Air Accident Investigation Unit
(Belgium)
Federal Public Service
Mobility and Transport
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Safety Investigation Report

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Status: Final

About this report

As per Annex 13 and EU regulation EU 996/2010, each civil aviation safety investigation shall be concluded with a report in a form appropriate to the type and seriousness of the accident and serious incident. For this occurrence, a limited-scope, fact-gathering investigation and analysis was conducted in order to produce a short summary report.
It is not the purpose of the Air Accident Investigation Unit to apportion blame or liability. The sole objective of the investigation and the reports produced is the determination of the causes, and, where appropriate define recommendations in order to prevent future accidents and incidents.

INTRODUCTION

Classification:	Serious Incident	**Occurrence category:**	MAC: Airprox
Level of investigation:	Limited	**Type of operation:**	Commercial Air Transport - Passengers
Date and time[1]:	23 February 2018 10:35 UTC	**Phase:**	En-route – Climb to Cruise
Location:	Brussels TMA (class C airspace) around FL 70	**Operators:**	1. Air Europa Express 2. Deutsches Lufthansa
Aircraft:	1. ERJ195LR 2. A320-214	**Aircraft damage:**	No damage
Aircraft category:	Fixed Wing – Aeroplane – Large Aeroplane (MTOW > 5700 kg)	**Injuries:**	None

Abstract:

During departure from Runway 07R of Brussels Airport 2 subsequent aircraft were put on a converging course by ATC. This triggered a reaction from the ATC controller and eventually a TCAS RA around FL 70. The closest point of approach between the two airplanes is estimated to be 400 ft vertically and 1.36 NM horizontally.

[1] All time data in this report are indicated in UTC, unless otherwise specified

Table 1: Airprox data

	Aircraft 1	Aircraft 2
Aircraft model	Embraer ERJ195	Airbus A320-200
Airspace	Brussels TMA	Brussels TMA
Class	C	C
Rules	IFR	IFR
Service	Control service for separation IFR from IFR and IFR from VFR	Control service for separation IFR from IFR and IFR from VFR
Provider	Brussels Departure	Brussels Departure
Transponder	A, C, S	A, C, S
Speed	298 kt	278 kt
Track	235°	160°
Colours	White and blue tail	White and blue tail
Lighting	Strobes and nav	Strobes and nav
Meteo conditions	VMC	VMC
Traffic alert issued by ATS	No	No
Traffic alert heard	N/A	N/A
ACAS	TCAS	TCAS
Alert	TA followed by RA 'LEVEL OFF'	TA followed by RA 'CLIMB' followed by RA 'LEVEL OFF'
Visual contact	Yes	Yes
Separation		
Reported	/	/
Recorded	400 ft vertically and 1.36 NM horizontally	
Separation minima	1000 ft vertically – 3 NM horizontally	

Table 2: Summary of factors

Organisational	Management – Policy/procedure – Availability of procedures - ATC Management – Resources – Availability of equipment - ATC
Technical	Not determined
Human	Action/decision – Action – Incorrect action selection - ATCO Action/decision – Info processing - Expectation/assumption- ATCO Psychological – Perception/orientation/illusion – Situational awareness – ATCO Psychological – Mental/emotional state – Stress - ATCO Physical – Alertness/Fatigue – General – ATCO Task performance – Coordination – Between trainee ATCO and OJTi Task performance – Monitoring – OJTi Action/decision – action – Delayed action/lack of action – Flight crew
Environmental	Task environment – Physical workspace – Positioning – Effect on ATC OJTi Task environment – Physical workspace – Warnings/alarms – Availability of related info Operating environment – Air traffic – Departure procedure(s) – Effect on operation

1 FACTUAL INFORMATION

1.1 History of flight

At Brussels airport, at the time of the incident, the runway selection was as follows due to the wind conditions; runway 07R for departures and runway 01 for arrivals.

All departures from Brussels airport and traffic in the east part of the terminal maneuvering area (TMA) of Brussels were control of the 'Brussels Departure' station of the by the Approach Control Service (APP) on frequency 126.625. At that time this sector was manned by a trainee ATC Officer (ATCO) coached by an on-the-job training instructor (OJTi).

At 10:30:11, a Beechcraft B300 King Air 350 (hereafter named B350) called in on 'Departure' (DEP) frequency 126.625 after taking off from Antwerp Airport EBAW on the SID GILOM 2F (heading VOR station BUN). The B350 was passing 4500 ft QNH and instructed by the ATCO to continue on that heading and to climb to FL150.

At 10:32:15 an Embraer 195 with callsign AEA1172 (hereafter named ERJ195) called in 126.625. It was a flight under an IFR flight plan to Madrid (LEMD). The ERJ195 just took off from runway 07R under control of Brussels Tower and was following the CIV 7J departure. The aircraft was passing 3700 ft QNH with a climb rate of 100 ft/min. The ATCO cleared the Embraer to FL 070. Climb rate increased to 3000 ft/min.

An A320 with callsign DLH4Y took off 2 minutes after the Embraer, following the SPI 5J departure. The A320 was flying under an IFR flight plan to Frankfurt (EDDF) and called in on the DEP frequency at 10:32:42. The aircraft was passing 2700 ft and had a climb rate of 2800 ft/min. The A320 was cleared to FL 080. At this time, the preceding Embraer was passing 4800 ft.

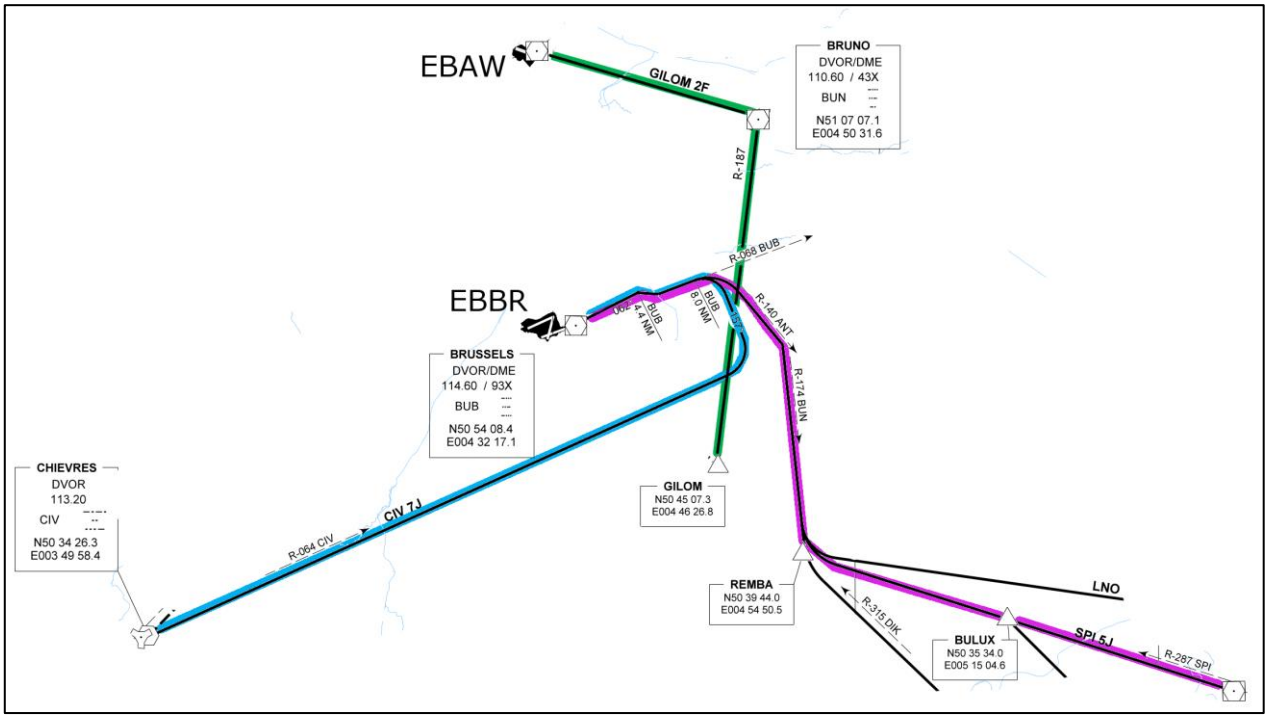

Figure 1: showing the 3 cleared departure routes: GILOM 2F (green) for the B350, SPI 5J (blue) for the ERJ195 and CIV 7J (magenta) for the A320 (superposition of the different available charts, not on scale)

