Report

IN-032/2018

Incident involving a Boeing 737-800, registration EI-FHZ, operated by Norwegian Air International, at the Alicante Airport (Spain) on 7 June 2018

MINISTERIO DE FOMENTO

SUBECRETARÍA

COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

NOTICE

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

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

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

CONTENTS

ABBREVIATIONS

º ..... Degrees
AESA ..... National Aviation Safety Agency
APP ..... Approach control
ATC ..... Air traffic control
ATIS ..... Automatic terminal information service
ATZ ..... Aerodrome traffic zone
CECOP ..... Operations coordination center
CLR ..... Clearance delivery
COAM ..... Maneuvering area operations coordinator
CTOT ..... Calculated takeoff time
CVR ..... Cockpit voice recorder
GND ..... Ground control
GS ..... Ground speed
h ..... Hours
IFR ..... Instrument flight rules
km ..... Kilometer
kt ..... Knots
LCL ..... Local control
m ..... Meters
METAR ..... Meteorological aerodrome report
MHz ..... MegaHertz
min ..... Minutes
N ..... North
QAR ..... Quick access recorder
RTO ..... Rejected takeoff
RWY ..... Runway
S/N ..... Serial number
SDP ..... Apron management service
s ..... Seconds
SPP ..... Runway and apron service
TOAM ..... Maneuvering area operations technician
TOGA ..... Takeoff and go-around
TWR ..... Control tower
TWY ..... Taxiway
W ..... West

SYNOPSIS

Owner and operator:	Norwegian Air International
Aircraft:	Boeing 737-800, registration EI-FHZ
Date and time of incident:	Thursday, 7 June 2018 at 16:30 local time[1]
Site of incident:	Alicante Airport
Persons on board:	Crew: 6, uninjured
	Passengers: 175, uninjured
Type of flight:	Commercial air transport – scheduled – international - passenger
Phase of flight:	Takeoff – takeoff run
Flight rules:	IFR
Date of approval:	28 December 2018

Summary of incident:

On Thursday, 7 June 2018, a Boeing 737-800 aircraft operated by Norwegian Air International, callsign IBK2WH, began its takeoff run at 16:30 from runway 10 at the Alicante Airport (Spain) with 181 persons on board. Its destination was the Oslo Airport (Norway).

At the time of the incident, with one control position staffed in the control tower, there was a student controller in training and an instructor.

Four minutes earlier, at 16:26, the control tower had cleared two runway and apron service (SPP in Spanish) vehicles to check the runway. These vehicles were on the runway at the time of the takeoff. The takeoff clearance given to the aircraft was heard by the SPP vehicles, which immediately cleared the runway and informed the tower of the situation. The controller instructed the aircraft to reject its takeoff. The vehicles exited the runway without further incident. The aircraft stopped its takeoff run and also exited the runway without further incident.

The investigation has determined that the distance between the aircraft and the two vehicles was in excess of 1000 m throughout the event.

The investigation has concluded that the incident occurred due to an inappropriate takeoff clearance given to the aircraft by the control tower while the runway was occupied by two previously cleared SPP vehicles. The following factors contributed to the event:

- The possible excessive workload for a student controller.
- The single-position configuration in the tower when, based on the demand expected at the time, two positions should have been staffed.

[1] All times in this report are local, and obtained from the control tower service.

- The lack of effective supervision by the instructor at the time of the incident.
- The use of Spanish to communicate with the SPP vehicles, which prevented the crew of the aircraft from understanding their content.

The report contains one safety recommendation for FERRONATS, the service provider at the Alicante Airport control tower.

1. FACTUAL INFORMATION

1.1. History of the flight

On Thursday, 7 June 2018, a Boeing 737-800 aircraft, registration EI-FHZ and operated by Norwegian Air International, with callsign IBK2WH, began its takeoff run from runway 10 at the Alicante Airport (Spain) with 181 persons on board. Its destination was the Oslo Airport (Norway).

