

TECHNICAL REPORT

IN-041/2022

Incident on 13 July 2022 involving an AIRBUS A-330-343X aircraft operated by AIR CANADA, on registration C-GHLM, and a CESSNA CITATION 550 aircraft operated by the Spanish Navy, on registration U20.03, in the vicinity of Adolfo Suárez Madrid - Barajas Airport (Madrid, Spain)

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.

NOTICE

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

In accordance with the provisions in Article 5.4.1 of Annexe 13 of the International Civil Aviation Convention; and with Articles 5.6 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010; Article 15 of Law 21/2003 on Air Safety; and Articles 1 and 21.2 of RD 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent their recurrence. The investigation is not intended to attribute any blame or liability, nor to prejudge any decisions that may be taken by the judicial authorities. Therefore, and according to the laws specified above, the investigation was carried out using procedures not necessarily subject to the guarantees and rights by which evidence should be governed in a judicial process.

As a result, the use of this report for any purpose other than the prevention of future accidents may lead to erroneous conclusions or interpretations.

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ABBREVIATIONS

°	Sexagesimal degrees
ACC	Area Control Centre
AESA	Spain's National Aviation Safety Agency
AIP	Aeronautical Information Publication
APP	Approach control
ATC	Air traffic control
ATPL(A)	Air transport pilot licence (aircraft)
CLD	Clearance delivery
CPL(A)	Commercial pilot license (aircraft)
CLWY	Clearway
DEN	Eastern take-off control sector
DME	Distance measuring equipment
DWN	Western take-off control sector
E	East
ft	Feet
GAT	General air traffic
GCA LETO	Torrejón Air Base approach sector
GND LETO	Torrejón Air Base ground control
GMC	Ground movement control position
h	Time
HDG	Heading
ILS	Instrument landing system
IFR	Instrument flight rules
IR(A)	Instrument rating (aircraft)
K4	Last exit to the taxiway from runway 32R
K5	Quick exit to the taxiway from runway 32R
kg	Kilogram
km	Kilometre
L	Left
LCL LETO	Local control position in the Torrejón tower
LDA	Landing distance available
LEMD	ICAO code for Madrid Barajas Airport
LEMDAIN	Initial approach sector
LEMDAPN	Final approach sector that incorporates LEMDAIN
LEMDEDN	Departure/approach sector that incorporates LEMDNN and extends to level 160
m	Metre
N	North
NM	Nautical mile
O	West
ICAO	International Civil Aviation Organisation
OAT	Operational air traffic
PPL(A)	Private pilot license (aircraft)
QNH	Atmospheric pressure at sea level deduced from that of the aerodrome (Query nautical height)
R	Right
RADAR	Radio detection and ranging
RESA	Runway end safety area
STPWY	Stopway
TCAS	Traffic collision advisory system
TR (A)	Training rating (aircraft)
TDZ	Touchdown zone
THR	Runway threshold
TWR	Control tower
TWR LEMD	Control tower at Adolfo Suárez Madrid-Barajas Airport
TWR LETO	Control tower at Torrejón Air Base
VOR	Very high frequency omnidirectional range

TECHNICAL REPORT

IN-041/2022

AIRCRAFT 1

Owner and Operator: AIR CANADA

Aircraft: AIRBUS A-330-343X, with registration C-GHLM

Persons on board: Two hundred and fifty-six (256). Eleven (11) crew members (three in the cockpit - eight in the passenger cabin) and two hundred and forty-eight (248) passengers.

Flight rules: IFR

Type of flight: Commercial air transport

AIRCRAFT 2

Owner and Operator: SPANISH NAVY

Aircraft: CESSNA CITATION 550, with registration U20.03

Persons on board: Ten, three (3) crew and seven (7) passengers

Flight rules: IFR

Type of flight: Passenger transport

Date and time of the accident: Wednesday, 13 July 2022 at 11:03 h (local time)

Location of the incident: Adolfo Suárez Madrid-Barajas Airport (Madrid)

Approval date: November 30 2022

SYNOPSIS

Summary:

An AIRBUS A-330-343X aircraft with on registration C-GHLM, flight number ACA824, from Toronto Airport (Canada) and a CESSNA CITATION 550 military aircraft belonging to the Spanish Navy, on registration U20.03, flight number ORCA03D, were involved in a loss-of-separation event. The incident occurred when the AIRBUS was on its final approach to Adolfo Suárez Madrid-Barajas Airport, at 5 NM from runway 32 L, and the CESSNA had just taken off from runway 22 at Torrejón Air Base (LETO), en route to Palma de Mallorca (Balearic Islands).

The two aircraft subsequently continued their respective flights without further incident.

The investigation has determined that the loss of separation occurred as a result of a failure to adhere to the authorised departure procedures (SID NANDO 3H) by the crew of the military aircraft.

1. FACTUAL INFORMATION

1.1. History of the flight

At 11:03:31 h on 13 July 2022, there was a loss of separation between an AIRBUS A-330-343X, on registration C-GHLM, call sign ACA824, and a CESSNA CITATION 550 military aircraft, on registration U20.03, flight number ORCA03D. The AIRBUS A-330-343X had departed from Toronto Airport - CYYZ (Canada) and was 5 NM from the head of runway 32 L on approach to Madrid-Barajas Airport. The CESSNA CITATION 550 had just taken off from runway 22 at Torrejón Air Base (LETO), bound for Palma de Mallorca - LEPA (Balearic Islands).

At their closest point, the aircraft were separated by 400 ft vertically and 0.6 NM horizontally.

Between 10:10:00 h and 10:42:23 h, while the ORCA03D military aircraft was taxiing, the GND LETO military ground control unit and the LEMDEDN civil take-off sector at the Torrejón Control Centre coordinated with each other, agreeing that it would depart following the NANDO3H standard procedure. At the same time, the LEMDEDN sector also coordinated with the civil final approach sector, LEMDAPN, to free-up the approach path to runway 32 R at Madrid Barajas Airport - LEMD.

When ORCA03D was at the holding point for runway 22, the GCA LETO military approach controller instructed the LCL LETO local military controller in charge of the take-off clearance to transfer the flight directly to the LEMDEDN sector. LCL LETO then coordinated with the LEMDEDN sector, which cleared the aircraft to depart within 4 minutes. While this last communication was taking place, GCA LETO changed its initial instruction to LCL LETO, indicating that it should transfer the flight to GCA LETO and that LCL LETO should request the departure approval from the LEMDEDN sector. However, this instruction was not acknowledged by LCL LETO.

GCA LETO then coordinated with the LEMDEDN sector to arrange the departure procedure, which would be on a heading of 80° with an initial climb to 8,000 ft.

Once ORCA03D was airborne, LCL LETO transferred the aircraft to the LEMDEDN controller on 131.175 MHz. This controller noticed that it was prolonging its left-hand turn with a higher than published speed and redirected it to climb to flight level FL 160 on a heading of 80°, but the crew did not acknowledge the altitude. Shortly afterwards, the Cessna aircraft took a different course to the one assigned to it and crossed the approach path of runway 32 R. This put it on a collision course with the AIRBUS A-330-343X with call sign ACA824, which was approaching on the runway 32 L localiser.

This aircraft had been transferred to the 118.155 MHz frequency used by the local controller for runway 32 L in the Madrid-Barajas control tower at 11:02:49 h when it was at 8 NM in the LEMDAPN final approach sector.

The two aircraft subsequently continued their respective flights without further incident.

1.2. Injuries to persons

Injuries	Crew		Passengers		Total in the aircraft		Others	
	AIRBUS	CESSNA	AIRBUS	CESSNA	AIRBUS	CESSNA		
Fatal	0	0	0	0	0	0	0	0
Serious	0	0	0	0	0	0	0	0
Minor	0	0	0	0	0	0	0	0
Unharmmed	8	3	248	7	256	10	0	0
TOTAL	8	3	248	7	256	10	0	0

1.3. Damage to the aircraft

Neither aircraft suffered damages

1.4. Other damage

N/A

1.5. Information about the personnel**1.5.1. Crew of the AIRBUS A – 330– 343X aircraft**

The crew consisted of three pilots.

The captain was 49 years old and had an ATPL(A) commercial airline transport pilot licence issued on 5 October 1998, with an AIRBUS A - 330 rating.

