



**COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL**

Report IN-029/2016

Incident involving an Airbus A-320 aircraft, registration EC-LRE (operated by Vueling), and an Airbus A-321 aircraft, registration HB-ION (operated by Swiss), in the vicinity of point NITBA in the Barcelona TMA (LECB, Spain) on 25 July 2016.



GOBIERNO
DE ESPAÑA

MINISTERIO
DE FOMENTO

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Foreword

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) n° 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

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Abbreviations

ACAS	Airborne Collision Avoidance System
ACS	Area control surveillance rating
ADI	Aerodrome control instrument rating
AESA	Spain's National Aviation Safety Agency
AIP	Aeronautic Publication Information
AIR	Air control rating endorsement
AP	Autopilot
APS	Approach control surveillance rating
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot License (Airplane)
BDS	CommB Definition Subfield
CAP	Conflict alert prediction
CAV	Conflict alert violation
CAVOK	Ceiling and visibility OK
CIAIAC	Spain's Civil Aviation Accident and Incident Investigation Commission
CPA	Closest Point of Approach
CPL(A)	Commercial Pilot License (Airplane)
CVR	Cockpit Voice Recorder
DAL	Distance Azimuth Line
DFDR	Digital Flight Data Recorder
EASA	European Aviation Safety Agency
EU-FCL	EASA regulation for flight crew licensing
EVAIR	Eurocontrol voluntary ATM incident reporting
FA	Flight Attendant
FCTM	Flight Crew Training Manual
FD	Flight Director
FDM	Flight Data Monitoring
FL	Flight level
ft	Feet
ft/min	Feet/minute
GMC	Ground movement control rating endorsement
GMS	Ground movement surveillance rating endorsement
h	Hours
IAF	Initial approach fix

InCAS	Interactive Collision Avoidance Simulator
Km	Kilometer
Kt	Knots
LEBL	ICAO identifier for the Barcelona/El Prat airport
LECB	ICAO identifier for the Barcelona Area Control Center
LIRN	ICAO identifier for the Naples/Capodichino Airport
LSZH	ICAO identifier for the Zurich Airport
METAR	Meteorological Aviation Routine Weather Report
MOPS	Minimum Operational Performance Standards
MSL	Mean Sea Level
ND	Navigation Display
NM	Nautical miles
OJTI	On the Job Training Instructor
PF	Pilot Flying
PFD	Primary Flight Display
PM	Pilot Monitoring
QAR	Quick Access Recorder
RA	Resolution Advisory
RAD	Radar license endorsement
SACTA	Automated Air Traffic Control System
SID	Standard Instrument Departure
S/N	Serial Number
STAR	Standard Arrival
STCA	Short-term conflict alert
TA	Traffic advisory
TCAS	Traffic collision avoidance system
TCL	Terminal control license endorsement
TMA	Terminal Maneuvering Area
TWR	Tower control license endorsement
UTC	Coordinated universal time
VSI	Vertical Speed Indicator

Synopsis

Owner and Operator 1:	Vueling
Aircraft 1:	Airbus A320-232, registration EC-LRE
Owner and Operator 2:	Swiss
Aircraft 2:	Airbus 321-212, registration HB-ION
Date and time of accident:	Monday, 25 July 2016 at 18:36 ¹
Site of incident:	Barcelona TMA (vicinity of point NITBA)
Personas a bordo en aeronave 1:	2 flight crew, 4 flight attendants (FA) and 151 passengers, no injuries
Persons onboard aircraft 2:	2 flight crew, 6 flight attendants (FAs) and 203 passengers, no injuries
Type of flight aircraft 1:	Commercial air transport - Scheduled – International - Passenger
Type of flight aircraft 2:	Commercial air transport - Scheduled – International - Passenger
Date of approval:	26 July 2017

Summary of incident:

On 25 July 2016, an Airbus A-321 registration HB-ION, operated by Swiss, with callsign SWR191Q, had taken off from the Barcelona Airport en route to the Zurich Airport (Switzerland). At the same time, an Airbus A-320 registration EC-LRE, operated by Vueling, with callsign VLG6502, was flying from Barcelona to the Naples Capodichino Airport (Italy).

The former was flying on standard instrument departure DALIN3Q, while the latter was following standard instrument departure VERSO3Q. These two routes have a segment in common until point NITBA, from which the aircraft proceed to the final fix of the standard departure maneuver.

¹ All times in this report are in UTC, unless otherwise specified. To obtain local time, add 2 hours to UTC.

The aircraft operated by the company Swiss was ahead of the Vueling aircraft in the departure sequence. To avoid conflicting with arriving aircraft, air traffic control instructed the crews of both aircraft to turn left and fly direct to the final fix of their standard departure maneuvers (DALIN and VERSO) once they reached flight level FL080.

The different climb rates of the aircraft caused the separation between them to diminish, until it reached a minimum value of 1.2 NM horizontally and 200 ft vertically, which triggered a TCAS traffic advisory (TA) and then a resolution advisory (RA).

The execution of the evasive maneuvers created a separation of the aircraft that allowed both aircraft to resume normal navigation.

The airborne collision avoidance system (ACAS) did not respond as expected based on its theoretical parameters. Analyzing this type of event using simulation tools requires an analysis of the BDS10 and BDS30 data protocols used by the S-mode radar.

For this investigation, the air navigation services provider, ENAIRE, was not able to provide valid data from said protocol for analysis. As a result, the following safety recommendation is issued:

REC 54/17: It is recommended that ENAIRE record the data from the S-mode radar BDS10 and BDS30 data protocols so as to facilitate the investigation of events involving the airborne collision avoidance system (ACAS).

1. FACTUAL INFORMATION

1.1. History of the flight

On 25 July 2016, an Airbus A-321 registration HB-ION, callsign SWR191Q, was flying from the Barcelona/El Prat Airport (LEBL) to the Zurich Airport (LSZH) in Switzerland. While in radar and radio contact with Barcelona Control (LECB), at 18:30:57 it was cleared to climb to FL190 and fly standard instrument departure DALIN3Q.

At the same time, an Airbus A-320 registration EC-LRE, callsign VLG6502, was flying from the Barcelona/El Prat Airport (LEBL) to the Naples Capodichino Airport (LIRN) in Italy. This aircraft had followed the Swiss aircraft in the departure sequence, and while in contact with Barcelona Control (LECB), at 18:32:36 it was cleared to climb to FL190 and fly standard instrument departure VERSO3Q.

These two routes have a common segment to a point called NITBA, from where aircraft then fly to the final fix of the standard departure.

