Federal Safety Investigation Authority

Final Report

Serious incident with the aircraft
Bombardier DHC-8-402 and Airbus A319-112,
on 16 June 2017, at approx. 10:58 UTC
in the area 11 nm east-northeast of the waypoint BALAD, Burgenland
Ref.: 2023-0.473.392

Vienna, 2023

Imprint

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Investigation report

This report pursuant to Article 16 of Regulation (EU) No. 996/2010 was approved by the Head of the Federal Safety Investigation Authority after completion of the consultation procedure pursuant to Article 16 of Regulation (EU) 996/2010 in conjunction with § 14 para. 1 UUG 2005.

Preamble

The safety investigation is carried out in accordance with Regulation (EU) No. 996/2010 and the Accident Investigation Act - UUG 2005, Federal Law Gazette [BGBI. I] No. 123/2005 as amended.

The sole purpose of the safety investigation is the prevention of future accidents or incidents. The determination of the causes does not imply a finding of blame or administrative, civil, or criminal liability (Article 2 (4) of Regulation (EU) 996/2010).

The regulations cited in the investigation report always refer to the version applicable at the time of the occurrence, unless the investigation report expressly refers to other versions or to regulations that were not adopted until after the occurrence.

This investigation report is based on the information that was provided. In the event that the information base is expanded, the Federal Safety Investigation Authority reserves the right to supplement the present investigation report.

The extent of the safety investigation and the procedure to be followed in conducting the safety investigation shall be determined by the Federal Safety Investigation Authority, taking into account the lessons it expects to draw from the investigation for the improvement of aviation safety (Article 5 (3) of Regulation (EU) 996/2010).

Unless stated otherwise, the safety recommendations are addressed to those bodies in a position to implement these safety recommendations in the form of suitable actions. The decision to implement these safety recommendations will be at the discretion of such bodies.

To preserve the anonymity of all persons involved in the incident, the report is subject to content restrictions.

All times given in this report are stated in 24 hour format and UTC (local time = UTC + 2 hours). Altitudes given in this report refer to altitude above sea level (QNH setting) unless otherwise specified.

This is a courtesy translation of the report on the safety investigation. As accurate as the translation may be, the original text in German is the work of reference.

Content

Introduction

Aircraft A	
Aircraft operator:	Austrian airline
Operating mode:	Scheduled flight according to instrument flight rules
Aircraft manufacturer:	Bombardier Inc., Canada
Type designator:	DHC-8-402
Aircraft type:	Powered aircraft
Nationality:	Austria

Aircraft B	
Aircraft operator:	Austrian airline
Operating mode:	Scheduled flight according to instrument flight rules
Aircraft manufacturer:	Airbus Industries, France
Type designator:	A319-112
Aircraft type:	Powered aircraft
Nationality:	Austria

Incident site:	approx. 11 nm east-northeast of the waypoint BALAD
Coordinates (WGS84):	47°49'35"N 016°29'35"E

The coordinates refer to the intersection of the trajectories of both aircraft.

Altitude above sea level:	approx. 7 000 ft
Date and time:	16 June 2017, 10:58 UTC

Abstract

Aircraft A, approaching Vienna Airport (LOWW) and aircraft B, departing from Vienna Airport (LOWW) experienced a loss of separation in which the horizontal and vertical separation were lower than half the separation minima. Both aircraft followed the vertical resolution advisories of the onboard collision warning system TCAS. After the incident, both aircraft continued to their destination airport.

The standby service of the Federal Safety Investigation Authority Civil Aviation Transport Division was informed of the incident by Austro Control GmbH (ACG) Search and Rescue Center at 13:19 on 16 June 2017. In accordance with Article 5(1) of Regulation (EU) No 996/2010, a safety investigation into the serious incident was initiated.

In accordance with Art. 9 para. 2 of Regulation (EU) No. 996/2010, the states involved were informed of the serious incident:

State of manufacturer:	Canada, France
State of operator:	Austria

Remarks

Investigation progress

Since the interim report, which was published in June 2022, further surveys have been conducted in the course of the investigation and for the preparation of this report. These have resulted in new findings regarding the location of the incident. Accordingly, the incident did not occur over the territory of Lower Austria, but over Burgenland. Due to new findings, the time and altitude data in this report may also differ from those in the Interim Reports 2022 and 2023.

TCAS/ACAS

The Traffic Alert and Collision Avoidance System (TCAS) on board of aircraft is a specific implementation of the Airborne Collision Avoidance System (ACAS) concept. Since TCAS II, which was mandatory at the time of the incident, is the only implementation of the ACAS II concept to date, the terms TCAS and ACAS can be considered equivalents in this report.

1 Factual information

1.1 Events and history of the flights

The history of the flights and the course of the incident were reconstructed based on information and records of the air traffic control organs involved, the air navigation service provider involved, the flight crew members involved, the operator of the aircraft in conjunction with investigations of the Federal Safety Investigation Authority. This required among other things merging data recorded by the ATS[1] surveillance system of the air navigation service provider, data from the QAR[2] of the aircraft involved and radiotelephony recordings. It showed that the data partly had different time bases. Therefore the data were synchronised using common characteristics and referenced to the same time base. All times in this report refer to the system time of the ATS surveillance system used by the air navigation service provider in UTC.

Aircraft A, a Bombardier DHC-8-402, had departed from Prague Airport (LKPR) at 10:24 under instrument flight rules (IFR) and was on approach to Vienna Airport (LOWW). Originally, aircraft A was to approach runway 34 via the RNAV[3] instrument approach NERDU 4 N, but was guided into the left-hand downwind leg of runway 34 south of the airport to shorten the flight path. Aircraft A was planned to approach Runway 34 using the ILS[4].

Aircraft B, an Airbus A319-112, had departed from Vienna Airport at 10:54 on runway 29 under instrument flight rules and was cleared for the standard instrument departure SASAL 2 C south of the airport. The destination airport was Podgorica in Montenegro (LYPG).

At the time of the serious incident, the approach control unit with the call sign WIEN RADAR was responsible for providing air traffic control service in the terminal control area on

[1] Air Traffic Service
[2] Quick Access Recorder (data recorder; supplement to flight data recorder (FDR) with simplified access)
[3] Area Navigation
[4] Instrument Landing System

radiotelephone frequency 134.675 MHz. The approach control unit with the call sign WIEN DIRECTOR (119.800 MHz) was responsible for the final approach area of Runway 34.

In the following, the events are listed chronologically. Read back radio transmissions and conversations with other aircraft are not included in the event listing. A complete transcript of the radio communications is attached to this report.

For illustration purposes, the flight routes with the key events are shown in Figure 1 and the altitude profiles and distances between the aircraft are shown in Figure 2. The numbers in red, enclosed in square brackets, help to better understand the sequence of events. The dashed connections in Figure 1 in white illustrate the position of the other aircraft associated with the event.

At the beginning of the listing, aircraft A was already in contact with WIEN RADAR. Aircraft B was still on the ground.

10:50:00	Aircraft A is cleared to descend to 10 000 ft, in addition the local QNH[5] (1014 hPa) of Vienna airport (LOWW) is transmitted. The clearance had to be repeated by WIEN RADAR because aircraft A was not ready to hear.
10:53:35	Aircraft A is instructed to fly a speed of 220 kt IAS[6] and a clearance for further descent is announced in two minutes.
10:54:46	Aircraft A is cleared to descend to 8 000 ft.
10:56:00	Aircraft A is instructed to fly heading 145.
10:56:12	Initial call of aircraft B at WIEN RADAR coming from aerodrome control with the call sign WIEN TOWER. Aircraft B reports passing 4 000 ft with clearance for a climb to 5 000 ft. From this point on, both aircraft A and aircraft B were in contact with WIEN RADAR.
10:56:23 **[1]**	Aircraft B is cleared for a climb to 6 000 ft and instructed to maintain 6 000 ft thereafter due to other traffic.

[5] Altimeter sub-scale setting to obtain elevation when on ground in hPa
[6] Indicated Airspeed

10:56:36 [2]	Aircraft A is cleared for a descent to 7 000 ft.
10:57:13 [3]	Aircraft B requests heading 170 which is deviating from the cleared standard instrument departure route SASAL 2 C due to weather. This is subsequently cleared by WIEN RADAR. The deviating heading subsequently brought aircraft B closer to aircraft A, which was on the left-hand downwind leg of runway 34.
10:57:24 [4]	In order to guide aircraft A from the left- into the right-hand pattern of runway 34, a change of the heading from 145 to 090 is instructed by WIEN RADAR. The route change is instructed to the "right" and subsequently read back correctly by the flight crew. In order to guide aircraft A into the right-hand pattern of runway 34, an course change to the "left" would have been necessary, as also planned by air traffic control.
10:57:49 [5]	Aircraft A is handed over to WIEN DIRECTOR.
10:57:57 [6]	Aircraft B is cleared for a climb to flight level 230.
10:58:17 [7]	The flight crew of aircraft A reports a right turn to heading 090 at initial contact with WIEN DIRECTOR. The air traffic controller then asks the flight crew to confirm the right turn to the heading 090. From this point on, aircraft A was in contact with WIEN DIRECTOR and aircraft B was in contact with WIEN RADAR.
10:58:24 [8]	Aircraft B is instructed to stop the climb immediately: „Stop climb immediatly! “ At this time, the ATS surveillance system indicated an altitude of 6 400 ft (climbing) for Aircraft A and 7 100 ft for Aircraft B.
10:58:27	The onboard collision warning system TCAS of aircraft A issues a traffic advisory (TA).
10:58:28 [9]	Loss of separation between aircraft A and aircraft B. Separation according to ATS monitoring system: 2.9 nm horizontal and 500 ft vertical (Minimum separation: 3 nm horizontal and 1 000 ft vertical). The onboard collision warning system TCAS of aircraft B issues a traffic advisory (TA).

10:58:30	Essential traffic information from Wien DIRECTOR to aircraft A: "Traffic on your right wing, same altitude, climbing through your level". At this time, the ATS surceillance system indicates an altitude of 6 600 ft (climbing) for aircraft A and 7 100 ft for aircraft B.
10:58:32	The proximity warning system STCA[7]of the ATS surveillance system indicates the loss of separation. Distance between aircraft according to the ATS surveillance system: 2.6 nm horizontal and 200 ft vertical.
10:58:34	Essential traffic information from WIEN RADAR to aircraft B: "essential traffic, 12 o'clock, 2.3 nm crossing, left to right, miss-navigating, same altitude". At this time, the ATS surveillance system indicates an altitude of 6 800 ft (climbing) for aircraft A and an altitude of 7 000 ft for aircraft B.
10:58:37	Aircraft A reports aircraft B in sight.
10:58:38 [10]	Generation of TCAS resolution advisories (RA) for both aircraft. Aircraft separation according to ATS surveillance system: 2.3 nm horizontal and 0 ft vertical Aircraft A receives an resolution advisory to descend: „Descent, descent“ Aircraft B receives an resolution advisory to climb: „Climb, climb“
10:58:39	Aircraft A is cleared for descent to 6 000 ft.
10:58:42	Aircraft B reports the TCAS RA. No response to this message from WIEN RADAR.
10:58:43	Aircraft A reports the TCAS RA. No response to this message from WIEN DIRECTOR.
10:58:48 [11]	Minimum distance of aircraft according to the ATS surveillance system, which corresponds to a qualified loss of separation[8]: 1.2 nm horizontal and 300 ft vertical
10:58:53	Aircraft B receives the TCAS RA to stop the climb: „Level off, level off“

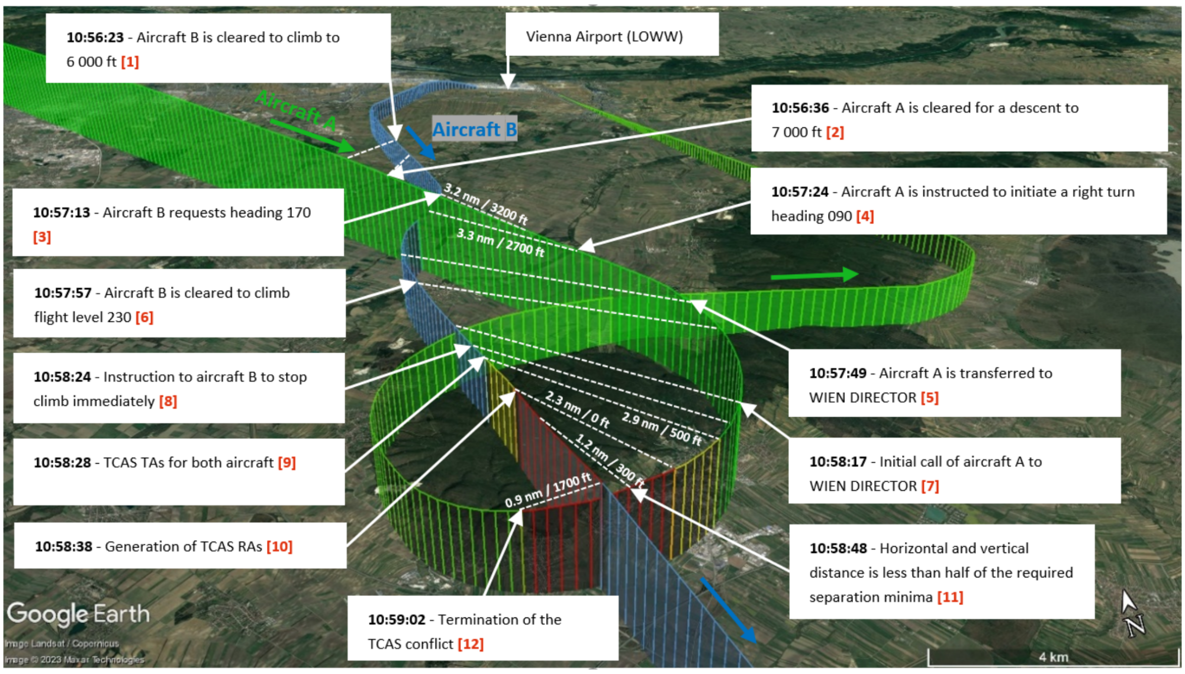
[7] Short Term Conflict Alert

[8] The separation minima (vertical and horizontal separation) specified for collision avoidance are lower than half the separation minima

10:59:02 [12]	The TCAS collision warning system indicates the resolution of the conflict situation to both aircraft with "clear of conflict". Distance of the aircraft according to the ATS surveillance system: 0.6 nm horizontal and 1 500 ft vertical.
10:59:14	Aircraft A reports the resolution of conflict situation and return to original clearance (descent to 6 000 ft and right turn).
10:59:24	Aircraft B is cleared to flight level 230.
10:59:28	Aircraft B reports the resolution of the conflict situation and confirms the clearance to climb to flight level 230. No response to this message from WIEN RADAR.
11:00:33	Aircraft B reports: „just for information, 2min ago we had a TCAS RA.“

Aircraft A continued the right turn and was subsequently guided to the final approach of runway 34 by means of a step descent and instructed headings and cleared for an ILS approach at 11:01:58. At 11:03:59, Aircraft A was transferred to aerodrome control with the call sign WIEN TOWER (123.800 MHz). Aircraft B continued the climb to flight level 230 on heading 170 and was transferred to area control BUDAPEST RADAR (133.200 MHz) at 11:01:42. The responsible controllers of WIEN RADAR and WIEN DIRECTOR were released from their working positions following the incident.

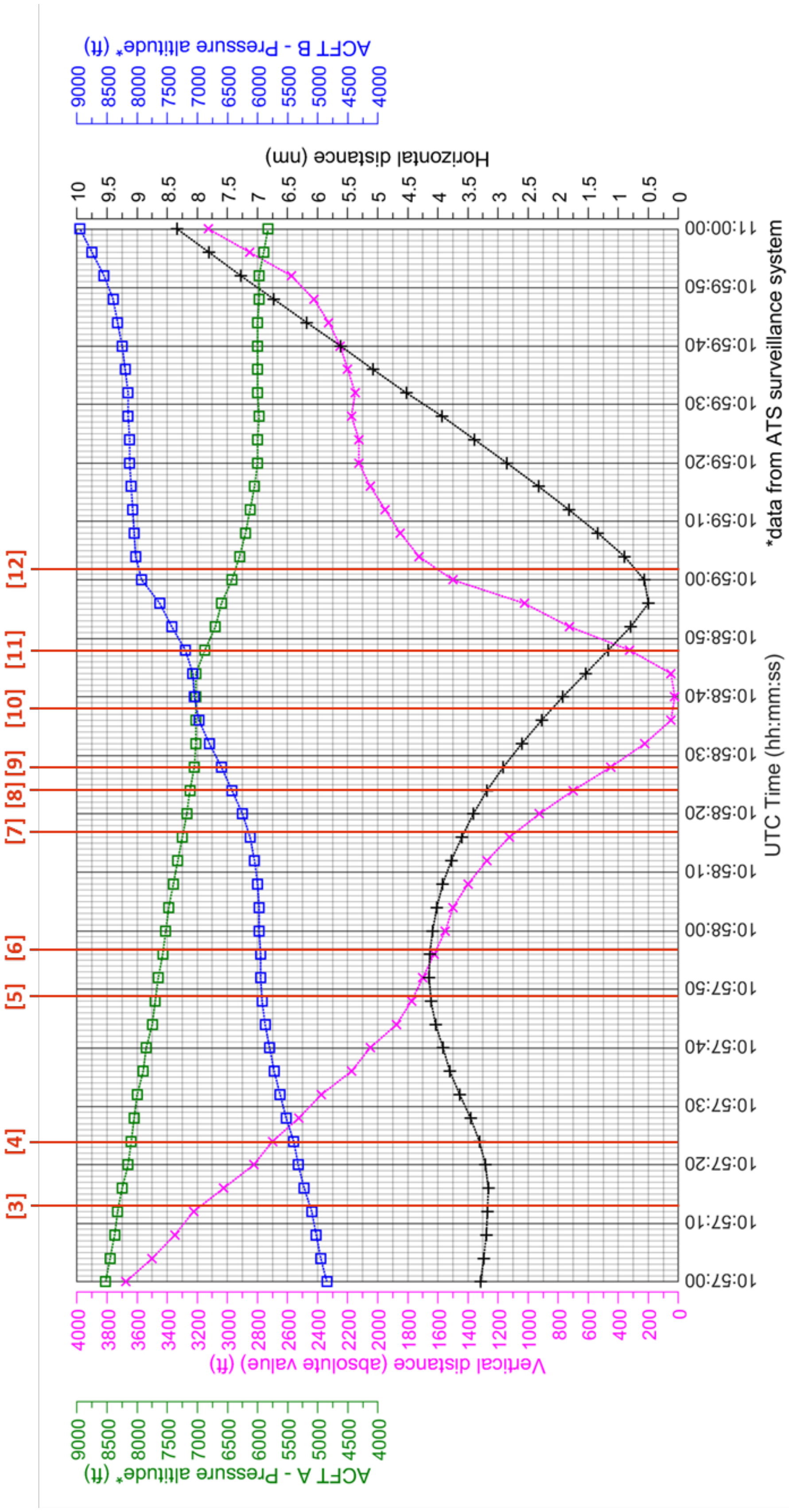
Figure 1: Flight path overview



Source: ANSP, aircraft operator; time data and layout: SUB
Figure created with Google Earth ©

The ATS surveillance system displays the traffic situation on the controllers' air situation display, which refreshes the positions and data of the aircraft every 4 seconds. The same basic data are available to all air traffic controllers of the approach control unit. The visualization of the distance between two aircraft is usually not displayed automatically. This has be done by manually selecting the aircraft symbols. The numerical values of horizontal distances between aircraft given in Figure 1 and in the event list correspond to the display of WIEN RADAR's air traffic controller. If no numerical value is available, no distance was displayed to the WIEN RADAR controller at that moment.

Figure 2: Horizontal and vertical distances over time



Source: ANSP; time data and layout: SUB

1.1.1 Flight preparation

The flight preparation required pursuant to Implementing Regulation (EU) No. 923/2012 Annex SERA.2010 lit. b, as amended, was performed for both flights. For each flight, the Federal Safety Investigation Authority was provided with an operational flight plan consisting of route and fuel planning, the technical aircraft log and the loadsheet.

1.2 Injuries to persons

Table 1: Injuries to persons aircraft A

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	2 cockpit + 2 cabin	55	

Table 2: Injuries to persons aircraft B

Injuries	Crew	Passengers	Others
Fatal	-	-	-
Serious	-	-	-
Minor	-	-	-
None	2 cockpit + 3 cabin	127	

1.3 Damage to aircraft

No damage was caused to the aircraft.

1.4 Other damage

No other damage occurred.

1.5 Flight crew aircraft A

Pilot flying (PF) of aircraft A was the copilot, the commander was pilot monitoring (PM).

The flight experience stated corresponds to the records of the airline and does not include any flight experience which may have been accumulated in addition to the professional activity for the airline.

1.5.1 Commander (PM)

Age:	39 years
Type of civil aviation licence:	ATPL(A)[9]
Authorizations:	Fixed-wing powered airplane
Model/type rating:	DHC8
Instrument rating:	DHC8(IR[10])
Instructor licence:	None
Other authorizations:	Language proficiency: german level 6, english level 4
Validity:	Valid on the day of the incident
Checks:	
Medical check:	Medical Class 1, valid on the day of the incident
Total flight experience	
(including serious incident flight):	approx. 9 679 hours
of which in the last 90 days:	approx. 140 hours
of which in the last 30 days:	approx. 47 hours
of which in the last 24 hours:	approx. 3 hours

[9] Airline Transport Pilot Licence, Aeroplane
[10] Instrument Rating

1.5.2 Copilot (PF)

Age:	28 years
Type of civil aviation licence:	MPL(A)[11], SEP[12] (land)
Authorizations:	Fixed-wing powered airplane
Model/type rating:	DHC8(COP[13])
Instrument rating:	DHC8(IR)
Instructor licence:	None
Other authorizations:	Night rating, Radiotelephony privileges in german and english, Language proficiency: german level 6, english level 4
Validity:	Valid on the day of the incident
Checks:	
Medical check:	Medical Class 1, valid on the day of the incident

Total flight experience			
(including serious incident flight):	approx.	231	hours
of which in the last 90 days:	approx.	109	hours
of which in the last 30 days:	approx	34	hours
of which in the last 24 hours:	approx	7	hours

The flight experience of the copilot of aircraft A can be attributed to the initial issue of the MPL(A) licence on 22 December 2016 (approximately 6 months prior to the serious incident).