He had 17,639 h of flight experience, of which 146 h were in type as captain, 8,980 h as an AIRBUS A-319/320/321 captain, 4,031 h as an AIRBUS A-319/320/321 co-pilot, 1,178 h as a McDONELL DOUGLAS DC9 co-pilot (all working for AIR CANADA) and a further 3,304 h as the pilot of various single-engine aircraft.

The second pilot was also 49 years old and had an ATPL(A) licence issued on 4 January 2016, with an AIRBUS A - 330 rating. He had 19,000 h of flight experience, of which 400 h were in type.

The third pilot was 51 years old and had an ATPL(A) licence issued on 13 April 2015, with an AIRBUS A - 330 rating. He had 13,500 h of flight experience, of which 930 h were in type.

All had valid licenses and Class 1 medical certificates.

1.5.2. Crew of the CESSNA CITATION 550 aircraft

The two pilots had the relevant aptitude and instrument ratings, all of which were in force.

The captain's licence was first issued in April 2016. He had 1,480 h of flight experience, of which 1,120 h were in type.

The co-pilot's license was first issued in June 2021. He had 480 h of flight experience, of which 240 h were in type.

Both had passed the periodic Class 1 medical examination.

1.5.3. Civil air traffic controllers

The executive controller of the LEMDEDN sector was 57 years old and had an air traffic controller license issued by AESA on 16 April 1999.

He held the required ratings for the role and had been stationed at Madrid ACC since 22 May 2002.

The LEMDEDN sector planner controller was 61 years old and had a community air traffic controller licence issued by AESA on 30 June 1995.

He held the required ratings for role and had been stationed at Madrid ACC since 16 December 1999.

The local controller for runway 32 L at TWR LEMD was 54 years old and had a community air traffic controller license issued by AESA on 22 April 2003.

He held the required ratings for the role and had been stationed at the Madrid-Barajas control tower since 28 January 2010. All three had their respective licences, ratings and medical examinations in force.

1.5.4. Military air traffic controllers

The GND LETO, LCL LETO, and GCA LETO controllers all had a military controller certificate of aptitude issued by the Ministry of Defence and the necessary ratings for the duties they were performing. Their licences, ratings and medical examinations were in force.

1.6. Aircraft information

1.6.1. AIRBUS A-330-343X aircraft

The AIRBUS A-330-343X aircraft was built in 2001, with serial number 0419. It measures 22.18 m long, has a wingspan of 60.3 m and stands 17.3 m tall. It's powered by two ROLLS ROYCE RR TRENT 772B-60 engines.

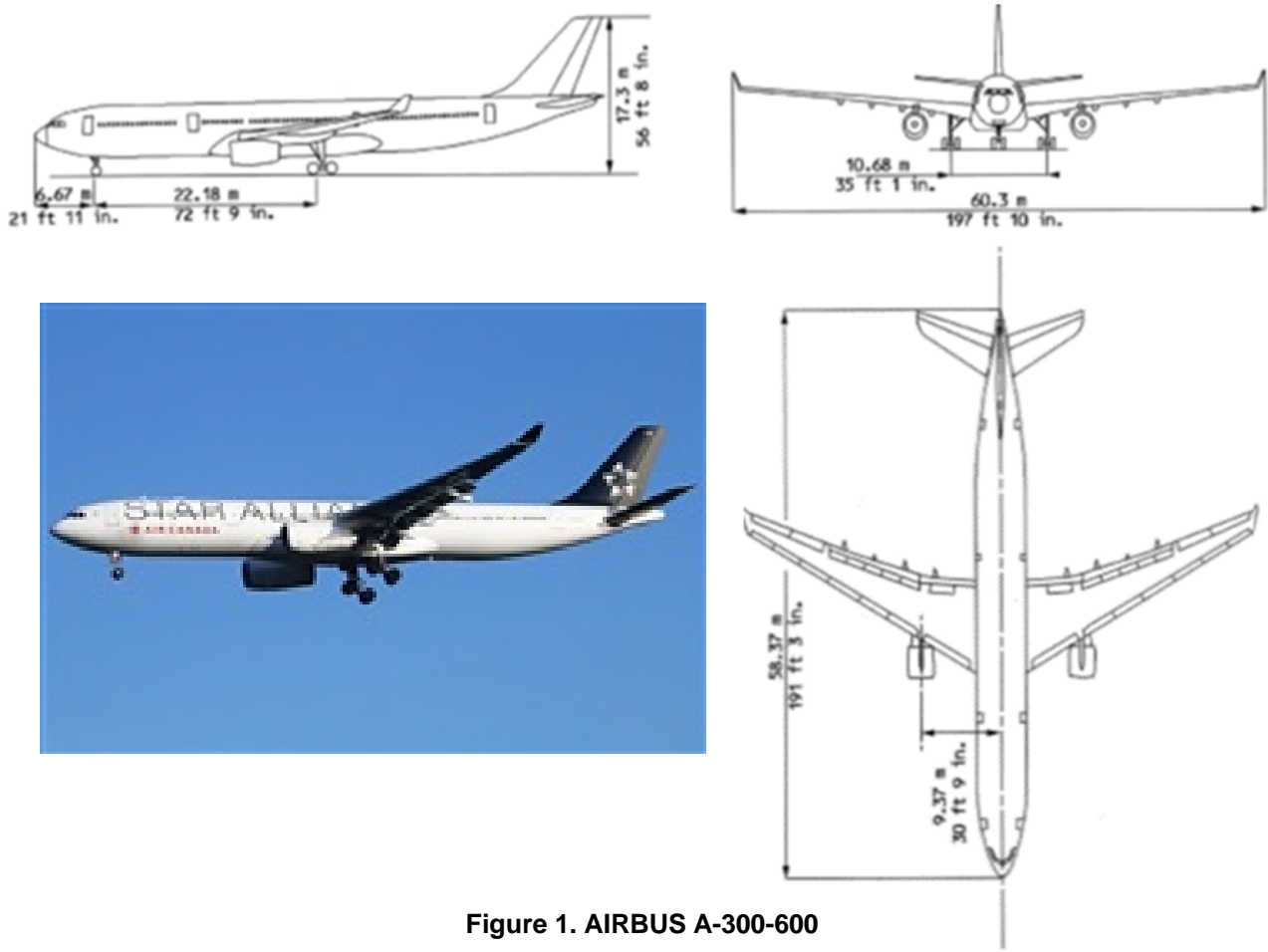


Figure 1. AIRBUS A-300-600

At the time of the event, the aircraft had a cumulative flight time record of 87,075:59 h (14,076 cycles), the left engine had operated for 80,431:56 h (13,316 cycles) and the right for 18,322:37 h (4,086 cycles). It had a valid certificate of airworthiness

1.6.2. CESSNA 550 CITATION II aircraft

The CESSNA 550 CITATION II aircraft is a pressurised low-wing twin-engined aircraft with a metal airframe and fuselage prepared for two pilots, with eight seats in total. It is FAR-25 certified as a VFR and IFR transport.

It has two PRATT & WHITNEY JT15D-4 turbofan engines mounted at the rear of the fuselage, each providing 2,500 lb of thrust.

It has a wingspan of 15.76 m, a length of 14.40 m and a height of 4.51 m. Its maximum speed is 262 kt, and its maximum range is 2,326 km.

