DATA SUMMARY

LOCATION

Date and time	**Monday, 07 January 2013 at 02:45 UTC[1]**
Site	**Airway UN-873 (Canaries UIR), vicinity of point IPERA**

AIRCRAFT

Registration	**CS-TOC**	**F-GSQJ**
Type and model	**AIRBUS A340-312**	**BOEING B777-328-ER**
Operator	**TAP – Transportes Aéreos Portugueses**	**AFR – Compagnie Nationale Air France**

Engines

Type and model	**CFM56-5C3**	**General Electric GE90-115B**
Serial Number	**4**	**2**

CREW

	Captain	Captain
Age	**N/A**	**57 years**
Licence	**CPL(A)**	**CPL(A)**
Total flight hours	**13,738:52 h**	**14,503 h**
Flight hours on the type	**715:22 h**	**3,240 h**

INJURIES	Fatal	Serious	Minor/None	Fatal	Serious	Minor/None
Crew			**12**			**18**
Passengers			**262**			**281**
Third persons						

DAMAGE

Aircraft	**None**	**None**
Third parties	**None**	**None**

FLIGHT DATA

Operation	**Air Transport – Scheduled – International – Passenger**	**Air Transport – Scheduled – International – Passenger**
Phase of flight	**Climb**	**En route**

REPORT

Date of approval	**18th December 2013**

[1] All times in this report are in UTC. Local time is the same as UTC.

1. FACTUAL INFORMATION

1.1. Description of the event

On 7 January 2013, an Airbus A-340-314 aircraft, registration CS-TOC, was on a flight with call sign TAP-087 from the Lisbon Airport (LPPT) in Portugal to the Sao Paulo Airport (SGBR) in Brazil. At the same time, a Boeing B-777-328 ER aircraft, registration F-GSQJ, was on a flight with call sign AFR-457, from the Sao Paulo Airport in Brazil to the Paris-Charles de Gaulle Airport (LFPG) in France.

Both aircraft were on airway UN-873, the former flying southbound at flight level FL340, and the latter northbound at FL350. The control stations responsible for supervising the flights in the area were the Canarias Oceanic Control (GCCC OCE) and the Sal (GVXC OCE) stations, the latter of which is located in Cape Verde. Weather conditions were suitable for flight.

At 02:18:53, while in the vicinity of waypoint LIMAL on UN-873, aircraft TAP-087 requested clearance from GCCC OCE to climb to FL360. The ATC controller denied the request due to other traffic, aircraft AFR-443, which was flying on the same airway in the opposite direction at FL350, and instructed TAP-087 to wait at point ISOKA the clearance to climb. On reaching this point at 02:36:33, TAP-087 once more requested clearance to climb. GCCC OCE then called GVSC OCE at 02:37:17 to coordinate the climb, with the latter replying it would not be a problem. The GCCC OCE controller then attempted to contact TAP-087 on VHF to give the clearance, but there was no reply.

After this, at 02:41:28, GCCC OCE coordinated with the high-frequency operator (GCCC HF) to have this station clear TAP-087 to climb. According to the QAR data on the TAP-087, the aircraft began its climb to FL360 at 02:44:42. More than a minute later the GCCC HF operator called GCCC OCE and informed that he had already cleared TAP-087 to climb. By the time TAP-087 was cleared to climb, it had already crossed with AFR-443.

Minutes later, at 02:47:09, a pseudotrack appeared on the controller's screen showing aircraft AFR-457 over point IPERA, located at the FIR/UIR limit between Sal and the Canaries, that indicated the aircraft was holding at FL350. AFR-457 had not established an ADS/CPDLC (Automatic Dependent Surveillance/Controller-Pilot Data Link Communications) connection and had not yet made contact on the GCCC OCE VHF frequency.

At 02:48:21, as TAP-087 was reaching point IPERA and climbing out of FL354, a minute after AFR-457 had passed this point, both aircraft received advisories on their respective TCAS (Traffic Alert and Collision Avoidance) systems, first a traffic advisory (TA – TRAFFIC), and then a resolution advisory (RA), instructing aircraft TAP-087 to climb (RA-CLIMB) and AFR-457 to descend (RA-DESCEND).

The crews on both aircraft carried out the procedures applicable to this type of situation and once informed by their respective TCAS that they were clear of conflict, TAP-087 established on FL360 and AFR-457 re-established on FL350. Both aircraft reported the event to GCCC OCE.

1.2. Personnel information

1.2.1. *Information on the crew of aircraft TAP-087*

The captain of aircraft TAP-087, a Portuguese national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force A340 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 13,738:52 flight hours, 715:22 of which had been on the type.

The second captain onboard aircraft TAP-087, a Portuguese national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force A340 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 14,015:58 flight hours, 685:29 of which had been on the type.

The first officer of aircraft TAP-087, a Portuguese national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force A340 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 6,337:09 flight hours, 1,102:23 of which had been on the type.

1.2.2. *Information on the crew of aircraft AFR-457*

The captain of aircraft AFR-457, a 57-year old French national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force B777 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 14,503 flight hours, 3,240 of which had been on the type.

The first officer of aircraft AFR-457, a 53 year old French national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force B777 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 9,397 flight hours, 676 of which had been on the type.

The second first officer of aircraft AFR-457, a 45-year old French national, had a JAR-FCL Airline Transport Pilot License (ATPL(A)), with a valid and in force B777 rating. He also had a valid and in force class 1 medical certificate. He had a total experience of 8,380 flight hours, 5,729 of which had been on the type.

1.2.3. *Information on ATC personnel*

During the event, the GCCC OCE sector control post at the Canaries ACC was staffed by an executive controller, a planning controller and a controller under instruction. The executive controller was training the controller under instruction, who was physically in the executive controller's post.

The executive controller, a 44-year old Spanish national, had an air traffic controller's license and a medical certificate, both valid and in force. He also had the required unit endorsements and had had an instructor's rating since 11 November 2011.

The planning controller, a 36 year old Spanish national, had an air traffic controller's license and a medical certificate, both valid and in force. He also had the required unit endorsements.

1.3. Aircraft information

1.3.1. *General information on aircraft TAP-087*

The aircraft with registration CS-TOC, an A340-312 with serial number 0079, was outfitted with four CFM56-5C3 engines. The aircraft had a valid airworthiness certificate and had been maintained in keeping with its approved maintenance program. The last type A inspection had been performed on 26 January 2013, with 84,336 h and 12,520 cycles on the aircraft.

As noted in the aircraft's flight plan, it was equipped with an RNP 10 approved RNAV.

1.3.2. *General information on aircraft AFR-457*

The aircraft with registration F-GSQJ, a B777-328-ER with serial number 32852, was outfitted with two General Electric GE90-115B engines. The aircraft had a valid airworthiness certificate and had been maintained in keeping with its approved maintenance program. The last type A inspection had been performed on 12 December 2012.

According to its flight plan, the aircraft was equipped with an RNP 10 approved RNAV.

The flight plan also noted that the aircraft was equipped with a FANS 1/A unit (Future Air Navigation System) which provides ADS and pilot-controller communications functions via CPDLC. The ADS function allows the aircraft to automatically downlink to the ATS station information from its onboard navigation systems, including its latitude, longitude and altitude. The CPDLC function allows for ATC communications between the controller and pilot via a data link instead of a voice link.

1.4. Aids to navigation

1.4.1. *Information taken from the SACCAN system data*

The GCCC OCE sector has the SACCAN system to aid it in providing control services to aircraft in its airspace that are equipped with FANS 1/A units. The SACCAN system comprises the land side of the ADS/CPDLC's functionalities. The ADS feature is intended for use in areas with no or inadequate radar coverage, as is the case over oceans; while the CPDLC improves operating abilities in those areas where voice communications are patchy and require resorting to HF relays from non-ATC personnel.

The main functions of the SACCAN system are:

- To monitor tracks based on ADS information.
- To monitor ADS-SSR integration tracks, information obtained from ADS and SSR (Secondary Surveillance Radar) in those areas with radar coverage.
- To provide Short-Term Conflict Alerts (STCA) and Minimum Safe Altitude Warnings (MSAW) based solely on ADS, SSR or integrated ADS-SSR.
- To detect the input of incorrect reporting points. The system compares the next two reporting points received by ADS against the flight plan data contained in the system so as to detect discrepancies between the onboard and ground routes. When a discrepancy is detected, the system issues an alert to the controller.
- To monitor compliance. The system uses ADS, ADS-SSR or SSR tracking data to automatically detect and alert of lateral deviations of the aircraft with respect to the authorized route (the tolerance limit is set to 5 NM).
- Navigation Integrity Monitoring. The system periodically and automatically cross checks the positional data received from the ADS data link against the positional data measured using the SSR to detect potential discrepancies indicative of a malfunction of the onboard navigation system. An alarm is issued to the controller when this happens.
- Automated handling of ADS contracts. An ADS contract is initiated automatically once the aircraft makes a connection. The contract is also terminated automatically, though it can be terminated manually also.
- Efficient CPDLC management through the extensive use of windows and mouse clicks.

An ADS-enabled aircraft must establish the connection with the SACCAN system between 15 and 30 minutes before entering Canaries airspace. The connection is made manually by entering the Canaries ICAO code "GCCC" into the aircraft's onboard equipment. Once the connection is established, the SACCAN automatically sets up an initial periodic reporting ADS contract. These periodic contracts are used by aircraft to

provide, among other things, positional data, which the SACCAN system then displays on the controller's screen.

For non-ADS enabled aircraft flying in the Canaries Oceanic Sector airspace, the SACCAN system offers the option of displaying the track from the flight plan. This feature displays a synthetic or pseudotrack on the system screen whose position is estimated using the information from the aircraft's flight plan stored in SACTA and any updates entered manually by the controller based on the position reports received on frequency from the aircraft. These types of tracks are only shown in areas with no radar coverage that have aircraft with no ADS-CPDLC connection or capacity. The pseudotracks appear on the system display at the time listed in the SACTA flight plan for an aircraft's expected entry into the Canaries ACC airspace.