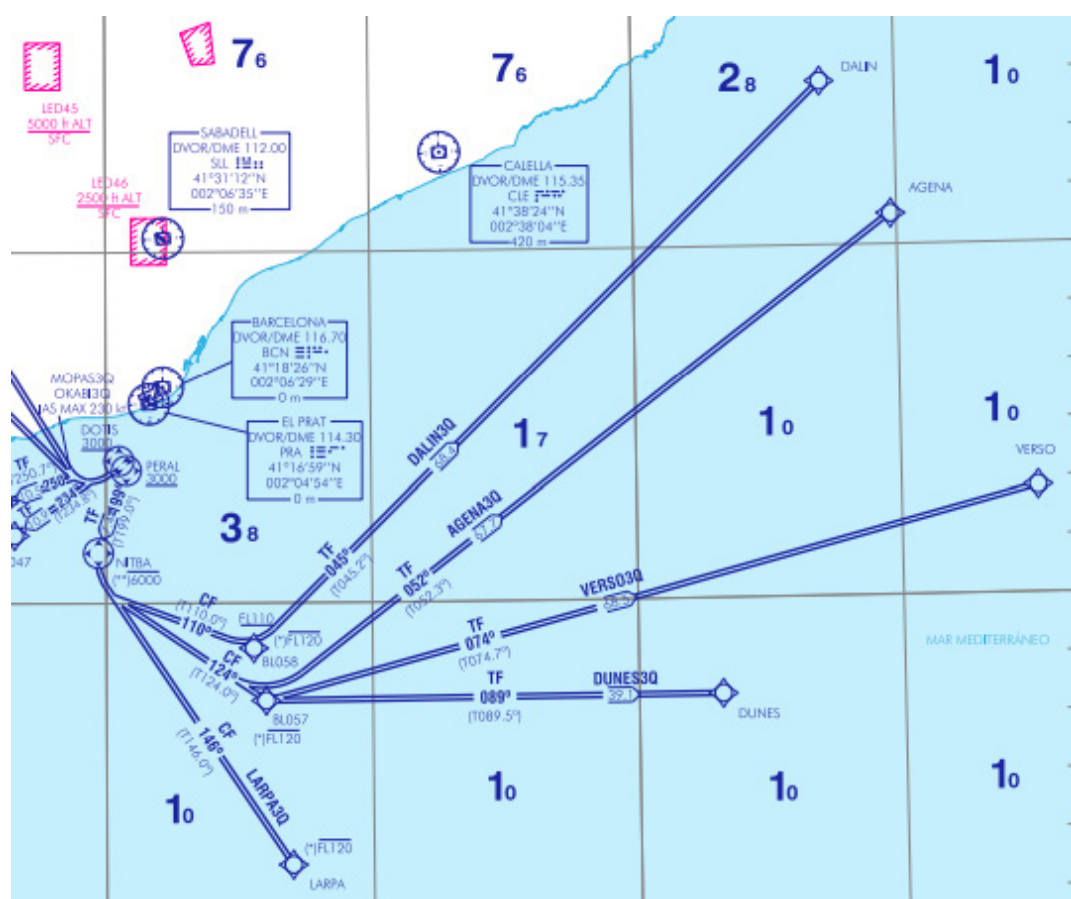


Figure 1: Standard Instrument Departures AIP Spain

Several aircraft were departing as others were flying the arrival procedure via sector T2W. To avoid conflicts between them, the sector T3W controller at the TMA, with whom both aircraft involved in the incident were in contact, instructed them to proceed to DALIN and VERSO (final fixes for their instrument departure maneuvers) once they cleared FL080, thus shortening the length of both maneuvers. Since they were different routes, and the two traffic were separated, he did not regard them as essential traffic².

Before establishing radio contact with the traffic involved in the incident, at 18:30:20, the executive controller was monitoring a potential traffic conflict that could occur in the southern part of the sector between a Swiftair aircraft (SWT8169), entering via point ESPOT, and a Vueling aircraft (VLG3537), entering via point MARTA. Both aircraft were inbound, flying standard terminal arrival routes NEPAL2V and MARTA5Y, respectively. VLG3537 was faster than SWT8169, and had been assigned a lower number in the approach sequence. It had thus been cleared to descend from FL180 to FL080, while the second aircraft remained at FL140, the idea being that by the conflict point (NEPAL), VLG3537 would be below SWT8169. The descent rate used by the crew was lower than expected by the controller, so the controller instructed them to increase their descent rate and focused his attention on resolving this conflict, diverting his attention from the two incident aircraft.

In the meantime, at 18:34:41, the Swiss aircraft reached FL080 and started to turn toward point DALIN and horizontally past point NITBA, as instructed. The separation with aircraft VLG6502 was 5.3 NM horizontally and 2000 ft vertically.

The higher climb rate of VLG6502 caused it to reach FL080 at 18:35:07, at a position on the lateral trajectory of the maneuver prior to point NITBA, therefore cutting off the horizontal trajectory of SWR191Q. At that moment they were separated by 4.9 NM horizontally and 1100 ft vertically.

The instructions provided by the controller resulted in two lateral trajectories that crossed in space, thus causing a loss of separation between the two aircraft with a closest point of approach, at 18:36:26, that was 1.2 NM apart horizontally and 200 ft vertically.

When alerted by the planner to the loss of separation of the Vueling aircraft, the executive controller assumed he was referring to the aircraft he was monitoring. By the time he was notified of the event that was taking place, the separation between

² Essential traffic is controlled traffic to which the provisions of separation by ATC are applicable but that, in relation to a particular controlled flight, is not or will not be separated from other controlled traffic by the appropriate separation minimum.

the aircraft had already been lost and he informed the crew of the affected Vueling of the presence of the other traffic that was crossing at the same level. The crew reported a TCAS resolution advisory, and stated that they had the traffic in sight. The crew of the Swiss aircraft also reported having the aircraft in sight close by.

Once they were separated, both aircraft resumed their navigation as planned.

1.2. Injuries to persons

AIRCRAFT EC-LRE/ VLG6502

Injuries	Crew	Passengers	Total	Other
Fatal				
Serious				
Minor				Not applicable
None	2+4	151	157	Not applicable
TOTAL	6	151	157	

AIRCRAFT HB-ION / SWR191Q

Injuries	Crew	Passengers	Total	Other
Fatal				
Serious				
Minor				Not applicable
None	2+6	203	211	Not applicable
TOTAL	8	203	211	

1.3. Damage to aircraft

Neither aircraft was damaged.

1.4. Other damage

There was no other damage.

1.5 Personnel information

1.5.1 *Information on the crew of aircraft VLG6502*

The captain of aircraft VLG6502, a 35-year old Spanish national, had an EU-FCL Airline Transport Pilot License (ATPL(A)) issued by AESA with an A320 type rating that was valid until 31 January 2017. He also had a class-1 medical certificate that was valid until 4 December 2016. He had a total of 5272 flight hours, of which 3281 had been on the type.

The copilot of aircraft VLG6502, a 25-year old Spanish national, had an EU-FCL Commercial Pilot License (CPL(A)) issued by AESA with an A320 type rating that was valid until 31 March 2017. He also had a class-1 medical certificate that was valid until 25 October 2016. He had a total of 1106 flight hours, of which 182 had been on the type.

1.5.2 *Information on the crew of aircraft SWR191Q*

The captain of aircraft SWR191Q, a 48-year old Swiss national, had an EU-FCL Airline Transport Pilot License (ATPL(A)) issued by the Swiss Federal Office of Civil Aviation with an A320 type rating that was valid until 30 September 2016. He also had a class-1 medical certificate that was valid until 31 May 2017. He had a total of 10152 flight hours.

The copilot of the aircraft, a 35-year old Swiss national, had an EU-FCL Airline Transport Pilot License (ATPL(A)) issued by the Swiss Federal Office of Civil Aviation with an A320 type rating that was valid until 30 November 2016. He also had a class-1 medical certificate that was valid until 30 September 2016. He had a total of 2412 flight hours.

1.5.3 *Information on control personnel*

The executive controller, a 57-year old Spanish national, had an air traffic controller license issued by Spain's National Aviation Safety Agency (AESA) on 07/11/2014, and a class-3 medical certificate that was valid until 28/09/2016. The license included the ADI/AIR-GMC-TWR-GMS-RAD, APS/RAD-TCL and ACS/RAD-TCL ratings and endorsements, obtained on 22/12/1988. He also had APS/RAD-TCL rating and endorsements, which were valid until 06/10/2016.

The planning controller, a 59-year old Spanish national, had an air traffic controller license issued by Spain's National Aviation Safety Agency (AESA) on 20/06/2016, and a class-3 medical certificate that was valid until 22/12/2016. The license included the ADI/AIR-GMC-TWR-GMS-RAD, APS/TCL and ACS/TCL ratings and endorsements,

obtained on 23/03/1984. He also had APS/TCL rating and endorsement, which were valid until 17/07/2017.

He also had an OJTI license endorsement that was valid until 04/09/2017, and an Evaluator endorsement that was valid until 31/07/2017.

1.6 Aircraft information

1.6.1 General information on aircraft VLG6502

Aircraft EC-LRE is an AIRBUS 320-232, with serial number 1914. It is outfitted with two IAE V2527-AS engines. The aircraft had valid registration and airworthiness certificates.

The last inspection of the aircraft prior to the incident had been on 23 June 2016. It had been a type-A inspection conducted as per its approved maintenance program. At the time the aircraft had 37327 hours and 23459 flight cycles.



Figure 2: Photograph of aircraft EC-LRE³

1.6.2 General information on aircraft SWR191Q

Aircraft HB-ION is an AIRBUS 321-212, with serial number 5567. It is outfitted with two CFMI CFM56-5B1/3 engines. The aircraft had valid registration and airworthiness certificates.

The aircraft had 10857 hours and 6233 cycles.

³ Image taken from <http://www.planespotters.net>

The last inspection of the aircraft prior to the incident had been on 15 May 2016. It had been a type-A inspection conducted as per its approved maintenance program. At the time the aircraft had 10282 hours and 5882 flight cycles



Figura 3: Photograph of aircraft HB-ION⁴

1.6.3 Surveillance and Anticollision System

Both Airbus aircraft were equipped with version 7.1 of the TCAS II collision avoidance system, which is able to detect any aircraft located in the vicinity of the aircraft that is outfitted with an altitude reporting transponder. The system provides various advisory levels based on the range and altitude of intruding aircraft and the calculated closest point of approach (CPA).

