Report

IN-039/2018

Incident involving two Boeing 737-800 aircraft, registrations EI-FRY and EI-DWW, operated by Ryanair, at reporting point GOSVI at FL340 (Navarre) on 2 October 2018

Please note that this report is not presented in its final layout and therefore it could include minor errors or need type corrections, but not related to its content. The final layout with its NIPO included (Identification Number for Official Publications) will substitute the present report when available.

GOBIERNO DE ESPAÑA
MINISTERIO DE TRANSPORTES, MOVILIDAD Y AGENDA URBANA
SUBSECRETARÍA
COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

NOTICE

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) nº 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

ACC ..... Area control center

A/P ..... Autopilot

A/T ..... Auto Throttle

ATC..... Air traffic control

ATPL (A) ..... Airline transport pilot license (airplane)

CAS ..... Calibrated airspeed

CPL (A) ..... Commercial pilot license (airplane)

FL..... Flight level

fpm..... Feet per minute

ft..... Feet

GS..... Ground speed

h..... Hours

kt ..... Knots

LFBB..... Bordeaux Control Center (France)

min ..... Minutes

NM ..... Nautical miles

No. ..... Number

s ..... Seconds

S/N..... Serial number

STCA ..... Short-term conflict alert

STCA PAC..... Conflict alert prediction

STCA VAC..... Conflict alert violation

TCAS ..... Traffic collision avoidance system

TCAS RA ..... TCAS resolution advisory

TCAS TA..... TCAS traffic advisory

UTC ..... Coordinated universal time

SYNOPSIS

Owner and operator:	Aircraft 1: Ryanair
	Aircraft 2: Ryanair
Aircraft:	Aircraft 1: Boeing 737-800, registration EI-FRY, RYR55CB
	Aircraft 2: Boeing 737-800, registration EI-DWW, FR1192
Date and time of incident:	Tuesday, 2 October 2018 at 14:57 UTC[1]
Site of incident:	Reporting point GOSVI (Navarre) at FL340
Persons on board:	Aircraft 1: 184, uninjured
	Aircraft 2: 160, uninjured
Type of flight:	Aircraft 1: Commercial air transport – Scheduled – Domestic – Passenger
	Aircraft 2: Commercial air transport – Scheduled – International – Passenger
Phase of flight:	Aircraft 1: En route
	Aircraft 2: En route
Date of approval:	3 June 2020

Summary of event:

On Tuesday, 2 October 2018 at 14:57:09, there was a loss of separation event between aircraft EI-FRY and EI-DWW while they were level at FL340 with a CAS of 250 kt and a GS of 400 kt. The two aircraft were in airspace under the control of sector PAL of the Madrid ACC, although one of them had been transferred 3 min earlier to adjacent sector ZGZ, meaning that during the conflict, each aircraft was in radio contact with a different controller.

The conflict had been identified 1 min 27 sec earlier (14:55:42) by the Bordeaux ACC, but the actions of the controllers in sectors PAL and ZGZ did not prevent the aircraft from continuing on converging tracks until 14:57:09, when they reached the closest point of approach, separated by 2.3 NM horizontally and 334 ft vertically. This closest approach occurred while executing the TCAS RA maneuvers, which both aircraft had received 9 s earlier (14:57:00).

The investigation has determined that the incident was caused by the failure of the PAL sector controller to identify the conflict, and the subsequent transfer of aircraft 2 (EI-DWW) to the adjacent sector, ZGZ, without being clear of the conflict. Contributing to the incident was the improper handling of the conflict by the controllers in both sectors, who issued similar instructions to the two aircraft, contrary to what had been agreed previously.

[1] All times in this report are in UTC, taken from air traffic services.

1. FACTUAL INFORMATION

1.1. History of the flight

On Tuesday, 2 October 2018, two Boeing 737-800 aircraft operated by Ryanair were established in the route phase in the airspace of the Madrid ACC, on the following flight paths:

- Aircraft 1, EI-FRY, callsign RYR55CB, heading southeast en route from Santiago de Compostela (Spain) to Palma de Mallorca (Spain).
- Aircraft 2, EI-DWW, callsign FR1192, heading northeast en route from Seville (Spain) to Toulouse (France).

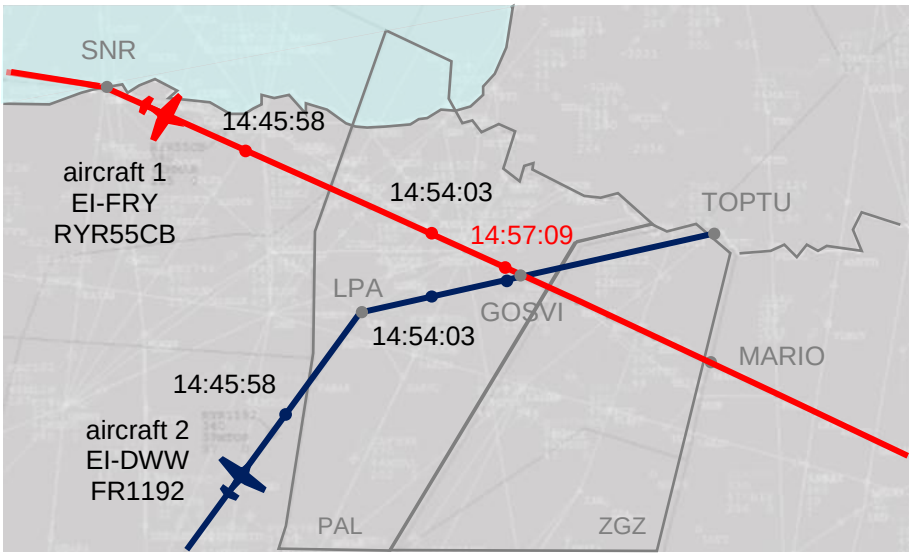

Figure 1. Aircraft flight paths

At 14:45:58, both aircraft were in contact with sector PAL in the Madrid ACC, both at FL340. At 14:54:03, aircraft 2 was transferred to adjacent sector ZGZ in the Madrid ACC, while aircraft 1 remained in sector PAL. Both continued at FL340 on convergent headings toward GOSVI, reducing their separation until they reached the closest point of approach three minutes later, at 14:57:09.