The following symbols are used for the different tracks displayed in the SACCAN system:

Flight plan tracks/Pseudotracks	ADS track

The information shown below from the SACCAN system was provided by the Oceanic Sector of the Canaries ACC station.

According to the SACCAN information, at 02:18:54, when aircraft TAP-087 first requested to climb to FL360, it was on the segment of airway UN-873 between waypoints LIMAL and ISOKA and flying south at FL340. The presence of an ADS track of an aircraft flying in the opposite direction at FL350 prompted ATC to deny the initial climb request by the crew of TAP-087.

At 02:37:17, when Sector GCCC OCE called the SAL ACC to coordinate the level change of aircraft TAP-087 to FL360, the SACCAN screen was showing that the pseudotrack of aircraft TAP-087 was past waypoint ISOKA, and that the traffic impeding the climb was above waypoint IPERA. The radar screen did not show an ADS track for aircraft AFR-457.

At 02:45:39, almost a minute after aircraft TAP-087 started to climb, based on its FDR data (it left FL340 at 02:44:42), the aircraft's pseudotrack showed it to be some 41 NM before waypoint IPERA. The SACCAN system still was not showing either a pseudotrack or an ADS track for aircraft AFR-457 (figure 1).

A minute and a half later, at 02:47:09, a pseudotrack for aircraft AFR-457 appeared on the SACCAN display over waypoint ISOKA at FL350. The pseudotrack for aircraft TAP-087 showed it to be about 28 NM away from that point. Its label indicated FL360 (based on FDR data, aircraft TAP-087 was climbing through FL350).

The SACCAN display did not show an ADS track for aircraft AFR-457 until 02:53:25, meaning the flight by then had connected to the system. The aircraft had already crossed the point of entry into the Canaries FIR, waypoint IPERA.

Figure 1. Image from the SACCAN system at 02:45:39

Figure 2. Image from the SACCAN system at 02:53:25

1.5. ATC communications

The incident took place in an area where the air traffic control service is provided by the Oceanic Sector (OCE) of the Canaries ACC. In this sector, in addition to the VHF frequencies (119.3 MHz and 133.0 MHz) for voice communications, there are two HF frequencies (8861 and 6535 KHz) to ensure the continuity of voice communications, since the size of the sector can lead to problems with VHF communications. The HF Canaries Radio service is not provided by ATC controllers, but by radio operators whose sole function is to relay clearances issued by controllers to aircraft and to inform controllers of any messages received from aircraft on the relevant HF frequencies.

The communications between the two aircraft and ATC were held in English. A summary of the most relevant exchanges between the aircraft and Sector GCCC OCE is given below.

At 02:02:56, Sector GCCC OCE received the first ABI (Advanced Boundary Information) message from aircraft AFR-457 via OLDI, which estimated that the flight would be over waypoint IPERA at 02:47 at FL350.

At 02:09:37, aircraft TAP-087 established contact on the Sector GCCC OCE frequency (133.00 MHz), which informed it that the radar service had terminated and requested that it report its ETA to waypoint IPERA and its Mach number at the flight level it was maintaining, FL340. Aircraft TAP-087 reported that it was at Mach 0.80 and its ETA at IPERA was 02:51.

At 02:18:53, aircraft TAP-087 asked Sector GCCC OCE permission to climb to FL360, though ATC indicated this was not possible due to traffic in the opposite direction at a higher level [the aircraft with call sign AFR-443 that was flying on the same airway (UN-873) as TAP-087, in the opposite direction at FL350]. Sector GCCC OCE also informed aircraft TAP-087 that it could authorize the climb after waypoint ISOKA.

At 02:27:43 the first ACT (activation) message was received from aircraft AFR-457 via OLDI. This message gave an ETA to waypoint IPERA of 02:47 at FL350. This activation resulted in the first strip being printed out for the aircraft.

Subsequently, at 02:36:33, aircraft TAP-087 reported to Sector GCCC OCE that it was past waypoint ISOKA and that it was awaiting clearance to climb to FL360. ATC instructed it to stand by, since the climb had to be coordinated with the adjacent station, SAL ACC (control station to which aircraft TAP-087 would be transferred upon leaving Canaries airspace and that had information on northbound traffic on airway UN-873 in the segment beyond the Canaries FIR/UIR). Then, at 02:37:17, Sector GCCC OCE called the SAL ACC on a hotline to inform it that aircraft TAP-087

had just passed waypoint ISOKA and was requesting to climb to FL360, which SAL ACC approved.

Immediately afterwards, at 02:38, 29, Sector GCCC OCE called aircraft TAP-087 and instructed it to stand by, after which the station sent messages to other aircraft. After this, between 02:40:21 and 02:40:38, Sector GCCC OCE once more tried to contact aircraft TAP-087, calling three times but receiving no reply. Sector GCCC OCE then asked the Canaries HF operator if aircraft TAP-087 had established contact on the HF frequency, which it had not. Sector GCCC OCE then requested that he try to contact aircraft TAP-087 to relay the clearance to climb to FL360.

About four minutes later, the Canaries HF operator informed the Sector GCCC OCE controller that it had relayed the clearance and that TAP-087 was climbing to FL360.

According to the flight data recorder on aircraft AFR-457, the button for the left VHF microphone was depressed from 02:48:45 and 02:48:47, and later at 02:48:52, it was depressed a second time for a period of thirteen seconds.

At 02:53:17, HF Canaries informed the OCE Sector controller[2] that aircraft TAP-087 had crossed waypoint IPERA a minute ago at FL360 and had transferred it to the SAL ACC station. He also informed him that the aircraft had reported crossing the path of another aircraft during the climb.

Later, at 02:58:45, HF Canaries called Sector GCCC OCE to report that aircraft AFR-457 had passed waypoint IPERA at 02:47 at FL350, and that it was connected via CPDLC. Lastly, he informed that the aircraft had reported crossing the flight path of aircraft TAP-087.

At 03:00:08, SAL Oceanic Control informed Sector GCCC OCE that aircraft TAP-087 had reported receiving a "Climb" resolution advisory on its TCAS due to the near miss with aircraft AFR-457, which had crossed 300 ft below.

At 03:06:57, aircraft AFR-457 contacted on the Sector GCC OCE frequency and reported that it had received a "Descend" TCAS RA in the vicinity of point IPERA, and had descended as far as FL345.

Later (at around 03:08) during a conversation on the hotline between SAL Oceanic Control and the controller in service at Sector GCCC OCE Canaries ACC, SAL explained that it accepted the climb by TAP-087 to FL360 because at the time of the request from Sector GCCC OCE, there was sufficient separation between the two aircraft. Both controllers agreed that the near miss occurred due to the delay by aircraft TAP-087 in commencing the climb.

[2] The Sector OCE planning controller had been relieved and a new controller, one who had not coordinated with the HF operator, was manning the position.

1.6. Flight recorders

1.6.1. *Flight recorders on aircraft TAP-087*

Due to the time that elapsed between the incident and when it was reported to the CIAIAC, the information from the flight recorders on aircraft TAP-087 could not be retrieved. This aircraft's operator did however, through the Portuguese accident investigation authority (GPIAA), provide the report on the analysis of the flight data obtained from the QAR (Quick Access Recorder) as part of its FDM (Flight Data Monitoring) program.

Based on this report, aircraft TAP-087 left FL340 at 02:44:42 en route to FL360. The aircraft's initial climb rate was 400 ft/min.

At 02:48:09 a TCAS traffic advisory was received, which twelve seconds later, at 02:48:21, became a resolution advisory. The crew then increased the climb rate to a maximum of 1,856 ft/min. The TCAS clear of conflict message was received at 02:49:03; by that time the aircraft was at an altitude of 36,152 ft. The flight data analysis revealed that at 02:48:54 a Mach low event had happened; this type of event does not issue any warnings to the crew. See figure 3.