The aircraft had been cleared to take off at 16:30:20 by the controller in the control tower (TWR). Twenty-eight seconds later, the controller canceled the clearance, instructing the aircraft to reject its takeoff immediately because the runway was occupied by two runway and apron service (SPP) vehicles (callsigns PAPA1 and PAPA6), which were conducting a routine check of the runway[2]. These vehicles had been cleared by the same controller to enter the runway 4 min before the incident, at 16:26:27, and were near the 28 threshold (since runway checks are conducted in the opposite direction of the runway in use).

The situation was identified by the PAPA1 and PAPA6 vehicles, which, after hearing the takeoff clearance given to the aircraft, alerted on the controller frequency that they were still on the runway, which they proceeded to clear immediately via quick exit taxiways C4 and C2, respectively. For their part, the aircraft crew managed to stop and exit the runway via C2 after being instructed to stop the takeoff.

There were no injuries or damage.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Other
Fatal				
Serious				
Minor				
None	6	175	181	
TOTAL	6	175	181	

1.3. Damage to aircraft

None.

1.4. Other damage

None.

[2] Four routine checks are done every day. This was the day's third check.

1.5. Personnel information

1.5.1 Aircraft

The captain, a 37-year-old German national, had an airline transport pilot license and an aircraft rating that was valid until July 2019. He had a total of 8304 flight hours, of which 8101 had been on the type. At the time of the incident he was the pilot flying.

The first officer, a 30-year-old French national, had an commercial pilot license and an aircraft rating that was valid until February 2019. He had a total of 1428 flight hours, of which 1008 had been on the type.

1.5.2 Runway and apron service vehicles

The vehicle with callsign PAPA6 was occupied by the maneuvering area operations coordinator (COAM), a 45-year-old French national who spoke perfect Spanish. He had 16 years of experience on the job, all of them at the Alicante Airport. He had started his shift at 09:00[3].

The vehicle with callsign PAPA1 was driven by a maneuvering area operations technician (TOAM), a 48-year-old Spanish national. He had 10 years of experience as a TOAM, all of them at the Alicante Airport. He had started his shift at 08:00[4].

All communications between the two vehicles and the tower were conducted through vehicle PAPA6, with PAPA1 monitoring. The two vehicles were able to communicate with one another on a different frequency.

1.5.3 Control tower

Student controller

The student controller, a 34-year-old Spanish national, had a student air traffic controller license issued by AESA (National Aviation Safety Agency) on 16 February 2018 that was valid until the year 2027. He had a medical certificate that was valid until August 2019.

After receiving his student controller license, he had been at the Alicante tower (since 20 March 2018), where he had completed the theoretical training phase (51 h). At the time of the incident, he was doing practical training in the TWR; specifically, he was finishing level 3[5]. He had 96 h (phases 1 to 3) of control experience, all of them at the Alicante tower.

[3] The COAMs coordinate the duties of the TOAMs (maneuvering area operations technician). They work 12-h shifts, with the day shift lasting from 9 am to 9 pm, and the night shift from 9 pm to 9 am.
[4] The TOAMs work 12-h shifts that are one hour out of sync with the COAM shifts. The day shift runs from 8 am to 8 pm, and the night shift from 8 pm to 8 am.
[5] The practical training contains five phases: phase 1 (20 h), phase 2 (40 h), phase 3 (40 h), phase 4 (40 h) and phase 5 (40 h). In all, the practical phase has 180 h. Each phase focuses on certain objectives; specifically, phases 3 and 4 focus on “traffic management.” Information taken from the FERRONATS unit training plan.

On the day of the incident, he was the controller on the frequency. He had gone on duty at 15:00[6], starting his shift with a one-hour break. His activity on the frequency started at 16:00. The previous day he had also worked the afternoon shift, and with the same instructor as on the day of the incident.

Instructor

The instructor, a 40-year-old Spanish national, had an air traffic controller license issued by AESA, with an aerodrome controller rating since July 2014, a rating he had obtained at the Alicante tower. In other words, he had been a controller at that unit for practically four years, this accounting for the totality of his work experience as a controller[7]. He had also been an instructor for three weeks (license endorsement dated 16 May 2018). He had a medical certificate that was valid until July 2019.

