# Technical report

# IN-031/2022

---

Incident on 29 April 2022 involving an Airbus 320 aircraft operated by Vueling, registration EC-KLT, and a Boeing 737 aircraft operated by Ryanair, registration EI-EPA, at Josep Tarradellas Barcelona-El Prat Airport (Barcelona, Spain)



GOBIERNO DE ESPAÑA
MINISTERIO DE TRANSPORTES Y MOVILIDAD SOSTENIBLE
SUBSECRETARÍA
COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

# NOTICE

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission 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 5.5 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.

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.

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

# CONTENTS

# ABBREVIATIONS

AESA ..... Spain's National Aviation Safety Agency

AIP ..... Aeronautical Information Publication

APP ..... Approach control service

A-SMGCS ..... Advanced surface movement guidance and control system

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

ATZ ..... Aerodrome transit zone

CIAIAC ..... Civil Aviation Accident and Incident Investigation Commission

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

DFTI ..... Distance from touchdown indicator

GA ..... Go-around manoeuvre

GS ..... Ground speed

IAS ..... Indicated airspeed

IFR ..... Instrument flight rules

IR(A) ..... Instrument rating

km ..... Kilometres

kt ..... Knots

L ..... Left (in reference to runway identification)

LCL ..... Local (in reference to control position)

LEBL ..... ICAO code for Josep Tarradellas Barcelona-El Prat Airport

m ..... Metres

METAR ..... Aviation routine weather report

NM ..... Nautical miles

RWY ..... Runway

R ..... Right (in reference to runway identification)

s/n ..... Serial number

SACTA ..... Automated air traffic control system

TWR ..... Aerodrome control tower

UTC ..... Coordinated universal time

VIG ..... General information window

# Technical Report IN-031/2022

| | |
|---|---|
| Owner and operator: | 1: Vueling |
| | 2: Ryanair |
| Aircraft: | 1: Airbus A-320-216, EC-KLT (Spain) |
| | 2: Boeing 737-800, EI-EPA (Ireland) |
| Date and time of incident: | Friday, 29 April 2022; 21:40 local time (19:40 UTC)[1] |
| Site of accident: | Josep Tarradellas Barcelona-El Prat Airport (Barcelona) |
| Persons on board: | 1: 6 crew members + 152 passengers (unharmed) |
| | 2: 6 crew members + 150 passengers (unharmed) |
| Type of flight: | 1: Commercial air transport - international - passengers |
| | 2: Commercial air transport - international - passengers |
| Phase of flight: | 1. Approach |
| | 2. Take-off – take-off run |
| Flight rules: | 1. IFR |
| | 2. IFR |
| Date of approval: | 24 April 2024 |

# Synopsis

Summary:

On Friday, 29 April 2022, at 21:40 local time in night conditions, two aircraft crossed paths on runway 06R (the EC-KLT aircraft on approach to runway 02 and the EI-EPA aircraft on take-off from runway 06R) at Barcelona Airport (LEBL) while following ATC instructions.

The aircraft on take-off had not rotated and was on the first third of the runway and the aircraft on approach was initiating a go-around as instructed by ATC. The separation between the two aircraft was 285 m horizontally and 59 ft (18 m) vertically.

The investigation focused on the service provided by the Barcelona control tower as the most significant factor in the event and, to a lesser extent, on the detection and management of the conflict by the aircraft.

The investigation concluded that the probable cause of the incident was the issue of a clearance to take off from runway 06R with traffic on approach to runway 02 at less than the 4NM distance stablished for the ENR configuration.

The report contains 4 safety recommendations addressed to ENAIRE, the organisation responsible for the air traffic control service in the Barcelona control tower.

[1] All times referenced were obtained from the tower ATC service. At the time of year the incident took place, UTC is calculated by subtracting 2 hours from the local time.

# 1. FACTUAL INFORMATION

## 1.1. Summary of the incident

On Friday, 29 April 2022, at 21:40 local time in night conditions, two aircraft crossed paths on runway 06R (the EC-KLT aircraft on approach to runway 02 and the EI-EPA aircraft on take-off from runway 06R) at Barcelona Airport (LEBL).

The airport had changed its operating configuration 12 minutes before the event, from operating in the WRL daytime preferred configuration with parallel runways (24R for arrivals and 24L for take-offs) to the ENR[2] night-time preferred configuration with intersecting runways (landings on runway 02 and take-offs on runway 06R). The new configuration affected the local controller for runway 24L in position 2 of the east tower, who, previously in charge of take-offs on 24L, became the single local controller responsible for take-offs on 06R and arrivals on 02.


Figure 1. Change of configuration at 21:28 (12 minutes before the incident)

The configuration change required manual modifications to the information display system to be made by each controller at their position[3], which, in this case, were not completed at position 2. Specifically, the arrival runway selected (in green in Figure 1) in the general information window (VIG) was not changed. Consequently, the times and distances to the threshold for the inbound traffic that the local controller saw on his screen[4] were longer than the actual times and distances because the system's calculations were based on using runway 24R rather than runway 02. In this context, at 21:39:09, the local controller cleared the aircraft that was taxiing to take off from runway 06R, thinking that the approaching aircraft was further away than it was.

The aircraft continued to follow the instructions received until 21:39:57 when the proximity conflict alert (VIO) was triggered in TWR. Thirteen seconds later, at 21:40:10, the controller instructed the approaching EC-KLT aircraft to go around while the other EI-EPA aircraft continued with its take-off.

The two aircraft crossed paths on runway 06R at 21:40:13, with a horizontal separation of 285 m and a vertical separation of 59 ft (18 m). The approaching aircraft was flying over the runway at

[2] According to the AIP the ENR night-time operating configuration is enabled from 23:00 to 07:00 local time. On the day of the incident, the changeover was brought forward from 23:00 to 21:28. Under certain conditions (weather and traffic) this change can be done. The day of the event, these conditions were met.
[3] The term position refers to the integrated tower control position (PICT).
[4] This data is shown on the last line of the arriving traffic's label.

148 kt IAS and 59 ft (18 m) altitude, while the aircraft on take-off was accelerating at 97 kt GS but had not yet executed the rotation.

The aircraft on take-off completed its manoeuvre. The inbound aircraft executed a missed approach and subsequently landed on runway 02 without further incident. There was no damage and nobody on board was injured during the incident.

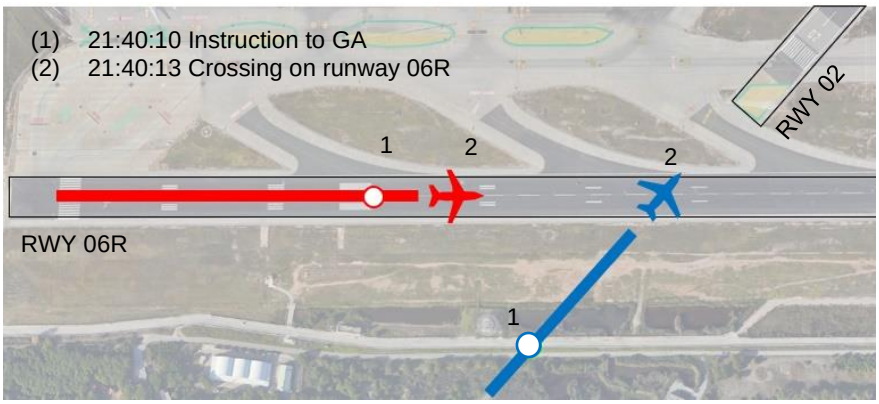



Figure 2. Crossing of the two aircraft on the runway 06R at 21:40:13

## 1.2. Injuries to persons

| Injuries | Crew | Passengers | Total in the aircraft | Others |
|---|---|---|---|---|
| Fatalities | | | | |
| Serious | | | | |
| Minor | | | | |
| Unharmed | 6 | 152 | 158 | --- |
| TOTAL | 6 | 152 | 158 | --- |

Figure 3. Injuries aircraft on approach Vueling EC-KLT

| Injuries | Crew | Passengers | Total in the aircraft | Others |
|---|---|---|---|---|
| Fatalities | | | | |
| Serious | | | | |
| Minor | | | | |
| Unharmed | 6 | 150 | 156 | --- |
| TOTAL | 6 | 150 | 156 | --- |

Figure 4. Injuries aircraft on take-off Ryanair EI-EPA

## 1.3. Damage to the aircraft

None.

## 1.4. Other damages

None.