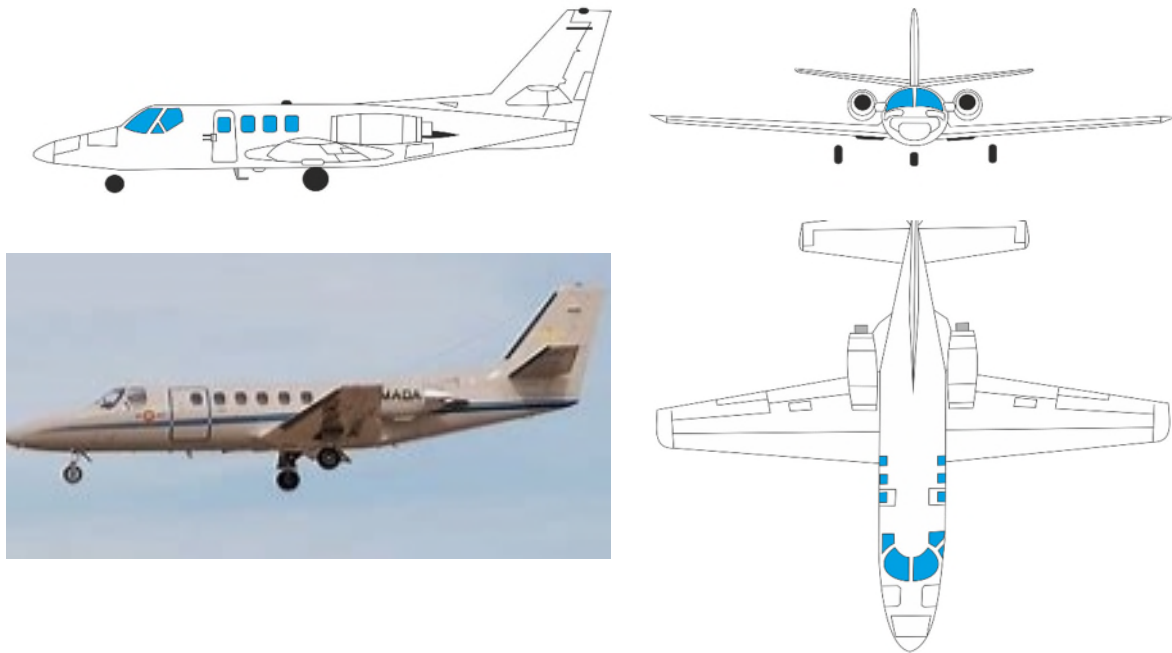


Figure 2. CESSNA 550 CITATION II

The aircraft involved in the incident was built in 1998 and had a cumulative flight time record of 11,167 h. The left engine, serial number 71.166, had 8,537:30 operating hours, and the right engine, serial number 71.227, had 10,242:42 operating hours.

1.7. Meteorological information

Not relevant to the investigation

1.8. Aids to navigation

The sequence that ended with a loss of separation between the two aircraft was captured by RADAR¹ as follows:

At 11:02:18 h, the CESSNA CITATION 550 aircraft with registration number U20.03 and call sign ORCA03D was climbing through 2,500 ft after taking off from the Torrejón - LETO Air Base. At that time, the AIRBUS A-330-343X aircraft with call sign ACA824 was on the runway 32 L localiser (LOC) and descending through 4,100 ft.

At 11:02:31 h, ORCA03D was on the runway heading at 2,500 ft, and ACA824 was at 4,000 ft.

At 11:02:49 h, ORCA03D was continuing on the runway heading, climbing through 2,600 ft and close to crossing the LOC localiser for runway 32 R. ACA824 was on the LOC localiser for runway 32 L, maintaining 4,000 ft.

At 11:03:00 h, ORCA03D was continuing its climb through 3,000 ft and turning left over the LOC localiser for runway 32 R, and ACA824 was on the LOC localiser for runway 32 L, maintaining 4,000 ft at 6 NM from runway 32 L.

At 11:03:07 h, ORCA03D was continuing its climb through 3,300 ft, turning to its left and positioned between the localisers for runways 32 R and 32 L, while the ACA824 aircraft was on the localiser for runway 32 L, descending through 3,900 ft. At that moment, the horizontal distance between the two was 3.2 NM with a vertical separation of 600 ft.

¹ The RADAR information is provided for reference only; the QAR offers more accurate data.

At 11:03:16 h, ORCA03D was continuing its climb through 3,500 ft, turning to its left over the localiser for runway 32 L, and ACA824 was on the localiser for runway 32 L, descending through 3,700 ft. The horizontal distance between the two was 2.3 NM with a vertical separation of 200 ft, and they were on converging courses.

At 11:03:22 h, ORCA03D was continuing its climb through 3,600 ft between the two localisers, and ACA824 was descending through 3,600 ft on the localiser for runway 32 L. The two aircraft were separated by 1.4 NM horizontally, with no vertical separation.

At 11:03:31 h, ORCA03D was continuing its climb through 3,800 ft between the two localisers, and ACA824 was descending through 3,400 ft on the localiser for runway 32, with a separation between them of 0.6 NM horizontally and 400 ft vertically.

From that moment on, the separation between them began to increase, and by 11:03:34 h, as ORCA03D continued to climb through 4,000 ft and ACA824 continued to descend through 3,300 ft on the localiser for runway 32 L, the horizontal distance between them remained the same, i.e. 0.6 NM, but the vertical separation had increased to 700 ft.

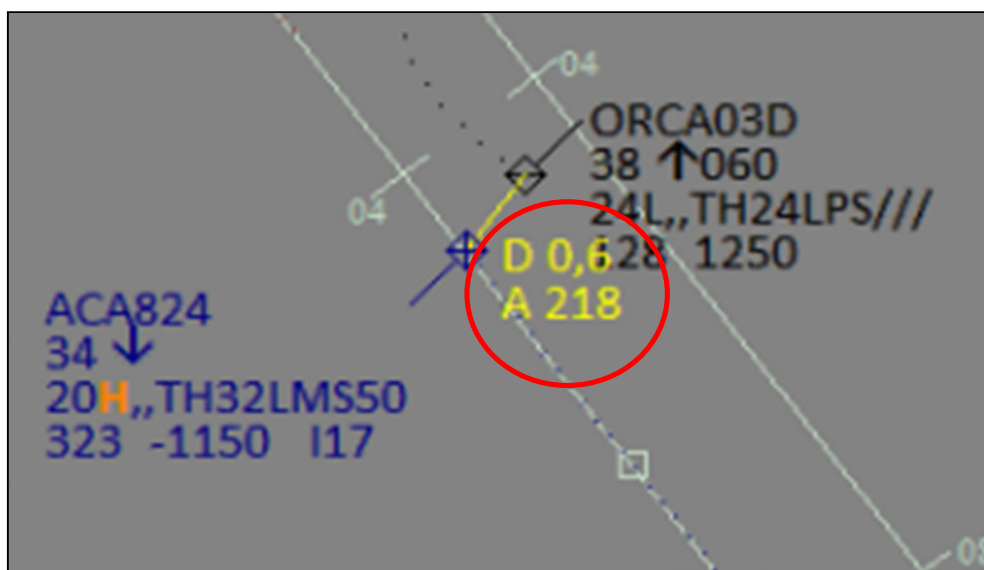


Figure 3. Position of the aircraft at 11:03:31 h

1.9. Communications

The most relevant communications related to the event are summarised below:

The initial communication between the CESSNA CITATION 550 with call sign ORCA03D and the military ground controller in the Torrejón tower, GND LETO, took place at 10:39:11 h. The crew requested clearance for start-up, which the controller granted, indicating QNH 1,023, the weather conditions and runway 22 in service. The crew acknowledged the information.

At 10:40:00 h, there was a telephone conversation between the civil controller of the LEMDEDN departure/approach sector and GND LETO, in which they agreed that both the ORCA03D aircraft and another aircraft not involved in the incident with the call sign DUNA95 would take off from LETO on runway 22 and follow the NANDO3H departure procedure.

At 10:42:23 h, the two controllers spoke again by telephone, and the LEMDEDN sector controller confirmed to the GND LETO controller that they were going to create space on the approach to LEMD runway 32 L so that the two aircraft could take off from LETO and follow the agreed departure route. Subsequently, the controllers agreed that when they were at 6,000 ft, the aircraft would switch to the 131.75 MHz frequency to communicate with the LEMDEDN sector.

At 10:46:54 h, ORCA03D was cleared to carry out the NANDO3H departure, climbing to 6,000 ft and switching to 131.75 MHz once airborne. The instruction was read back correctly.

At 10:50:54 h, there was a handover of the LEMDEDN control position.

At 10:57:06 h, the civil controller of the LEMDAPN final approach sector cleared the crew of the AIRBUS A-330-343X aircraft with the call sign ACA824 to maintain its course for runway 32 L, and the crew acknowledged the clearance.

At 10:58:09 h, the crew of ACA824 reported that they were on a heading of 080° and asked if they should maintain it. Control instructed them to set a heading of 070°. The instruction was read back correctly.

At 10:58:15 h, there was a handover of the LEMDAPN executive controller position.

At 10:58:53 h, the DUNA95 aircraft took off from runway 22 at LETO following the NANDO3H standard departure procedure.

At 10:59:00 h, there was a handover of the LEMDAPN sector control position.