The event took place in the vicinity of point GOSVI. At their closest point, the aircraft were 2.3 NM apart horizontally and 334 ft apart vertically, with aircraft 1 above aircraft 2.

TCAS RAs were received on both aircraft during the conflict, but no STCA alerts were activated at either control position.

After the event, the aircraft resumed their navigation and reached their destinations without further incident. There were no injuries.

1.2. Injuries to persons

AIRCRAFT 1: EI-FRY, callsign RYR55CB

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				
None	6	178	184	
TOTAL	6	178	184	

AIRCRAFT 2: EI-DWW, callsign FR1192

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				
None	6	154	160	
TOTAL	6	154	160	

1.3. Damage to aircraft

None.

1.4. Other damage

None.

1.5. Personnel information

1.5.1 AIRCRAFT 1: EI-FRY, callsign RYR55CB

The captain, a 39-year-old Spanish national, had an ATPL(A) license. He had a total of 10,800 flight hours, of which 8,500 had been on the type. The first officer, a 35-year-old Spanish national, had a CPL(A) license. He had a total of 1,511 flight hours, of which 1,275 had been on the type.

1.5.2 AIRCRAFT 1: EI-DWW, callsign FR1192

The captain, a 40-year-old Irish national, had an ATPL(A) license. He had a total of 8,220 flight hours, of which 7,950 had been on the type. The first officer, a 40-year-old Italian national, had a CPL(A) license. He had a total of 3,600 flight hours, of which 3,100 had been on the type.

1.5.3 Executive controller in sector PAL

The controller was a 62-year-old Spanish national. He had valid unit ratings and endorsements at the time of the incident. He had been at the unit since 1996 and at the post since 2009.

1.5.4 Executive controller in sector ZGZ

The controller was a 49-year-old Spanish national. He had valid unit ratings and endorsements at the time of the incident. He had been at the unit since 2002 and at the post since 2010.

1.5.5 Planning controller in sector PAL

The controller was a 47-year-old Spanish national. He had valid unit ratings and endorsements at the time of the incident. He had been at the unit since 2014.

1.5.6 Planning controller in sector ZGZ

The controller was a 42-year-old Spanish national. He had valid unit ratings and endorsements at the time of the incident. He had been at the unit since 2012.

1.6. Aircraft information

Aircraft 1, EI-FRY, Boeing 737-8AS, S/N 44750, had 7052.25 total hours. Both engines had the same number of hours: 7053 h.

Aircraft 2, EI-DWW, Boeing 737-8AS, S/N 33629, had 36604.05 total hours. Engines 1 and 2 had 3447 and 30812 h, respectively.

1.7. Meteorological information

Not relevant.

1.8. Aids to navigation

The information on navigational aids has been integrated into Section 1.11 to provide a more complete description of the incident.

1.9. Communications

The information on communications has been integrated into Section 1.11 to provide a more complete description of the incident.

1.10. Aerodrome information

Not applicable.

1.11. Flight recorders

This section combines the information recorded by ATC services (radar tracks and communications) and by the aircraft (flight recorders and TCAS units). The data from the flight recorder and TCAS unit on aircraft 1 are used.

Since the flights were uneventful prior to and after the incident, this section focuses on the time period between 14:54:03, when each aircraft was transferred to different controllers, and 14:57:44, when the TCAS conflict cleared.

Aircraft at the same level on converging headings:

14:45:58 The aircraft were established in the cruise phase at FL340, both with sector PAL.

- 1: FL340, heading 111º, 421 GS, 255 CAS, A/P ON.
- 2: FL340, heading 038º, 397 GS, 252 CAS, A/P ON.

14:54:03 Aircraft 2 was transferred to adjacent sector ZGZ, despite still being in the airspace of sector PAL, 37.5 NM away from sector ZGZ.

- 1: FL340, heading 110º, 423 GS, 253 CAS, A/P ON.
- 2: FL340, heading 75º, 401 GS, 251 CAS, A/P ON.