At 10:32:57, the AEA1172 is re-cleared to climb and maintain FL 80, and is advised about opposite traffic above (flight TAR788, a A320 at FL 90 FLO-BUB, destination EBBR RWY 01)

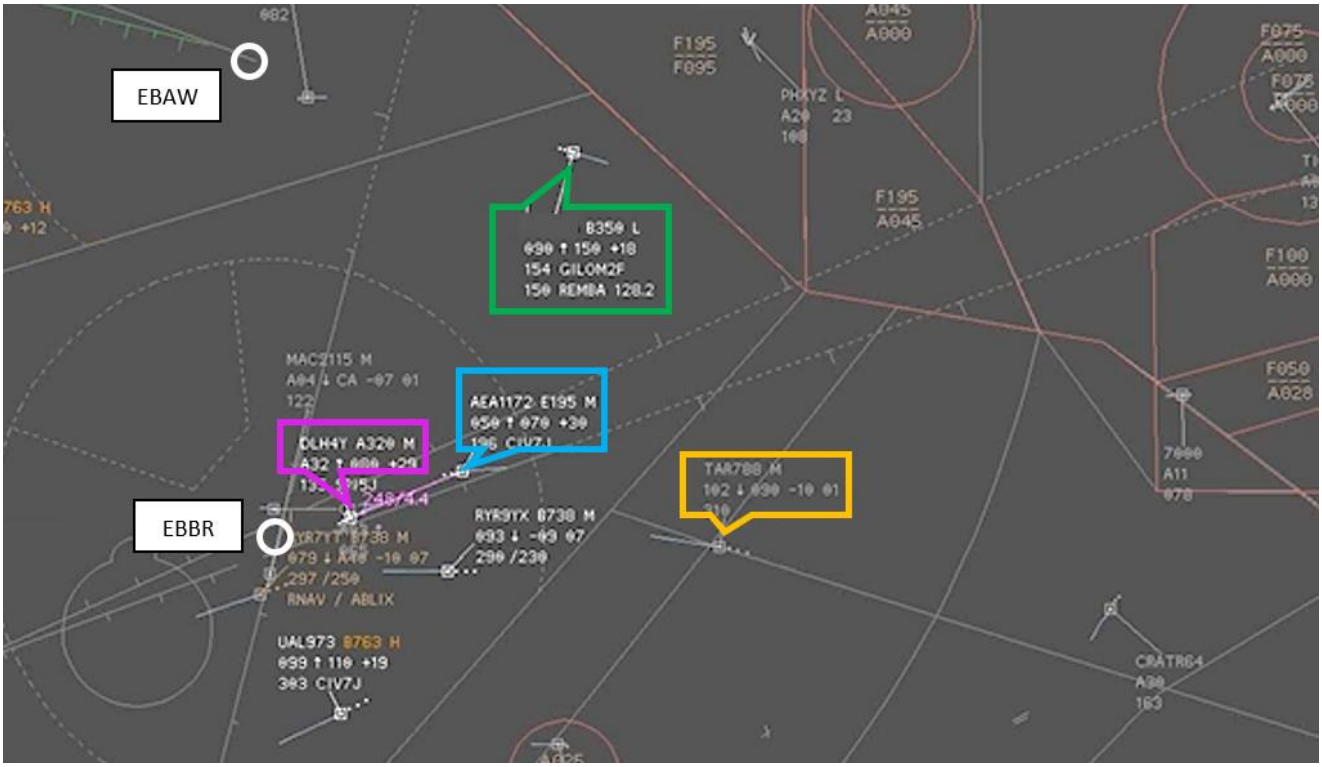

Figure 2: radar display at 10:32:57 showing the A320 (magenta), the ERJ195 (blue), the B350 (green) and the A320 at FL 90 inbound EBBR (yellow)

At 10:33:10, the B350 was routed direct to waypoint REMBA. The aircraft turned almost overhead BUN towards REMBA (right turn) putting him on a track crossing the extended axis of RWY 07R at around 14 NM.

At 10:33:21, the ERJ195 was instructed to turn right to VOR station CIV.

At 10:34:03, the A320 was instructed to turn right to REMBA. At this moment the A320 was passing 4900 ft (+ 1400 ft/min) and the ERJ190 was passing FL 61 (+ 700 ft/min).

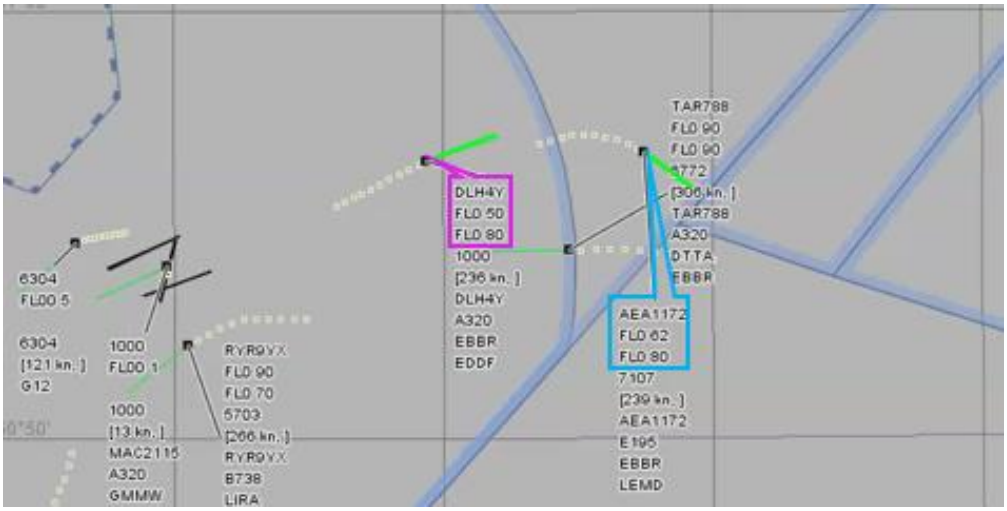

Figure 3: radar replay (not the real display an ATCO sees) at 10:34:05 showing the right-hand turn of the ERJ195 (blue)

At 10:34:19, the A320 started its right-hand turn, passing FL 56 (+3400 ft/min) and was laterally 5 NM from the ERJ195, who was passing FL 63 (+700 ft/min).

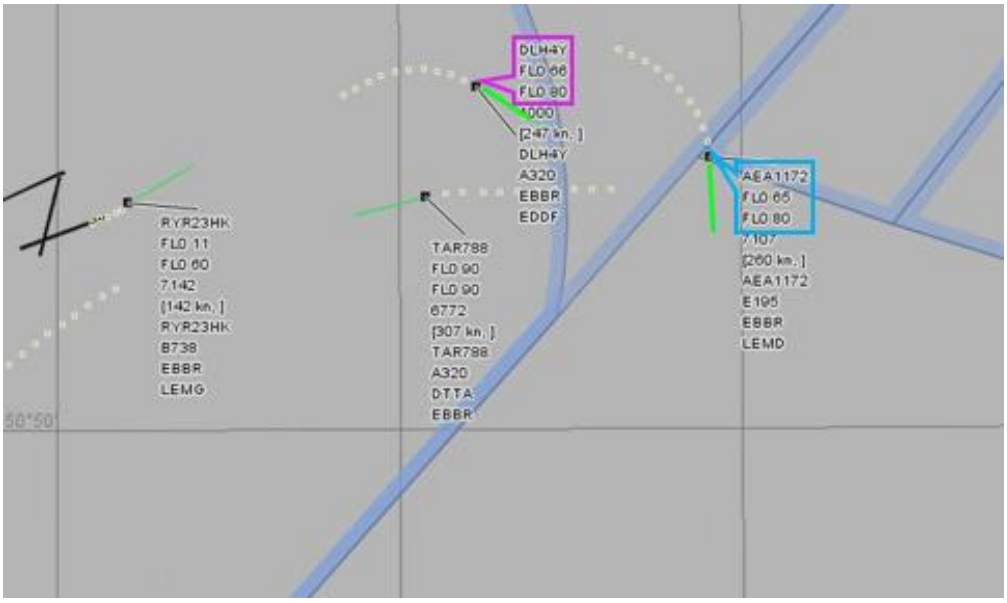

Figure 4: radar replay at 10:34:34 showing the right-hand turn of the A320 (magenta)

At 10:34:45, RYR23HK, a Boeing 737 just taken off from Brussels, was calling in on the frequency. During the call, at 10:34:49, the Short Term Conflict Alert (STCA) became visible on the radar display. The A320 was passing FL 69 (+1200 ft/min) and was 4 NM laterally separated from ERJ195, who was passing FL 67 (+700 ft/min).