At 10:59:21 h, the LCL LETO local controller coordinated the departure of ORCA03D from runway 22 with GCA LETO by telephone, with the latter indicating that the aircraft would be transferred directly to the LEMDEDN sector as its departure did not affect the LCL LETO control area. Right in the middle of their conversation, the crew of the ORCA03D aircraft requested permission to take off, and the LCL LETO controller replied that the clearance would have to be given by approach, not by him. LCL LETO then coordinated with the LEMDEDN sector to request clearance for the aircraft to depart, and it was cleared to take off within the following 4 minutes. While this last communication was taking place, GCA LETO amended the initial coordination with TWR LETO, stating that it would be transferring it to them and that GCA LETO would request the departure clearance from the LEMDEDN sector. There was no acknowledgement from TWR LETO. Finally, GCA LETO coordinated with LEMDEDN to arrange the departure procedure, which would be on a heading of 080° with an initial climb to 8,000 ft.

LCL LETO then cleared the crew of ORCA03D aircraft to enter runway 22 and take off. The crew acknowledged the clearance correctly.

At 11:00:10 h, the LEMDAPN controller instructed the crew of ACA824 to turn north and cleared them to make the ILS Z approach to runway 32 L, receiving the correct acknowledgement.

At 11:02:13 h the TWR LETO controller transferred ORCA03D to the LEMDEDN sector frequency and the crew acknowledged the transfer.

At 11:02:32 h, the crew of the ORCA03D aircraft contacted the LEMDEDN sector controller, who informed them that they had been assigned the NANDO3H departure. The LEMDEDN controller confirmed that they had radar contact and cleared them to climb to FL 160. The ORCA03D crew asked them to repeat the instruction. The LEMDEDN controller instructed them to turn to their left on a heading of 080° but did not repeat the instruction to climb.

At 11:02:49 h, the LEMDAPN controller asked the crew of the ACA824 aircraft to switch to the TWR LEMD LCL32L frequency, 118.155 MHz. Only the first digit of the frequency can be heard in the acknowledgement, with the remainder being audible on the frequency to which they had transferred, i.e. the crew changed frequency before completing the read-back.

At 11:02:55 h, the crew of the ACA824 aircraft finished the read-back of the previous instruction and the local controller of runway 32 L, TWR LEMD LCL 32L, instructed them to continue their approach and gave them information about the preceding traffic on the runway.

At 11:03:08 h, there was an internal coordination call between the LEMDEDN controller and the LEMDAPN sector controller, in which the former stated that he did not know what ORCA03D was doing and suggested that the crew of ACA824 should be instructed to climb to prevent the two aircraft getting any closer. The LEMDAPN sector controller replied that the ACA824 aircraft was already on the tower frequency, TWR LEMD.

At 11:03:16 h, the crew of the ACA824 aircraft informed the local controller of runway 32 L, TWR LEMD LCL32L, that they had the other traffic in sight, referring to the ORCA03D aircraft, and the controller copied the communication.

At 11:03:34 h, the crew of the ORCA03D aircraft called the LEMDEDN sector to confirm the course they had been instructed to fly and were once again instructed to turn to 080° and to climb to flight level FL 160. The crew of the ORCA03D aircraft acknowledged the instruction correctly.

At 11:04:00 h, there was an internal coordination call in which the LEMDEDN controller called TWR LETO to ask what had happened with the ORCA03D aircraft. TWR LETO asked if the aircraft was on their frequency and the LEMDEDN controller replied that it had crossed the runway 32 R localiser. TWR LETO said that it had been pilot error and asked if they had called the crew of the ORCA03D aircraft after take-off. The LEMDEDN controller did not reply, as he was coordinating with another sector at the same time.

At 11:04:05 h, the TWR LEMD LCL32L controller cleared the ACA824 aircraft to land on runway 32 L, receiving the correct acknowledgement from the crew.

At 11:04:29 h, the LEMDEDN controller cleared the ORCA3D crew to climb to flight level FL 160, receiving no response from the crew.

At 11:05:12 h, the LEMDEDN controller contacted the ORCA03D crew to ask them why they had gone towards the localisers, and they replied that they had turned at mile 1 but that the aircraft has a wide turn angle. The LEMDEDN controller told them they had come very close to the ACA824 aircraft and that they would be filing a report. He finally cleared them to proceed to the NANDO waypoint, receiving the correct acknowledgement from the crew.

At 11:05:16 h, the controller told the ORCA03D crew that they should have turned to their left on a heading of 60° just after departure, but instead, they had headed towards the runway 32 L localiser. They replied that they had started turning at 1 NM, but the aircraft had a much wider turning radius than anticipated.

At 11:06:00 h, the TWR LEMD LCL32L controller instructed the crew of aircraft ACA824 to clear the runway to their left, and the crew asked if they had a conflict with a traffic on short final. The TWR LEMD LCL32L controller replied that he didn't know but that the supervisor was seeking information. The crew of aircraft ACA824 replied that they had received a TCAS RA warning at approximately 3,000 ft.

At 11:06:24 h, the LEMDEDN controller transferred the ORCA03D aircraft to the 124.23 MHz frequency and gave them a 030° heading, receiving the appropriate acknowledgement.

1.10. Information about the aerodrome

1.10.1. Adolfo Suárez Madrid-Barajas Airport.

Adolfo Suárez Madrid-Barajas Airport (LEMD) is located 13 km northeast of the city and is designated as a category 4E² airport by ICAO. Its reference point coordinates are 40° 28' 20" N - 03° 33' 39" W, and its elevation is 609 m (1,998 ft).

It has four two-by-two parallel runways, designated 18R/36L, 18L/36R, 14R/32L and 14L/32R. When the airport operates in the north configuration, the runways designated as 36 are used for take-offs, and those designated 32 are used for landings. When operating in the south configuration, the runways designated as 14 are used for take-offs, and those designated 18 are used for landings.

Runway 32 L, which is where the AIRBUS A-330-343X aircraft landed, measures 3,988 m x 60 m. The coordinates for its threshold (THR), which lies at an altitude of 589.1 m (1,933 ft) and is displaced by 928 m are 40° 27' 47,10" N - 03° 33' 14,02" W. The touchdown zone (TDZ) is at an altitude of 587.7 m (1,928 ft).

² The number 4 indicates a minimum reference field length of 1,800 m, while the letter E indicates that aircraft must have a wingspan of between 52 m and 65 m, and a maximum outer main landing gear wheel span of between 9 m and 14 m, in order to use the airport.

According to ENAIRE’s AIP (Aeronautical Information Publication), this runway has an available landing distance (LDA) of 3,000 m, the clearway (CLWY) is 222 m long, and the length of the stopway (STPWW) is not provided. The runway strip measures 4,108 m x 300 m and the runway safety area (RESA) measures 240 m x 150 m. Figure 3 shows the profile of runway 32R / 14L.

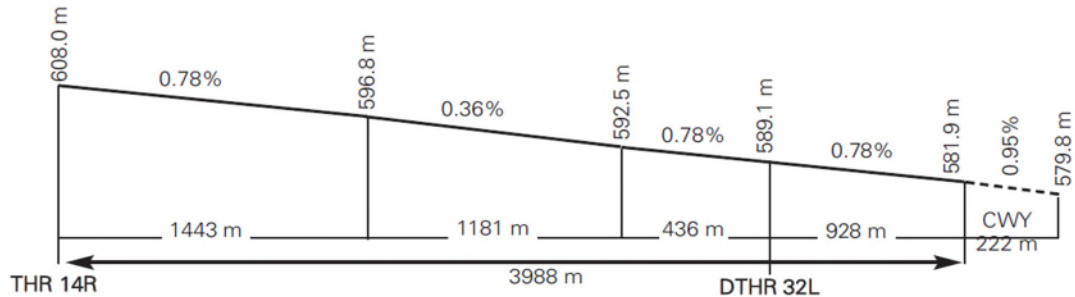


Figure 4. Profile of runway 32L / 14R

1.10.2. Torrejón Air Base

Torrejón air base (LETO) is located 2 km east of the city. Its reference point coordinates are 40° 29' 48" N - 03° 26' 45" W, and its elevation is 618 m (2,026 ft).