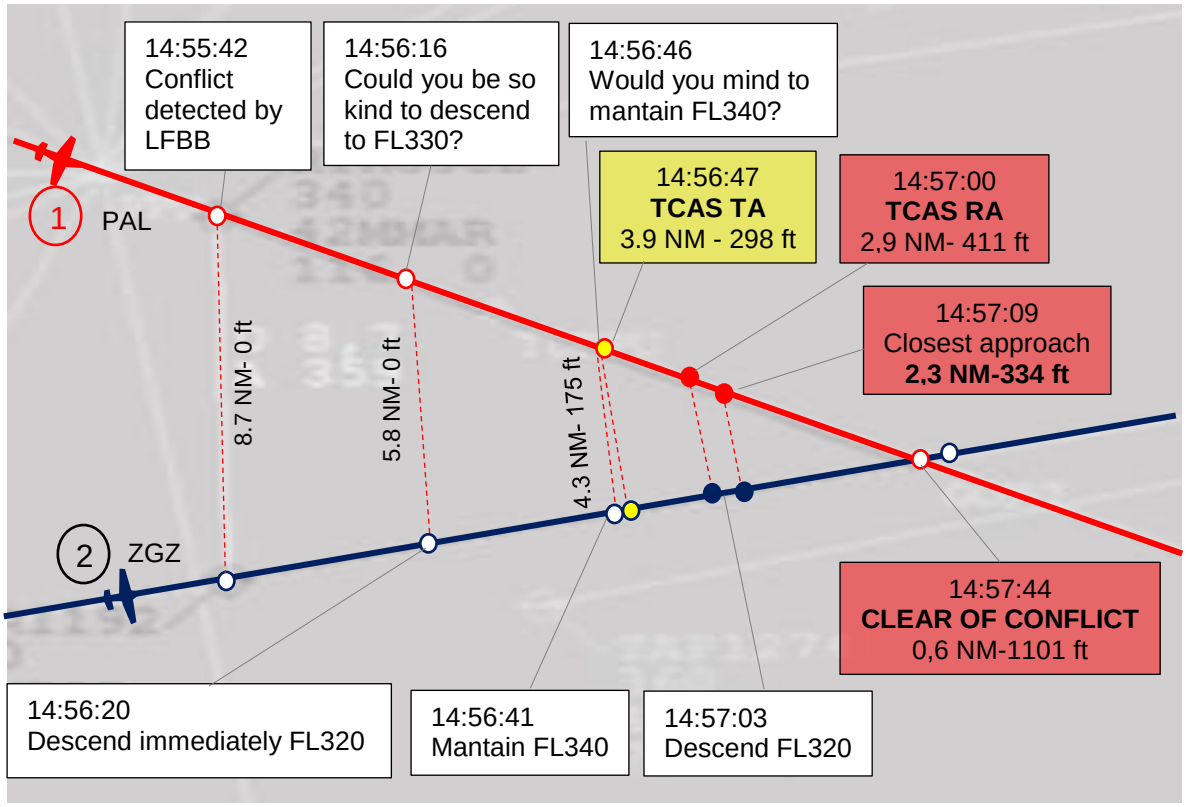

Figure 2. Flight paths between 14:55:42 and 14:57:44

At 14:54:36, an STCA PAC alert should have appeared for the two aircraft. This alert, which is displayed about 2 min before the minimum required separation is breached, was not generated[2].

At 14:54:59, aircraft 2 contacted sector ZGZ for the first time. This call was placed as the executive controllers in this sector were turning over, with the oncoming controller replying to the crew.

Conflict detection by Bordeaux ACC (8.7 NM- 0 ft)[3]:

14:55:42 The Bordeaux ACC controller notified the PAL sector controller of the conflict between the two aircraft. Judging by his reply, the PAL controller had not detected it. At this time, the aircraft were still level at FL340 and 8.7 NM away. Immediately

[2] Sections 1.16.10 and 1.18.1 contain information on the STCA system and its operational problems during the incident.
[3] Horizontal and vertical separation between the two aircraft.

after finishing the conversation, the PAL controller called ZGZ to correct the situation. The ZGZ controller also had not identified it.

14:56:02 PAL: "Do you want me to lower my RYR (aircraft 1) to 33 (FL330) just in case?"

14:56:12 ZGZ: "Yes, please!"

Descent instructions from both controllers (5.8 NM- 0 ft):

14:56:16 PAL to aircraft 1: "*Would you be so kind to descend to level 330 for a while? I'm afraid there's some other traffic at 34 (FL340) by your right*". This new cleared flight level was not entered into the label.

14:56:20 ZGZ to aircraft 2 "*descend immediately level 320*". The controller changed the label to reflect the new cleared level.

Within one second of acknowledging the instruction, the change in flight level from FL340 to FL330 was recorded in aircraft 1. However, this aircraft did not start the descent since a short time later, the crew requested confirmation of the instruction after seeing the traffic descending on the TCAS display.

In aircraft 2, the change in flight level from FL340 to FL320 was recorded within two seconds of acknowledging the instruction. It would commence the descent later.

New conflict detected by the controllers and by aircraft 1 (4.7 NM- 37 ft):

14:56:31-33 There were three simultaneous conversations: the two controllers, who informed each other they were descending their aircraft, and aircraft 1, which requested confirmation of the descent instruction:

- ZGZ: "*I'm descending mine, I'm descending mine*".
- PAL: "*Mine is already descending*!"
- Aircraft 1: "Can you confirm it's descend FL330?"

At that time, they were within 5 NM and 1000 ft, meaning the minimum separation was being violated. If the STCA system had worked properly, the PAC alert, which would have been activated for approximately 2 min, would have changed to a VAC.

Climb instructions from both controllers (4.3 NM- 175 ft):

14:56:41 ZGZ to aircraft 2: "*Maintain level 340 please, maintain 340, maintain 340*". This flight level was not entered into the label by the controller.

14:56:46 PAL to aircraft 1: "*My apologies, it seems that the other traffic is the one who is descending. Would you mind to maintain 34 for a while?"*

At that time, aircraft 1 still had not initiated its descent but aircraft 2 had, having lost 175 ft.

TCAS TA (3.9 NM- 278 ft):

14:56:47 TCAS TA while separated by 3.9 NM and 278 ft. Aircraft 1 maintained altitude. Aircraft 2 was below 1 and descending at -1450 fpm.

The communication initiated by the sector PAL controller at 14:56:46 coincided with the appearance of the TCAS TA. Since aircraft 1 had not initiated a descent, the aircraft had not moved vertically. A new change to the altitude selected, from FL330 to FL340, was immediately recorded.

Aircraft 2 acknowledged ATC's instruction to maintain FL340 while changing its selected flight level from FL320 to FL340. At 14:56:57, the controller informed the crew of the presence of traffic to the left, and the crew confirmed it had it on the TCAS.

As a result of the ATC instructions issued at 14:56:41 and 14:56:46 to maintain FL340, aircraft 1 maintained its altitude and aircraft 2, which was descending, stopped doing so and began climbing again, reaching a positive climb rate of +544 fpm.