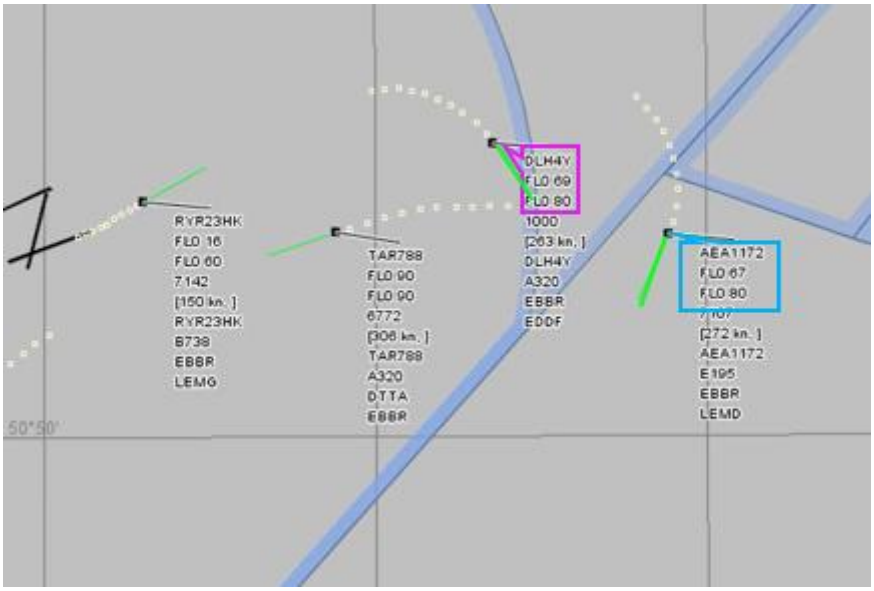

Figure 5: radar replay at 10:34:49, the moment the STCA pops up on the ATCO's display

Figure 6: how STCA is shown on radar display

Transcript:

RYR22HK: "Departure, good day, RYR22HK, passing 1800 ft climbing 6000 ft, on a CIV7J departure"

At 10:35:54:
ATCO: "RYR4Y, stop climb flight level…, correction DLH…4Y….."

At 10:35:00:
ATCO: "AEA1172, turn left HDG180, immediately"
ERJ195: "Left HDG180, immediately"

At 10:35:06:
ATCO: "DLH4Y turn left heading…, stop climb immediately"
A320: "DLH4Y, stopping climb"

At 10:35:14:
ATCO: "AEA1172, descend level 60"
ERJ195: "Unable AEA1172, TCAS RA"

At 10:35:26 the A320 also reported TCAS RA

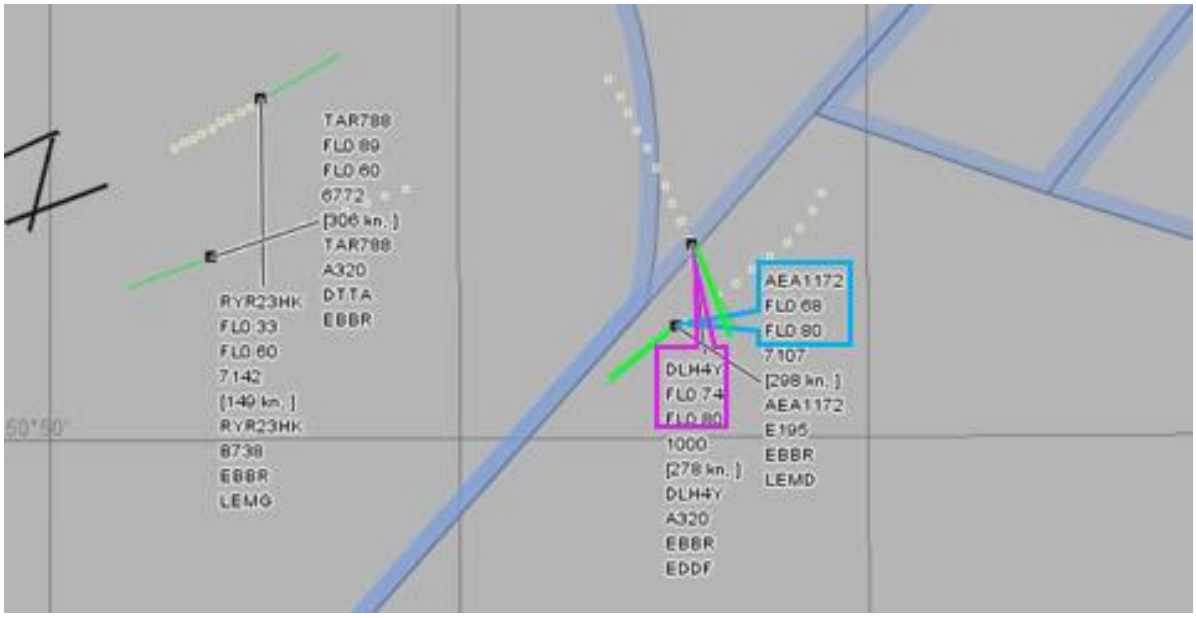

Figure 7: radar replay during closest point of approach (CPA) at 10:35:27

At 10:35:43 the ERJ195 reported clear of conflict. ATC (taken over by the ATC instructor) responded that the aircraft was cleared to continue climbing to FL 110.

At 10:36:11 the A320 at FL 76 called ATC to request climbing instruction, the ATC cleared it to FL 110.

Evolution of the loss of separation:

At 10:35:05, separation lost; 2,9 NM – 400 ft
At 10:35:17: 1,9 NM – 400 ft
At 10:35:21: 1,6 NM – 400 ft
At 10:35:25: 1,4 NM – 500 ft (gradually increase of vertical separation)
At 10:35:30: 1,3 NM – 700 ft (just past the closest point of approach)
At 10:35:33: 1,3 NM – 800 ft (gradually increase of horizontal separation)
At 10:35:37: 1,5 NM – 800 ft
At 10:35:48, the vertical separation was restored: 2,2 NM – 1000 ft

1.2 Crew reports

1.2.1 Crew report AEA1172 – ERJ195

“Departure assigned CIV 7J with initial climbing clearance of FL060. After departure we switched to 126.625 and ATC cleared us to climb FL080 and to be aware of a traffic 1000ft above us.

We located the traffic with no problem, flying from North to South. In order to avoid the RA, the Pilot Flying (PF) switched to VS (vertical speed) autopilot mode with a rate of climb of 800 fpm.

After that, once cleared of that traffic, we were cleared to fly direct to waypoint CIV. As we were turning to CIV (right turn to heading 250), and slowly increasing airspeed we received an incoming communication of “turn immediately left heading 180”.

As we received the radio call, the TCAS alerted us with a “TRAFFIC TRAFFIC” of an aircraft we were not informed about. Just after that, as the pilot flying was commanding the turn, we received a further ATC instruction of immediate descend.
In order to recall, we were climbing, accelerating and turning right and we received a complete modification of the path request to turn left and descend.
Just as we were receiving the descend instruction, the TCAS RA ordered a “LEVEL OFF”. I informed ATC with an unable, “TCAS RA”. The PF disconnected the autopilot and followed the TCAS and I managed to have visual contact with the traffic.

After the “CLEAR OF CONFLICT”, we resumed the flight. ATC gave not more information related to the conflict.”

1.2.2 Crew report DLH4Y – A320

Captain:
"Weather was CAVOK. When changing to departure frequency, we received a new altitude clearance. Much traffic. When the TCAS RA was generated, we could immediately identify the intruder aircraft. The TCAS RA was followed according to OM/B (Operations Manual part B)."

First Officer:
"The RA was followed, however slightly delayed, following a verbal input from my side. Pilot flying was CM1 (crew member 1 or captain). At the time of the event the weather was clear. We were in VMC, and the traffic was in sight. At the time of the RA no risk of collision existed anymore. Shortly before the "Climb" RA, the ATC controller advised us to stop the climb."

1.3 Aircraft information

Table 3: General data on involved aircraft

Type	Beechraft B350	Embraer ERJ195	Airbus A320-200
State of Registry	Belgium	Spain	Germany
Crew	1-2	2	2
Capacity	11	120	168
Propulsion type	2 turboprop	2 turbofan	2 turbofan
Propulsion make	PT6A-60A	GE CF34-10E5A1	CFM56-5B4/P
MTOM	6 804 kg	49 000 kg	78 000 kg

1.4 Personnel Information

The ATC Personnel

The radar sector was manned by 2 persons, a trainee ATCO and an On-the job training instructor (OJTI).