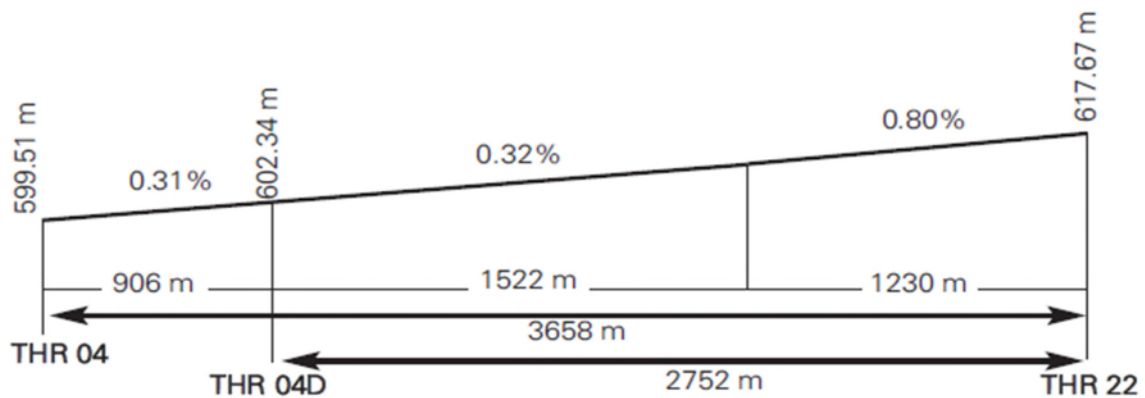


Figure 5. Profile of runway 04 / 22

It’s an alternative technical aerodrome to Adolfo Suárez Madrid-Barajas Airport that can be used by civil aircraft on IFR and VFR flights with a Letter of Agreement from the Base Headquarters. It has three runways designated 04 / 22 and 04 D.

Runway 04 / 22 measures 3,658 m x 60 m. The coordinates for its threshold (THR) and touchdown zone (TDZ), which lie at an altitude of 599.5 m (1,967 ft), are 40° 29' 05,18" N - 03° 27' 38,52" W. The runway strip measures 4,338 m x 150 m and the runway safety area (RESA) measures 240 m x 150 m.

1.11. Flight recorders

By the time the CIAIAC became aware of the event and opened an investigation, it was no longer possible to recover the recorders of either aircraft because more than twenty days had passed (20).

However, a copy of the AIRBUS A-330-343X aircraft’s Quick Access Recorder (QAR) was available, and this provided the information that, together with the RADAR data, made it possible to establish the relative positions of both aircraft and the most relevant parameters during the event.

The TCAS TA warning sounded on the AIRBUS at 11:03:07 h when the aircraft was flying at an altitude of 3,485 ft with a ground speed of 195.9 kt.

Twelve (12) seconds later, the TCAS RA warning sounded for fifteen seconds, during which time the instruction it received was "DON'T CLIMB".

During that time, the aircraft's altitude varied from 3,253 ft to 3,038 ft, and its ground speed decreased from 196.1 kt to 194.4 kt.



Figure 6. Trajectories of the two aircraft

1.12. Aircraft wreckage and impact information

N/A

1.13 Medical and pathological information

We have found no evidence to suggest that the flight crew on board either aircraft were affected by any physiological or disabling factors.

1.14. Fire

No fire broke out.

1.15. Survival aspects

N/A

1.16. Tests and research

1.16.1. Investigation carried out by ENAIRE

ENAIRE conducted an internal investigation into the event, which concluded with the following findings:

The ORCA03D aircraft failed to comply with the take-off procedure for runway 22 at LETO, crossing the runway localiser for runway 32 R at LEMD and coming into conflict with the ACA824 aircraft that was on final approach to runway 32 L at LEMD, which received a TCAS RA warning as a result of the encounter with the military traffic.

The LETO TWR controller had coordinated with the EDN sector controller (DEN+ENN) to arrange the take-off of two military traffics, one of which (call sign DUNA95 (BE20)) was not involved in the event and the take-off of aircraft ORCA03D from runway 22 at LETO.

The LETO TWR controller informed the EDN sector controller that the two military traffics would follow the SID NANDO3H. The EDN sector controller then authorised the NANDO3H departure procedure and subsequent climb to 6,000 ft for the two traffics that took off from runway 22 at LETO.

On this basis, the EDN Sector controller notified the APN sector controller (integrated sectors AIN+AFN) of the take-off of the first military traffic behind the traffic approaching runway 32 R at LEMD.

Before the take-off of the DUNA95 aircraft, the GCA Torrejón controller called the EDN sector controller to indicate that the traffic on take-off would remain under their control in order to separate it from other traffic with the aim of transferring it on a heading of 80° for 8,000 ft. The DUNA95 aircraft eventually took off from runway 22, turned left after take-off and reported on the EDN sector frequency that it was carrying out the SID NANDO3H departure.

There is no record of any coordination between the LETO TWR controller and the GCA controller.

The same happened with the take-off of the ORCA03D aircraft; the GCA controller informed the EDN sector controller that the traffic on take-off would remain under their control and that it would be transferred on a heading of 80° for 8,000 ft.

The military traffic did not proceed in accordance with this last coordination. Instead, it took off from runway 22 at LETO following the NANDO3H departure and called the EDN sector controller. This time, however, the ORCA03D military traffic did not turn as per the assigned instrument departure nor as coordinated with GCA, but continued on the runway heading beyond 1 NM DME from VJZ, crossing the runway 32 R localiser believing that there was no traffic on approach because control had created a gap as a precautionary measure. This action caused it to violate the regulatory minimum separation with the ACA824 aircraft on final to runway 32 L and already on the LEMD TWR LCL 32 L frequency, which received a TCAS resolution notice as a result of the encounter with the ORCA03D aircraft.

When the crew of the ORCA03D aircraft was asked about what had happened, they replied that the “aircraft has a much wider turn radius than they expected”.

ENAIRE drafted its report without obtaining information from the military and, therefore, without having access to the communications between the LETO TWR and GCA Torrejón controllers or the

instructions that the military traffic finally received. Despite this, it concluded that the military traffic failed to comply with both the SID NANDO3H departure coordinated with the LETO TWR controller and the left turn at 80° coordinated with the GCA controller, both of which would have prevented the aircraft from coming into conflict with the operations on runway 32 L at LEMD.

According to the AIP Spain Supplement 19/22, published due to the decommissioning of the DVOR/DME BRA, the LETO runway 22 NANDO3H instrument departure was unavailable.

It's clear from the facts that neither the LETO TWR unit nor the Madrid TMA were aware of this circumstance at the time of the incident. However, given that the DUNA95 aircraft took off under the same conditions as the ORCA03D aircraft and correctly made the left turn established by the instrument departure, this does not appear to have influenced the incident.

We cannot be sure that the event would not have happened if the SID NANDO3H departure had not been authorised.

It should be noted that on 14 July 2022, the TMA Operations Manager issued an informative note to all Madrid TMA controllers reminding them of the LETO manoeuvres affected by the decommissioning of the DVOR/DME BRA.

ENAIRE issued the following two recommendations to the Air Navigation Service as a result of its internal investigation report:

1. Coordinate with the Air Force to implement measures that could prevent any repetition of events such as those described in this report. E.g., modifying the LECM-LETO LoA to designate a single person responsible for coordinating which departure procedure military aircraft use, analysing the feasibility of establishing LETO runway 04 as the priority runway for take-offs, or seeking, through design, ways to limit the turning radius of departures from LETO runway 22.
2. Review and update the LEMD and LETO manoeuvre compatibility document.

1.16.2. Analysis of the incident by the Spanish Air and Space Force

For its part, the Torrejón Air Base, which belongs to the Air and Space Force, carried out an analysis of the incident in which it verified the following facts:

- At 10:43 h, LETO TWR tower coordinated with Madrid DES (Madrid departures) to arrange the take-off of aircraft ORCA03D from runway 22 using the NANDO3H standard instrument departure up to 6,000 ft.
- At 10:59 h, the ORCA03D aircraft was at the holding point for LETO runway 22, and its crew reported that they were ready for take-off. LETO TWR authorised them to take off if they could do so within the following 4 minutes.
- When the ORCA03D aircraft had taken off, the LETO TWR unit transferred it to Madrid DES on the 131.175 MHz frequency.
- When the LETO TWR unit saw that the ORCA03D aircraft wasn't turning left as per the coordinated departure, i.e. NANDO3H, they called the crew twice but didn't get a response because the aircraft's radio had already been switched to the MAD DESP ESTE frequency.
- The ORCA03D aircraft did not comply with the instructions received and continued climbing on the LETO runway 22 heading, passing the LEMD runway 32 R localiser and finally turning left towards the heading of the aircraft approaching LEMD runway 32 L.
- There were no limiting meteorological conditions at any point during the incident.

