

Technical report

IN-049/2019

Incident involving two Boeing 737-8AS aircraft, registrations
EI-ENH and EI-DYR, on 11 September 2019 at Málaga
Airport



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 object of the investigation, its probable causes and its consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with Articles 5.5 of Regulation (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, 4 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 detailed 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.

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



CONTENTS

Notice	ii
CONTENTS.....	iii
Table of illustrations	v
Abbreviations.....	vi
Technical Report IN-049/2019	8
Synopsis.....	8
1. FACTUAL INFORMATION.....	9
1.1. Description of the event.....	9
1.2. Injuries to persons.....	10
1.2.1. Aircraft EI-ENH.....	10
1.2.2. Aircraft EI-DYR.....	10
1.3. Damage to the aircraft.....	10
1.4. Other damage	10
1.5. Personnel information	10
1.5.1. Information about the crew of the EI-ENH aircraft.....	10
1.5.2. Information about the crew of the EI-DYR aircraft.....	11
1.5.3. General information about the LCL position air traffic controller	11
1.5.4. General information about the air traffic controller in the ground movement position 12	
1.6. Aircraft information	12
1.6.1. General information about the EI-ENH aircraft.....	12
1.6.2. General information about the EI-DYR aircraft.....	13
1.7. Meteorological information	13
1.8. Aids to navigation.....	13
1.8.1. Information extracted from the SACTA system	13
1.9. Communications	17
1.10. Aerodrome information	19
1.10.1. General information about Málaga-Costa del Sol Airport.....	19
1.10.2. Information about the control tower at Málaga-Costa del Sol Airport	21
1.10.3. Information on runway use configurations at Málaga-Costa del Sol airport	21
1.11. Flight recorders.....	22
1.11.1. Data recorder in the EI-ENH Aircraft	22
1.11.2. Data recorder in the EI-DYR Aircraft	23
1.12. Aircraft wreckage and impact information	24
1.13. Medical and pathological information	24
1.14. Fire	24
1.15. Survival aspects	24
1.16. Tests and research.....	25
1.16.1. Information provided by crews.....	25
1.17. Organisational and management information.....	25
1.17.1. LEMG operating manual - single-runway operations	25
1.17.2. LEMG operating manual - north holding bay use (runway head 13)	27
1.17.3. LEMG operating manual - holding bay management.....	27
1.17.4. Capacity control procedure at LEMG.....	27
1.18. Additional information	31

1.18.1.	Similar events at Málaga-Costa del Sol Airport.....	31
1.18.2.	Contributing factors detected by ENAIRE	33
1.18.3.	Corrective measures applied by ENAIRE	33
1.18.4.	Air Traffic Regulation provisions regarding the separation of aircraft using the same runway	35
1.18.5.	ICAO runway incursion prevention manual.....	35
1.18.6.	Recommendations and best practices to mitigate possible inadequate separations between instrument or visual departures and missed approaches	36
1.19.	Useful or effective investigation techniques	36
2.	ANALYSIS	37
2.1.	Analysis of the meteorological conditions	37
2.2.	Operational analysis.....	37
2.2.1.	Analysis of the taxi.....	37
2.2.2.	Analysis of the line-up and take-off	39
2.2.3.	Analysis of the landing.....	41
2.2.4.	Analysis of the minimum separation between aircraft	42
2.3.	Analysis of the capacity.....	43
2.4.	Analysis of the repetitiveness of loss-of-separation events at Málaga-Costa del Sol Airport.....	45
3.	CONCLUSIONS.....	47
3.1.	Findings	47
3.2.	Causes/contributing factors	47
4.	OPERATIONAL SAFETY RECOMMENDATIONS	48

Table of illustrations

Illustration 1 Dimensions of the B737-800 aircraft	12
Illustration 2 Position of aircraft RYR75JV at 19:50:22 UTC	14
Illustration 3 Position of aircraft at 19:51:17 UTC	14
Illustration 4 Position of aircraft at 19:52:27 UTC, RYR75JV (right) and RYR9UD (left)	14
Illustration 5 Position of aircraft at 19:52:58 UTC	15
Illustration 6 Position of aircraft at 19:53:29 UTC	15
Illustration 7 Position of aircraft at 19:53:59 UTC	15
Illustration 8 Position of aircraft at 19:54:03 UTC	16
Illustration 9 Position of aircraft at 19:54:08 UTC	16
Illustration 10 Position of aircraft at 19:54:11 UTC	16
Illustration 11 Position of aircraft at 19:54:15 UTC	17
Illustration 12 Position of aircraft at 19:54:35 UTC	17
Illustration 13 Position of aircraft RYR75JV at 19:49:19 UTC	18
Illustration 14 Position of aircraft RYR75JV at 19:49:49 UTC	18
Illustration 15 Diagram RWY 13/31	20
Illustration 16 Access taxiways to the head of runway 13	20
Illustration 17 Distribution of positions in the LEMG control tower	21
Illustration 18 Aircraft trajectories at the moment of touchdown	42

Abbreviations

°	Sexagesimal degree
°C	Degrees Celsius
A/C	Aircraft
ACP	Area control procedural rating
ACS	Area control surveillance rating
ADI	Aerodrome control instrument rating
ADV	Aerodrome control visual rating
AENA	Spanish Airports and Air Navigation
AESA	Spain's National Aviation Safety Agency
AIP	Aeronautical Information Publication
AIR	Aerodrome control endorsement
AMSL	Above mean sea level
APP	Approach control procedural rating
APS	Approach control surveillance rating
ATC	Air traffic control
ATPL	Airline transport pilot license
ATPL (A)	Airline transport pilot license (aircraft)
ATS	Air traffic service
CEANITA	Commission for the study and analysis of air traffic incident notifications
CIAIAC	Civil Aviation Accident and Incident Investigation Commission
CLD	Departure clearance message
CPL	Commercial pilot license
CPL(A)	Commercial pilot license (aircraft)
CVR	Cockpit voice recorder
EDDH	ICAO code for Hamburg Airport
EGGP	ICAO code for Liverpool Airport
FDR	Flight data recorder
ft	Feet
GMC	Ground movement control endorsement
GMS	Ground movement surveillance endorsement
GND	Ground control
GS	Ground speed
h	Hours
hPa	Hectopascals
IAA	Irish Aviation Authority
IFR	Instrumental flight rules
km	Kilometres

kt	Knots
LCL	Local air traffic control position
LEMG	ICAO code for Málaga Airport - Costa del Sol
m	Metres
METAR	Aviation routine weather report
MHz	Megahertz
NM	Nautical mile
ICAO	International Civil Aviation Organisation
QAR	Quick access recorder
QNH	Atmospheric pressure adjusted to mean sea level in the airport area
RAD	Aerodrome radar control endorsement
RWY	Runway
s	Seconds
SACTA	Automated air traffic control system
SNS	Event notification system
t	time
TCL	Terminal control endorsement
TMA	Traffic management area
TWR	Aerodrome control tower or aerodrome control
UTC	Coordinated universal time

Technical Report IN-049/2019

	AIRCRAFT 1	AIRCRAFT 2
Operator:	Ryanair	Ryanair
Aircraft:	Boeing 737-8AS registration EI-ENH (Ireland)	Boeing 737-8AS registration EI-DYR (Ireland)
Persons on board:	196, unharmed	185, unharmed
Type of flight:	Commercial air transport - Scheduled - International - With passengers	Commercial air transport - Scheduled - International - With passengers
Phase of flight	Take-off, take-off run	Landing, flare for landing
Flight rules	IFR	IFR
Date and time of incident:	11 September 2019, 19:50 UTC ¹	
Site of incident:	Málaga Airport-Costa del Sol (LEMG)	
Date of approval:	24 th November 2021	

Synopsis

Summary of the investigation:

On 11 September 2019, the Boeing 737-8AS aircraft with registration EI-ENH was flying with callsign RYR75JV, from Málaga Airport-Costa del Sol (LEMG) to Liverpool (EGGP), United Kingdom. At the same time, the Boeing 737-8AS aircraft with registration EI-DYR was flying with callsign RYR9UD, from Hamburg Airport (EDDH), Germany, to Málaga Airport-Costa del Sol (LEMG).

Both aircraft were in radio contact with the Local Control Position (LCL) at the LEMG control tower. The air traffic controller instructed the RYR75JV aircraft to enter via the head of runway 13 for take-off and then instructed the RYR9UD aircraft to continue its approach to runway 13 and wait for the late landing clearance.

At around 19:50 UTC, as the RYR75JV aircraft began its rotation on take-off run from runway 13, the RYR9UD aircraft flew over the head of runway 13 to land, with both aircraft occupying the runway area simultaneously.

There were no injuries, and neither aircraft sustained any damage.

¹ All times used in this report are UTC. Local time can be calculated by adding 2 hours to UTC

The investigation has determined that the incident occurred because an aircraft was given clearance to land on a runway that was occupied by another aircraft in the process of taking off, without respecting the regulatory distances.

Deficient planning by the air traffic controller, who took advantage of a gap between two landings to authorise a take-off, is considered a contributing factor in the incident.

Furthermore, given the immediate danger posed by the loss of regulatory separation, the absence of decision-making (to cancel the take-off, for example) by the air traffic controller is also deemed to have been a factor.

As a result of repeated incidents involving a loss of separation at Málaga-Costa del Sol Airport (LEMG), the CIAIAC decided to approve and issue two urgent safety recommendations before concluding the investigation and prior to the approval and publication of the final report: one addressed to ENAIRE, and the other to AESA.

1. FACTUAL INFORMATION

1.1. Description of the event

At 19:50 UTC on 11 September 2019, an incident occurred due to a loss of separation between two aircraft on runway 13 at Málaga-Costa del Sol Airport. One aircraft was on the take-off run, and the other was on short final.

The first aircraft was a Boeing 737-8AS, registration EI-ENH, flying with the callsign RYR75JV from Málaga-Costa del Sol Airport (LEMG). The second aircraft was a Boeing 737-8AS, registration EI-DYR, flying with the callsign RYR9UD, bound for Málaga-Costa del Sol Airport (LEMG).

Málaga-Costa del Sol Airport was using the preferential single-runway configuration, with take-offs and landings via the head of runway 13. Aircraft RYR75JV notified the control tower that it was ready for departure while taxiing to holding point HN-3 on runway 13. The air traffic controller at the LCL position instructed it to hold short of the runway. Aircraft RYR9UD then informed the air traffic controller that it was established at the locator for runway 13, and the controller instructed it to continue its approach.

Subsequently, the air traffic controller at the LCL position instructed aircraft RYR75JV to line up and hold on runway 13. Nineteen seconds after this communication, the LCL controller at TWR LEMG cleared the aircraft to take off immediately from runway 13.

Once aircraft RYR75JV was on the take-off run, the TWR LEMG LCL controller cleared aircraft RYR9UD to land with the departing traffic in view.

The sequence of events outlined above led to a loss of separation and, given that both aircraft were on the runway at the same time, a runway incursion.

No damage occurred as a result of the incident.

1.2. Injuries to persons

1.2.1. Aircraft EI-ENH

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				
Unharmmed	6	190	196	
TOTAL	6	190	196	

1.2.2. Aircraft EI-DYR

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious				
Minor				
Unharmmed	6	179	185	
TOTAL	6	179	185	

1.3. Damage to the aircraft

Neither aircraft sustained damage.

1.4. Other damage

There was no other damage

1.5. Personnel information

This section outlines the most relevant information about the crew of both aircraft and the personnel involved at the different control tower positions.

1.5.1. Information about the crew of the EI-ENH aircraft

The 38-year-old commander had an airline transport pilot license ATPL(A), issued by the Irish Aviation Authority (IAA) on 04/12/2014, with the B737 300-900 type rating valid until 30/04/2020.

He also had a class 1 medical certificate, valid until 11/04/2020.

He had a total flight experience of 7,430 hours, of which 7,242 hours were in the type of aircraft involved in the incident.

The 30-year-old co-pilot had an airline transport pilot license ATPL(A), issued by the Irish Aviation Authority (IAA) on 18/09/2017, with the B737 300-900 type rating valid until 31/03/2020.

He also had a class 1 medical certificate, valid until 25/08/2020.

He had a total flight experience of 1650 hours, of which 1450 hours were in the type of aircraft involved in the incident.

1.5.2. Information about the crew of the EI-DYR aircraft

The 32-year-old commander had an airline transport pilot license ATPL(A), issued by the Irish Aviation Authority (IAA) on 15/05/2015, with the B737 300-900 type rating valid until 31/03/2020.

He also had a class 1 medical certificate, valid until 25/11/2019.

He had a total flight experience of 7218 hours, of which 6842 hours were in the type of aircraft involved in the incident.

The 29-year-old co-pilot had an airline transport pilot license ATPL(A), issued by the Irish Aviation Authority (IAA) on 18/07/2019, with the B737 300-900 type rating valid until 30/06/2020.

He also had a class 1 medical certificate, valid until 07/01/2020.

He had a total flight experience of 1983 hours, of which 150 hours were in the type of aircraft involved in the incident.

1.5.3. General information about the LCL position air traffic controller

The 40-year-old local position air traffic controller (LCL) had an air traffic controller license issued by Spain's National Aviation Safety Agency (AESA) on 18/08/2008, with the following ratings: ADV, ADI (with the endorsements: AIR, GMC, TWR, GMS, RAD), APP, APS (with the TCL endorsement), ACP and ACS (with the TCL endorsement). For the unit, the controller had the ADI rating with TWR and RAD endorsements valid until 23/06/2020, and the APS rating valid until 23/03/2020.

He had a medical certificate valid until 16/01/2020.

He had a total of 11 years of experience in air traffic control. He passed the training for the TWR LEMG unit in June 2014.

The controller's activity on the day of the event was as follows:

Start time (hh:mm)	Activity time (hh:mm)	Accumulated activity time (hh:mm)	Position
13:00	00:10	00:10	Integrated (CLD, GND)
13:10	02:20	02:30	Local (TWR)
15:30	03:11	05:41	Integrated (CLD, GND)
18:41	01:17	06:58	Local (TWR)

1.5.4. General information about the air traffic controller in the ground movement position

The 47-year-old ground movement controller (GMC) had an air traffic controller license issued by Spain's National Aviation Safety Agency (AESA) on 31/01/2008.

He had a medical certificate valid until 18/09/2020.

He had a total of 11 years of experience in air traffic control. He passed the training for the TWR LEMG unit in July 2013.

1.6. Aircraft information

1.6.1. General information about the EI-ENH aircraft

The BOEING 737-8AS aircraft with registration EI-ENH and serial number 35033 was manufactured in 2010. It was equipped with two CFMI CFM56-7B26 engines.

It has a certificate of airworthiness issued by the Irish Aviation Authority and an airworthiness review certificate valid until 25 October 2019. On the day of the incident, the aircraft had flown a total of 28,631 flight hours and 14,394 cycles.

The aircraft had been maintained according to its approved maintenance programme, and it underwent its most recent Type A overhaul on 28 May 2019, when the aircraft had 27,527 hours and 13,857 flight cycles.