Their flight paths, which were once again converging, meant that 13 s after the TCAS TA was received, both TCAS RA were generated, at 14:57:00, which remained active for 43 s.

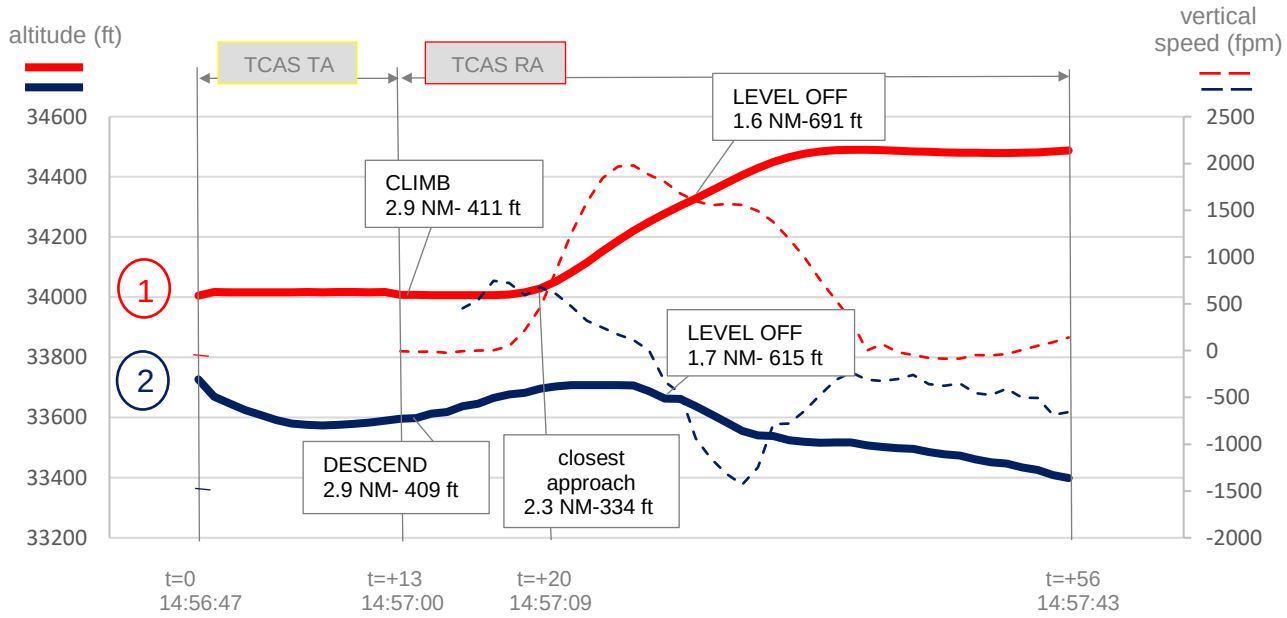

Figure 3. Changes in altitude and vertical speed during the TCAS RA

Initial TCAS RA (2.9 NM- 411 ft)

14:57:00-18 TCAS "CLIMB" RA in aircraft 1, which was level at FL340. This advisory was in effect for 18 seconds, during which:

- 14:57:02: the A/P and A/T were disengaged.
- 14:57:09: the aircraft reached the point of closest approach, 2.3 NM and 334 ft (aircraft 1 at 34029 ft and aircraft 2 at 33695 ft).
- 14:57:16: the aircraft reported TCAS RA to ATC.
- The vertical speed began to increase gradually to a maximum of +1979 fpm.
- The aircraft climbed a total of 328 ft.

14:57:01-16 TCAS "DESCEND" RA in aircraft 2, which was climbing at a rate of +544 fpm. This advisory was in effect for 15 seconds, during which:

- 14:57:03: ZGZ issued a new descend instruction to the crew: "*The traffic is now maintaining 340, please descend 320 sir, descend 320".* Since the crew were responding to the TCAS RA, they did not acknowledge ATC's instruction; instead, their next message was to report the TCAS RA.
- 14:57:04: the A/P and A/T were disengaged.
- 14:57:09: the crew reported the TCAS RA to ATC just as the aircraft were at their closest point of approach: 2.3 NM and 334 ft.
- The vertical speed decreased gradually from the initial values, which were in excess of +500 fpm, to around 0 fpm.
- Due to these positive values for vertical speed, the aircraft initially climbed toward aircraft 1, resulting in the closest point of approach at 14:57:09, after which aircraft 2 began to descend while aircraft 1 accelerated its climb, increasing the vertical separation between them.
- This phase lasted 16 s, during which aircraft 2 had a net elevation gain of 89 ft.

Following TCAS RA (1.7 NM- 615 ft)

14:57:17-43 TCAS "LEVEL OFF" RA in aircraft 2, with a descent rate of -330 fpm. At that time, the separation between the aircraft was 1.7 NM and 615 ft. This advisory was in effect for 26 s, during which:

- The vertical speed continued to increase for 5 s, reaching a maximum rate of -1431 fpm. It then decreased to -259 fpm as the aircraft leveled off.
- The aircraft descended a total of 264 ft during this period.

14:57:19-43 TCAS "LEVEL OFF" RA in aircraft 1, with a climb rate of +1597 fpm. At that time, the separation between the aircraft was 1.6 NM and 691 ft. This advisory was in effect for 24 s, during which:

- At 14:57:23, the vertical speed decreased and stabilized at around 0 fpm.
- The aircraft climbed 159 ft during this period, thus maintaining its altitude.
- The aircraft was transferred by the PAL controller to ZGZ, to whom it again reported the TCAS RA at 14:57:37.