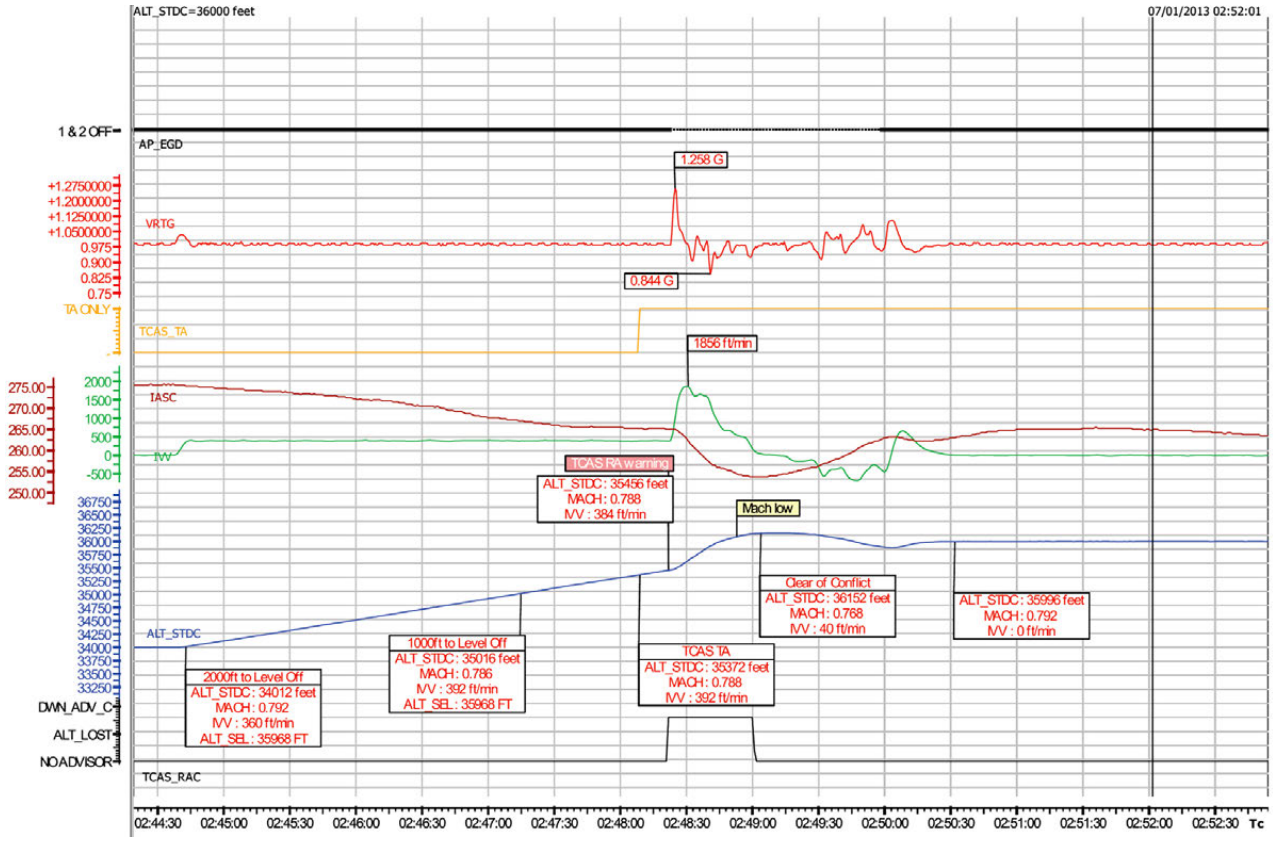

Figure 3. Image from the QAR data report for aircraft TAP-087

1.6.2. *Flight recorder on aircraft AFR-457*

Due to the time that elapsed between the incident and when it was reported to the CIAIAC, the information from the flight recorders on aircraft AFR-457 could not be retrieved. This aircraft's operator did however, through the French accident investigation authority (BEA), provide the flight data obtained from the quick access recorder (DAR Digital ACMS (Aircraft Conditions Monitoring System Recorder)) outfitted on the aircraft.

An analysis of these data revealed that a "Don't climb" resolution advisory was received on the TCAS at 02:48:27, followed by a "Descend" advisory three seconds later, when the aircraft was at 35,000 ft. The crew followed the TCAS indication, reaching a maximum descent rate of 1,952 ft/min. The clear of conflict message was received at 02:49:05, after the aircraft has descended to an altitude of 34,595 ft.

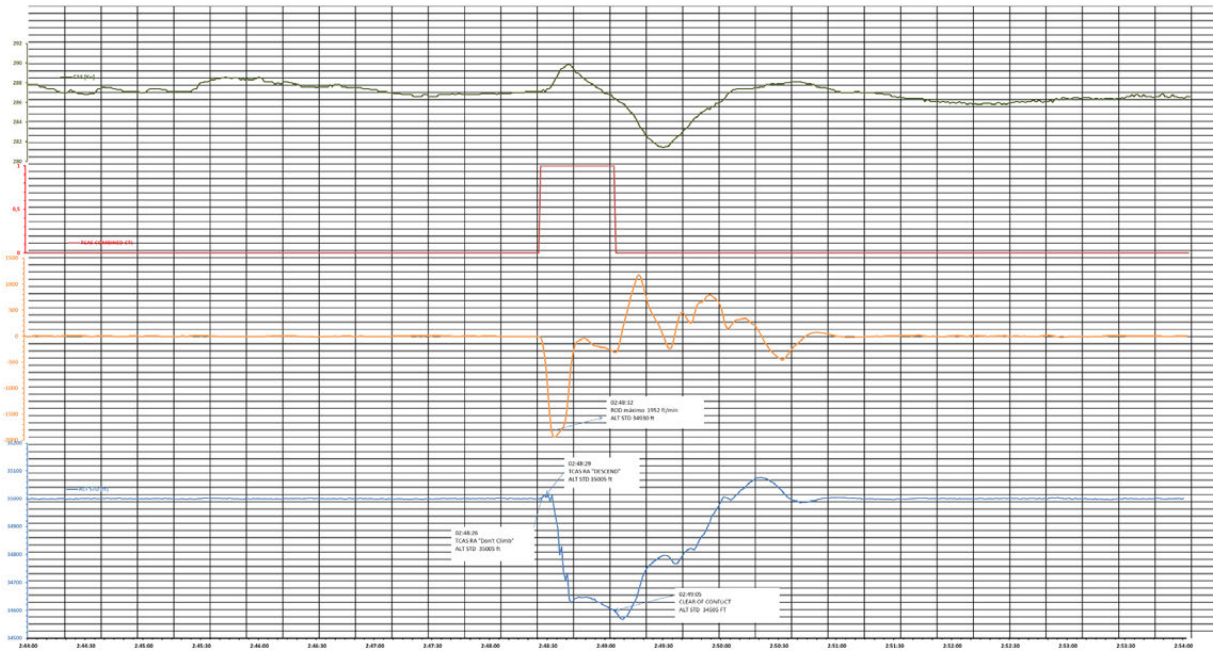

Figure 4. Graph of the QAR data from aircraft AFR-457

1.7. Tests and research

1.7.1. *Report from the crew of aircraft TAP-087*

The crew of aircraft TAP-087 stated in its report that as they were approaching waypoint IPERA, they received a TCAS traffic advisory, which was followed by a "Climb" resolution advisory. The crew climbed as instructed by the TCAS and reported this to the SAL ACC. The TCAS gave a minimum vertical approach distance to AFR-457 during the near miss of 400 ft.

1.7.2. *Report from the crew of aircraft AFR-457*

The crew of aircraft AFR-457 stated in its report that at the time of the incident, they were in cruise flight at FL350 (northbound) on airway UN-873, having left IPERA 1 NM back. They were 1 NM right of the airway centerline (strategic offset). The two first officers were at the controls while the captain rested. As for communications, they stated that they had just signed off with SAL OCEANIC Control and were attempting to establish contact with the Canaries ACC on 133.00 MHz (Sector OCE) and 8,861 KHz (Canaries HF). They also stated that they had not established an ADS-CPDLC connection with the Canaries ACC (GCCC).

At 02:48, a minute after crossing waypoint IPERA, they received a TCAS traffic advisory, after which the pilot flying prepared to take the controls and the pilot monitoring identified the conflict aircraft. They established visual contact with aircraft TAP-087, which was some 300 ft above them. Seconds later they received a TCAS "Descend" resolution advisory, the autopilot and auto-throttle disengaged and they adhered to the advisory as per procedure, descending to a level of FL344. Once the conflict was clear, they returned to FL350. The crew regarded the event as serious.

1.7.3. *Statement from ATC personnel*

1.7.3.1. Statement from the executive controller instructor

The executive controller, who that night was also acting as a controller instructor, stated that upon reaching his post, they put the flight progress strips in place to arrange the airplanes by airway and flight level so as to detect any potential conflicts. On finishing this task, he observed that the flight progress strips were correctly placed. During his first hour on duty, since there was little traffic he also reviewed the features of the SACCAN system with the controller under instruction.

They then observed the progress of the various aircraft, interrupted only by flight level change requests. He stated that the workload was average.

He noted that aircraft TAP-087 was flying southbound on airway UN-873 and requested to climb from FL340 to FL360 while at waypoint LIMAL, a request that was denied since there was oncoming traffic at FL350. TAP-087 once more requested to climb upon reaching ISOKA. Since it was close to the boundary between the Canaries UIR and SAL Oceanic, they called this station to coordinate the climb. SAL Oceanic agreed to the maneuver, after which they called aircraft TAP-087 on the frequency to authorize the climb, but it did not respond. They then tried to contact the oncoming traffic (AFR-443) to have it confirm its position and to provide the usual separation with aircraft TAP-087, although they knew from the CPDLC data link that AFR-443 had already passed waypoint ISOKA. This process kept the frequency occupied for a while since AFR-443

did not respond and another aircraft offered to relay the messages. At the same time, a position request was sent via CPDLC to AFR-443, which did reply.

The controller stated that until then, there were no yellow flight progress strips in the board (yellow indicates northbound flights) associated with waypoint IPERA. He then called Canaries HF to have that station relay the clearance for aircraft TAP-087 to climb to FL360.

Later, while looking over the flight progress strips on the board, the controller noticed a yellow strip associated with waypoint BIPET (UN-857) and corresponding to a northbound Air France flight at FL350 (aircraft AFR-457). The strip was improperly positioned since it should have been in the airway associated with waypoint IPERA (UN-873). He did not know who could have placed the strip in the wrong place or when. He was not expecting this traffic since the SAL ACC controller had not mentioned it while they were coordinating the climb of aircraft TAP-087.

In light of this, and aware that aircraft TAP-087 should have been climbing to or reaching the cleared flight level (FL360), he asked the planning controller to immediately call Canaries HF and have that station check if aircraft TAP-087 was established on FL360. The HF operator replied that it was, and aircraft TAP-087 had encountered an oncoming traffic and had reported the activation of a TCAS resolution advisory. The pseudotrack of aircraft AFR-457 later appeared on the SACCAN screen, and even though the aircraft was ADS-CPDLC enabled, it did not connect until a short while later.

1.7.3.2. Statement from the executive controller under instruction.

The controller under instruction in the executive controller's post of Sector GCCC OCE stated that aircraft TAP-087 requested to climb to FL360 after passing waypoint LIMAL, but that at that moment there was an oncoming traffic at FL350, and so TAP-087 was instructed to wait until waypoint ISOKA to climb. Upon reaching that point, the aircraft once more requested to climb. This second request prompted a call to SAL Oceanic Control to check for traffic that would affect the climb. SAL approved the climb, and so GCCC OCE called TAP-087 several times without receiving a reply. The station then called Canaries HF, which was busy at that moment. When they called back, the HF operator was instructed to clear aircraft TAP-087 to climb. By the time the clearance was relayed there was another aircraft (AFR-457) at waypoint IPERA.

1.7.3.3. Statement from the planning controller

The planning controller of Sector GCCC OCE stated that the workload during the sequence of events was typical for that time of night and involved various actions and checks due to the complexity of the control console, which uses two different systems in which data are processed in one direction only.

It was in this context that TAP-087 requested to climb from FL340 to FL360, which was denied due to an oncoming traffic. Subsequently, once the climb was coordinated with SAL Oceanic, the clearance was relayed via HF due to poor VHF coverage.

The planning controller stated that he had not noticed the incorrect placement of the flight progress strip for aircraft F-GSJQ and did not know when it could have been placed in the wrong position.