The aircraft has a wingspan of 35.8 metres, making it a category C aircraft according to ICAO's airport reference code set out in Chapter 1 of Annex 14. The airport reference code is used to determine the operations of a specific airport complex.

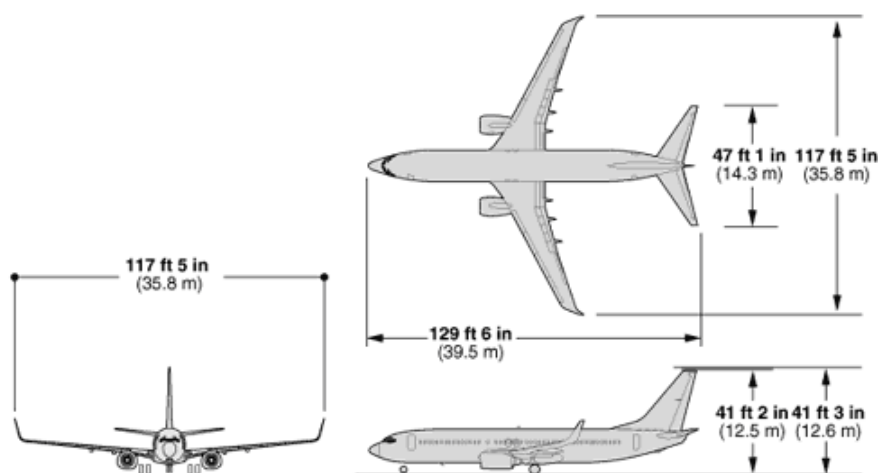


Illustration 1 Dimensions of the B737-800 aircraft

1.6.2. General information about the EI-DYR aircraft

The BOEING 737-8AS aircraft with registration EI-DYR and serial number 37513 was manufactured in 2008. It was equipped with two CFMI CFM56-7B26 engines.

It has a certificate of airworthiness issued by the Irish Aviation Authority and an airworthiness review certificate valid until 04 December 2019. On the day of the incident, the aircraft had flown a total of 35880 flight hours and 20152 cycles.

The aircraft had been maintained according to its approved maintenance programme, and it underwent its most recent Type A overhaul on 27 June 2019, when the aircraft had 35144 hours and 19745 flight cycles.

The aircraft has a wingspan of 35.8 metres, making it a category C aircraft according to ICAO's airport reference code set out in Chapter 1 of Annexe 14. The airport reference code is used to determine the operations of a specific airport complex.

1.7. Meteorological information

The METAR for Málaga-Costa del Sol Airport (LEMG) at the time of the incident was as follows:

METAR LEMG 112000Z 10007KT 9999 FEW085 23/13 Q1018 NOSIG

Wind direction 100°, speed 7 kt. Visibility of 10 km or more and scattered clouds at 8,500 ft. Temperature 23°C, dew point 13°C and QNH 1,018 hPa. No significant changes in climatic phenomena expected.

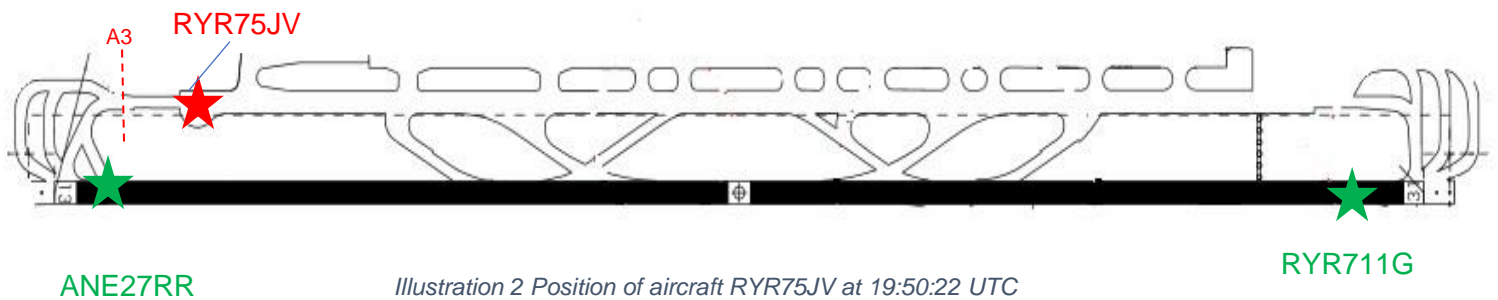
On the day of the incident and in the Málaga-Costa del Sol region, sunset was at 18:34 UTC. Therefore, at the time of the incident, at approximately 19:50 UTC (1 hour and 16 minutes after sunset), it was dark.

1.8. Aids to navigation

The Málaga control unit has a SACTA system (Automated Air Traffic Control System) for processing flight data and radar coverage in the area where the aircraft were flying. The data extracted from the flight recorders has also been incorporated to add specificity to the information collected from the SACTA system. The most significant data relative to the aircraft involved in the incident is included below.

1.8.1. Information extracted from the SACTA system

At 19:50:22 UTC, the trace shows two aircraft not involved in the incident: aircraft RYR711G is on its take-off run, and aircraft ANE27RR is lined up on RWY 13. The second aircraft in the departure sequence was the RYR75JV aircraft, which was taxiing on taxiway A but had not reached the A3 intermediate holding point.



At 19:51:17 UTC, the trace shows aircraft RYR2HW, which was not involved in the incident, on short final at 1.3 NM from the end of RWY 13, and aircraft RYR9UD as the second aircraft in the approach sequence, 7.5 NM from the threshold of RWY 13.

At that moment, the trace shows aircraft RYR75JV taxiing to holding point HN-3 for RWY 13, having already passed the A3 intermediate holding point.

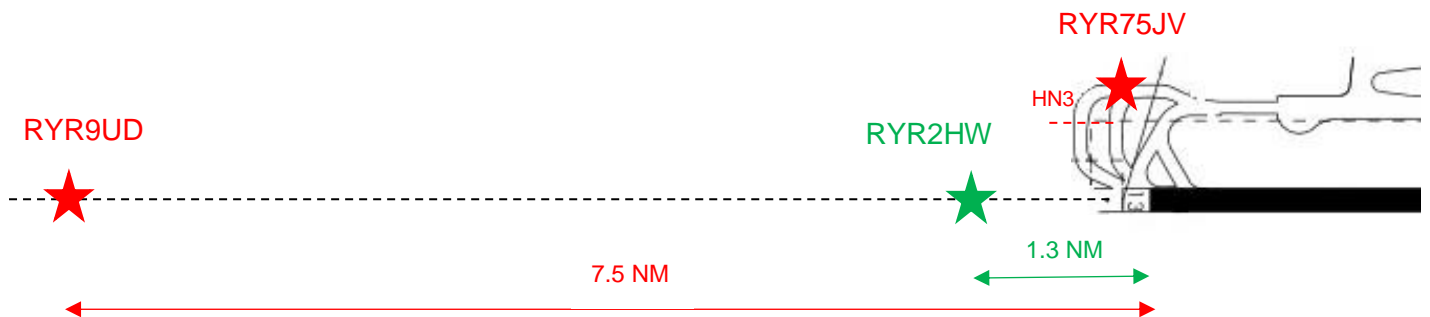


Illustration 3 Position of aircraft at 19:51:17 UTC

At 19:52:27 UTC, the trace shows aircraft RYR9UD established on final at 3.9 NM from the threshold of RWY13 with a ground speed of 168 kt. At that moment, the RYR75JV aircraft was at the HN-3 holding point signal.

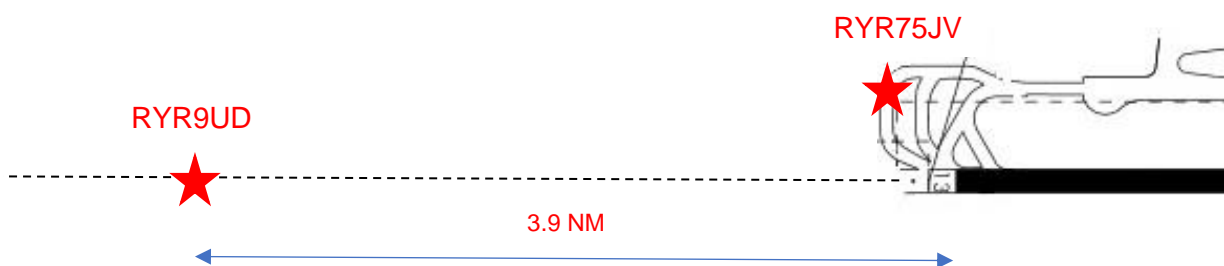


Illustration 4 Position of aircraft at 19:52:27 UTC, RYR75JV (right) and RYR9UD (left)

At 19:52:46 UTC, the trace shows aircraft RYR9UD established on final at 3.1 NM from the threshold of RWY13 with a ground speed of 156 kt. At that moment, the RYR75JV aircraft was at the HN3 holding point signal.

At 19:52:58 UTC, the trace shows aircraft RYR9UD established on final at 2.6 NM from the threshold of RWY13. At that moment, the RYR75JV aircraft had just passed the HN3 holding point signal.

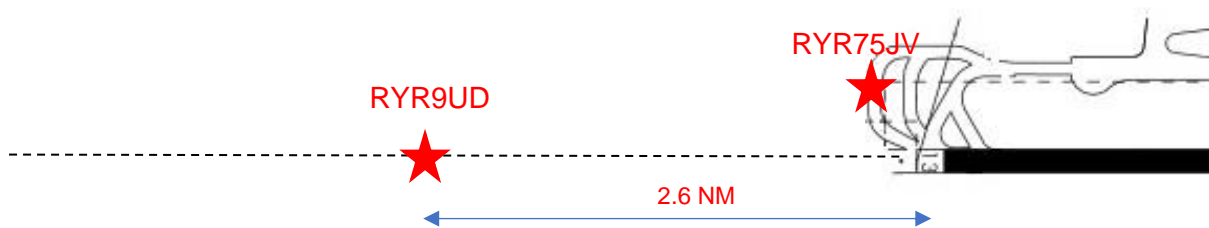


Illustration 5 Position of aircraft at 19:52:58 UTC

At 19:53:21 UTC, the trace shows aircraft RYR9UD established on final at 1.7 NM from the threshold of RWY 13 at 600 ft of altitude AMSL. At that moment, the RYR75JV aircraft was proceeding to the head of runway 13.

At 19:53:29 UTC, the trace shows aircraft RYR9UD established on final at 1.4 NM from the threshold of RWY 13 at an altitude of 500 ft AMSL, and aircraft RYR75JV proceeding to RWY 13, approaching the runway threshold.

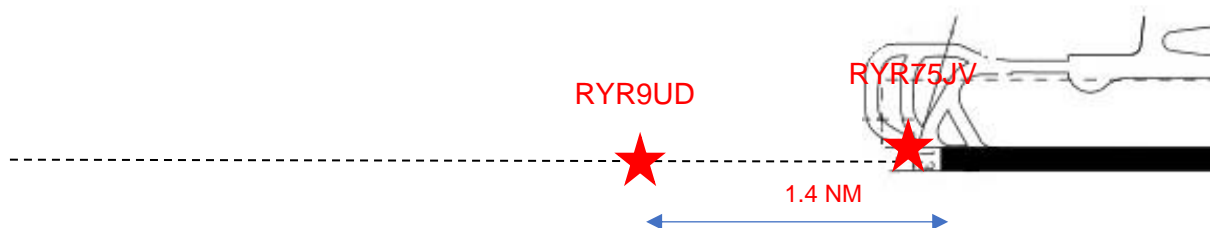


Illustration 6 Position of aircraft at 19:53:29 UTC

At 19:53:59 UTC, the trace shows aircraft RYR9UD established on short final at an altitude of 200 ft AMSL, and aircraft RYR75JV on its take-off run on RWY 13 at a speed of 94 kt (GS). The distance between the two aircraft was 0.4 NM.

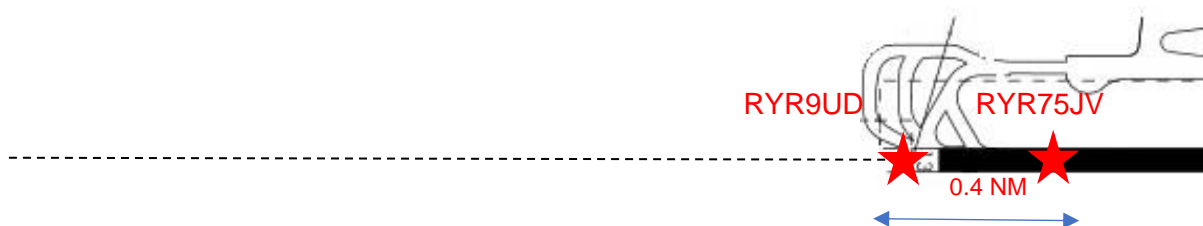


Illustration 7 Position of aircraft at 19:53:59 UTC

At 19:54:03 UTC, the trace shows aircraft RYR9UD over the threshold of RWY 13, travelling at an altitude of 100 ft AMSL and a speed of 150 kt (GS), and aircraft RYR75JV on its take-off run from the same runway at a speed of 111 kt (GS). The distance between the two aircraft was 710 m (0.38 NM)

RYP9UD

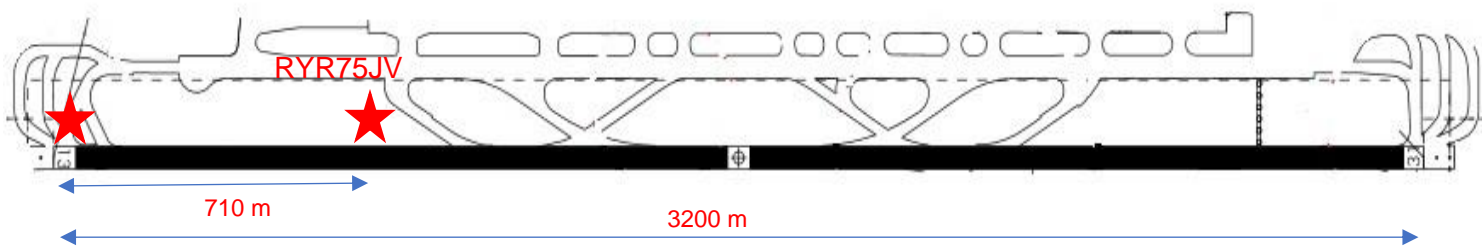


Illustration 8 Position of aircraft at 19:54:03 UTC

At 19:54:07 UTC, the trace shows aircraft RYP9UD over RWY 13 at an altitude of 100 ft AMSL, travelling at a speed of 150 kt (GS) with its main landing gear not yet having made contact with the runway, and aircraft RYP75JV on its take-off run from the same runway at a speed of 127 kt (GS). The distance between the two aircraft was 650 m (0.35 NM)

At 19:54:08 UTC, the trace shows aircraft RYP9UD over RWY 13 with its main landing gear not yet having made contact with the runway, and aircraft RYP75JV on its take-off run from the same runway, not yet having commenced rotation. The distance between the two aircraft was 610 m (0.33 NM)