## 1.5. Information about the personnel

### 1.5.1. Control personnel

Single local controller

The single local controller[5] was 32 years old and had an air traffic controller license issued by AESA on 06 October 2021. His experience in the unit was approximately 7 months, completed during the post-pandemic period as he was recruited in the last intake of controllers. He held the unit endorsements with an aerodrome control rating valid until 30 September 2022. His experience as a single local controller was approximately 45 h[6], with the majority in ENR configuration. On that day, he had started work at 14:30 and was about to finish his shift, which ended at 22:00. When the conflict occurred, he was in the last block of the 20:30-22:00 period.

Supervisor

The supervisor was 60 years old and had an air traffic controller license issued by AESA on 19 January 1999. He had 22 years of experience at the unit. He held the unit endorsements with an aerodrome control rating valid until 02 February 2023. On that day, he was working the night shift, and although he started at 22:00, he had arrived earlier than 21:30.

### 1.5.2. Flight crew

1.5.1 Aircraft on approach EC-KLT

Captain

The 40-year-old captain had a valid ATPL(A) licence and valid A320 and IR(A) ratings. His medical certificate was also in force at the time of the incident and did not specify any limitations. His total flight experience was approximately 10000 hours. On the A319/320/321, he had flown 6935 hours, acquired entirely at Vueling, where he had worked since 2010. He qualified as a captain in 2013.

His flight activity that day had started at 12:25 after several days of rest beforehand. The incident flight was his second and last flight of the day, and he was in the left-hand seat. He had flown with the co-pilot on numerous occasions. He was based in Barcelona, so he was very familiar with the airport, including its configuration changes for environmental reasons.

Co-pilot

The 25-year-old co-pilot had a valid CPL(A) licence and valid A320 and IR(A) ratings. His medical certificate was also in force at the time of the incident and specified a visual limitation that required him to wear corrective lenses for distance vision. His total flight experience was approximately

[5] Single controller means that only one aerodrome controller was responsible for both the arrivals on runway 02 and departures from runway 06R.
[6] Which amounts to approximately 5 nights.

1800 hours. He had flown 1350 hours on the A319/320/321, acquired entirely as a co-pilot for Vueling, where he had worked since 2018.

He was based in Barcelona, so was very familiar with the airport. His flight activity on the day of the event was identical to that of the captain. His position in the aircraft was the right-hand seat.

1.5.2 Aircraft on take-off EI-EPA

Captain

The 36-year-old captain had a valid ATPL(A) licence and valid B737 and IR(A) ratings. His medical certificate was in force at the time of the incident and did not specify any limitations. His total flight experience was 9268 hours, of which 8953 had been in the B737 300-900. He had been working for Ryanair since 2009 and was currently based at Luton (London).

The incident flight was the fourth and final sector of the day and he had been on active duty for 6:28 hours. He was sat in the left-hand seat of the cockpit. With regard to his experience at Barcelona airport, he stated that it was familiar to him as he had been based at Palma de Mallorca in 2015 and from there, he flew 2-3 times a week to Barcelona. From his current base, however, he only flew to Barcelona occasionally. As for the operating configuration at LEBL, he stated that it is quite predictable as 90% of the time, runways 24 are in service. He had only used runway 02 a couple of times.

Co-pilot

The 30-year-old co-pilot had a valid CPL(A) licence and valid B737 and IR(A) ratings. His medical certificate was also in force at the time of the incident and did not specify any limitations. His total flight experience was 1803 hours, of which 1647 had been in the B737 300-900.

On the day of the incident, he had started work alongside the captain, so his hours of active duty were the same. His position in the cockpit was the right-hand seat. With regard to his experience at Barcelona Airport, he stated that he had flown there approximately 15 times. He had never taken off on runway 06R but had landed on runway 02.

## 1.6. Information about the aircraft

The aircraft on approach was an Airbus A320-216 s/n 3376 operated by Vueling Airlines. It had an airworthiness review certificate issued in January 2022, in force at the time of the incident.

The aircraft on take-off was a Boeing 737-8AS s/n 34987 operated by Ryanair. It had an airworthiness review certificate issued in October 2021, in force at the time of the incident.

Neither aircraft had any anomaly or system that influenced the event. Both aircraft have similar dimensions and operating characteristics, and on the day of the event they were similarly loaded.

## 1.7. Meteorological information

At 21:30[7], despite being dark at Barcelona Airport, the conditions were calm with maximum visibility. According to the information gathered in the interviews with the controllers and crews, these conditions allowed visual contact between tower-aircraft and aircraft-aircraft, although with the limitations described in sections 1.16.11 and 1.16.12.

## 1.8. Aids to navigation

The relevant information on aids to navigation is included in section 1.11.

## 1.9. Communications

In regard to the communications exchanged during the incident, the investigation has only had access to the communications between the aircraft and ATC, and these have been incorporated into section 1.11 to facilitate understanding of the sequence of events.

The cockpit communications from both aircraft were recorded over because the incident was not reported to the CIAIAC directly but to the SNS by Vueling and to the Irish Aviation Authority by Ryanair. The CIAIAC was made aware of the event on 13/05/2022 by the SNS and on 09/06/2022 by the Irish Accident Investigation Unit. The investigation was opened on 15/06/2022, almost two months after the event, and therefore, these communications were no longer available.

## 1.10. Information about the aerodrome

Josep Tarradellas Barcelona-El Prat Airport (LEBL) is located 10 km to the southwest of the city of Barcelona at an elevation of 4 m (14 ft). It has three runways: two parallel and one intersecting.

The runways are used in accordance with the operating configurations published in the AIP. Among the possible configurations are two preferred operating configurations: daytime WRL with parallel runways and night-time ENR with intersecting runways, which are activated at 07:00 and 23:00, respectively. The AIP also stipulates that under certain conditions[8], the night-time configuration may be extended beyond 07:00 or brought forward before 23:00, as was the case on the day of the event when it was brought forward by 1 h 32 min.

[7] METAR at 21:30 local time: wind direction 210º, wind speed 3 knots, visibility more than 10 km, scattered clouds at 5000 ft above the ground, temperature 17ºC, QNH 1022 and no change expected. METAR LEBL 291930Z 21003KT 9999 FEW050 17/12 Q1022 NOSIG=

[8] These conditions are based on weather and traffic criteria and were met on that day.

The TWR control service at Barcelona airport is provided by ENAIRE and its staff are stationed in two towers. The controller responsible for the aircraft involved in the event was stationed in the east TWR, the location of which is shown in Figure 5.

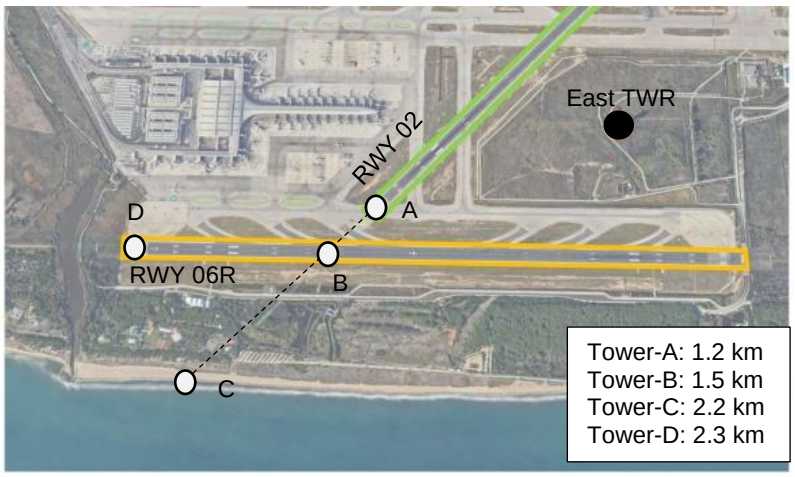



Figure 5. Separation between TWR and the aircraft (ENR configuration)

## 1.11. Flight recorders

This section integrates and outlines the information from the aircraft data recorders, the communications with the local controller involved in the event, the radar traces and the A-SMGCS[9] alert warnings. The relevant time frame starts at 21:19:58 during the configuration change process. The previous events are not significant to the investigation and are therefore not included.

Preliminary coordination before the change

21:19:58 The airport was in the WRL daytime preferred configuration. Communications were recorded between the LCL24L controller in charge of departures on runway 24L and TMA Barcelona to agree on the last departure traffic in the daytime configuration, as per the letter of agreement between the two units. The coordination was carried out correctly, and no errors were identified in the transmission of information.

Configuration change and runway selection error in the VIG

21:28:00 Start of ENR configuration. The supervisor had already modified the "RUNWAY USAGE[10]" correctly. Consequently, all control positions displayed the new operational runways with the correct symbols and colours[11]. The RW runway incursion alerts were activated centrally and locally at position number 2.