The navigation display (ND) shows information on the aircraft, along with the relative bearing and distance to the intruder, its closure rate and the difference in relative altitudes.

A traffic advisory (TA) informs the crew of the presence of a potential threatening aircraft, and alerts them to be ready for a possible evasive maneuver. A resolution advisory (RA) warns the crew of the presence of an aircraft that poses a threat and recommends an evasive maneuver to ensure sufficient separation.

Depending on the situation, the system will generate different RAs. The crew are shown visual information on the primary flight display (PFD) to execute a maneuver along the vertical plane as indicated by an aural alert, which will be generated based on the geometry of the encounter.

4 Image taken from <http://www.planspotters.net>

The crew should never maneuver in the direction opposite that indicated in the resolution advisory, since the separation maneuvers provided to both aircraft are coordinated by the system logic.

The system has a mode selector with the following operating options:

- TA/RA: Normal mode of operation. Intruders are shown on the ND and the system provides TA and RA information.
- TA: The system does not generate any vertical maneuver instructions. This mode is used if the aircraft's performance is degraded (engine failure, gear-down operations, etc.) or if parallel runway operations are in effect.

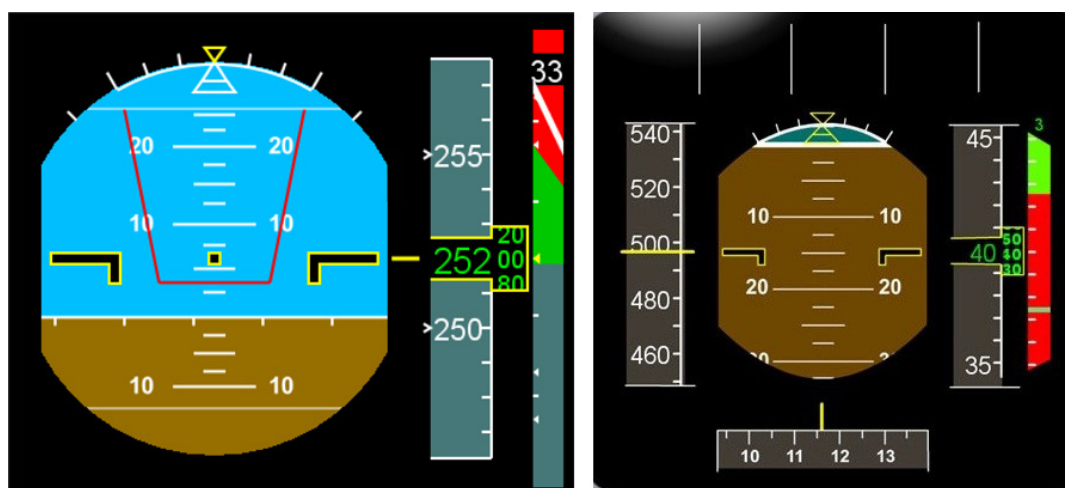


Figure 4: TCAS vertical rate indications

1.7 Meteorological information

The following METARs had been issued at the Barcelona Airport at the time of the incident:

METAR LEBL 251800Z 22012KT CAVOK⁵ 27/21 Q1017 NOSIG

METAR LEBL 251830Z 23012KT CAVOK 27/21 Q1017 NOSIG

METAR LEBL 251900Z 23011KT CAVOK 26/21 Q1018 NOSIG

⁵ CAVOK entails the following conditions: a) visibility 10 km or higher, and the lowest unreported visibility; b) no clouds of significance to operations; and c) no weather conditions of significance to aviation.

This information indicates that the weather conditions were stable, with high visibility and no significant cloud formations.

1.8. Aids to navigation

Not applicable.

1.9. Communications

The communications held between the crews and the executive controller from the Barcelona TMA, where the incident took place, were available to the investigation.

According to these communications, at 18:27:30, a Swiftair traffic en route to Barcelona contacted on the sector T3W frequency while entering from the south via point ESPOR and holding at FL140. The controller cleared it to proceed via standard arrival route NEPAL2V. At 18:30:20, a Vueling aircraft contacted T3W en route to point MARTA at FL180. The controller cleared it to fly standard arrival route MARTA5Y. Both aircraft's trajectories converged at point NEPAL.

At 18:30:57, the Swiss aircraft (SWR191Q), outbound from Barcelona on DALIN3Q, contacted the controller, who cleared it to climb to FL190 with no altitude restrictions.

At 18:31:38, the controller cleared the Vueling aircraft, inbound from the south, to descend to FL080.

At 18:32:10, the T3W controller cleared SWR191Q to proceed to DALIN once above FL080.

At 18:32:26, he contacted VLG6502, which had taken off from Barcelona on route VERSO3Q, and cleared it to FL190 with no altitude restrictions.

At 18:34:18, the controller cleared outbound traffic VLG6502 to proceed to point VERSO upon reaching FL080.

At 18:35:21, the controller instructed the Vueling aircraft, inbound from the south, to accelerate its descent through FL130.

At 18:36:01, the controller informed traffic VLG6502 of the proximity of SWR191Q, which affected it as it left FL150 for FL190.

The crew of VLG6502 then stated that they had the traffic insight. The controller apologized, explaining to them that he had been watching another near miss and had not realized that they had turned before he expected them to. At that point the crew of VLG6502 reported the activation of a TCAS resolution advisory.

At 18:36:38, the crew of VLG6502 reported clear of conflict.

At 18:38:00, the T3W controller transferred SWR191Q to the next vector. The crew requested information on the vertical distance that had separated them from VLG6502. The controller replied that they had crossed 2 NM apart at the same altitude, and that the other traffic had them in sight. The crew of SWR191Q replied that they too had the other traffic in sight, but that they had been very close at the same altitude.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

Due to the time that elapsed between the incident and when the CIAIAC became aware of it, it was not possible to preserve the cockpit voice recorder (CVR) and the flight data recorder (DFDR), though the information taken from both airplanes' quick access recorders (QAR) was available to investigators.

The Swiss investigation authority was asked for the raw data from the QAR, as well as the parameter data frame, in order to convert them into engineering parameters. The operator offered to provide the necessary parameters already transformed, stating that its FDM department used a specific and proprietary Swiss program designed by the operator, called EMS, to transform the data.