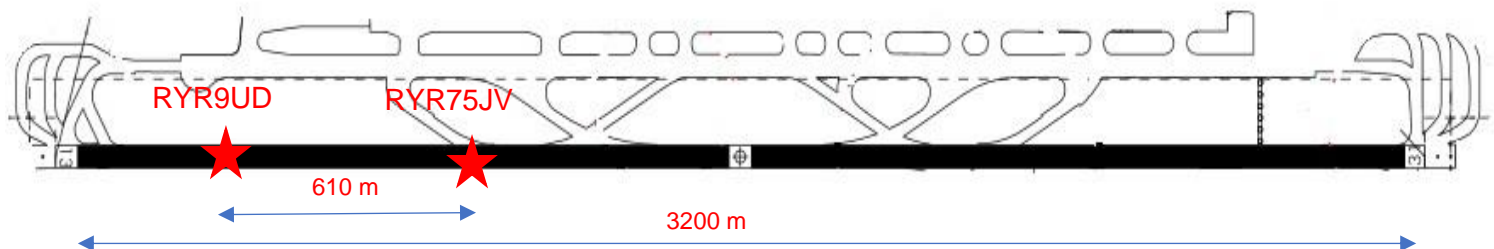


Illustration 9 Position of aircraft at 19:54:08 UTC

At 19:54:11 UTC, the trace shows aircraft RYP9UD over RWY 13 with its main landing gear not yet having made contact with the runway, and aircraft RYP75JV on its take-off run initiating the rotation manoeuvre (forward landing gear in the air and main landing gear on the ground). The distance between the two aircraft was 530 m (0.29 NM)

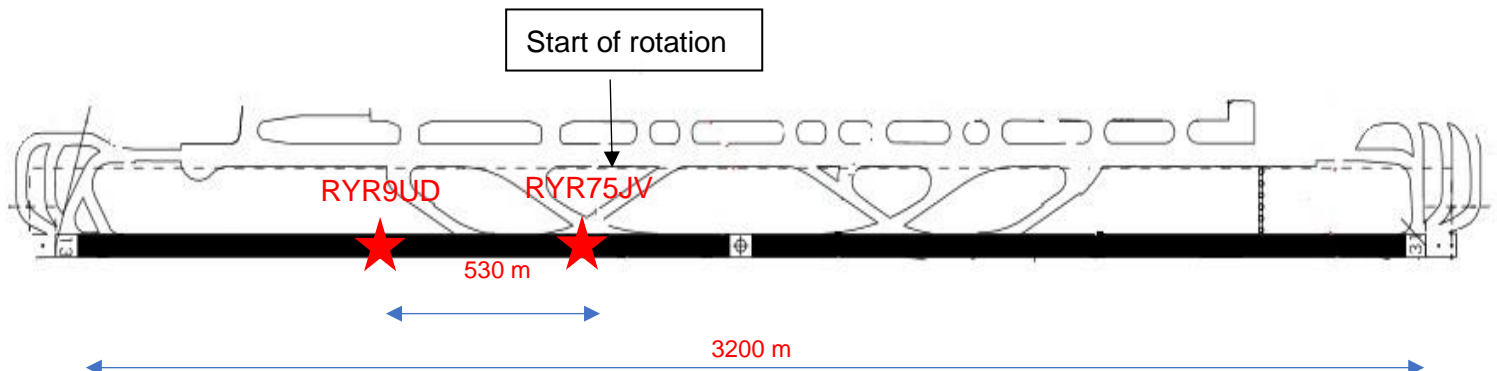


Illustration 10 Position of aircraft at 19:54:11 UTC

At 19:54:14 UTC, the trace shows aircraft RYR9UD touching down with its main landing gear on RWY 13, and aircraft RYR75JV in rotation on its take-off run (forward landing gear in the air and main landing gear on the ground).

At 19:54:15 UTC, the trace shows aircraft RYR9UD over RWY13 with its main landing gear on the runway, and aircraft RYR75JV finishing the rotation manoeuvre on its take-off run (forward landing gear in the air and main landing gear on the ground). The distance between the two aircraft was 520 m (0.28 NM), the shortest separation recorded between them.

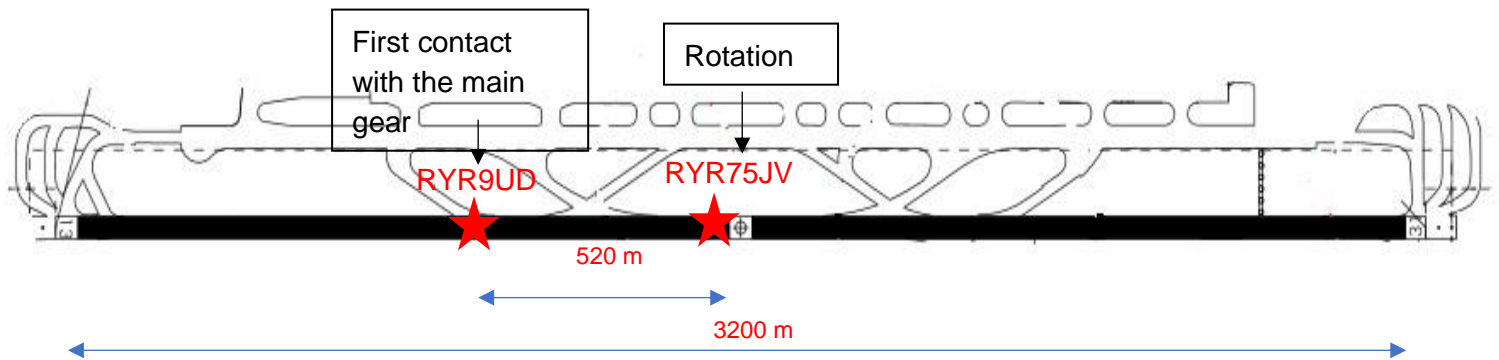


Illustration 11 Position of aircraft at 19:54:15 UTC

At 19:54:28 UTC, the trace shows aircraft RYR9UD decelerating during its landing roll-out on RWY 13, and aircraft RYR75JV on its initial climb at an altitude of 400 ft AMSL. The distance between the two aircraft was 0.5 NM.

At 19:54:35 UTC, the trace shows aircraft RYR9UD decelerating during its landing roll-out on RWY 13, and aircraft RYR75JV on its initial climb, passing the threshold of runway 31 at an altitude of 700 ft AMSL. The distance between the two aircraft was 0.6 NM.

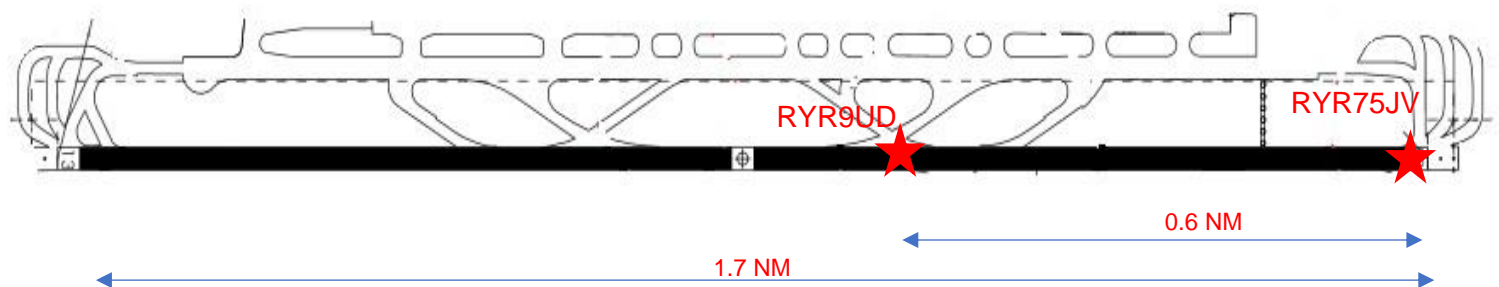


Illustration 12 Position of aircraft at 19:54:35 UTC

1.9. Communications

The investigation was able to access the communications between the aircraft and the local (LCL) and ground movement (GND) control frequencies during the event. However, coordination between LCL and GND is by word of mouth and, as a result, could not be evaluated.

According to the communications records for the 121.705 MHz ground control frequency (GND), at 19:45:57 UTC, the GND controller instructed the RYR75JV aircraft to taxi to the holding point at the head of RWY 13.

At 19:49:19 UTC, the GND controller instructed the RYR75JV aircraft to contact the LCL controller on the 118.150 MHz frequency and signed off. At that time, the RYR75JV aircraft was approximately 900 m from the A3 intermediate holding point, as shown in the following image:

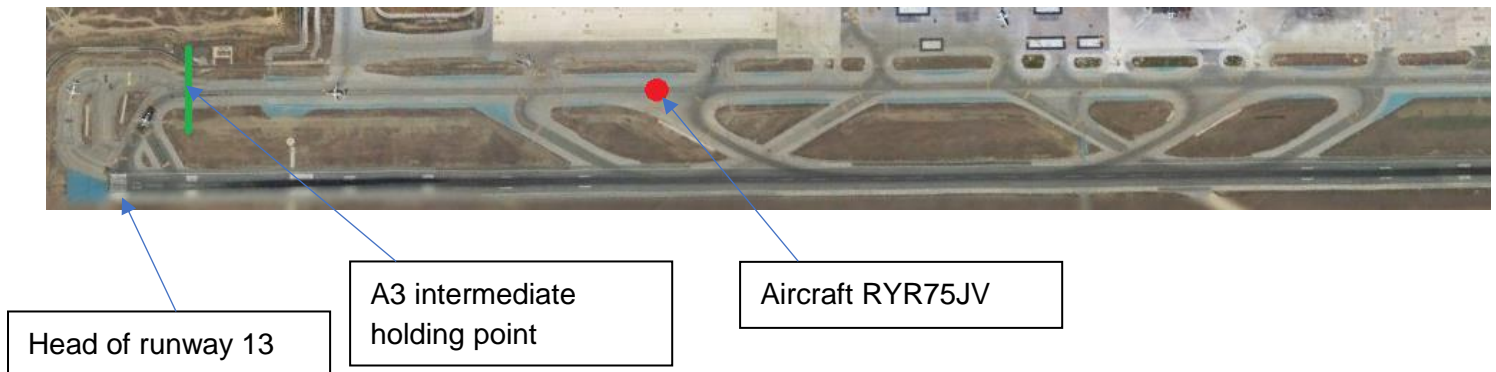


Illustration 13 Position of aircraft RYR75JV at 19:49:19 UTC

According to the communications records for the 118.150 MHz frequency corresponding to the LCL control position, at 19:49:37 UTC, the aircraft with callsign RYR75JV established initial contact with TWR LEMG and informed it that it was ready for departure and taxiing to the holding point for RWY 13.

At 19:49:49 UTC, the LCL TWR LEMG controller instructed aircraft RYR75JV to hold short of the runway, and the crew acknowledged the instruction. At that moment, the RYR75JV aircraft was 600 m from the A3 intermediate holding point.

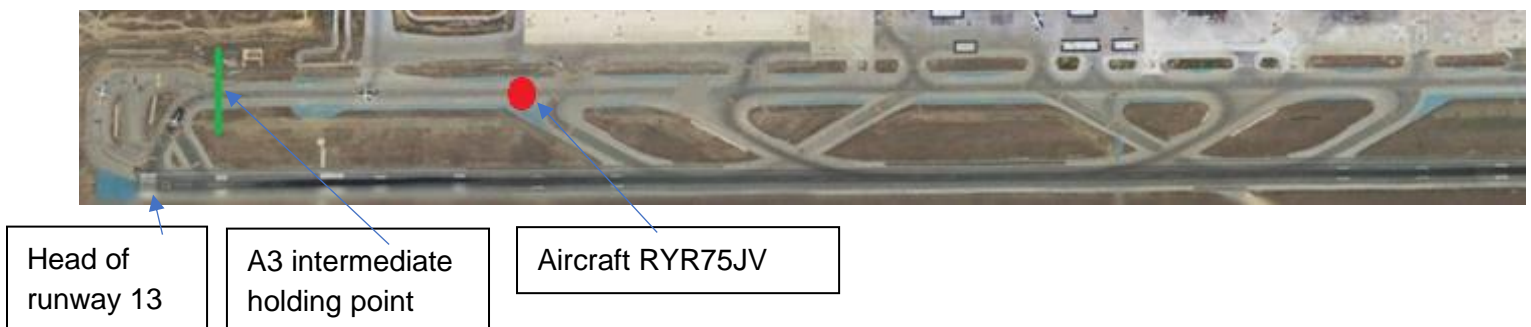


Illustration 14 Position of aircraft RYR75JV at 19:49:49 UTC

At 19:50:44 UTC, the aircraft with callsign RYR9UD made initial contact with TWR LEMG and reported that it was established for approach to RWY 13. Subsequently, the LCL TWR LEMG controller instructed it to continue and adjust speed to 160 kt. The crew of the RYR9UD aircraft acknowledged the message.

At 19:52:27 UTC, the LCL TWR LEMG controller contacted aircraft RYR75JV, which was at holding point HN-3, to instruct it to line up and hold. The aircraft's crew acknowledged

the instruction six seconds later. At this precise moment (19:52:27 UTC), the RYR9UD aircraft was established on final at a distance of 3.9 NM from the threshold of runway RWY 13.

At 19:52:46 UTC, the LCL TWR LEMG controller cleared aircraft RYR75JV for immediate take-off from RWY 13, when the aircraft was at holding point HN-3. The aircraft's crew acknowledged the instruction. At that moment (19:52:46 UTC), the RYR9UD aircraft was established on final at a distance of 3.1 NM from the threshold of RWY 13.

At 19:53:21 UTC, the RYR9UD aircraft notified the LCL TWR LEMG controller that they were at 500 ft. At that moment, the RYR9UD aircraft was established on final at a distance of 1.7 NM from the threshold of RWY 13. The RYR75JV aircraft was proceeding to RWY 13, a few metres from lining up on the runway threshold.

At 19:53:29 UTC, the LCL TWR LEMG controller responded to aircraft RYR9UD, instructing it to continue and await late landing clearance. The crew acknowledged the instruction. At that moment, the RYR9UD aircraft was established on final at a distance of 1.4 NM from the threshold of RWY 13. The RYR75JV aircraft was proceeding to RWY 13, a few metres from lining up on the runway threshold.

At 19:53:59 UTC, the LCL TWR LEMG controller cleared aircraft RYR9UD to land with the preceding traffic in view on RWY 13. The aircraft's crew acknowledged the landing clearance. At that moment, aircraft RYR9UD was on short final for RWY 13 at an altitude of 200 ft AMSL, and aircraft RYR75JV was on its take-off run on RWY 13 at a speed of 90 kt (GS). The distance between the two aircraft was 0.4 NM.

At 19:54:35 UTC, the RYR9UD aircraft notified the LCL TWR LEMG that they had really been on the limit and very close to the preceding traffic.

1.10. Aerodrome information

Málaga-Costa del Sol Airport is located 7 km to the southwest of the city of Málaga. General information about the runway access taxiways and the control positions is provided below.