Table 4: Trainee controller data

Age	30
License	Holder of an Air Traffic Controller Licence first issued by the Civil Aviation Agency of Latvia in July 2008.
Ratings	ACS – Area Control Surveillance APS – Approach Control Surveillance
Endorsement	TCL – Terminal Control
English proficiency	Level 5

The trainee controller was an active controller in Latvia before he was recruited by Skeyes. Although already qualified generically, a traffic controller, before being considered operational, must be trained for the specific surroundings, procedures and equipment of his new assignment. This is done for the most part with an on-the-job training (OJT). This training is done in several phases, where the last one, Phase 3 is performing the actual task of an ATCO, under the supervision of an instructor (OJTi)

The trainee started his on the job training on October 9th, 2017 and had already completed 81 days of OJT. Although the trainee had been a qualified ATCO with Riga ATC in Latvia, the training at EBBR APP did not always progress as could be anticipated. It required a lot of attention from the On-the-job Instructors and during the debriefings a number of issues to improve were formulated.
At the end of his Phase 2 (Day 30), it was decided that, due to an insufficient positive learning curve, a ‘re-sit’ of that phase was necessary for this trainee. At the time of the incident, the trainee was in Phase 3, day 22 and could theoretically be released as qualified APP ATCO after Phase 3, day 35 (13 training days later). It is therefore imperative at this stage of the training, that the trainee shows the ability to work alone or at least, to some degree, independent from his On-the-job Instructor (OJTi).

Already in his 82nd day of training, the trainee stated in the interview that it has been a hard and tiring training. During this training, he wants to be at his very best to prove to the OJTi’s that he is able to perform his tasks as an APP ATCO. Every training day can be considered as an examination which induces extra stress.

In previous debriefings OJTi’s were regularly mentioning his low voice, sometimes difficult to comprehend, as an action item to be improved for the trainee.

That day he started his shift at 06:45 UTC and had a break 30 minutes before the incident.

The On the job training Instructor (OJTI)

Table 5: OJTi data

Age	54
License	Holder of an Air Traffic Controller Licence first issued by the Belgian Civil Aviation Authority in December 1992.
Ratings	Active - APS – Approach Control Surveillance ADV – Aerodrome Control Visual since December 1992. ADI – Aerodrome Control Instruments since December 1992. APP - Approach Control Procedural since December 1992. APS – Approach Control Surveillance since May 1997. ACP – Area Control Procedural since May 1997. ACS – Area Control Surveillance since May 1997
Endorsement	Active – SRA (Surveillance Radar Approach) and TCL (Tower Control) TWR – Tower Control - since December 1992. GMC – Ground Movement Control - since December 1992. GMS – Ground Movement Surveillance - since December 1992. AIR – Air Control - since December 1992. RAD – Aerodrome Radar Control - since December 1992. SRA – Surveillance Radar Approach - since May 1997. TCL – Tower Control – since May 1997
Other endorsements	OJTI – valid until May 2020. Assessor – valid until 2019.
English proficiency	Level 4

The instructor has a lot of experience as both active ATCO and instructor. He was the designated trainer for this trainee on 2 other days and added positive comments to both debriefing reports.
On this day, they started in the morning, and they were roughly at mid-day. He considered the traffic at the time of the incident as not heavy. According to him the trainee had experience of heavy traffic, and earlier on the day, they had the peak hours of departures and arrivals.

1.5 Meteorological information

Weather was CAVOK (ceiling (or clouds) and visibility OK), meaning that visibility was at least 10 kilometres, and no clouds below 5000 feet. At the time and location of the incident there were no clouds at all. So Visual Meteorological Conditions (VMC) prevailed.

1.6 Airspace information

The incident occurred in terminal control area, also known as a terminal manoeuvring area (TMA) of Brussels Airport. It is a designated area of controlled airspace surrounding a major airport where there is a high volume of traffic. The Brussels TMA is divided into different segments each having different vertical limits. At the closest point of approach (CPA), aircraft one was flying in Brussels TMA 5 (with lower limit of 3500 ft AMSL) and aircraft 2 was flying in Brussels TMA 1 (with lower limit of 1500 ft AMSL). However both TMA's are airspace class C and under control of the same unit on the same frequency ('Brussels Departure').

Airspace class C means that all aircraft are subject to clearance and that separation is provided by ATC between IFR and IFR flights and between IFR and VFR flights. The minimum separation required in Brussels TMA is 1000 ft vertical and reduced to 3 NM horizontal (due to the capability of the airport terminal surveillance radar).

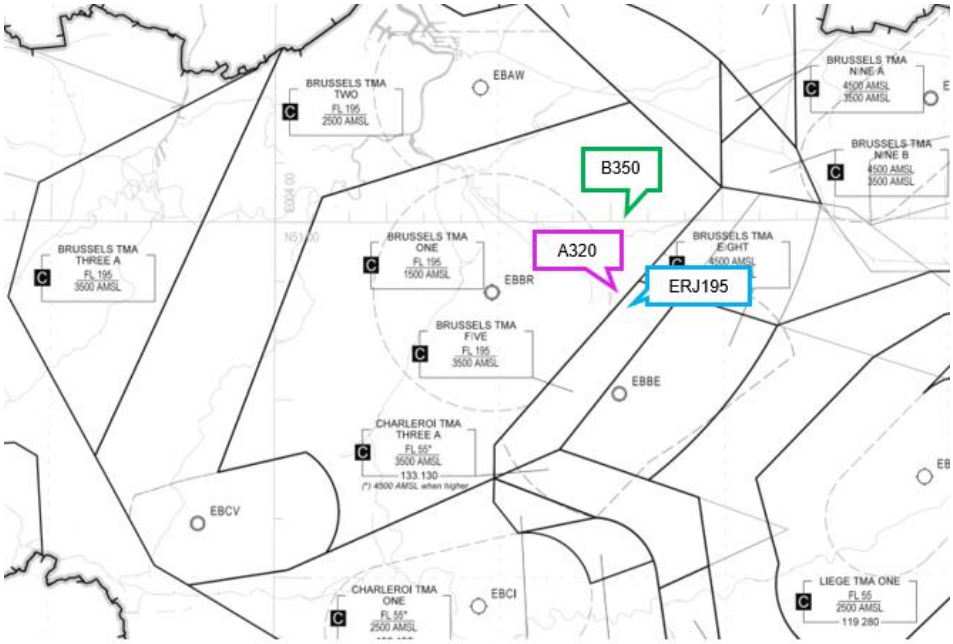

Figure 8: airspace configuration

1.7 Standard instrument departure routes

Aircraft taking off from Brussels und an IFR (instrument flight rules) plan are assigned published routes, the Standard Instrument Departure (SID). A SID is a coded departure procedure that has been established at certain to simplify clearance delivery procedures. It strikes a balance between terrain and obstacle avoidance, noise abatement (if necessary), and airspace management considerations. Such a route will guide the aircraft to the cruise track and cruise level. The assigned routes are visualized on Figure 1.

AEA1172 was flying to LEMD using the CIV 7J route towards Chièvres (CIV). The procedure is as follows: Flying the runway track until 700 ft QNH where a slight turn has to be made to track 062°. At a distance of 4,4 NM from BUB radial 068 has to be intercepted. At 8 NM of BUB a right turn has to be made to intercept track 157° and subsequently to intercept radial 064 inbound CIV.

DLH4Y was flying East, to EDDF, using the SPI 5J route towards the REMBA reference point. This procedure is the same as for CIV 7J except that at 8 NM of BUB a right turn has to be made to intercept radial 140 of ANT and subsequently a right turn to intercept radial 174 of BUN to REMBA.

The two routes, CIV 7 J and SPI 5J do not cross.

ATCO may, of course instruct aircraft to deviate from the published route, taking the actual traffic into account.

1.8 Organisational: Air Traffic Control

1.8.1 General

Skeyes (formerly known as Belgocontrol) is an autonomous public company, created in October 1998, with the mission to guarantee the safety of air navigation in the airspace for which Belgium is responsible.

Its zone of activities extends from ground level to flight level (FL) 245 (8,000 meter) for Belgium and between FL 135 / FL 165 and FL 245 (from 4417 / 4722 to 7465 meter) for the Grand-Duchy of Luxembourg.