On the day of the incident, he had started his shift at 15:00, with his activity on the frequency starting at 16:00. The previous day had been his first work day as an instructor, with the same student as on the day of the incident, meaning the day of the incident was his second acting as an instructor.

1.6. Aircraft information

The Boeing 737-800 8JP aircraft, registration EI-FZH, S/N 39005, had 25912 total flight hours. It was equipped with two CFM56-7B26/3 engines, S/N1 805783 and S/N2 804785, which had been installed new on the aircraft. Both had the same total number of hours as the aircraft: 25912.

1.6.1 RTO (Rejected Takeoff)

A rejected takeoff is regarded as a non-standard operation. The manufacturer's procedure lays out several reasons for performing this maneuver. It also specifies the 80-kt value as the limit above which the conditions for conducting an RTO are limited. The procedure lays out actions in the cockpit (involving the thrust levers, braking system and reporting the maneuver executed) and then, once the aircraft stops, actions to check for brake heating so as to calculate the required cooling time. This calculation is done using tables. An RTO done at speeds at or near 80 kt are deemed low-speed, and thus low-energy. The cooling time, if needed, varies from 1 to 60 minutes.

1.7. Meteorological information

The 16:30 METAR[8] (aerodrome observation report) indicated that visibility was in excess of 10 km. It did not reflect the presence of any adverse phenomena. The footage from the airport's surveillance cameras showed that it was a clear day with no visibility problems.

[6] The shift ended at 23:00 h.
[7] Previously (since 2011), he had worked as an operator and instructor in the SDP (apron control service) and as the manager of the aeronautical office.
[8] METAR LEAL 071430Z 18010KT 110V240 9999 FEW020 SCT055 26/13 Q1015 NOSIG=

1.8. Aids to navigation

Not applicable.

1.9. Communications

The ATC communications from the incident, held on the operating frequency at the Alicante Airport, were available to investigators. As concerns the activity of the student controller, during his first ten minutes of activity on the frequency (from 16:00 to 16:10), there were two positions open in the tower, with the controller working on the local (LCL) position. At 16:10, a single-position[9] layout was implemented, meaning a single staffed control position, with the student taking over all communications on the 118.150 MHz frequency.

The ATC communications from 16:10:00 until the event at 16:30:45 revealed:

- 1.9.1: The communications that the TWR needs to make to manage a departing aircraft.
- 1.9.2: The overall traffic situation at the airport.
- 1.9.3: The traffic movements during this time period.

1.9.1 Communications needed to manage a departing aircraft

To manage a departing aircraft, which was the predominant traffic type at the airport during the event, the controller had to perform a minimum of six steps (with the communications involved with each clearance: request-issue-confirmation of correct reception of clearance). An analysis of the communications in the 20 minutes prior to the event yielded the following findings:

1. CLEARANCE delivery (departure instructions). The aircraft is at its parking stand and needs the TWR to confirm the instrument departure it will take, the associated transponder code, the initial altitude to reach after takeoff, the CTOT[10] (calculated takeoff time), the QNH and the current ATIS (automated terminal information service) information. These reports are long due to the amount of information they contain, and in the incident, lasted between 11 and 17 s.
2. PUSHBACK AND STARTUP clearance. The aircraft is still at its parking stand. This clearance confirms the stand number, the QNH and the crew are authorized to start the engines, push back and line up to taxi. In addition to this basic information, the approval for several aircraft was conditioned on passing behind another taxiing aircraft, thus requiring even longer communications. The duration of these clearances lasted between 7 and 11 s.
3. TAXI clearance. The aircraft is cleared to taxi on a specific route in order to reach its authorized holding point, and informed of the runway in use. These communications lasted 4 to 6 s.

[9] Single position means a one controller handles every aspect of the aircraft from the time they are at their parking stand until they are transferred to the next station (approach control). This is for departing aircraft. For arriving aircraft, the operations are reversed.

[10] Regulated aircraft are assigned a CTOT. In the case of the aircraft handled by the controller in the 20 min prior to the event, they were all regulated, and thus they all had a CTOT.