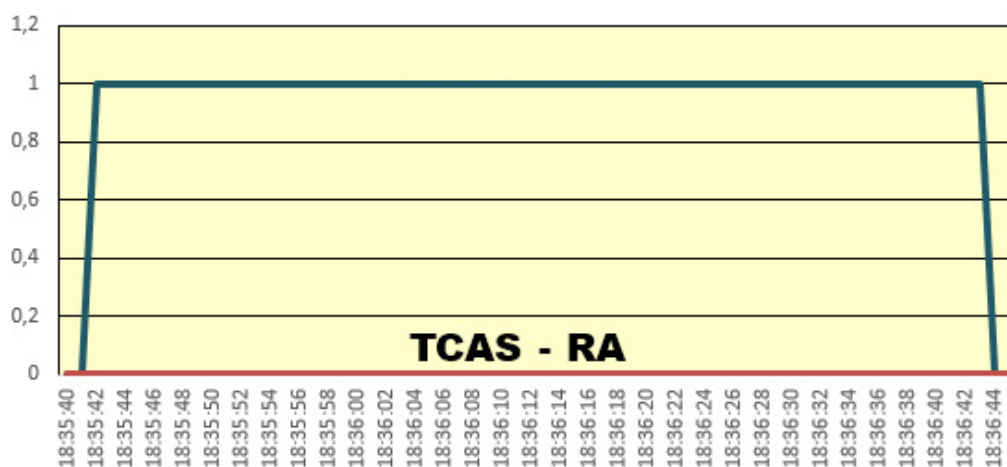
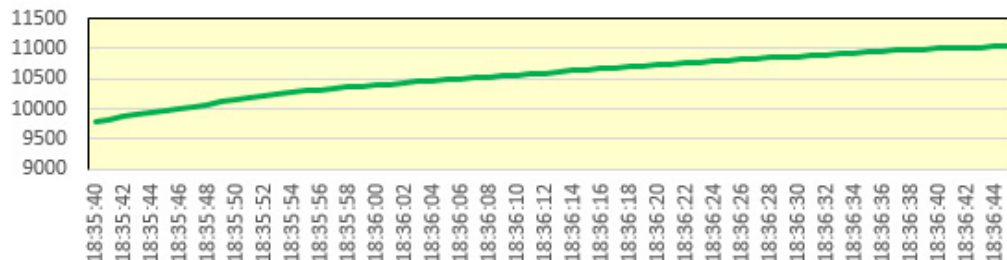
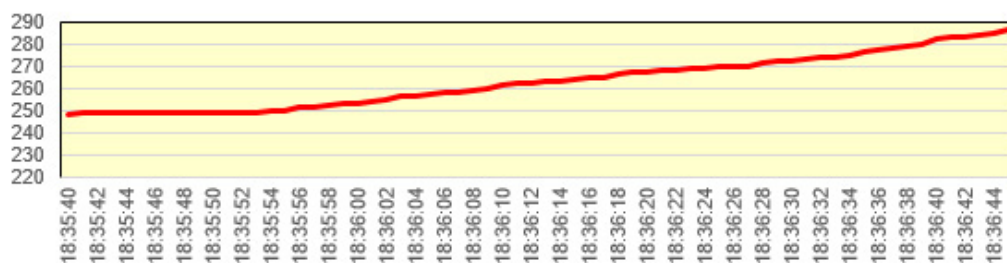
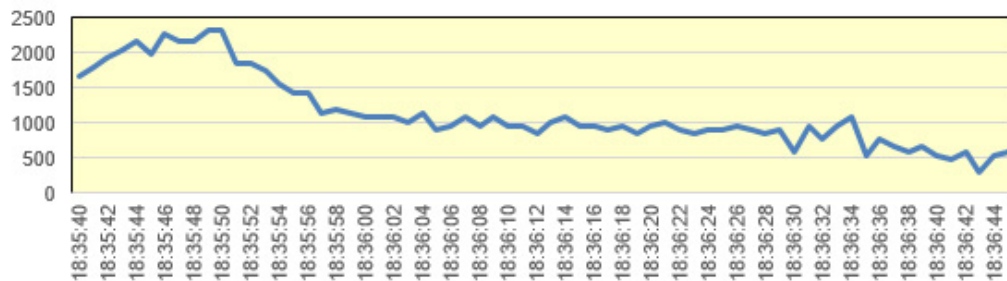
1.11.1 Analysis of data from SWR191Q.

The crew of SWR191Q, after being cleared to turn to DALIN after climbing through FL080, reduced their speed to 220 kt, which yielded a climb rate in excess of 2000 feet per minute.

After 18:35:02, when the aircraft reached FL090, it started to accelerate to 250 kt, and to 290 kt at 18:35:54. These two actions reduced its climb rate.

At 18:35:42, the TCAS issued a TA, which was active for 61 seconds.

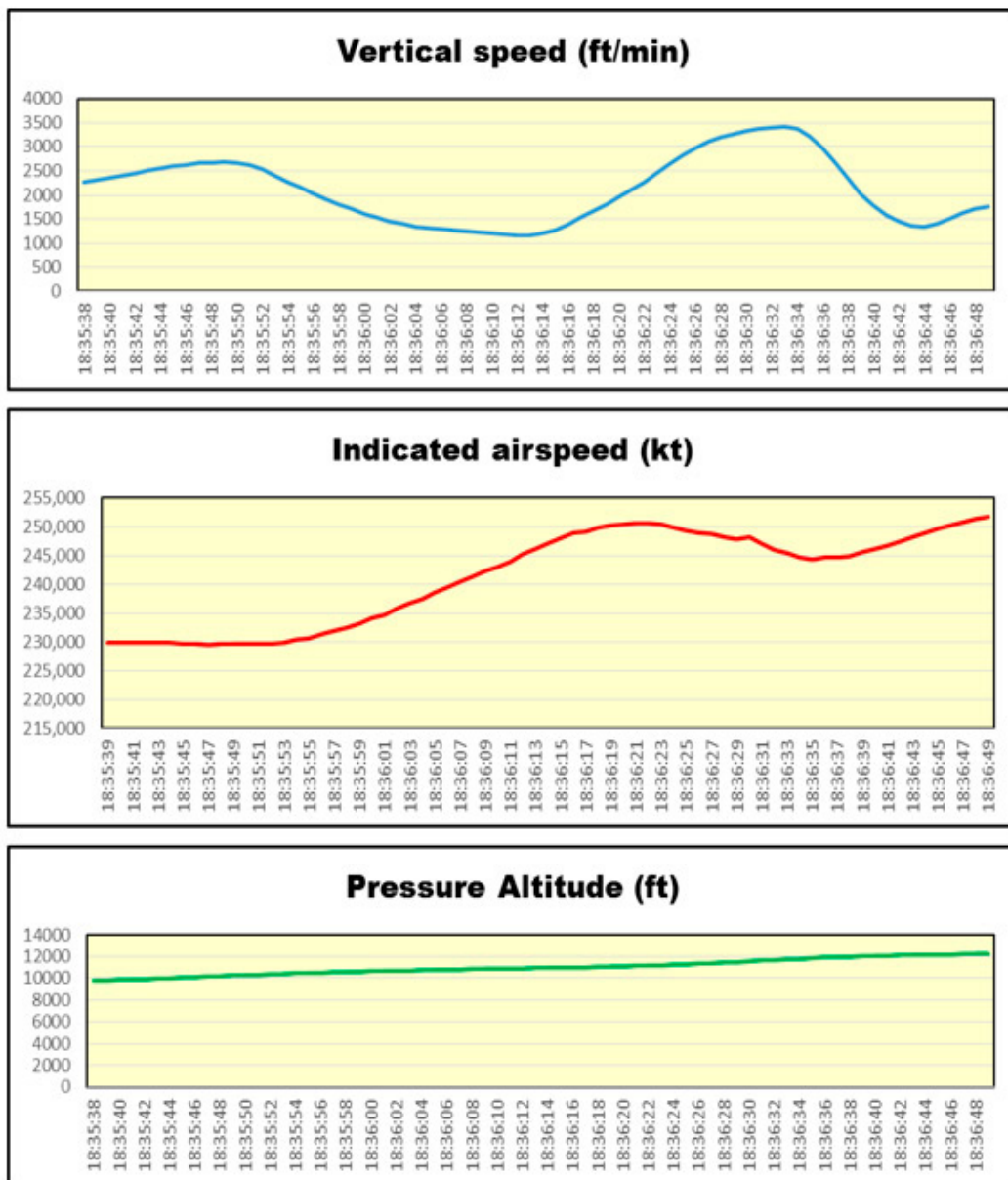
The activation of this alert coincided with a drop in the aircraft's climb rate, caused by the acceleration of the aircraft to 290 kt as it climbed through FL100.



1.11.2 Analysis of data from VLG6502.

Aircraft VLG6502 remained at 220 kt to an altitude of 3000 ft, after which it accelerated to 250 kt, which it held to an altitude of 6000 ft. This speed yielded a climb rate in excess of 2500 feet per minute.

At 18:34:30, passing through 6000 ft, the speed was reduced to 230 kt. This lower speed yielded climb rates in excess of 4000 feet per minute, stabilizing at a rate of about 3200 feet per minute.