The analysis concluded that certain factors could have influenced the event, as listed below:

- In the communications with the crew of the ORCA03D aircraft, its Commander repeatedly stressed the presence of an authority on board, requesting that the LETO TWR Controller review the clearances received. Despite this, the controller maintained the instructions previously given and explained the reason for them to the Commander.
- This type of operation is carried out regularly between the control units involved, with one such example having taken place with complete normality moments before the event in question.
- Furthermore, many of the take-off operations from the Torrejón Base can influence operations at Madrid-Barajas Airport, so coordination between the two aerodromes is commonplace, and adequate training in this regard is provided to the controllers.
- The crew's failure to comply with the instructions given, therefore, could have occurred because they were overly focused on having an authority on board, and this may have caused the incident.

1.17 Organisational and management information

1.17.1. Management by the Madrid-Barajas Airport control tower.

ENAIRE has a specific procedure for the management of the control tower at Madrid-Barajas Airport.

The procedure explains that in the 'cab' there is one Supervisor position, two (2) for Clearances (CLD-E and CLD-W), four (4) for ground control (GMC-CS, GMC-CN, GMC-EN and GMC-ES) and another four (4) for Local control (LCL-14L/32R, LCL-14R/32L, LCL-18L/36R, LCL-18R/36L).

The procedure clearly establishes the functions of the controllers stationed at the Clearance (CLD), Runway (GMC) and Local (LCL) positions.

The default location of each of these control positions in the control tower cab is shown in figure 7 below:

It also provides guidelines for carrying out handovers properly to ensure that the controller taking control of a particular traffic is fully aware of its position. Specifically, it states that they should follow the checklists included in one of the annexes, which contain a series of fields specifying the tasks to be checked by the controllers at each handover. Orally completing the checklist is mandatory for both the incoming and outgoing controller at every handover.

The procedure also devotes a section to measures that prevent runway incursions and excursions³ and, in this regard, gives concise recommendations to improve the safety of runway operations in accordance with ICAO Document 9870.

³ A runway incursion is any occurrence at an aerodrome involving the improper presence of an aircraft, vehicle or person in the protected area of a surface designated for the landing or take-off of aircraft.

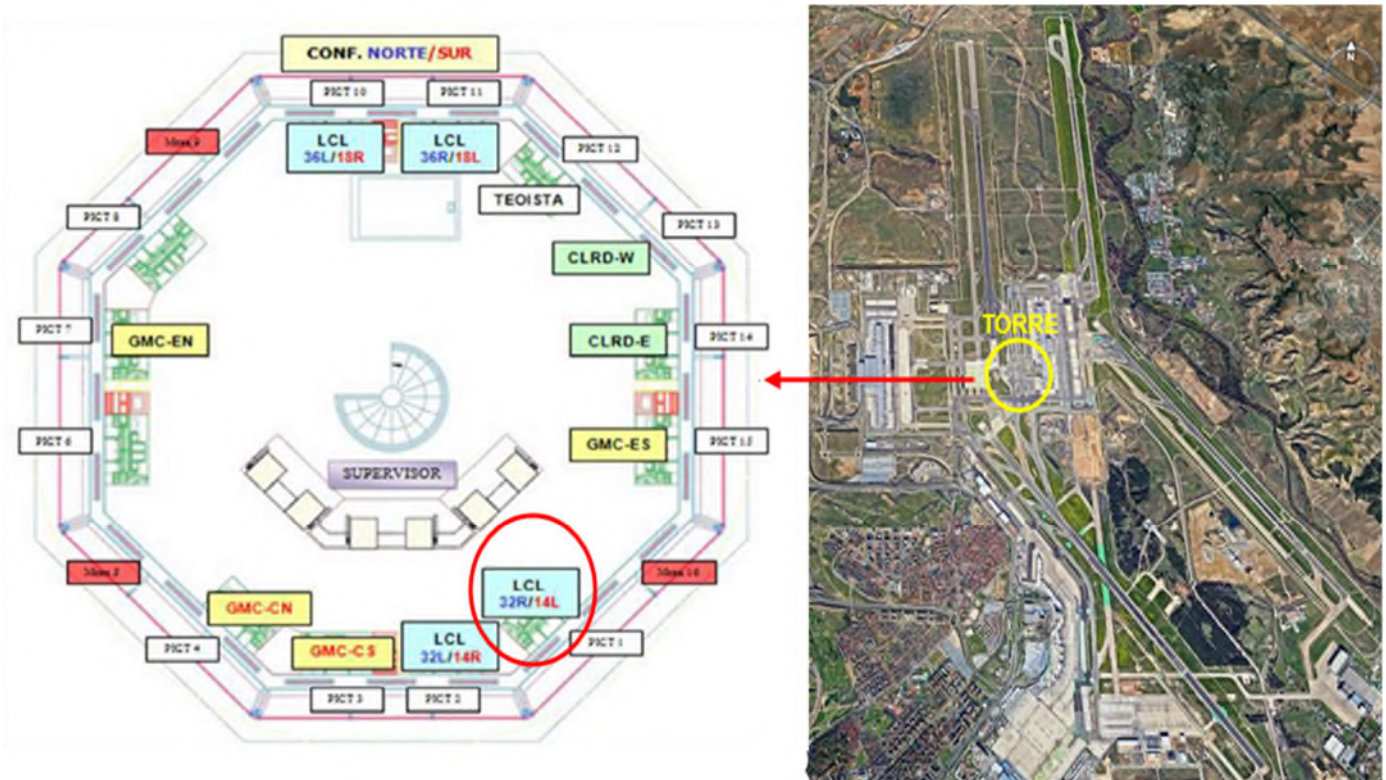


Figure 7. Positions in the Madrid-Barajas Airport control tower cab

These recommendations are directly related to communications, aircraft operations on the runway and crossing and occupying the runway.

The Madrid-Barajas Airport Tower Operating Manual (TWR LEMD) states that “landing clearance will be issued when the sensitive areas of the ILS are clear before the approaching aircraft is 2 NM from the touchdown zone. If this is not possible, instructions shall be given to execute a missed approach manoeuvre”.

1.17.2. Letter of agreement between the LECM-LETO control units

A Letter of Agreement between ENAIRE and the Torrejón Air Base has been in force since 20 June 2019. It defines the coordination procedures to be applied between Madrid ACC and Torrejón TWR/APP/GCA when providing Air Traffic Services to General Air Traffic (GAT) and Operational Air Traffic (OAT), these procedures being considered supplementary to those specified by ICAO, EC Regulations, the Operational Air Traffic Regulations and AIP-Spain.

The letter defines the lateral and vertical limits of the control units involved (Madrid ACC and Torrejón TWR/APP/GCA) and covers the different aspects of coordination between them, which are set out in eight (8) annexes.

The relevant annexes and information from some of the sections are detailed below:

Annexe A: Definitions and abbreviations

General Air Circulation/General Air Traffic (GAC/GAT): Flights conducted according to the rules and procedures established by the Spanish Civil Aviation Authority and operating according to the Air Traffic Regulations.

Annexe B: Area of common interest

In section B.3.1 it establishes the *delegation of Madrid ACC to Torrejón APP* with 5 sectors:

Annexe C: Exchange of information in flight

Annexe D: Coordination procedures

Section D.3.2 Flights from Torrejón TWR/APP/GCA to Madrid ACC specifies that:

LETO TWR:

LETO TWR will request ATC clearance from Madrid ACC for its ETD⁴ or CTOT⁵, as appropriate.

Madrid ACC shall provide LETO TWR with departure clearance for each aircraft or formation of aircraft with FPL GAC/IFR.

LETO TWR will inform Madrid ACC by direct voice circuit (hotline) when the aircraft initiates its “take-off run”, this being the actual take-off time that both control units will record.

LETO APP/GCA:

- o LEMD in North Configuration:

Runway in service 22: With prior authorisation from Madrid ACC, aircraft with a GAC/IFR flight plan may take off under the control of Torrejón APP in specific cases. Torrejón APP will be able to release traffic within the delegated airspace (EAD), coordinating the transfer point and level with Madrid ACC.

Annexe E: Transfer of control and communications

Annexe F: Coordination procedures based on the RADAR

Annexe G: Supplementary procedures

Annexe H: Track changes sheet.