1.8. Organizational information on the Canaries Control Center

1.8.1. *Canaries ACC Operations Manual*

The incident took place on airway UN-873 between reporting waypoints IPERA and ISOKA, in the Canaries UIR. Providing air traffic services in this airspace is the responsibility of AENA Air Navigation. The service is provided from the Canaries Area Control Center (Canaries ACC).

The Canaries ACC airspace is divided into a specific number of blocks called sectors or positions. The number of positions or sectors and the various combinations of open blocks depend on the amount of traffic and on the number of controllers on duty.

Figure 5 shows an overhead view of Sector GCCC OCE, where the near miss between the two aircraft took place. The same figure shows Sector ST, which is a block of airspace in the Canaries UIR/FIR that borders Sector GCCC OCE to the north. Sector ST is within the radar coverage area of the Canaries ACC. This sector is in charge of reassigning the flight levels of aircraft that are crossing from one hemisphere to the other via the Canaries UIR.

Section 9.5-2.2, Sector GCCC OCE, of the unit manual lists the following requirements involving the flight level clearances within Sector GCCC OCE. One allows the sector to authorize flight level changes and another expressly states that changes must be limited to radar coverage areas, which does not include Sector GCCC OCE:

- *Sector GCCC OCE shall not allow flight level changes unless previously coordinated via voice (SVC) with the corresponding adjacent sector. The adjacent sector, then, shall be responsible for flight level changes.*
- *Flight level changes, if required, shall be conducted under radar coverage.*

Again in Section 9.7-3.1, on the operation of the SACCAN system in Sector GCCC OCE, it states once more that flight level changes must take place under radar coverage.

- *All FL changes are to be carried out within radar coverage whenever possible.*

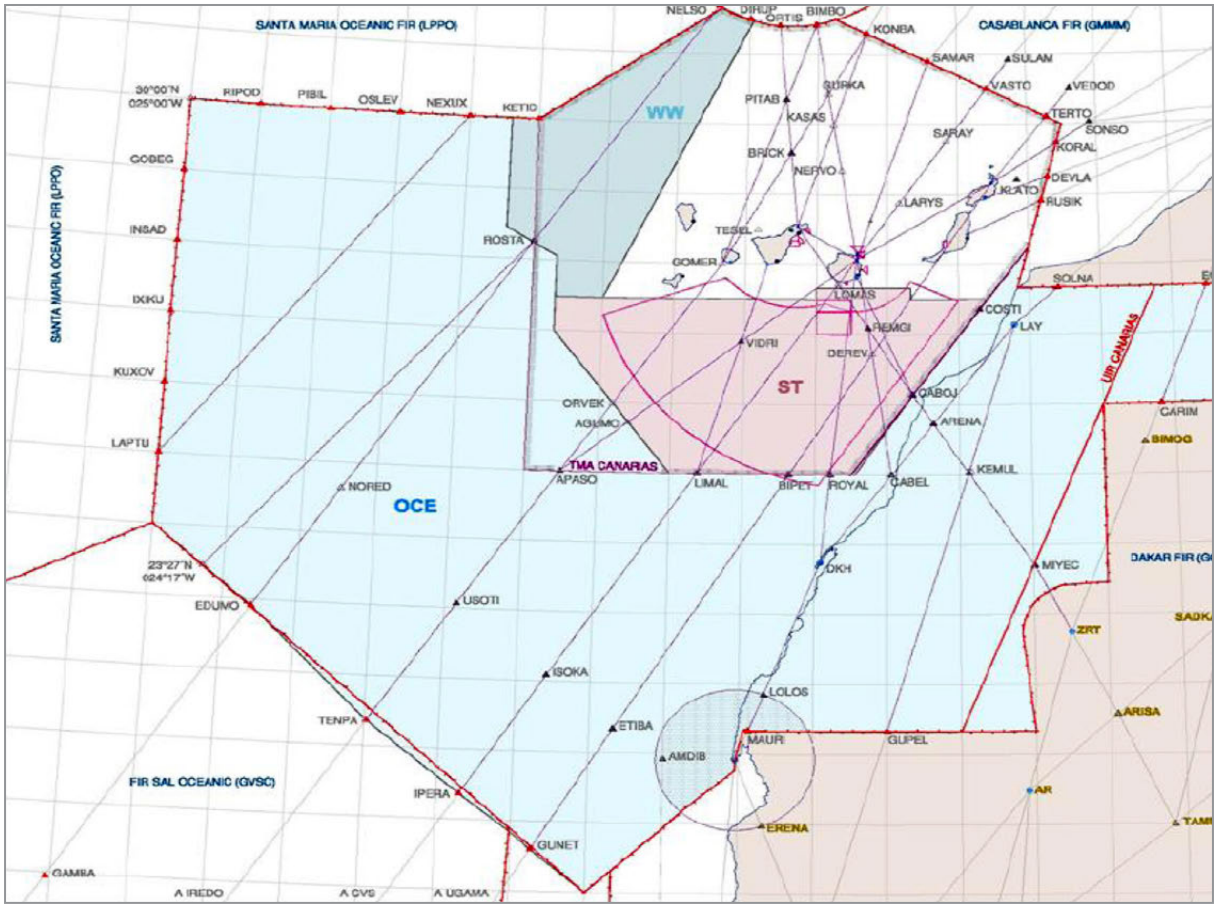

Figure 5. Sector GCCC OCE and Sector ST

Section 9.7 of the manual, SACCAN Operability, gives the procedures to be used in Sector GCCC OCE involving the operation of SACCAN:

Sector GCCC OCE is operational 24 hours a day and is in charge of handling the ADS/CPDLC contracts of aircraft flying inside the Canaries FIR, but it can only issue control clearances based on ADS/CPDLC information when the aircraft is inside Sector GCCC OCE airspace. When ADS/CPDLC enabled aircraft are under the control of Sector GCCC OCE, this station can exempt them from the requirement to notify passing over notification waypoints, except at the FIR Canaries boundary waypoints.

Sector GCCC OCE must ensure that ADS/CPDLC enabled aircraft flying SOUTH connect upon entering the Canaries FIR/UIR. Once connected, it must inform the preceding adjacent sectors.

A description of the SACCAN post at the Sector GCCC OCE is given in Section 9.7-2, Layout of the Work Station, of the manual. The station consists of an executive controller's post and a planning controller's post. To carry out his duties, the executive controller's post has a TPT display for the SACCAN system that shows both pseudotracks

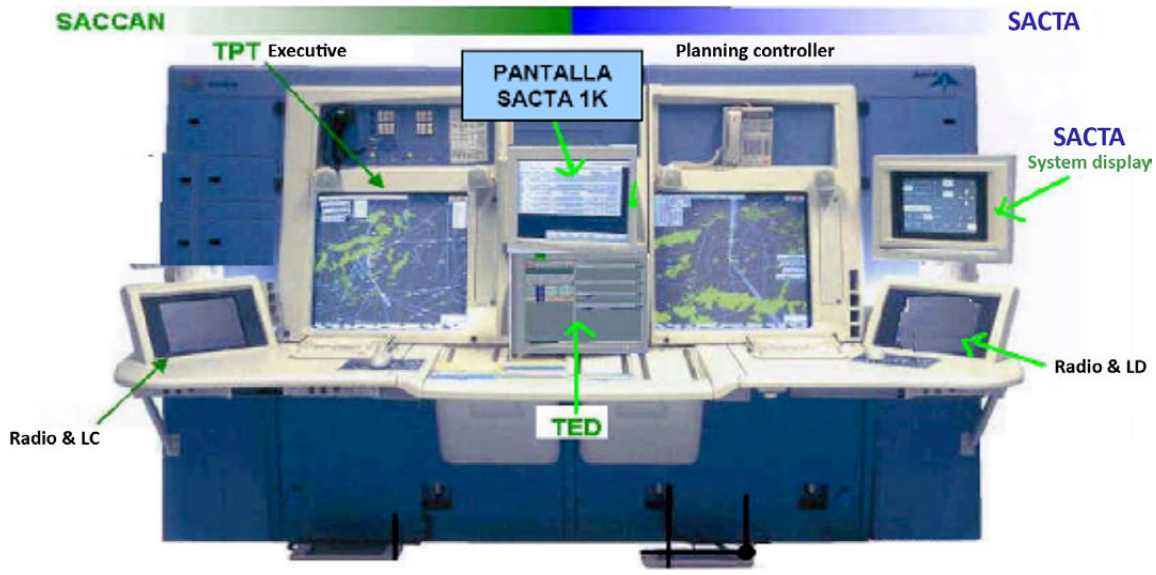

Figure 6. View of the SACCAN post in Sector GCCC OCE

and ADS tracks. A mouse is also provided. In addition there is a TED post for handling CPDLC messages between aircraft and ATC. The executive controller shares a SACTA system display (SACTA 1K) with the planning controller, which also has a mouse. The planning controller's station features a SACTA display and a PCV keyboard.

Between the two posts and underneath the TED display is the board where the aircraft flight progress strips are located.

Sections 7.9-3 and 7.9-4 of the manual define the operations of Sector GCCC OCE, which depends on whether the aircraft is ADS/CPDLC enabled or not and, if not, also on whether the aircraft is flying northbound or southbound. A summary of the procedure to be followed in each of the cases is given below:

1. Non-ADS/CPDLC enabled aircraft flying northbound: when the estimated time of entry into the Canaries FIR is received, either via OLDI or by telephone, the flight strip is generated in the adjacent sectors and when the time of entry comes, the SACCAN system shows the pseudotrack on the screen. Once the pilot reports an ETO (Estimated Time Over) the boundary waypoint and the pseudotrack appears, the controller must verify that the information in the SACTA system is correct and modify it if it is not. Any change entered into the SACTA system will be automatically updated in the SACCAN system. It also indicates that Sector GCCC OCE will handle changing the flight levels of aircraft to the levels specified in the LoAs (Letters of Agreement) with adjacent control center.
2. Non-ADS/CPDLC enabled aircraft flying southbound: the SACCAN system will display a pseudotrack on the TPT screen when the area leaves the area of radar coverage and enters the block under OCE's jurisdiction. Sector GCCC OCE controller

must enter into the SACTA system any change to the flight plan (estimates, speed, route or FL), which will result in the SACCAN system being automatically updated.