4. LINE UP AND WAIT clearance[11]. This clearance allows the aircraft to enter the runway, line up with the centerline and hold until takeoff clearance is received. This clearance includes the runway in use. It lasted 3 to 4 s.
5. TAKEOFF clearance. This clearance includes information on the wind and the runway in use. This communication lasted 3 to 8 s.
6. Transfer to APP (approach) [12]. This communication completes TWR's management of the aircraft and includes the new frequency for the crew to call. It lasted 4 s.

1.9.2 Traffic situation at the airport

The controller had to handle one arriving aircraft, ten departing aircraft and make additional necessary associated arrangements (coordinate with three SPP and CECOP cars). The traffic situation[13] expected in the 20 minutes prior to the event was as follows:

Aircraft requiring immediate attention (next CTOT and arrivals):

- 1 arriving aircraft (VLG13QW, which would go to stand 45), still with APP.
- 1 departing aircraft, (VLG3936), which had its clearance delivered and had pushback and startup clearance.
- 2 departing aircraft (T7C-stand 49 and RYR56TL-stand 31), which had their clearances delivered.
- 1 departing aircraft (EZY34ER-stand 27), which had not requested its clearance yet.

Aircraft not requiring immediate attention (CTOT further in the future):

- 2 departing aircraft (IBK2WH-stand 27 and IBK5358-stand 47), which had their clearance.
- 4 departing aircraft (AFL2523-stand 23, IBK5302, EZY45D and RYR761Y), which had not requested their clearance.

Coordination with other airport services:

- 2 SPP vehicles, which were going to do a routine check of the runway. All communications between these vehicles and the tower were in Spanish.
- Airport CECOP to arrange for the parking stand for an arriving aircraft and to reposition another.
- 1 SPP car different from the two doing the runway inspection, to guide an aircraft to another location in the airport.

1.9.3 Traffic movements between 16:10:00 -16:15:52

- **16:10:00:** the tower starts single-position operation, with the student controller on the frequency.
- **16:11:36:** PAPA6 reports they are[14] at gate D[15] and request to start "taxi runway route". They are cleared to holding point C9[16]. At this point there is:

[11] This clearance may, depending on the traffic situation, not be needed. In the case of the aircraft handled by the controller in the 20 min prior to the event, they all received this clearance.
[12] Approach control.
[13] The parking stand where the aircraft was located is given for each aircraft. See Figure 1, section 1.10.

- 1 departing aircraft (VLG3936) taxiing to A5.

- **16:15:52:** PAPA6 reports being at holding point C9. They are told to stand by, and the communication confirms the controller has spotted them. At this point there is:
  - 1 departing aircraft (VLG3936) lined up on the runway awaiting takeoff clearance.
  - 1 arriving aircraft (VLG13QW), just landed and awaiting taxi instructions.
  - 2 departing aircraft (T7C and RYR56TL) with the engines running.

During this period, the speaking speed is much slower than in the later sequences, and the frequency was occupied 69.5%. The controller handled:

- 1 arrival (VLG13QW).
- Coordination with CECOP to assign a parking stand to an arriving aircraft.
- 1 taxi to threshold (VLG3936).
- 2 pushback and startup clearances for two aircraft (T7C and RYR56TL):
  - Immediate clearance for the former.
  - Clearance with a 30-s delay for the latter.
- 1 clearance for an aircraft with a later CTOT (AFL2523):
  - Issue delayed 1 min 52 s.
- 1 repositioning request[17] for one of the scheduled departures (EZY34RE).

1.9.4 Traffic movements between 16:15:52 - 16:18:33

- **16:15:52:** PAPA6 reports reaching holding point C9.
- **16:18:33:** The controller clears PAPA1 and PAPA6 to enter the runway. At this point there are:
  - 2 aircraft (RYR56TL and T7C) taxiing to runway 10.
  - 1 arriving aircraft (VLG13QW) taxiing to parking stand 45.
  - 2 departing aircraft (IBK2WH and IBK5358) awaiting pushback and startup clearance.