TCAS: CLEAR OF CONFLICT (0.6 NM- 1101 ft):

14:57:44 The TCAS RA cleared on both aircraft at 14:57:44. They were 0.6 NM apart horizontally and 1101 ft apart vertically, with aircraft 1 above aircraft 2:

- 1: 34489 ft, heading 111º, 424 GS, 250 CAS.
- 2: 33388 ft, heading 75º, 414 GS, 263 CAS.

The ZGZ controller was informed by crew of aircraft 2 that it was CLEAR OF CONFLICT at 14:57:48, and by the crew of aircraft 1 at 14:58:00. Aircraft 1 remained at FL340 and aircraft 2 was again instructed to descend to FL320.

The A/P and A/T were engaged at 14:58:27 and 14:57:50, respectively.

15:02:58 Aircraft 2 was transferred to LFBB, the unit that had warned of the conflict 7 minutes earlier. It was transferred at FL320, a condition that the ZGZ controller had to caution the LFBB controller about, since this was not in accordance with the letter of agreement between the two units[4].

1.12. Wreckage and impact information

Not applicable.

1.13. Medical and pathological information

Not applicable.

1.14. Fire

Not applicable.

1.15. Survival aspects

Not applicable.

1.16. Tests and research

1.16.1 Statement from crew of aircraft 1: EI-FRY

While level at FL340, they received an instruction from ATC to descend to FL330 due to another traffic at the same level. After this message, they saw another aircraft on the display coming from their right, at the same level and descending. They then received a TCAS TA, followed by a TCAS RA with a “CLIMB” instruction, which then changed to “LEVEL OFF”. The conflict cleared at 34500 ft. They followed the procedures and reported the TCAS RA to ATC. The pilot flying at the time of the event was the first officer.

1.16.2 Statement from crew of aircraft 2: EI-DWW

While level at FL340, they were instructed to descend immediately to FL320. They began to descend, but were then instructed to climb again to FL340. Immediately after starting the climb to FL340, the TCAS TA was activated for 1 or 2 s, quickly followed by a TCAS RA, which instructed them to “DESCEND”. They executed the procedure and reported it to ATC. The pilot flying at the time of the event was the captain.

1.16.3 Statement from the executive controller in sector PAL

He stated that the main reason for the near miss is that the PAC/VAC did not work. It was his first day back at work after a vacation. As concerns the conflict between the two aircraft, at no time

[4] According to the letter of agreement between the two units, aircraft en route to the Toulouse Airport must be descending to FL280 when they are transferred from sector ZGZ.

did they think it was possible since aircraft RYR1192, because of its destination, would be instructed to descend to FL280 by sector ZGZ, as per procedure.

1.16.4 Statement from the planning controller in sector PAL

He stated that the STCA PAC/VAC alert was not activated.

1.16.5 Statement from the oncoming executive controller in sector ZGZ

He had just gone on duty as the sector ZGZ executive controller when the incident took place (the relief was logged at 14:55:13). He reviewed the traffic in his sector and carried out checks involving several aircraft. He did not recall having to resolve any conflicts. Upon assuming the watch, he had RYR1192 (aircraft 2) on the frequency at FL340. Without realizing it, due to being displayed in white, and to being on the sector PAL frequency, RYR55CB (aircraft 1) was at FL340 flying from the PPN VOR/DME to point MARIO, which led to a conflict at GOSVI, with both aircraft receiving TCAS RA. The conflict alert system did not work. As concerns the instruction given to his aircraft to descend to FL320 after the initial detection of the aircraft, he stated that it was issued because the other aircraft (aircraft 1) was taking too long to descend.

1.16.6 Statement from the offgoing executive controller in sector ZGZ

At the time of the relief (approximately 14:54), RYR1192 (aircraft 2) switched to his frequency while at FL340. RYR55CB (aircraft 1) was on the PAL sector frequency.

1.16.7 Statement from the planning controller in sector ZGZ

He stated that the incident occurred during a relief in the airspace of the adjacent sector (PAL), which is why it was not detected earlier in his sector. He also noted that the conflict alert system did not issue any warnings.

1.16.8 Statement from the control room manager and Route 1 and Route 2 supervisors

The supervisors and the control room manager described the scenario as normal, with no recent changes or other factors that could have had any effect on the incident. The workload in the sectors was not at its maximum. In their reports, they stated that the workload in sector PAL at the time was low, and in sector ZGZ it was medium-high.

1.16.9 Operation of the STCA system during the incident

On 2 and 3 October, three events occurred during which the STCA in the Madrid ACC was noted to be malfunctioning. Two events involved the absence of VAC/PAC alerts (one of them the incident considered herein), and the other had to do with the faulty generation of a VAC alert.

ENAIRE opened the relevant investigation and confirmed a problem with the software. A fix was issued and applied on the night of 4-5 October. In addition, hourly traces were run on the processes involving the STCA. On Wednesday, 10 October, SACTA update 3.Z5.71.R was released, which corrected the technical problems identified involving the STCA alerts and protected the related software processes.

1.17. Organizational and management information

Not applicable.

