air traffic controller did not react in accordance with the procedures for detecting and resolving the conflict;
- Lack of expediency of EXE and PLN air traffic controller in providing Air Traffic Services.

A significant contribution to the realization of the event was the high load of the EXE and PLN air traffic controller due to switching from backup to main AATMS and change in the sector configuration

4 Conclusion

4.1 Findings

1. The investigation did not reveal any information on existing technical failures of the aircraft systems of TCX1NB and Automated ATM System SATCAS that may have caused or influenced the realization of the serious incident;
2. It is unlikely that the operation of the TCAS system in TA / RA mode on board of aircraft with call sign TVS3729 is due to a technical malfunction;
3. There are no interruptions and disturbances during the radio broadcasting with not a single aircraft in the sector.
4. On board of the aircraft with call sign TCX1NB, which was at FL206, generated the RA "*Climb, climb!*", and weakening "*Level Off*".
5. On board of the aircraft with call sign TVS3729 TCAS system, did not generate "*Traffic Traffic*" nor RA warning.
6. SATCAS generated warning for MTCD between A/C TCX1NB and A/C TVS3729, which is displayed at both the working positions of VBL sector.
7. The SATCAS generated visual indication in bright red colour with sound alarm for STCA between A/C TCX1NB and A/C TVS3729, which is displayed at both the working positions of VBL sector.
8. The flight crew of TCX1NB reacted to the visual indication and aural resolution advisories (RAs) of their traffic alert and collision avoidance systems (TCASs) without delay, which prevented the escalation of the conflict.
9. The flight crew of TCX1NB informed the EXE ATCO that they had received a resolution advisory (RA) from their TCAS.
10. Probably a technical failure or incorrect actions of the flight crew of TVS3729 in selecting a transponder mode have contributed to their TCAS system did not generate the RA.
11. The flight crew of TCX1NB and TVS3729 did not contribute to the emergence of the dangerous convergence;
12. The flight of TCX1NB is carried out in accordance with the flight plan along the route London Gatwick Airport (EGKK) to Burgas (LBBG).

13. The flight of TVS3729 is carried out in accordance with the flight plan along the route Varna (LBWN) to Nantes Atlantique Airport (LFRS).
14. The Supervisor changes the sector configuration for Sofia Control Unit, FS Varna, and FS Sofia in order to avoid exceeding of the declared sectors' values.
15. At the start of work at 08 00 h UTC of sector VBL after an instruction issued by the Supervisor, EXE and PLN began to switch the display from backup to main AATMS – ODS SATCAS V3 DL.
16. The applicable separation minima based on ATS surveillance systems of 5 NM within area of responsibility of Sofia ACC SBL sector is infringed;
17. The aviation occurrence is contributed of the ACC-Sofia;
18. EXE and PLN air traffic controller did not detect the conflict in VBL sector;
19. Issuing of a conflict clearance by EXE, which lead to a dangerous convergence between A/C TCX1NB and A/C TVS3729;
20. Ineffective interaction in the EXE/PLN team in the conflict situation;
21. EXE and PLN air traffic controller did not react in accordance with the procedures for detecting and resolving the conflict;
22. Lack of a preliminary plan for resolving potential conflicts;
23. Lack of expediency of EXE and PLN air traffic controller in providing Air Traffic Services;
24. The EXE ATCO detected the conflict between the two aircraft following a warning from the ATCO from a neighbouring sector.
25. The high load of the EXE and PLN air traffic controller due to switching from backup to main AATMS and change in the sector configuration;
26. AO Smartwings did not provide FDR data of a Boeing 737-800-8FN aircraft with a call sign TVS3729;
27. BULATSA did not provide the ambient workplace recordings at the working positions of VBL sector;
28. At the time of realization of this aviation occurrence, PLN ATCO was involved in realizing of one serious incident on 12.08.2018;
29. The PLN ATCO in 2018 and 2019, when reissuing an aviation medical certificate, did not inform the Commission for aero-medical examination that it was a participant in realizing of a serious incident;
30. When reissuing an aviation medical certificate for the confirmation of a certificate of competence - ATCL in 2018 and 2019, BULATSA and the General Directorate 'Civil Aviation Administration' have not notified the Commission for Aeromedical Certification that the PLN ATCO is a participant in realizing of serious incidents;

31. There is no established procedure for medical examination of the participants in case in the realization of accidents and serious incidents.