1.10.1. General information about Málaga-Costa del Sol Airport

Málaga-Costa del Sol Airport (LEMG) is located at an elevation of 16 metres and has 2 runways, one designated 12-30 and the other 13-31. At the time of the event, the airport was operating with a single runway, with runway head 13 being used for both take-offs and landings. This is the airport's preferred configuration with a single runway in operation. Runway 13-31 is 3,200 m long and 45 m wide.

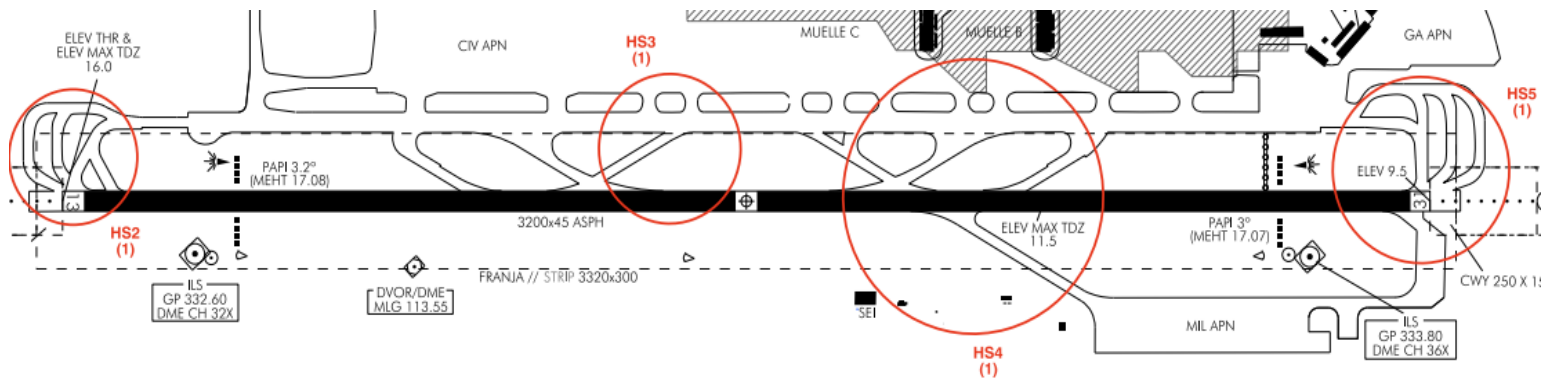


Illustration 15 Diagram RWY 13/31

The access taxiways to runway 13 are shown in the following diagram:

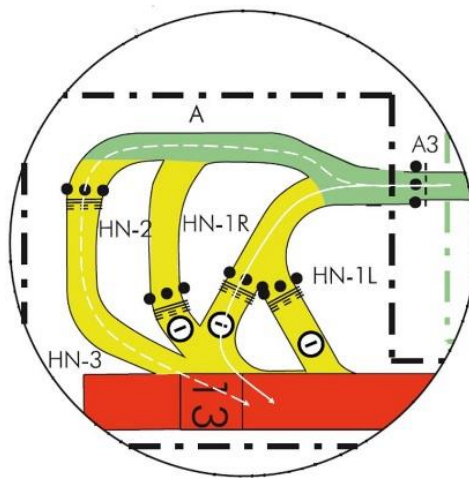


Illustration 16 Access taxiways to the head of runway 13

According to the information published in the AIP, the following precautions are established for taxiing aircraft:

"Bearing in mind the incompatibilities of the holding bay of RWY 13, all aircraft proceeding to RWY 13 shall initially taxi up to the corresponding intermediate holding position A3."

"Unless otherwise advised by ATC, access to RWY 13/31 shall be carried out preferably via HN-3 or HS-3, whenever only one aircraft is operating."

"HN-1R shall not be used except when so indicated by ATC."

The following taxi restrictions are also published in the AIP:

TWY	HN-1L	HN-2	HN-3
Maximum permitted aircraft	D	C	D
	C	(X)	E
	C	E	(X)

Where unoccupied holding points are represented by (X), aircraft with a wingspan between 24 and 36 metres by C, aircraft with a wingspan between 36 and 52 metres by D, and aircraft with a wingspan between 52 and 65 metres by E.

The information published in the AIP also includes a procedure for the minimum runway occupation time for aircraft departures:

“Pilots should be ready for departure when reaching the runway-holding position.

On receipt of line-up clearance, pilots should ensure that they are able to taxi and line-up on the runway as soon as the preceding aircraft has commenced either its take-off run or landing roll.

Pilots should be able to commence the take-off run immediately when take-off clearance is issued.

Pilots unable to comply with this requirement shall notify ATC as soon as possible and await instructions. When appropriate, ATC could cancel the clearance and instruct the aircraft to vacate the runway.”

1.10.2. Information about the control tower at Málaga-Costa del Sol Airport

At Málaga-Costa del Sol Airport, the control tower positions are distributed as follows:

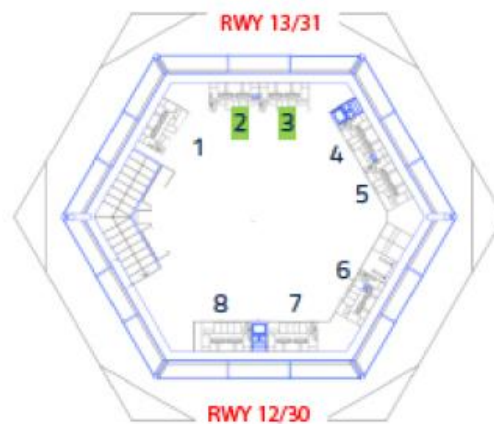


Illustration 17 Distribution of positions in the LEMG control tower

At the time of the event, the control tower cab was configured with two open positions. The LCL controller was in position 3 as of 18:41 UTC. The GMC-CLD controller was in position 2 from 18:56 UTC, handling taxiing and clearance.

1.10.3. Information on runway use configurations at Málaga-Costa del Sol airport

According to the provisions published in the AIP, at Málaga-Costa del Sol Airport, the number of runways in use will depend on traffic demand.

The South configuration is the preferred configuration, with one or two runways in use depending on traffic and capacity:

- Two Runway South Configuration: Arrivals RWY 12 and Departures RWY 13
- One Runway South Configuration: Arrivals and Departures RWY 13

At the time of the incident, the airport was operating in the One Runway South Configuration.

1.11. Flight recorders

The time synchronisation of the Quick Access Data Recorders (QAR) was achieved using the aircraft's communications with the Airport Control Tower.

1.11.1. Data recorder in the EI-ENH Aircraft

The EI-ENH aircraft with callsign RYR75JV was equipped with flight data recorders (FDR) and cockpit voice recorders (CVR). Due to the time that elapsed between the date of the incident and the date it was reported to the CIAIAC, we were unable to retrieve the information from either the CVR or the FDR. However, we were able to retrieve the information recorded by the Quick Access Recorder (QAR).

The most relevant data obtained from the QAR is detailed below:

- **Aircraft arrives at holding point HN-3**

According to the data extracted, the aircraft arrives and stops at the HN-3 holding point at 19:51:47. It shows the aircraft's HEADING parameter remaining constant at 244° and zero ground speed.

- **Crew selects power to taxi from holding point HN-3**

According to the data extracted, the crew set the power to taxi at 19:52:40. The THROTTLE ANGLE parameters increased to the power selected by the crew for taxiing.

Between the crew's acknowledgement at 19:52:33 and the moment they selected the power to taxi, 7 seconds elapsed.

The N1 and GROUND SPEED parameters do not become active until 19:52:49 (9 seconds after the power selection by the crew) due to the physical reaction time between the power being selected and the aircraft beginning to move.

The aircraft reached a speed of 14 kt while taxiing to the head of the runway.

- **Crew selects take-off power and lines up at the head of runway 13**

According to the data extracted, the crew selected take-off power at 19:53:42. Seconds later, at 19:53:47, the take-off power is effective and the aircraft is lined up at the head of runway 13 with a ground speed of 38 kt.

Between the start of movement from the HN-3 holding point and lining up on the runway with effective take-off power, 58 seconds elapse.

- **Start of the rotation manoeuvre**

According to the data extracted, the aircraft lifts its forward landing gear off the runway, thereby initiating the rotation manoeuvre at 19:54:11. At that moment, a status change in the AIR/GROUND STATUS NOSE GEAR parameter can be observed.

In addition, the ground speed at that moment was 143 kt.

- **End of the rotation manoeuvre**

According to the data extracted, the aircraft lifts its main landing gear off the runway, thereby completing the rotation manoeuvre at 19:54:15. At that moment, a status change in the AIR/GROUND STATUS MAIN GEAR parameter can be observed. From that moment on, the radio altimeter values begin to increase, indicating the ascent of the aircraft.

In addition, the ground speed at that moment was 157 kt.

1.11.2. Data recorder in the EI-DYR Aircraft

The EI-DYR aircraft with callsign RYR9UD was equipped with flight data recorders (FDR) and cockpit voice recorders (CVR). Due to the time that elapsed between the date of the incident and the date it was reported to the CIAIAC, we were unable to retrieve the information from either the CVR or the FDR. However, we were able to retrieve the information recorded by the Quick Access Recorder (QAR).

The most relevant data obtained from the QAR is detailed below:

- **Aircraft at 4 NM from the runway threshold**

According to the data extracted, at 19:52:27, the aircraft was 4NM from the runway threshold, travelling at 168 kt of ground speed and through 1,342 ft of radio-altimeter.

- **Aircraft at 3.2 NM from the runway threshold**

According to the data extracted, at 19:52:46, the aircraft was 3.2 NM from the runway threshold, travelling at 156 kt of ground speed and through 966 ft of radio-altimeter.

- **Aircraft at 1.8 NM from the runway threshold**

According to the data extracted, at 19:53:21, the aircraft was 1.8 NM from the runway threshold, travelling at 144 kt of ground speed and through 593 ft of radio-altimeter.

- **Aircraft at 1.5 NM from the runway threshold**

According to the data extracted, at 19:53:29, the aircraft was 1.5 NM from the runway threshold, travelling at 146 kt of ground speed and through 504 ft of radio-altimeter.

- **Aircraft at 0.3 NM from the runway threshold**

According to the data extracted, at 19:53:59, the aircraft was 0.3 NM from the runway threshold, travelling at 152 kt of ground speed and through 125 ft of radio-altimeter.

- **Main landing gear on the runway**

According to the data extracted, the aircraft's main landing gear makes contact with the runway at 19:54:14. At that moment, a status change in the AIR/GROUND STATUS MAIN GEAR parameter can be observed.

In addition, the ground speed at that moment was 141 kt.

1.12. Aircraft wreckage and impact information

N/A.

1.13. Medical and pathological information

N/A.

1.14. Fire

N/A.

1.15. Survival aspects

N/A.

1.16. Tests and research

1.16.1. Information provided by crews

According to the report submitted to the CIAIAC by the crew of the aircraft taking off (registration EI-ENH), the air traffic controller instructed them to hold short of RWY 13.

Having not received specific instructions from the air traffic controller as to where they should go, the crew chose to taxi to holding point HN-3, which is the holding point furthest from the runway head.

Once established at the HN-3 holding point, the EI-ENH aircraft crew could see the lights of two approaching aircraft but could not judge how far away they were because it was dark.

The crew stated that the air traffic controller cleared them to line up at the head of runway 13 and hold. A few seconds later, when the aircraft had not yet reached the runway head, the air traffic controller cleared it to take off immediately.

According to the crew of the aircraft taking off, at no time did the air traffic controller inform them that an aircraft was on short final.

When the EI-ENH aircraft entered the runway, the crew heard another Ryanair aircraft on the radio reporting that they were at 500 ft.

For their part, the crew of the EI-DYR aircraft stated that they received clearance to land with preceding traffic in view when they were at approximately 100 ft. The crew decided to continue with the landing because executing a go-around would have put the aircraft in even greater proximity and danger.

1.17. Organisational and management information

1.17.1. LEMG operating manual - single-runway operations

Unit-specific procedures are described in Annexe B of the LEMG operating manual. Chapter 6 establishes the local LEMG TWR procedures and, in particular, single-runway operations:

6.4.5 Operaciones en pista única: separación entre arribadas y salidas autorizadas a despegue inmediato

Con carácter general, se tendrá en consideración que:

- En su caso, la autorización de despegue se expedirá cuando la aeronave esté lista y próxima a la pista, evitando autorizaciones de despegue excesivamente tempranas.
- Puede concederse la autorización de aterrizar a una aeronave sólo si se tiene un grado razonable de seguridad de que la separación reglamentaria existirá cuando dicha aeronave cruce el umbral de la pista en uso.
- Salvo que aplique lo indicado en RCA 4.5.11 o RCA 4.5.15, no se permitirá cruzar el umbral de la pista, en su aproximación final, a ninguna aeronave que vaya a aterrizar hasta que la aeronave precedente en despegue haya cruzado el extremo de la pista en uso o haya iniciado un viraje.
- Se concederá la autorización de aterrizaje con la mayor antelación posible, normalmente antes de que la arribada alcance la posición de 1 NM en final.
- Tan pronto se prevea que la autorización vaya a concederse más tarde, se dará información de tránsito y se instruirá a la aeronave a que continúe aproximación.

Con la mayor antelación posible, una vez valorados los factores anteriores y determinada la viabilidad de la secuencia salida-arribada, el CTA realizará la siguiente secuencia de actuaciones:

1. Informar a la arribada de que se va a producir un despegue, o en su caso, de la secuencia en el uso de la pista que puede esperar.
2. Si procede, preguntar si tiene al tráfico en salida a la vista y solicitar que se ajuste.
3. Informar a la aeronave de salida de la posición que ocupa la arribada y de su velocidad si se considera necesario, y preguntar si se encuentra lista para despegue inmediato (antes de entrar en pista).
4. En caso de que responda afirmativamente, y si se considera que existe un tiempo suficiente para realizar el ajuste, autorizar a despegue inmediato.
5. Vigilar la evolución de ambas aeronaves con los medios disponibles incluido el sistema de vigilancia ATS de modo que, si se prevé que pueda perderse la separación reglamentaria entre ambas aeronaves, se cancele preferentemente la autorización de despegue, evitando en lo posible detener el despegue una vez haya iniciado la carrera de despegue.
6. En caso de que, después de dar una autorización de despegue o una autorización de aterrizaje, el CTA advierta que pudiera infringirse la separación reglamentaria indicada, actuar con la mayor celeridad aplicando las siguientes medidas según sea procedente:
 1. Cancelar o detener el despegue, según proceda (ver fraseología en RCA 4.10.3.4.12).
 2. Motor y al aire (ver fraseología en RCA 4.10.3.4.19).

1.17.2. LEMG operating manual - north holding bay use (runway head 13)

Unit-specific procedures are described in Annexe B of the LEMG operating manual. Chapter 6 establishes the local LEMG TWR procedures and, in particular, the use of the holding bay at the head of runway 13:

6.6.3.1 Uso del apartadero norte (cabecera 13)

El apartadero norte (cabecera 13) presenta las siguientes particularidades:

- La barra de parada HN-3 está a una distancia de eje de pista mayor de lo habitual con el fin de garantizar que no se vulneren ni la zona despejada de obstáculos de la superficie de aproximación; ni la superficie de ascenso en el despegue; ni el área crítica/sensible del ILS.
- El acceso a pista para alinear desde HN-3 tiene una pendiente en ascenso que reduce la velocidad de rodaje hasta la pista.