[9] The A-SMGCS system, which is part of the SACTA system, detects conflicts in the airport environment and reports them in the form of visual and acoustic hazard warnings (WRN) and violation warnings (VIO) on the controller's display.
[10] The A-SMGCS RUNWAY USAGE menu allows the personnel to define the use of runways (in use, not in use and closed) and the directions (take-offs, arrivals or mixed), which at the same time enables the service's A-SMGCS alert functionality.
[11] Runway contour colours, runway head colours and runway direction of use arrows. Figures 8 show this display.

The number 2 control position in the east tower was enabled to carry out the function of single local controller LCL, which meant the controller seated there, previously in charge of take-offs on runway 24L, became responsible for take-offs on 06R and arrivals on 02. This change implied several actions on the part of the controller, one of which was not carried out: the selection, in the general information window (VIG), of the new arrivals runway for the calculation of times and distances to the threshold (DFTI) (the previous runway, 24R, was left as the selected runway). As a consequence, in the VIG, the arrivals runway button remained in yellow and would remain so until after the event.

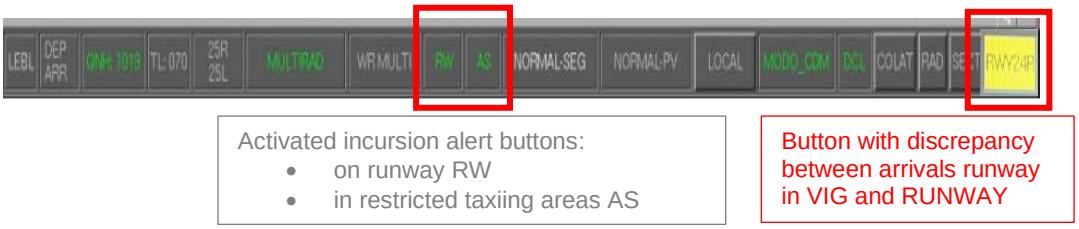



Figure 6. VIG of position 2 in the east tower

21:28:07 The first departing traffic reported its position at the holding point for runway 06R. Being the first departure after the change, the LCL controller requested approval from APP in accordance with the letter of agreement between the two agencies. During these communications, the local controller identified the traffic with an erroneous callsign on two occasions, although without any consequences for safety.

Traffic after the change of configuration

After the configuration change and leading up to the event, there were a total of 6 take-offs and 3 landings, sequenced as follows: 2 take-offs, 1 arrival, 3 take-offs, 1 arrival, 1 take-off and 1 arrival. During this period, the controller correctly provided information on other traffic, speeds and distances between arriving traffic. No conflicts occurred during these preceding sequences.

The two aircraft involved in the incident were the next departure (the 7th since the configuration change) and the next arrival (the 4th).

Traffic involved in the incident. First calls (1 and 2 in Figure 7)

21:36:16 First call from VLG1VD on approach, reporting that they were at 10 NM. They were cleared to proceed and were informed of the wind on runway 02. The next communication was from the controller clearing the ORO1022 traffic, which was ahead of VLG1VD, to land on runway 02.

21:38:34 First call from RYR18UD taxiing over K9 at 22 kt on a heading of 246º. The crew advised that they were taxiing to the 06R holding point and ready for take-off. The aircraft was cleared to enter and line up on runway 06R.
At that time, the VLG was 4.5 NM from the runway 02 threshold (5.8 NM for the controller).

21:39:04 The controller asked the RYR if it was ready for immediate departure, *"ready for immediate?"* informing them that there was traffic at 4 NM on final, but without specifying the runway. The crew replied in the affirmative.
At the time of these communications, the taxiing aircraft was still taxiing at 17 kt GS without having initiated a course change to enter the runway.
The aircraft on approach was actually at 3.1 NM (4.4 NM for the controller).

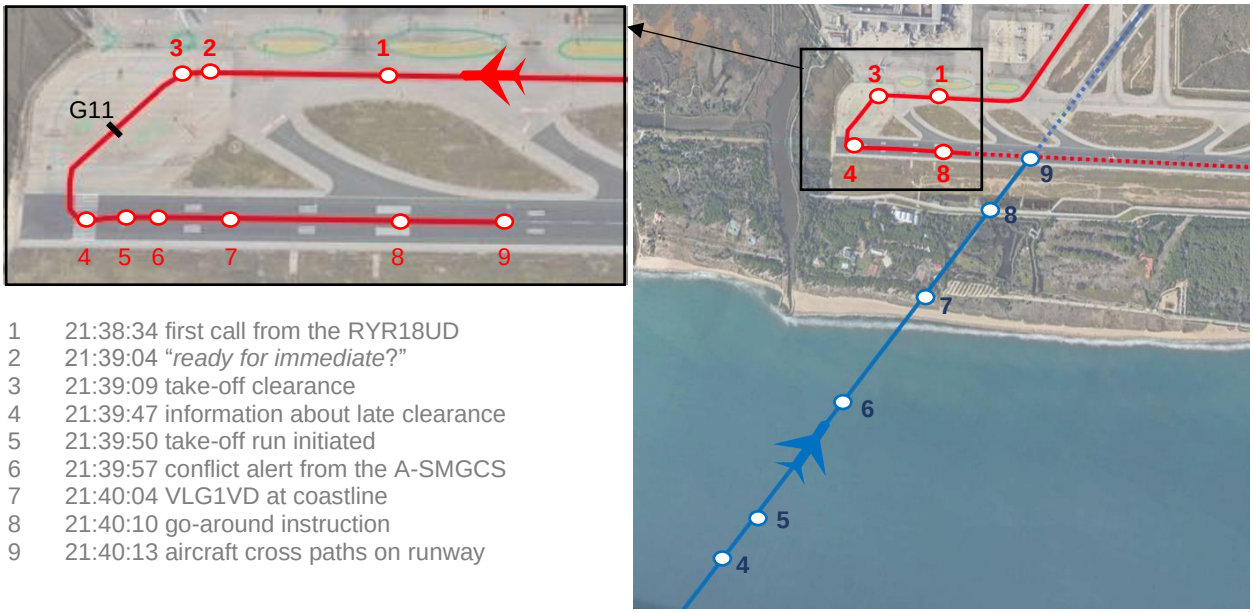
Take-off clearance (3 in Figure 7)

21:39:09 Clearance for take-off for the RYR using the words "*cleared for rolling take-off*", which was read back using the same exact words by the crew.
The aircraft on take-off was still taxiing at 14 kt GS, maintaining a heading of 245º parallel to the runway. At this point, it started to turn left to head towards G11 (one of the three runway holding points).
The aircraft on approach was 2.9 NM from the runway 02 threshold (4.1 NM for the controller).

21:39:15 The taxiing aircraft was reading back the take-off instruction at 13 kt GS.

21:39:25 The taxiing aircraft was crossing holding point G11 with the approaching aircraft at 2.2 NM actual (2 NM from the intersection[12]). This point is the D1 distance of the A-SMGCS alert activation (see section 1.16.1).

21:39:33 The controller was communicating with the ORO1022 aircraft ahead of the VLG, informing it of the new frequency once it had left the runway.




1 21:38:34 first call from the RYR18UD
2 21:39:04 "*ready for immediate*?"
3 21:39:09 take-off clearance
4 21:39:47 information about late clearance
5 21:39:50 take-off run initiated
6 21:39:57 conflict alert from the A-SMGCS
7 21:40:04 VLG1VD at coastline
8 21:40:10 go-around instruction
9 21:40:13 aircraft cross paths on runway

Figure 7. Trajectory prior to the crossing

Information about late clearance due to take-off (4 in Figure 7)

21:39:47 The controller notified the aircraft on approach: "*expect late landing clearance, one departure*". The VLG1VD crew read back "*Ok, no problem*".

[12] Crossing point refers to the intersection of runway 06R with the extension of runway 02.

The taxiing aircraft was lining up on the runway at 11 kt GS without having yet initiated the take-off run (it would do so 3 seconds later). The aircraft on approach was 1.3 NM from the head of runway 02 (2.6 NM for the controller) and 1.1 NM from the crossing point.

Start of take-off run (5 in Figure 7)

21:39:50 RYR18UD was commencing its take-off run on runway 06R. At that moment, the aircraft on approach was 1.1 NM from runway 02 (2.4 NM for the controller) and 0.9 NM from the crossing point.

21:39:52 The traffic preceding VLG1UD was leaving runway 02.

Activation of the conflict alert (VIO) for the controller (6 in Figure 7)

21:39:57 Activation of the A-SMGCS Level 2 conflict alert (VIO). The aircraft on approach was 0.9 NM from runway 02 (2.1 NM for the controller) and 0.7 NM from the crossing point. The aircraft on take-off was on the take-off run at 26 kt GS, having travelled 100 m from the threshold.