In both of the above cases, the Sector OCE planning controller is responsible for entering any changes in the FLP (flight plan) (changes in ETA's to transfer waypoints, FL, speed or route) and for receiving and conveying estimated times with adjacent sectors, be it via OLDI or voice. The manual also warns that pseudotracks are never to be used to ensure separation, as their sole purpose is to provide an estimate of an aircraft's position. This position will be made more exact if the estimated time over a waypoint coincides with the aircraft's actual fly-over time (as reported by the aircraft), and if the speed in the flight plan entered into SACTA matches the airplane's real speed.

Lastly, for the two preceding cases it states that a change from an odd flight level to an even RVSM flight level is to be done in block ST (northernmost sector in Sector GCCC OCE), which has radar coverage.

3. ADS/CPDLC enabled aircraft: Aircraft must connect the ADS/CPDLC manually 15 to 30 minutes before entering the Canaries FIR by manually inputting the code for the Canaries (GCCC) into the onboard equipment. Once the connection is made, the SACCAN system automatically activates the initial 15-minutes ADS contract with the aircraft.

   Aircraft connected via ADS can omit voice position reports and will only have to report via voice or CPDLC the entry position into the FIR /UIR when flying northbound. The SACCAN post controller must confirm that the data on the ADS label matches those for the flight plan on the flight progress strip, and indicate the corresponding checks in blue.

   Lastly, the manual warns that the ADS display is not to be used to provide separation between ADS tracks. It is only to be used to monitor deviations, planned routes, ADS position reports, emergencies, track monitoring, and to detect incorrect reporting points and minimum altitude violations.

   If the aircraft is CPDLC enabled, it can use the CPDLC connection to exchange messages instead of using voice messages with the controller. This connection does not exempt crews from the requirement to monitor the relevant VHF/HF frequencies.

1.8.1.1. Changes made to the GCCC Operations Manual

Over the course of the investigation into this incident, the Canaries ACC modified its Operations Manual to include Appendix I "SOP between the OCE, RST and RWW volumes" in the manual. This appendix establishes, among others, the procedures for

aircraft flying in the EUR/SAM corridor under the control of the Canaries ACC. The specifications on the EUR/SAM corridor state that:

1. For southbound aircraft:

   - The RST and RWW sectors (located north of Sector OCE), which have radar coverage, are in charge of assigning the final flight levels to aircraft so that before they leave the ACC's area of responsibility, the usual separation criteria are observed as specified in the LoAs.
   - The transfer between the remaining sectors and Sector OCE is done via SACTA and the OCE's acceptance must be verified.
   - Sectors RST and RWW cannot change the flight level of aircraft 30 NM before the limit with Sector OCE, unless a level change has been coordinated with said sector.
   - As regards operations in Sector OCE, it states that when faced with any situation that could hamper correct evaluations on the board (double check, or even consult with an assistant to detect possible errors in the placement of the strips), Sector OCE will not make any flight level changes. It also specifies that frequent checks are to be made of the board to keep it constantly updated and to verify the traffic present in the sector. If any flight level changes are made the SACTA system must be updated.
   - As regards ADS/CPDLC enabled aircraft, Sector OCE must ensure that they are connected upon entering the Canaries FIR/UIR, as specified in the procedure described in point 9.9.5.4 of the Operations Manual. It also recalls the requirements of the letter of agreement with the SAL ACC, which states that an aircraft's FL cannot be changed within 30 NM of the boundary except in an emergency, such as strong turbulence, which must be coordinated with the SAL ACC.
   - For aircraft without an ADS/CPDLC connection, it states that in those cases where an ADS/CPDLC enabled aircraft is not connected, that it be instructed to connect during the initial call. It also recalls once more how the letter of agreement forbids changing an aircraft's flight level within 30 NM of the boundary, and underscores that pseudotracks shall never be used to ensure separation.

2. For northbound aircraft:

   - For traffic with no ADS/CPDLC connection, it states that if the aircraft is ADS/CPDLC enabled but not connected to the system, it will be requested to connect during the initial call. It also notes how if an aircraft crosses the boundary without calling, and if five minutes have elapsed after its estimated entry time without contact being established, its waypoint progression shall be verified with the SAL ACC and emergency calls made via relay, as needed, to determine whether to declare an INCERFA. The supervisor shall always be notified.
   - Sector RST is in charge of assigning the final FL to comply with the LoAs and shall ensure radar separation between traffic in its sector. It also states that any FL changes are to be made no closer than 30 NM with the Sector OCE boundary.

1.8.2. *Placement of the flight progress strips in the Sector OCE board*

The placement of the flight progress trips on the board plays a key role in how Sector OCE manages traffic, since this sector has no radar coverage, meaning that conventional procedural-based controls must be applied.

The strips are placed on the board in Sector GCCC OCE as follows: the flight progress strips are placed in holders of different colors depending on the aircraft's flight direction (north or south), with blue for southbound and yellow for northbound. There are also red strip holders on the board that identify the reporting waypoints on each airway. The number of these is determined by how much room there is physically on the board and by operational needs.

Once the strips for each aircraft are placed in the corresponding holder (blue or yellow), a strip holder is placed for each flight along the reporting waypoints that the aircraft must cross, with the order of the reporting waypoints being determined by the fly-over time and the flight direction.

Section 9.4-2.1.1 in the Canaries ACC Operations Manual also specifies the Functions of the Route Sector Controllers, which include:

- *Carrying out the planning and assistance tasks mentioned in sections 7 to 14, arranging the flight progress board based on the sequences, priorities, reporting waypoint fly-over times and flight levels. Manning the hotlines to adjacent sectors. These tasks shall be assigned by non-executive personnel.*

Before the changes described in 1.8.8.1 were made, the manual did not require supervising the placement of strips on the board.

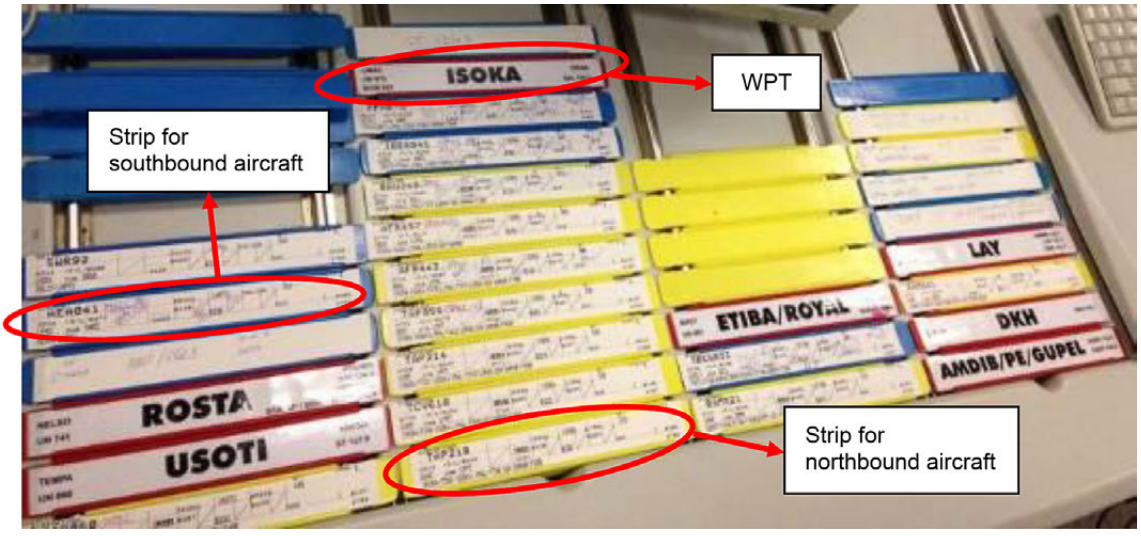

Figure 7. Flight progress board in Sector GCCC OCE

1.8.3. *Letter of Agreement between the Canaries ACC and the SAL ACC*

The Letter of Agreement (LoA) signed between the Canaries ACC and the SAL ACC defines the procedures to be used by the two units to coordinate the provision of air traffic services.

In the LoA in effect on the day of the incident it states that flight data will be exchanged automatically via OLDI messages, with one OLDI ABI message 45 minutes before the coordination point or 25 minutes later if the aircraft took off from within SAL, and an OLDI ACT message sent no later than 20 minutes before the coordination point or 100 NM before for aircraft flying at a speed of 250 kt or less.

As for the general conditions for accepting flights (Appendix D in the LoA), it states that flights shall be turned over at established coordination waypoints, which in the case of airway UN-873, is waypoint IPERA, and that aircraft are to maintain the flight level coordinated at the coordination waypoint except when clear conditions for descending or climbing are verbally coordinated between the units. It also specifies that for any deviation from the specified transfer conditions (flight level, coordination waypoint, route), the transferring unit must ask the accepting unit for an Approval Request. If coordinated verbally, this must be done at least 10 minutes beforehand.

When transferring ADS/CPDLC-enabled aircraft from the SAL ACC to the Canaries ACC, it states that the SAL ACC must instruct the pilot to manually connect the ADS/CPDLC between 15 and 45 minutes before reaching the limit waypoint between the two units.

Lastly, Appendix E specifies that control must be transferred at waypoints on the boundary between the two FIRs, which is waypoint IPERA in the case of airway UN-873. When over this point, aircraft must be in communication with the accepting unit on the corresponding VHF frequency. During the initial message the aircraft must report its position, flight level, Mach number and estimated time over the next waypoint. If communications cannot be established on VHF, then HF communications must be established.

After the incident, the Canaries and SAL ACCs revised the LoA to improve the coordination procedure between the two units by correcting some of the deficiencies detected in the wake of this incident. The changes made include:

- The addition of a new type of OLDI message, an OLDI REV (Revision) message to the automatic data exchanged between the two units. This type of message can be sent after an OLDI ACT and up to 10 minutes before the coordinated transfer waypoint. This message type is used when some portion of the information included in the ACT message has changed, such as flight level, route, etc.
- Specifying that controllers cannot modify the flight level of an aircraft that is within 30 NM of the boundary waypoint between the two units.