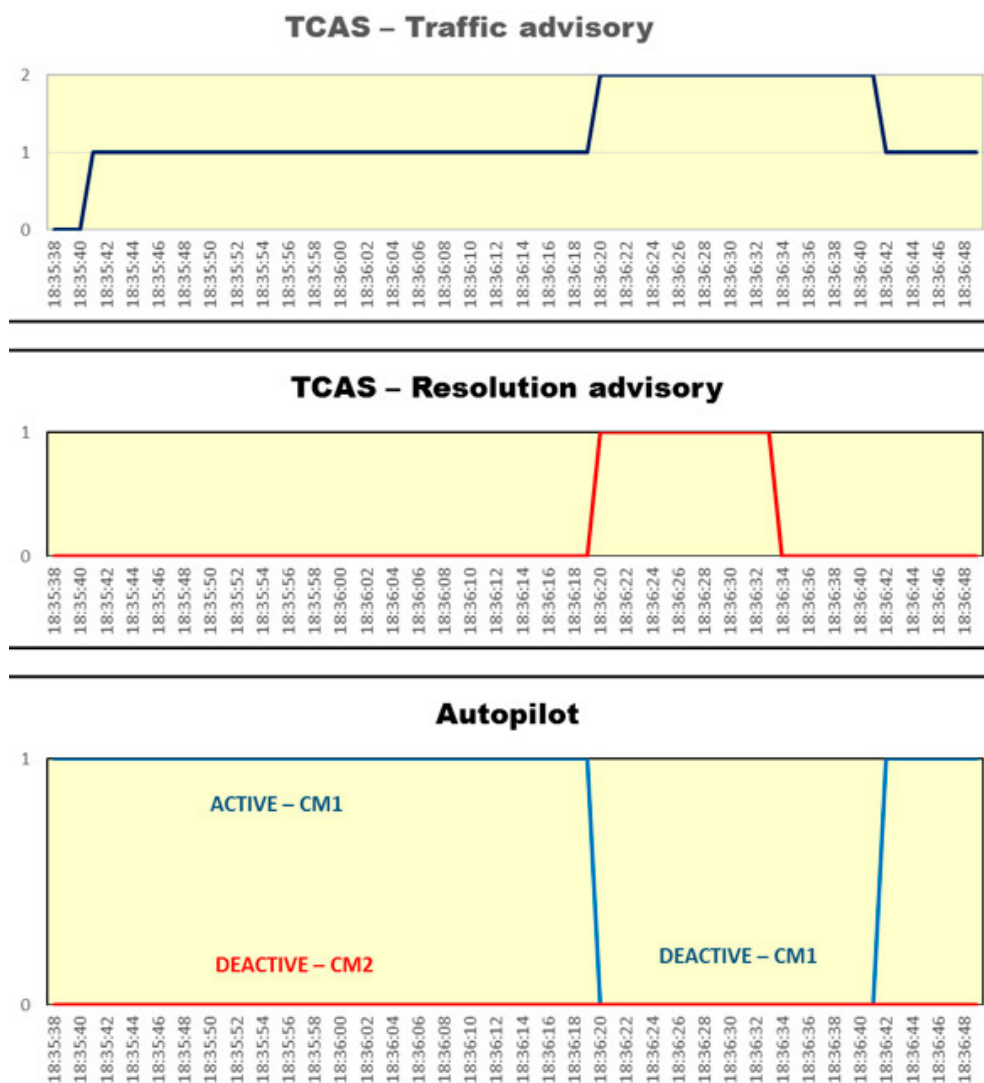


At 18:35:42, the TA was activated. The traffic was climbing through 9900 ft at 230 kt with a climb rate of 2500 feet per minute.

At 18:36:18, the "CLIMB" RA was activated, which required the crew to increase the climb rate. The aircraft was climbing through 11100 ft at 250 kt and 1900 ft/min.

The crew disengaged the autopilot and increased the climb rate to 3400 ft/min, maintaining 250 kt. The RA was activated for 16 seconds.

The TA remained active until 18:36:42, that is, for an additional 8 seconds.



In order to analyze the TCAS maneuver, two parameters were evaluated, and which were deemed to be valid on EC-LRE.

- TCAS Warning (discrete): Can have four values:
 - NO TA/RA Dangerous: there's no alert TCAS RA "Traffic Traffic" nor TCAS RA
 - TA Most dangerous: TCAS TA "Traffic Traffic"
 - RA Most dangerous: TCAS RA
 - * No TCAS signal received
- TCAS – Up advisory (discrete): The RA alert type can have two values
 - No Up Advisory: there's no RA alert
 - Climb: TCAS RA "Climb Climb"

1.12 Wreckage and impact information

The aircraft involved in the incident were not damaged.

1.13 Medical and pathological information

There were no indications that the crewmembers or the air traffic controllers were affected by physiological factors or incapacitated.

1.14. Fire

There was no fire.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

In its section on “RA Statistics”, the “Eurocontrol ACAS Guide”, published in May 2016, states that the data collected as part of the EVAIR⁶ project in 2014 revealed that in most TCAS encounters, only one of the aircraft involved received a RA. The possible reasons given for this are:

- The geometry of the conflict was such that the RA was not generated on the TCAS II-equipped threat aircraft;
- The threat aircraft was not TCAS II equipped;
- The threat’s TCAS II was in TA-only mode.

Since in the incident under investigation only one of the aircraft received a RA, the investigation team contacted an expert at Eurocontrol, who confirmed that in approximately half of the encounters between two aircraft equipped with TCAS II, a RA is generated on only one of the aircraft, while the other may or may not receive a TA. This behavior is normal and expected for the system, and depends on several factors such as vertical speeds, turns, etc. Each TCAS unit evaluates the other aircraft independently, and the TCAS logic on each aircraft activates several filters that can inhibit a RA.

The CIAIAC asked Eurocontrol to analyze this event to determine if the TCAS II units on the aircraft involved in the incident reacted correctly.

For this determination, the experts used version 3.3 of the InCAS⁷ tool, designed to analyze incidents in which the TCAS provides instructions to avoid a collision. The event is recreated on the tool, which simulates the unit’s logic for avoiding collisions (specified in the TCAS II MOPS⁸). The tool displays both horizontal and vertical views of the event. Based on the aircraft flight paths, taken either from the DFDR or from ATC radar data, the simulator issues the TCAS advisories, just as they would have occurred in the actual situation, and provides details on the decisions made by the units analyzed.

From its analysis of the data, Eurocontrol deduced the following:

- Behavior of VLG6502

6 Eurocontrol Voluntary ATM Incident Reporting.

7 InCAS: Interactive Collision Avoidance Simulator.

8 MOPS: Minimum Operational Performance Standards.

The TCAS advisory times and type on VLG6502 were generally consistent with the comparison of the data recorded by the aircraft and by the simulation. The differences observed could be explained by the data processing limitations.

- Behavior of SWR191Q

A comparison of the data recorded by the aircraft and those output by the simulation reveals a discrepancy between the advisory times and alert type received by the aircraft.

The data recorded by the aircraft show that no RAs were issued during the incident, while the simulation showed that a Level off" RA should have been issued.

This discrepancy cannot be explained by the data processing limitations.

Given the vertical and horizontal convergence rates, it is thought that under normal circumstances, SWR191Q should have received a RA.

The possible hypotheses to explain the absence of this alert are:

- The TCAS unit on SWR191Q was in "TA-only" mode.
- A fault in the TCAS unit in the aircraft.

In light of these findings, the investigation focused on identifying the reason behind the discrepancy detected by Eurocontrol.

The operator was asked about the unit, which replied that it had been selected to TA/RA mode. When asked for the parameter, the operator replied that the QAR did not record the TCAS selection mode, meaning that this information was assumed to have been provided by the crew.

The specialists at Eurocontrol proposed asking for the BDS10⁹ data protocol record ("Data link capability report") issued by mode S of the radar. The initial radar query records this protocol, which contains the mode of operation of the TCAS.

ENAIRE was asked for the record of this protocol in the BDS10 data that was sent by the navigation services provider, but after being analyzed by Eurocontrol

9 CommB (Short data link download message (56 bits)) Definition Subfield

specialists, it was noted that they did not contain the desired information on the TCAS II active mode. ENAIRE's Technical Department also stated that its system does not record the BDS30 protocol ("ACAS active resolution advisory"), which is of importance to investigating certain events involving the activation and logic of the collision avoidance system.

As a result, a recommendation is issued to ENAIRE so that both the BDS10 and 30 S-mode radar protocols be recorded and preserved so as to facilitate the investigation and analysis of events involving the ACAS.

1.17 Organizational and management information

1.17.1 Airbus procedures in response to TCAS TA/RA

The Airbus A319/A320/A321 FCTM specifies that the crew take the following actions if a TCAS TA/RA is received.