The warning was acknowledged by the controller at 21:40:04 and remained active for 16 seconds until the approaching aircraft passed the crossing point.


Figure 8. Activation of the VIO warnings on the controller's screen

VLG1UD sobre la línea de costa (7 in Figure 7)

21:40:04 The aircraft on approach had just crossed the coastline while the aircraft on take-off was accelerating at 59 kt GS and had travelled 170 m from the runway threshold. Between point 7 and 8 the VLG1UD crew detected the aircraft on the runway.

Go-around instruction to VLG1VD (8 in Figure 9)

21:40:10 The controller issued the go-around instruction in English *"go around"* to the approaching VLG1VD aircraft, which, at that time, was over the airport perimeter road 0.3 NM from runway 02 (1.6 NM for the controller) and 0.16 NM from the crossing point. The aircraft on take-off was accelerating at 85 kt GS, having travelled 425 m on the runway and was 420 m from the crossing point.

Crossing above the runway and end of conflict alert (VIO) (9 in Figures 7 and 9)

21:40:13 VLG1VD was flying over runway 06R at 59 ft (18 m) altitude, 148 kt IAS and -340 fpm while reading back the instruction and changing the autothrottle mode to TOGA. The traffic on take-off was on his left, accelerating at 97 kt GS without having rotated and at a distance of 285 m from VLG1UD, having travelled 550 m from the threshold markings.

After the crossing, by system definition, the conflict alert (VIO) disappeared from the local controller's screen, having been active for 16 seconds.

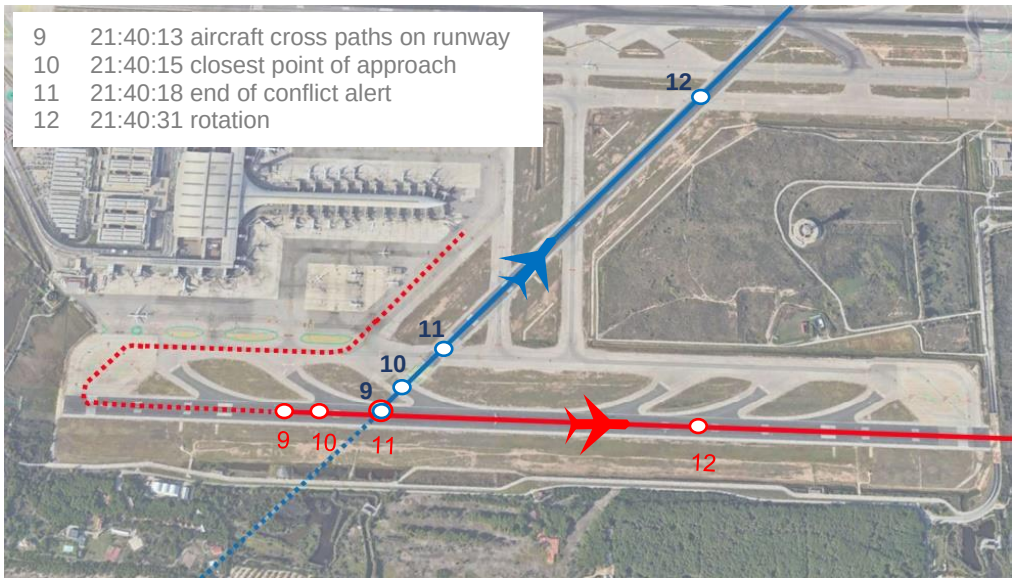



Figure 9. Trajectory after the crossing

Closest point of approach (10 in Figure 9)

21:40:15 The closest point of approach between the aircraft was 247 m and occurred after the approaching aircraft had flown over the runway 06R intersection. This moment coincided with the maximum descent of the VLD1UD to 44 ft. The aircraft on take-off was still on the take-off run at 105 kt GS, on the ground, and had not reached the crossing.

Rotation of RYR18UD (11 and 12 in Figure 9)

21:40:18 The traffic on take-off was crossing the runway 02 extension at 113 kt GS, still without having executed the rotation at the same time as VLG1UD reached the runway 02 threshold.

21:40:31 The traffic on take-off executed the rotation at 155 kt GS after having travelled 1800 m on the runway. At this time VLG1UD was flying above the runway and climbing.

After the event, one of the controllers in the cab approached position 2 and noticed that the VIG runway button was in yellow, i.e. runway 24R was still incorrectly selected as the arrival runway.

## 1.12. Aircraft wreckage and impact information

N/A.

## 1.13. Medical and pathological information

Investigation has found no evidence to suggest the actions of the flight crew were affected by any physiological or disabling factors.

## 1.14. Fire

There was no evidence of in-flight fire.

## 1.15. Survival aspects

N/A.

## 1.16. Tests and research

### 1.16.1 Activation of the VIO alert during the event

The design of the A-SMGCS level 2 system at TWR LEBL allowed for two types of runway incursion alerts to be activated, alerting the controller to a potential conflict due to close approach:

- WARNING (WRN), which is a visual pre-emptive alert. This warning is associated with the appearance of the letters WRN above the label and yellow highlighting around the radar label, which flashes until the controller acknowledges the warning.
- VIOLATION (VIO), which is a reactive visual and acoustic alert of greater severity. This warning is associated with the appearance of the letters VIO above the label (see Figure 8), a red highlight on the radar label, a red frame, bold font, flashing until the controller acknowledges the warning and a LAD, which is a red line connecting both traffics in conflict.

In this event (intersecting runways with take-offs and arrivals), the system skipped the first alert (WRN) and moved straight to the second. Which alert is triggered depends on the combination of four predefined distances to the crossing point, as shown in Figure 10, and on the progress of the aircraft on take-off. For this event, the defined distances were as follows: D1= 3704 m (2 NM), D2=D3=1852 m (1NM) and D4=1 m. As far as the aircraft on take-off is concerned, in addition to being on the runway, it must be travelling at a speed of over 20 kt.

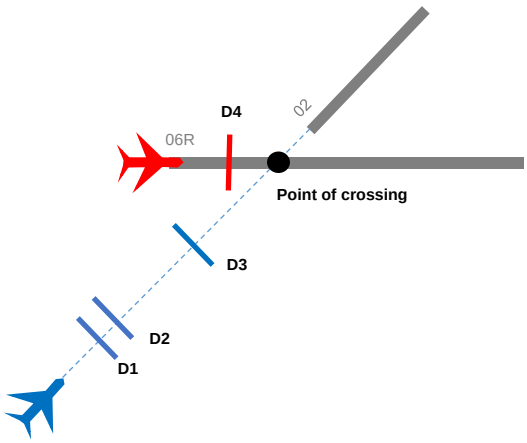



Figure 10. Alert activation geometry

This data explains why, even though the approaching aircraft had exceeded the D1 distance at 21:39:25, no WARNING or VIOLATION alert was triggered until 32 seconds later because during this period, the other aircraft was not on the runway during take-off and when it did enter the runway it was below 20 kt GS. This rules out system malfunctions.

### 1.16.2 Arrivals runway button in the VIG for the calculation of distances and times to the threshold

To assist with traffic management and, above all, to make adjustments between departing and arriving traffic, the controller responsible for arrivals has two pieces of information on the last line of the labels for each of their traffics: the time (in minutes and seconds) and the distance (in NM) to the runway (DFTI).

For the system to calculate these two pieces of information, the controller must enter the arrivals runway in the VIG at their position. In this incident, following the change of configuration, it had to be changed from RWY24R to RWY02. The runway is selected using the right-hand button in a horizontal line of 18 buttons called the VIG (general information window). This line, although configurable, i.e. it can be moved, always remains on the top left margin of the screen, as confirmed by the 10 unit controllers interviewed[13].

### 1.16.3 Illumination of the arrivals runway button in the VIG

The arrivals runway selected in the VIG, which serves exclusively to calculate the distances and times displayed to the controller on the label, is independent of the arrivals runway selected in the RUNWAY USAGE window. If the runway selected in RUNWAY USAGE differs from that selected in the VIG, the latter illuminates in yellow, as occurred in position 2 of the east tower. There is no other alarm and no other impact on the continuation of control duties, but the distances and the time to landing displayed will be wrong (higher or lower depending on the geometry between the arrival runways), and the button will remain illuminated in yellow on the screen.

This discrepancy between arrival runways is not unusual; the button illuminates during the initial stages of every configuration change after the supervisor changes the runway selected in the RUNWAY USAGE window, which causes the runway button on the VIG to illuminate at all control positions. In other words, it is a repeated and common occurrence for the yellow light to illuminate during the initial seconds of every configuration change.