[11] Multi-Crew Pilot Licence, Aeroplane
[12] Single Engine Piston (licence for pilots of single-engine, piston-powered aircraft)
[13] Copilot

1.6 Flight crew aircraft B

Pilot flying (PF) of aircraft B was the commander, the copilot was pilot monitoring (PM).

The flight experience stated corresponds to the records of the airline and does not include any flight experience which may have been accumulated in addition to the professional activity for the airline.

1.6.1 Commander (PF)

Age:	45 years
Type of civil aviation licence:	ATPL(A), SEP(land)
Authorizations:	Fixed-wing powered airplane
Model/type rating:	A320[14]
Instrument rating:	A320(IR)
Instructor licence:	TRI[15] A320
Other authorizations:	TRE[16] A320, Radiotelephony privileges in german and english, Language proficiency: german level 6, english level 6
Validity:	Valid on the day of the incident

Checks:

Medical check:	Medical Class 1, valid on the day of the incident

Total flight experience

(including serious incident flight):	approx.	15 072	hours
of which in the last 90 days:	approx.	156	hours
of which in the last 30 days:	approx.	54	hours
of which in the last 24 hours:	approx.	7	hours

[14] The licence entry "A320" covers all series of the A320 family (A318, A319, A320 und A321).

[15] Type Rating Instructor

[16] Type Rating Examiner

1.6.2 Copilot (PM)

Alter:	26 years
Type of civil aviation licence:	MPL(A)
Authorizations:	Fixed-wing powered airplane
Model/type rating:	A320[17](COP)
Instrument rating:	A320(IR)
Instructor licence:	None
Other authorizations:	Radiotelephony privileges in german and english, Language proficiency: english level 4,
Validity:	Valid on the day of the incident

Checks:	
Medical check:	Medical Class 1, valid on the day of the incident

Total flight experience (including serious incident flight):	approx.	586	hours
of which in the last 90 days:	approx.	138	hours
of which in the last 30 days:	approx.	40	hours
of which in the last 24 hours:	approx.	12	hours

1.7 Aircraft A

Aircraft type:	Powered aircraft
Manufacturer:	Bombardier Inc., Canada
Manufacturer designation:	DHC-8-402
Year of manufacture:	2005
Aircraft operator:	Austrian airline
Total operating hours:	24 713:36
Landings:	27 155
Engines:	Two propeller turboshaft engines
Manufacturer:	Pratt & Whitney, Canada
Manufacturer designation:	PW150A

[17] The licence entry "A320(COP)" covers all series of the A320 family (A318, A319, A320 und A321).

1.7.1 Aircraft documents

Certificate of registration:	Issued on 01 April 2015 by Austro Control GmbH
Airworthiness certificate:	Issued on 13 April 2007 by Austro Control GmbH
Airworthiness review certificate (ARC):	Issued on 04 June 2016, extended on 30 May 2017
Noise certificate:	Issued on 11 March 2011 by Austro Control GmbH
Insurance:	Valid on the day of the incident
Permit for an aircraft radio communication system:	Issued on 12 March 2015 by the telecommunications office for Vienna, Lower Austria and Burgenland

1.7.2 Aircraft loading and centre of gravity

The calculation of mass and centre of gravity was carried out by the operator in the course of flight preparation and handed over to the flight crew as a loadsheet. The flight crew has to check the loadsheet before departure and take into account any changes to the loading (LMC[18]) at short notice. Any changes have to be noted on the loadsheet.

The loadsheet of the flight concerned features a handwritten note "2 DAA[19]" for the last-minute changes. This means that two pieces of hand baggage are not carried in the cabin but in the cargo hold. The cargo hold is located in the rear area of the fuselage behind the passenger cabin.

The data of the loadsheet (without considering the position of the two pieces of hand luggage) are shown in Table 3 and Table 4. Since the limitating centre of gravity values were not noted on the submitted loadsheet, they were recalculated using the operations manual OM-B.

[18] Last Minute Changes
[19] Delivery at Aircraft

Table 3: Aircraft A masses

	Mass	Limit / Maximum
Zero Fuel Weight[20] (ZFW)	23 579 kg *51 983 lb*	25 855 kg *57 000 lb*
Take-Off Fuel[21] (TOF)	2 330 kg *5 137 lb*	-
Take-Off Weight[22] (TOW)	25 909 kg *62 371 lb*	28 998 kg *63 930 lb*
Trip Fuel[23] (TIF)	917 kg *2 022 lb*	-
Landing Weight[24] (LAW)	24 992 kg *55 098 lb*	28 009 kg *61 750 lb*

Source: Load sheet, AFM[25]

Table 4: Aircraft A centre of gravity

	Centre of gravity	MAC limits*		LI[26]	LI limits *	
	% MAC[27]	FWD	AFT		FWD	AFT
TOW (take-off)	22,7	17,3	34,0	44,75 *(LITOW)*	15,55	105,97
LAW (landing)	22,3	16,7	34,0	44,75 *(LILAW)*	15,48	105,76

Source: Load sheet, *calculations according to OM-B by SUB

The change in the centre of gravity due to the hand baggage in the rear hold corresponds to less than 2 LI or 0.4% MAC (assuming 10 kg per bag). Since the change is positive, the centre of gravity moves to the rear.

[20] Aircraft mass - DOM (Dry Operating Mass) plus payload, passengers and/or cargo but without fuel
[21] Fuel mass at take-off
[22] Aircraft mass at take-off
[23] Fuel mass used during the flight
[24] Aircraft mass at landing
[25] Aircraft/Airplane Flight Manual
[26] Loaded Index
[27] Mean Aerodynamic Chord

All values were within the approved operating limits throughout the flight, even taking into account the position of the hand baggage items in the rear cargo hold.

1.7.3 TCAS/ACAS Equipment

Aircraft A was equipped with ACAS II, version 7.1 in accordance with Regulation (EU) No 1332/2011 as amended.

1.8 Aircraft B

Aircraft type:	Powered aircraft
Manufacturer:	Airbus Industries, France
Manufacturer designation:	A319-112
Year of manufacture:	2005
Aircraft operator:	Austrian airline
Total operating hours:	32 179:09
Landings:	19 116
Engines:	Two turbofan engines
Manufacturer:	CFM International, France
Manufacturer designation:	CFM56-5B6/P

1.8.1 Aircraft documents

Certificate of registration:	Issued on 01 April 2015 by Austro Control GmbH
Airworthiness certificate:	Issued on 27 June 2008 by Austro Control GmbH
Airworthiness review certificate (ARC):	Issued on 16 September 2015, extended on 30.09.2016
Noise certificate:	Issued on 28 June 2013 von Austro Control GmbH
Insurance:	Valid on the day of the incident
Permit for an aircraft radio communication system:	Issued on 10 March 2015 by the telecommunications office for Vienna, Lower Austria and Burgenland

1.8.2 Aircraft loading and centre of gravity

The calculation of mass and centre of gravity was carried out by the operator in the course of flight preparation and handed over to the flight crew as a loadsheet. The flight crew has to check the loadsheet before departure and take into account any changes to the loading (LMC) at short notice. Any changes have to be noted on the loadsheet.

On the loadsheet of the flight concerned, there were no notes regarding last-minute changes to the load.

The data of the loadsheet are shown in Table 5 and Table 6. Since the limitating centre of gravity values were only noted for the zero fuel weight (ZFW) on the submitted loadsheet, the permissible values for the take-off mass (TOW) and the MAC limits for both masses were recalculated using the AHM[28].

Table 5: Aircraft B masses

	Mass	Limit / Maximum
Zero Fuel Weight (ZFW)	54 650 kg	57 000 kg
Take-Off Fuel (TOF)	7 900 kg	-
Take-Off Weight (TOW)	62 550 kg	68 000 kg
Trip Fuel (TIF)	2 820 kg	-
Landing Weight (LAW)	59 730 kg	61 000 kg

Source: Loadsheet, AHM

Table 6: Aircraft B centre of gravity

	Centre of gravity	MAC limits*		LI	LI limits	
	% MAC	FWD	AFT		FWD	AFT
TOW (take-off)	27,6	23,1	37,3	37,00 *(LITOW)*	25,10*	62,17*
ZFW	29,0	23,8	37,0	39,00 *(LILZFW)*	28,22	57,52

Source: Loadsheet, *calculations according to AHM by SUB

[28] Airport Handling Manual

All values were within the approved operating limits during the entire flight.

1.8.3 TCAS/ACAS Equipment

Aircraft B was equipped with ACAS II, version 7.1 in accordance with Regulation (EU) No 1332/2011 as amended.

1.9 Meteorological information[29]

1.9.1 Aviation weather outlook

Table 7: Aviation weather outlook

FXOS41 LOWW (translated from german)
FXOS41 LOWW 152200 AVIATION WEATHER OVERVIEW AUSTRIA, valid for the Danube region and the regions north of the Danube as well as the foothills of the Alps and the eastern edge of the Alps, issued on Friday, 16.06.2017 at 00:00 lct. Forecast until tomorrow morning. WEATHER SITUATION: The cold front over Austria, with an upstream zone of zone of instability, will move towards the Balkans by late afternoon. A stormy northwesterly flow of moderately humid cold air from the sea towards the Alps. WEATHER OUTLOOK: The day will start with passing, high reaching compact cloud fields and showers and thunderstorms. At the same time strong, partly stormy northwesterly winds. Continuing northern thunderstorms. In the course of the morning, the thunderstorms will move off to the east. Local showers will subside from noon onwards and in the afternoon, before becoming more dense again in the evening. Winds decrease somewhat during the night.

[29] For abbreviations to this section see list of abbreviations

FXOS41 LOWW (translated from german)
WIND AND TEMPERATURE IN THE FREE ATMOSPHERE for today 14:00 lct: 5000ft amsl 280/30kt 13 degrees C 10000ft amsl 290/30-40kt 2 degrees C zero degree limit: 11000ft amsl ADDITIONAL INFORMATION IFR: CB Tops FL350-400. Until noon high reaching icing over FL110. In the afternoon icing between 8000ft amsl and FL110 (main cloud top). Moderate turbulence at all altitudes.

Source: Austro Control GmbH aviation weather service

1.9.2 MET REPORT, METAR and TAF

Table 8: Weather report Vienna airport (LOWW)

MET REPORT LOWW
MET REPORT LOWW 161050Z: WIND RWY 11 TDZ VRB BTN 220/ AND 290/13KT RWY 16 TDZ 270/14KT RWY 29 TDZ 270/12KT RWY 34 TDZ 280/15KT VIS RWY 11 TDZ 35KM RWY 16 TDZ 35KM RWY 29 TDZ 35KM RWY 34 TDZ 35KM CLD RWY 11 FEW 4500FT FEW CB 5000FT RWY 16 FEW 4500FT FEW CB 5000FT RWY 29 FEW 4500FT FEW CB 5000FT RWY 34 FEW 4500FT FEW CB 5000FT T24 DP 15 QNH 1014HPA 2996INS QFE 992HPA QFE RWY 11 993HPA RWY 16 993HPA RWY 34 993HPA WXR OBS ISOL SIG ECHO 25NM N OF AD MOV E WKN AD TREND NOSIG=

Source: Austro Control GmbH aviation weather service

Table 9: Weather observation Vienna airport (METAR LOWW)

METAR LOWW
METAR LOWW 160950Z 27015KT 9999 FEW045 FEW050CB BKN300 24/16 Q1015 NOSIG
METAR LOWW 161020Z 28013KT 9999 FEW045 FEW050CB BKN150 24/16 Q1014 NOSIG
METAR LOWW 161050Z 27013KT 9999 FEW045 FEW050CB BKN150 24/15 Q1014 NOSIG
METAR LOWW 161120Z 26014KT 9999 FEW045 FEW050CB BKN150 24/15 Q1014 NOSIG

Source: Austro Control GmbH aviation weather service

Table 10: Weather forecast Vienna airport (TAF LOWW)

TAF LOWW
TAF LOWW 160515Z 1606/1712 28012KT 9999 FEW050 BKN180 TX25/1612Z TN15/1704Z TEMPO 1606/1610 30020G30KT 6000 SHRA BKN050 FEW055CB FM161100 29015G25KT CAVOK TEMPO 1612/1617 30020G35KT TEMPO 1622/1706 31012KT 9999 -SHRA BKN050=

Source: Austro Control GmbH aviation weather service

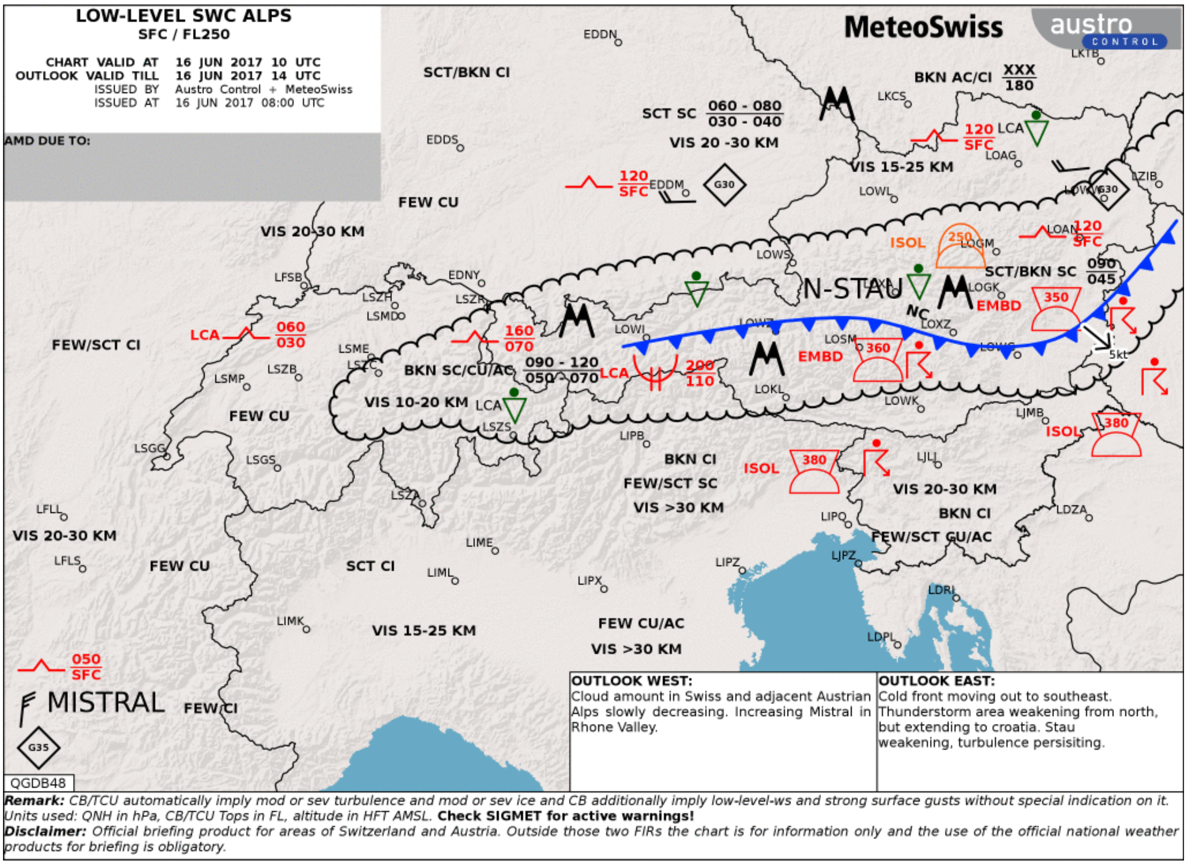
Table 11: Automatic weather observation Eisenstadt (weather station no.: 11190)

METAR 11190
METAR 11190 160930Z AUTO 29009G21KT 9999 FEW170 26/17
METAR 11190 161000Z AUTO 28009KT 9999 SCT200 25/16
METAR 11190 161030Z AUTO 27009G21KT 9999 BKN160 BKN190 25/15
METAR 11190 161100Z AUTO 27010KT 9999 BKN150 24/13

Source: Austro Control GmbH aviation weather service

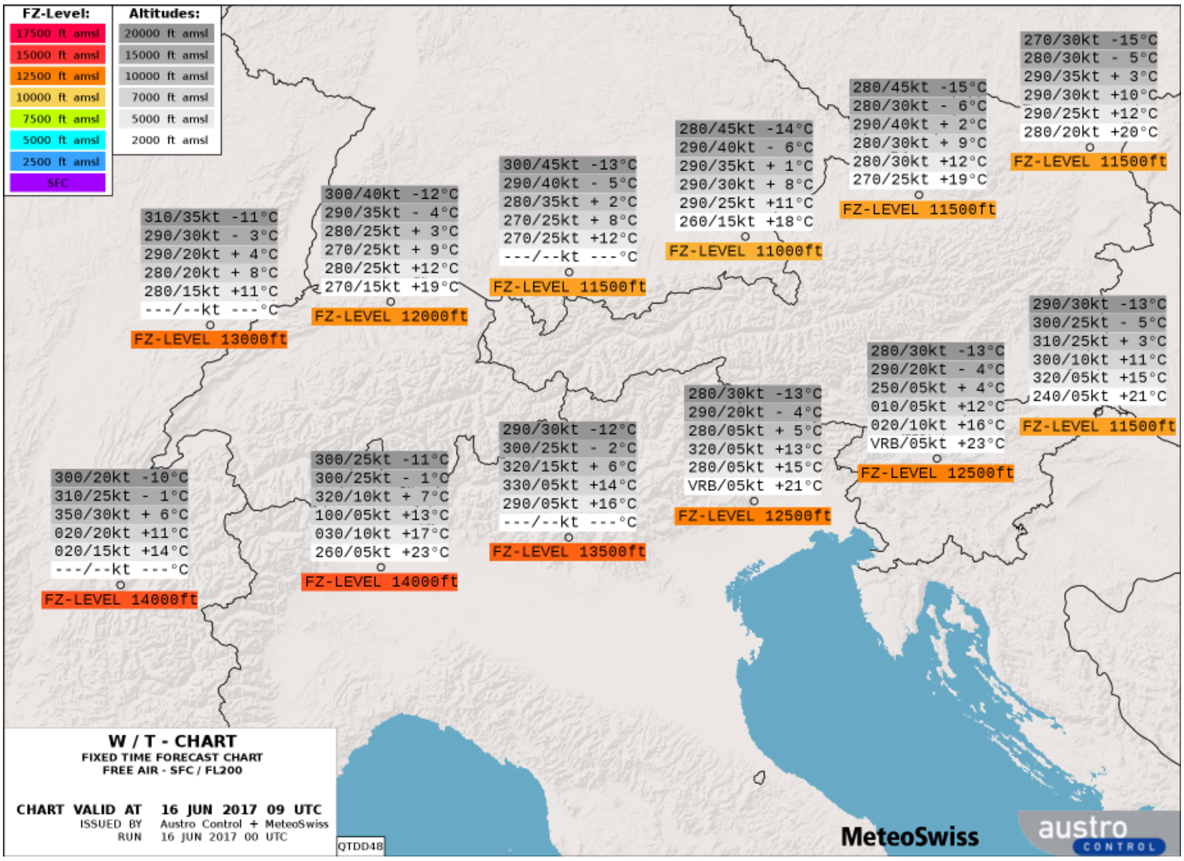
1.9.3 Weather charts

Figure 3: Low-level SWC ALPS valid at 16 June 2017 10:00



Source: Austro Control GmbH aviation weather service

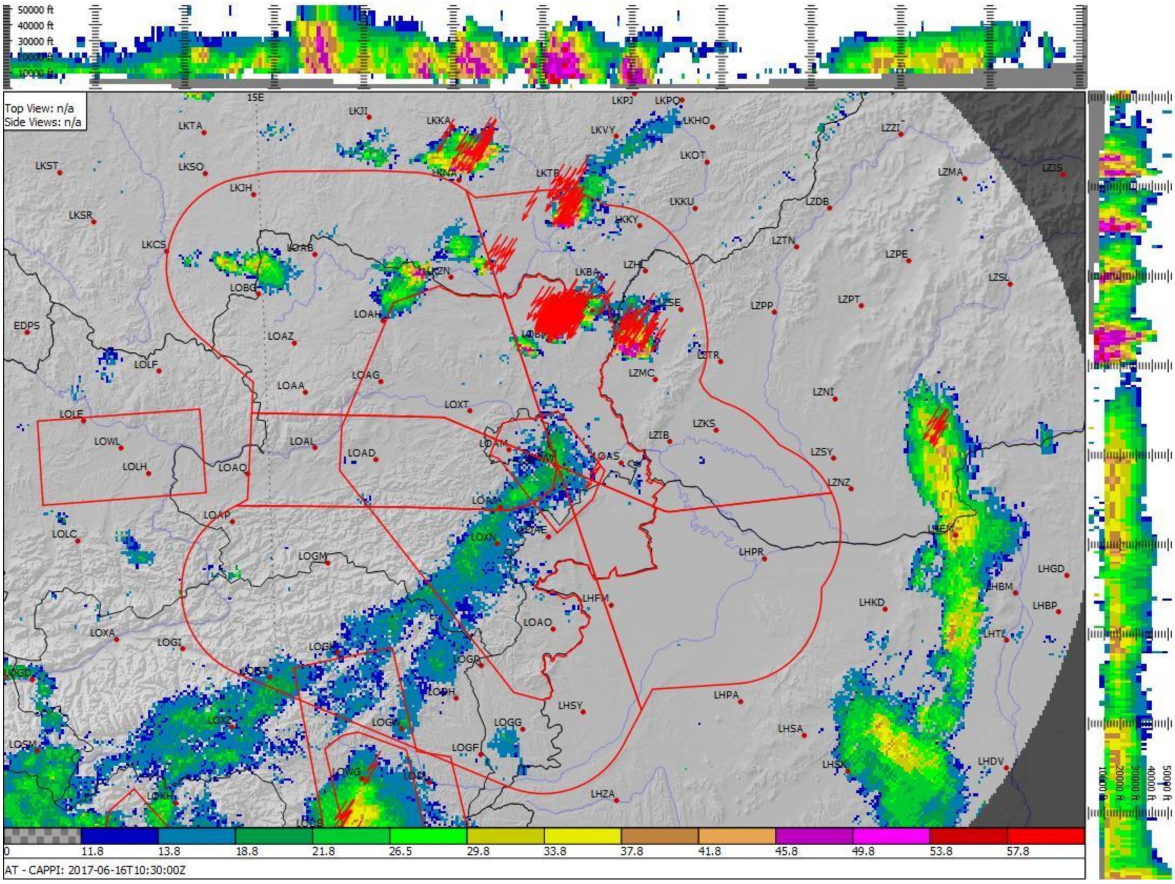
Figure 4: Wind and temperature forecast valid at 16 June 2017 09:00