During this period, the controller's speaking speed has increased and the frequency was busy 78.8%. He managed:

- 1 departing aircraft (VLG3936), issuing a takeoff clearance and transferring it to APP.
- Checking the clearance for AFL2523, which its crew had not acknowledged.
- 2 taxi clearances (T7C and RYR56TL) to A5.
- 1 taxi route correction for T7C to avoid conflict with arriving aircraft.
- 1 arriving aircraft (VLG13QW), which he instructs to parking stand 45.
- 2 pushback and startup requests (IBK2WH and IBK5358), which he cannot handle at this time:
  - Clearance delayed 3 min 3 s for the former.
  - Clearance delayed 2 min 21 s for the latter, informing that the reason for the delay is the presence of a taxiing aircraft behind it.

[14] There are two cars, identified as PAPA1 and PAPA6, but only PAPA6 communicated with the tower.
[15] The location of the airport reference points is shown in Figure 1, section 1.10.
[16] Runway checks are authorized in the opposite direction of the runway in use, which is why they are cleared to holding point C9, which is a holding point for runway 28.
[17] This will require coordinating later with a marshaller to guide it to the new parking stand and duplicating the communication process to clear the move on the apron, and later to arrange the taxi for takeoff.

1.9.5 Traffic movements between 16:18:33 -16:20:56

- **16:18:33:** the controller clears PAPA1 and PAPA6 to enter the runway, but the two cars do not leave the holding point because they have been unable to use the frequency to acknowledge the TWR's clearance.
- **16:20:56 –** the controller asks PAPA6 about its position. It confirms they are at holding point 28. They are instructed again to wait. At this point there are:
  - 2 departing aircraft (RYR56TL and T7C) at the runway 10 holding point awaiting takeoff clearance.
  - 3 departing aircraft (IB2WH, IBK5358 and AFL2523) at their parking stands starting their engines.

During this period, the frequency has been busy 57.3% and the controller handled:

- 1 pushback and startup request and clearance for a departing aircraft (AFL2523), which was delayed 30 s due to an aircraft taxiing behind it (T7C). The controller informs of the reason for the delay.
- 2 pushback and startup clearances for two aircraft that were waiting (IBK2WH and IBK5358).
- Coordination with marshaller to reposition a delayed departing aircraft (EZY34RE) from stand 27 to 6B.

1.9.6 Traffic movements between 16:20:56 -16:26:27

- **16:20:56 –** the controller asks PAPA6 about its position.
- **16:26:27 –** controller clears PAPA1 and PAPA6 to enter runway. PAPA6 acknowledges clearance and this time both cars enter the runway. At this point there are:
  - 3 departing aircraft (AFL2523, IBK2WH and IBK5358) taxiing to the runway 10 threshold. Despite having a later CTOT than the other two, AFL2523 is first in the taxi sequence because it requested to taxi before the other two.
  - 1 departing aircraft (EZY34RE) with the engines running awaiting clearance to reposition to stand 6B.

During this period, the frequency has been busy 52.8% and the controller handled:

- 2 takeoff clearances and coordination with APP (RYR56TL and T7C). He was proactive and waiting for them to reach the holding point; the aircraft did not have to contact the controller and report their position.
- 1 pushback and startup clearance for the repositioning aircraft (EZY34RE).
- 3 taxi clearances for departing aircraft (AFL2523, IBK2WH, IBK5358), which are cleared immediately.
- 1 holding point correction for AFL2523 after 20 s, assigning it A6.
- 1 clearance request for a new traffic on the scene (IBK5302):
  - Information delayed 1 min.
- 1 taxi clearance request from a departing aircraft (EZY34RE):
  - Clearance delayed 2 min 19 s.