### 1.16.4 Controller workstation and location of the VIG bar

The workstations in the Barcelona tower have 4 horizontal screens arranged as shown in Figure 11. The screen identified as number 2, the largest of the four, shows the traffic on a black background, a map of the area to be controlled, which each controller configures according to the relevant area, and any alerts emitted by the A-SMGCS level 2 system.

[13] They indicated that they always find the VIG in that position and some were even unaware that the VIG could move.

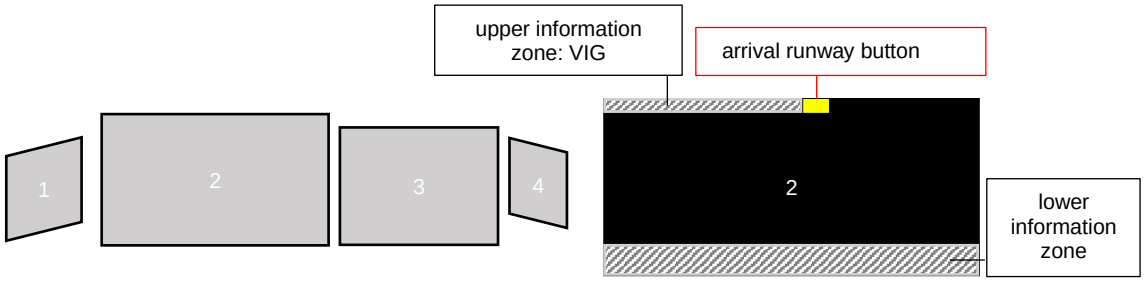



Figure 11. Controller's workstation and relative position of the VIG on screen 2

Of the total surface area of screen 2, 80% is dedicated to displaying traffic and 20% to displaying information and/or configurations, the latter being distributed between two areas: an elongated area at the bottom of the screen (18%) and an upper information line, the VIG, at the top left of the screen (2%). The VIG covers half the length of the screen, and the arrangement of its 18 buttons is always the same, with the arrival runway button on the right.

Of interest to the investigation is the fact that the information contained in the VIG does not have to be consulted to carry out control tasks but provides information on the operational status of the system's functions. The only exception is the QNH, which is included in the VIG, but the controllers consulted reported that they normally check the QNH on screen 4, which displays information about the weather and wind conditions (Cefiro and Hermes applications).

### 1.16.5 Distance references

At Barcelona Airport, controllers use various sources to obtain distance information. Their main reference is the information displayed on the radar label, which is calculated based on the runway selected in the VIG. Other references include the ATZ circle at 4 NM and the coastline depicted on the maps. In addition, the coastline, which is visible from the cab but hard to make out at night, provides an external visual reference during daylight hours.

### 1.16.6 Relevant information from the interview with the local controller

The controller at the single local position was interviewed. He provided the following data of interest to the investigation:

- When he took over as local controller, he had to modify the map and the zoom in order to see the whole of the ATZ and the runway 02 localiser.
- His impression of the traffic on take-off was that it was taxiing swiftly and that everything was running smoothly before the alarm was triggered. He couldn't recall anything that might be relevant happening before the incident.
- He recalled that the inbound traffic called him from a long way out, at mile 10, when they usually call at mile 4.
- He remembered looking outside and seeing that the VLG was close but then checking the label and finding it was further away.
- When the alarm went off, he was surprised.

He said that, according to his references, with inbound traffic at 1.4 min or 3.5 NM, there is sufficient margin to clear a take-off from 06R. The separation between arriving traffic in the ENR

configuration is 4 NM. Furthermore, he judged that the take-off would be quick because the RYR would not stop at the runway head but continue to taxi straight into a rolling take-off.

He described the cab as being quiet because the controllers due to work the next shift had not yet arrived, and there was no noise or distractions. Specifically, there were two other controllers in the cab, seated to his right in positions 3 and 4, as well as the supervisor. Regarding the workload, he stated that, although intersecting runways involve more concentration, he didn't recall having a high workload. The use of the intersecting runways ENR configuration had been commonplace during his training as it was used a lot in the post-pandemic period, and if distances are maintained, it's not particularly complex. Moreover, he pointed out that the change of configuration was not one of the more complex and that there are other more complicated transitions. The bringing forward of the ENR configuration to 17:00 in the afternoon happened quite often, so it wasn't a new configuration for him, nor was it the first time he had worked in it, although the traffic volume had been increasing.

With regard to selecting the runway for distance calculations, he stated that it had happened to him on other occasions but with no consequences because he had been in control positions where it wasn't relevant, for example, ground movements. Regarding the change of configuration, he described being clear about the sequence he had to follow, the first being to change the map and zoom and the second to change the runway in the VIG for DFTI. He stated that it was the controller at position number 4 who realised that his runway button for DFTI was lit up after the incident.

Regarding the VIO warnings, he pointed out that they can give false alarms, so the first thing he does is to check if the warning is real.

### 1.16.7 Relevant information from the interview with the controller located in position 3

The controller at position 3 was to the right of the local controller in position 2, so they could talk to each other normally. He was responsible for ground control, and on that day, as there wasn't much traffic, he transferred the traffic on take-off relatively early and was able to listen to the communications. He recalled that when he heard the taxiing traffic confirm they were ready for take-off, he told the local controller that there wasn't room. The local controller said there was because it was 3 NM away, and the ground movement controller told him that it was less than 2 NM away. He didn't insist any further.

### 1.16.8 Relevant information from the interview with the supervisor (night shift)

The night-shift supervisor who had just come on duty was interviewed. The most relevant information for the investigation is as follows:

- The ENR configuration was already implemented when he came on duty so he didn't have to do anything in that respect.
- After the handover with the outgoing supervisor, he sat down in his position to prepare the briefing (notams, airport works, movements and demand, current and forecast weather...) that he would give to the night-shift controllers who were due to come on duty half an hour later, at 22:00. However, a problem arose with the beacon console. He stood up to call the

electrical department and was still talking to them when he saw the GA, and the alarm went off.

- He approached the LCL position and saw the RYR taking off. The controller was busy coordinating the traffic he had instructed to go around, and he didn't realise the seriousness of what had happened. The controller's shift ended shortly afterwards, and he went home.

1.16.9 Relevant information from the interview with the supervisor (afternoon/evening shift)

The supervisor on the afternoon shift who carried out the change of configuration was interviewed, confirming that he didn't conduct the handover with the incoming supervisor until the change was effective. All actions related to the changeover to ENR were carried out by him. The incoming supervisor did not take any action in this regard. Among the tasks he had to carry out for the configuration change, the change in the RUNWAY USAGE window was the last thing he did.

The configuration change was carried out calmly and without the haste that a change of configuration due to weather, for example, can entail (with additional pressure from the operations).

Regarding the workload of the local controller at the time, he was of the opinion that he was not overworked or overstretched.

1.16.10 Relevant information from the interviews with the TWR LEBL controllers

During the investigation, 10 face-to-face and telephone interviews were conducted with controllers at the TWR LEBL unit, including supervisors and instructors. Among those interviewed, the range of experience both as controller and at the unit was very wide (from 22 years to 7 months). The findings of interest to the investigation are listed below:

- With regard to selecting the arrival runway in the VIG, all indicated that either it had happened to them or that they knew someone who had forgotten to select the runway.
- With regard to the emphasis placed on this task during their training, all were aware of its importance for the calculation of distances and agreed a great deal of emphasis had been placed on it in training, to the extent that a failure in this aspect was grounds for suspension.
- Regarding the yellow highlighting: the yellow highlighting, implemented relatively recently, was deemed an improvement to the system used to alert them to an arrival runway discrepancy. The older controllers who had worked without the enhancement viewed it very positively and found it helpful. Regarding the capacity of the yellow colour to alert them, they stated that it attracted attention because the rest of the screen is black or grey.
- Regarding the information they used from the VIG, all except one interviewee confirmed that none of the data in the VIG was required to perform control tasks that would make it necessary to look at that area of the screen. Only one of the interviewees said they consulted the QNH on that bar rather than in the Hermes application, which is where the other controllers checked that data.
- With regard to the VIO incursion alerts, all the controllers confirmed that they frequently produce false alarms (false alarms were a weekly occurrence, and all the controllers consulted had experienced one in the last week). Some of the controllers estimated that 90-

99% of the VIO alerts are false. The system had only recently been implemented (approximately a year ago), and they felt that it was still immature. The majority reported false alarm issues with the windsock and duplicate echoes. In fact, the first thing they do when they receive an alert is to check the veracity of the warning: first, they look at the screen and then outside. They do not deactivate the audible warning.