Source: Austro Control GmbH aviation weather service

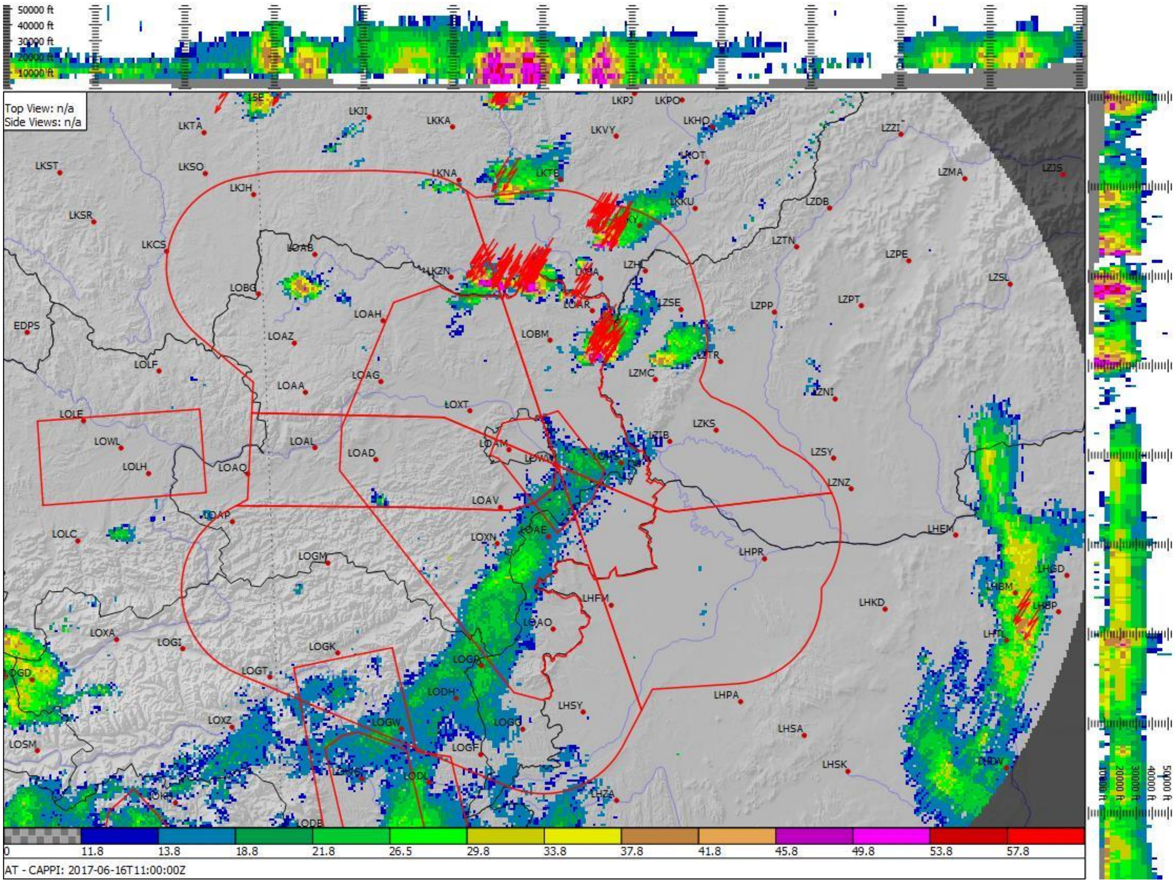
1.9.4 Weather radar

Figure 5: Weather radar image with lightning data ALDIS at 10:30



Source: Austro Control GmbH aviation weather service

Figure 6: Weather radar image with lightning data ALDIS at 11:00 Uhr



Source: Austro Control GmbH aviation weather service

1.9.5 Natural light conditions

The serious incident occurred at approximately 10:58 UTC (12:58 local time). At this time it was daylight.

1.10 Aids to navigation

Both flights were conducted according to instrument flight rules.

Aircraft A was originally to approach runway 34 via NERDU. NERDU is the last waypoint of the LANUX 6 W standard arrival route (STAR) indicated in the flight plan. Following this, the RNAV instrument approach (transition) NERDU 4 N was planned, which would have led the aircraft via the right-hand pattern to the final approach of runway 34.

A shortcut guided aircraft A towards the left-hand downwind leg of runway 34.

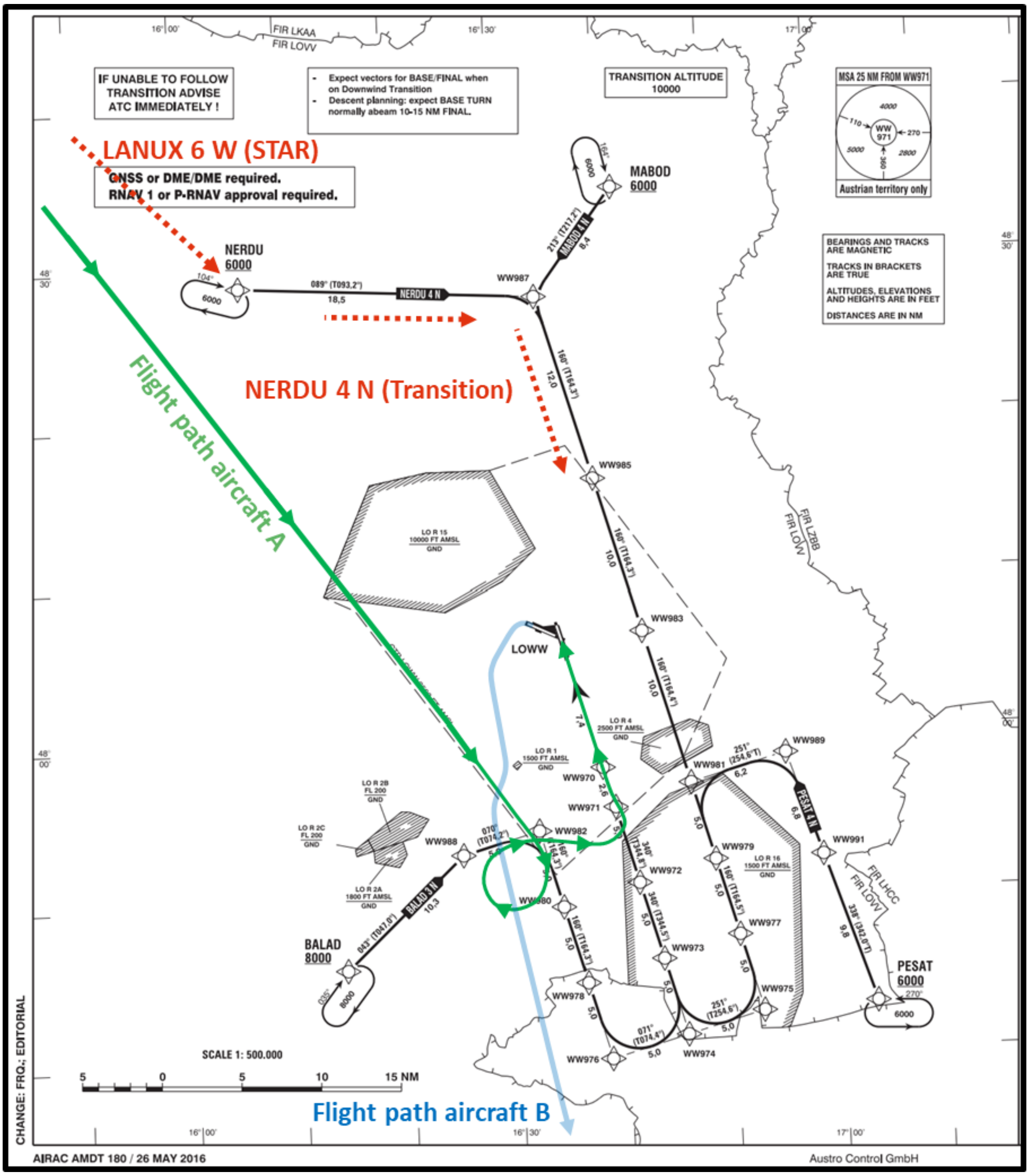
After loss of separation, aircraft A was guided to the final approach of runway 34, where it landed after an ILS approach.

The RNAV instrument approaches (transitions) of runway 34 published in the Aeronautical Information Publication (AIP) and the actual flight paths of both aircraft are shown in Figure 7.

Aircraft B followed the SASAL 2 C standard instrument departure (SID) after take-off. Between waypoints WW375 and WW370, aircraft B deviated from the departure route on cleared heading 170 due to weather conditions along the departure route. The heading was maintained until leaving the terminal control area.

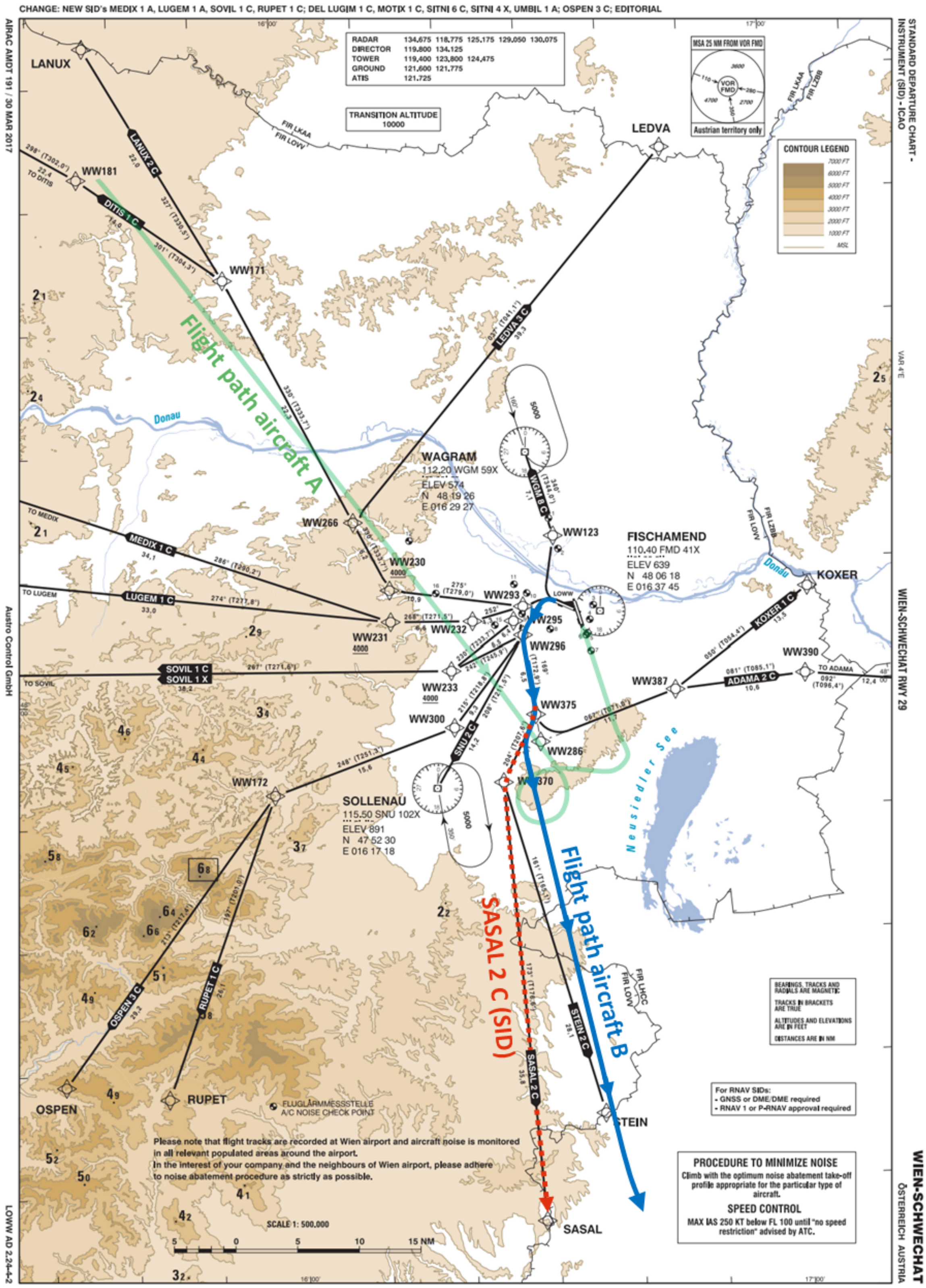
The published SIDs of runway 29, which were published in the AIP, and the flight paths of both aircraft are shown in Figure 8.

Figure 7: RNAV-Arrival chart, transitions to final runway 34



Source: AIP Austria (AIRAC AMDT 180 / 26 MAY 2016); editing: SUB

Figure 8: Standard departure chart (SID) runway 29



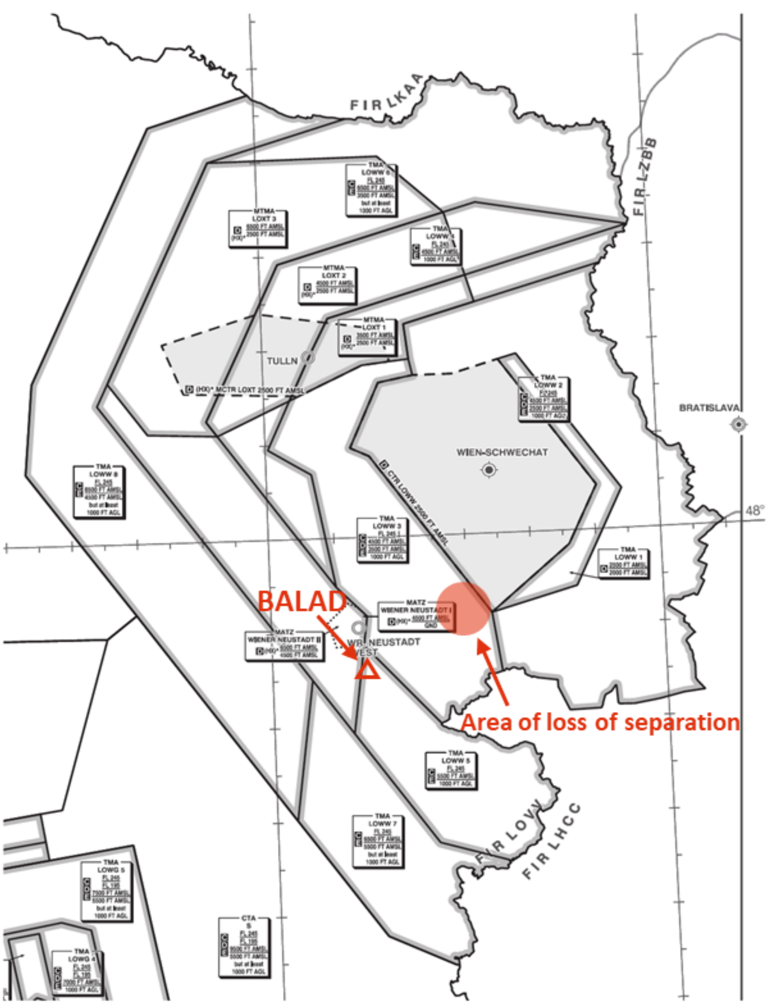
Source: AIP Austria (AIRAC AMDT 191 / 30 MAR 2017); editing: SUB

1.11 Air navigation services

1.11.1 General

At the time of loss of separation both aircraft were at approximately 7 000 ft in the terminal control area TMA LOWW 3 and thus in Class C airspace (see Figure 9).

Figure 9: TMAs LOWW



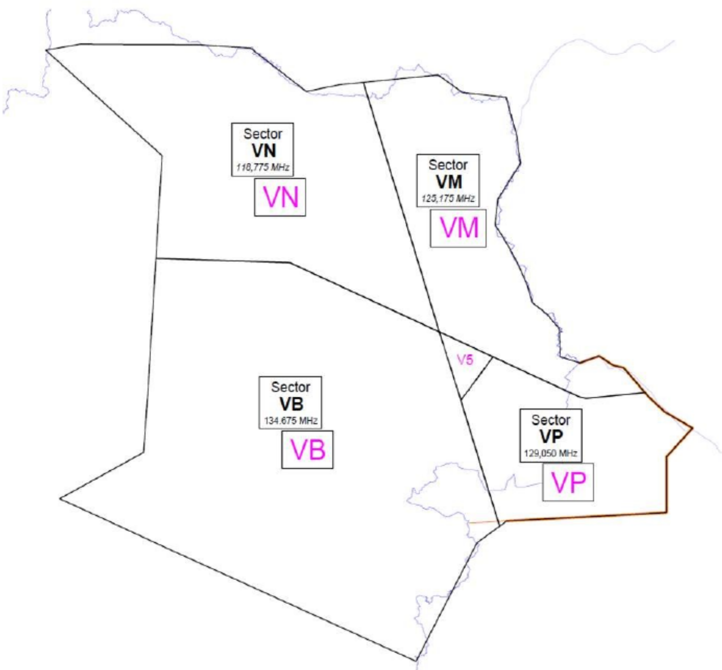
Source: ANSP (effective date: 14.06.2017); editing: SUB

In Class C airspace, flights may be operated under instrument and visual flight rules (VFR). Air traffic control service is provided for all flights and separation of IFR flights from other IFR and VFR flights is ensured. The clearances issued by ATC shall ensure separation between IFR flights, which shall be in accordance with the separation minima established for use within the airspace. These minima require a vertical separation of at least 1 000 ft or a horizontal separation of at least 3 nm within the TMAs.

1.11.2 Approach sectors

The responsible area of approach control of Vienna Airport consists of five sectors. These sectors can be combined in different ways depending on the runway operational configuration and traffic load. Figure 10 shows the lateral boundaries of the sectors. In principle, the four sectors VB (BALAD), VN (NERDU), VM (MABOD) and VP (PESAT) each have a radio frequency with the call sign WIEN RADAR. Sector V5 is assigned to the other sectors depending on the combination. When combining the sectors, the radiotelephony frequencies are coupled.

Figure 10: Approach sectors



Source: ANSP (effective date: 14.06.2017)

The working positions of air traffic controllers consist of a large screen (air situation display with data of the ATS surveillance system) and other screens on which, for example, weather radar, surface movement radar of Vienna Airport and other information required can be displayed. Each working position is equipped with a radio device for communication with aircraft and further equipment for communication with other working positions or ATS units via dedicated lines.

In the operations room of the approach control unit there are two working positions per sector (VB, VN, VM or VP), one position for the planning controller (PLC) and one for the executing radar controller (EC)

In order to guide the aircraft onto the final approach, a radiotelephony frequency with the call sign WIEN DIRECTOR has been set up for each of the runways 11/29 and 16/34. This task is performed by a radar controller (FC[30]) from a separate working position.

The supervisor on duty (SUP) is responsible for the management of the control sectors. For the decision to open or close a sector, the traffic load and other relevant factors are taken into account. In order to analyse the traffic load for sector planning, a "Collaboration Human Machine Interface" (CHMI) based on the predicted traffic load is used.

On the day of the incident the approach control was understaffed. At the time of loss of separation, all sectors were combined into one, for which a radar controller (EC) with the call sign WIEN RADAR was responsible. He was supported by a planning controller (PLC). In addition, a radar controller (FC) was responsible for the final approach of runway 34 on the radiotelephony frequency 119.800 MHz with the call sign WIEN DIRECTOR. This corresponded to the standard occupation at noon. The working position of the radar controller (EC) was located in the operations room between the working positions of the planning controller (PLC) and the radar controller (FC).

According to the supervisor on duty at the time of the incident, the opening of an additional sector was not necessary from his point of view before the incident. The relevant parameters of the CHMI were within the limits and the prevailing weather was taken into account. However, the necessary personnel would have been available to open an additional sector.

According to feedback from supervisors, the available CHMI is not sufficient for detailed traffic planning, because it only takes predicted traffic load into account and does not consider other parameters e.g. sector complexity, traffic mix and weather.

[30] Feeder Controller (radar controller for the final approach area)

1.11.3 Traffic and frequency load

This section describes the situation on the frequency of WIEN RADAR shortly before loss of separation.

At the time of the incident and prior to it, arrivals and departures were conducted at Vienna Airport in accordance with instrument flight rules. Departures were mainly from runway 29 to the south-western part of the TMA, which crossed the flight paths of aircraft approaching runway 34 in the BALAD area. Furthermore, there also was a flight to land at the Wr. Neustadt/Ost (LOAN) airport, which cancelled the flight in accordance with procedures under instrument flight rules in order to perform the landing under visual flight conditions (VMC[31]).

Due to the prevailing weather situation in the north of the TMA and in the area south-west of Vienna Airport, there were several weather-related deviations from the planned approach and departure routes.