4.2 Causes

Based on the analysis performed, the Commission points out:

Immediate causes of the serious accident:

- Ineffective interaction in the EXE/PLN team;
- EXE and PLN air traffic controller did not detect the conflict in VBL sector;
- Lack of a preliminary plan for resolving potential conflicts;
- EXE and PLN air traffic controller did not react in accordance with the procedures for detecting and resolving the conflict;
- Lack of expediency of EXE and PLN air traffic controller in providing Air Traffic Services.

The main cause of the serious incident was that the EXE ATCO issued a conflict clearance for descend of the aircraft, which led to a hazardous convergence with another aircraft performing a climb after issued clearance.

The following was identified as a contributing factor to the serious incident:

The high load of the EXE and PLN air traffic controller due to switching from backup to main AATMS and change in the sector configuration

5 Safety recommendations:

In view of the causes for the realized serious incident and the deficiencies found in the course of investigation, the Commission proposes the following safety recommendations to be fulfilled:

BG.SIA-2019/05/01 BULATSA to incorporate in the program for periodic training of the ATCOs exercise scenarios, in communication skills for the EXE/PLN team in situations of immediate actions to prevent violation of the required separation between aircraft.

BG.SIA-2019/05/02 DG CAA of Republic of Bulgaria to strengthen the control of aviation organizations involved in realizing of aviation occurrences regarding the provision of the necessary information to the safety investigative authorities.

BG.SIA-2019/05/03 In the case of realization of an aviation accident and a serious incident, DG CAA of Republic of Bulgaria should establish a procedure for medical certification on the participants in the occurrence.

On the grounds of Article 18, §5 of Regulation (EU) 996/2010, the safety recommendation issued will be recorded in the centralized European system SRIS (Safety Recommendations Information System).

The Investigation Commission reminds all organizations, to which flight safety recommendations are sent that, on the grounds of Article 18 of Regulation (EU) 996/2010 on Investigation and Prevention of Accidents and Incidents in Civil Aviation and Article 19, paragraph 7 of Ordinance No. 13 on the Investigation of Aviation Accidents are obliged to notify the Air, Maritime and Railway Accidents Investigation National Board in writing of the action taken on the recommendations made.

NOTE: After providing the Draft Final Report for the investigation to the parties concerned, the Commission on safety investigation received responses as follows:

1. Air Accidents Investigation Institute of the Czech Republic (AII) provided comment paper that include objections and suggestions for additions to the Draft Final Report, as well as notes on technical or terminological mistakes allowed in it.

2. Air Accidents Investigation Branch of UK declared it has no comments and no remarks on the report content;

3. The EASA declared it has no comments and no remarks on the report content;

4. DG CAA of Bulgaria did not provide any comments and remarks on the report content;

5. BULATSA declared it has no comments and no remarks on the report content;

The Commission on safety investigation after discussing the comments provided made the following substantiated changes to the final report:

- Changed the text in paragraphs 2.16, paragraphs 3 and point 10 of paragraph 4 concerning information from FDR data and the actions of the flight crew of a Boeing 737-800-8FN aircraft with a call sign TVS3729;

- The Safety Recommendations BG.SIA-2019/05/02 are defined again.

Copies of the data and comment document received from Air Accidents Investigation Institute of the Czech Republic are attached to the case of the event under investigation.

AIR, MARITIME AND RAILWAY ACCIDENTS INVESTIGATION NATIONAL BOARD

COMMISSION ON INVESTIGATION OF THE SERIOUS INCIDENT

Sofia, 8 September 2021



ANNEX 1

TCAS analysis for Bulgarian Aircraft, Maritime and Railway Accident Investigation Directorate TVS3729 TCX1NB –23 July 2019

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Senior ACAS Expert

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Background

- An incident between TVS3729 and TCX1NB occurred on 23 July 2019 in Bulgarian airspace.