1.9.7 Traffic movements between 16:26:27 -16:30:45

- **16:26:27:** clearance from controller to PAPA1 and PAPA6 to enter runway.
- **16:28:50:** clearance to IBK2WH to line up and wait.
- **16:30:20:** takeoff clearance for IBK2WH. At this time, the situation in the airport was as follows:
  - IBK2WH on runway access taxiway A5.
  - AFL2523 at holding point A6.
  - IBK5358 reaching holding point A5.
  - PAPA1 and PAPA1 on the runway.
  - EZY34RE taxiing to new parking point.
- **16:30:45:** PAPA6 reports it is on the runway. After clearing IBK2WH to take off, the controller cleared IBK5358 to line and wait. These communications kept the frequency busy, and as a result PAPA6 was unable to contact the tower until 16:30:45.

Local time	Station	Message
16:30:20	TWR	IBK2WH wind 160º 09 knots, runway 10, cleared for take off.
16:30:25	IBK2WH	Cleared take off runway 10, IBK2WH.
16:30:29	TWR	IBK5358 ready for departure?
16:30:32	IBK5358	Affirm, fully ready, IBK5358
16:30:35	TWR	IBK5358 behind the traffic departing, line up and wait runway 10 behind.
16:30:41	IBK5358	Behind the departing traffic, cleared to line up and wait runway 10 behind, IBK5358
16:30:45	PAPA6	Torre PAPA6, estamos en pista eh? (Tower, PAPA6, we're on the runway, ok?)

During this period, the frequency has been busy 70.1% and the controller handled:

- Coordination with an SPP car to reposition EZY34RE.
- 1 taxi clearance for EZY34RE.
- 1 clearance issued to last departing traffic (IBK5302), which was still outstanding.
- 1 proactive clearance issued proactively (that is, with no call made by the crew) to a departing aircraft (EZY45DR).
- 1 clearance request for a new departing aircraft (RYR761Y9), which he tells to stand by.
- Information to AFL2523 that its CTOT is 16:43.
- 1 line up and wait clearance for IBK5358.
- 1 takeoff clearance for IBK2WH

1.9.8 Traffic movements between 16:30:45 -16:31:11

- **16**:**30:45:** PAPA6 reports it is on the runway.
- **16:30:48:** departing traffic instructed to reject takeoff. This instruction is immediately acknowledged by the crew, after which the instructor takes over the frequency and repeats the instruction.
- **16:31:11:** PAPA6 reports runway clear.

Local time	Station	Message
16:30:45	PAPA6	Torre PAPA6, estamos en pista eh? (Tower, PAPA6, we're on the runway, ok?)
16:30:48	TWR	PAPA6 espere (wait), ah… IBK2WH stop immediately I say again stop immediately. Vehicles on the runway
16:30:53	IBK2WH	Stopping 2WH
16:30:57	TWR (instructor)	IBK2WH stop immediately I say again stop immediately, stop
16:31:01	IBK2WH	We are stopping, IBK2WH
16:31:04	TWR (instructor)	PAPA6 y PAPA1, disculpen abandonen pista, ya les veo con pista libre, disculpen (PAPA6 and PAPA1, sorry, leave runway, I see runway clear, sorry)
16:31:11	PAPA6	PAPA1 PAPA6 pista libre (runway clear)

The aircraft left the runway via exit taxiway C2. ATC asked the crew to again taxi to the runway 10 threshold to start a new takeoff, but the crew reported they would call back when ready. At 16:33:27, the crew again requested to taxi for takeoff, and at 16:37:26, the aircraft began its takeoff run.

1.10. Aerodrome information

The Alicante Airport has one 3000-m long asphalt runway in a 10/28 orientation. The runway slopes up from threshold 28 to 10, varying from 0.74% to 1.23%. On the day of the incident, runway 10 was in use. The TWR is located some 1000 m away from threshold 10 and 2000 m away from threshold 28. There is an unobstructed view of the entire runway and both thresholds from the control tower[18]. The tower control service provider is FERRONATS, which is responsible for the Alicante ATZ.

The airport has surveillance cameras throughout the facility. Two cameras in particular, one on the corner of the terminal roof and another under the control tower, were of use in this investigation.

Figure 1 shows the location of the points of interest to the investigation (surveillance cameras in green, parking stands in blue and points of the airport in red).

[18] The control tower was visited to check the visibility to both thresholds and the runway from the control room, and specifically from the controller's post at the time of the incident.