In some cases, radio transmissions from WIEN RADAR had to be repeated because some transmissions were overheard by the flight crews or blocked out.

These factors led to an increase in frequency load from about 10 minutes before loss of separation. Figure 11 shows the frequency load of WIEN RADAR from 10:48 to 11:00. Conversation in this context means several radio transmissions in a conversation with an aircraft.

The responsible radar controller (EC) instructed some of the incoming aircraft upon initial call that no reports were necessary (just turn without asking for permission for weather avoidance). This is a common procedure to reduce frequency load upon initial contact in hight workload phases.

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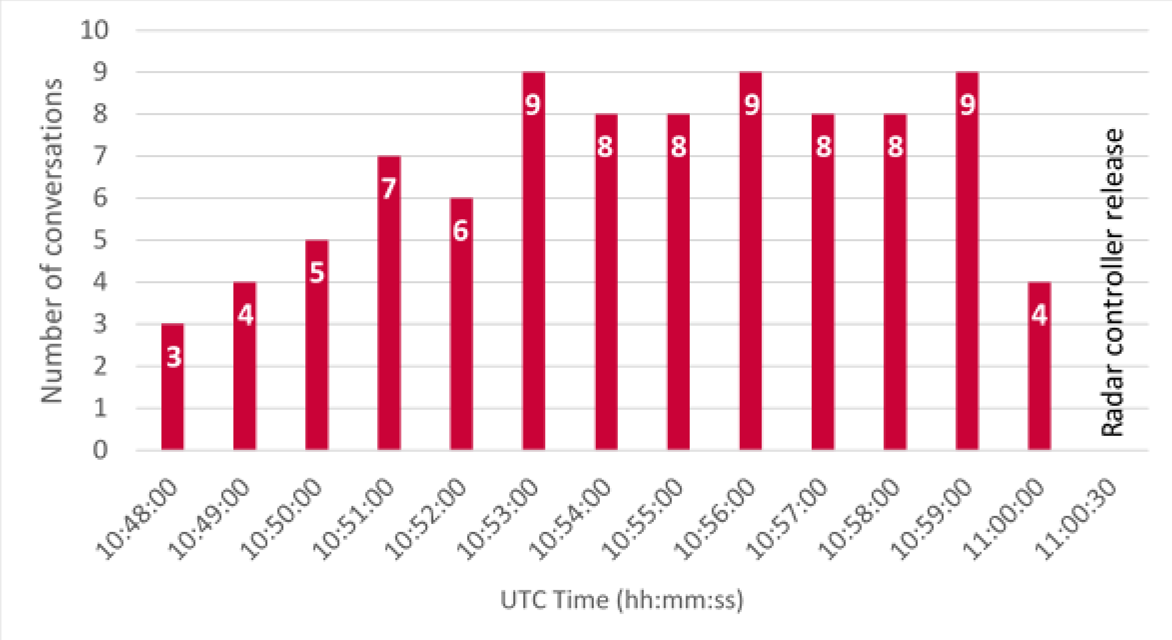
[31] Visual Meteorological Conditions

Figure 11: Frequency load WIEN RADAR



Source: ANSP; editing: SUB

1.11.4 ANSP personnel information

Based on the facts, the data of the responsible radar controller (EC) of WIEN RADAR were requested:

Radar controler (EC) WIEN RADAR

Age:	32 years
Rating/Endorsement:	APS[32]/TCL[33]
Unit Endorsement:	AEXE[34], APLC[35]
Validity:	Valid on the day of the incident
Checks:	
Medical check:	Valid on the day of the incident

The air traffic controller had been working for the air navigation service provider as an approach controller since 2010 (issue of the unit endorsements).

Working and rest times

The radar controller (EC) commenced the shift at 04:30 UTC (06:30 local time) on 16 June 2017. The separation minimum infringement occurred in his sixth run, approximately 30 minutes after he had resumed work following a 60-minute rest period.

Withing the 14 days before the incident, the controller had been on duty for 88.5 hours. He had eight working days in a row (including two days of unscheduled extra overtime), one day off and then two more working days. The incident occurred on the last working day.

Prior to the incident, between two days (10 June 2017 / 11 June 2017), the minimum rest period according to working time act (AZG[36]) of eleven hours between shifts was not adhered and was reduced to nine hours. The rest period can, as in this case, be reduced to eight hours under certain conditions with the consent of the controller in accordance with

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[32] Approach Control Surveillance

[33] Terminal Control (competence to provide air traffic control services with the use of any surveillance equipment to aircraft operating in a specified terminal area and/or adjacent sectors)

[34] Competence to provide the duties of a radar controller (EC) at approach control Vienna

[35] Competence to provide the duties of a planning controller (PLC) at approach control Vienna

[36] Arbeitszeitgesetz

the collective agreement. Due to increased sick leave, it was not possible to find a suitable replacement in this specific case without to reduce the daily rest period for a controller.

Statements after the incident

The following information was provided by the radar controller (EC) in the course of an incident investigation in accordance with the SMS[37] of the air navigation service provider:

- He felt fit and rested at the beginning of the working day.
- Traffic-load, workload and traffic complexity increased slowly after he started the working session.
- At the beginning of the working session he felt well organized
- Short before the incident he felt overloaded, because he was no longer ahead of the upcoming situations.
- He was well supported by his planner (PLC). However, it was difficult for the PLC to submit some information to him due to the high workload.
- Heading 170 led aircraft B closer to aircraft A. The plan was to take aircraft A into the right-hand pattern of runway 34 in order to establish enough spacing to clear the aircraft for further climb and descent.
- He probably mixed up "right" with "left" and had misspoken, because he had in his mind to clear aircraft A to the “right” hand pattern
- He was asked by the radar controller (FC) for the intentions of aircraft A. He then instructed aircraft A to stop the climb immediately and issued aircraft A an essential traffic information. Aircraft A reported a TCAS RA.
- He was well assisted by the radar controller (FC). After the incident, FC informed him that aircraft A was conflicting with another aircraft C, which had taken off from Vienna Airport and was on the radio frequency of WIEN RADAR. Aircraft C was instructed to fly heading 240.

[37] Safety Management System

1.12 Aerodrome information[38]

Location:	9 nm southeast of Vienna
ICAO / IATA identifier:	LOWW / VIE
ARP (Aerodrome Reference Point):	48°06'37"N 016°34'11"E
Aerodrome elevation above MSL:	183 m / 600 ft
Runways:	11/29 - 3500 m x 45 m bitumen
	16/34 - 3600 m x 45 m bitumen

Instrument approach procedures:

- Runway 11: ILS CAT I / LOC-DME, RNAV (GNSS)
- Runway 16: ILS CAT I / LOC-DME, ILS CAT II/IIIb, RNAV (GNSS), VOR
- Runway 29: ILS CAT I / LOC-DME, ILS CAT II/IIIb, RNAV (GNSS)
- Runway 34: ILS CAT I / LOC-DME, RNAV (GNSS), VOR

At the time of the incident, runway 29 was in operation for take-offs and runway 34 for landings.

1.13 Flight recorder and other records

1.13.1 Quick access recorder

Flight data recorders (FDR) were prescribed, installed and functional. Quick access recorders were also on board for maintenance tasks and for the purpose of flight data monitoring (FDM[39]). QARs provide the same parameters and data as FDRs. The QARs were read out by the operator. Based on the data read out, a video animation was created by the operator from the perspective of the aircraft B cockpit. The QAR data and video animation requested by the Federal Safety Investigation Authority were provided by the operator. The QAR data are available from both aircraft for the entire flight (from take-off to landing) and are illustrated in the Annex.

[38] For abbreviations to this section see list of abbreviations

[39] Procedure for collecting and analyzing FDM/QAR data

1.13.2 Cockpit voice recorder

Cockpit voice recorders (CVR) were prescribed and installed. No recordings were requested from the Federal Safety Investigation Authority.

1.13.3 Radiotelephony records

In the course of the incident investigation by the air navigation service provider, the routinely created radiotelephony recordings of the WIEN RADAR and WIEN DIRECTOR working positions were secured and transcribed. An employee of the Federal Safety Investigation Authority listened to the voice radiotelephony recordings once. The transcripts are available to the Federal Safety Investigation Authority and are attached to this report.

1.13.4 Radar data

The radar data requested by the Federal Safety Investigation Authority was provided by the air navigation service provider in the already processed form of the ATS surveillance system for both aircraft. Time in UTC, position (coordinates) and altitude (transmitted pressure altitude of Mode S transponder in 25 ft resolution) were provided. For aircraft A, data are available from 10:50:00 to 11:07:11 and for aircraft B from 10:54:28 to 11:09:59. The recording interval is approximately 4 seconds. At the time of incident, both aircraft were recorded with a max. time difference of 0.2 seconds to each other.

1.13.5 Passive plots

The presentation of the ATS surveillance system data on the air situation display of the working positions of the controllers were recorded at two-second intervals. These "screenshots" record what was displayed on the screens at that specific moment. This also includes any manipulations made by the operator, such as measuring the distance between two aircraft.

These so-called "passive plots" were secured by the air navigation service provider for the working position of the WIEN RADAR radar controller (EC) and made available to the Federal Safety Investigation Authority upon request. The submitted plots cover the period from 10:53:58 to 11:01:58.

1.14 Medical and pathological information

There are no indications of any pre-existing mental or physical impairment of the flight crews and air traffic controllers.

1.15 Organisations and procedures

1.15.1 Air navigation service provider

Procedures

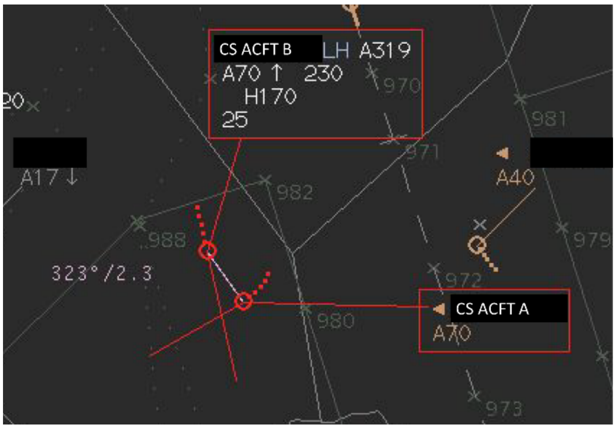
Procedures regarding TCAS/ACAS are prescribed by the regulations listed in section 1.16.2.

If the distance between two aircraft is below the applicable separation minimum or if it is expected that the separation minimum will be infringed, the controller shall issue essential traffic information to each of the aircraft involved in accordance with ICAO Doc 4444, Chapter 5, 5.10. Such traffic information does not relieve the controller from issuing any other information at its disposal with a view to enhancing air safety.

Air traffic controllers are supported by the ground-based automated warning system STCA. It is based on radar data and integrated into the ATS surveillance system. The objective of the STCA function is to assist controllers in preventing collision between aircraft by generating an alert of a potential or actual infringement of separation minima. On the air situation display, the alert is represented by red symbols and red bordered labels[40] (see Figure 12).

[40] Aircraft data window displayed on the ATS surveillance system screen.

Figure 12: STCA alert visualization



Source: ANSP; editing: SUB

If an STCA warning is generated, the controller shall, in accordance with ICAO Doc 4444, Chapter 5, 15.7.2, assess the situation and take action as necessary to ensure that the applicable separation minimum will not be infringed or will be restored.

“When a pilot reports an ACAS RA, the controller shall not attempt to modify the aircraft flight path until the pilot reports ‘CLEAR OF CONFLICT’. […]

“Once an aircraft departs from its ATC clearance or instruction in compliance with an RA, or a pilot reports an RA, the controller ceases to be responsible for providing separation between that aircraft and any other aircraft affected as a direct consequence of the manoeuvre induced by the RA.” (SERA.11014)

TCAS serves as final safety net to prevent a collision between aircraft. For a more detailed description of TCAS/ACAS, see Section 1.16.

In addition to the theoretical and practical basic training, air traffic controllers have regular refresher trainings in the simulator. Controllers who work at approach control are also trained and briefed on TCAS/ACAS procedures during simulator trainings. The training content is based on Chapter 6 of ICAO Doc 9863 (Recommended Content of Controller Training Programmes).

Investigation, results and actions

The incident was investigated in accordance with the SMS of the air navigation service provider. The radiotelephony recordings and passive plots already mentioned in this report were used for the investigation. In addition, the air traffic controllers involved were interviewed.

The final report of the investigation is available to the Federal Safety Investigation Authority and is summarised as follows:

„

- *At the time of the incident all sectors were combined at Vienna approach and additionally FEE[41] and PLC sectors were opened*
- *Responsible supervisor did not open a second sector, because the CHMI charts did not show the need for an additional sector*
- *Some aircraft unexpectedly requested deviation headings to avoid weather and some aircraft did not maintain continuous listening watch to controller's (EC) instructions and some transmissions were blocked out; therefore EC had to transmit clearances twice*
- *High frequency load and workload increased significantly during short period of time*
- [CS[42] ACFT[43] A] *was announced to arrive via NERDU but was taken into a left hand pattern for runway 34 and was a conflicting traffic for departure* [CS ACFT B]
- *EC was overloaded short before incident due to complexity of traffic situation and high frequency load*
- *Due to requested deviation heading (170) of* [CS ACFT B]*, EC planned to clear* [CS ACFT A] *for right hand pattern in order to enable both aircraft a further descent/climb instruction*
- *EC confused "right" with "left" and instructed* [CS ACFT A] *to turn "right heading 090" instead of "left heading 090", because he felt overloaded at that time*
- [CS ACFT A] *was sent to feeder and informed on initial call that they were in a right turn heading 090*
- *Essential traffic information were issued and pilots reported TCAS RA*
- *Closest approximation was recorded with 1.2NM and 300ft"*

[41] Feeder (corresponds to the working position of the FC)

[42] Call Sign

[43] Aircraft

The following recommendation was issued:

„ATM: Awareness – increased sector and frequency load

It is recommended to raise awareness for the possibility of increased sector and frequency load and to remind staff about relevant opportunities to manage these situation (e.g. sector opening, adopt working style accordingly etc.).“

The following measures were taken after the incident:

- Approach staff was advised by email of possible frequency overload at noon.
- An additional sector has been opened by SUPs around the noon time since the incident.

Event assessment

The event was classified as "Major Incident - B" according to ESARR[44] 2.[45] The ESARR 2 classification table is shown in Figure 13.

The risk was assessed using the "RAT methodology" (Risk Analysis Tool Methodology) as follows:

- ATM[46] overall severity score: B2
- ATM ground severity score: B2

[44] European Safety Regulatory Requirements
[45] See addition in section 1.19
[46] Air Traffic Management

Figure 13: Classification table according to ESARR 2

SEVERITY	EXAMPLES of Occurrences
Accident	**ICAO Annex 13:** - "Mid air Collision between aircraft or between aircraft and other objects - Collision with the ground including Controlled Flight Into Terrain or Collision on the ground, between aircraft or between aircraft and other objects".
Serious Incident (A)	**ICAO Doc 4444**: **Airprox - Risk Of Collision**: "The risk classification of an aircraft proximity in which serious risk of collision has existed". Critical near collision between aircraft or between aircraft and obstacle(s). Separations lower than half the separation minima (e.g., 2NM). **ICAO Annex 13/Attachment D**: - "Near Collisions requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or when an avoidance action would have been appropriate - Controlled Flight Into Terrain only marginally avoided - Aborted take-offs on a closed or engaged runway/Take-offs from a closed or engaged runway with marginal separation from obstacles/Landings or attempted landings on a closed or engaged runway/take off or landing incidents, such as under-shootings, overrunning or running off the runway".
Major Incident (B)	**ICAO Doc 4444**: **Airprox- Safety Not Assured**: "The risk classification of an aircraft proximity in which the safety of the aircraft may have been compromised". Loss of separation (separation higher that half the separation minima/e.g., 4NM) which is not fully under ATC control. Safety margins not respected (higher than half the applicable safety margins) which is not fully under ATC control. A Crew avoidance manoeuvre and/or an ATC instruction allowed to reduce the risk, without eliminating it, as safety margins were still infringed.
Significant Incident (C)	**ICAO Doc 4444-Airprox- No risk Of Collision**: "The risk classification of an aircraft proximity in which no risk of Collision has existed". After visual contact between two aircraft, no avoidance manoeuvre was seen as necessary or was carried out within safety margins. Aircraft deviation from ATC clearance (such as flight level, route, heading, runway), Unauthorised penetration of airspace, Runway incursion with no other traffic in the vicinity (hence, where no avoiding action was necessary).
No safety effect (E)	Occurrences which have no safety significance.
Not determined (D)	**ICAO Doc 4444-Airprox- Risk Not determined**- "The risk Classification of an aircraft proximity in which insufficient information was available to determine the risk involved or inconclusive or conflicting evidence precluded such determination".

Source: ESARR 2 GUIDANCE TO ATM SAFETY REGULATORS, Edition 1.0, 12.11.1999[47]

The "RAT methodology" is a risk analysis methodology developed by the European Organisation for the Safety of Air Navigation (Eurocontrol) for the classification of ATM safety events.

"ATM ground severity score" means the part of the RAT methodology that assesses the system performance (procedures, equipment and human) of the ATM system.

[47] https://skybrary.aero/sites/default/files/bookshelf/278.pdf, retrieved on 17.02.2023

“ATM overall severity score” means the ATM ground severity score and ATM airborne severity score combined into one single score, whereas the “ATM airborne severity score“assesses operation performance of the occurrence. The classification matrix for the RAT methodology is shown in Figure 14.

Figure 14: Risk classification scheme for operational occurrences

>= 32	very frequent	1	A1	B1	C1	E1	D1
24 to 31	frequent	2	A2	B2	C2	E2	D2
17 to 23	occasional	3	A3	B3	C3	E3	D3
11 to 16	rare	4	A4	B4	C4	E4	D4
0 to 10	extremely rare	5	A5	B5	C5	E5	D5
			A	B	C	E	D
			serious	major	significant	No safety effect	no determined
			>= 31	30 to 18	17 to 10	9 to 0	RF too low

Source: Risk Analysis Tool – RAT, Guidance Material, Version 2.0 - 04/12/2015[48]

1.15.2 Aircraft operator

TCAS/ACAS Procedures

Procedures regarding TCAS/ACAS are prescribed by the regulations listed in section 1.16.2. The operating procedures required by AUR.ACAS.1010 have to be be established by the operator in an operations manual (OM). Part A (OM-A) of the operations manual contains the non-type related procedures and Part B (OM-B) those procedures that are to be applied for the respective aircraft type. Part D (OM-D) also contains the flight crew training programmes, which shall also be established in accordance with AUR.ACAS.1010.

[48] https://www.skybrary.aero/sites/default/files/bookshelf/3276.pdf, retrieved on 17.02.2023

The relevant TCAS/ACAS procedures according to the OM-B of the operator of the aircraft types involved are shown in Figures 15 to 17. These procedures contain "memory items", which pilots have to process by heart in time-critical situations.

According to OM-D (Revision 22, 01.12.2016) of the operator for TCAS/ACAS training:

„[…]

2.1.17 TCAS/ACAS Training

Procedures for the proper response to TCAS alerts shall be trained and checked during initial ground and simulator training subsequently during recurrent flight simulator training and/or checking once every year.

To underline the LOFT[49] characteristic of simulator sessions, flight instructors are encouraged to create additional traffic scenarios during all kinds of simulator sessions whenever deemed feasible. […]*"*

The IOSA[50] Standards Manual[51], which is published by IATA, prescribes a period of 36 months.

[49] Line Oriented Flight Training

[50] IATA Operational Safety Audit

[51] IOSA Standards Manual Edition 16

Figure 15: TA procedure DHC-8-402

3.10.2 FLIGHT PROCEDURES

3.10.2.1 Traffic Advisory (TA)

Manoeuvres based on TAs (Traffic Advisories) are not recommended.

PF	PM
"TRAFFIC, TRAFFIC" aural alert	
• Both pilots check that TCAS is in TA/RA mode (indicated on PFD/MFD, to assure that RA is possible if required). • If TA/RA is not indicated: **"RA not possible"**. When operated in TA-only mode, collision avoidance is still maintained by the TCAS II of the other aeroplane, both pilots look out for other traffic.	
• is ready to take over controls manually and react to possible RA • looks out for traffic and calls out visual contact • no avoiding action based on TA information only	• checks intruders data tag • looks out for traffic and calls out visual contact

Note: Aeroplanes without an altitude - encoding (mode C/S) transponder will not generate a resolution advisory. Proper look-out for such traffic is essential in case of TA.

Source: OM-B of the aircraft operator (DASH 8/402 - Rev.38, 17.04.2017)

Figure 16: RA procedure DHC-8-402

3.10.2.2 Resolution Advisory (RA)

PF	PM
in case of RA	
• disengages autopilot • changes pitch/power smoothly to establish a VS within the green arc as directed on the IVSI/TCAS indicator • keeps out of red arc on IVSI/TCAS indicator • monitors IAS and aeroplane speed limits • respects Stall or GPWS warning	• monitors the IVSI/ TCAS indicator and VS • monitors IAS and aeroplane speed limits • advises PF when deviating from TCAS commanded VS and/or when IAS is exceeding limits • looks out for intruder and other traffic • notifies ATC: **"TCAS RA"** • if an ATC clearance contradictory to the ACAS RA is received: **"UNABLE, TCAS RA"**
additional corrective RA issued	
• smoothly manoeuvres to establish new target VS rate, avoiding exceedance of load limits (especially when changing from climb to descent – consider using MAX RPM to increase drag)	
"CLEAR OF CONFLICT"	
• manually returns to ATC clearance as soon as possible • engages AP	• notifies ATC: **"CLEAR OF CONFLICT, RETURNING TO (assigned clearance)"**
assigned ATC clearance has been resumed	
	• notifies ATC: **"CLEAR OF CONFLICT, (assigned clearance) RESUMED"**

Note: PF look-out during RA is not recommended as this might be misleading and distracting.
Manoeuvres opposite to the direction of a RA shall not be made.
Do not change setting of altitude preselect controller.
If possible, using the HGS for RA guidance is recommended.