- As for the phrase "*expect late landing clearance*", all the controllers used it because it allows them to delay the clearance until just before touchdown. Some delayed the clearance until mile 1 at the latest, while others felt the clearance could be delayed until just before the touchdown.
- With regard to the phrase *"Rolling take-off"*, the responses varied: some controllers never used it, while others did. [14]
- Regarding the ENR configuration, all agreed it requires more attention to make adjustments, but they did not find it stressful. All had internalised the fact that 4 NM were needed, with the limit to clear a take-off being when the inbound traffic was at 3 NM.

### 1.16.11 Visibility from the local controller position

During the visit to the east tower, it was found that position 2, where the single local controller sits in the ENR configuration, is opposite the intersection of runways 02 and 06R, with visibility of arriving and departing traffic, but with the following limitations:

- The arriving traffic is almost head-on, so the controller has no perspective of the separation between two consecutive traffics on approach.
- The only way to discern distance is through the brightness of the aircraft's landing lights, and this only serves to discern very long distances from very short distances.
- The separation distances between the controller and the traffic operating on the intersecting runways vary between 1.2 and 2.3 km, as shown in Figure 5.

This means that, although visual contact was feasible on that day, as only a qualitative near-far assessment was possible rather than a quantitative one, it would have been impossible to judge the distance of the arriving traffic. Interviews with 10 controllers from the Barcelona tower control unit confirmed these conclusions.

### 1.16.12 Visibility from the cockpits

The ENR configuration involves the operation of aircraft on converging trajectories forming an angle of 40º. Based on the information gathered during the interviews and the relative positions of the two aircraft during the event, shown in Figure 7, the likelihood of visual detection between the two aircraft was very low:

- The traffic on take-off was the less likely of the two to be able to see the other, as the approaching traffic was almost directly to the right of it. From the cockpit, it would require a 90º head turn to the right.

[14] This is not a term that exists as such in any official document. The official phraseology is *" "cleared for immediate take-off".*

- The crew on board the arriving traffic crew would have needed to raise their heads and look to the left over the front instrument panel to see a traffic initiating the take-off run.

### 1.16.13 Relevant information from the interviews with the aircraft on approach

The captain and co-pilot of the aircraft on approach were interviewed. The general description of the event provided by both pilots was consistent with the sequence of events obtained from the radar traces and ATC communications. The relevant information provided was as follows:

- The captain was the pilot at the controls.
- The approach frequency was very busy, and they heard multiple instructions for vectors, speed reductions and descents. They had prepared the approach for another runway but were then informed that the runway for arrivals would be 02. This involved preparing the FMS for the new approach and conducting a new briefing.
- They were transferred to TWR, which was quiet compared to APP, and TWR informed them that there was traffic ahead of them for 02. ATC's "late landing clearance" prompted them to look for traffic on their runway, with which they established visual contact and heard the preceding traffic notify leaving the runway.
- Under normal circumstances, they receive clearance to land at 4 NM. With late clearance, it can be delayed to 1 NM before or even 50-80 feet, so they were used to this instruction.
- When they saw the traffic taking off, they had passed the coastline and were at 200-300 ft. The aircraft on take-off was in the first 300 m of its run. They identified the model by its size and the company logo and assessed that it would take some time to get airborne. Based on this information, they decided to continue with the landing as climbing at that point would be worse due to the change of aircraft configuration and the possible descent and change of attitude that a GA would entail.
- They were surprised when, after the crossing, ATC instructed them to GA.
- They did not hear the take-off clearance and were not expecting traffic taking off on 06R.
- With regard to the prior identification of traffic on take-off, the background lighting (airport, terminal, etc.) can make it difficult to detect the specific position of a traffic.
- They did not recall seeing any TCAS warning during the event.

### 1.16.14 Relevant information obtained from take-off aircraft interviews

The captain and co-pilot of the aircraft on take-off were interviewed. The general description of the event provided by both pilots was consistent with the sequence of events obtained from the radar traces and ATC communications. The relevant information provided was as follows:

- They knew that they would be taking off from runway 06R before commencing the taxi, and although ATC didn't tell them that the arrivals were on runway 02, it was obvious to them.
- The pilot at the controls on that sector was the co-pilot, who was also in charge of communications, although the captain was in charge of the throttle.
- In relation to the ATC instructions, they stated that "rolling take-off" was commonly used at other airports and described a standard taxi at normal speed, not stopping on entering the runway and focusing on the checklists, checks and take-off simultaneously. Access to the

runway is constrained by the turn at the holding point, which you can't do as fast as a straight taxi.

- They were informed that there was traffic at 4 NM. In regard to this distance, they deemed that it was sufficient to be able to depart and said that, visually, it was impossible to assess whether the approaching aircraft was further away or closer than 4 NM.
- Before entering the runway, they looked toward the 02 approach path. They saw that there were a lot of lights on the RWY02 approach. This perspective was lost when they entered the runway, as the view is highly oblique, at more than 90º.
- The crew recalled making the 80 kt check and shortly afterwards, at about 90-100 kt, seeing an aircraft they were not expecting pass in front of them. The rotation speed was at 140 kt.
- They didn't consider aborting the take-off because the crossing had already occurred, and they judged that the take-off had not been compromised.
- They didn't recall hearing any clearance to land.
- Nor did they recall hearing the "expect late landing clearance", which they described as a fairly common clearance that is always related to traffic on the same runway as you.
- After completing the take-off, they wondered if the aircraft that had crossed was the 4 NM aircraft. ATC didn't give them any information about what had happened.
- They did not recall seeing any TCAS warning during the event.

### 1.17. Organisational and management information

The following documents provided by ENAIRE were reviewed:

- LEBL Operating Manual (S41-06-MAN-002-7.2).
- Procedure for use of ENR configuration in daylight hours (S41-16-PLC-001-1.2).
- Procedure for Configuration Changes at J.T. Barcelona-El Prat Airport (DORE-09-DTC-011-3.1).
- SACTA operating mode for control tower at J.T. Barcelona-El Prat Airport (S41-20-PES-004-1.4).
- Description of the function A-SMGCS Level 2. Runway Incursion Alerts and Restricted Areas (SGVDR3745.400).

The information included in the previous sections was extracted from these documents, as was the following information of interest to the investigation:

- The runway designator must be included in any communication related to that runway.
- Local controllers must visually check the runway and final approach area in both directions before issuing clearances.
- In the event of a runway crossing, they must ensure that they know the exact position of the applicant, the status of the runway (active or not active), the crossing point and the path it will follow.
- In the event of a possible loss of separation between arrivals and take-offs, the controller must apply, as appropriate, two types of measures:
  a) Cancel or delay the take-off
  b) Instruct the arriving aircraft to go around

- Local controllers should be aware that when the runway incursion warning functionality is enabled, runway incursion alarms will be triggered if an aircraft or vehicle crosses an active runway.
- The configuration change procedure specifies a series of tasks to be performed by the supervisor and by the controllers at each position:
  a) For the supervisor, there is a checklist with actions to be taken before and after the change.
  b) However, there isn't a checklist for the controller, and, in fact, some controllers have made their own checklists.
- The A-SMGCS system generates conflict alerts at enabled control positions to warn the controller that an aircraft or vehicle is or will be incorrectly present on a runway (RW) or in a restricted taxiing area (AS).
- Before the A-SMGCS Operational Safety alert service can be activated at the controller's position, the RUNWAY USAGE must have been previously defined according to the operational configuration at any given time.
- This function not only provides visual information to facilitate the controller's situational awareness but also enables the calculation of conflict alerts for both runway incursions and restricted taxiing zones.
- The function should be activated to be available at the control positions as well as the supervisor position.
- The ILS approaches in the ENR configuration set a 4 NM arrival gap but do not stipulate a cut-off point.

### 1.18. Additional information

N/A.

### 1.19. Special investigation techniques

N/A.

## 2. ANALYSIS

On Friday, 29 April 2022, at 21:40:13, during the take-off run of aircraft RYR18UD on runway 06R at Barcelona Airport, aircraft VLG1VD overflew it at 59 ft (18 m) on its way to land on runway 02. The crossing, formally classified as a safety event, occurred in post-sunset light conditions with the following geometry:

- The flight paths formed an angle of 40°.
- The horizontal and vertical separations were 285 m and 59 ft (18 m), respectively.
- The aircraft on take-off was accelerating to 97 kt GS while still far from the rotation, which it would execute 18 seconds later.
- The aircraft on approach at 148 kt IAS was at that moment initiating a go-around manoeuvre as instructed by ATC.

The following sections focus on the areas for improvement identified during the investigation, taking into account the following overview:

- The conflict originated in the control service operating from the Barcelona tower, this being the main contributor to the event (95%).
- Once the conflict arose, detection and management of the situation by the aircraft involved was more feasible for the aircraft on approach (4%) and virtually impossible for the aircraft on take-off (1%).