	Aircraft 1	Aircraft 2
Callsign	TVS3729	TCX1NB
Aircraft type	B738	A321
Registration	OK-TVM	G-TCDG
Mode S address	49D13F	406AE0

- Bulgarian Aircraft, Maritime and Railway Accident Investigation Directorate has asked EUROCONTROL to conduct analysis of the event to assess TCAS II (Traffic alert and Collision Avoidance System) performance.



InCAS v4.2.3 (Interactive Collision Avoidance Simulator)

- InCAS recreates aircraft vertical and horizontal trajectories based on radar data and replays events with horizontal and vertical views.
- InCAS can also:
 - Show pilot displays;
 - Simulate idealised pilot response;
 - Give details of ACAS decision making.
- In the following analysis vertical rates are average rates between radar updates (rounded to the nearest 100 ft). Altitudes are interpolated.
- The following trajectory smoothing was applied:
 - Horizontal: Smoothing: 0.01 / Deviation 0.2
 - Vertical: Smoothing: 0.01 / Deviation 1



RA downlink vs. InCAS simulation

- Typically, InCAS is used for this type of incident analysis to recreate TCAS alerts.
- In the case examined here, RA downlink messages were available and were used in addition to InCAS simulation.
- RA downlink messages provide information on RAs as they occurred on the aircraft (with the latency of up to the time of radar rotation cycle, assuming perfect radar detection).
- There is no possibility to reproduce “as was” TCAS air-to-air surveillance, so some discrepancies are possible.
- As TAs are not downlinked, InCAS has been used to simulate the timing of TAs.
- Finally, expert judgement was used to assess if TCAS performance was as expected.



Data source & processing

- BULATSA provided radar recordings (ASTERIX Cat 48) (update rate ~4-5 sec). That included:
- Altitude;
- Horizontal aircraft positions expressed as X/Y coordinates; • Mode S address and callsign.
- Mode S RA downlink and ACAS status messages were provided every 10 seconds from one radar (identifier SAC/SIC 132/1). • Note: TA are not downlinked
- The data relevant to the two aircraft was extracted between 08:34:48 and 08:37:07.
- Data was converted to .eu1 format for InCAS processing.



TCAS II equipage

- Based on their Maximum Take Off Mass and passenger seating, both aircraft were required to be equipped with TCAS II version 7.1 (Commission Regulation (EU) No 2016/583 of 15 April 2016 amending Regulation (EU) No 1332/2011).
- ACAS capability data received from BULATSA's radar indicate that both aircraft were equipped as required.
- TCX1NB: Mode S downlink BDS1.0 indicates that equipped TCAS II was operational during the whole time of the event.
- TVS3729: Mode S downlink BDS1.0 indicates that TCAS II was operated in the "TA-Only" mode.
- In the "TA-Only" mode RAs will be inhibited and only TAs can be issued.
- The mode selection is performed by flight on the transponder panel.



Network Manager
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the European Commission

ACAS status – TVS3729

HH:MM:SS	ACAS Status
08:34:48	TCAS Active; TCAS V7.1, TA-Only
08:34:53	TCAS Active; TCAS V7.1, TA-Only
08:34:58	TCAS Active; TCAS V7.1, TA-Only
08:35:02	TCAS Active; TCAS V7.1, TA-Only
08:35:07	TCAS Active; TCAS V7.1, TA-Only
08:35:12	TCAS Active; TCAS V7.1, TA-Only
08:35:17	TCAS Active; TCAS V7.1, TA-Only
08:35:21	TCAS Active; TCAS V7.1, TA-Only
08:35:26	TCAS Active; TCAS V7.1, TA-Only
08:35:31	TCAS Active; TCAS V7.1, TA-Only
08:35:37	TCAS Active; TCAS V7.1, TA-Only
08:35:41	TCAS Active; TCAS V7.1, TA-Only
08:35:45	TCAS Active; TCAS V7.1, TA-Only
08:35:50	TCAS Active; TCAS V7.1, TA-Only
08:35:55	TCAS Active; TCAS V7.1, TA-Only