1.18. Additional information

1.18.1 Mid-air collision protection: TCAS[5]

The TCAS system detects and classifies surrounding aircraft as potential intruders, issuing information to the crew in four phases:

- Proximate traffic detected: the approaching aircraft is shown in white in order to increase the crew's situational awareness.
- Traffic advisory (TA): the approaching aircraft is shown in yellow in order to prepare the crew for a potential RA.
  - The crew must identify and find the aircraft.
  - Maneuvers are not recommended since they could reduce the separation.
  - ATC instructions take priority over TCAS in this phase.
  - TAs are generated 10-13 s before RAs.
- Resolution advisory (RA): the approaching traffic is shown in red and maneuvers to change the aircraft's vertical speed are issued to avoid a mid-air collision.
  - The RA maneuver takes priority over ATC instructions.
  - The purpose of an RA is to achieve a vertical separation of 300 to 700 ft.
  - The crew are expected to react to the first RA within the initial 5 s.
  - For subsequent RAs, the reaction time is assumed to be 2.5 s.
  - The crew's reaction will be to disengage the autopilot and autothottle and gently adjust the pitch angle and thrust to execute the RA maneuver.
  - RA maneuvers only require small changes to the pitch angle, which should be executed smoothly and quickly. Specifically, for a TAS of 250, a pitch angle of 4º will be needed to achieve the vertical speeds required.
  - No sudden or prolonged maneuvers are required, and it is important to realize that the cabin crew or passengers may not be seated during said maneuvers.
  - Vertical speeds of -1500 to -2000 fpm for DESCEND advisories.
  - Vertical speeds of +1500 to +2000 fpm for CLIMB advisories.
  - As concerns ATC communications, the execution of RA maneuvers must be reported to ATC, and once clear of conflict, this too must be reported to ATC.
- Clear of Conflict notification: indicates that separation between the aircraft has been achieved. This situation must also be reported to ATC, after which the crew will resume ATC's previous instructions.

[5] Information taken from the Operator's procedures, the Eurocontrol ACAS Guide, published in December 2017, and EASA guidelines on TCAS.

1.18.2 Mid-air collision protection: STCA

As with TCAS, ATC services have their own system, called STCA, which also generates two alerts to prevent close approaches between aircraft. These alerts, called PAC (conflict alert prediction) and VAC (conflict alert violation) are analogous to the TCAS TA and RA, respectively. The difference is that the STCA system is designed to activate before TCAS, providing a preliminary barrier to keep aircraft from having to execute evasive maneuvers. With this philosophy, the alerts generated en route, as in this incident, are as follows:

- PAC alerts: generated in the system and, after three consecutive confirmations (meaning they hold for 15 s), they are displayed to the controller approximately 2 minutes before the minimum required separation is violated. In an en route situation, this separation is 5 NM horizontally and 1000 ft vertically. This means that in this incident, the PAC alert should have been generated between 14:54:36 and 14:56:31. This information is included in Section 1.11.
- VAC alerts: generated when minimum required separation distance is violated. In this case, the threshold values of 4.8 NM and 800 ft are used to trigger the shift from PAC to VAC. This means that in this incident, the VAC alert should have appeared between 14:56:36 and 14:57:16. This information is included in Section 1.11. STCA VAC alerts should be displayed about 30 s before a TCAS RA.

1.18.3 Internal ENAIRE investigation

ENAIRE conducted an exhaustive investigation of the incident that included a technical report regarding the STCA failures. The results led not only to the internal dissemination of its findings and the application of the technical measures described un paragraph 1.16.9, but also to measures to improve the following aspects identified in the investigation:

- Refresher theory and practical training through an on-the-job session for the sector where the incident occurred.
- Analysis of the routine practices for transferring aircraft inbound to point TOPTU from PAL to ZGZ in order to enhance training, if necessary.
- Development of a system to detect faults in the operation of the STCA that allows information to be provided on said faults in real-time to the operators.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

On Tuesday, 2 October 2018 at 14:57:09, an aircraft proximity event occurred involving aircraft EI-FRY and EI-DWW as they were flying level at FL340 at a CAS of 250 and a GS of 400 kt. Both aircraft were in the airspace of Madrid ACC sector PAL, although one of them had been transferred 3 min earlier to adjacent sector ZGZ. This means that during the conflict, each aircraft was in radio contact with a different controller.

The conflict had been detected 1 min 27 s earlier (14:55:42) by the Bordeaux ACC, but its handling by the controllers in sectors PAL and ZGZ did not prevent the aircraft from continuing on converging headings until 14:57:09, when they reached their closest point, separated by 2.3 NM horizontally and 334 ft vertically.

This closest point of approach occurred during the execution of the TCAS RA maneuvers, which had been generated 9 s earlier (14:57:00) in both aircraft.

In this general context, one of the first conclusions is the key contribution to the incident by ATS, both in terms of its initiation and its continuation. The actions of the crews are deemed not to have contributed in any way. Because of this, the analysis of this incident primarily revolves around the actions of air traffic control:

- 2.1: General conditions prior to the event.
- 2.2: Source of incident: failure to detect the conflict
- 2.3: Detection of the conflict by LFBB 1 min 27 s earlier.
- 2.4: Failure of the STCA system to identify the conflict.
- 2.5: Improper handling of the conflict by ATC.
- 2.6: Detection of the conflict by TCAS 22 s earlier.

2.1. General conditions prior to the event

The weather conditions were irrelevant in this incident and did not affect the outcome of the event (the aircraft had not diverted from their original routes nor were there any weather conditions that limited the aircraft's performance or routes).

No unusual conditions were present that could have affected the capacity or ability of the controllers involved. The sectors were configured as planned and there were no circumstances that resulted in complex conditions in the sector or in the operating environment. The workload of the controllers was below their maximums, and thus this aspect is deemed irrelevant to the incident.

As regards the controllers involved, they all had ample experience both in their units and in ATC in general. None of them was in training, and these factors are deemed to have had no influence on the incident.

The only aspects of note due to their potential contribution to the incident are as follows:

- The recent shift change involving the sector ZGZ executive controller, which may have affected his situational awareness of the traffic in the sector.

- The return to work after vacation of the executive controller in sector PAL, which may have affected his actions, as reflected in the lack of urgency in his communications during the conflict and the failure to enter the cleared flight level.

From the point of view of the crews, the flights had been uneventful prior to the incident, with no deviations from the planned routes, and thus did not contribute to the event.