"If a TA is generated:

- *The PF announces: "TCAS, I have controls".*
- *No evasive maneuver should be initiated, only on the basis of a TA.*

If a RA is generated:

- *The flight crew must always follow the TCAS RA orders in the correct direction, even:*
 - *If the TCAS RA orders are in contradiction with the ATC instructions*
 - *At the maximum ceiling altitude with CLIMB, CLIMB or INCREASE CLIMB, INCREASE CLIMB*

TCAS RA orders

- *If it results in crossing the altitude of the intruder.*

CAUTION *If a pilot does not follow a RA, he should be aware that the intruder may be TCAS equipped and may be maneuvering toward his aircraft in response to a coordinated RA. This could compromise safe separation.*

- *The PF disconnects the AP, and smoothly and firmly follows the Vertical Speed Indicator (VSI) green sector within 5 s, and requests that both FDs be disconnected.*

Note: Both FDs must be disconnected once APs are disconnected:

- *To ensure autothrust speed mode*
- *To avoid possible confusion between FD bar orders and, TCAS aural and VSI orders*
- *The PM disconnects both FDs, but will not try to see intruders.*
- *The PF will avoid excessive maneuvers, and keep the Vertical Speed outside the red area of the VSI and within the green area. If necessary, the PF must use the full speed range between $V_{\alpha max}$ and V_{max} .*
- *The PM must notify ATC.*
- *The flight crew should never maneuver in the opposite direction of the RA, because TCAS maneuvers are coordinated.*
- *In final approach, i.e. "CLIMB", "CLIMB NOW", "INCREASE CLIMB", the flight crew will initiate a go-around.*

When clear of conflict:

- *The flight crew must resume normal navigation, in accordance with ATC clearance, and using the AP, as required"*

1.18 Additional information

1.18.1 Statement from the crew of aircraft VLG6502

After taking off from runway 25L at Barcelona on SID VERSO 3Q, ATC informed them that they could proceed to VERSO after passing FL080, which they did.

The other traffic was a Swiss Airbus A321, whose callsign they could not recall, but which was on a northerly heading and approaching them from their 3 o'clock position. They were in visual contact with the intruding traffic.

As the Swiss approached them, ATC informed them that he had not realized it, but that there was an aircraft very close by and asked if they had it in sight. The copilot acknowledged, replying to his order "unable TCAS RA", since just then the TCAS RA was activated with a CLIMB advisory. They climbed very little, since the other aircraft's climb rate was very low and they were much higher, but at a distance of approximately 3 NM.

When instructed by the TCAS, they climbed, a little over 1000 ft, and quickly cleared the other aircraft, although in reality they would not have been in conflict since they were in visual contact and while it was very close, they were clear.

1.18.2 Statement from the crew of aircraft SWR191Q

They took off from runway 25L at Barcelona on standard departure DALIN3Q. They were cleared to climb with no restrictions on a heading of around 200°. They recalled an additional instruction that, "when passing 8000 ft turn left direct DALIN", so they selected a speed of around 220 kt to obtain a higher climb rate.

Shortly thereafter they received the instruction to proceed direct to DALIN (at 7000-8000 ft).

A short time later, established on course to DALIN and climbing at around 10000 ft, they received a traffic diamond on the navigation display at 7 o'clock and climbing. A few seconds later, the diamond turned amber, still showing -1000 ft.

The traffic was visible through the captain's rear side window. The PM asked about the traffic, and ATC replied something like "the traffic is crossing behind you".

After the traffic crossed behind them, ATC answered their question about the closest point of approach, stating "2.4 NM, I'm sorry, please contact now with (next frequency)".

The crew recalled that the vertical distance shown had been 400-500 feet.

They did not receive or execute any RA.

1.18.3 *Statement from the executive controller in Barcelona sector T3W*

That day he was on watch as the executive controller in sector T3 of the Barcelona TMA, with runway 25R being used for landings and 25L for takeoffs (WRL configuration). At the time of the incident there was not much traffic in the sector.

In this sector, the flight paths of departing aircraft can conflict with those of inbound traffic, meaning that the controller must route the traffic to avoid these conflicts by altering the takeoff routes.

At that time there were several departures and arrivals. The former would not give rise to conflicts if they were rerouted before their SIDs overlapped the STARs.

SWR191Q was instructed to proceed direct to DALIN after climbing through FL080, a restriction he gave so it would not turn too soon and conflict with arrivals from sector T2. VLG6502 then took off and was instructed to proceed to VERSO after clearing FL080, with the same intention.

The instructions he gave both aircraft were similar and he was convinced they were sufficient to ensure their separation without generating subsequent conflicts, since the routes were different and the traffic were far apart. He did not consider the possibility that the lower traffic would increase its climb rate, or that the other traffic would climb slower and be overtaken by the former. He acknowledged his error in perception since he thought that the aircraft were sequenced differently based on their destination, meaning that the higher traffic was going to VERSO and the lower one to DALIN, though he gave them the correct instruction based on their callsigns.

Further south he had to separate a Vueling aircraft from a Swiftair aircraft that had left Palma de Mallorca. The former was much faster than the latter and had an earlier approach sequence, so it was cleared to a lower level. Even so, it was descending slower than expected, so he instructed it to accelerate its descent to avoid having the two aircraft approach each other. While he was monitoring this conflict, putting a DAL¹⁰ between them, he stopped monitoring the other two aircraft, whose separation he thought was assured. Someone then warned him that the Vueling aircraft was in conflict, but he thought the CAP¹¹ had been activated for the one he was monitoring.

10 DAL Distance Azimuth Line. SACTA tool to link two aircraft and obtain relative course and distance information.
LAD Línea Azimut Distancia.

11 CAP Conflict Alert Prediction

When he became aware of the event, he called the pilot of VLG6502 to alert him to the proximity of the traffic. The pilot replied, stating that he had the aircraft in sight and was not concerned. The controller apologized, and then he received a CAV¹², at which point the pilot reported that he was executing a RA maneuver.

After executing the conflict maneuver, the conflict cleared and the aircraft were transferred to the next sector. The crew of SWR191Q also stated that they had kept the aircraft in sight and asked about the closest distance. The controller replied that it had been 2 NM at the same altitude.

In conclusion, the controller stated that he intended to provide a continuous climb to both departing aircraft, and that to do so he planned to modify their route and shorten their trajectory. He thinks that he did not give proper attention to identifying the fact that the first traffic was on SID DALIN3Q and the second one on VERSO3Q, and the planned instruction to instruct both aircraft to proceed to DALIN and VERSO, respectively, when they cleared FL080 was incorrect, since it caused their flight paths to cross.

He noted that the instruction to clear both aircraft to climb directly to FL190 “with no altitude restrictions” did not adhere to standard phraseology, since he was actually referring to not restricting the climb to the limitation present at point NITBA¹³. An altitude restriction would have avoided the conflict.

The STCA¹⁴ did not work correctly since the CAP mode, which would have drawn his attention to the possible conflict and helped to resolve the situation, was not activated.

As for the possibility of fatigue, the controller thought it was not a factor, since he had returned to work following a recent vacation period.

He did admit that the event took place toward the end of his watch, when he may have been less alert.

As for the actions of his planning controller, he noted that due to the low amount of traffic in his sector, at that moment he was paying attention to the sequence of arrivals expected from the adjacent T2 sector in order to control the speed of the aircraft inbound from point RULOS (IAF¹⁵ for his sector) and coordinate them with

12 CAV Conflict Alert Violation

13 Limit the climb to 6000 ft or below unless ATC authorizes otherwise.

14 STCA - Short-Term Conflict Alert.

15 IAF - Initial approach fix

those inbound from the LESBA IAF (sector T2). He was thus unaware of the instructions given to departures. He only managed to warn the executive controller of the conflict as it was about to happen.

1.18.4 *Statement from the planning controller in Barcelona sector T3W*

The planning controller stated that he was focused on another conflict point and on the sequence from an adjacent sector in order to facilitate the other sector controller's sequencing at the RULOS IAF. As a result, he did not hear the instructions the executive controller was giving to departing aircraft.