HH:MM:SS	ACAS Status
08:36:00	TCAS Active; TCAS V7.1, TA-Only
08:36:05	TCAS Active; TCAS V7.1, TA-Only
08:36:10	TCAS Active; TCAS V7.1, TA-Only
08:36:14	TCAS Active; TCAS V7.1, TA-Only
08:36:19	TCAS Active; TCAS V7.1, TA-Only
08:36:24	TCAS Active; TCAS V7.1, TA-Only
08:36:29	TCAS Active; TCAS V7.1, TA-Only
08:36:33	TCAS Active; TCAS V7.1, TA-Only
08:36:38	TCAS Active; TCAS V7.1, TA-Only
08:36:43	TCAS Active; TCAS V7.1, TA-Only
08:36:48	TCAS Active; TCAS V7.1, TA-Only
08:36:51	TCAS Active; TCAS V7.1, TA-Only
08:36:57	TCAS Active; TCAS V7.1, TA-Only
08:37:02	TCAS Active; TCAS V7.1, TA-Only
08:37:07	TCAS Active; TCAS V7.1, TA-Only



ACAS status – TCX1NB

HH:MM:SS	ACAS Status
08:34:48	TCAS Active; TCAS V7.1, TA+RA
08:34:53	TCAS Active; TCAS V7.1, TA+RA
08:34:58	TCAS Active; TCAS V7.1, TA+RA
08:35:02	TCAS Active; TCAS V7.1, TA+RA
08:35:07	TCAS Active; TCAS V7.1, TA+RA
08:35:12	TCAS Active; TCAS V7.1, TA+RA
08:35:17	TCAS Active; TCAS V7.1, TA+RA
08:35:21	TCAS Active; TCAS V7.1, TA+RA
08:35:26	TCAS Active; TCAS V7.1, TA+RA
08:35:31	TCAS Active; TCAS V7.1, TA+RA
08:35:37	TCAS Active; TCAS V7.1, TA+RA
08:35:41	TCAS Active; TCAS V7.1, TA+RA
08:35:45	TCAS Active; TCAS V7.1, TA+RA
08:35:50	TCAS Active; TCAS V7.1, TA+RA
08:35:55	TCAS Active; TCAS V7.1, TA+RA



HH:MM:SS	ACAS Status
08:36:00	TCAS Active; TCAS V7.1, TA+RA
08:36:05	TCAS Active; TCAS V7.1, TA+RA
08:36:10	TCAS Active; TCAS V7.1, TA+RA
08:36:14	TCAS Active; TCAS V7.1, TA+RA
08:36:19	TCAS Active; TCAS V7.1, TA+RA
08:36:24	TCAS Active; TCAS V7.1, TA+RA
08:36:29	TCAS Active; TCAS V7.1, TA+RA
08:36:33	TCAS Active; TCAS V7.1, TA+RA
08:36:38	TCAS Active; TCAS V7.1, TA+RA
08:36:43	TCAS Active; TCAS V7.1, TA+RA
08:36:48	TCAS Active; TCAS V7.1, TA+RA
08:36:51	TCAS Active; TCAS V7.1, TA+RA
08:36:57	TCAS Active; TCAS V7.1, TA+RA
08:37:02	TCAS Active; TCAS V7.1, TA+RA
08:37:07	TCAS Active; TCAS V7.1, TA+RA