1.9. Additional information

1.9.1. *Aeronautical Information Publication – AIP Spain*

According to ENR 3.3-48, airway UN-873, in the segment between reporting waypoints LIMAL and IPERA, is a route designated for air navigation (RNAV) that conforms to RNP 10 specifications. It likewise states that southbound aircraft are to be assigned even flight levels between FL400 – FL300, and northbound aircraft odd levels between FL410 – FL290.

The airspace in which the incident took place is outside the radar coverage area, meaning that radar service is not provided. As stated in ENR 1.3-22, SSR (Secondary Surveillance Radar) Coverage Area, the southern limit of the stated coverage at FL300 is in the vicinity of the 24º N parallel. The coordinates of waypoint ISOKA are 22º04'53'N, 019º35'24"W, which is south of the radar coverage limit.

Based on ENR 1.7-3, Cruise Flight Levels, in Spanish airspace where the vertical separation minimum (VSM) is applicable, the even levels are reserved for flights on magnetic headings between 180º and 359º, while odd levels are for aircraft on magnetic headings between 0º and 179º. See figure 8.

AIP ESPAÑA — ENR 1.7-3 13-JUN-02

→ ***TABLA DE NIVELES DE CRUCERO*** / TABLE OF CRUISING LEVELS

a) En áreas en que se aplique una separación vertical mínima (VSM) de 300 m (1000 ft) entre FL290 y FL410 inclusive:

a) Whitin areas where the vertical separation minimum (VSM) of 300 m (1000 ft) between FL290 and FL410 inclusive is applied:

RUTA MAGNÉTICA / MAGNETIC TRACK												
De 000° a 179° / From 000° to 179° (Impares/Odds)						De 180° a 359° / From 180° to 359° (Pares/Evens)					
Vuelos IFR Flights			Vuelos VFR Flights			Vuelos IFR Flights			Vuelos VFR Flights		
FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT
50	1.500	5.000	55	1.700	5.500	60	1.850	6.000	65	2.000	6.500
70	2.150	7.000	75	2.300	7.500	80	2.450	8.000	85	2.600	8.500
90	2.750	9.000	95	2.900	9.500	100	3.050	10.000	105	3.200	10.500
110	3.350	11.000	115	3.500	11.500	120	3.650	12.000	125	3.800	12.500
130	3.950	13.000	135	4.100	13.500	140	4.250	14.000	145	4.400	14.500
150	4.550	15.000	155	4.700	15.500	160	4.900	16.000	165	5.050	16.500
170	5.200	17.000	175	5.350	17.500	180	5.500	18.000	185	5.650	18.500
190	5.800	19.000	195	5.950	19.500	200	6.100	20.000	205	6.250	20.500
210	6.400	21.000	215	6.550	21.500	220	6.700	22.000	225	6.850	22.500
230	7.000	23.000	235	7.150	23.500	240	7.300	24.000	245	7.450	24.500
250	7.600	25.000	255	7.750	25.500	260	7.900	26.000	265	8.100	26.500
270	8.250	27.000	275	8.400	27.500	280	8.550	28.000	285	8.700	28.500
290	8.850	29.000				300	9.150	30.000			
310	9.450	31.000				320	9.750	32.000			
330	10.050	33.000				340	10.350	34.000			
350	10.650	35.000				360	10.950	36.000			
370	11.300	37.000				380	11.600	38.000			
390	11.900	39.000				400	12.200	40.000			
410	12.500	41.000				430	13.100	43.000			
450	13.700	45.000				470	14.350	47.000			
490	14.950	49.000				510	15.550	51.000			
etc	etc	etc				etc	etc	etc			

Figure 8. Table of Cruising Levels based on magnetic track in VSM airspace

1.9.2. *Spain's Air Traffic Regulations (RCA)*

The airspace under the control of Sector GCCC OCE is class C, as per the ICAO classification. The services provided and the requirements placed on IFR aircraft in Class C airspace are as follows:

- Separation is provided with all other traffic, whether IFR or VFR.
- Air traffic control services are provided.
- Constant radio communications must be maintained on the control frequency.
- They are subject to ATC clearance.

According to Spain's RCA, the minimum longitudinal separation based on RNAV distance inside RNP airspace, as is the case of segment LIMAL – IPERA in airway UN-873 (where aircraft AFR-457 and TAP-087 were), when ADS is not in use is as follows:

> 4.3.8.6.3.1. With regard to aircraft in cruise flight, climbing or descending on the same track, the following separation minimums may be used:

Separation minimum	RNP type	Communications requirements	Surveillance requirements	Distance verification requirements
93 km (50 NM)	10	Direct pilot-controller communications	Required position reports	At least every 24 minutes

The RCA also indicates that when aircraft are on opposite tracks, a climb or descent shall not be authorized through levels occupied by other aircraft until the aircraft have conclusively passed each other and the aforementioned distance exists between them.

> 4.3.8.6.3.4. Aircraft on opposite tracks. Aircraft may be authorized to climb or descend to or through levels occupied by other aircraft only if it can be unequivocally established that the aircraft have crossed each other and the distance between them is at least equal to the applicable minimum separation distance.

The distance between aircraft is determined using the position reports transmitted by the aircraft and based on the waypoints situated on the airway. Messages between the controller and pilot to report position may be oral or via CPDLC.

> 4.3.8.6.2. Separation shall be established and a distance between aircraft positions maintained that is no less than the specified distance, reported in reference to the same waypoint on the track located between both aircraft whenever possible, or reported by way of an automated position reporting system.
>
> Note. *The term "on the track" means that the aircraft is flying either directly toward or away from the station or waypoint.*

4.3.8.6.2.2. Direct communications shall be maintained between the controller and the pilot when distance-based separation minimums are applied. Direct communications between the controller and the pilot shall be oral or via CPDLC. The communications criteria needed for CPDLC to satisfy the requirement for direct communications between the controller and pilot shall be established by means of a suitable safety study.

As concerns the assignment of flight levels based on the track flown by the aircraft to provide separation between aircraft, the RCA specifies the following:

3.3.3.4. The separation provided by an air traffic control unit shall be obtained by at least one of the following means:

a) vertical separation, by assigning different levels, selected between:

1) the tables of cruising levels shown in Appendix B, or
2) a *modified table of cruising levels, when so prescribed pursuant to Appendix B,* for flights above flight level 410; though the correlation between the levels and tracks prescribed there *shall not be applicable when so indicated in the relevant aeronautical information publications* or in air traffic control clearances;

4.3.5.8. Cruising levels or, in the case of cruise climbs, the series of levels to be assigned to controlled flights, shall be selected from among those designated for IFR flights from:

a) the cruising level tables shown in Appendix B, or from
b) a modified cruising level table, when so prescribed pursuant to Appendix B, for flights above flight level 410, though the correlation between the levels and tracks prescribed in said table shall not be applicable when a different method is indicated in the air traffic control clearances *or when another method has been specified by the competent ATS authority in the aeronautical information publications.*

These points in the RCA state that the levels shall be determined using the table contained in Appendix B of the RCA or using another method if so established by the ATS authority in the aeronautical information publications. In the case of the AIP Spain, it contains the same levels table as the RCA.

Appendix B in the RCA, shown below, states that the tracks in the table may be shifted to go from 090° to 269° and from 270° to 089° so as to adhere to predominant air traffic directions. This change shall be effected by means of regional air navigation agreements and must be specified in the relevant transition procedures.

Los niveles de crucero que han de observarse cuando así lo exija este Reglamento, son los siguientes:

a) En las áreas en que, en virtud de acuerdos regionales de navegación aérea y de conformidad con las condiciones especificadas en los mismos, se aplique una separación vertical mínima (VSM) de 300 m (1000 ft) entre FL 290 y FL 410 inclusive*.

DERROTA **												
De 000° a 179° ***						De 180° a 359° ***					
Vuelos IFR			Vuelos VFR			Vuelos IFR			Vuelos VFR		
FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT	FL	ALTITUD / ALTITUDE M	FT
-90						0	–	–			
10	300	1000	–	–	–	20	600	2000	–	–	–
30	900	3000	35	1050	3500	40	1200	4000	45	1350	4500
50	1500	5000	55	1700	5500	60	1850	6000	65	2000	6500
70	2150	7000	75	2300	7500	80	2450	8000	85	2600	8500
90	2750	9000	95	2900	9500	100	3050	10000	105	3200	10500
110	3350	11000	115	3500	11500	120	3650	12000	125	3800	12500
130	3950	13000	135	4100	13500	140	4250	14000	145	4400	14500
150	4550	15000	155	4700	15500	160	4900	16000	165	5050	16500
170	5200	17000	175	5350	17500	180	5500	18000	185	5650	18500
190	5800	19000	195	5950	19500	200	6100	20000	205	6250	20500
210	6400	21000	215	6550	21500	220	6700	22000	225	6850	22500
230	7000	23000	235	7150	23500	240	7300	24000	245	7450	24500
250	7600	25000	255	7750	25500	260	7900	26000	265	8100	26500
270	8250	27000	275	8400	27500	280	8550	28000	285	8700	28500
290	8850	29000				300	9150	30000			
310	9450	31000				320	9750	32000			
330	10050	33000				340	10350	34000			
350	10650	35000				360	10950	36000			
370	11300	37000				380	11600	38000			
390	11900	39000				400	12200	40000			
410	12500	41000				430	13100	43000			
450	13700	45000				470	14350	47000			
490	14950	49000				510	15550	51000			
etc.	etc.	etc.				etc.	etc.	etc.			

* Excepto cuando, en virtud de acuerdos regionales de navegación aérea, se prescriba una tabla modificada de niveles de crucero basada en una separación vertical nominal mínima de 300 m (1000 ft) para ser utilizada, en condiciones especificadas, por aeronaves que vuelen por encima del FL 410 dentro de sectores determinados del espacio aéreo.