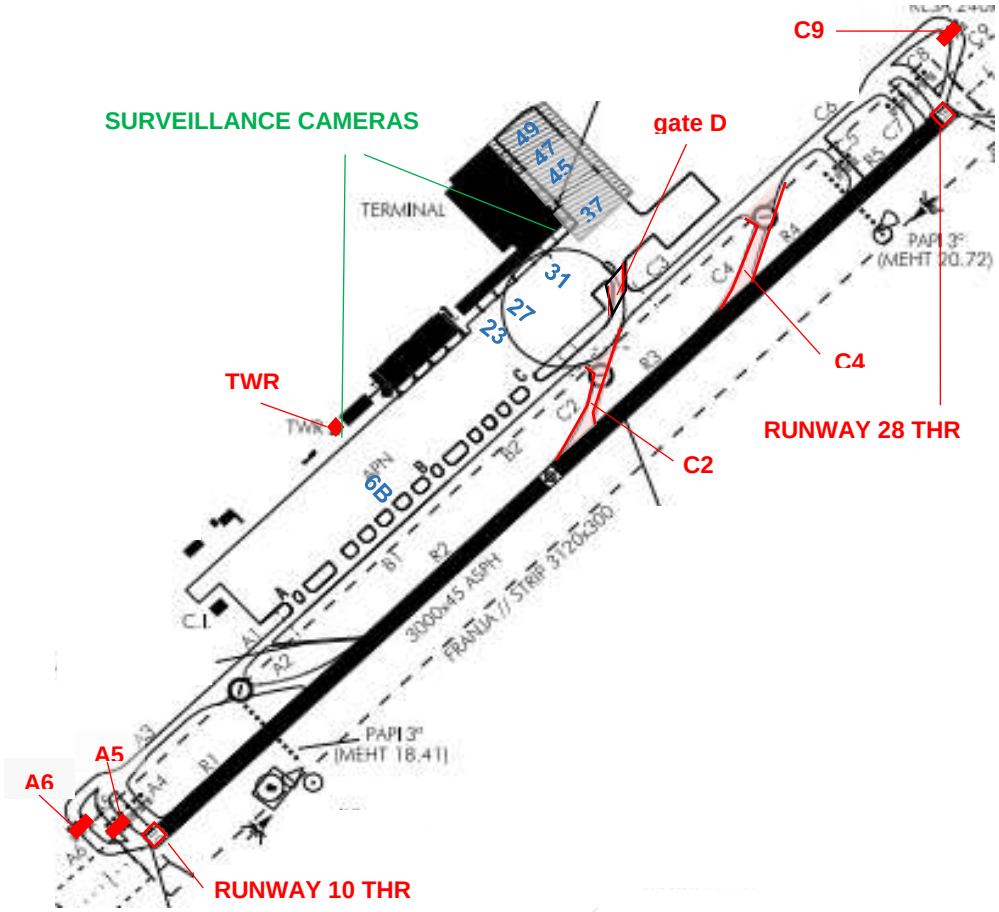

Figure 1. Locations of reference points of interest at the Alicante Airport

1.11. Flight recorders

The aircraft was equipped with voice and data recorders. The CVR was recorded over by the next flight, meaning the cockpit communications by the pilot could not be recovered. However, due to the nature of the event, the communications on the tower frequency yielded sufficient and complete information on the incident.

The quick access recorder (QAR) was available to investigators. The data of interest to the investigation are shown below[19], with information from the ATC communications, so as to provide a complete picture of the sequence of events:

- 16:30:25 h Aircraft acknowledges takeoff clearance, "*Cleared takeoff runway 10 IBK2WH*". Taxiing at GS of 6 kt on heading 178º, that is, still on the runway access taxiway and not in the runway.
- 16:30:36 h TOGA[20] switch activated in cockpit. The aircraft is at the threshold markings.
- 16:30:39 Aircraft starts moving, GS=10 kt
- 16:30:45 PAPA6 reports still on the runway, location of aircraft shown at this moment. GS=38 kt.
- 16:30:48 TWR cancels takeoff clearance. The aircraft is over the first touchdown zone markings at a GS of 53 kt. Location of aircraft shown at this moment.