Timings of RA downlink messages

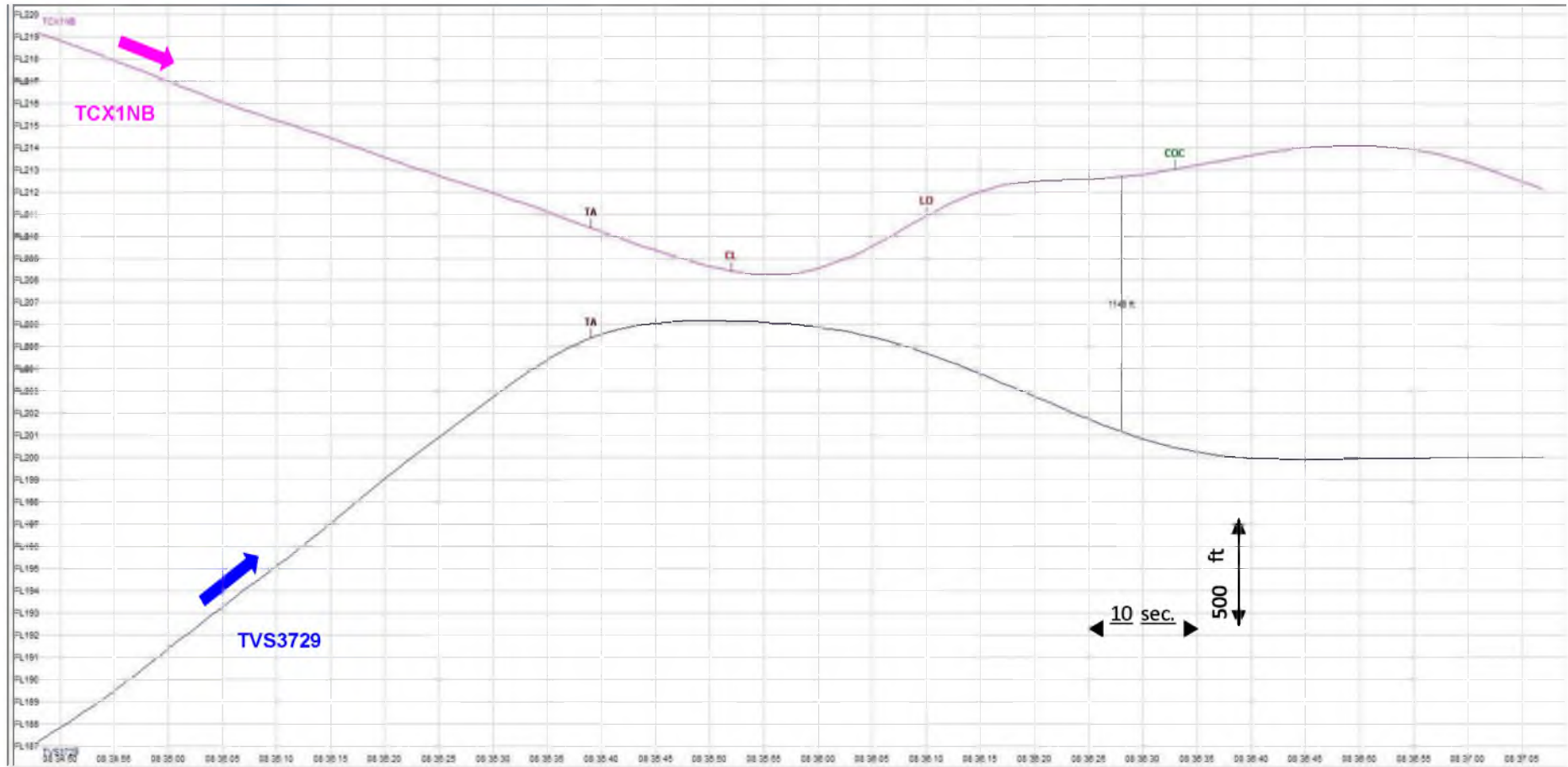
Event (cockpit aural annunciation)	Downlinked time (event time timeframe)
TCX1NB Climb RA <i>(Climb, climb)</i>	08:35:47 08:35:37 - 08:35:47
TCX1NB Level Off RA <i>(Level off, level off)</i>	08:35:57 08:35:47 - 08:35:57
TCX1NB RA Terminated <i>(Clear of conflict)</i>	08:36:38 08:36:28 - 08:36:38

Notes:

- The actual timing of RA based on the RA downlink message is delayed up to the number of seconds representing the update rate (10 seconds in this case)
- The downlinked times are used in the subsequent analysis.