Source: OM-B of the aircraft operator (DASH 8/402 - Rev.38, 17.04.2017)

Figure 17: TA and RA procedures Airbus A319-112

[redacted] A318/A319/A320/A321 OPERATIONS MANUAL PART B	PROCEDURES ABNORMAL AND EMERGENCY PROCEDURES SURV

[MEM] TCAS WARNINGS

Applicable to: ALL

3

- **Traffic advisory: "TRAFFIC" messages:**

  Do not perform a maneuver based on a TA alone.

- **Resolution advisory: All "CLIMB" and "DESCEND" or "MAINTAIN VERTICAL SPEED MAINTAIN" or "LEVEL OFF, LEVEL OFF" or "MONITOR VERTICAL SPEED" type messages:**

  AP (if engaged)........OFF

  BOTH FDs........OFF

  Respond promptly and smoothly to a RA by adjusting or maintaining the pitch, as required, to reach the green area and/or avoid the red area of the vertical speed scale.

  Note: Avoid excessive maneuvers while aiming to keep the vertical speed just outside the red area of the VSI , and within the green area. If necessary, use the full speed range between Vαmax and VMAX.

  Respect stall, GPWS, or windshear warning.

  Notify ATC.

  - **GO AROUND procedure must be performed when a RA "CLIMB" or "INCREASE CLIMB" is triggered on final approach:**

    Note: Resolution Advisories (RA) are inhibited below 900 ft.

- **When "CLEAR OF CONFLICT" is announced:**

  Resume normal navigation in accordance with ATC clearance.

  AP/FD can be reengaged as desired.

Source: OM-B of the aircraft operator (A318/A319/A320/A321 FLEET - 09.05.2017)

Investigation, results and actions

As part of the safety culture, the operator runs a system for flight data monitoring (FDM), which is carried out extensively. Internal investigations are conducted when certain parameters (trigger levels) are exceeded during take-off, landing or during the flight, as well as in the event of accidents or incidents. If necessary, parameter exceedances or incidents are discussed with the respective crews on a voluntary basis in the context of a follow-up or a processing of the incident. In addition, as part of the safety promotion, selected incidents and their analyses are used to draw attention to current safety-relevant topics within the respective fleets. This is done, among other things, by means of a monthly "Safety Report", which is addressed to the pilots of the airline.

The incident concerned was routinely investigated and analysed by the FDM programme. The following results were reported by the operator:

- Both flight crews duly reported the incident.
- The flight crews of both aircraft correctly followed the respective TACS RA.

- During the execution of the TCAS RA procedure for aircraft B, the flight crew deviated from point "BOTH FD.....OFF" (see Figure 17). The flight director (FD) was not deactivated.
- The (FDM) events were classified.

An FDM profile was already available for the proper processing of TCAS procedures due to the general possibility of procedural deviations. The incident was debriefed and discussed together with the flight crew of aircraft B.

Event assessment

The event was classified according to the event severity classification matrix, which was in the SMS implementation phase at the time of incident. The Classification Matrix is shown in Figure 18:

- Likelihood of occurrence: E10
- Severity of consequences: A5
- Risk level: e

Figure 18: Event severity classification matrix

Event Severity Classification Matrix **Question 1**: If this event had escalated into an accident outcome, what would have been the most credible accident scenario An/A0 to A5? (answer below)	**Question 2**: What was the effectiveness of the remaining barriers between this event and the most credible accident scenario E0 to E12? (answer below)												
	None		Not effect-tive 90%		Minimal 99%		Limited 99,9%		Effective 99,99%		Very effect-tive 99,999		Normal 99,9999%
	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
	***Alternative* Question 2**: What is the likelihood that this event leads to the most credible accident scenario?												
	1 out of 1	1 out of 3	1 out of 10	1 out of 30	1 out of 100	1 out of 300	1 out of 1.000	1 out of 3.000	1 out of 10.000	1 out of 30.000	1 out of 100.000	1 out of 300.000	1 out of 1 mio.
Loss of aircraft or multiple fatalities (3 or more) *Catastrophic Accident (S5)* – **A5**	a	a	a	a-b	b	b-c	c	c-d	d	d-e	e	e-f	f
Several fatalities, multiple serious injuries, serious damage to the aircraft (almost lost) *Serious Accident (S4 – S5)* – **A4**	a	a-b	b	b-c	c	c-d	d	d-e	e	e-f	f	f-g	g
1 or 2 fatalities, multiple serious injuries, major damage to the aircraft *Major Accident (S4)* – **A3**	b	b-c	c	c-d	d	d-e	e	e-f	f	f-g	g	g-h	h
Serious incident with injuries and/or substantial damage to aircraft *Serious Incident (S3)* – **A2**	c	c-d	d	d-e	e	e-f	f	f-g	g	g-h	h	h-i	i
Incident with injuries and/or damage to aircraft *Incident (S2 – S3)* **A1**	d	d-e	e	e-f	f	f-g	g	g-h	h	h-i	i		
Minor injuries, minor damage to aircraft *Minor Injuries or damage (S2)* – **A0**	e	e-f	f	f-g	g	g-h	h	h-i	i				
Incident with discomfort and/or less than minor system damage or less *Incident or none (S1 or S0)* – **An**	f	f-g	g	g-h	h	h-i	i						

Source: Aircraft operator

Due to the procedural deviation (FD not deactivated), the likelihood of occurrence was classified at a higher level.

1.16 TCAS/ACAS

1.16.1 Description

The following description of the Airborne Collision Avoidance System (ACAS) has been extracted from the website www.skybrary.aero (a data and information source established by Eurocontrol, ICAO and the Flight Safety Foundation).[52] The illustrations are taken from the ACAS Guide (March 2022) of Eurocontrol, where indicated.[53]

„ […]

Description

The Airborne Collision Avoidance System II (ACAS II) was introduced in order to reduce the risk of mid-air collisions or near mid-air collisions between aircraft. It serves as a last-resort safety net irrespective of any separation standards.

ACAS II is an aircraft system based on Secondary Surveillance Radar (SSR) transponder signals. ACAS II interrogates the Mode C and Mode S transponders of nearby aircraft ('intruders') and from the replies tracks their altitude and range and issues alerts to the pilots, as appropriate. ACAS II will not detect non-transponder-equipped aircraft and will not issue any resolution advice for traffic without altitude reporting transponder.

ACAS II works independently of the aircraft navigation, flight management systems, and Air Traffic Control (ATC) ground systems. While assessing threats it does not take into account the ATC clearance, pilot's intentions or Flight Management System inputs. ACAS II is not connected to the autopilot, except the Airbus AP/FD (Auto pilot/flight director) TCAS capability (which provides automated responses to RAs).

Currently, the only commercially available implementations of ICAO standard for ACAS II (Airborne Collision Avoidance System) is TCAS II version 7.1 (Traffic alert and Collision Avoidance System). ICAO Annex 10 vol. IV states that all ACAS II units must be complaint with version 7.1 as of 1 January 2017. In Europe version 7.1 has been mandatory since 1 December 2015. However, in some countries (notably in the United States, where ACAS

[52] https://skybrary.aero/articles/airborne-collision-avoidance-system-acas, retrieved on 17.02.2023
[53] https://www.eurocontrol.int/sites/default/files/2022-03/eurocontrol-safety-acas-guide-4-1.pdf, retrieved on 17.02.2023

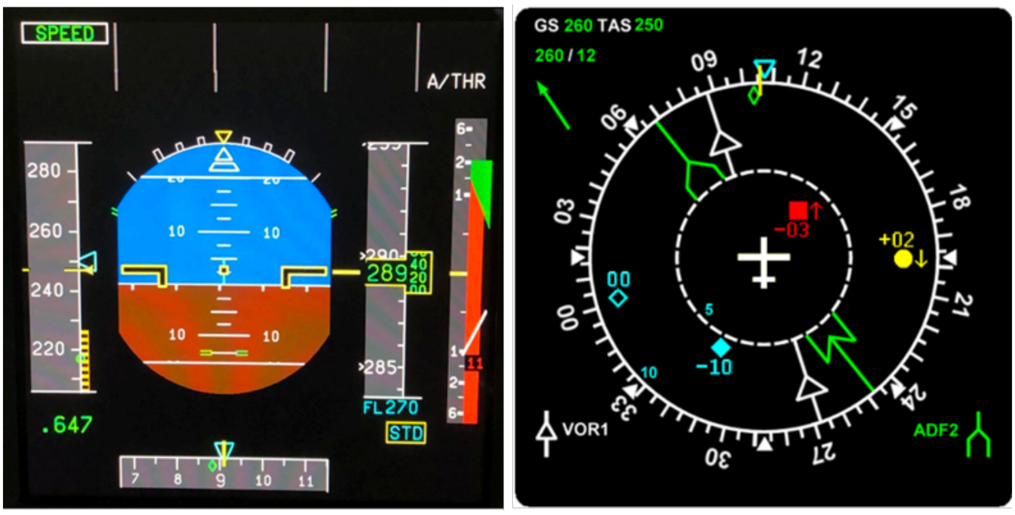
mandates are different) there is a large population of aircraft still operating versions 6.04a and 7.0.

Information Provided by ACAS

Two types of alert can be issued by ACAS II - TA (Traffic Advisory) and RA (Resolution Advisory). The former is intended to assist the pilot in the visual acquisition of the conflicting aircraft and prepare the pilot for a potential RA.

If a risk of collision is established by ACAS II, an RA will be generated. Broadly speaking, RAs tell the pilot the range of vertical speed at which the aircraft should be flown to avoid the threat aircraft. The visual indication of these rates is shown on the flight instruments. It is accompanied by an audible message indicating the intention of the RA. A "Clear of Conflict" message will be generated when the aircraft diverge horizontally.

Figure 19: Examples of ACAS II display



Left: PFD[54] with vertical speed tape indicating a Climb RA on an Airbus A320

Right: Traffic display example – Electronic Flight Instrument System (EFIS)

Note on EFIS representation: yellow filled circle for a TA; red filled square for an RA.

Source: ACAS Guide (March 2022)

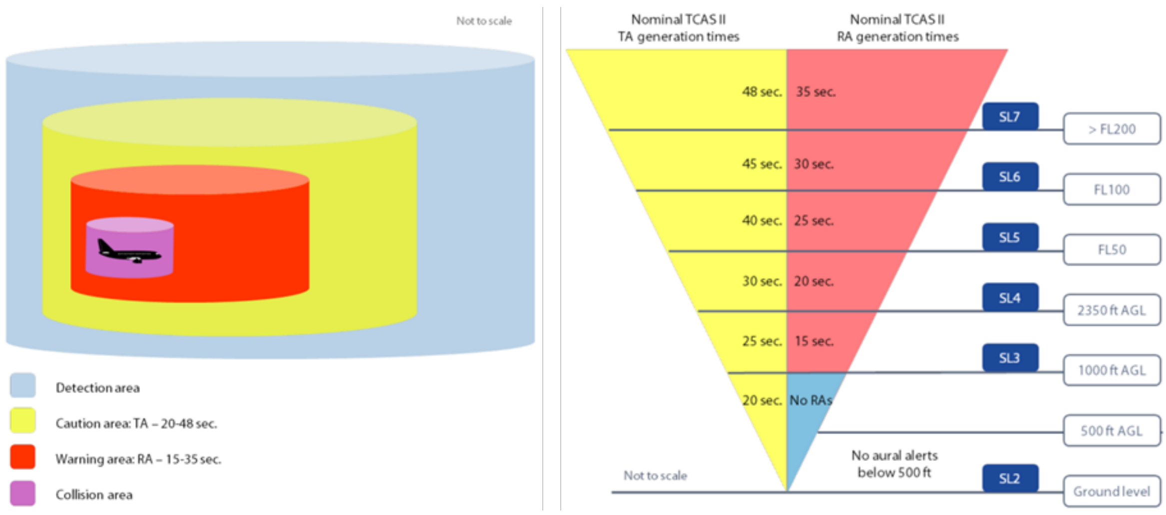
[54] Primary Flight Display

Once an RA has been issued, the vertical sense (direction) of the RA is coordinated with other ACAS II equipped aircraft via a mode S link, so that two aircraft choose complementary manoeuvres. RAs aim for collision avoidance by establishing a safe vertical separation (300 - 700 feet), rather than restoring a prescribed ATC separation.

ACAS II operates on relatively short time scales. The maximum generation time for a TA is 48 seconds before the Closest Point of Approach (CPA). For an RA the time is 35 seconds. The time scales are shorter at lower altitudes (where aircraft typically fly slower). Unexpected or rapid aircraft manoeuvre may cause an RA to be generated with much less lead time. It is possible that an RA will not be preceded by a TA if a threat is imminent. The effectiveness of an RA is evaluated by the ACAS equipment every second and, if necessary, the RA may be strengthened, weakened, reversed, or terminated.

A protected volume of airspace surrounds each ACAS II equipped aircraft. The size of the protected volume depends on the altitude, speed, and heading of the aircraft involved in the encounter. See illustration below.

Figure 20: TCAS II/ACAS II protected volume (side and plan view)



Source: ACAS Guide (March 2022)

A protected volume of airspace surrounds each ACAS II equipped aircraft RAs can be generated before ATC separation minima are violated and even when ATC separation minima will not be violated. In Europe, for about two thirds of all RAs, the ATC separation minima are not significantly violated.

Types of RA (TCAS II version 7.1)

Figure 21: Types of ACAS RA ver 7.1

Upward sense			Downward sense		
RA	Required vertical rate (ft/min)	Aural	RA	Required vertical rate (ft/min)	Aural
Climb	1500	Climb, climb	Descend	– 1500	Descend, descend
Crossing Climb	1500	Climb, crossing climb; Climb, crossing climb	Crossing Descend	– 1500	Descend, crossing descend; Descend, crossing descend
Maintain Climb	1500 to 4400	Maintain vertical speed, maintain	Maintain Descend	– 1500 to – 4400	Maintain vertical speed, maintain
Maintain Crossing Climb	1500 to 4400	Maintain vertical speed, crossing maintain	Maintain Crossing Descend	– 1500 to – 4400	Maintain vertical speed, crossing maintain
Level Off [1]	0	Level off, level off	Level Off [1]	0	Level off, level off
Reversal Climb [2]	1500	Climb, climb NOW; Climb, climb NOW	Reversal Descent [2]	– 1500	Descend, descend NOW; Descend, descend NOW
Increase Climb [2]	2500	Increase climb, increase climb	Increase Descent [2]	– 2500	Increase descent, increase descent
Preventive RA	No change	Monitor vertical speed	Preventive RA	No change	Monitor vertical speed
RA Removed	—	Clear of conflict	RA Removed	—	Clear of conflict

1 New RA in version 7.1, replacing "Adjust vertical speed, adjust" from version 7.0
2 Not possible as an initial RA

Complying with RAs

Pilots are required to comply immediately with all RAs, even if the RAs are contrary to ATC clearances or instructions.

If a pilot receives an RA, he/she is obliged to follow it, unless doing so would endanger the aircraft. Complying with the RA, however, will in many instances cause an aircraft to deviate from its ATC clearance. In this case, the controller is no longer responsible for separation of the aircraft involved in the RA.

On the other hand, ATC can potentially attempt to interfere with the pilot's response to RAs. If a conflicting ATC instruction coincides with an RA, the pilot may assume that ATC is fully aware of the situation and is providing the better resolution. But in reality ATC is not aware of the RA until the RA is reported by the pilot. Once the RA is reported by the pilot, ATC is required not to attempt to modify the flight path of the aircraft involved in the encounter. […]"

In the specific case, the limit values were:

- Warning time for TCAS TAs (tau TA): 40 s
- Warning time for TCAS RAs (tau RA): 25 s
- Vertical separation threshold for TCAS TAs (ZTHRTA): 850 ft
- Vertical separation threshold for TCAS RAs (ZTHR): 600 ft

The TCAS II/ACAS II reference logic is described in ICAO Doc 9863.

1.16.2 Regulations

The following regulations concerning TCAS/ACAS, as amended, were applicable on the event date:

- **Implementing Regulation (EU) No. 923/2012** of the Commission of 26 September 2012 laying down common air traffic rules and operating rules for air traffic control services and procedures and amending Implementing Regulation (EC) No. 1035/2011 and Regulations (EC) No. 1265/2007, (EC) No. 1794/2006, (EC) No. 730/2006, (EC) No. 1033/2006 and (EU) No. 255/2010 **(SERA)**
- **Regulation (EU) No. 965/2012** of the Commission of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council
- **Regulation (EU) No. 1332/2011** of the Commission of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance
- **AIC B 4/12**, Radio Communication Procedures for the Aeronautical Mobile Service
- **ICAO Doc 4444 Sixteenth Edition, 2016**, Procedures for Air Navigation Services – Air Traffic Management
- **ICAO Doc 9863 Second Edition, 2012**, Airborne Collision Avoidance System (ACAS) Manual

The relevant excerpts from the regulations are summarised in the Annex.

1.17 Human factors

1.17.1 Human error types

The following description of human error types has been excerpted from the website www.skybrary.aero.[55]

„[…]

Definition

Errors are the result of actions that fail to generate the intended outcomes. They are categorized according to the cognitive processes involved towards the goal of the action and according to whether they are related to planning or execution of the activity.

Description

Actions by human operators can fail to achieve their goal in two different ways: The actions can go as planned, but the plan can be inadequate, or the plan can be satisfactory, but the performance can still be deficient (Hollnagel, 1993).

Errors can be broadly distinguished in two categories:

Category 1 *- A person intends to carry out an action, the action is appropriate, carries it out incorrectly, and the desired goal is not achieved. - An execution failure has occurred. Execution errors are called Slips and Lapses. They result from failures in the execution and/or storage stage of an action sequence. Slips relate to observable actions and are commonly associated with attentional or perceptual failures. Lapses are more internal events and generally involve failures of memory.*

Kategorie 2 *- A person intends to carry out an action, does so correctly, the action is inappropriate, and the desired goal is not achieved - A planning failure has occurred. Planning failures are Mistakes. "Mistakes may be defined as deficiencies or failures in the judgmental and/or inferential processes involved in the selection of an objective or in the specification of the means to achieve it." (Reason, 1990).*

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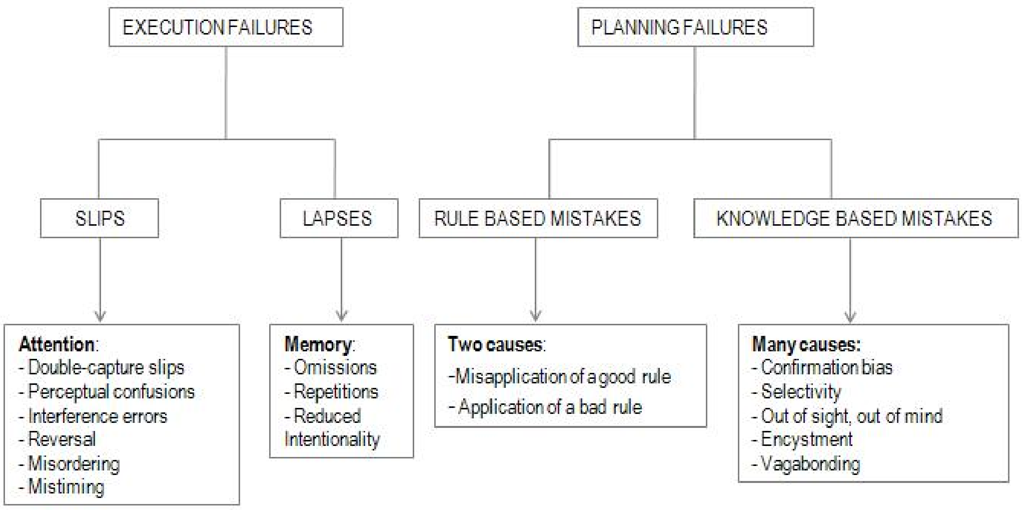
[55] https://skybrary.aero/articles/human-error-types, retrieved on 17.02.2023

Execution errors correspond to the Skill based level of Rasmussen's levels of performance (Rasmussen 1986), while planning errors correspond to the Rule and Knowledge-based levels (see Figure 22).

Figure 22: Execution and planning failures adapted from Rasmussen



Slips and Lapses

In a familiar and anticipated situation people perform a skill-based behaviour. At this level, they can commit skill-based errors (slips or lapses). In the case of slips and lapses, the person's intentions were correct, but the execution of the action was flawed - done incorrectly, or not done at all. This distinction, between being done incorrectly or not at all, is another important discriminator.

When the appropriate action is carried out incorrectly, the error is classified as a slip. When the action is simply omitted or not carried out, the error is termed a lapse. "Slips and lapses are errors which result from some failure in the execution and/or storage stage of an action sequence." Reason refers to these errors as failures in the modality of action control: at this level, errors happen because we do not perform the appropriate attentional control over the action and therefore a wrong routine is activated.

Examples of slips and lapses in aviation

A classic example is an aircraft's crew that becomes so fixated on trouble-shooting a burned out warning light that they do not notice their fatal descent into the terrain. In contrast to *attention failures (slips), memory failures (lapses) often appear as omitted items in a checklist, place losing, or forgotten intentions. Likewise, it is not difficult to imagine that when under stress during in-flight emergencies, critical steps in emergency procedures can be missed. However, even when not particularly stressed, individuals have forgotten to set the flaps on approach or lower the landing gear.*

Mistakes

Once a situation is recognised as unfamiliar, performance shifts from a skill-based to a rule-based level. First of all, the human tries to solve the problem by relying on a set of memorised rules and can commit rule-based mistakes. These kinds of error depend on the application of a good rule (a rule that has been successfully used in the past) to a wrong situation, or on the application of a wrong rule.

In the case of planning failures (mistakes), the person did what he/she intended to do, but it did not work. The goal or plan was wrong. This type of error is referred to as a mistake.