** Derrota magnética, o en zonas polares a latitudes de más de 70° y dentro de las prolongaciones de esas zonas que puedan prescribir las autoridades ATS competentes, derrotas de cuadrícula, según determine una red de líneas paralelas al Meridiano de Greenwich superpuesta a una carta estereográfica polar, en la cual la dirección hacia el Polo Norte se emplea como norte de cuadícula.

*** Excepto cuando, en virtud de acuerdos regionales de navegación aérea, se prescriba que de 090° a 269° y de 270° a 089° se destinen a atender las direcciones predominantes del tránsito y se especifiquen los correspondientes procedimientos de transición apropiados.

2. ANALYSIS

2.1. General information

On 7 January 2013 there was a near miss between aircraft TAP-087 and AFR-457 when they were in the vicinity of waypoint IPERA, the limit waypoint on the boundary between the Canaries ACC FIR/UIR and the SAL ACC FIR/UIR and part of the EUR/SAM corridor, within the airspace controlled by Sector GCCC OCE and in which radar tracking is not provided.

Aircraft TAP-087 was flying southbound on airway UN-873 at FL340. Upon reaching waypoint ISOKA, it requested to climb to FL360 a second time. Sector GCCC OCE, after coordinating the climb with the SAL ACC via telephone, contacted aircraft TAP-087 and asked it to stand by. On attempting to contact with it again to provide the climb clearance, it received no response. After several unsuccessful attempts, Sector GCCC OCE asked the HF operator to relay the information to aircraft TAP-087. The HF operator managed to contact the aircraft a few minutes later. In the meantime aircraft AFR-457, which was still in SAL ACC airspace, was flying northbound on airway UN-873 toward waypoint IPERA at FL350. Almost ten minutes before the coordination between the SAL ACC and Sector GCCC OCE, the flight progress strip for aircraft AFR-457 had been created in Sector GCCC OCE. On this strip the estimated time of entry into the Canaries FIR/IUR was shown as 02:47, at which time it was incorrectly placed in the board. At 02:47:09, the pseudotrack for aircraft AFR-457 appeared for the first time on the SACCAN screen in Sector GCCC OCE. The aircraft, despite being equipped with an ADS/CPDLC system, had not connected to the SACCAN system nor had it contacted Sector GCCC OCE by radio. One minute and twelve seconds later aircraft TAP-087 received a TCAS "climb" RA while at FL354. Immediately afterwards aircraft AFR-457 received a TCAS "descend" RA while at FL350, both caused by the two aircraft crossing each other within the established separation minimums.

2.2. History of the flight

2.2.1. *General aspects*

Aircraft TAP-087 and AFR-457 were flying on airway UN-873, which conforms to RNP 10 specifications. Both aircraft met the requirements for flying on this type of airway and were equipped with RNAV units that were RNP 10 approved. The airway is in the Canaries UIR airspace. It is categorized as Class C airspace, meaning that air traffic services are provided, radio communications must be maintained and separation is provided between IFR aircraft. The minimum separation distance specified for RNP 10 airways is 50 NM between aircraft on the same track when flying toward or away from the same waypoint. Likewise, an aircraft flying in an RNP 10 regime with oncoming traffic can only be cleared to climb or descend when the two aircraft have already crossed and the distance between them is equal to or greater than the established minimum of 50 NM.

2.2.2. *Aircraft flight paths*

Aircraft TAP-087 first contacted Sector GCCC OCE at 02:09:37. It had entered the sector via reporting waypoint LIMAL and it was southbound on airway UN-873 at FL340. It was flying the segment of the airway between reporting waypoints LIMAL and ISOKA.

Minutes later, at 02:18:53, aircraft TAP-087 asked the Sector GCCC OCE controller to climb to FL360. Sector GCCC OCE denied the request because there was traffic (aircraft AFR-443) flying on the same airway as TAP-087 in the opposite direction at FL350. The controller informed aircraft TAP-087 that the climb could be authorized at waypoint ISOKA, once the two aircraft had crossed.

In the meantime, aircraft AFR-457 was still in SAL ACC airspace, which is south of the Canaries UIR and adjacent to the Canaries ACC. The aircraft was also flying on airway UN-873 but northbound, in the opposite direction as aircraft TAP-087, at FL350. AFR-457 estimated time of entry into the Canaries UIR was 02:47 via reporting waypoint IPERA, the same waypoint via which aircraft TAP-087 would leave Sector GCCC OCE at FL350. The data on the flight plan for aircraft AFR-457 had been provided to the Canaries ACC by the SAL ACC at 02:27:43 via OLDI. It was then that the flight progress strip was generated for aircraft. The strip should have been placed on the board in Sector GCCC OCE in the proper sequence at entry waypoint IPERA on airway UN-873.

At 02:44:42 aircraft TAP-087 left FL340 to climb to FL360. Some eight minutes earlier it had reported to Sector GCCC OCE that it had crossed waypoint ISOKA and was en route to waypoint IPERA. Sector GCCC OCE had coordinated the climb with the SAL ACC at 02:37:17, but the clearance was not given to aircraft TAP-087 until minutes later through the HF operator, since Sector GCCC OCE was unable to contact the aircraft on its frequency after telling it to stand by following the coordination.

Two and a half minutes later, at 02:47:09, the estimated fly-over time, the pseudotrack for aircraft AFR-457 first appeared over waypoint IPERA on the SACCAN display in Sector GCCC OCE. The aircraft was not connected via ADS-CPDLC. Shortly afterwards, at 02:48:21, aircraft TAP-087 received a TCAS climb RA while flying through FL354. Aircraft AFR-457 then received a TCAS descend RA.

2.3. Personnel actions

2.3.1. *Crew of aircraft TAP-087*

Based on the report from the in-flight safety department of the airline that operated aircraft TAP-087, the flight left FL340 at 02:44:42 after being told by the HF operator that it was cleared to climb to FL360. The initial climb rate was 360 ft/min. Almost two and a half minutes later, the aircraft had reached FL350 and its climb rate was 392 ft/min.

At 02:48:09, the TCAS traffic advisory was received while TAP-087 was at FL353 and climbing at 392 ft/min. Immediately afterwards, at 02:48:21, the crew received a TCAS "climb" resolution advisory. They were then at FL354. The autopilot was immediately disengaged and the climb rate increased to 1,856 ft/min. During the climb following the TCAS advisory, the flight data analysis revealed a drop in the aircraft speed (Mach Low). At 02:49:03 the TCAS reported that the aircraft was clear of conflict.

2.3.2. *Crew of aircraft AFR-457*

Based on the DAR data from aircraft AFR-457, at the estimated time over waypoint IPERA, at 02:47:09, the aircraft was established on FL350. Immediately afterwards, the left microphone in the cockpit remained depressed for six seconds, from 02:47:11 to 02:47:17. This information corroborates the statement made by the crew of AFR-457, which expressed that they tried to contact Sector GCCC OCE upon entering the Canaries UIR. At 02:47:39, the left microphone was again depressed for two seconds.

Seconds later, at 02:48:26, aircraft AFR-457 received its first TCAS resolution advisory with an indication not to climb, followed by a TCAS descend RA at an indicated descent rate of 1,500 ft/min. The crew disengaged the autopilot and carried out the instruction, reaching a maximum descent rate of 1,952 ft/min.

While they were descending as instructed by the TCAS RA, the crew of aircraft AFR-457 pressed the left microphone twice, first for two seconds at 02:48:44, and then at 02:48:51 for thirteen seconds.

The information provided by the airline of aircraft AFR-457 shows no record of the ADS-CPDLC connecting to the SACCAN system, meaning that the crew's claim that it tried to connect several times before entering Sector GCCC could not be verified. The aircraft did not establish an ADS-CPDLC link until after entering the Canaries UIR, at 02:53.

2.3.4. *Controllers on duty in sector GCCC OCE*

During the event, the control post in Sector GCCC OCE was manned by three controllers: an executive controller, a planning controller and a controller under instruction, the last of whom was physically located in the post of the executive controller.

When they went on duty, more than an hour before the incident, the controllers arranged the flight progress strips in the holder in the position specified by the unit's procedures, ordering them by airway, flight level and direction of flight for each aircraft. The strip for aircraft AFR-457 had not yet been printed at that time and thus it was not placed on the board.

The executive controller in Sector GCCC OCE rejected aircraft TAP-087's initial climb request to FL360 at 02:09:37 because there was traffic on the same airway flying in the opposite direction at FL350 and they had not yet crossed. The controller calculated that the aircraft would cross in the vicinity of waypoint ISOKA and informed aircraft TAP-087 that it would be able to authorize the climb at said point. On checking the board, the controllers did not see any traffic in the UN-873 sequence that could affect aircraft TAP-087. The flight progress strip for flight AFR-457 had not yet been printed. This would happen at 02:27:43, as indicated on the aircraft's flight progress strip.

When aircraft TAP-087 reached waypoint ISOKA at 02:36:33, one of the Sector GCCC OCE controllers called the SAL ACC to coordinate its climb to FL360. The SAL ACC cleared the climb, not noticing the potential conflict with aircraft AFR-457, which was still under its control. The Sector GCCC OCE controllers, for their part, also failed to notice during their check of the board that aircraft AFR-457 was going to enter the Canaries FIR via waypoint IPERA some ten minutes later, at 02:47 as per the reported estimate, and thus conflict with the climb clearance of aircraft TAP-087. This failure to detect the immediate presence of aircraft AFR-457 on airway UN-873 occurred because its flight progress strip was not correctly positioned on the board.

The clearance given to aircraft TAP-087 to climb to FL360 was delayed because despite being told to stand by on the Sector GCCC OCE frequency, the controller was unable to establish contact again due to problems on the frequency, so he had to ask the HF operator to try to raise aircraft TAP-087 on his frequency to relay the clearance. By the time the HF operator was finally able to inform aircraft TAP-087 that it was cleared to climb to FL360, several minutes had elapsed since the coordination with the SAL ACC and under three minutes remained before the estimated entry time of aircraft AFR-457 into Sector GCCC OCE.

The conflict was not detected until the controller instructor called the HF operator, who informed him that aircraft AFR-457 and TAP-087 had both reported a TCAS RA resulting from their near miss. The controller instructor checked the board and noticed that the strip holder for aircraft AFR-457 was not placed in the sequence for airway UN-873.