Por ello, cuando dicha cabecera 13 esté en uso y se tengan que hacer ajustes entre arribadas y despegues, LCL tendrá en cuenta:

- Extremar la precaución a la hora de realizar ajustes entre arribadas y salidas desde HN-3.
- Consultar al tráfico de salida si está listo para inmediato, en caso afirmativo, informar de la posición del tráfico de arribada.
- En caso de despegue entre dos arribadas, utilizar siempre la fraseología:

TINAIR 1234, DETRÁS DEL BOEING 737 DE IBERIA EN FINAL, ENTRE Y MANTENGA PISTA 13 Y ESPERE. DETRÁS.

TINAIR 1234, BEHIND THE BOEING 737 IBERIA ON SHORT FINAL, LINE UP RUNWAY 25 AND WAIT. BEHIND.

- En caso de que con alta demanda de tráfico haya que ajustar tráficos de salidas y arribadas, sería recomendable utilizar principalmente los apartaderos (HN-2 y HN-1 R/1 L) teniendo en cuenta las incompatibilidades de aeronaves en apartaderos publicadas en AIP-España AD2-LEMG Ítem 20.

1.17.3. LEMG operating manual - holding bay management

Unit-specific procedures are described in Annexe B of the LEMG operating manual. Chapter 6 establishes the local LEMG TWR procedures and, in particular, the airfield configurations.

As indicated in the SOUTH ONE-RUNWAY configuration, the holding bay and the management and assignment of the runway access taxiway is the responsibility of the controller in the LCL position. The air traffic controller in the GMC position transfers the aircraft to LCL when they arrive at A3 so that LCL can organise the take-off sequence.

1.17.4. Capacity control procedure at LEMG

The ATC (TWR) Capacity refers to the number of operations per unit of time that the control tower can manage, taking into account the control positions, infrastructures and the associated technical means.

The ATC (APP) Capacity refers to the number of aircraft that can be safely accepted in the airspace during a set unit of time.

Airport capacity refers to the number of operations (arrivals, departures and totals) associated with the airport infrastructure, i.e., the airfield and runway system. This capacity is determined by AENA, as the airport manager.

Declared Capacity is the maximum permitted traffic flow within a specific unit of time that can be maintained over time in accordance with the safety requirements.

Maximum Capacity is the maximum permitted traffic flow within a specific unit of time (usually one hour) that cannot be sustained over a long period of time. It is calculated by increasing the declared capacity by 10% for a period not exceeding 1 hour.

The Declared Capacity is the lowest of the following three values for any given period:

- ATC (TWR) capacity
- ATC (APP) capacity
- Airport capacity

The ATC (APP) capacity, defined by ENAIRE in the different sectors that constitute Málaga, is as follows:

REGIÓN SUR			
MÁLAGA			
APROXIMACIÓN			
SECTOR	VOL	CAP	OBSERVACIONES
LEMGANM SFC - FL145	MGSUR	30	Sector Elemental. Se reduce la capacidad a 25, por Área de Bloqueo con dos pistas. Se reduce la capacidad a 25 con pista única.]
	MGW		
LEMGAPM SFC - FL145	MGCEN	25	
	MGE		
	MGSUR		
	MGW		
LEMGASM SFC - FL145	MGCEN	30	Sector Elemental. Se reduce la capacidad a 25 con pista única.
	MGW		
LEMGDNM SFC - FL145	MGCEN	30	Sector Elemental. Se reduce la capacidad a 25 con pista única.
	MGE		
LEMGDSM SFC - FL145	MGE	30	Sector Elemental. Se reduce la capacidad a 25 con pista única.
	MGSUR		

As can be seen from the previous table, for a single-runway configuration, the ATC (APP) capacity is 25 operations per hour.

The ATC (TWR) capacity, defined by ENAIRE for Málaga-Costa del Sol, is as follows:

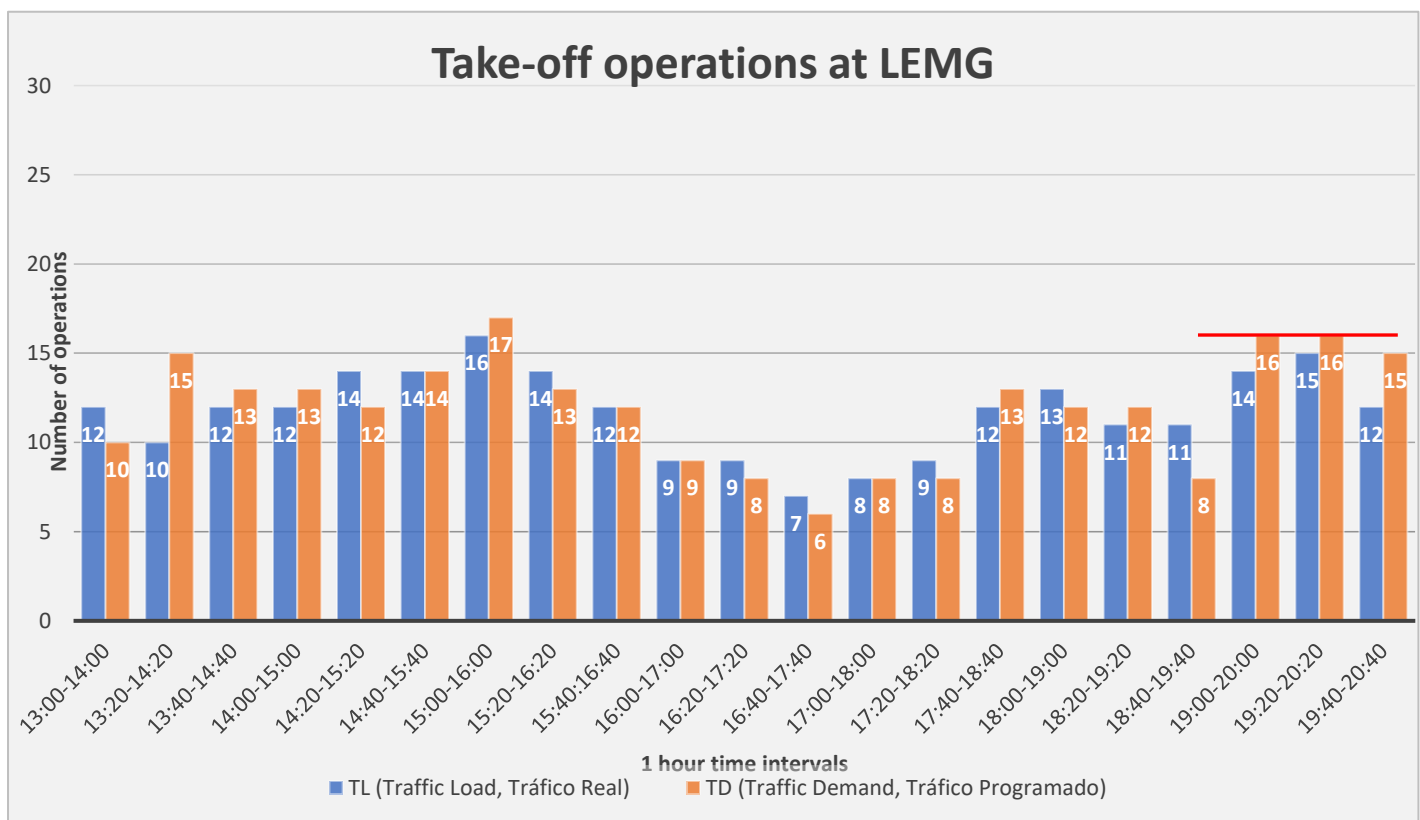
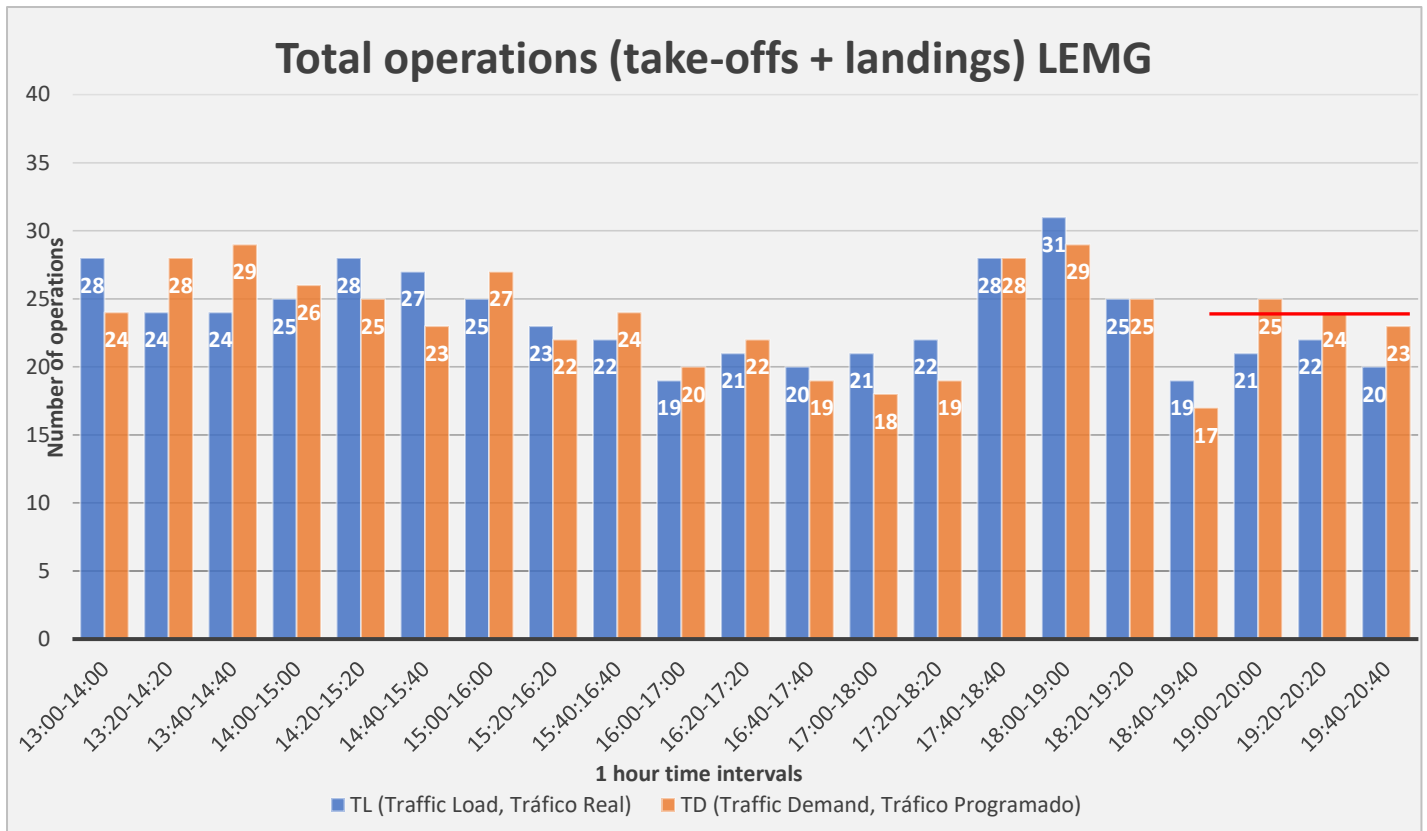
Servicio de control de tránsito aéreo prestado	Número de pistas	Número de posiciones de control abiertas	Número de movimientos IFR por hora		
			Totales	Llegadas	Salidas
Aeródromo	2	5	60	35	35
		4	50	28	28
		3	35	19	19
		2	23	14	14
	1	3	37	24	24
		2	24	16	16
		1	12	8	8

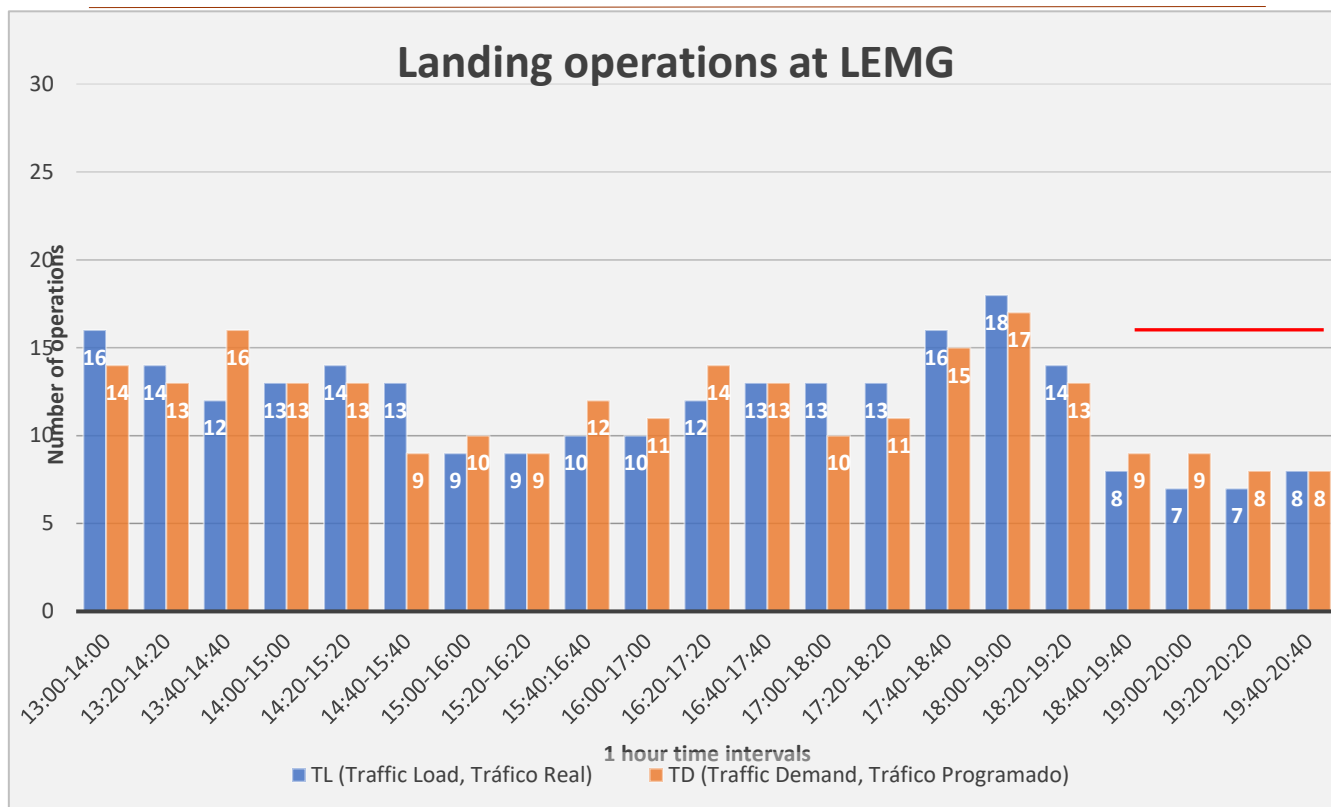
According to the above table, when operating with a single runway and 2 open control positions, the ATC capacity is 24 total operations per hour, 16 departures per hour and 16 arrivals per hour.