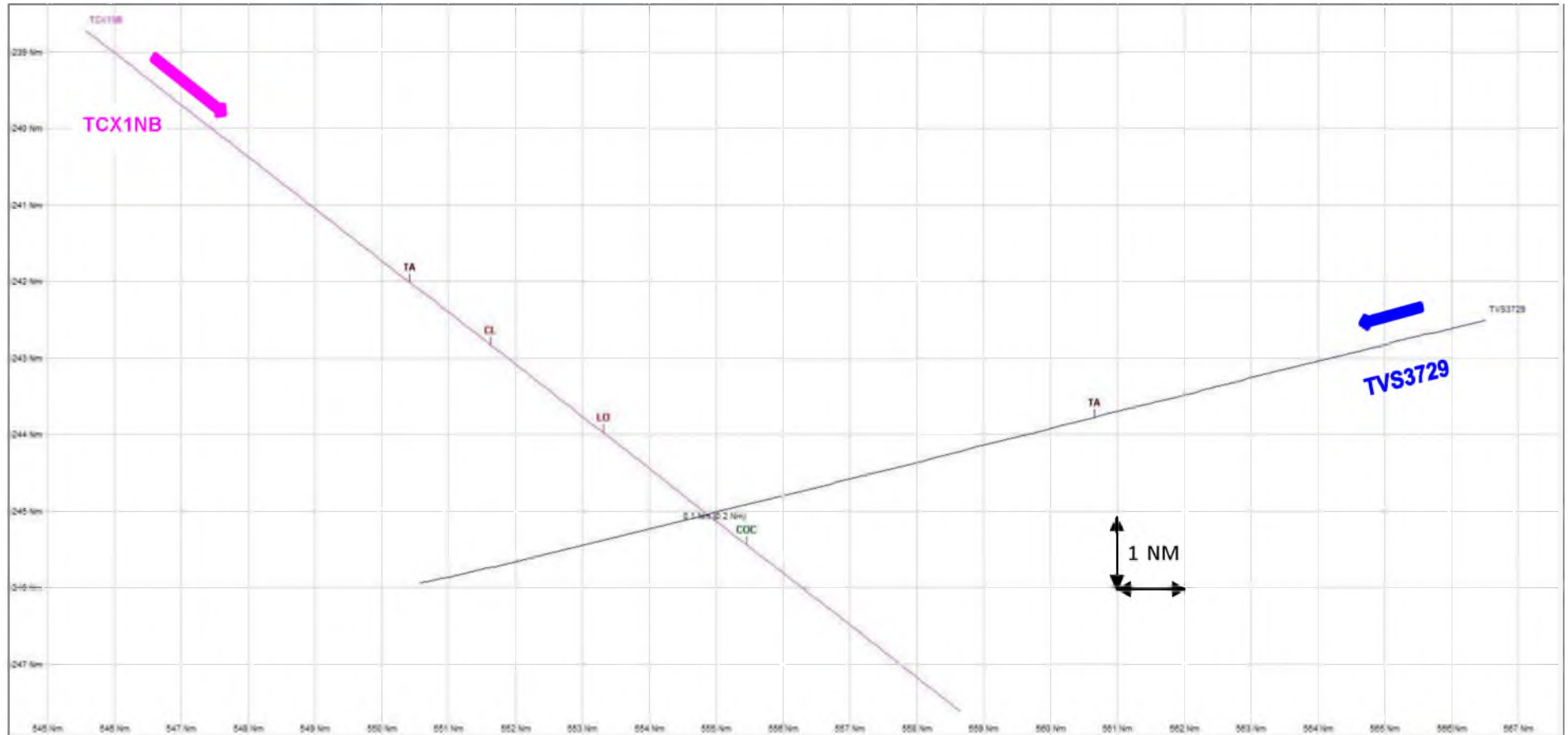
InCAS vertical trajectories



Timing of alerts per InCAS simulation.



InCAS horizontal trajectories



Timing of alerts per InCAS simulation.



Timing of events (1)

Time	Event cockpit aural annunciation	Horizontal separation [NM]	Vertical Separation [ft]	TVS3729		TCX1NB	
				Altitude [ft]	Vertical Rate [ft/min]	Altitude [ft]	Vertical Rate [ft/min]
08:34:48	Start of simulation	21.3	3196	18800	1800	21900	-1000
08:35:39	TCX1NB Traffic advisory(simulated) <i>Traffic, traffic</i>	10.4	497	20500	1100	21000	-1000
08:35:47	TCX1NB Climb RA (downlinked) <i>Climb, climb</i>	8.7	289	20600	0	20900	-800
08:35:52	TCX1NB Climb RA (simulated) <i>Climb, climb</i>	7.6	226	20600	0	20800	-500
08:35:57	TCX1NB weakening Level Off RA (downlinked) <i>Level off, level off</i>	6.6	225	20600	-200	20800	200
08:36:10	TCX1NB weakening Level Off RA (simulated) <i>Level off, level off</i>	3.8	618	20500	-1000	21000	1500
08:36:28	Closest Point of Approach	0.1	1148	20100	-1000	21200	200

Notes:(1) All downlinked events occurred at the time stamp or preceding 10 seconds.