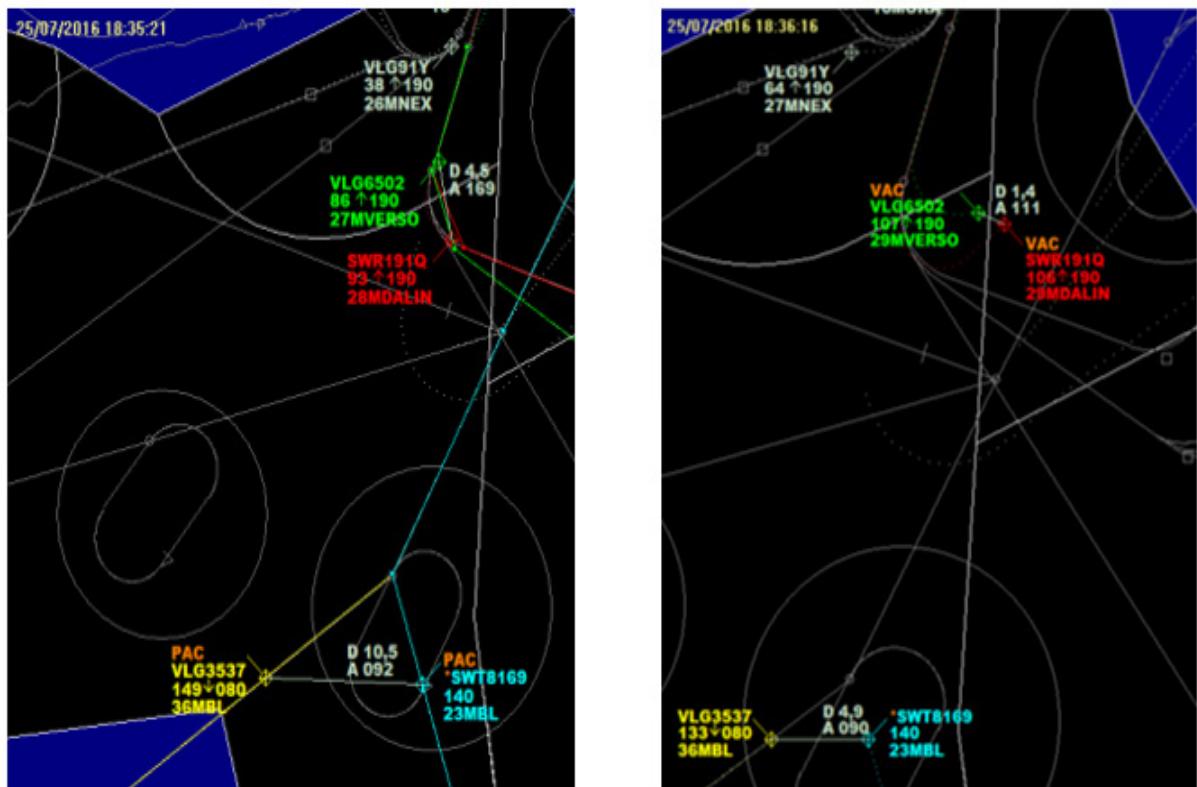
By the time he noticed the loss of separation, the executive controller was already informing the aircraft involved.

1.18.5 *STCA*

Air traffic control stations feature a prediction system called STCA, which uses data sent by the aircraft to identify situations in which two aircraft could enter into conflict with each other. Depending on the distance between the aircraft, the system generates aural and visual alerts. The first, issued when the aircraft are still within the stipulated radar distance, is called Conflict Alert Prediction (CAP). If this distance is violated, another warning is generated called Conflict Alert Violation (CAV). The radar display shows these initials (PAC and VAC in Spanish) and an aural signal is also activated to alert the controller.

According to the data from this system, at 18:35:21, a CAP alert was generated for aircraft that were inbound to Barcelona in the south of the sector. At that moment, VLG3537 was descending through FL149 to level out at FL080, and SWT8169 was holding at FL140, on a converging course with VLG3537. This alert remained active until the descending aircraft crossed the flight level maintained by the essential traffic.

The aircraft affected by the incident (VLG6502 and SWR191Q) were 4.5 NM and 700 ft apart, but below FL100. No alerts attracted the controllers' attention to their potential conflict.



At 18:36:16, a CAV alert was issued due to the two aircraft. The horizontal distance between them had dropped to 1.4 NM and the vertical distance to 100 ft. Both aircraft were above FL105.

So as not give nuisance alerts, this function of the STCA system was inhibited below FL105 at the Barcelona TMA.

As a result of the investigation into this incident, in October 2016 ENAIRE reported that it was optimizing the STCA tool in the airspace of TMAs, and in particular in the Barcelona TMA. The goal of this process was to minimize the volumes of airspace in which this tool is inhibited (due to airspace design, traffic flows, etc.), due to the unacceptable number of nuisance alerts. After the relevant tests and analyses, this optimized use of the STCA went into operation in February 2017.

1.18.6 Measures taken by ENAIRE

Between 2016 and June 2017, a controller blind spot was a causal factor in fewer than 1% of the incidents reported in the east Air Navigation Region.

Eurocontrol defines a blind spot as the failure of a controller to identify a conflict that is shown on the display, either due to a lack of attention or to the loss of situational awareness.

After all of these incidents, the Operational Safety Department shared the factors that had caused the incidents with the controllers involved so as to identify areas of improvement and avoid a recurrence of similar mistakes. It resorted to the report Eurocontrol Operational Safety Study: Blind Spots¹⁶, which is an openly available operational safety study of incidents in which the blind spot effect, meaning the inefficient detection of a conflict with the nearest aircraft is involved. It also seeks to serve as a reference for the potential actors involved in the event that they engage in studies or activities to avoid said incidents.

Half of the reports issued as a result of investigations into this type of incident were sent to the Training Department of the unit involved so they could be used during the incident analysis training sessions that are attended by all air traffic controllers.

Recommendations have also been made in the following regards:

- Discuss the incidents at training meetings that are attended by all the instructors, in the case that the incident occurred while providing OJT.
- Send the investigation report to the airline, in those cases where the crew contributed to the incident.
- Improve the technological barriers to detect conflicts and thus avoid the consequences of a blind spot.
- Discuss the incidents in meetings with supervisors, which are attended by all supervisors, in those cases where supervisors contributed to the incident.
- Incident repeatability study in sectors with a similar layout.

In the specific case of the air traffic controller involved, since he had been implicated in incidents of varying severity in the previous 24 months, he was temporarily removed from duty following the application of the "Procedure for declaring and managing temporary disqualifications for executing the duties of an ATC license". Based on the report from the Regional Operational Safety Department, the controller received five on-the-job training sessions and an Extraordinary Aptitude Evaluation, which he passed, after which he resumed his duties normally.

1.19 Useful or effective investigation techniques

N/A

16 <https://eurocontrol.int/sites/default/files/publication/files/top-5-safety-n2-study-blind-spot.pdf>

2. ANALYSIS

2.1. Analysis of the operation

The incident occurred while the Barcelona Airport was in a WRL configuration, meaning runway 25L was in use for takeoffs and 25R for landings.

According to the statement from the sector T3W executive controller, the traffic in the sector was light at the time, although they were mindful of arriving aircraft in adjacent sectors so they would not conflict with departing aircraft in their sector.

To avoid these potential conflicts, the controller was assigning departure flight paths that avoided converging with arriving traffic.

The first departing aircraft involved in the incident was SWR191Q, on instrument departure DALIN3Q. This aircraft was cleared to proceed direct to DALIN, the final point of its departure maneuver, upon climbing through FL080 to FL190. The crew lowered the speed to 220 kt with the intention of increasing their climb rate in order to execute the authorized maneuver in the shortest time possible.

The second aircraft, VLG6502, contacted sector T3W 1 minute 39 seconds later. It was assigned instrument departure VERSO3Q, and it was also cleared to proceed to the final point on its maneuver, VERSO, after climbing through FL080 to FL190. The crew also reduced the indicated airspeed to improve the climb speed, thus obtaining a better climbing performance than the preceding traffic.

According to the controller's statement, the instructions he gave to the two aircraft were similar, and he was convinced that they would achieve his goal of separating them without creating subsequent conflicts, since the routes were different and the aircraft were far apart. He did not consider the possibility that the lower traffic would increase its climb rate and that the other traffic would climb slower and be overtaken by the second. He acknowledged his loss of situational awareness, since he thought that the aircraft were sequenced differently based on their destination, meaning that the higher traffic was going to VERSO and the lower one to DALIN, though he gave them the correct instruction based on their callsigns.

Carrying out the instructions received by the controller would cause the flight paths to cross laterally, since point DALIN is further north than VERSO (see Figure 1). The instruction issued was thus incorrect.

Before the two incident aircraft took off, there were two arriving aircraft in the south of the sector that caused a conflict situation, thus indirectly contributing to this incident since, as the controller stated, they diverted his attention as he

attempted to resolve the conflict. The conflicting aircraft were SWT8169, which entered the sector via point ESPOT at FL140, which he cleared to fly standard arrival route NEPAL2V, and VLG3537, which entered via point MARTA at FL180 and which was cleared to fly route MARTA5Y.