When we recognise that the current situation does not fit with any rule stored, we shift to knowledge-based behaviour. At the knowledge-based behaviour level we can commit planning errors (Knowledge based mistakes). They basically concern the difficulty we have in gathering information on all the aspects of a situation, in analysing all the data and in deriving the right decision. Planning is based on limited information, it is carried out with limited time resources (and cognitive resources) and it can result in a failure. […]

Contributing factors:

- *Fatique*
- *Situation awareness*
- *Workload*
- *Training and experience/expertise*
- *Familiarity*
- *Memory in ATC*

  […]“

1.17.2 Human Performance – Error Management

The following description of Human Performance - Error Management has been excerpted from the Airbus "Flight Operations Briefing Note: Error Management"[56]

„[…] *Slips and lapses are failures in the execution of the intended action* Slips are actions that do not go as planned, while lapses are memory failures. For example, operating the flap lever instead of the (intended) gear lever is a slip. Forgetting a checklist item is a lapse. [...]

Slips and lapses typically emerge at the skill-based level. There are several known mechanisms behind slips and lapses. It is known, for example, that mental "programs" which are most commonly used, may take over from very similar programs, which are less frequent or exceptional. [...]

Slips are usually easy to detect quickly and do not have immediate serious consequences due to in-built system protections.

Lapses may be more difficult to detect, and therefore may also be more likely to have consequences. [...]

One common false assumption is that errors and violations are limited to incidents and accidents. Recent data from Flight Operations Monitoring (e.g. LOSA) indicate that errors and violations are quite common in flight operations. According to the University of Texas LOSA database, in around 60% of the flights at least one error or violation was observed, the average per flight being 1.5.

A quarter of the errors and violations were mismanaged or had consequences (an undesired aircraft state or an additional error). The study also indicated that a third of the errors were detected and corrected by the flight crew, 4% were detected but made worse, and over 60% of errors remained undetected. This data should underline the fact that errors are normal in flight operations and that, as such, they are usually not immediately dangerous. [...]

Real solutions for human error require systemic improvements in the operation. One way consists of improving working conditions, procedures, and knowledge, in order to reduce the

[56] https://skybrary.aero/sites/default/files/bookshelf/174.pdf, retrieved on 17.02.2023

likelihood of error and to improve error detection. Another way is to build more error tolerance into the system, i.e. limit the consequences of errors. [...]

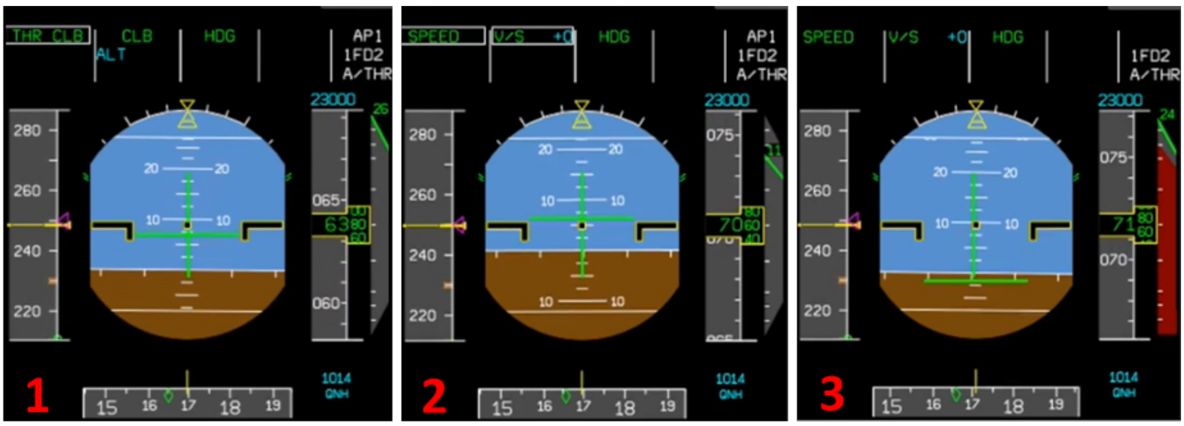
Error Prevention aims at avoiding the error all-together. This is possible only in some specific cases and, almost without exception, requires design-based solutions. [...]

Error Tolerance aims at making the system as tolerant as possible towards error, i.e. minimizing the consequences of errors. […]“

1.18 States of the aircraft B autoflight system

Figure 23 shows the primary flight display (PFD) of aircraft B in three different situations. In the upper part of the PFD, the status of the autoflight system can be read from the flight mode annunciator (FMA).

Figure 23: PFD of aircraft B in three different situations



Source: Video animation of the aircraft operator; editing: SUB

<u>Picture 1 (left)</u>

- AP[57]1: active
- FD1+2: active
- A/THR[58]: active

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[57] Autopilot
[58] Autothrust

The aircraft is to flight level 230 before the level off is instructed. The thrust is maintained at a constant value by the autothrust system A/THR in THR CLB mode. The autopilot AP1 maintains the speed of 250 kt set by the FMS[59] by varying the pitch angle. A heading of 170 is maintained.

<u>Picture 2 (middle)</u>

- AP1: active
- FD1+2: active
- A/THR: active

The flight crew has been instructed to stop the climb. Thus the flight crew manually sets a climb rate of 0 ft/min. A/THR switches automatically to SPEED mode to maintain the last set speed of 250 kt by varying thrust. The heading of 170 is still maintained automatically.

<u>Picture 3 (right)</u>

- AP1: deactivated
- FD1+2: active
- A/THR: active

The aircraft follows the TCAS RA "Climb, climb". For this, the autopilot was deactivated and the climb was initiated manually. To do this, the vertical speed on the right side of the display must be brought from the red to the green range. The A/THR remains in the last active SPEED mode when the autopilot is deactivated.

The FD is displayed on the PFD by a horizontal and a vertical green bar. The vertical bar commands the roll direction and rate to maintain set heading 170. The horizontal bar commands a reduction in pitch angle to achieve the set vertical speed of 0 ft/min.

[59] Flight Management System (electronic device for flight control and flight navigation)

1.19 Event classification

In general, separation minimum infringments represent a potential safety hazard, but do not in all cases meet the criteria of a serious incident or an accident within the meaning of the Accident Investigation Act (UUG 2005) or Regulation (EU) No 996/2010. While an accident is clearly defined, there is discretion in the classification of a serious incident.

For this investigation, the classification as a severe incident was also based on the fact of a qualified loss of separation, in which the distance between the aircraft is lower than half the separation minima. This also corresponded to ICAO Doc 4444 in earlier versions (see also Figure 13):

*„**Airprox - Risk Of Collision:** The risk classification of an aircraft proximity in which serious risk of collision has existed.*

Critical near collision between aircraft or between aircraft and obstacle(s).

<u>Separations lower than half the separation minima (e.g., 2NM)</u>.“

This classification, based on the extent of separation minima infringement, had already been removed from ICAO Doc 4444 before the incident. Therefore it is possible that the classification according to ESARR 2 in the course of the investigation according to the SMS of the air navigation service provider differs from the classification of the Federal Safety Investigation Authority.[60]

[60] See event assessment of the ANSP in section 1.15.1**Fehler! Verweisquelle konnte nicht gefunden werden.**

2 Analysis

2.1 Altitude data comparison of QAR and ATS surveillance system

Figure 24 shows the QAR and ATS surveillance system altitude data of aircraft A and B as a function of time. The data have an offset in time by approx. 2.5 seconds. The reason for this is the time required for the processing of the data by the radar tracker in order to subsequently display them on the air situation display. Since altitude data, in contrast to the position data, are not extrapolated in time, they correspond to the pressure altitude transmitted by aircraft when displayed on the air situation display (mode C). The transmitted altitude from the transponders have a resolution of 25 ft, whereas the air situation display of the ATS surveillance system has a resolution of 100 ft (rounded).

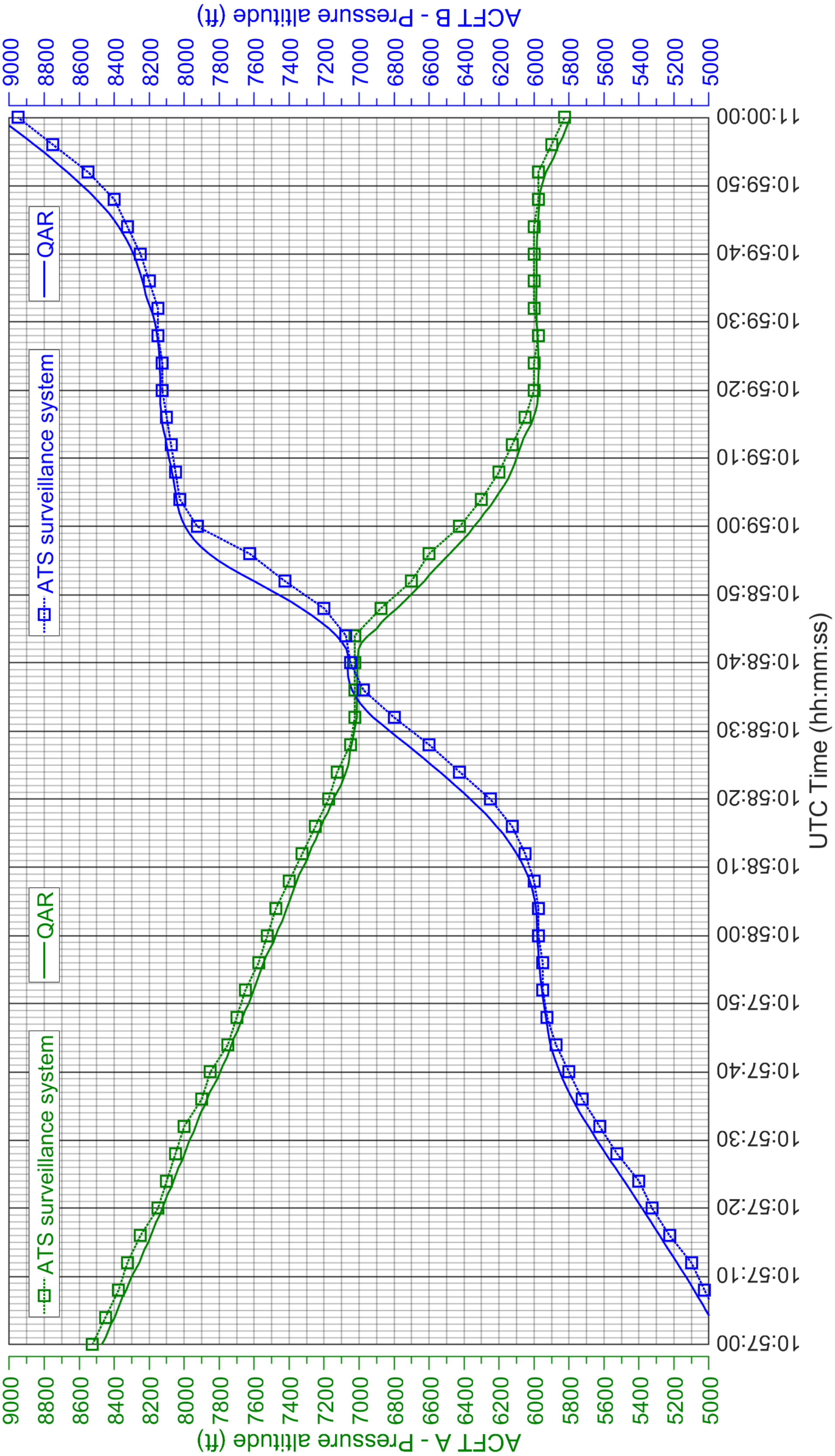
Due to the time offset, the difference between the displayed and actual altitude depends on the vertical speed of the aircraft. The greater the rate of climb, the greater the deviation in altitude. For example, a climb rate of 1 500 ft/min and an assumed time offset of 2.5 seconds results in a difference of 62.5 ft. At 3 000 ft/min the difference is 125 ft.

If one also takes into account the update rate of the ATS surveillance system of 4 seconds, the displayed altitude can already be more than 6 seconds old when the air traffic controller looks at the screen. At 1500 ft/min climb, this results in a difference of 150 ft and at 3 000 ft/min it is 300 ft.

This situation is well known to air traffic controllers. For example, the altitude data reported by flight crews on initial calls often deviates slightly from the data displayed on the air situation display during climb and descent.

For position data, however, the time offset is eliminated by the calculation of the radar tracker. Therefore, the displayed positions correspond sufficiently accurately to the actual values.

Figure 24: Comparison of QAR and ATS surveillance system altitude data



Source: ANSP, aircraft operator; time data and layout: SUB

2.2 TCAS/ACAS

The behaviour of TCAS/ACAS in the specific incident was evaluated by SUB using the reference logic described in ICAO Doc 9863[61].

The evaluation showed that the system performed according to the reference logic. The warning times and altitude limits were taken into account by the system as intended.

In addition, the case without climb interruption of aircraft B was considered. With this assumption, aircraft B continues to climb at the last rate of climb of 3 000 ft/min. The calculated altitude difference results in more than 1 200 ft at the CPA under the assumption that aircraft A maintains the altitude of 7 000 ft (conservative consideration). In this case, aircraft B is at a higher altitude than aircraft A at the CPA.

According to the reference logic, a maximum altitude limit (ZTHR) of 600 ft is specified in this case at the CPA to generate an RA. Since the altitude limit would be exceeded by double in the assumed case and aircraft B was already above aircraft A when the RA was generated, no TCAS RA would have occurred if the climb had continued.

Since TCAS/ACAS reference logic is not part of air traffic controller training in this level of detail, it cannot be assumed that the radar controllers involved were aware of it.

2.3 Event history

In the following, the course of events is analysed chronologically.

Flight path of aircraft A from waypoint NERDU

Aircraft A was guided by WIEN RADAR instead of the planned RNAV instrument approach (transition) NERDU 4 N, on a direct path into the left-hand downwind leg of runway 34. Later, in the area south of Vienna, the aircraft was instructed heading 145 for this purpose. Such a diversion, which corresponds to a significant shortening of the flight path, is a

[61] ICAO Doc 9863 Second Edition, 2012, Airborne Collision Avoidance System (ACAS) Manual

common procedure. It is used by air traffic control in consideration of the given traffic situation in order to ensure an efficient and ecological traffic flow.

Vertical separation before loss of separation [1], [2]

The descent of aircraft A was stepwise (10 000 ft, 8 000 ft, 7 000 ft). This is a procedure in which the aircraft is only cleared to the next vacant level or altitude. Aircraft departing from Vienna Airport, such as aircraft B in this case, receive a standard clearance for a climb to 5 000 ft. Aircraft B was cleared to 6 000 ft after initial call to WIEN RADAR. Therefore, due to the small horizontal distance between the two aircraft, 7 000 ft was the next available altitude for aircraft A to maintain 1 000 ft vertical separation.

Horizontal separation before loss of separation [3]

The requested heading (170) by aircraft B brought the diverging flight paths of both aircraft closer together. At time of the clearance, there was a horizontal separation of 3.2 nm between the aircraft, however, the rear aircraft B was approximately 30 kt faster. In order to allow the aircraft to continue climbing and descending and to hand over aircraft A to WIEN DIRECTOR, the radar controller (EC) had to reschedule due to the new situation. The new plan was to guide aircraft A with a course change into the right-hand pattern of runway 34.

Change of course of aircraft A for right pattern of runway 34 [4]

Aircraft A was instructed by the radar controller (EC) to change the course to the right on heading 090. This corresponds to a course change of 305° to the right instead of 55° to the left. The flight crew read the instruction back correctly.

Such an instruction regarding turn direction is unusual and not common for pilots. There was no questioning of the instruction by the flight crew. The instruction was given with the addition "...vectors for a right hand downwind and descent". This addition probably reinforced the statement of the radar controller (EC). In addition, the frequency load was high at the time the instruction was issued.

Usually, a flight crew expects to make a left turn on the left-hand downwind leg in order to subsequently turn (via a base leg) onto the runway's localizer. At this point, however, the aircraft was at an altitude of approx. 8000 ft and thus too high for such a procedure. A change to the right-hand pattern of runway 34 via a heading of 090 therefore makes sense, not only to solve the horizontal separation problem, but also with regard to altitude reduction.

Transfer of communication of aircraft A to WIEN DIRECTOR [5]

Since from the point of view of the radar controller (EC) the separation between the two aircraft was ensured, aircraft A was handed over to WIEN DIRECTOR. At the time of the instruction to change frequency, the right turn of aircraft A, which had already been initiated, was not yet recognizable on the air situation dispays on the basis of the past positions displayed. Seconds later the right turn was clearly recognizable. This was due to the slight course change of approx. 20° at this time and the update rate of the ATS surveillance system of 4 seconds.

Instruction to aircraft B to climb to flight level 230 [6]

Aircraft B was cleared to climb to flight level 230 at an altitude of 6 000 ft. This further reduced the vertical separation to aircraft A, which was descending to 7 000 ft at approximately 7 500 ft at the time.

Initial call from aircraft A to WIEN DIRECTOR [7]

At the latest with the initial call of aircraft A to WIEN DIRECTOR, the radar controller (FC) recognised the conflict between the two aircraft. Whether he then verbally asked the radar controller (EC) about the intentions of aircraft A and thus made him aware of the conflict or radar controller (EC) recognised it himself is not known.

In any case, 2 to 3 seconds after the initial call of aircraft A to WIEN DIRECTOR, presumably to get an overview of the situation, the radar controller (EC) looked at the extended labels[62] of both aircraft on the air situation display. Up to this point, there is no indication that the radar controller (EC) was aware that aircraft A was flying contrary to its plan to the "right" instead to the "left".

[62] Extended data window to the aircraft symbol, which can be displayed on the screen of the ATS surveillance system.

Stop of climb of aircraft B and TCAS TA [8]

4-5 seconds after the conflict was probably first detected, the radar controller (EC) instructed aircraft B to stop the climb ("Stop climb immediatly!"). At the same time, TCAS issued a traffic advisory. At this point, according to the air situation display, the aircraft were approx. 700 ft (decreasing) vertically separated at a horizontal distance of approx. 3.2 nm from each other on intersecting control courses. At this point, it was no longer possible to avert a loss of separation.

It is likely that the radar controller (EC) wanted to bring aircraft B to a lower altitude than aircraft A in order to achieve the greatest possible vertical separation between the aircraft. At the time of the instruction, according to the ATS surveillance system, aircraft B was climbing at 6 400 ft, aircraft A was descending to 7 000 ft and was at 7 200 ft. However, due to the delayed altitude display and update rate of the ATS surceillance system (see Section 2.1), aircraft B was already approx. 150 ft higher at 6 550 ft. In addition, the decision was based on the previous update. According to this, the controller was displayed 6 300 ft, but aircraft B was already at approx. 6 500 ft shortly before the next update of the air situation display.

In order to achieve the greatest possible vertical separation, the instruction to stop the climb was inappropriate in this case (see section 2.2). However, it should be noted that the estimation of vertical separation at the CPA and the assessment of the possible options, even under optimal conditions, is challenging for an experienced controller, if this is possible at all due to the situation. Due to the update rate and the time-delayed altitude display of the ATS surveillance system, an estimation of the rate of climb is not possible with sufficient precision, especially in phases of non-constant climb rate, such as the initial climb of aircraft B in this case. Even at a constant rate of climb, the display resolution of 100 ft means that any estimate is subject to great inaccuracies. Furthermore, the reaction time of the flight crew is an unknown factor.

STCA alert and essential traffic information [9]

The separation minima of 3 nm horizontally and 1 000 ft vertically were infringed. The STCA proximity warning system indicated this in red on the controllers' air situation display.

Both radar controllers issued essential traffic information to aircraft in accordance with ICAO Doc 4444, Chapter 5, 5.10. The WIEN DIRECTOR radar controller (FC) indicated this with "...traffic at your right wing, same level, climbing through your level" that aircraft B was climbing. He was obviously not aware that aircraft B had already been instructed to stop the climb.

Aircraft A then reported that there was visual contact with aircraft B. Probably to increase vertical separation, the radar controller (FC) then instructed aircraft A to descend to 6 000 ft.

TCAS RA and avoidance maneuvers [10]

The level off of aircraft B resulted in an altitude of approx. 7 050 ft, whereby the vertical speed was still slightly positive at the time of RA generation. Aircraft A continued the cleared right turn at 7 000 ft at this time. Both aircraft were therefore only separated vertically by approx. 50 ft.

Both aircraft duly followed the resolution advisories. The flight crews of both aircraft reported compliance with the respective RA. Both radar controllers did not respond with "Roger" as required by the radiotelephony procedure.

Termination of TCAS RAs [12]

The radar controller (EC) instructed aircraft B to climb to flight level 230 after completion of the RA but prior to reporting “clear of conflict” to ATC. This was contrary to the requirement of SERA.11014(c) not to modify the flight path of the aircraft prior to the “clear of conflict” message.

Both aircraft, after termination of the conflict situation with "clear of conflict" by TCAS, continued their flights in accordance with the last clearance received and communicated this to the radar controllers.

There was again no response from the radar controller (EC) to the report from aircraft B that the TCAS conflict situation was terminated. This probably caused aircraft B to advise the radar controller (EC) over a minute later that there was a TCAS RA and that they had followed it.

After loss of separation, a conflict arose between aircraft A and another aircraft C, which had taken off from Vienna Airport and was on the frequency of WIEN RADAR. Radar controller (FC) alerted radar controller (EC) to this conflict. Aircraft C was instructed to fly heading 040, aircraft A meanwhile continued the right turn to heading 090. There was no critical situation/loss of separation between aircraft A and C.

Due to the altitude already reduced by the right turn, aircraft A no longer needed to be guided into the right-hand pattern of runway 34. Aircraft A joined the approach sequence of runway 34 after completing the right turn on heading 090.

2.4 Personell

2.4.1 General

On the day of the incident, the air traffic controllers involved were authorised to work at the approach control unit and were appropriately trained and instructed in TCAS/ACAS procedures. After the incident, the controllers were released.