(2) In the vertical rate columns, the + sign indicates a climb, the – sign indicates a descent.

(3) The latest of the derived times is used in the subsequent analysis. ... continued on the next page ...



Timing of events (21)

Time	Event cockpit aural annunciation	Horizontal separation [NM]	Vertical Separation [ft]	TVS3729		TCX1NB	
				Altitude [ft]	Vertical Rate [ft/min]	Altitude [ft]	Vertical Rate [ft/min]
08:36:33	TCX1NB RA Terminated (simulated) Clear of Conflict	1.1	1255	20000	-600	21300	500
08:36:38	TCX1NB RA Terminated (downlinked) Clear of Conflict	1.7	1309	20000	-400	21300	500

- Notes:(1) All downlinked events occurred at the time stamp or preceding 10 seconds.
(2) In the vertical rate columns, the + sign indicates a climb, the – sign indicates a descent.
(3) The latest of the derived times is used in the subsequent analysis.



Sequence of events(1)

- At 08:34:48 TVS3729 was climbing through FL188 with a rate of 1800 ft/min., while TCX1NB was descending through FL219 with a rate of -1000 ft/min.
- Based on the simulation conducted by InCas, both aircraft received Traffic Advisory at 08:35:39.
- According to downlinked radar data, between 08:35:37 and 08:35:47 a Climb Resolution Advisory was issued for TCX1NB. InCAS simulates the first RA to be at 08:35:52 (i.e. 5 seconds after the downlink time).
- TCX1NB complied with RA and started to increase its vertical speed to the required 1500 ft/min. At the time when the RA was issued TCX1NB was levelling off.
- No Resolution Advisory has been downlinked for TVS3729 as the aircraft operated in the “TAOnly” mode.
- A subsequent Resolution Advisory (Level Off) for TCX1NB was issued between 08:35:47 and 08:35:57. At the time of RA, its vertical rate was 200 ft/min. InCAS simulates the subsequent RA to be at 08:36:10 (i.e. 13 seconds after the downlink time).

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Sequence of events(2)

- At the Closest Point of Approach at 08:36:34 the distance between the aircraft was
- 1.3 NM horizontally and 1274 feet vertically.
- RA downlink information indicates that the TCX1NB RA terminated between 08:36:28 and 08:36:38. InCAS simulates the RA termination to be at 08:36:33 (i.e. 5 seconds earlier than the downlink time).



Conclusions (1)

- For the duration of the encounter, TVS3729 TCAS remained in the “TA-Only” mode. Therefore, the aircraft was not capable of creating any RAs.
- Aircraft with TCAS II in a “TA-Only” mode are treated as unequipped with TCAS II by other TCAS II equipped aircraft.
- There is no difference between types of RAs received via Mode S downlink and simulated by InCAS.
- There are minor differences between the times of RAs as there is no possibility to reproduce “as was” TCAS air-to-air surveillance in post-event analysis. Time differences are relatively small and could have been caused by a long radar time update rate, which was 10 sec.

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Conclusions (2)

- TCX1NB complied with all Resolution Advisories, which prevented the escalation of the conflict.
- Based on the information available, it cannot be determined why TCAS II on TVS3729 was in the “TA-Only” mode.
- At the Closest Point of Approach the distance between the aircraft was 0.1 NM horizontally and 1274 feet vertically.



Conclusions (3)

- Had TVS3729 TCAS II been operated in the “TA/RA” mode, TVS3729 would have received the following Resolution Advisories:
 - Descend RA at 08:35:53
 - weakening Level Off RA at 08:36:10
- However, responding to ATC instructions TVS3729 started to descend at the time coinciding with the simulated RA.
- Assuming TVS3729 had received RAs, a different vertical distance would have been generated at the Closest Point of Approach (1071 ft) .