Since aircraft SWT8169 was much slower than VLG6502, the sequence number for the latter was slower, and the controller instructed it to a lower level and monitored its descent so that by NEPAL, the point of conflict between the two standard terminal arrival routes authorized, it would be below SWT8169. The descent rate of the authorized traffic was lower than expected by the controller and a CAP alert was activated, which was inhibited once the aircraft's vertical trajectories crossed.

Given the positions of the departing aircraft involved in the incident and their similar speeds, the controller's plan resulted in their flight paths crossing. The Swiss aircraft, as it turned toward DALIN, cut off the lateral trajectory ahead of the Vueling aircraft, which also had a higher climb rate. This resulted in both aircraft's flight paths crossing at almost the same level, causing a loss of separation as the two aircraft came within 1.2 NM horizontally and 200 ft vertically of each other.

The planning controller reported that since the workload in his sector was low, he was focusing his attention on the sequence at the initial approach fix in the adjacent sector in order to control the speeds of inbound aircraft and help out the executive controller. He was unaware of the instruction that had been given to departing traffic. He informed the executive controller of the conflict just as it was about to occur.

The STCA alarm was activated when the separation between the aircraft was lost, resulting in a Conflict Alert Violation (CAV) without a preceding Conflict Alert Prediction (CAP). At the time of the incident, this alarm had been inhibited from FL105 to MSL.

In October 2016 ENAIRE reported that it was optimizing the STCA tool in the airspace of TMAs, and in particular in the Barcelona TMA. The goal of this process was to minimize the volumes of airspace in which this tool is inhibited (due to airspace design, traffic flows, etc.), due to the unacceptable number of nuisance alerts. After the relevant tests and analyses, this optimized use of the STCA went into operation in February 2017. As a result, no safety recommendations are issued in this regard.

When the executive controller noticed the near miss, he informed VLG6502 of the position of SWR191Q. The crew replied that they had the traffic in sight, but immediately reported that they were executing a TCAS RA at 18:36:18,

The crew of SWR191Q also reported being in visual contact with the intruding traffic, which had gotten close to them.

2.2. Analysis of the evasive maneuver

Based on the data obtained from the quick access recorder (QAR) and from the radar tracks, both aircraft received TCAS traffic advisories (TA), while only VLG6502 received a climb resolution advisory (RA), which lasted 16 seconds.

The crews reacted as indicated in the Airbus FCTM, monitoring the intruding traffic in case of a TA, and following the indications on the vertical speed indicator (VSI) in case of a RA.

Their use of communications and phraseology was also correct.

The investigators were surprised by the fact that only one of the aircraft involved received a resolution advisory, so experts at Eurocontrol were asked to assist in analyzing the maneuver. Eurocontrol confirmed that its statistics indicated that this happened in a large number of cases.

Eurocontrol analyzed the event using its InCAS tool, which showed that the behavior of the TCAS unit on aircraft VLG6502 was correct. Their analysis of the simulation also showed that the unit on aircraft SWR191Q should have generated a "Level Off" RA.

To explain this discrepancy, the Eurocontrol specialists requested the BDS10 data protocol records ("Datalink capability report") for the S-mode radar from ENAIRE. The data provided did not contain the information desired on the active mode of operation of the TCAS unit installed on aircraft SWR191Q. As a result, this discrepancy could not be corroborated except by the information provided by the operator, which stated that the unit was selected to TA/RA mode.

SWISS commented that the flight crew of SWR191Q confirmed, that in their opinion the TCAS unit must have been set to the TA/RA mode. The setting of the selector to TA/RA before takeoff is a standard checklist point and, even though of course not impossible, it seems highly improbable that the crew moved the selector to the TA only and not the TA/RA position. Besides the flight crew would have been aware of the "TA only" white memo indication on their navigation display during the climb out if this checklist point had been performed incorrectly. An incorrect setting and the overlooking of an "abnormal" indication of the navigation display would indicate a double failure, which does not seem likely. In addition, the intruder was displayed on the navigation displays of SWR191Q shortly after takeoff and thus, becoming aware of the traffic, the Commander obtained visual contact with the

intruder (out of the left cockpit window). So the alertness of the crew with regard to a possible TCAS warning was raised at an early stage. In summary, even if a mishandling of the selector cannot be totally excluded, it must be assumed that the setting of the TA/RA selector was correct. Additionally, the operator stated that no technical fault of the TCAS unit of HB-ION could be traced.

ENAIRE's Technical Department stated that its system does not record the BDS30 protocol (ACAS active resolution advisory). Eurocontrol specialists regard both the records of this mode and those of the BDS10 as essential for analyzing events involving the collision avoidance system.

For this reason, a safety recommendation is issued to ENAIRE to request that it record the BDS10 and BDS30 data protocols for the S-mode radar so as to facilitate the investigation of events involving the airborne collision avoidance system (ACAS).

2.3. Analysis of the measures taken by the navigation services provider.

The investigation has determined that the blind spot effect played a role in the evolution of the event being investigated.

According to the controller's statement, he focused his attention on another potential conflict that could arise in his sector, which diverted his attention from the incident considered herein.

The East Operational Safety Department recommended that the causal factors be shared with the controllers involved in this type of event so as to identify areas of improvement and avoid similar errors from happening again. This measure is deemed to be correct since, in the case of the blind spot, which is an infrequent situation, the controller may not realize the cause of the mistake made.

Reports on the events were also sent to the Training Departments at the units for use in the incident analysis training activities that are given to all of the controllers.

Since ENAIRE has informed and trained controllers on the characteristics of this incident, no safety recommendation is issued in this regard.

Since the controller was involved in other incidents of varying severity, ENAIRE applied its "Procedure for declaring and managing temporary disqualifications for executing the duties of an ATC license". Based on the report from the Regional Operational Safety Department, the controller received five on-the-job training sessions and an Extraordinary Aptitude Evaluation, which he passed, after which he resumed his duties normally. This measure is considered sufficient, and thus no safety recommendation is issued in this regard.

3. CONCLUSIONS

3.1. Findings

- The aircraft had their documentation in order and they were airworthy.
- The crewmembers of aircraft RYR314Q and VLG2226 had valid licenses and medical certificates.
- The executive and planning controllers had valid licenses, unit endorsements and medical certificates.
- Aircraft SWR191Q and VLG6502 established contact with sector T3 1 minute and 39 seconds apart, and were cleared to proceed direct to the final fix of their respective departure routes, DALIN and VERSO, after climbing from FL080 to FL190.
- According to his statement, the controller did not expect these lateral trajectories to cross. This, along with their different climb rates, resulted in a loss of separation between the aircraft. The minimum distance between them was 1.2 NM horizontally and 200 ft vertically.
- The Conflict Alert Violation (CAV) was activated once the aircraft cleared FL105, since the STCA at the Barcelona TMA is inhibited below that level.
- VLG6502 received a TCAS RA, to which the crew reacted as instructed.
- Only a TCAS TA was received on aircraft SWR191Q. The analysis of the maneuver by Eurocontrol determined that the unit on the aircraft should have issued a TCAS "Level off" RA. The fact that the mode of operation was not recorded on the QAR, as well as the unavailability of valid data from the S-mode radar BDS10 and BDS30 protocols, prevented investigators from determining the cause of this event.
- The executive controller's attention was focused on a potential conflict between two aircraft in the south of the sector.

3.2. Causes/Contributing factors

The incident was the result of an incorrect instruction from the executive controller, who crossed the lateral trajectories of the aircraft without considering their different climb rates, resulting in the loss of separation between them.

The following contributing factors are deemed to have influenced the incident:

- The controller focusing his attention on a potential conflict between other aircraft in the south of the sector.
- The inhibition of the STCA system in the Barcelona TMA below FL105.

4. SAFETY RECOMMENDATIONS

The investigation identified that the airborne collision avoidance system (ACAS) did not respond as expected based on its theoretical parameters. Analyzing this type of event, using Eurocontrol simulation tools, requires an analysis of the BDS10 and BDS30 data protocols used by the S-mode radar.

For this investigation, the air navigation services provider, ENAIRE, was not able to provide valid data from said protocol for analysis. As a result, the following safety recommendation is issued:

REC 54/17: It is recommended that ENAIRE record the data from the S-mode BDS10 and BDS30 data protocols so as to facilitate the investigation of events involving the airborne collision avoidance system (ACAS).