2.2. Source of incident: failure to detect the conflict

The root cause of the incident is deemed to lie in the failure of the PAL sector controller to identify their converging headings while both were in contact with this sector. As a result, the PAL sector controller transferred aircraft 2 to the adjacent sector, ZGZ, while it was still in conflict.

According to the statement from the PAL sector controller, due to the destination of aircraft 2, he assumed that it would be instructed to descend to FL280 after being transferred to adjacent sector ZGZ, as this was specified in the unit's procedures and in the letter of agreement with the Bordeaux control center. This outcome was assumed by the controller without communicating or coordinating with the controller in the adjacent sector. He also did not follow up on the aircraft after it was transferred to verify that it had maneuvered as expected.

As a result, this transfer 3 min before the event took place under the following conditions:

- The transferred aircraft was not clear of conflict, since it was at the same flight level and on a converging heading toward aircraft 2.
- The conflict had not been identified earlier by the PAL controller, nor by the PAL or ZGZ controllers after it was transferred.
- The transfer was made early, since the aircraft was still in the airspace of sector PAL, 37.5 NM away from the geographic limit of sector ZGZ.

In his statement, the ZGZ controller said that he had just gone on duty when he received the call from aircraft 2. At no time did he, nor the offgoing controller, realize that the aircraft was in conflict, since that is a requirement for transferring an aircraft. This was reflected in his initial actions to familiarize himself with the traffic in his sector. While he did check other aircraft for potential conflicts, he did not do so with these. As a result, for different reasons, when the transfer was made, neither controller (in sector PAL or the offgoing or oncoming controllers in ZGZ) identified the conflict between the aircraft.

Consequently, the aircraft proceeded on converging headings for 1 min 39 s until the conflict was detected.

2.3. Detection of the conflict by the Bordeaux ACC 1 min 27 s earlier

The conflict was not detected by the controllers in sector PAL or ZGZ; rather, it was detected by the Bordeaux ACC, adjacent to the Madrid ACC. At 14:55:42, a French controller called the PAL sector controller to inform him of the situation, since both aircraft were in the airspace of sector PAL. At that time, the two aircraft were 8.7 NM away and at the same flight level, FL340, still outside the minimum required distance horizontally (5 NM), though not vertically (1000 ft).

The tone of voice used by the PAL controller, and later by the ZGZ controller, confirmed that neither one had been aware until that point of the conflict between the two aircraft. The PAL controller's reaction was immediate: call ZGZ and propose corrective steps to take involving aircraft 1, which was still in contact with him.

The time that elapsed during the call from the Bordeaux ACC and the 10 s it took the ZGZ controller to reply to the proposed corrective action from PAL resulted in a 34-s delay before instructions were given to the two aircraft. During this time, due to the speed of the aircraft (250 CAS and 410 GS), the distance between them fell from 8.7 NM to 5.8 NM.

2.4. Failure of the STCA system to identify the conflict

Had the STCA worked, it would have generated two alerts, spaced 2 min apart:

- the first, a PAC alert, at 14:54:36
- the second, a VAC alert, at 14:56:31

Between the two alerts that the PAL and ZGZ controllers would have had (if the STCA had functioned), the call from the Bordeaux ACC was received (14:55:42) when both aircraft were 8.7 NM away. With this call air traffic controllers became aware of the conflict, meaning it was identified in time and there was time enough to handling the conflict before the generation of the TCAS RA, even with the malfunction of the STCA.

Had the controller in the Bordeaux ACC not placed the call, there was still the barrier provided by the TCAS systems on board, which did work correctly.

The reason for the failure of the STCA system to work correctly in this and two other aircraft proximity events was identified and corrected by ENAIRE, which immediately and successfully implemented corrective measures. As a result, as of the date of this report, it is not necessary to issue any safety recommendations since the actions taken by ENAIRE resolved the problems identified.

2.5. Improper handling of the conflict by ATC

The mid-air collision avoidance system is achieved by first issuing alerts to ATC (STCA) and then to the crews (TCAS), with ATC being understood as the first barrier in order to keep the aircraft crews from having to perform avoidance maneuvers. As a result, the alert activation thresholds at the control stations (PAC, VAC) are much earlier than on board the aircraft (TA, RA), as described in sections 1.18.1 and 1.18.2. The alert sequence is thus PAC-VAC-TA-RA.

In this case, ATC became aware of the conflict between the PAC and VAC (had they been generated), and thus before the TCAS issued any advisories.

Because of this, the controllers in the two sectors had time to issue instructions to the crews before the TCAS went into action; however, these instructions were inadequate, since both controllers issued the same maneuvers to the two aircraft for different reasons, aggravating the situation:

- In the first case, the two controllers did coordinate, but the one in ZGZ thought that the other aircraft was taking too long to start the maneuver. He was also influenced by the fact that the PAL controller had not entered the authorized lower flight level. As a result, he instructed his aircraft, despite not being in his airspace, to execute the same maneuver. This instruction was not coordinated with or reported to the controller in sector PAL.
- In the second case, there was no coordination between the PAL and ZGZ controllers, both of whom, seeing the conflict that had resulted from the same descend instruction, again instructed the crews to climb to the same flight level while they were separated by 4.3 NM horizontally.

As for the phraseology used by the controller:

- The ZGZ controller did convey the urgency of the instructions (through the tone of his voice, the fast delivery, by repeating the instruction as many as three times and by using the term “immediately”), although he did not give information on the conflict aircraft.
- The PAL controller did not convey the urgency of the instructions (he did not use the term “immediately”, his voice and pace were calm, very long sentences), but he did give information on the conflict aircraft.

In response to these serious deficiencies in the handling of this conflict, ENAIRE, in the internal investigation it conducted after the incident, took steps to improve the training of its controllers. The measures taken by ENAIRE are deemed adequate and sufficient to correct the problems identified, and as a result no safety recommendations are issued in this regard.