The pilots of both aircraft were authorised to pilot the respective aircraft type on the day of the incident. According to the aircraft operator's OM-D, the pilots were trained and instructed in ACAS/TCAS manoeuvres and procedures.

2.4.2 Human factors

Radar controller (EC)

The responsible radar controller (EC) was under a high workload at the time of the incident. The rapid increase in workload was not expected when the work session began approximately 30 minutes earlier. The weather-related deviations of several aircraft, the resulting complex traffic situation and the high frequency load contributed significantly to the increase in workload.

The instruction to aircraft A to change the heading from 145 to 090 was planned by the controller to the "left", but was instructed to to the "right". This is called a slip. A slip is a failure that occurs during the execution of a planned action and can be attributed to the lack of attention.

For the detection of the slip, e.g. by the correct read back of aircraft A, the controller apparently had no more available attention resources. The controller himself stated that he had already been overloaded shortly before the incident.

The subsequent decision situation to stop or not to stop the climb at the imminent loss of separation in order to restore the greatest possible separation took place at the real-based level due to the unfamiliar situation for the controller. Since there is no standard solution or checklist for such situations available, knowledge-based behaviour probably occurred. It is generally difficult to collect information about all aspects of a situation, to analyse all data and to derive the right decision. Planning is based on limited information and it is done with limited time (and cognitive) resources.

When the controller realised the conflict between aircraft A and B just before the separation minimum infringement, he was in conversation with another aircraft to which he had to transmit a clearance twice. As a result, he was distracted. In addition, he was already overloaded. Moreover, since the conflict situation came as a surprise to him, decision-making was probably also influenced by the surprise effect. These conditions made the assessment of the already very dynamic conflict situation much more difficult.

Flight crew aircraft B

Aircraft B was in a climb before loss of separation. In general, the workload for flight crews in climb and descent is significantly increased compared to cruise flight.

Due to the prevailing weather, the flight crew had to deviate from the planned flight route in climb, taking into account the display of the on-board weather radar. This is a normal procedure in corresponding weather, but requires increased attention from the pilots and coordination with air traffic control.

The instruction to interrupt the climb came unexpectedly to the crew shortly after leaving 6 000 ft. As the instruction was entered into the aircraft's autoflight system, a TCAS TA was generated simultaneously. The resulting traffic situation displayed on the navigation screens presented an unusual and contradictory situation to the crew. During the execution of the instruction, the vertical separation of the two aircraft further reduced to a few feet altitude difference, which was indicated to the pilots by the indication of "00" next to the yellow circle symbol of the conflict aircraft on the navigation screens. The flight crew most likely expected a greater vertical separation to the conflict aircraft after being instructed to "Stop climb immediatly". This resulted in a significant increase in pilot workload even before the TCAS RA was generated. A TCAS RA is already a stressful situation despite regular training in the simulator.

The procedural deviation that occurred during the subsequent TCAS RA of not deactivating the FD is called a lapse. Similar to the slip, this is an execution error, but is assigned to memory. A lapse is characterised, as in this case, by the omission of items from a checklist or procedure. Despite CRM[63], the PF's failure not to order the deactivation of the FD was not noticed by the PM.

Under high stress, even in familiar and trained situations, everyone is prone to execution errors, so additional training and checks to avoid such actions have little effect. Proposed solutions are therefore usually a fault-tolerant design, warning devices to detect a wrong action or a technical solution.

A technical solution that no longer requires the deactivation of the autopilot and FD and automates compliance with an RA has already been implemented with the "AP/FD TCAS Mode". For more on this, see section 2.7.

2.5 Aircraft

Both aircraft were equipped with an ACAS II collision avoidance system version 7.1 in accordance with Regulation (EU) No 1332/2011, as amended. The generated traffic and resolution advisories were in accordance with the reference logic described in ICAO Doc 9863.

Both aircraft were operated within the permissible range with regard to mass and position of the centre of gravity during the entire flight.

2.6 Meteorological analysis

The weather observation at Vienna Airport reported thunderclouds (FEW CB[64]) at 10:50. At the same time, isolated significant radar echoes with lightning activity were detected in the

[63] Crew Resource Management
[64] Cumulonimbus

north of the TMA, moving towards the east. In the south of the TMA and in the departure area of runway 29, the predicted cold front moved in a south-easterly direction and intensified according to the radar echos in the 30 minutes before the incident.

Due to the prevailing weather, some aircraft approaching via the northern area of the TMA (STAR MABOD 4 N) and some aircraft departing via the southern area of the TMA had to deviate from planned routes.

Thus, the weather had an influence on the incident.

2.7 Procedural deviation aircraft B

The item "BOTH FDs...OFF" is required in the OM-B procedure so that the A/THR switchs to SPEED mode in any case after the autopilot is deactivated. If only the autopilot is deactivated, the last A/THR mode remains active.

Only in SPEED mode, when manual flight control is required by the procedure, the speed is maintained at the last set value by the A/THR. In other modes where thrust is kept constant (e.g. THR CLB or THR IDLE), the speed will also change if the flight attitude deviates from the FD. This can cause a increase or decrease in speed in manual flight during a TCAS RA, depending on the flight condition and direction of the RA.

Furthermore, the FD's indication of the flight attitude during an RA deviates and gives an instruction contrary to the RA. This was also the case in this incident. Due to the instruction to stop the climb, the system was given a vertical speed of 0 ft/min. This caused the A/THR mode to change to SPEED mode. After initiating the climb according to the TCAS RA, the FD indicated a reduction of the pitch angle to bring the aircraft back to a vertical speed of 0 ft/min.

Since A/THR was already in SPEED mode when the TCAS RA was generated (due to the set vertical speed of 0 ft/min), there was no deviation with regard to speed during the avoidance manoeuvre. The PF followed the RA and not the instruction of the FD.

The procedure deviation therefore had no effect on compliance with the TCAS RA.

The development of the new "AP/FD TCAS Mode", which has been installed in newly delivered aircraft of the Airbus A320 family since 2017, represents a significant improvement. In this mode, the autopilot and FD no longer need to be deactivated. The autopilot follows the TCAS RA automatically.

2.8 Safety actions

The air navigation service provider scheduled an additional approach sector by default at noon. Furthermore, the staff of the approach control unit was informed by e-mail of possible frequency overload at noon. From the point of view of the Federal Safety Investigation Authority, the actions taken are assessed positively. The SUB is not aware of any similar incident that has occurred in the area of responsibility of the air navigation service provider since this serious incident.

The incident was debriefed and discussed together with the flight crew of aircraft B. The results of the FDM analysis were incorporated into the operator's safety culture. These actions are welcomed by the Federal Safety Investigation Authority.

3 Conclusions

3.1 Findings

- The flight crews of both aircraft held all the required ratings and were appropriately trained in TCAS/ACAS procedures.
- The air traffic controllers involved were authorised to work at the respective working positions and were appropriately trained in TCAS/ACAS procedures.
- The radar controller (EC) was on duty for nine days in the ten days before the incident (including two days of unscheduled extra overtime). In the 14 days prior to the incident day, he worked 88.5 hours. In the days prior to the incident, the rest period between two duties was reduced once to nine hours with the consent of the controller in accordance with the collective agreement.
- On the day of the incident, the radar controller (EC) startet to work at 04:30 UTC (06:30 local time). The incident occurred during the last run after a 60-minute break. He had felt rested and fit at the start of his shift on the day of the incident.
- No irregularities were found in regard to documentation, maintenance and certification of the aircraft.
- Both aircraft were operated within operational limits in terms of load and centre of gravity position.
- The weather in the TMA Vienna was characterised by a cold front with thunderstorm activity.
- The sectors of approach control with the call sign WIEN RADAR were combined at the time of the incident and were controlled by a radar controller (EC). A planning controller (PLC) supported him with regard to coordinating and planning activities.
- A radar controller (FC) with the call sign WIEN DIRECTOR was responsible for the approach area of runway 34.
- According to the supervisor on duty at the approach control unit there was no need to open an additional sector due to weather, taking into account the characteristics of the CHMI, which were within normal limits.
- Weather is not taken into account by the CHMI.
- Due to the prevailing weather situation, some aircraft deviated from their planned approach or departure routes.
- As some transmissions were overheard by the flight crews or were blocked out, radio transmissions from WIEN RADAR had to be repeated.

- Weather-related flight path deviations, the resulting complex traffic situation and the high frequency load led to a rapid increase in workload and subsequently to an overload of the radar controller (EC).
- The plan of the radar controller (EC) to guide aircraft A into the right-hand pattern of runway 34 due to the weather-related flight path deviation of aircraft B is comprehensible and coherent.
- During the realization of the plan prepared by the radar controller (EC), an execution error occurred during the transmission of the clearance, the wrong direction of turn was instructed ("right" instead of "left").
- The instruction to change course to "right" was read back correctly by aircraft A and was not questioned.
- The turn direction of aircraft A to the right could not be recognised by the radar controllers at the time of the handover due to the small course change of approx. 20° and the update rate of the ATS surveillance system.
- At the latest at the time of the initial call of aircraft A to WIEN DIRECTOR or shortly thereafter, the radar controllers noticed that there was a conflict between aircraft A and B.
- It can be assumed that a sufficient assessment of the conflict situation by the radar controller (EC) was not possible on the basis of the available data (time-delayed altitude display of the ATS surveillance system and its update rate), taking human factors into account.
- The minimum separation infringement was indicated by the proximity warning system STCA of the ATS surveillance system and both aircraft received essential traffic information in accordance with ICAO Doc 4444, Chapter 5, 5.10.
- Aircraft A had visual contact with aircraft B.
- It can be assumed that the flight crew of aircraft B was already exposed to a significantly increased workload during the TCAS TA due to the stop of the climb and the resulting unusual and contradictory traffic situation.
- TCAS performed according to the reference logic as described in ICAO Doc 9863.
- Both aircraft followed the TCAS RAs in accordance with SERA.11014 and within the permitted limits.
- TCAS RAs were duly reported by both aircraft. Both radar controllers did not respond with "Roger" as required by the radiotelephony procedure.
- A procedural deviation occurred by the flight crew of aircraft B when following the TCAS RA, the FD was not deactivated.
- The procedure deviation by the flight crew of aircraft B had no effect on compliance with the TCAS RA.

- The minimum separation of the aircraft according to the ATS surveillance system was 1.2 nm horizontally and 300 ft vertically.
- According to the TCAS/ACAS reference logic, the vertical separation between the two aircraft at the CPA, without interrupting the climb of aircraft B, would have been more than 1 200 ft. In this case, according to the reference logic, no TCAS RAs would have been generated.
- The instruction given to Aircraft B to continue the climb to flight level 230 was contrary to the requirement of SERA.11014(c) not to modify the flight path of the aircraft prior to reporting "clear of conflict" to ATC. As the conflict situation had already been resolved by TCAS at this point, this instruction had no effect on compliance with the RA.
- The resolution of the conflict situation by TCAS was reported by both aircraft as intended.
- The radar controller (EC) did not respond to the TCAS conflict resolution message from aircraft B with 'Roger' or an alternative clearance as intended, probably due to the previously issued clearance to continue the climb to flight level 230.
- Both aircraft, after resolving the conflict situation, returned to the last clearance issued and continued their flight to the destination airport.
- An additional conflict situation between aircraft A and another aircraft C was resolved by the radar controller (EC) by instructing a course to aircraft C. There was no further minimum separation infringement.
- Both radar controllers were duly released after the incident.

3.2 Probable causes

- Confusion of "right" with "left" by the radar controller (EC) when instructing aircraft A a heading change.
- Inappropriate instruction to aircraft B to stop the climb to resolve the conflict with aircraft A.

3.2.1 Probable factors

- Prevailing cold front with thunderstorm activity in the Vienna TMA.
- Lack of listening capability of several aircraft that were in contact with the approach control with the call sign WIEN RADAR.
- Overload of the radar controller (EC) due to deviation manoeuvres caused by weather, a resulting complex traffic situation and a high frequency load.
- Update rate and time-delayed altitude display of the ATS surceillance system.
- Insufficient consideration of weather in sector planning.

4 Safety recommendations

As the air navigation service provider has already taken actions, no safety recommendations are issued.

Since this serious incident, no similar incident have been reported to the Federal Safety Investigation Authority.

5 Consultation

Pursuant to Art. 16 (4) Regulation (EU) No. 996/2010, the Federal Safety Investigation Authority solicited comments from the authorities concerned, including EASA, and, through them the certificate holders for the design, the manufacturers and the operator concerned prior to publishing the final report.

In soliciting such comments, the Federal Safety Investigation Authority follows the international standards and recommendations regarding investigations of aviation accidents and incidents as approved under Article 37 of the Chicago Convention on International Civil Aviation.

Pursuant to article 14 para. 1 of the UUG [Accident Investigation Act] 2005 as amended, the Federal Safety Investigation Authority gave, prior to the completion of the final report, the parties involved the opportunity to comment in writing on the facts and conclusions relevant to the incident under investigation (consultation procedure).

Feedback without comments was received from EASA and TSB Canada. The ANSP submitted a statement that was considered and incorporated in the investigation report.

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Federal Act on the Independent Safety **Investigation of Accidents and Incidents (Accident Investigation Act 2005 - UUG)**, Federal Law Gazette I No. 123/2005 last amended by Federal Law Gazette I No. 231/2021

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 the repeal of Directive 94/56/EC

Regulation (EU) No. 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation, amending Regulation (EU) No 996/2010 of the European Parliament and of the Council and repealing Directive 2003/42/EC of the European Parliament and of the Council and Commission Regulations (EC) No 1321/2007 and (EC) No 1330/2007

Implementing Regulation (EU) No. 923/2012 of the Commission of 26 September 2012 laying down common air traffic rules and operating rules for air traffic control services and procedures and amending Implementing Regulation (EC) No. 1035/2011 and Regulations (EC) No. 1265/2007, (EC) No. 1794/2006, (EC) No. 730/2006, (EC) No. 1033/2006 and (EU) No. 255/2010 (**SERA**)

Regulation (EU) No. 965/2012 of the Commission of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council

Regulation (EU) No. 1332/2011 of the Commission of 16 December 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance

AIC B 4/12, Radio Communication Procedures for the Aeronautical Mobile Service

ICAO Doc 4444 Sixteenth Edition, 2016, Procedures for Air Navigation Services — Air Traffic Management

ICAO Doc 9863 Second Edition, 2012, Airborne Collision Avoidance System (ACAS) Manual

Abbreviations

A/THR	Autothrust
ACAS	Airborne Collision Avoidance System
ACFT	Aircraft
ACG	Austro Control GmbH
AD	Aerodrome
AEXE	Competence to provide the duties of a radar controller (EC) at approach control Vienna
AFM	Aircraft/Airplane Flight Manual
AFT	Aft
AHM	Airport Handling Manual
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
ALDIS	Austrian Lightning Detection & Information System
AMDT	Amendement
AMSL	Above Mean Sea Level
ANSP	Air Navigation Service Provider
AP	Autopilot
APLC	Competence to provide the duties of a planning controller (PLC) at approach control Vienna
APS	Approach Control Surveillance
ARP	Aerodrome Reference Point
ATC	Air Traffic Control
ATM	Air Traffic Management
ATPL(A)	Airline Transport Pilot Licence, Aeroplane
ATS	Air Traffic Service
AUTO	Automated Observation
AZG	Arbeitszeitgesetz (working time act)
BKN	Broken

BTN	Between
BUD	Budapest (meaning: area control BUDAPEST RADAR)
CAT	ILS Category 1 to 3
CAVOK	Ceiling And Visibility OK
CB	Cumulonimbus
CHMI	Collaboration Human Machine Interface
CLD	Clouds
COP	Copilot
CPA	Closest Point of Approach
CRM	Crew Resource Management
CS	Call Sign
CVR	Cockpit Voice Recorder
DAA	Delivery at Aircraft
DIR	Director (meaning: approach contol WIEN DIRECTOR)
DME	Distance Measuring Equipment
DP	Dewpoint in °C
E	East
EASA	European Union Aviation Safety Agency
EC	Executive Controller
EFIS	Electronic Flight Instrument System
ESARR	European Safety Regulatory Requirements
FC	Feeder Controller (radar controller for the final approach area)
FD	Flight Director
FDM	Flight Data Monitoring (procedure for collecting and analyzing FDM/QAR data)
FDR	Flight Data Recorder
FEE	Feeder (corresponds to the working position of the FC)
FEW	Few
FL	Flight Level
FM	From
FMA	Flight Mode Annunciator

FMS	Flight Management System (electronic device for flight control and flight navigation)
ft, FT	Feet (1 ft = 0,3048 m)
ft/min	Feet per minute (1 ft/min = 0,00508 m/s)
FWD	Forward
FZ	Freezing
G	Gusts
GNSS	Global Navigation Satellite System
HDG	Heading
hPa, HPA	Hektopaskal (1 hPa = 100 N/m^2)
IAS	Indicated Airspeed
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inch of Mercury (1 inHg = 3386,389 N/m^2)
IOSA	IATA Operational Safety Audit
IR	Instrument Rating
ISOL	Isolated
km, KM	Kilometer (1 km = 1000 m)
kt, KT	Knots (1 kt = 0,51444 m/s)
LAW	Landing Weight (aircraft mass at landing)
lb	Pound (1 lb = 0,4536 kg)
lct	Local Time
LI	Loaded Index
LILAW	Loaded Index at LAW
LITOW	Loaded Index at TOW
LKPR	ICAO identifier for Prag airport
LMC	Last Minute Changes
LOAN	ICAO identifier for Wr. Neustadt/Ost airport

LOC	Localizer
LOC-DME	LOC-DME Approach
LOFT	Line Oriented Flight Training
LOWW	ICAO identifier for Vienna airport
LYPG	ICAO identifier for Podgorica airport in Montenegro
MAC	Mean Aerodynamic Chord
MCTOM	Maximum Certified Take-Off Mass
METAR	Meteorological Aviation Routine Weather Report
MHz	Megahertz (1 MHz = 10^6 Hz)
MOPSC	Maximum Operational Passenger Seating Configuration
MOV	Moving
MPL(A)	Multi-Crew Pilot Licence, Aeroplane
MSL	Mean Sea Level
N	North
nm, NM	Nautical Mile (1 nm = 1852 m)
NOSIG	No Significant Change
OBS	Observation
OM	Operations Manual
PF	Pilot Flying
PFD	Primary Flight Display
PLC	Planning Controller
PM	Pilot Monitoring
Q, QNH	Altimeter sub-scale setting to obtain elevation when on ground in hPa
QAR	Quick Access Recorder (data recorder; supplement to flight data recorder (FDR) with simplified access)
QFE	Atmospheric pressure at aerodrome elevation
RA	Resolution Advisory
RAT	Risk Analysis Tool
RNAV	Area Navigation
RWY	Runway

SCT	Scattered
SEP	Single Engine Piston (licence for pilots of single-engine, piston-powered aircraft)
SERA	Standardised European Rules of the Air
SFC	Surface
SHRA	Rain Shower
SID	Standard Instrument Departure
SIG	Significant
SMS	Safety Management System
STAR	Standard Arrival Route
STCA	Short Term Conflict Alert
SUB	Sicherheitsuntersuchungsstelle des Bundes (Federal Safety Investigation Authority)
SWC	Significant Weather Chart
T	Temperature in °C
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TCAS	Traffic Alert and Collision Avoidance System
TCL	Terminal Control (competence to provide air traffic control services with the use of any surveillance equipment to aircraft operating in a specified terminal area and/or adjacent sectors)
TDZ	Touchdown Zone
TEMPO	Temporary
TIF	Trip Fuel (fuel mass used during flight)
TMA	Terminal Control Area
TN	Identifier for the predicted minimum temperature
TOF	Take-Off Fuel (fuel mass at take-off)
TOW	Take-Off Weight (aircraft mass at take-off)
TRE	Type Rating Examiner
TRI	Type Rating Instructor
TSB Canada	Transportation Safety Board Canada

TWR	Tower (meaning: aerodrome control WIEN TOWER)
TX	Identifier for the predicted maximum temperature
UTC	Universal Time Coordinated
VFR	Visual Flight Rules
VIS	Visibility
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Range
VRB	Variable
W/T	Wind/Temperature
WGS84	World Geodetic System 1984
WKN	Weakening
WXR	Weather Radar
Z	Zulu Time (UTC)
ZFW	Zero Fuel Weight (aircraft mass - DOM (Dry Operating Mass) plus payload, passengers and/or cargo but without fuel)
ZTHR	Vertical separation threshold for TCAS RAs
ZTHRTA	Vertical separation threshold for TCAS TAs

Abbreviations related to weather observations (METAR) and forecasts (TAF) can be found in the WMO manual “Aerodrome Reports and Forecasts”, WMO-No. 782 (https://library.wmo.int/doc_num.php?explnum_id=5981).