### 2.1. ATC: Failure to select the new arrivals runway in the VIG

The incident began at 21:28 when the airport configuration change took place. As far as the supervisor was concerned, the configuration change was carried out thoroughly and correctly, including modifying the RUNWAY USAGE in the system.

As a consequence of this change, the arrivals runway was changed from 24R to 02, and at all active control positions, the yellow arrivals runway button light on the VIG illuminated, signalling a discrepancy between the new arrivals runway selected by the supervisor in RUNWAY USAGE (02) and that of the previous configuration selected in the VIG (24R) on the controllers' displays. From this point on, each controller had to select the new arrivals runway in the VIG button, thereby eliminating the discrepancy and turning off the visual warning. This action was not performed by the controller at position 2, and therefore, the VIG runway button on his display remained illuminated from the start of the configuration change until after the event, i.e. for more than 12 minutes.

The presence of the visual warning was not detected by the controller at the position, who was responsible for the task, nor by the two supervisors (the one on the afternoon/evening shift and the one covering the night shift), although it should be noted that this was not one of their duties.

A safety-critical task

This oversight was the source of the conflict, as the system uses the runway selected in the VIG as the reference for calculating the distances and times to landing that appear on the labels of the arriving traffic. While this data is essential for the controller responsible for arrivals in any configuration, it is even more important when operating on intersecting runways because the adjustments between take-offs and landings are made using this information. Therefore, the selection of the arrivals runway in the VIG is considered to be a safety-critical task.

In terms of what led the controller to forget to execute this task and not detect the activated status of the visual indicator, the investigation has identified the following:

- Training:
  a) Conceptual errors relating to the implications of selecting the wrong arrival runway in the VIG have been ruled out, as all the controllers were aware that the information included in the arrival traffic labels (distance and time to landing) is derived solely and exclusively from this selection.
  b) No training deficiencies were identified in terms of the specific weight and importance given to this selection in the initial training of controllers.
- Change of task:
  c) The configuration change placed more demand on the controller and increased his workload, as the position of local controller with intersecting runways is the most demanding. In addition, his previous activity had been related to departures, which didn't require him to refer to the time and distance to landing, and in which the runway selection in the VIG is not relevant.
  d) There were no checklists for configuration changes at the control positions, and the whole process was carried out from memory.
  e) The controller's limited overall experience in the ENR configuration and as a single local controller, the demands of the new task and the pressure he placed on himself could have affected the execution of the changeover.
- Aspects relating to ergonomics and attention:
  f) The relative position of the VIG on the screen, located in the upper left corner, and its small size compared to the rest of the screen (2%) means that the eye is not naturally drawn to it.
  g) The VIG does not contain any information essential for issuing routine control clearances, so it is not an area that controllers have to repeatedly turn their attention to.
  h) As opposed to the location, size and content of the VIG, the rest of the screen contains information that controllers are constantly monitoring, so their attention is focused on this central area.
- Habituation:
  i) Although the visual warning consists of a yellow light and is, according to all the controllers, conspicuous on a black screen, its warning function was ineffective in this event. Our assessment is that this could potentially be explained by habituation because the yellow light illuminates during every routinely and regularly occurring configuration change, and therefore, its intended warning effect is compromised.

Together, these factors and conditions explain how a light could be on for 12 minutes and not be noticed.

As a consequence, the report includes safety recommendations related to this safety-critical task, suggesting the implementation of two preventive barriers and one recovery barrier:

- The implementation of an automated VIG arrival runway change each time a change of RUNWAY USAGE takes place. If the above isn't possible, it would be helpful to implement a warning in the form of an alert message to signal the discrepancy, similar to other warnings that appear whenever there are inconsistencies in the selections made.
- The drafting of a control position checklist to detect any omitted tasks when a configuration change occurs. This checklist should include checking the arrivals runway in the VIG, particularly for the local controller responsible for arriving traffic.

## 2.2. ATC: Reliability of the A-SMGCS level 2 VIO alert

Correct activation of the alert

The A-SMGCS level 2 proximity conflict detection and alert feature worked correctly in this event since the failure to select the arrival runway in the VIG is not linked to this system. However, the configuration entered in the RUNWAY USAGE menu does affect it and was correctly modified by the supervisor on the afternoon shift.

As indicated in section 1.16.1, the geometry and evolution of the traffic involved in the event meant that the system skipped the WRN hazard warning and went straight to the VIO violation warning, ruling out problems related to the activation or logic of the system's operation. The times and distances at which they were triggered were also in line with the criteria defined for the unit and the configuration.

Management of the alert

After the VIO violation warning appeared on the controller's display, the reaction times were 7 seconds to acknowledge it and 13 seconds to issue a resolution instruction. These values are abnormally high and far exceed the usual reaction times to stimuli.

The investigation has been able to establish, as stated in sections 1.16.6 and 1.16.10, that these reaction times are the result of a lack of confidence in the alert system. The system regularly gives false warnings of conflict alerts, so there is a perception – in this case a well-founded one – among all personnel, that the system is unreliable.

This perception most likely caused the controller to question the veracity of the warning, waiting, as on other occasions, for it to disappear and, in doing so, consuming much of the time available to resolve the conflict.

Once he realised that the warning was real, he took the decision to instruct the approaching aircraft to perform a go-around as an alternative to stopping the take-off of the RYR18UD aircraft

that was accelerating at 85 kt GS. It is our view that this decision was the most appropriate one to take because stopping a take-off at high speed would probably have had more consequences for both the aircraft itself, e.g. overheating of the brakes, and for the subsequent availability of the runway.

In addition to the effect of the lack of confidence in the system, the controller's lack of experience may have contributed to his extended reaction time and delay in making a decision once he had acknowledged the conflict.

### 2.3. ATC: Non-viable traffic adjustment

The criterion defined in the unit's procedures for issuing a take-off clearance in the ENR configuration is that there must be a gap of 4 NM. According to the information gathered during the interviews this gap could be adjusted up to a maximum limit of 3 NM. Considering the distance from touchdown data (DFTI) and display markings (the ATZ at 4 NM) available to the controller during this event, following observations are made:

- From the first radio contact with the departing traffic, the controller used terms to accelerate the take-off (*immediate* and *rolling take-off*) and delay the landing clearance (*late landing clearance*), which confirms that he was aware that he was making an adjustment with limited room to manoeuvre.
- The first enquiry made to the traffic on take-off as to whether it was ready for immediate take-off was made when the arrival traffic was at 3.1 NM (actual distance), so it should have crossed the ATZ reference at 4 NM on the controller's screen.
- The take-off clearance was issued when the arrival traffic was at 4.1 NM (controller's distance), but the problem is that the departing traffic was still taxiing in the opposite direction to the runway heading 40 seconds before it lined up on the runway.
- When the aircraft had lined up and commenced the take-off run, the controller advised the approaching traffic to expect late clearance, suggesting that he was aware of the position of the traffic on take-off. At these times, the inbound traffic was at 2.6 and 2.4 NM, respectively, according to the values seen by the controller. This distance is well below even the 3 NM maximum permitted; therefore, he should have taken action, even given the erroneous references he was using.

The data shows that the controller tried to make an adjustment that was infeasible from the outset, even given the values displayed on his screen, and that, once it had been implemented, he was incapable of realising that the execution was not progressing correctly, ignoring the available data (such as the distances on the label or the ATZ reference), and reacting with tunnel vision. An inappropriate plan in itself falls into the category of knowledge error, reflecting insufficient understanding or the use of erroneous hypotheses about the operation of a particular part of the system, such as, for example, the time it would take for the taxiing traffic to enter the runway from the taxiway.

## 2.4. ATC: Distance references used

The observations in section 2.3 above highlight a further aspect, namely the exclusive reliance on the arrival traffic label information, which is derived from the VIG selection, to make adjustments when operating in intersecting runway configurations. As indicated in section 1.16.5, in addition to this information, the ATZ line at 4 NM serves as another distance reference, which, although less accurate, at least allows controllers to assess whether the traffic has crossed this line.

Despite being available during the incident, this visual reference was not used. Comparing the label data with the traffic's position in relation to the ATZ line was the only way of detecting the inconsistency between the two sources of information. If, at some point, the controller did compare the two information sources, the decisions he took suggest that he rejected the second, giving priority to and being more confident in the reliability of the first: the label. This reinforces the need to categorise the selection of the arrivals runway in the VIG as a safety-critical task and, therefore, to implement improvement measures in this regard.