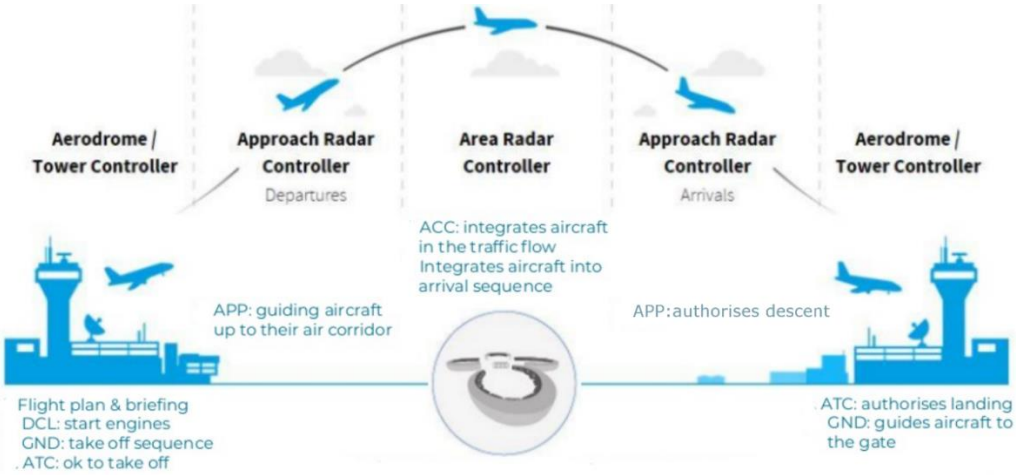

Figure 9: ATC in the Brussels FIR

The Eurocontrol centre in Maastricht is responsible for the area above FL 245, and jointly manages the air traffic of the upper airspace of Belgium, Luxembourg, the Netherlands and the western part of Germany.

The Belgian Air Traffic Control Center, called CANAC 2 (Computer Assisted National Air Traffic Control Center) features 4 integrated work areas or so-called 'petal' (ACC West, ACC East, APP and training) coordinated by a Supervisor and a Traffic Manager. Each work area groups 14 working positions and is under the monitoring of a team leader.

Figure 10: part of a work area (like APP) at CANAC 2

Each working position is manned by one controller (or by a trainee and his instructor) and consists of 3 screens:

- The middle screen displays the radar images, containing crucial flight data of the aircraft
- The screens and right hand side display operational applications which can be modified by the controller

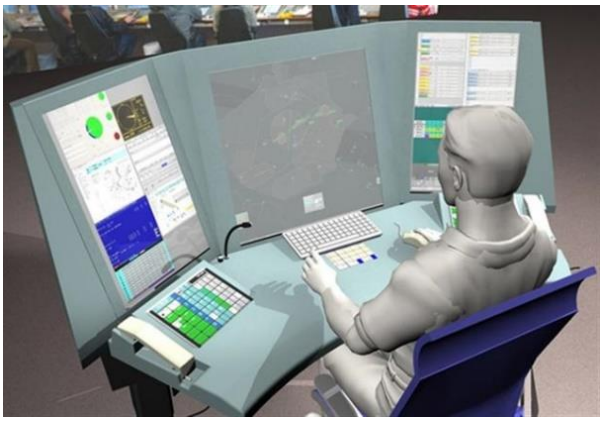

Figure 11: layout of the ATCO working position (source https://www.symbio.pro)

Figure 12: top view of the ATCO working position

Communication with the aircraft is done by means of a headset.

In case of a trainee controller, the instructor sit next and a little bit behind of him. The instructor also wears a headset but has no full view on the radar display as the trainee has.

1.8.2 Radar screen

On the radar screen, the Air Traffic Controller gets information regarding the flight. A dot in a square indicates the position of the aircraft. The orientation of the line starting from the dot indicates the track of the aircraft and its length indicates the speed.

Figure 13: flight data on a radar screen

AEA1172 – the flight Number
E195 – the type of aircraft (Embraer 195)
061 – the current altitude of the aircraft (x 100 ft) (flight level as from transition altitude)
↑ - the arrow indicates a climb or a descent
080 – indicates the altitude assigned to the aircraft (x 100 ft)
+ 07 – indicates the rate of climb (700 ft/min climbing)
238 – indicates the speed (kt)
CIV7J – indicates the route assigned to the aircraft

1.9 Recordings

For the further analysis the recorded radar data were used. At the time of the incident ambient voice recording (AVR) was neither installed nor required at the ATS working station.

Flight data recorders (FDR) and Cockpit voice recorders (CVR) were installed at both the ERJ195 and A320 but not used for this investigation.

1.10 Safety nets to provide a loss of separation and collision

Today several so-called 'safety nets' (or barriers) do exist to prevent a collision in a chronological order:

- Preventing tactical conflict by the design of the routes and procedures
- Tactical separation assurance by the ATCO by being proactive
- Ground (ATC) automated collision avoidance system
- Air automated collision avoidance system
- Visual collision avoidance (provided that visual meteorological conditions prevail)
- Providence

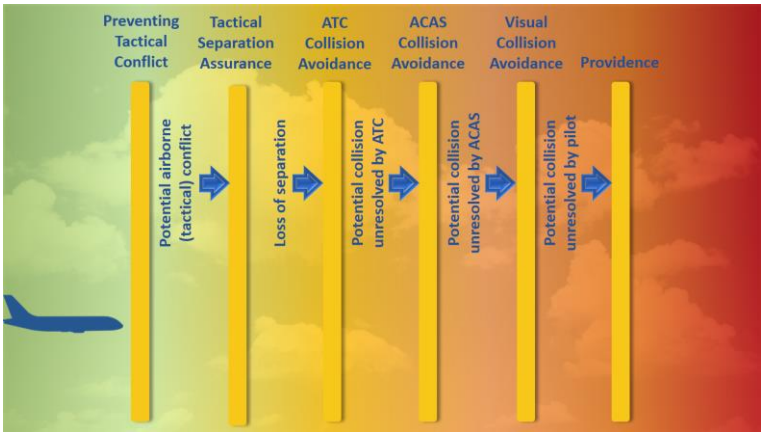

Figure 14: schematic of the different safety nets

1.10.1 Automated Collision Avoidance System on the ground.

The radar system used by Skeyes is equipped with a STCA (Short term conflict alert).

A Short Term Conflict Alert (STCA) is a system to warn the ATCO of any situation where user defined minimum separation distances between any pair of surveillance tracks is, or is predicted to be violated within a short look ahead time (usually 2 minutes). It gives a warning on the screen of the Traffic controller by marking the call signs and aircraft symbols steady red. It gives no resolution for the conflict as a TCAS does.

Figure 15: Visualisation of STCA at radar display

1.10.2 Automated Collision Avoidance System on aircraft

Both aircraft were equipped with a TCAS II version 7.1. Traffic Collision Avoidance System.

This system It monitors the airspace around the aircraft for other aircraft equipped with a corresponding active transponder, independent of air traffic control, and warns pilots of the presence of other transponder-equipped aircraft which may present a threat of mid-air collision.

The TCAS systems of the concerned aircraft work in a coordinated manner. In function of the respective aircraft position, heading and speed, the systems of both aircraft are generating coordinated instructions to the crew (one would be instructed to climb, while the other would be instructed to descend)

The aircraft crew are alerted by a visual and an aural signal. There are 3 levels of warnings:

- The traffic advisory (TA)
- The resolution advisory (RA)
- Clear of conflict (CC)

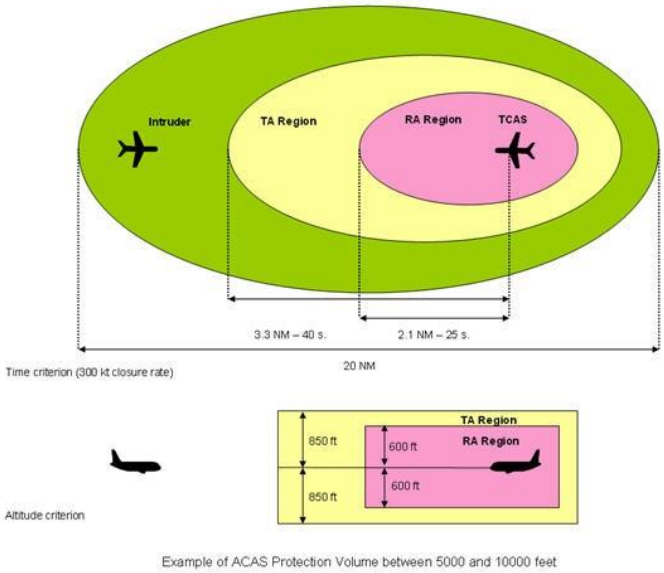

Figure 16: TCAS principle

When a “TA” warning is issued, pilots are instructed to look for the traffic causing the TA. If the other aircraft is visually acquired, pilots are instructed to maintain visual separation.