Appendices

Radiotelephony transcript WIEN RADAR

Table 12: Radiotelephony transcript WIEN RADAR

UTC time (hh:mm:ss)	From	To	Content
10:50:00	WIEN RADAR	ACFT A	[CS ACFT A] descend altitude 10-000, QNH1-0-1-4.
			Conversation with another aircraft
:19	WIEN RADAR	ACFT A	[CS ACFT A] calling a 2nd time, descend 10-000ft, Q[65]1-0-1-4.
:25	ACFT A	WIEN RADAR	[CS ACFT A] descending 10-000ft, Q1-0-1-4.
			21 conversations with other aircraft
10:53:35	WIEN RADAR	ACFT A	[CS ACFT A] speed 2-20, I call you back for descend in 2min.
			Aircraft calling in
:41	ACFT A	WIEN RADAR	[CS ACFT A].
			7 conversations with other aircraft
10:54:46	WIEN RADAR	ACFT A	[CS ACFT A] descend 8-000ft.
:51	ACFT A	WIEN RADAR	Descending 8-000ft, [CS ACFT A].
			9 conversations with other aircraft
10:56:00	WIEN RADAR	ACFT A	[CS ACFT A] fly HDG[66]1-4-5.
:04	ACFT A	WIEN RADAR	HDG1-4-5, [CS ACFT A].
			Conversation with another aircraft

[65] QNH
[66] Heading (magnetischer Steuerkurs)

UTC time (hh:mm:ss)	From	To	Content
10:56:12	ACFT B	WIEN RADAR	Wien Servus [CS ACFT B], passing 4-000, climbing 5-000.
			Conversation with another aircraft
:23	WIEN RADAR	ACFT B	[CS ACFT B] Guten Tag, climb 6-000ft and maintain, traffic above.
:26	ACFT B	WIEN RADAR	6-000ft traffic above [CS ACFT B].
			Conversation with another aircraft
:36	WIEN RADAR	ACFT A	[CS ACFT A] descend 7-000ft.
:39	ACFT A	WIEN RADAR	Descending 7-000ft, [CS ACFT A].
			4 conversations with other aircraft
10:57:13	ACFT B	WIEN RADAR	[CS ACFT B] request HDG1-7-0?
			Conversation with another aircraft
:20	WIEN RADAR	ACFT B	[CS ACFT B] HDG1-7…0 is approved.
:22	ACFT B	WIEN RADAR	1-7-0 approved.
:24	WIEN RADAR	ACFT A	[CS ACFT A] turn right HDG0-9-0 vectors for a right hand down wind and descent.
:30	ACFT A	WIEN RADAR	Right on a HDG0-9-0, [CS ACFT A].
			Conversation with another aircraft
:49	WIEN RADAR	ACFT A	[CS ACFT A] DIR[67] 1-1-9-8, bye-bye.
:53	ACFT A	WIEN RADAR	DIR 1-1-9-8, [CS ACFT A].
:57	WIEN RADAR	ACFT B	[CS ACFT B] climb FL2-3-0.
:59	ACFT B	WIEN RADAR	Climb level 2-3-0, [CS ACFT B].
			2 conversations with other aircraft
10:58:24	WIEN RADAR	ACFT B	[CS ACFT B] stop climb immediately!
:29	ACFT B	WIEN RADAR	Stop climb immediately, [CS ACFT B].
			Aircraft calling in

[67] Director (meaning: approach contol WIEN DIRECTOR)

UTC time (hh:mm:ss)	From	To	Content
10:58:34	WIEN RADAR	ACFT B	[CS ACFT B] essential traffic, 12 o'clock, 2.3nm crossing, left to right, miss-navigating, same altitude.
:42	ACFT B	WIEN RADAR	Climbing TCAS RA.
			5 conversations with other aircraft
10:59:24	WIEN RADAR	ACFT B	[CS ACFT B] continue climb level 2-3-0.
10:59:28	ACFT B	WIEN RADAR	Clear of conflict and continue climb 2-3-0, [CS ACFT B].
			8 conversations with other aircraft
11:00:33	ACFT B	WIEN RADAR	[CS ACFT B] just for information, 2min ago we had a TCAS RA.
			Radar controller (EC) release (controller change)
:36	WIEN RADAR	ACFT B	[CS ACFT B] that's ah… copied.
			4 conversations with other aircraft
11:01:42	WIEN RADAR	ACFT B	[CS ACFT B] contact BUD[68] on 1-3-3,2, Servus.
:47	ACFT B	WIEN RADAR	1-3-3,2 bye-bye, [CS ACFT B].

Source: ANSP; time data and layout: SUB

[68] Budapest (meaning: area control BUDAPEST RADAR)

Radiotelephony transcript WIEN DIRECTOR

Table 13: Radiotelephony transcript WIEN DIRECTOR (119,8 MHz)

UTC time (hh:mm:ss)	From	To	Content
10:58:17	ACFT A	WIEN DIRECTOR	DIR Guten Tag [CS ACFT A], we got a right turn on HDG0-9-0.
:22	WIEN DIRECTOR	ACFT A	[CS ACFT A] Servas, confirm right turn?
:26	ACFT A	WIEN DIRECTOR	Affirm, we got a right turn on HDG0-9-0, [CS ACFT A].
:30	WIEN DIRECTOR	ACFT A	[CS ACFT A] roger, traffic at your right wing, same level, climbing through your level.
:37	ACFT A	WIEN DIRECTOR	In sight, [CS ACFT A].
:39	WIEN DIRECTOR	ACFT A	[CS ACFT A] roger, descend 6-000ft.
:43	ACFT A	WIEN DIRECTOR	[CS ACFT A] TCAS RA.
			Conversation with another aircraft
10:59:14	ACFT A	WIEN DIRECTOR	[CS ACFT A] clear of conflict, we are levelling off at 6-000 and continue now right turn.
:19	WIEN DIRECTOR	ACFT A	[CS ACFT A] can you stop the right turn HDG3-4-0?
:23	ACFT A	WIEN DIRECTOR	Stopping the turn HDG3-4-0, [CS ACFT A].
:26	WIEN DIRECTOR	ACFT A	Ah [CS ACFT A] ah disregard that, continue the right turn HDG0-9-0 and descent 4-000.
:32	ACFT A	WIEN DIRECTOR	Continuing in HDG0-9-0, descending 4-000ft, [CS ACFT A].
			2 conversations with other aircraft
:56	WIEN DIRECTOR	ACFT A	[CS ACFT A] would a radar HDG0-7-0 or 0-8-0 be fine for you as well?
11:00:03	ACFT A	WIEN DIRECTOR	0-7-0 is fine, [CS ACFT A].
:06	WIEN DIRECTOR	ACFT A	Okay, do so, thank you.
11:00:11	ACFT A	WIEN DIRECTOR	[CS ACFT A] I glab da hat sich dxx Kollegxx [de-identified] vertahn mit'n right turn, oder?

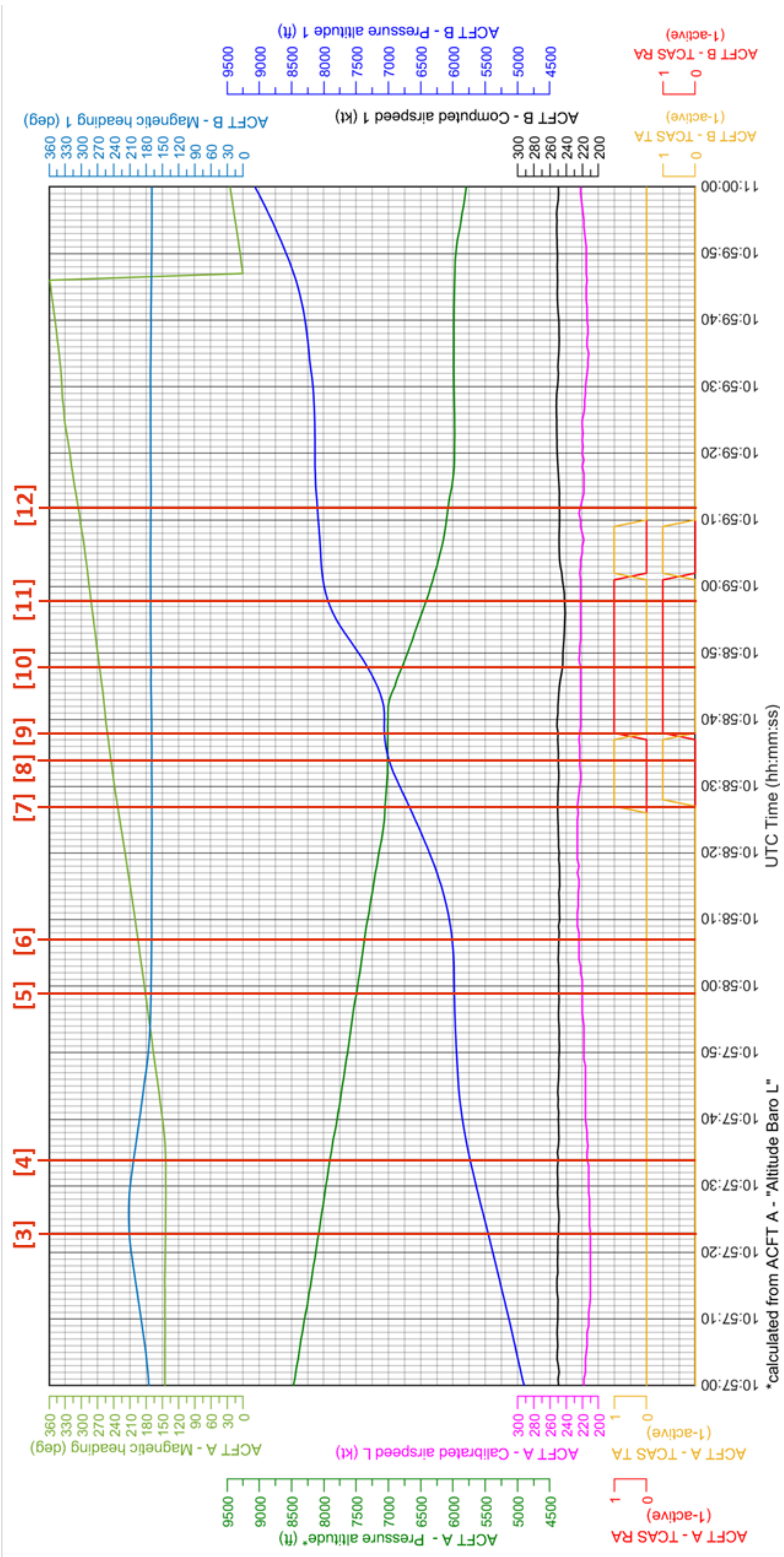
UTC time (hh:mm:ss)	From	To	Content
:15	WIEN DIRECTOR	ACFT A	Ja, des ah dürft so sein, ja [CS ACFT A].
:17	ACFT A	WIEN DIRECTOR	??? [unintelligible].
:28	WIEN DIRECTOR	ACFT A	Na… [CS ACFT A] continue the right turn HDG east, just for few miles.
:33	ACFT A	WIEN DIRECTOR	Continuing HDG east, [CS ACFT A].
			Conversation with another aircraft
:57	WIEN DIRECTOR	ACFT A	[CS ACFT A] descend 3-000ft.
11:01:01	ACFT A	WIEN DIRECTOR	Descending 3-000, [CS ACFT A].
			2 conversations with other aircraft
:25	WIEN DIRECTOR	ACFT A	[CS ACFT A] left HDG3-6-0.
:29	ACFT A	WIEN DIRECTOR	Left HDG3-6-0, [CS ACFT A].
			Conversation with another aircraft
:55	WIEN DIRECTOR	ACFT A	[CS ACFT A] cleared ILS3-4.
:58	ACFT A	WIEN DIRECTOR	Cleared ILS3-4, [CS ACFT A].
			2 conversations with other aircraft
11:02:47	WIEN DIRECTOR	ACFT A	[CS ACFT A] reduce to 1-60.
:50	ACFT A	WIEN DIRECTOR	Reducing to 1-60, [CS ACFT A].
			2 conversations with other aircraft
11:03:59	WIEN DIRECTOR	ACFT A	And [CS ACFT A] contact TWR[69] 1-2-3-8, Servus.
11:04:02	ACFT A	WIEN DIRECTOR	TWR 1-2-3-8, [CS ACFT A] Ciao.
			Radar controller (FC) release (controller change)

Source: ANSP; time data and layout: SUB

[69] Tower (meaning: aerodrome control WIEN TOWER)

Illustration of relevant QAR data

Figure 25: Illustration of relevant QAR data



Source: aircraft operator; time data and layout: SUB

Summary of relevant regulations

Essential traffic information

ICAO Doc 4444 Sixteenth Edition, 2016, version of 10.11.2016:

„[…]
Chapter 5 – SEPARATION METHODS AND MINIMA […]

5.10 ESSENTIAL TRAFFIC INFORMATION

5.10.1 General

5.10.1.1 Essential traffic is that controlled traffic to which the provision of separation by ATC is applicable, but which, in relation to a particular controlled flight is not, or will not be, separated from other controlled traffic by the appropriate separation minimum.

Note.— Pursuant to Section 5.2, but subject to certain exceptions stated therein, ATC is required to provide separation between IFR flights in airspace Classes A to E, and between IFR and VFR flights in Classes B and C. ATC is not required to provide separation between VFR flights, except within airspace Class B. Therefore, IFR or VFR flights may constitute essential traffic to IFR traffic, and IFR flights may constitute essential traffic to VFR traffic. However, a VFR flight would not constitute essential traffic to other VFR flights except within Class B airspace.

5.10.1.2 Essential traffic information shall be given to controlled flights concerned whenever they constitute essential traffic to each other.

Note.— This information will inevitably relate to controlled flights cleared subject to maintaining own separation and remaining in visual meteorological conditions and also whenever the intended separation minimum has been infringed.

5.10.2 Information to be provided

Essential traffic information shall include:

a) direction of flight of aircraft concerned;

b) type and wake turbulence category (if relevant) of aircraft concerned;

c) cruising level of aircraft concerned; and

1) estimated time over the reporting point nearest to where the level will be crossed; or

2) relative bearing of the aircraft concerned in terms of the 12-hour clock as well as distance from the conflicting traffic; or

3) actual or estimated position of the aircraft concerned.

Note 1. — Nothing in Section 5.10 is intended to prevent ATC from imparting to aircraft under its control any other information at its disposal with a view to enhancing air safety in accordance with the objectives of ATS as defined in Chapter 2 of Annex 11.

Note 2.— Wake turbulence category will only be essential traffic information if the aircraft concerned is of a heavier wake turbulence category than the aircraft to which the traffic information is directed. […]*“*

Short Term Conflict Alert (STCA)

ICAO Doc 4444 Sixteenth Edition, 2016, version of 10 November 2016:

„[…]

Chapter 5 –SEPARATION METHODS AND MINIMA […]

15.7 OTHER ATC CONTINGENCY PROCEDURES […]

15.7.2 Short-term conflict alert (STCA) procedures

Note 1.— The generation of short-term conflict alerts is a function based on surveillance data, integrated into an ATC system. The objective of the STCA function is to assist the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima.

Note 2. — In the STCA function the current and predicted three-dimensional positions of aircraft with pressure-altitude reporting capability are monitored for proximity. If the distance between the three-dimensional positions of two aircraft is predicted to be reduced to less than the defined applicable separation minima within a specified time period, an acoustic and/or visual alert will be generated to the controller within whose jurisdiction area the aircraft is operating.

15.7.2.1 Local instructions concerning use of the STCA function shall specify, inter alia:

a) the types of flight which are eligible for generation of alerts;

b) the sectors or areas of airspace within which the STCA function is implemented;

c) the method of displaying the STCA to the controller;

d) in general terms, the parameters for generation of alerts as well as alert warning time;

e) the volumes of airspace within which STCA can be selectively inhibited and the conditions under which this will be permitted;

f) conditions under which specific alerts may be inhibited for individual flights; and Chapter 15. Procedures Related to Emergencies, Communication Failure and Contingencies 15-19

g) procedures applicable in respect of volume of airspace or flights for which STCA or specific alerts have been inhibited.

15.7.2.2 In the event an STCA is generated in respect of controlled flights, the controller shall without delay assess the situation and, if necessary, take action to ensure that the applicable separation minimum will not be infringed or will be restored.

15.7.2.3 Following the generation of an STCA, controllers should be required to complete an air traffic incident report only in the event that a separation minimum was infringed.

15.7.2.4 The appropriate ATS authority should retain electronic records of all alerts generated. The data and circumstances pertaining to each alert should be analysed to determine whether an alert was justified or not. Non-justified alerts, e.g. when visual separation was applied, should be ignored. A statistical analysis should be made of justified alerts in order to identify possible shortcomings in airspace design and ATC procedures as well as to monitor overall safety levels. […]“

Radio Communication Procedures for the Aeronautical Mobile Service

AIC B 4/12, effective date 23 August 2012:

„[…]

5.1.7 TCAS climb/descent

5.1.7.1 After a flight crew starts to deviate from any ATC clearance or instruction to comply with an ACAS resolution advisory (RA) (pilot and controller interchange)

A: ***TCAS RA***
G: ***ROGER***

5.1.7.2 After the response to an ACAS RA is completed and a return to the ATC clearance or instruction is initiated (pilot and controller interchange)

A: ***CLEAR OF CONFLICT, RETURNING TO*** *(assigned clearance)*
G: ***ROGER*** *(or alternative instructions)*

5.1.7.3 After the response to an ACAS RA is completed and the assigned ATC clearance or instruction has been resumed (pilot and controller interchange)

A: ***CLEAR OF CONFLICT*** *(assigned clearance)* ***RESUMED***
G: ***ROGER*** *(or alternative instructions)*

5.1.7.4 After an ATC clearance or instruction contradictory to the ACAS RA is received, the flight crew will follow the RA and inform ATC directly (pilot and controller interchange)

A: ***UNABLE, TCAS RESOLUTION ADVISORY***
G: ***ROGER***
[…]“

TCAS/ACAS

Implementing Regulation (EU) No. 923/2012, version of 06 June 2017:

„[…]

SECTION 3 – General rules and collision avoidance […]

CHAPTER 2 – Avoidance of collisions […]

SERA.3201 General

Nothing in this Regulation shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment, as will best avert collision. […]

SERA.11014 ACAS resolution advisory (RA)

a) ACAS II shall be used during flight, except as provided in the minimum equipment list specified in Commission Regulation (EU) No 965/2012 ([1]) in a mode that enables RA indications to be produced for the flight crew when undue proximity to another aircraft is detected. This shall not apply if inhibition of RA indication mode (using traffic advisory (TA) indication only or equivalent) is called for by an abnormal procedure or due to performance-limiting conditions.

b) In the event of an ACAS RA, pilots shall:

1. *respond immediately by following the RA, as indicated, unless doing so would jeopardise the safety of the aircraft;*
2. *follow the RA even if there is a conflict between the RA and an ATC instruction to manoeuvre;*
3. *not manoeuvre in the opposite sense to an RA;*
4. *as soon as possible, as permitted by flight crew workload, notify the appropriate ATC unit of any RA which requires a deviation from the current ATC instruction or clearance;*
5. *promptly comply with any modified RAs;*

6. *limit the alterations of the flight path to the minimum extent necessary to comply with the RAs;*
7. *promptly return to the terms of the ATC instruction or clearance when the conflict is resolved; and*
8. *notify ATC when returning to the current clearance.*

c) When a pilot reports an ACAS RA, the controller shall not attempt to modify the aircraft flight path until the pilot reports 'CLEAR OF CONFLICT'.

d) Once an aircraft departs from its ATC clearance or instruction in compliance with an RA, or a pilot reports an RA, the controller ceases to be responsible for providing separation between that aircraft and any other aircraft affected as a direct consequence of the manoeuvre induced by the RA. The controller shall resume responsibility for providing separation to all the affected aircraft when:

1. *the controller acknowledges a report from the flight crew that the aircraft has resumed the current clearance; or*
2. *der the controller acknowledges a report from the flight crew that the aircraft is resuming the current clearance and issues an alternative clearance which is acknowledged by the flight crew.*

Footnote:

([1]) Commission Regulation (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 296, 25.10.2012, p. 1). […]“

Regulation (EU) No. 965/2012, version of 22 March 2017:

„[…]

ANNEX IV – COMMERCIAL AIR TRANSPORT OPERATIONS (PART-CAT) […]

SECTION 1 – Motor-powered aircraft […]

CAT.GEN.MPA.105 Responsibilities of the commander […]

c) Whenever an aircraft in flight has manoeuvred in response to an airborne collision avoidance system (ACAS) resolution advisory (RA), the commander shall submit an ACAS report to the competent authority. […]

SUBPART B – OPERATIONAL PROCEDURES

SECTION 1 – Motor-powered aircraft […]

CAT.OP.MPA.295 Use of airborne collision avoidance system (ACAS)

The operator shall establish operational procedures and training programmes when ACAS is installed and serviceable so that the flight crew is appropriately trained in the avoidance of collisions and competent in the use of ACAS II equipment. […]

SUBPART D – INSTRUMENTS, DATA AND EQUIPMENT

SECTION 1 – Aeroplanes […]

CAT.IDE.A.155 Airborne collision avoidance system (ACAS)

Unless otherwise provided for by Regulation (EU) No 1332/2011, turbine-powered aeroplanes with an MCTOM[70] of more than 5 700 kg or an MOPSC[71] of more than 19 shall be equipped with ACAS II. […]“

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[70] Maximum Certified Take-Off Mass

[71] Maximum Operational Passenger Seating Configuration

Regulation (EU) No. 1332/2011, version of 25 August 2016:

„[…]
Article 2 – Definitions […]

1. 'airborne collision avoidance system (ACAS)' means an aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders;

2. 'airborne collision avoidance system II (ACAS II)' means an airborne collision avoidance system which provides vertical resolution advisories in addition to traffic advisories;

3. 'resolution advisory (RA) indication' means an indication given to the flight crew recommending a manoeuvre intended to provide separation from all threats or a manoeuvre restriction intended to maintain existing separation;

4. 'traffic advisory (TA) indication' means an indication given to the flight crew that the proximity of another aircraft is a potential threat. […]

ANNEX – Airborne collision avoidance systems (ACAS) II (Part - ACAS)

AUR.ACAS.1005 Performance requirement

1. *The following turbine-powered aeroplanes shall be equipped with collision avoidance logic version 7.1 of ACAS II:*

   a) aeroplanes with a maximum certificated take-off mass exceeding 5 700 kg;

   b) aeroplanes authorised to carry more than 19 passengers.

2. *Aircraft not referred to in point 1 which are equipped on a voluntary basis with ACAS II shall have collision avoidance logic version 7.1.*

3. *Point 1 shall not apply to unmanned aircraft systems.*

AUR.ACAS.1010 ACAS II training

Operators shall establish ACAS II operational procedures and training programmes so that the flight crew is appropriately trained in the avoidance of collisions and becomes competent in the use of ACAS II equipment. […]*“*

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