1.17.3. Information on the organisation of the airspace around LEMD and LETO.

Five control units were involved in the event. Three were civilian (LEMDDDEN, LEMDAFN and TWR LEMD), and two were military (LETO GCA and TWR LETO).

The LEMDDDEN sector is a departure/approach sector (APP) and the sector in charge of coordinating with LETO.

After coordinating with both LETO TWR tower and LETO GCA approach (ground-controlled approach), the agreed coordination must be communicated to the LEMDAFN arrivals sector, which is in charge of aircraft arriving at the runway 32 R and 32 L LOC localisers and is, therefore, the sector affected by departures from LETO when LETO runway 22 is in service.

⁴ ETD: Estimated time of departure

⁵ CTOT: Calculated take off time, subject to regulation

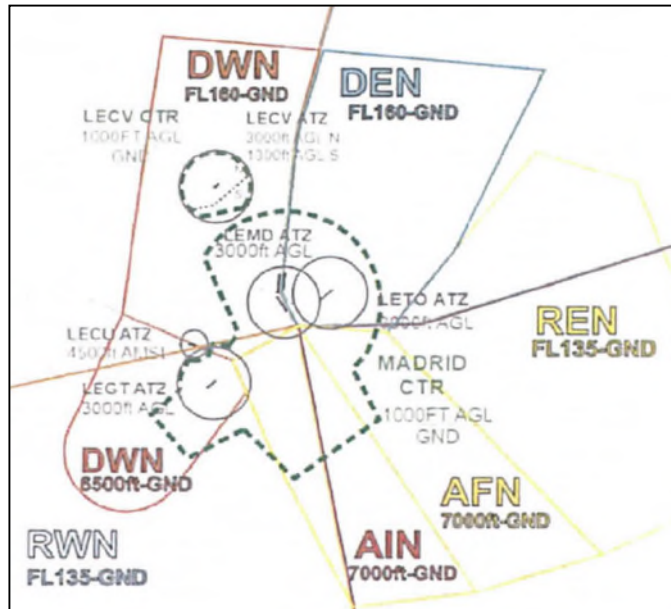


Figure 8. LEMDDEN and LEMDAFN sectors

The AIP Spain, AD2-LETO SID 2.3, indicated that the standard departures from Madrid-Torrejón runway 22, including NANDO3H, were not usable under SUP 19/22.

Supplement 19/22, which entered into force on 24 February 2022, reported the temporary decommissioning of the BRA DVOR/DME, indicating on page 2 that the NANDO3H standard departure from Madrid-Torrejón, among others, was not available.

➔ **SALIDA NANDO TRES HOTEL (NANDO3H)**
 Subir directo hasta alcanzar 2400 ft QNH. Virar a la izquierda antes de 1.0 DME VTZ (IAS MAX en viraje para aeronaves CAT A 110 kt, CAT B 145 kt, CAT C 180 kt, CAT D 205 kt y CAT E 255 kt) para seguir R-112 BRA directo a cruzar ELVIR a o por encima de 5000 ft. Virar a la derecha para seguir R-115 BRA directo a cruzar NANDO a o por encima de 10000 ft.
 Pendiente mínima de ascenso 5.25% hasta 5000 ft.

Figure 9. Extract of the chart showing the SID NANDO3H

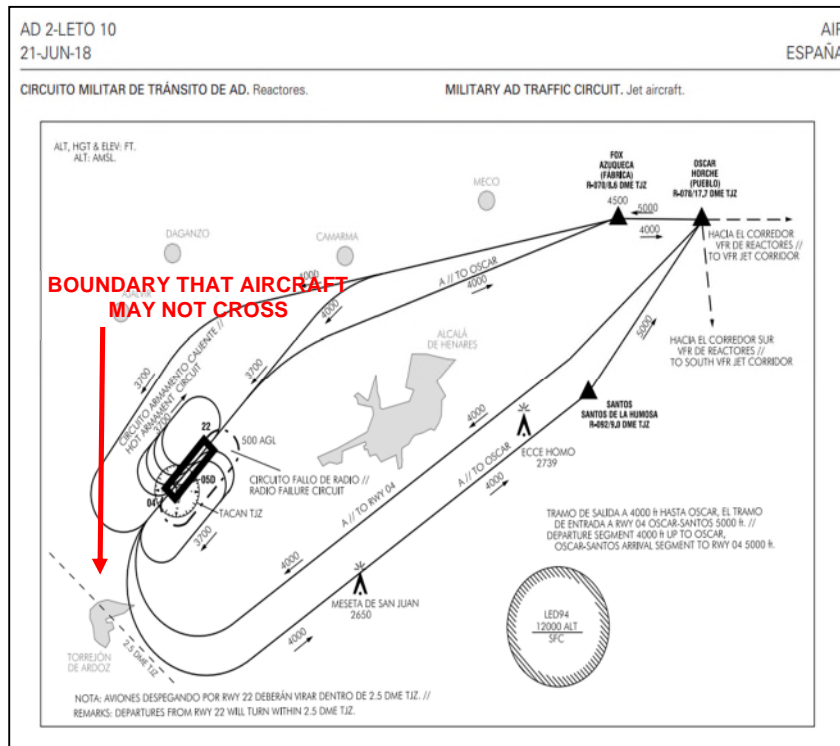


Figure 10. Extract of the AIP LETO traffic pattern chart

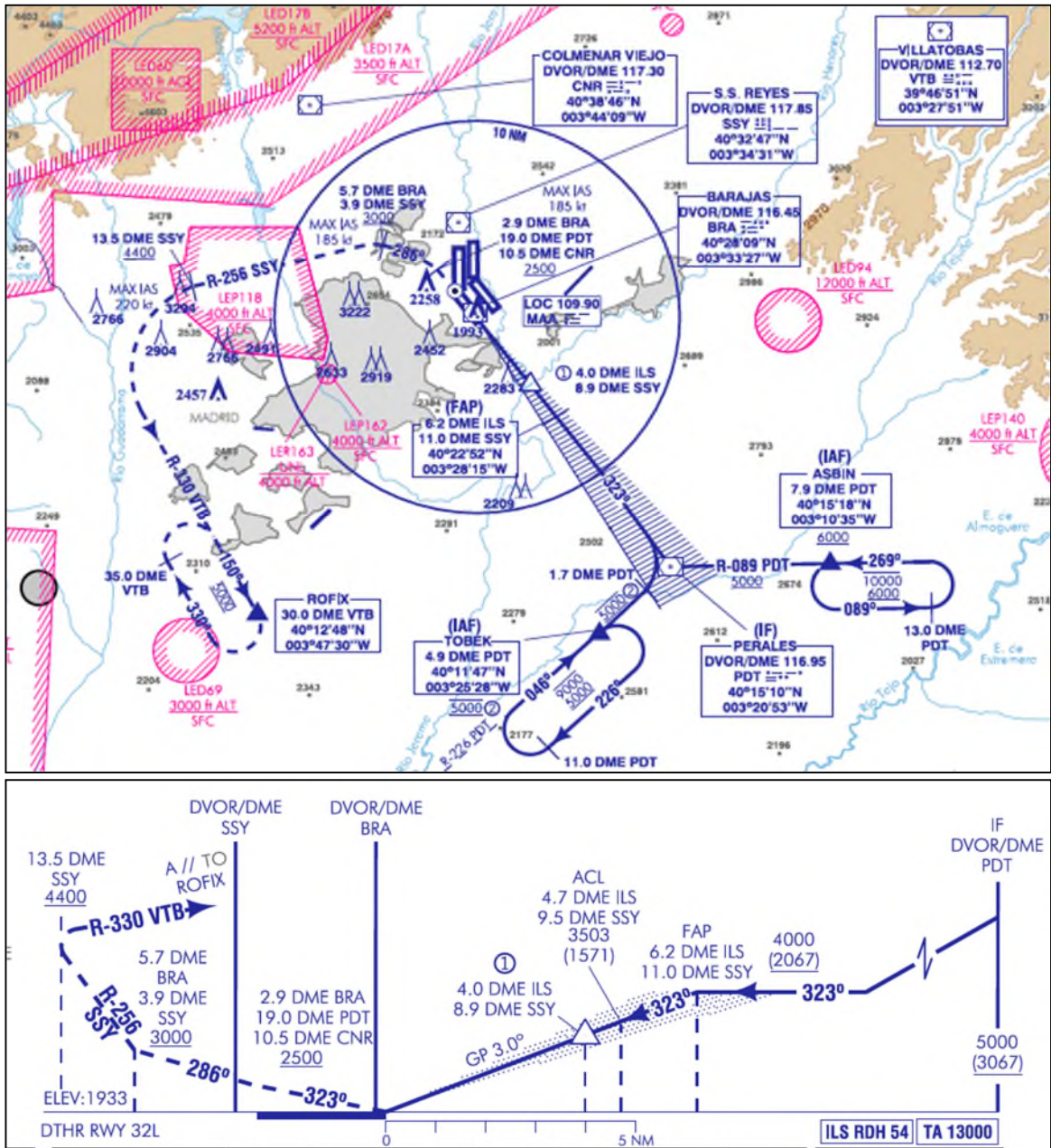


Figure 11. Extract of the ILS Z RWY 32L approach chart showing LETO

1.18. Additional information

N/A

1.19. Special investigation techniques

N/A

2. ANALYSIS

The fact that five control units were involved, two of them civilian (TWR LEMD and Madrid ACC with 2 sectors: LEMDAPN and LEMDEDN) and three military (LETO GCA, TLCL LETO and GND LETO) necessitates an analysis of the coordination between them.