In terms of the aircraft, the flight recorders show that the instructions issued by ATC, first to descend and then to climb, were entered into the computer immediately by the crews; however, the ensuing step to start the transition to the new flight level was different in each aircraft:

- In the case of aircraft 1, undoubtedly due to the lack of urgency and gravity conveyed by the controller in his messages, and to already having a blue “proximate traffic detected” message on the TCAS display, the crew questioned ATC’s instruction, which is why aircraft 1 did not execute a descent and instead waited for confirmation from ATC. The action of the crew of aircraft 1 showed excellent situational awareness of the immediate future, anticipating a potential conflict that was in effect taking place. By not starting its descent, the crew kept the conflict from becoming worse.

- In the case of aircraft 2, probably due to the immediacy and urgency conveyed by the messages from the ZGZ controller, the crew entered the new selected flight level and the aircraft began to descend and then to climb. This action is deemed equally correct, since ATC instructions always take priority (except with a TCAS RA), and at the time, the TCAS had not even issued a TA.

As a result of these contradictory instructions, the vertical separation between the aircraft increased at first (while aircraft 1 maintained its level and aircraft 2 descended), but following the second set of instructions to climb, aircraft 2 began to climb while aircraft 1 remained at the same flight level, thus reducing the vertical separation between them. In light of the worsening situation involving the aircraft, closing both vertically and horizontally, the TCAS came into play, issuing correct evasive maneuvers.

2.6. Detection of the conflict by the TCAS 22 s earlier

The TCAS TA and RA alerts were generated 22 s before the point of closest approach and with a 13-s separation between them, as per the design criteria. The RA maneuvers seek to achieve a separation of 300 to 700 ft. Due to the closing trend of aircraft 2 with respect to 1 (due to the climb instruction it had been issued by ATC), the system generated an RA with 411 ft.

Of the 43-s total duration of the TCAS RA, the first 9 were the most critical, since aircraft 1 had to initiate a climb and aircraft 2 had to change its upward trend and reverse it. Although the crews reacted to disengage the A/P and A/T within the 5-s design criteria of the TCAS, the achievement of a vertical speed by the two aircraft was logically not as fast, coinciding with the inflection point where aircraft 2 stopped climbing and aircraft 1 started its descent.

From that moment on, the two aircraft progressed as expected, with their vertical separation increasing to 700 ft, at which point the TCAS, as designed, stopped the climb and descent and issued new RA maneuvers to level off. Since at that point, the aircraft were about to cross (1 NM), the RA instruction was maintained until the aircraft finished crossing.

In conclusion, the TCAS worked correctly and ensured proper separation between the aircraft, as it is designed to do.

The execution of the TCAS procedures by both crews was complete and correct. The reaction times and the vertical speeds were within the values expected by the TCAS, the automatic control systems were disengaged and the situation was reported both during the event and once the conflict was clear.

3. CONCLUSIONS

3.1. Findings

General:

- The aircraft and pilots had the authorizations and licenses needed to perform the flights in question.
- The controllers had the licenses, certificates and ratings needed to provide the service they were rendering.

General conditions before the event:

- The controllers had ample experience at the unit and in ATC.
- The operational and traffic environments in control sectors PAL and ZGZ did not pose any complications or situations beyond those planned.
- The controllers' workload was below the maximum.
- The executive controller in ZGZ had just gone on duty and the executive controller in PAL had just returned after taking a vacation.
- The operation of the aircraft prior to the event was as planned.

About the event:

- 14:57:09: Closest approach, 2.3 NM horizontally and 334 ft vertically, reached while executing the TCAS RA maneuvers.
- During the event, the aircraft were in the airspace of sector PAL, but one of the aircraft had been transferred 3 min earlier (14:54:02) to the adjacent sector, ZGZ.
- Aircraft 2 was transferred to sector ZGZ at 14:54:02 without being clear of the conflict.

Conflict detection:

- PAL sector controller did not identify the conflict.
- Of the two technological barriers to avoid in-flight collisions (STCA and TCAS), only the TCAS worked.
- 14:54:36: The conflict should have been detected by the STCA, which should have generated a PAC alert at the control stations. This alert was not generated.
- 14:55:42: The conflict was detected by the Bordeaux ACC 1 min 27 s before the point of closest approach.
- 14:56:36: The conflict should have been detected by the STCA, which should have generated a VAC alert at the control stations. This alert was not generated.
- 14:56:47: The conflict was identified by TCAS, which issued a TA.
- 14:57:00: The conflict was identified by TCAS, which issued an RA.

Conflict management:

- The controllers issued similar instructions to the two aircraft, contrary to what they had agreed previously.
- ATC's instructions did not prevent the loss of separation.

- The TCAS RA maneuvers lasted 43 s and were generated in both aircraft.
- The crews executed the TCAS RA maneuvers, which increased their separation.
- The conflict cleared at 14:57:44, with the TCAS “CLEAR OF CONFLICT” message on both aircraft.
- The crews carried out the TCAS procedures and notified ATC as required by procedure.

Malfunction of the STCA:

- The STCA system did not function on a total of three events, including this incident.
- ENAIRE immediately and successfully identified, designed and implemented measures to resolve the problems with the operation of the STCA.

3.2. Causes/Contributing factors

The incident involving aircraft 1 (EI-FRY) and 2 (EI-DWW) was caused by the failure of the PAL sector controller to identify the conflict, and the subsequent transfer of aircraft 2 (EI-DWW) to the adjacent sector, ZGZ, without being clear of the conflict. Contributing to the incident is the improper handling of the conflict by the controllers in both sectors, who issued similar instructions to the two aircraft, contrary to what had been agreed previously.

4. SAFETY RECOMMENDATIONS

None.