Thus, for 1 open runway and 2 control positions, the most restrictive capacity is the ATC (TWR) capacity and, therefore it is also the Declared Capacity.

The capacity information provided by ENAIRE regarding the traffic data (arrivals and departures) in Málaga-Costa del Sol on the day of the incident (11 September 2019) is analysed in the following graphs displaying the following parameters:

- Real traffic
- Scheduled traffic
- Limit in red: Declared capacity at 19:50 UTC (24 total operations/hour, 16 departures/hour and 16 arrivals/hour)





1.18. Additional information

1.18.1. Similar events at Málaga-Costa del Sol Airport

The following is a list of events at Malaga-Costa del Sol airport, from 2019 to the present, in which separation between aircraft is reduced (either between arrivals and take-offs or between arrivals only) in single-runway configuration.

They are classified into two groups:

In the first group, those occurrences where, due to reduced separation between aircraft, ATC intervention was necessary to prevent both aircraft from coinciding simultaneously on the runway.

Date	Distance	Severity	Comments
01/01/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
04/02/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
17/03/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
08/08/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
07/10/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
26/12/2019	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
03/01/2020	-	-	Insufficient separation detected by ENAIRE's automated tools
23/01/2020	-	-	Insufficient separation detected by ENAIRE's automated tools
14/02/2020	-	-	Insufficient separation detected by ENAIRE's automated tools
28/02/2020	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
12/09/2020	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
01/10/2020	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)
22/12/2020	-	-	Go-around A/C due to insufficient separation (ATC INITIATIVE)

In the second group, those occurrences where, due to reduced separation between aircraft, a go-around manoeuvre was necessary at the flight crew initiative or both aircraft run into the same runway simultaneously.

Date	Distance	Severity	Comments
23/01/2019	-	-	Go-around A/C due to insufficient separation (A/C INITIATIVE)
26/04/2019	0,6 NM & 400 ft	-	Go-around A/C due to insufficient separation (A/C INITIATIVE)
17/07/2019	-	-	Go-around A/C due to insufficient separation (A/C INITIATIVE)
11/09/2019	519 m	Severity CEANITA A3 (Serious Incident)	Loss of separation between arrival and take off
15/09/2019	0,8 NM	Severity CEANITA B3 (Major Incident)	Loss of separation between arrival and take off
24/09/2019	0,4 NM	Severity CEANITA B3 (Major Incident)	Loss of separation between arrival and take off
27/09/2019	0,87 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation detected by ENAIRE automated tools
11/10/2019	0,5 NM & 1000 ft	-	Go-around A/C due to insufficient separation (A/C INITIATIVE)
22/10/2019	1,3 NM	Severity ENAIRE C3 (Significant Incident)	Loss of separation detected by ENAIRE automated tools
25/10/2019	0,79 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation detected by ENAIRE automated tools
26/10/2019	1,3 NM	Severity ENAIRE C3 (Significant Incident)	Loss of separation detected by ENAIRE automated tools
30/10/2019	1,24 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation detected by ENAIRE automated tools
07/11/2019	1,23 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation detected by ENAIRE automated tools
21/02/2020	-	-	Runway incursion due to simultaneous presence of 2 arrivals
12/03/2020	0,9 NM	-	Loss of separation detected by ENAIRE automated tools
19/07/2020	0,9 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation between arrival and take off
15/08/2020	1,3 NM	-	Loss of separation between arrival and take off
15/08/2020	1,2 NM	-	Loss of separation between arrival and take off
18/09/2020	1,3 NM & 500 ft		Loss of separation between arrival and take off
23/10/2020	0,9 NM	Severity ENAIRE B3 (Major Incident)	Loss of separation between arrival and take off
31/10/2020	1,5 NM	Severity ENAIRE C1 (Significant Incident)	Loss of separation between arrival and take off

Since 2019, a total of 34 events involving a loss of separation between aircraft in single-runway configuration have been reported to the National Occurrence System.

Of these, the 4 events indicated in yellow involved a go-around manoeuvre carried out by the approaching aircraft, at the initiative of the flight crew itself.

The 8 events indicated in red involved a situation where the distance between the aircraft landing and the aircraft taking off was less than 1NM.

1.18.2. Contributing factors detected by ENAIRE

According to ENAIRE, their internal investigations identified both individual and systemic factors in the cases analysed. The organisation also detected a relatively well-extended unit sub-culture of using work modes associated with traffic adjustments.

The systemic aspects detected by ENAIRE are summarised below:

- Historical factors: reduced runway separation procedures applied until 2017 in the Málaga unit that led to inertia in work modes
- Organisational factors: The ATC unit training plan does not reflect specific training scenarios for changes of plan or strategies for mitigating cognitive biases. The regulations do not explicitly require this. Furthermore, the operating manual contains general guidelines for separation between departures and arrivals but does not include specific criteria for whether or not these adjustments are allowed.
- Proximal factors: Operational pressures when handling departures, self-induced pressure to take advantage of gaps in arrivals and a tendency to use nominal gaps of 7NM for 2 departures.
- Human factors: Expectation bias on the crew's response to immediate take-off clearance, plan continuation bias, aversion to cancelling take-off clearances and poor risk perception as separations of less than one runway are not deemed significant enough to be reported.

1.18.3. Corrective measures applied by ENAIRE

On 24 October 2019, the first “LEMG Action Plan” prepared by ENAIRE came into force. After having recorded high severity incidents involving a loss of separation between traffics operating on the same runway, ENAIRE proposed the action plan to monitor operations at LEMG and identify any systemic factors that may have contributed to the events.

In a preliminary analysis, ENAIRE detected unreported incidents involving significant violations of the safety margins. For this reason, the organisation decided to install an automated detection tool to ensure that any losses of separation between aircraft would be identified.

ENAIRE established 11 corrective measures, with the last one being finalised in February 2020. The implementation of the corrective measures is shown in the following table:

Code	Action	Date
AC1	Communication with actors involved	
AC2	Meeting with the head of ATS LEMG	November 2019
AC3	Semi-automated monitoring of operations	December 2019
AC4	Opening of investigations	December 2019
AC5	Real-time operation observation	December 2019
AC6	Meeting with supervisors	November 2019
AC7	Meeting with instructors	November 2019
AC8	Dissemination DSEGU criteria	November 2019
AC9	Culture reinforcement	February 2020
AC10	Standardised notification request	November 2019
AC11	Feedback in the unit	February 2020

As a result of a series of incidents in July 2020 involving safety margin violations between arrivals and a previous departure, ENAIRE implemented a second package of actions that came into effect on 08 October 2020. The actions were structured in 3 large blocks:

- Dissemination and awareness
- Operational support
- Operational reinforcement in the control tower cab

Dissemination and Awareness Actions		
Code	Action	Date
DIV1	Follow-up meetings	December 2020
DIV2	EAPPRI / RAT presentations	January 2021
DIV3	Cognitive bias and risk perception presentations	February 2021
DIV4	Reference material	January 2021

Operational support actions		
Code	Action	Date
OPS1	Recommendations based on timings and distance	October 2020
OPS2	General recommendations guide	October 2020
OPS3	Specific LEMG recommendations guide	November 2020
OPS4	Criteria to support single runway decision-making	November 2020
OPS5	Dissemination / training on the recommendation guides	February 2021
OPS6	Dissemination to airlines	December 2020

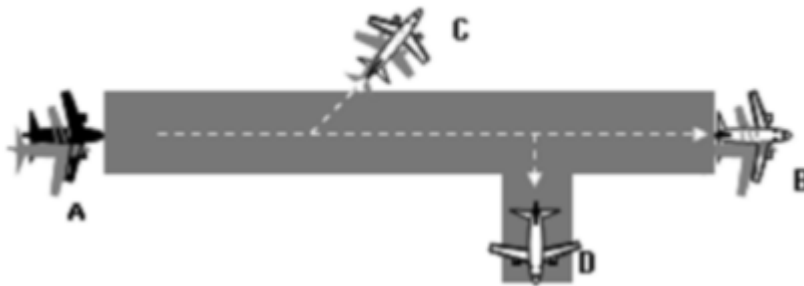
Operational reinforcement actions in the control tower cab		
Code	Action	Date
REF1	Communications to supervisors	November 2020
REF2	ATC technician	September 2020
REF3	Briefings	December 2020
REF4	Printing of the guides	December 2020

1.18.4. Air Traffic Regulation provisions regarding the separation of aircraft using the same runway

The consolidated text of the Air Traffic Regulations (Royal Decree 57/2002 of 18 January) establishes the procedures for air navigation services in its Fourth Book. Specifically, chapter 5 (aerodrome control service) sets out the provisions for the separation of aircraft using the same runway.

Provision 4.5.10.1.1:

“as a general rule, no aircraft on its final approach to land will be allowed to cross the runway threshold until the preceding aircraft taking off has passed over the end of the runway in use (B), initiated a turn (C) or until any recently landed aircraft (D) have cleared the runway.”



1.18.5. ICAO runway incursion prevention manual

In appendix C, “Best practices in air traffic control”, of the ICAO runway incursion prevention manual (Doc 9870), the following practices to avoid runway incursions are recommended:

- **Taxi Instructions:**

“Taxi instructions issued by a controller must always include a clearance limit, which is the point where the aircraft must stop until it receives an instruction to proceed.”

1.18.6. Recommendations and best practices to mitigate possible inadequate separations between instrument or visual departures and missed approaches

Spain's National Aviation Safety Agency, AESA, publishes document RECS-2015/003/2.0 with recommendations and best practices to minimise the occurrence of inappropriate separations in those cases where they cannot guarantee compliance with the regulatory level of separation between outbound and inbound traffic.

Among the recommendations and good practices included, the following are aimed at ATC service providers:

"IT IS RECOMMENDED that should the aerodrome control service realise that the distance between the approaching aircraft and the one cleared for take-off is considerably reduced, potentially resulting in a violation of the regulatory runway separation provision, it should cancel the take-off and instruct the approaching aircraft to perform a missed approach, avoiding, as far as possible, cancellations during the take-off run."

"IT IS RECOMMENDED that if the aerodrome control service intends to authorise a departure when the approaching traffic could lead to a situation whereby the separation between the two aircraft will not be much more than the established minimum, check with the departing aircraft before clearing it to enter the runway. Doing so will increase certainty when organising the runway sequence and improve safety."

"IT IS RECOMMENDED that Aerodrome Control Air Navigation Providers prepare and include procedures, performance criteria and best practices for the management of separations between arrivals and departures cleared for immediate take-off during single-runway operations, in the unit's control tower operating manuals."

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

An analysis of the following aspects is deemed relevant:

- Meteorological situation
- Operator
- Capacity
- Repetitiveness of events

2.1. Analysis of the meteorological conditions

The meteorological conditions at Málaga-Costa del Sol Airport around the time of the event (19:50 UTC) were night-time conditions, as it took place 1 h and 16 minutes after the sun went down at 18:34 UTC.

The crew of the EI-ENH aircraft taking off, which was at the HN-3 holding point, could see the lights of the approaching aircraft, but it was impossible for them to judge its distance from the runway because it was completely dark.

Therefore, the crew of the aircraft taking off followed the instructions of the air traffic controller at the LCL position, who instructed them to enter runway head 13 from the holding point, despite visually appreciating the lights of the approaching aircraft whose distance they could not judge.

2.2. Operational analysis

The section below contains a detailed analysis of the different stages of the flights: taxiing, alignment and take-off of the aircraft with registration EI-ENH, and landing of the aircraft with registration EI-DYR.

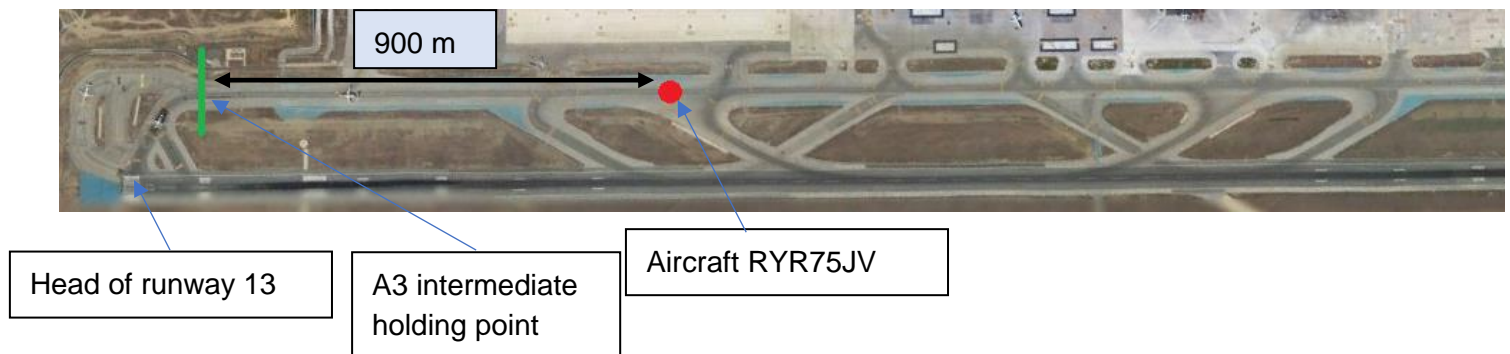
2.2.1. Analysis of the taxi

As indicated in the LEMG operating manual, the air traffic controller at the GMC position must transfer the aircraft to the LCL position when it arrives at intermediate holding point A3 so that the air traffic controller at the LCL position can organise the take-off sequence.

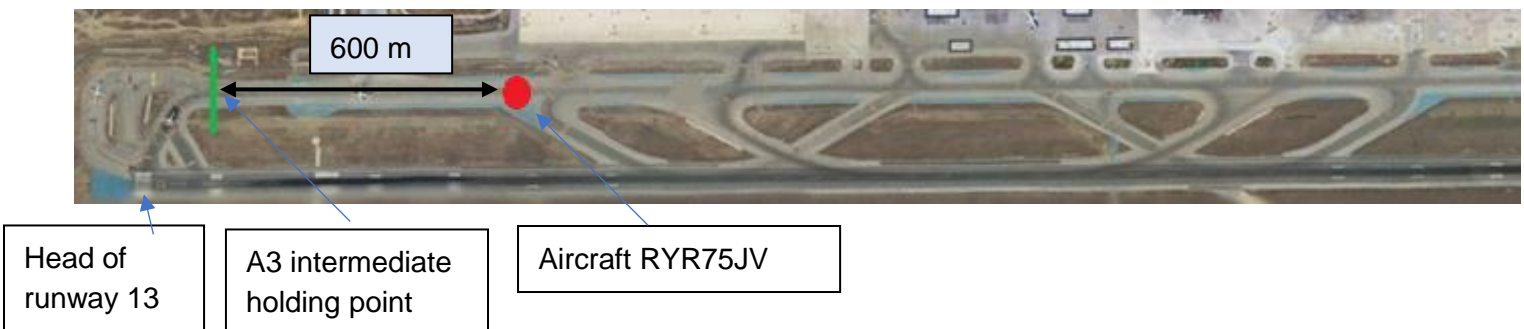
According to the 121.705 MHz communication records between the control tower and the EI-ENH aircraft (callsign RYR75JV), the air traffic controller at the GMC position did not instruct the aircraft to taxi to the intermediate holding point A3 but instead told it to taxi to the holding point for runway head 13, without saying which one. At that moment, the aircraft was still 900 m from intermediate holding point A3.