On two occasions, the military LETO GCA controller coordinated with the civilian LEMDEDN controller to indicate that the two military aircraft would remain under their control in order to separate them from civilian traffic.

The crews of the two military aircraft were given the same instructions, i.e. to perform the NANDO3H departure and then to take a heading of 80° and climb to 8,000 ft.

The crew of the first military aircraft (not involved in the incident) proceeded as instructed, was transferred to GCA LETO and turned before reaching mile 2.5 DME of the TJZ VOR.

By contrast, the crew of the second aircraft did not follow these instructions and continued on the take-off heading, first crossing the runway 32 R localiser and then coming close to crossing the runway 32 L approach path, resulting in the loss of separation with the ACA824 aircraft positioned on the runway 32 L localiser.

At 11:02:32 h, the crew of the ORCA03D aircraft contacted the LEMDEDN controller to say that they had been assigned the NANDO3H departure, and the controller authorised them to climb to flight level FL 160. The crew requested that the instruction be repeated, but the LEMDEDN controller did not repeat the climb clearance, instructing them instead to turn to their left on a heading of 80° without requiring them to do so immediately and without traffic information.

This was probably the critical moment because everything seems to indicate that the ORCA03D crew not assimilating the take-off instructions they had given and failing to make the assigned turn.

For the DUNA95 aircraft (not involved in the incident), the LEMDEDN controller transmitted the coordination with the military LETO GCA controller to the LEMDAPN controller. However, as this did not happen for the ORCA03D aircraft, the LEMDAPN controller in charge of approaches probably wasn't aware of the existence of the ORCA03D aircraft before the incident occurred.

Another relevant issue is that the ORCA3D aircraft was transferred directly by the LCL LETO tower controller to the LEMDEDN controller without the GCA LETO controller providing information on the heading and altitude previously agreed with the LEMDEDN controller.

This was the second critical moment; the lack of coordination between GCA LETO and LCL LETO led to the ORCA03D crew failing to follow the procedure that GCA LETO and LEMDEDN had agreed on, ultimately resulting in the loss of separation.

Both military units coordinated with LEMDEDN: LCL LETO to arrange that the ORCA3D aircraft would perform the SID NANDO3H, and GCA LETO to indicate that it would keep control of the aircraft and transfer it on a 080 heading and 8,000 ft. When GCA LETO called LCL LETO to coordinate the departure of the ORCA3D aircraft, their coordination was ineffective.

The ORDA03D crew continued on their take-off heading, did not follow the NANDO3H departure and did not turn to a heading of 80° as instructed by the LEMDEDN controller, who neglected to immediately provide the traffic information that would have helped the ORCA03D crew increase their situational awareness.

At 11:02:49 h, the LEMDAPN controller transferred the ACA824 aircraft to the tower local controller for runway 32 L, TWR LEMD LCL 32L.

At 11:03:07 h, the LEMDEDN controller called the LEMDAPN controller to say that he did not know what ORCA03D was doing and suggested that ACA824 be instructed to climb to prevent the two aircraft from getting any closer. LEMDAPN replied that the ACA824 aircraft was already in contact with the Madrid-Barajas tower controller.

At this point, the ORCA03D aircraft was climbing through 3,300 ft and turning to its left between the localisers for the two runways (32 R and 32 L) while the ACA824 aircraft was positioned on the localiser for runway 32 L, descending through 3,900 ft.

At 11:03:16 h, aircraft ACA824 reported to the LEMD LCL TWR controller for 32 L that it had traffic in sight, referring to the ORCA03D aircraft, with the distance between them being 2.3 NM and 200 ft on converging headings.

In the moments that followed, the ORCA03D aircraft continued to turn to its left, encroaching on the 32 R and 32 L runway localisers and decreasing the distance between the two aircraft both vertically and horizontally.

At 11:03:22, the distance between the aircraft was 1.4 NM horizontally, and they were at the same level. By 11:03:31, the distance had reduced to 0.6 NM horizontally and 400 ft vertically, this being the point of least separation.

At 11:03:34 h, after the loss of separation had occurred, the crew of the ORCA03D aircraft called the LEMDEDN controller to confirm the course they had been instructed to fly and were once again instructed to immediately turn to 80° and climb to flight level FL 160.

Subsequently, the LEMDEDN controller called the LCL LETO tower controller to ask what had happened with the ORCA03D aircraft. TWR LETO replied by asking if the aircraft was on their frequency and the LEMDEDN controller stated that it had crossed the runway 32 R localiser.

The LCL LETO tower controller replied that it had been pilot error.

At 11:04:29 h, the LEMDEDN controller cleared the crew of the ORCA3D aircraft to climb to flight level FL 160 but did not receive a response.

Almost one (1) minute later, at 11:05:12 h, the LEMDEDN controller contacted the ORCA03D crew to ask them why they had prolonged their initial heading to the point of crossing the localisers for both runways, and they replied that they had turned at 1 NM but that the aircraft's turn radius was quite wide.

The respective internal investigations by ENAIRE and the Spanish Air and Space Force agreed that the loss of separation occurred because the crew of the ORCA03D military aircraft failed to comply with the instructions issued by the control services.

3. CONCLUSIONS

3.1. Findings

- At 10:40:00 h, the LEMDEDN and GND LETO controllers coordinated the NANDO3H departure for the two military aircraft that were to take off from runway 22 at LETO.
- At 10:46:54 h, ORCA03D was cleared for the NANDO3H departure and instructed to switch to 131.75 MHz when they reached 6,000 ft. The instruction was read back correctly.
- At 10:57:06 h, the LEMDAPN controller cleared the ACA824 aircraft to maintain its course towards runway 32 L, and the clearance was acknowledged by the crew.
- At 11:00:10 h, the LEMDAPN controller instructed the crew of ACA824 to turn north and cleared them to make the ILS Z approach to runway 32 L, receiving the correct acknowledgement.
- At 11:02:13 h, the LCL LETO controller instructed the crew of ORCA03D to contact Madrid Control on frequency 131.175 MHz, and the crew acknowledged the instruction.
- At 11:02:49 h, the LEMDAPN controller asked the crew of the ACA824 aircraft to switch to the TWR LEMD 32L frequency, 118.155 MHz
- At 11:03:16 h, the crew of the ACA824 aircraft informed the local controller of runway 32 L, TWR LEMD LCL32L, that they had the other traffic in sight, referring to the ORCA03D aircraft, and the controller copied the communication. The horizontal distance between the two was 2.3 NM with a vertical separation of 200 ft, and they were on converging courses.
- At 11:03:31 h, the aircraft were at their point of least separation, with the distance between them being 0.6 NM and 400 ft.
- At 11:03:34 h, the crew of the ORCA03D aircraft called the LEMDEDN controller to confirm the course they had been instructed to fly and were once again instructed to immediately turn to 80° and climb to flight level FL 160. The crew of the ORCA03D aircraft acknowledged the instruction correctly.

3.2. Causes/contributing factors

The investigation has determined that the loss of separation occurred as a result of a failure to adhere to the authorised departure procedures (SID NANDO 3H) by the crew of the military aircraft.

4. RECOMMENDATIONS

None.