In addition to the data on his screen, the controller had the information provided by the ground movement controller about the actual distance value and the insufficient margin to make the adjustment. The controller did not consider this information, once again confirming his tunnel vision in rejecting any data that contradicted his initial plan.

As indicated in sections 1.16.5 and 1.16.11, the other visual references did not provide any useful information given the prevailing light conditions and perspective.

## 2.5. ATC: Phraseology

The communications between the controller and both the aircraft on take-off and the aircraft on approach were made in English, which rules out the influence of any language issues during the event. In regard to the terminology and content of the communications, the following conclusions are issued:

<u>Acknowledgements:</u>

- The controller provided information about the departing traffic to the aircraft on approach, with the intention of providing comprehensive information about the situation at the airport. However, the crew did not recall this information.
- The crew did not acknowledge this communication correctly, abbreviating their response to "*OK, no problem*", thereby eliminating an opportunity to detect the conflict. This departure from the communications procedures was not corrected by the controller, who assumed that the message had been understood.

<u>Runway designators:</u>

- The runway designators were not used in the communications. This aspect is not thought to have contributed to the event, given that the crew stated they were aware of how the airport operated and at no time were unsure about which runways were in use.

*Late landing clearance*:

- The use of this phrase is not included in the standard phraseology, nor is it referred to in the unit's documentation, although all the parties, both the controllers and the crew of both aircraft, stated that it is frequently used at all airports and that they were familiar with it.
- There appears to be no consensus between the crews or the controllers regarding up to what point you can delay a landing clearance and, consequently, make a decision if this point is exceeded. The responses varied between 2 NM and above the runway. Regardless, in these situations, the crews trust in the criteria of the controller.
- The use of this phrase prompted the crew of the aircraft on approach to focus their attention on the preceding traffic, interpreting that what was conditioning the late clearance was the preceding aircraft's exit from the runway and not the traffic taking off. In other words, in this case, it achieved the opposite effect to that intended by the controller.

*Rolling take-off:*

- Despite his limited experience in the sector, the controller used an expression that some controllers reported not having used for 15 years.
- The expression was intended to expedite the taxi and take-off. In this case, the speeds during the taxi decreased from 22 kt on the taxiway to 11 kt at the start of the take-off run because the aircraft had to turn to achieve a 180º change of heading. With this in mind, it is believed the taxi of the RYR18UD aircraft was carried out at normal speeds.
- Both this expression and the "*ready for immediate*" used previously had the effect of causing the crew of the aircraft on take-off to focus on completing the before take-off lists and checks, keeping their attention inside the cockpit.

A safety recommendation is therefore being included, recommending a review of the use of these terms in the TWR LEBL unit and the dissemination among control personnel of the effect that certain expressions can have on crews.

### 2.6. Management of the conflict by the aircraft on approach

Once the proximity conflict had been generated, the aircraft on approach was, of the two aircraft involved, the one that had some possibility of detecting it. The geometries of the two traffics as they drew closer to one another (Figure 7) made visual detection of the conflict practically impossible for the aircraft on take-off. They could only have detected it through active listening to the communications being made.

It seems clear that, both because they had the preceding traffic in sight and because they had understood the term "late landing clearance" to mean that it was this traffic that was conditioning their clearance, the crew was wholly focused on their runway and did not listen to the information

about the take-off. The fact that this was the last flight of the day and the crew were returning to base may have resulted in them taking a more relaxed approach to their performance and monitoring of the environment.

At some point after crossing the coastline the crew detected the presence of the traffic on take-off around the time they flew over the coastline. At that moment, the traffic had covered one-third of its take-off run. The decision to proceed with the take-off and not initiate a go-around is considered questionable. The criteria for making that decision were that they had identified the aircraft type and knew it wouldn't be able to get airborne that early. While this was indeed the case, and it would rotate much later, investigation has not been able to assess whether this identification was feasible, and the absence of the cockpit communications to evaluate the exact assessment made, but there are nevertheless other factors that could have shortened the take-off run, such as an empty flight. It is in this context that it is believed the fact that it was the last flight of the day and that they were returning to their base may have conditioned their decision-making process.

In the end, once instructed to initiate a "go-around" by ATC, the crew did not question the instruction, and the manoeuvre was executed immediately.

### 2.7. Management of the conflict by the aircraft on take-off

Of the three actors involved, the aircraft on take-off had the least chance of detecting the conflict, either visually or through communications. Due to the phase it was in at the time and the pressure it was under to expedite the take-off, external monitoring was reduced to a minimum, and the crew were focused on configuring the aircraft for take-off.

The recorder did not detect any action on the controls during the take-off run, which confirms that they did not see the aircraft until, as indicated by the crew, it suddenly crossed the runway in front of them. Once this had happened, the decision to continue was appropriate, as the crossing had already occurred.

# 3. CONCLUSION

## 3.1. Findings

In regard to the crossing:

- The aircraft crossed paths on runway 06R: the aircraft taking off was accelerating on the first third of runway 06R and the descending aircraft was approaching to land on runway 02.
- As they crossed paths, the horizontal and vertical separations between them were 285 m and 59 ft (18 m), respectively.
- When the crossing occurred, both aircraft were being guided by the single local controller in the Barcelona tower and following the controller's instructions.
- The take-off clearance was issued while the aircraft was still taxiing, and it took a further 40 seconds for it to line up on the runway.
- By the time the aircraft on take-off entered the runway and commenced its take-off run, the controller's screen told him that the aircraft on approach was 2.4 NM away when it was actually 1.1 NM away.
- The slot for take-off did not comply with the spacing of 4 NM prescribed by ENR configuration, even when using the controller's erroneous distance information.

On the distances the controller was using:

- Twelve minutes earlier, the unit had implemented a configuration change that had affected the functions of the local controller at position 2.
- During this change, the selection of the arrivals runway in the VIG at position 2, which was the single local controller's position, was not carried out. This oversight had the following implications:
    a) The controller was working with distance-and-time-to-threshold data for the inbound traffic that told him the aircraft were further away than they actually were.
    b) A warning light illuminated on the VIG but was not detected by the controller for 12 minutes.

On the detection and management of the conflict:

- The A-SMGCS level 2 system detected the conflict correctly and issued a violation alert.
- The controller's reaction to this alert was delayed.
- The A-SMGCS system frequently produced false alarms.
- The approaching aircraft detected the conflict shortly before the crossing and decided to continue with the approach.
- The aircraft on take-off did not detect the conflict.

## 3.2. Causes/contributing factors

The probable cause of the incident involving the aircraft EC-KLT and EI-EPA was the issue of a clearance to take off from runway 06R with traffic on approach to runway 02 at less than the 4 NM distance stablished for the ENR configuration.

## 4. RECOMMENDATIONS

In regard to the arrivals runway selection in the VIG

The selection of the arrivals runway in the VIG at the control positions is a safety-critical task that conditions the distance-and-time-to-touchdown information displayed on the last line of the arrival traffic label. These two pieces of data, collectively referred to as the DFTI (distance from touchdown indicator), are used almost exclusively by the controller responsible for arrivals to make adjustments and, when operating in the ENR intersecting runways configuration, are particularly critical.

Although the system produces a yellow warning light in the event of an arrival runway selection error in the VIG, this incident demonstrated that the warning was ineffective and went unnoticed by the controller for more than 12 minutes due to ergonomics and factors relating to attentional focus during the performance of control tasks.

In the interest of adding preventive and recovery barriers in the event of failures related to this safety-critical task, the following recommendations are issued:

REC 51/23: It is recommended that ENAIRE, as the ATC service provider for the Barcelona control tower, assess the possibility of implementing in the SACTA system an automated change of arrival runway in the VIG each time a change of arrival runway is made in the RUNWAY USAGE menu.

REC 52/23: It is recommended that ENAIRE, as the ATC service provider for the Barcelona control tower, increase the robustness of the current information systems with regard to discrepancies between the runway selected in the RUNWAY USAGE menu and the runway selected in the VIG.

REC 53/23: It is recommended that ENAIRE, as the ATC service provider for the Barcelona control tower, draft a control position checklist to facilitate the detection of any oversights during configuration changes. This checklist should include checking the arrivals runway in the VIG after a change of configuration, particularly for the local controller responsible for arriving traffic.

In regard to phraseology

During the investigation, several issues related to phraseology and the effect it had on the crews were identified. In this regard, the following recommendation is issued:

REC 54/23: It is recommended that ENAIRE, as the ATC service provider for the Barcelona control tower, review and disseminate information on:

- When to use the term "*expect late landing clearance*" and the point to which a clearance can be delayed.
- The effect that the use of this expression had on the approaching aircraft's crew, in causing them to focus almost exclusively on their runway.