According to the LEMG Operating Manual (“Holding bay management”), which describes the unit’s specific procedures for the SOUTH ONE- RUNWAY configuration, the management and assignment of the runway access taxiway are the responsibility of the air traffic controller at the LCL position, and the air traffic controller at the GMC position has to transfer the aircraft to LCL when it arrives at A3.

The following image shows the aircraft's position when it receives the instruction from the air traffic controller at the GMC position to taxi to the holding point for runway head 13 (19:49:19 UTC).



At 19:49:49 UTC, 30 seconds after the aircraft's last communication with the GMC position, the air traffic controller in the LCL position instructed aircraft RYR75JV to hold short of RWY 13. At that moment, the RYR75JV aircraft was 600 m from the A3 intermediate holding point.



Having not received specific instructions as to which holding point they should go to, the crew chose to taxi to holding point HN-3, which is the holding point furthest from the runway head.

The crew's decision to do this is consistent with the information given in the AIP, which says the following: *"Unless otherwise advised by ATC, access to RWY 13/31 shall be carried out preferably via HN-3 or HS-3, whenever only one aircraft is operating."*

Holding point HN-3 is the furthest from the runway head and has an uphill slope, significantly increasing runway access time compared to other holding points.

The radar trace shows the aircraft with callsign RYR75JV arriving at the HN-3 holding point signal at 19:51:47 UTC.

As established in the ICAO runway incursion prevention manual, DOC 9870:

"Taxi instructions issued by a controller must always include a clearance limit, which is the point where the aircraft must stop until it receives an instruction to proceed."

In this incident, the air traffic controller at the GMC position did not specify intermediate holding point A3 in his taxi instructions to the aircraft. For his part, the air traffic controller at the LCL position did not specify the HN-3 holding point in his taxi instruction, leaving the choice of holding point to the discretion of the flight crew.

The time it takes to access the runway from the HN-1L or HN-2 holding points is significantly less than the time required to access from HN-3. Knowing that the wingspan of the Boeing 737-800 aircraft on take-off is 35.8 m, the air traffic controller at the LCL position could have instructed the aircraft to taxi to any of these holding points to reduce the time required to access the runway. However, by leaving the choice of holding point to the discretion of the flight crew, the runway access time was considerably increased.

2.2.2. Analysis of the line-up and take-off

The LCL position controller planned to take advantage of the 6NM gap between two approaches to clear the take-off of the EI-ENH aircraft with callsign RYR75JV. The following image shows the relative positions of the aircraft at 19:51:17 UTC.



At 19:52:27 UTC, he instructed aircraft RYR75JV to line up on the runway and hold, when, at that moment, the approaching RYR9UD aircraft was established on final at a distance of 3.9 NM from the threshold of RWY 13. The following image shows the relative positions of the aircraft:



The crew of the RYR75JV aircraft took 6 seconds to acknowledge the instruction to line up and another 7 seconds to select the power to taxi. Because of the time it takes for the aircraft to begin moving after the power selection, the N1 and GROUND SPEED parameters did not become active until 19:52:49 UTC. This data does not signify the delay in the actions carried out by the crew is considered significant or excessive.

At 19:52:46 UTC, 19 seconds after instructing it to line up and hold, the air traffic controller cleared the RYR75JV aircraft to begin its take-off run immediately, while the aircraft on final was 3.1 NM from the threshold of RWY 13.

Without stopping at any time and reaching a speed of 14 kt while taxiing, It took the RYR75JV aircraft 58 seconds to move from the HN-3 holding point and line up on the runway with effective take-off power. Bearing in mind the information in the LEMG Operating Manual, which states that the HN-3 holding point is further away from the runway centreline than usual and that the access from it has an uphill slope that reduces speed while taxiing to the runway, we do not believe there was any significant or excessive delay in reaching the runway threshold for take-off on behalf of the crew.

The following factors are considered to have played a decisive role in reducing the separation between the aircraft:

- The air traffic controller's plan to take advantage of a gap of 6NM between two aircraft to clear the take-off of another aircraft at the HN-3 holding point.
- The air traffic controller's decision to line up an aircraft located at HN-3 when the aircraft on approach was less than 4NM away.
- The air traffic controller's decision to clear an aircraft at HN-3 for immediate take-off when the aircraft on approach was 3.1 NM away.

Annexe B of the LEMG Operating Manual, on specific unit procedures, establishes the following indications for the use of the north holding bay (header 13):

- Exercise extreme caution when making adjustments between arrivals.
- Consult the departure traffic to see if it is ready to take off immediately, and, if so, report the position of the arriving traffic.
- Should high traffic levels necessitate adjustments to departure and arrival traffic, it is advisable to use the HN-2 and HN-1 holding bays primarily.

For its part, Spain's National Aviation Safety Agency, AESA, publishes document RECS-2015/003/2.0 with recommendations and best practices for minimising the occurrence of inappropriate separations between outbound and inbound traffic. Specifically, it makes the following recommendation:

"IT IS RECOMMENDED that if the aerodrome control service intends to authorise a departure when the approaching traffic could lead to a situation whereby the separation between the two aircraft will not be much more than the established minimum, check with the departing aircraft before clearing it to enter the runway. Doing so will increase certainty when organising the runway sequence and improve safety."

In the incident being analysed, the air traffic controller did not take into account the instructions in the LEMG Operating Manual or the aforementioned AESA recommendations. The HN-3 holding point was chosen by the crew in the absence of specific instruction from the air traffic controllers; the departure traffic was not consulted to see if it was ready for immediate take-off, and the position of the arrival traffic was not reported to the departing aircraft. Furthermore, the air traffic controller had the opportunity to cancel the take-off of

the EI-ENH aircraft knowing that the aircraft on approach was 3.1 NM away. Instead, however, he decided to clear it for immediate take-off.

2.2.3. Analysis of the landing

The EI-DYR aircraft on approach with callsign RYR9UD notified the air traffic controller that they were proceeding to 500 ft at 19:53:21. The air traffic controller responded to aircraft RYR9UD, instructing it to continue and await late landing clearance.

At that moment, aircraft RYR9UD was established on final at 1.7 NM from the threshold of RWY 13 and aircraft RYR75JV was taxiing towards RWY 13. The air traffic controller did not recognise the imminent danger resulting from the loss of regulatory separation and continued with the initial plan, instructing the aircraft to continue on approach without informing the aircraft that was about to take off.

Given that the inbound traffic was 1.7NM from the runway threshold and the outbound aircraft was midway between the holding point and the runway threshold, the air traffic controller could have prevented a loss of separation and, therefore, a potentially hazardous situation between the inbound and outbound traffic in a single runway configuration by instructing the arriving traffic to abort its approach and cancelling the take-off of the taxiing aircraft, as per the following recommendation contained in document RECS-2015/003/2.0 published by AESA:

“IT IS RECOMMENDED that should the aerodrome control service realise that the distance between the approaching aircraft and the one cleared for take-off is considerably reduced, potentially resulting in a violation of the regulatory runway separation provision, it should cancel the take-off and instruct the approaching aircraft to perform a missed approach, avoiding, as far as possible, cancellations during the take-off run.”

However, at 19:53:59 UTC, the LCL TWR LEMG controller cleared the RYR9UD aircraft to land with the preceding traffic in view on runway 13 when it was established at 200 ft of altitude AMSL, and aircraft RYR75JV was on its take-off run on RWY 13 at a speed of 90 kt (GS). The distance between the two aircraft was 0.4 NM.



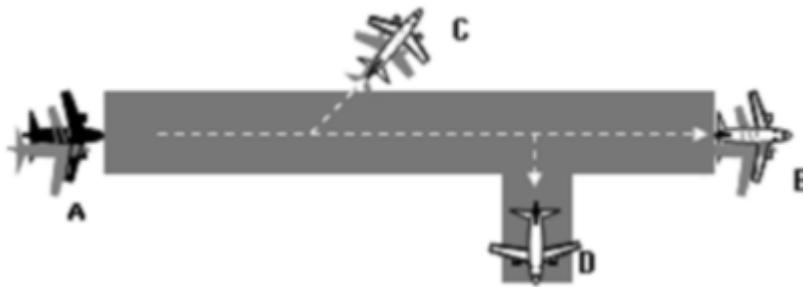
Annexe B of the LEMG Operating Manual, on unit-specific procedures, states that, in single-runway operations, the following must be taken into consideration in order to separate arrivals and take-offs with immediate departure:

- Clearance to land: only if there is a reasonable degree of assurance that the regulatory separation will exist when said aircraft crosses the threshold of the runway in use.

- No aircraft will be allowed to cross the runway threshold on its final approach to land until the preceding aircraft taking off has passed over the end of the runway in use.
- Landing clearance should be granted as far in advance as possible, generally before the arrival reaches 1NM on final.

In the incident being analysed, the air traffic controller did not heed any of the three aforementioned instructions or provision 4.5.10.1.1 of the Air Traffic Regulations, which establishes the following:

“as a general rule, no aircraft on its final approach to land will be allowed to cross the runway threshold until the preceding aircraft taking off has passed over the end of the runway in use (B), initiated a turn (C) or until any recently landed aircraft (D) have cleared the runway.”



The landing was authorised when the aircraft was practically above the runway threshold, allowing it to cross said threshold while the outbound aircraft was still on the runway. Moreover, there was no degree of assurance that the regulatory separation could be maintained, as the aircraft on approach was travelling faster than the aircraft on take-off, increasingly reducing the separation between the aircraft. The air traffic controller failed to anticipate the required separation between the aircraft.

2.2.4. Analysis of the minimum separation between aircraft

From the data obtained from the flight recorders we have been able to determine the exact moment at which the landing aircraft, with registration EI-DYR, makes contact with the runway for the first time with its main landing gear. This instant (19:54:14 UTC) has been represented in the following graphic, where the trajectory of the inbound aircraft is indicated in red, and that of the outbound aircraft is indicated in blue.



Illustration 18 Aircraft trajectories at the moment of touchdown

The landing EI-DYR aircraft touched down on the runway with a ground speed of 141 kt. For its part, the EI-ENH aircraft was on its take-off run executing the rotation manoeuvre, with a ground speed of 157 kt. The distance between the two aircraft was 520 m (0.28 NM). This was the point of minimum separation between the two aircraft.

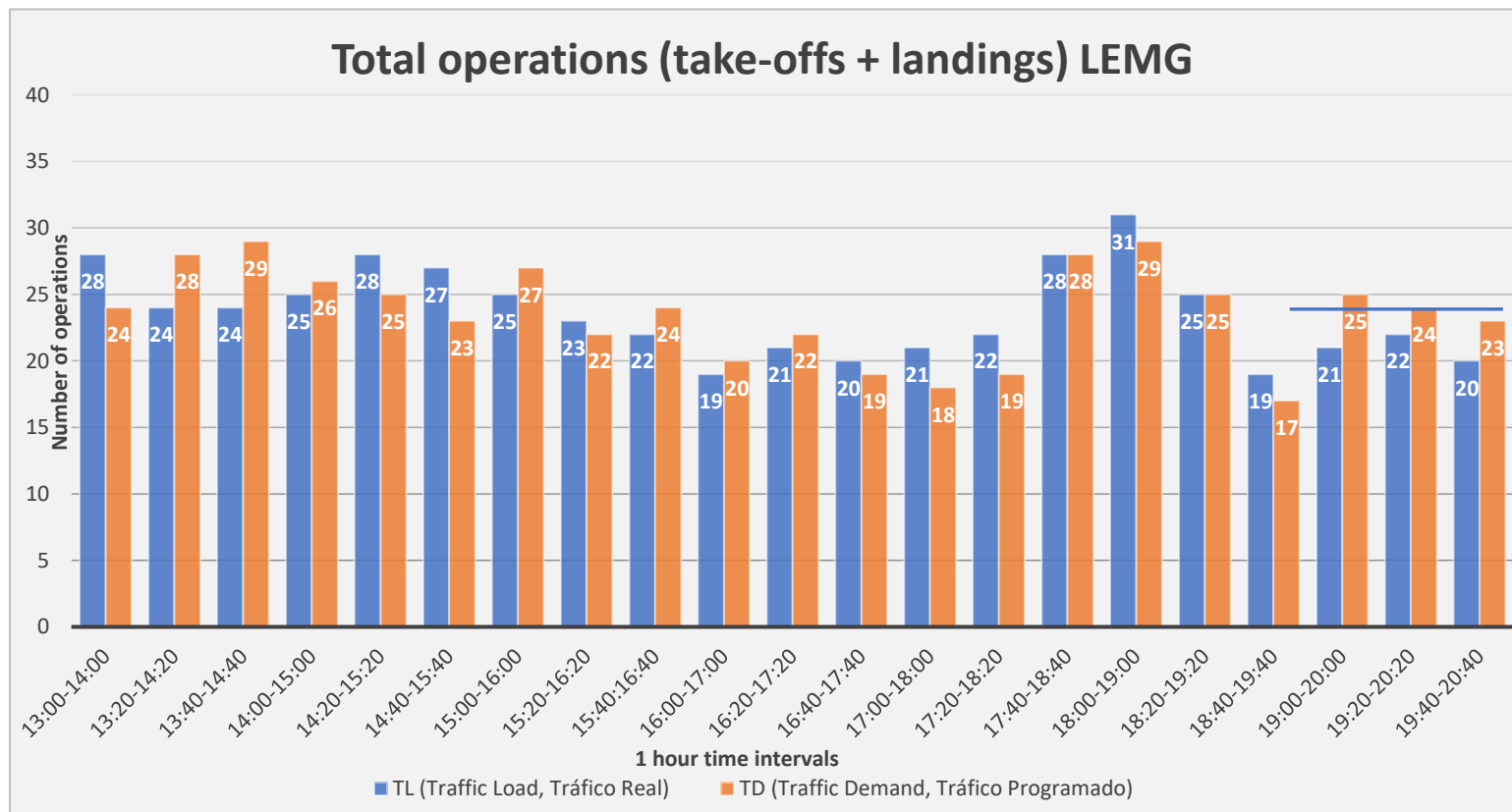
According to provision 4.5.10.1.1 of the Air Traffic Regulations, the minimum separation should have been at least the length of the runway in use, i.e., 3,200 m (1.7 NM). Therefore, the separation between the aircraft was reduced to approximately 16% of the statutory minimum.