The investigation was unable to determine which of the three controllers placed the strip in the wrong position or the reason for this misplacement; however, the event is considered to have resulted as a consequence of an error in the execute-supervise process that must be followed in a post that is staffed by more than one person.

2.4. Canaries ACC sectors

2.4.1. *Sector GCCC OCE*

Sector GCCC OCE is charged with providing air traffic control services to aircraft flying in the oceanic area belonging to the Canaries UIR/FIR. The airspace under its control is

unique in that VHF communications are patchy due to the size of the sector and its distance from ground stations. There is also no radar coverage, meaning that control service is conventional. The SACCAN system is intended to facilitate the task of Sector GCCC OCE. It provides a display of the positions of aircraft, both those that are ADS/CPDLC enabled and connected to the SACCAN system, and those that do not have ADS/CPDLC capabilities. The position information for aircraft connected to the SACCAN system is obtained via data links, while the position of aircraft not connected is obtained from information in the SACTA system, which is updated using the oral reports sent in by the aircraft crews themselves and input by controllers into the system. Any change input into the SACTA system is automatically updated in the SACCAN system, but not the other way around; if an aircraft reports a change via SACCAN, the SACTA system is not automatically updated, meaning the controller must manually input this change. This non bi-directionality has the effect of increasing the controller's workload.

Sector GCCC OCE has to coordinate with the various adjacent sectors and units, including the SAL Area Control Center, when transferring traffic flying in the EUR/SAM corridor, which crosses the airspace of both units. This coordination is handled in accordance with the Letter of Agreement between the Canaries and SAL ACCs, which specifies that information on aircraft (estimated time of entry into the corresponding UIR, flight levels, entry waypoint, etc.) will be exchanged via OLDI. The SAL ACC sent the relevant OLDI messages on aircraft AFR-457 to the Canaries ACC, the first 45 minutes prior to its entry into the Canaries UIR, and the second 20 minutes prior. When this second OLDI message is received, an ACT message, the aircraft's flight progress strip is printed out and placed on the board in the sequence for the corresponding airway and entry waypoint for the Canaries UIR. In the case of aircraft AFR-457, the flight progress strip was printed out at 02:27 but it was not placed in the sequence for airway UN-873 associated with waypoint IPERA; instead, it was placed in the sequence for a reporting point on a different airway.

The Letter of Agreement also states that if one unit wants to change the transfer conditions, it must request the other unit's approval at least 10 minutes in advance of the transfer in the case of an oral approval. Sector GCCC OCE called the SAL ACC to coordinate the level change for aircraft TAP-087 before the required ten minutes, and the SAL ACC approved the climb. When this transfer was coordinated there were approximately ten minutes left before aircraft AFR-457 entered the Canaries UIR. Neither unit was aware that the aircraft were flying on the same airway in opposite directions and that aircraft TAP-087, en route to its new flight level, had to cross the flight level occupied by aircraft AFR-457 before the two aircraft crossed each other.

As mentioned earlier, one of the problems present in Sector GCCC OCE is the bad quality of voice communications on the VHF frequency that often prevents establishing contact with aircraft. To ensure the continuity of communications, Sector GCCC OCE has an HF frequency that is monitored by non-ATC personnel who are only responsible for relaying to aircraft information that is provided by the sector controller. This causes

a certain delay when providing aircraft clearances. This is evident by the fact that aircraft TAP-087 received its clearance to climb to FL360 minutes after the maneuver was coordinated between the SAL ACC and Sector GCCC OCE, which reduced the amount of time left before aircraft TAP-087 crossed with aircraft AFR-457.

Sector GCCC OCE also relies on the CPDLC function of the SACCAN system to lessen the problems associated with the inconsistent communications. The CPDLC function can be used to replace voice communications with aircraft with data link communications with aircraft that are ADS/CPDLC enabled, thus reducing the reliance on the VHF frequency. ADS/CPDLC enabled aircraft flying northbound must establish an ADS connection through the SACCAN system some thirty minutes before entering the Canaries UIR. To this end, and pursuant to the LoA, the SAL ACC must remind crews to make the connection manually. Aircraft AFR-457 did not connect to SACCAN until it was inside Sector GCCC OCE, though the reason for this could not be determined. This meant that instead of the ADS track for aircraft AFR-457 being shown on the SACCAN display before it entered the sector, a pseudotrack was generated at waypoint IPERA at the time the aircraft was estimated to have entered the Canaries UIR. All this, combined with the fact that the strip for aircraft AFR-457 was not placed in the proper position on the board, resulted in the GCCC OCE controllers not noticing the presence of aircraft AFR-457 in airway UN-873, in direct conflict with the climb of aircraft TAP-087.

In the wake of this incident, the Canaries ACC made some changes to the operation of Sector OCE, as reflected in its Operations Manual. One of the changes made specified that Sector OCE must ensure that a flight's strip is correctly positioned on the board before a change in flight level is authorized. If this check cannot be made the flight level change will not be authorized. This requirement could have aided in detecting the incorrect placement of the strip for aircraft AFR-457. Another change made, which was also introduced to the LoA with the SAL ACC, was to limit clearances to change flight level within 30 NM of the boundary between the units to emergency conditions only. This stipulation avoids having aircraft in changing conditions during the transition between units and ensures that they will be transferred while they are established on a flight level. Lastly, another change was to verify that ADS-enabled aircraft are properly connected upon entering the Canaries UIR. Aircraft that are not connected are to be instructed during the initial communication to establish a connection.

The changes made to the Operations Manual are regarded as adequate with a view to avoiding incidents like the one that resulted in this investigation.

Lastly we note that the investigation revealed that the Canaries ACC Operations Manual does not clearly and concisely specify whether Sector GCCC OCE can provide flight level change clearances to aircraft within its airspace or not. In Section 9.7-3.1 on SACCAN operations, it states that all FL changes shall be made within radar coverage whenever possible, which makes it possible for Sector GCCC OCE to authorize flight level changes.

However, Section 9.5-2.2, on Sector GCCC OCE, states that any flight level changes that are required shall be made with radar coverage.

Since this is not an aspect that should be open to interpretation in its application and practice, a safety recommendation is issued in this regard.

2.4.2. *Sector ST*

As noted in 1.8.1, Sector ST is in charge of reassigning flight levels to aircraft crossing from one hemisphere to another through the Canaries UIR, since the tables where the cruising flight levels are assigned based on track are opposite in the two hemispheres. In the specific case of this incident, aircraft TAP-087, which was crossing the Equator from north to south on a track between 180º and 359º, was changed from an odd to an even flight level when it entered the Canaries airspace – the aircraft entered at FL330 and it was reassigned to FL340. Aircraft AFR-457, for its part, which crossed the Equator from south to north on a track between 000º and 179º, was cleared to FL360 from FL350 after leaving Sector GCCC OCE and being under the control of Sector ST.

2.5. Air Traffic Regulations and AIP Spain

As concerns the assignment of flight levels based on track, both the table of cruising levels that appears in Spain's Air Traffic Regulations and the table shown in the Aeronautical Information Publication Spain specify that aircraft on tracks between 000º and 170º must maintain an odd flight level, while aircraft on tracks between 180º and 359º must maintain an even flight level.

The investigation into this incident, however, revealed that the requirements of these tables are not complied with in Spanish airspace. Aircraft AFR-457, which was flying eastward on a track between 000º and 179º, was assigned FL360 to fly inside Spanish airspace, when the tables in the RCA and AIP Spain require that it be assigned an odd flight level. The opposite happened with aircraft TAP-087, which was flying west on a track between 189º and 359º at FL330 when it entered the Canaries UIR, when it should have been flying at an even FL based on the published tables.

While it is true that the table featured in the RCA states that regional air navigation agreements can be used to change the tracks used to assign odd or even flight levels to 090º-269º and 270º-089º if required to adhere to the predominant directions of air traffic, the AIP makes no such provision, despite this change in tracks being carried out in practice.

The AIP should contain the flight level assignment table with the tracks that are used in practice in Spanish airspace, and as a result a safety recommendation is published in this regard.

3. CONCLUSIONS

The incident took place because the flight progress strip for aircraft AFR-457 was placed in the sequence for airway UN-857, associated with waypoint BIPET, instead of in the sequence for airway UN-873, associated with waypoint IPERA, where the aircraft actually was.

This is believed to have happened as the result of an error in the execution-supervision process that should have been followed in the Oceanic Sector control post at the Canaries Control Center (GCCC OCE).

4. SAFETY RECOMMENDATIONS

Over the course of analyzing the information gathered during the investigation into this incident, two aspects were identified that despite not having had a direct effect on this event, should be taken into account in an effort to improve operational safety.

The last two paragraphs of point 2.4.1 in this report made it evident that the Operations Manual of the Canaries Control Center does not clearly and concisely establish whether the Sector GCCC OCE can authorize a flight level change for aircraft within its airspace. This is an aspect that, in practice, should not be a source of doubt, and thus the following safety recommendation is issued:

REC 59/13. It is recommended that AENA – Air Navigation ensure that any references in the Operations Manual for the Canaries Control Center to the criteria to be used when issuing clearances to change level in said center's Oceanic Sector (GCCC OCE) be reviewed such that these criteria are expressed clearly and concisely and in the same manner in all the references included in said manual.

Likewise, Section 2.5 of this report noted how the same table for cruise levels is published in both the AIP Spain and in Spain's Air Traffic Regulations (RCA), with even and odd level separations depending on whether the magnetic flight tracks are eastbound or westbound, when in Spain level separation is determined based on whether the magnetic flight tracks are northbound or southbound. The RCA states that the latter method may be stipulated so as to adhere to the prevailing practice in air traffic. The published information must be consistent with the criteria utilized in practice in Spanish airspace, as a result of which the following safety recommendation is issued:

REC 60/13. It is recommended that AENA – Air Navigation take the necessary measures to ensure that Section ENR 1.7-3 Tabla de Niveles de Crucero (Table of Cruising Levels) in the AIP Spain shows the level separation that is applicable in practice within Spanish airspace depending on whether the magnetic flight tracks are northbound (270º to 089º) or southbound (090º to 269º).