When an “RA” warning is issued, pilots are expected to respond immediately to the RA unless doing so would jeopardize the safe operation of the flight. This means that the instructions given by the TCAS system always takes precedence over the instructions given by ATC. The crew will also notify the ATC about the RA

The “RA” warning is given to crew in the form of an instruction, such as:

- “CLIMB”; the crew needs to establish a rate of climb of 1500 ft/min.
- “LEVEL OFF”; the crew needs to stop the climb (or descent)

The “CLEAR OF CONFLICT” warning informs the crew that the collision risk is no longer present and as a consequence, they need to comply with the instructions or clearances previously given by ATC.

For the Belgian ATC system, the TCAS resolution instruction (RA) for each aircraft is relayed to the radar screen of the ATC controller. TA’s are not downlinked.

Figure 17: visualisation of the TCAS RA on the radar display

1.11 Test and research

Eurocontrol, the European organisation for the safety of air navigation, analysed the incident with InCAS[2] v4.1.1. The available radar data were used to re-create the situation in order to cross check this versus the recorded RA downlink messages

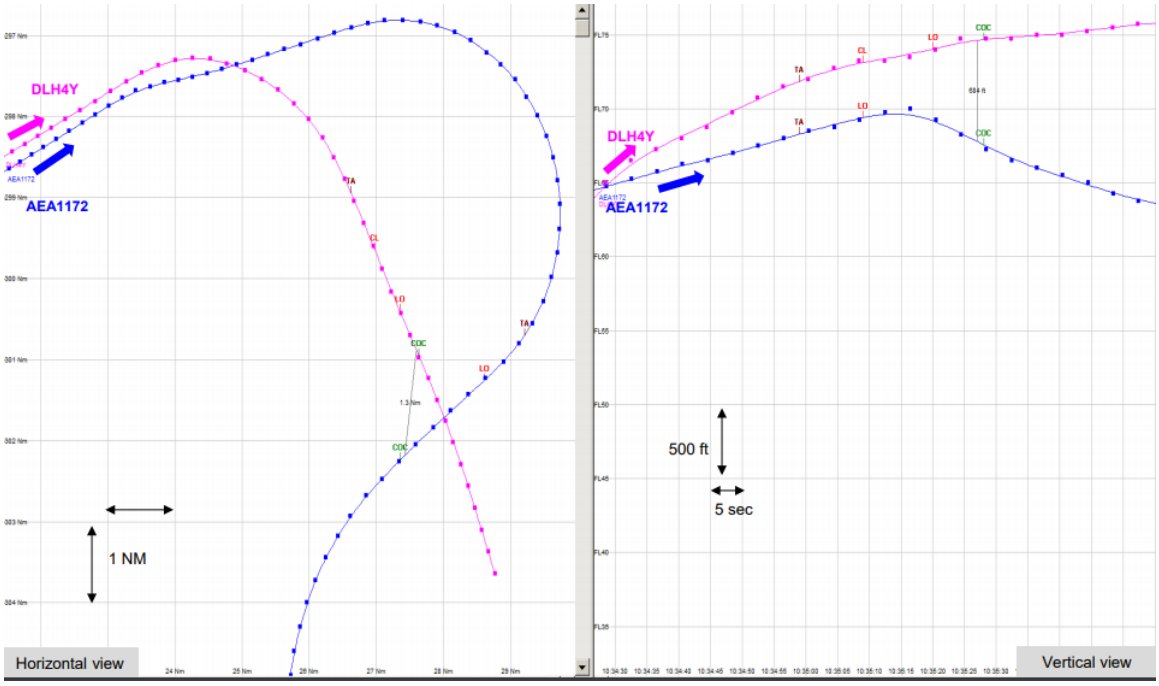

Figure 18: InCAS simulation

Table 6: InCAS simulation and Mode S downlinks compared

Time (InCAS)	Tim (downlinked Mode S)	Difference	Event (cockpit aural annunciation)
10:35:09	10:35:12	- 3 seconds	AEA1172 Level Off Resolution Advisory ("LEVEL OFF, LEVEL OFF")
10:35:09	10:35:12	- 3 seconds	DLH4Y Climb Resolution Advisory ("CLIMB, CLIMB")
10:35:20	10:35:24	- 4 seconds	DLH4Y Level Off Resolution Advisory ("LEVEL OFF, LEVEL OFF")
10:35:28	10:35:32	- 4 seconds	AEA1172 & DLH4Y Resolution advisories terminated ("CLEAR OF CONFLICT")

Eurocontrol did as well an analysis of the responses of the RAs of both flight crew based on the radar data. See chapter 2.2 of this investigation report.

[2] InCAS: Interactive Collision Avoidance Simulator. It is software that uses radar data, flight data recorder or Mod S RA downlink message to simulate (recreate) ACAS Resolution Advisories. The timing of simulated ACAS events are expected to have an accuracy of +/- 2 seconds

2 ANALYSIS

2.1 Traffic control

At the time of the incident, the trainee ATC controller is dealing with departures from Brussels to the North, the South (towards CIV – Chièvres) and to the East. He is also dealing with traffic going to EBCI, transiting in the South east of EBBR.
Incoming traffic from the East and departing traffic to the East and South are intersecting around the border of the CTR (8NM from EBBR).

The intensity of traffic flow at the time is average. In order to separate adequately departing traffic from transit traffic, departing traffic is instructed to climb to FL 080 while transiting traffic is instructed to maintain FL 090.

At the time of the incident, 5 aircraft where monitoring the frequency:

- The B350 flying from EBAW to REMBA
- ERJ195 towards CIV
- The A320 towards REMBA
- Ryanair RYR23HK who just called in and took off from EBBR
- Ryanair RYR9YX, an arriving Boeing 737 inbound EBCI

The attention is of course divided to other traffic as well:

- Another aircraft, and initially not expected by the ATCO trainee, transiting the north of the area was transferred to Brussels Control about 30 seconds before the STCA popped up.
- A third B737 from Ryanair was also in transit to EBCI but on the ‘Arrival’ frequency of Brussels
- A Tunis Air A320 inbound Brussels for a landing on RWY 01, also on the ‘Arrival’ frequency

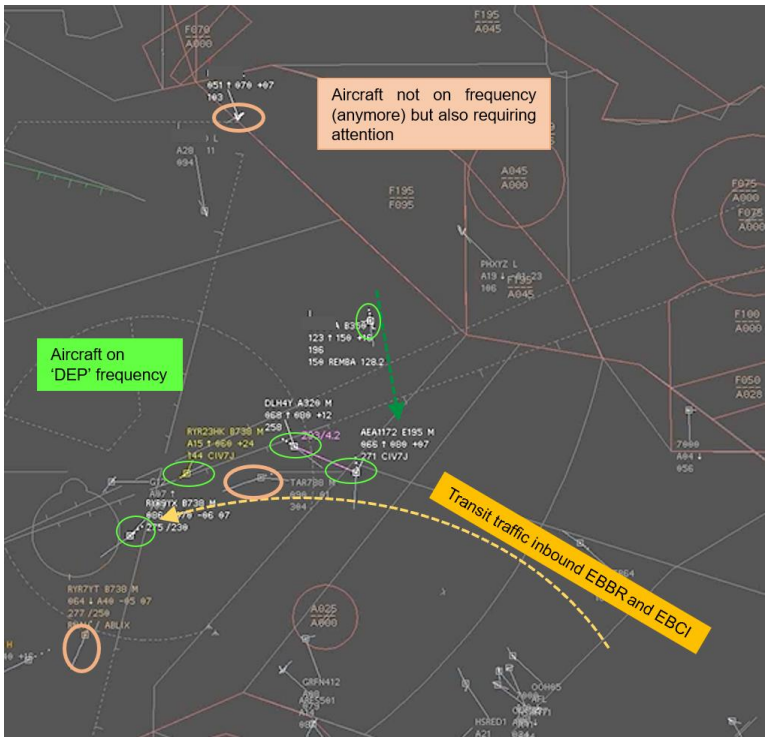

Figure 19: situation just prior to the STCA

The situation was new to the trainee ATCO and he felt uneasy. As a result, OJTi gave an active coaching to the trainee, correcting some of his actions.