2.3. Analysis of the capacity

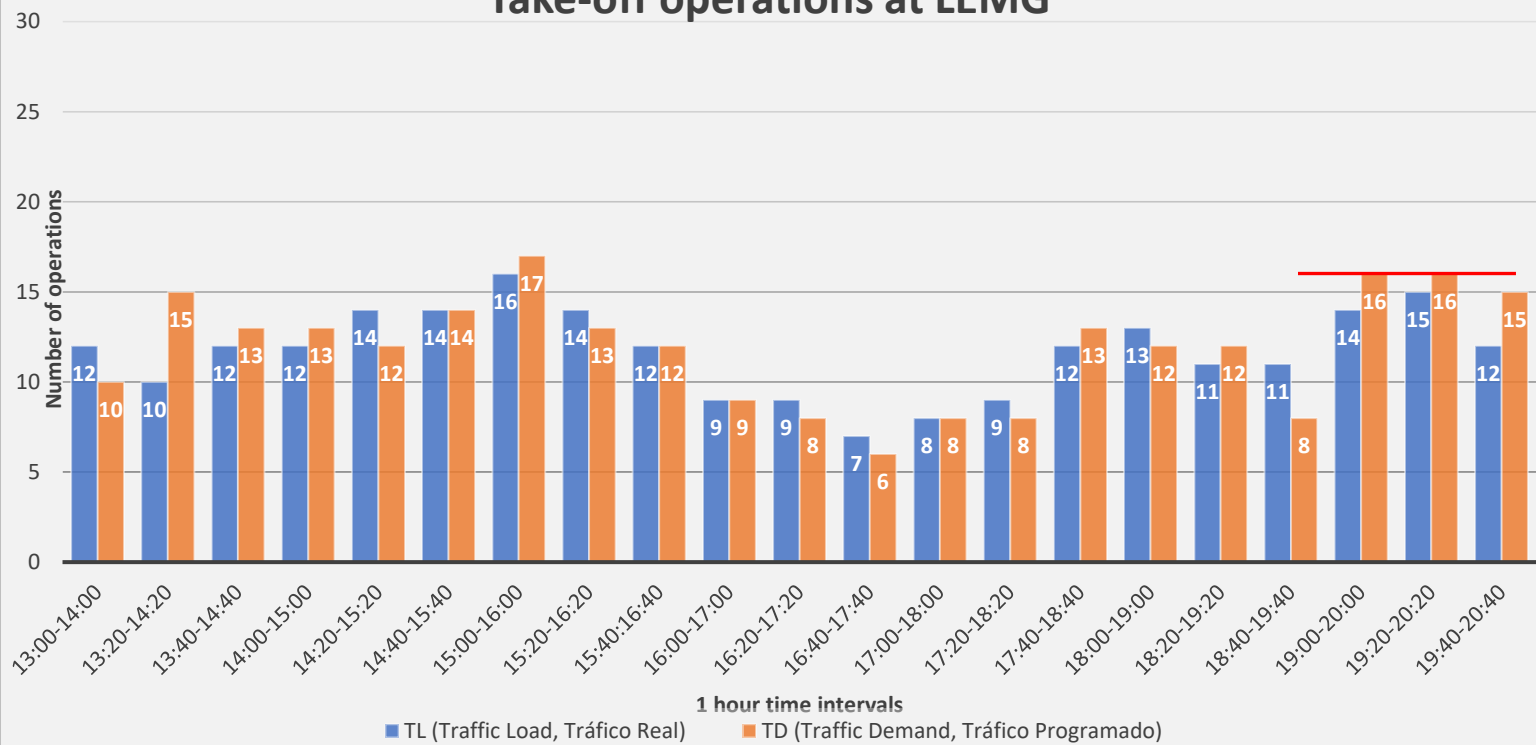
Declared Capacity is the maximum permitted traffic flow within a specific unit of time that can be maintained over time in accordance with the safety requirements.

As described in section 1.17.4, “Capacity control procedures at Málaga-Costa del Sol airport”, at the time of the incident (19:50 UTC), the airport was operating with 1 open runway and 2 control positions, with the ATC Capacity (TWR) being the most restrictive and, therefore, the Declared Capacity. This capacity was 24 total operations per hour, 16 departures per hour and 16 arrivals per hour.

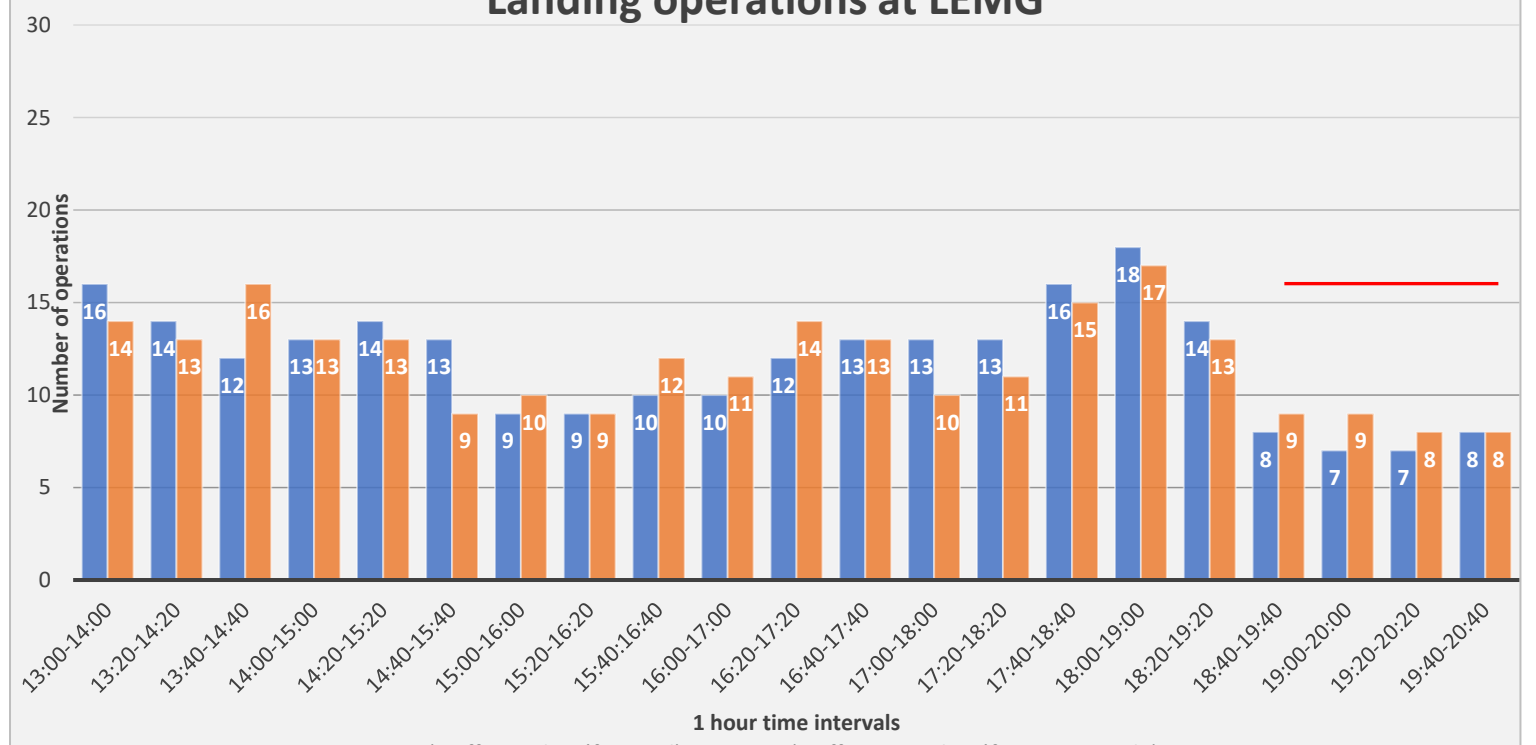
The following graphs represent the scheduled traffic in orange and the actual traffic in blue on 11 September 2019. The number of total operations, take-offs and landings are shown in time intervals of 1 hour, each separated by 20 minutes.



Take-off operations at LEMG



Landing operations at LEMG



In the graphs, the red horizontal line represents the capacity limit in the time slots in which only 2 control positions were open. The following can be observed:

- At the time of the incident (19:50 UTC), the actual traffic, both in terms of take-offs, landings and total operations, did not exceed the capacity limit for two open tower control positions.

Therefore, it is considered that, at the time of the incident, the workload was appropriate for the control positions that were open in the control tower. The volume of traffic at the time of the incident is not deemed to have been a factor in the decisions made by the air traffic controller when adjusting the arrival and take-off traffic.

2.4. Analysis of the repetitiveness of loss-of-separation events at Málaga-Costa del Sol Airport

Section 1.18.1, “*Similar incidents at Málaga-Costa del Sol airport*”, details the incidents involving a loss of separation between aircrafts that have occurred at the airport while in a single-runway configuration.

A total of 34 events have been reported to the National Occurrence System since 2019. Among them, the following are considered to be highly relevant:

- 4 events in which the landing aircraft executed a go-around manoeuvre at the initiative of the flight crew itself
- 8 events in which the distance between the aircraft landing and taking off was less than 1 NM

Given the repetitiveness of these events, ENAIRE identified historical, organisational and human factors that have contributed to particular ways of working in the unit, associated with adjustments between traffics. The most important factors detected by ENAIRE were as follows:

- Historical factors: reduced runway separation procedures applied until 2017 in the Málaga unit that led to inertia in work modes.
- Organisational factors: The ATC unit training plan does not reflect specific training scenarios for changes of plan or strategies for mitigating cognitive biases. The regulations do not explicitly require this. Furthermore, the operating manual contains general guidelines for separation between departures and arrivals but does not include specific adjust/don't adjust criteria.
- Proximal factors: Operational pressures when handling departures, self-induced pressure to take advantage of gaps in arrivals and a tendency to use nominal gaps of 7 NM for 2 departures.
- Human factors: Expectation bias in regard to the crew's response to immediate take-off clearance, plan continuation bias and aversion to cancelling take-off clearances.

Given the factors identified, on 24 October 2019, ENAIRE drafted the “*first LEMG Action Plan*”, with 11 corrective measures that were completed by February 2020.

Despite this first action plan, in February 2020, the loss-of-separation events continued to occur. Moreover, although there were fewer of them, some were classified as severe even after the first action plan had been fully implemented. The measures adopted in the first action plan included:

- Dissemination measures
- Culture reinforcement

While these measures are deemed to have been necessary, they were not sufficient to avoid recurring losses of separation at the unit. In addition, the historical factor detected by ENAIRE in its internal analysis is not considered to be directly related to the working modes acquired in the unit. The reduced separation minima procedures, as established in section 4.5.11 of the Air Traffic Regulation, are only applicable during the day, and are not applicable at night, as in the case of the incident.

As a consequence, on 08 October 2020, ENAIRE implemented the “*second LEMG Action Plan*”. The new action plan contained dissemination actions, operational support measures and reinforcement measures in the control tower cab.

The implementation of the second action plan was completed in February 2021. Since then, no relevant events involving a loss of separation between arrivals and departures at Málaga-Costa del Sol Airport have been reported.

The measures adopted in the second action plan included:

- Operational support
 - Criteria to support single runway decision-making
 - A recommendation guide with information on timings and distances
- Operational reinforcement in the control tower cab
 - Operational reinforcement with the presence of an ATC technician in the control tower cab

We have, therefore, concluded that the measures taken by ENAIRE in the second action plan, which included operational measures, have succeeded in mitigating the historical, organisational and human factors detected in the unit.

3. CONCLUSIONS

3.1. Findings

- When issuing taxiing instructions to the aircraft preparing to take off, the air traffic controller at the LCL position did not specify which holding point it should go to.
- Given that no particular holding point was specified, the crew of the aircraft preparing to take off, with registration EI-ENH, chose to taxi to holding point HN-3, in accordance with information given in the AIP.
- Holding point HN-3 is the furthest from the runway head and has an uphill slope, significantly increasing runway access time compared to the other holding points.
- The air traffic controller in the LCL position instructed aircraft EI-ENH to line up on the runway and hold when the aircraft on approach was established on final at a 3.9 NM from the threshold of the runway.
- The air traffic controller in the LCL position cleared aircraft EI-ENH for immediate take-off when it was initiating its taxi towards the head of the runway, and the aircraft on approach was established on final at a 3.1 NM from the threshold.
- The air traffic controller in the LCL position did not consult the departure traffic to see if it was ready for immediate take-off, nor did he inform it of the position of the arrival traffic.
- The take-off aircraft, with registration EI-ENH, took 58 seconds to travel from holding point HN-3 and line up on the runway, without stopping at any time and without any significant or excessive delay.
- The air traffic controller at the LCL position authorised the EI-DYR aircraft to land with the preceding traffic in view when it was proceeding to 200 ft of altitude AMSL, and the separation with the aircraft on take-off was 0.4 NM; the runway, therefore, being occupied.
- The minimum separation between the two aircraft was 520 m (0.28 NM), with both aircraft on the runway.
- The actual traffic at the time of the incident did not exceed the ATC capacity.
- Since 2019, a total of 34 events involving a loss of separation between aircrafts at Málaga-Costa del Sol airport have been reported to the National Occurrence System.
- ENAIRE, as the air traffic service provider, has implemented two action plans to mitigate the recurring loss-of-separation incidents at Málaga-Costa del Sol airport.
- The incident did not involve any type of damage to persons or property.

3.2. Causes/contributing factors

The investigation has determined that the incident occurred because an aircraft was given clearance to land on a runway that was occupied by another aircraft in the process of taking off, without respecting the regulatory distances.

Deficient planning by the air traffic controller, who took advantage of a gap between two landings to authorise a take-off, is considered to have been a contributing factor in the incident.

Furthermore, given the immediate danger posed by the loss of regulatory separation, the absence of decision-making (to cancel the take-off, for example) by the air traffic controller is also deemed to have been a factor.

4. OPERATIONAL SAFETY RECOMMENDATIONS

As a result of the repeated and elevated number of incidents involving a loss of separation at Málaga-Costa del Sol Airport (LEMG), the CIAIAC decided to approve and issue the following urgent safety recommendations before concluding the investigation and prior to the approval and publication of the final report.

The first safety recommendation, addressed to ENAIRE, was issued on 04 November 2020:

REC 18/20: It is recommended that ENAIRE, as the provider of air navigation services, should initiate a hazard identification and risk assessment process for the recent loss-of-separation events at Málaga-Costa del Sol Airport (LEMG) and coordinate with AESA to propose mitigation measures.

On 11 November 2020, ENAIRE issued a response to REC 18/20, the content of which was assessed as UNSATISFACTORY by the CIAIAC. On 24 February 2021, ENAIRE issued a second response to REC 18/20, the content of which was assessed as CLOSED, SATISFACTORY ANSWER.

The second safety recommendation, addressed to AESA, was issued on 04 November 2020:

REC 19/20: It is recommended that AESA should review the hazard identification and risk assessment process for the recent loss-of-separation events at Málaga-Costa del Sol Airport (LEMG), as well as the proposal for mitigation measures recommended to ENAIRE in recommendation REC 18/20

On 24 February 2021, AESA issued a response to REC 19/20, the content of which was assessed as CLOSED, SATISFACTORY ANSWER.