From the interview with the trainee, it appeared that he was in a (consciously – or unconsciously) mood 'eager to please' the OJTi; in need to show he could cope with the traffic, owing to previous bad experiences with other OJTi, being in a 'down 'mood. He didn't sleep very well the last days.

He aimed on resolving the developing potential conflict with the A320 (DLH4Y). He first turned the B350 to REMBA instead of GILOM as per SID.

Subsequently he directed the ERJ195 to turn to CIV earlier than according to the SID.

The B350 to REMBA, from the North, is a smaller turboprop aircraft and thus has in se less climb performance. In anticipation of a possible conflict, the ATCO decided to have the A320 initiate his turn earlier than usual. This would put both aircraft with more lateral separation and would have allowed the A320 to climb higher than the B350 before lateral separation of 3 NM would have become a problem.

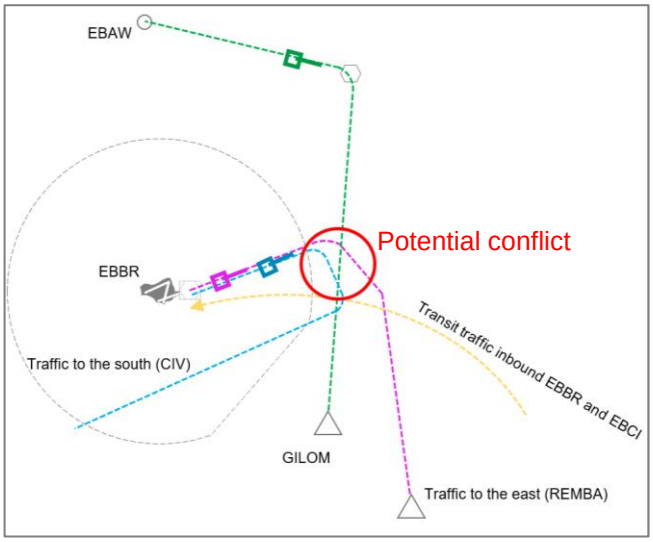

Figure 20: potential conflict following the published routes

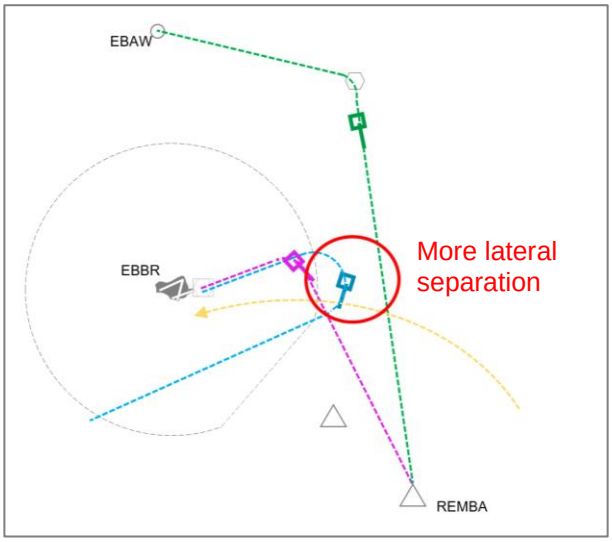

Figure 21: intended solution

Focused on this situation, the trainee ATCO did not realize that the ERJ195, that departed from Brussels ahead of the A320, could become a problem.

When two aircraft are departing one after the other, it is usual that the lead aircraft is at a higher altitude than the one following. This is true when both aircraft are climbing at (roughly) the same rate, but is not always the case, as the rate of climb is determined by the aircraft parameters (weight, engine thrust, etc) .

However, in this case, the lead aircraft ERJ195 had received information regarding aircraft above him and therefore had reduced its rate of climb to a lower value. It resulted that DLH4Y was climbing much faster than AEA1172. Although the information is available to the trainee ATCO on the screen, he did not look and notice that information.

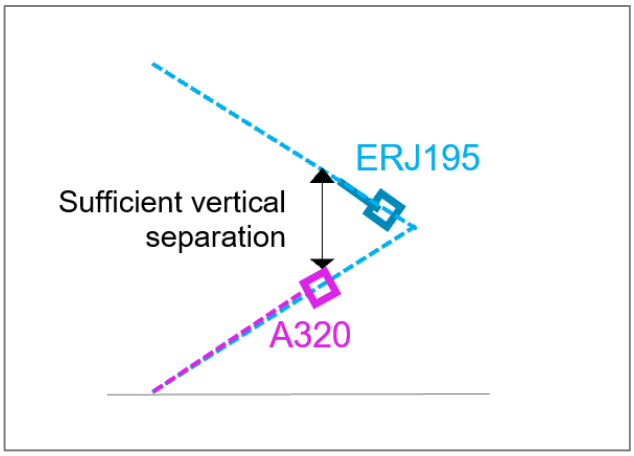

Figure 22: how the ATCO assumed the vertical separation was

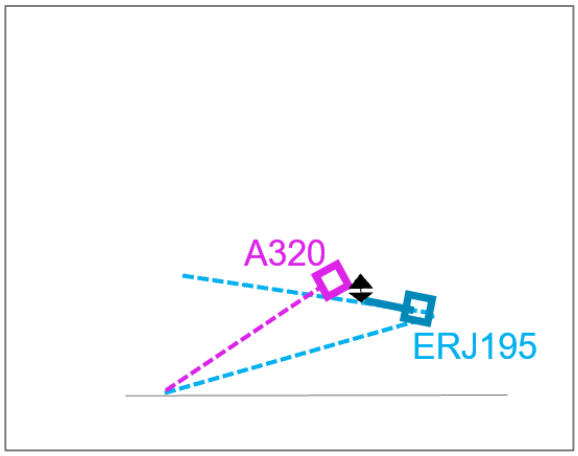

Figure 23: to the situation really was, the A320 already slightly above the ERJ195

Indication to this is that when the STCA went on, the first reaction of the trainee ATCO was to instruct DLH4Y to stop climbing, although at that time, DLH4Y was at a higher altitude than AEA1172 that was still climbing.

When the STCA went on, the trainee controller was totally surprised. At that time another aircraft (a Ryanair B737) was calling in. In the rush to cope with the problem, he started his sentence with the Ryanair code followed by the end of the DLH4Y code, calling a non-existing aircraft (RYR4Y) although he realized the mistake, the rest of his initial message was useless.

The trainee ATCO wanted then to separate the aircraft horizontally; he instructed the ERJ195 to turn left and was giving the instruction to A320 to turn left as well, but he interrupted and instructed the A320 to stop climbing again, instruction which was understood and readback by the aircraft.

The instructor interrupted the trainee (not on the frequency), stating to let the A320 climb further. The trainee afterwards reported that this - what he thought he saw on the screen and what the instructor was saying - was a conflict of information and that he was a bit lost.
Finally, the trainee realized the situation and gave a last instruction – for the ERJ195 to descend – before the OJTi instructor took over the frequency. It finally took relatively long (20 seconds) to give the correct instructions that were a solutions to the problem.

By that time, both aircraft got a TCAS RA warning as well.

The evolution of the events was evenly not immediately noticed by the instructor. He became aware of the situation upon the initiation of the STCA warning. This is due to several factors:

- The instructor is sitting next to the trainee ATCO and he does not have the same view on the radar screen. He has to look 'above the trainee shoulder';
- The trainee speaks naturally with a low voice and keeps his instructions to aircraft short, shorter than usual for an ATCo. This made that the initiation of the problem – the instruction given to DLH4Y to turn to REMBA - was not heard by the instructor;
- The confidence of the instructor in the capacity of the trainee to perform.

Figure 24: sketch showing that due to the configuration it's impossible for the OJTi to have the same view

During the interview, the instructor, who is not one of the three dedicated (usual) trainers for this trainee, stated that he was very pleased with his previous work that day at the ARR and DEP positions. He also stated that, since his performance for that day (and the two previous days they worked together) was more than acceptable, his confidence in his trainee was high. He therefore did not anticipate that the trainee would be able to give such a conflicting instruction which very quickly lead to a loss of separation.

2.2 Aircraft response to the TCAS warning.

Eurocontrol analysed the response to the TCAS warnings. The analysis showed:

ERJ195 (AEA1172):

- AEA1172 respond the Level Off RA promptly, arresting their climb within 5 sec. of the RA.
- Later, some 8 sec. after the RA, AEA1172 started to descend although the descent was not required by the Level Off RA.
- At the CPA (and coincidentally 1 sec. before the Clear of Conflict message), the descent rate was 1300 ft/min.
- AEA1172's response to the RA should be classified as "**excessive**" (i.e. the rate vertical rate exceeded the rate required by RA).
- However, that helped to increase the vertical miss distance given the lack of response by DLH4Y.

A320 (DLH4Y):

- There was no visible reaction by DLH4Y to the Climb RA. The vertical rate remained at the 400-500 ft/min. range although 1500 ft/min. is required by the RA.
- Given AEA1172's reaction to the RA, DLH4Y's RA subsequently weakened to Level Off.
- After the Level Off RA, DLH4Y's vertical rate decreased somewhat to reach 300 ft/min. just before Clear of Conflict.
- DLH4Y's response to the RAs should be classified as "**no reaction**" as there was no visible change of the vertical rate for the duration of the RAs requiring a positive response.

The conclusions are as follows:

1. The analysis shows that TCAS II performed as required on board of both aircraft.
2. RA downlink messages and InCAS simulations indicate that both aircraft received compatible RAs.
3. DLH4Y did not respond to the initial Climb RAs and did not establish the 1500 ft/min. climb. Furthermore, DHL4Y did not respond the weakening Level Off RA.
4. AEA1172 initially responded correctly to the Level Off RA arresting their climb but then established a descent (which was not required by the RA). However, given the lack of response by DLH4Y the descent helped to increase the vertical miss distance.
5. At the Closest Point of Approach the spacing between the aircraft was 1.3 NM horizontally and 684 ft vertically.

Eurocontrol also simulated the worst case, i.e. the case where both aircraft would not respond or were not equipped with TCAS. They came to the conclusion that the vertical miss distance would have been 268 i.s.o of 684 ft in that case.

AAIU(Be) comments:

- The last instruction given by the trainee ATCO – instructing AEA1172 to descend was correct and would solve the problem. The TCAS RA warning that followed provided equally an effective solution.
- The “excessive” reaction of AEA1172 was most probably due to the last instruction given by ATC to descend.
  The instructions when faced with a RA forbids specifically a manoeuvre in the opposite sense to an RA, nor maintain a vertical rate in the opposite sense to an RA, which is not the case for an excessive reaction.
- The crew of DLH4Y acknowledge the delay and the fact that they had the other aircraft in sight. This apparent lack of reaction is most probably due also to the rapid succession of events. The RA “Level off ” was followed 15 seconds after by a “Climb” instruction.
- For the given circumstances, this incident would not have resulted in an actual air collision.

3 CONCLUSIONS

3.1 Findings as to causes and contributing factors

- The trainee ATCO gave an instruction to the A320 (DLH4Y) to turn earlier than foreseen by the published route without taking the projected flight path of the ERJ195 AEA1172 into consideration. He assumed that there would be enough separation.
  [direct causal factor]

  [Action/decision – Action – Incorrect action selection - ATCO]

  [Action/decision – Info processing - Expectation/assumption- ATCO]

- The trainee ATCO declared he was a bit under stress and that he considered every shift as an examination. He was eager to show that he could be proactive
  [contributing factor]

  [Psychological – Mental/emotional state – Stress - ATCO]

- The potential conflict was initially not noticed by the OJTi. The trainee was speaking with rather low voice and the OJTi doesn't dispose of a separate radar screen.
  [contributing factor] ***[safety issue 4.1]***

  [Task performance – Monitoring – OJTi]

  [Task environment – Physical workspace – Positioning – Effect on ATC OJTi]

  [Management – Resources – Availability of equipment – ATC]

- The design of the departures from EBAW to GILOM and EBBR to REMBA lead to converging courses.
  [contributing factor]

  [Operating environment – Air traffic – Departure procedure(s) – Effect on operation]

- When the STCA popped up there was still a lack of situational awareness of the ATCO. He thought that the A320 was much lower than the ERJ195 while in fact the aircraft was already above. He initially gave the wrong instruction to stop climbing to the A320
  [contributing factor]

  [Psychological – Perception/orientation/illusion – Situational awareness - ATCO]

3.2 Findings as to factors that increase(d) risk

- The trainee stated that he was tired and not sleep very well

  [Physical – Alertness/Fatigue – General – ATCO]

- There was a delay in giving correct climb instructions to the A320. The OJTi knew what the solution was and informed the ATCO but as he was a bit confused he didn't react immediately**.**

  [Task performance – Coordination – Between trainee ATCO and OJTi]

- Currently no rule or procedure exist for the configuration of a trainee with his OJTi about who has the responsibility or priority in case of situations requiring immediate action.
  [safety issue 4.2]

  [Management – Policy/procedure – Availability of procedures – ATC]

- The crew of the A320 didn't react adequately on the TCAS RA. However they declared that they had visual contact with the conflicting traffic.

  [Action/decision – action – Delayed action/lack of action – Flight crew]

- Although the flight level is indicated on the radar display for each aircraft, the ATCO still sees a lateral 2-D view. No aids currently exist to show a 3D-situation and/or a vertical resolution to solve the conflict in case of a STCA.
  [safety issue 4.3]

  [Task environment – Physical workspace – Warnings/alarms – Availability of related info]

3.3 Other findings

- That day the trainee ATCO started his shift at 06:45 UTC and had a break 30 minutes before the incident. So it happened approximately after 3 hours and 40 minutes of working (breaks included).
- The OJTi was duly qualified and experienced.
- The ATCO tried to resolve the converging courses of the traffic from EBAW and EBBR (by design of the departure procedures) a bit by putting the B350 from EBAW to REMBA instead of GILOM.
- The STCA was triggered which allowed the ATC to react.

  [positive factor - hardware safety net]

- The ACAS system on both aircraft alerted the concerned crew.

  [positive factor - hardware safety net]

- At the time of the incident, VMC prevailed so both crew had visual contact.

  [positive factor - soft safety net]

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 Safety issue: the OJTi doesn't dispose of a separate radar screen.

Safety action:

Skeyes has taken the following actions:

The sectorisation of the APP petal has been reviewed and modified to allow up to 3 trainees with 3 OJTIs at the same time with a dedicated display for each other.
This new sectorisation plan has been implemented in 2019 (23/05/2019) and is referred in the page 26 of the CANAC/APP Supervisor manual.

4.2 Safety issue: no clarity regarding priority of control between OTJi and trainee

With respect to the priority of actions between the OJTi and the trainee, Skeyes responded:

‘Responsibilities between the OJTi and the trainee are clear, but indeed there is no formal phraseology, such as ‘I have controls’, like it exists within a crew of an aircraft.

Skeyes is treating the issue during training on communications.
No real phraseology, but actions are clear enough and most of the time associated with strong instructions like : "I take over" and if the situation permits, the trainee will be asked to follow the actions provided by the OJTi.’

AAIU (be) has no further recommendation on this issue.

4.3 Safety issue: limited representation of the vertical situation between aircraft involved in a separation conflict

Although the flight level is indicated on the radar display for each aircraft, the ATCO still sees a lateral 2-D view. No aids currently exist to show a 3D-situation and/or a vertical resolution to solve the conflict in case of a STCA. Therefore:

Safety recommendation BE-2020-0001:

It is recommended that Skeyes improves the STCA spatial presentation of aircraft in flight when a potential conflict is detected.

Skeyes responded that the current STCA system does not allow for such modification; however such improvement may be part of the future SAS3 system.

4.4 Safety improvement: background communication and aural environment recording

At the time of the incident it was not required for ATS to record ambient sounds at the ATC work stations. There's no doubt that this could be of help for this investigation seen the interaction with the trainee and the OJTi and the other coordination actions between the different sectors that took place.

However, as from 3 April 2020 Implementing regulation (EU) 2020/469 was published. This regulation amends amongst others ANNEX IV of Regulation(EU) 2017/373 – SPECIFIC REQUIREMENTS FOR PROVIDERS OF AIR TRAFFIC SERVICES (Part-ATS). Amongst others the following implementing rule was added:

ATS.OR.460 Background communication and aural environment recording

(a) Unless otherwise prescribed by the competent authority, air traffic services units shall be equipped with devices that record background communication and the aural environment at air traffic controller's, or the flight information service officer's, or the AFIS officer's work stations, as applicable, capable of retaining the information recorded during at least the last 24 hours of operation.

(b) Such recordings shall only be used for the investigation of accidents and incidents which are subject to mandatory reporting.

Belgian ATS provider Skeyes is required to implement the actions on 27 January 2022 at the latest.

Skeyes responded that the actions are in-progress; the ambient sound recording exists in MIL petal only. Next will be the SVR Suite followed by the Civil petals. Pre-installation exists but no recording system installed yet.