[19] The time stamp on the recorder is delayed 33 s on average with respect to the time in the control tower. The recorder data are referenced to ATC time.
[20] TOGA: Take off and go around.

- 16:30:53 Message from aircraft that must correspond to "*Stopping 2WH*". GS=80 kt. During the transmission, the levers are pulled back and an increase in brake pressure is recorded.
- 16:30:56 Maximum speed reached during event. GS=88 kt. Will be held for 2 s before it starts to slow.
- 16:30:58 Speed brake handle actuated. GS=86 kt.
- 16:31:01 Message sent from aircraft corresponding to "*We are stopping IBK2WH*". GS=76 kt
- 16.31:02 Reversers extended. GS=72 kt. Will remain extended for 6 s.
- 16:31:11 PAPA6 reports "*runway clear*". Location of aircraft shown at this moment. GS=41 kt.
- 16:31:32 Message from aircraft indicating leaving runway via C": "*C2 we vacate*". GS=36 kt.
- 16:31:44 Aircraft enters C2. GS=28 kt.
- 16:32:20 Aircraft on taxiway.
- 16:32:35 Aircraft stops until 16:33:26, that is, 52 s.
- 16:33:27 Aircraft starts moving to runway 10 threshold.
- 16:37:26 Takeoff run commenced.
- 16:38:03 Aircraft airborne.

The various locations of the aircraft on the runway during the takeoff run are shown in the figure below. Also included are the positions of the aircraft during some of the reports made by PAPA6 and TWR (text in red).

Figure 2. Positions of aircraft during takeoff run

1.12. Wreckage and impact information

Not applicable.

1.13. Medical and pathological information

Not applicable.

1.14. Fire

Not applicable.

1.15. Survival aspects

Not applicable.

1.16. Tests and research

1.16.1 Interview with the student controller

During his interview, the student controller gave the following statement:

"*On the day of the incident, I had the afternoon shift, which is less complex than the morning shift. I went on frequency at 16:00. Demand fluctuated between two positions and one. For about the first 15 minutes, we were operating with two positions open (LCL-GND), with me working local (LCL) and the instructor the other position. They then transferred to a single position (LCL). He stated that the traffic situation was very complex for him, although he had worked with similar workloads on other occasions. He stated that during the training phase he was in, some intervention is expected from the instructor, since as the student's level goes up, the instructor intervenes less and less.*

He had three requests to taxi, clearance requests from other aircraft and a request from the marshaller to check the runway. He noticed that he had sequenced the aircraft incorrectly for taxi, since he had set as number 1 the aircraft with the last departure time, and he informed the instructor of this. He focused on how to get the number 2 and 3 aircraft out ahead of number 1[21]*. He realized that in his current training phase, the concept that was emphasized was "traffic management", and that in the phase he was about to start, it was "efficiency", meaning that having sequenced the aircraft incorrectly did not satisfy these concepts*[22]*.*

He mentioned that a short time earlier, he had cleared the marshallers to enter the runway, but they had not done so, which the instructor pointed out to him. When he issued the clearance, he had placed their strip below the runway designator, and he had to reposition it under the taxi designator again. This situation had thrown him off a bit.

He mentioned that there was an assistant[23] *in the tower on his first day on the job who was asking the instructor a lot of questions. He could hear their conversations in the background.*

[21] The aircraft he is referring to are: number 1= AFL2523, number 2=IBK2WH and number 3=IBK5358.
[22] The "Unit Training Plan" in fact specifies that the student objectives for levels 3 and 4 are "Traffic management". Specifically, for level 3, "the student must sequence traffic correctly".
[23] The assistant helps with administrative tasks and is not a controller.

He was focused on solving the problem with the three incorrectly sequenced aircraft. He wanted to get IBK2WH out first, which was number 2, and then IBK5358, which was number 3, to correct his previous error. He forgot about the marshallers on the runway. When they told him they were on the runway, he looked at them and saw they were vacating it. At that point, IBK2WH was starting its takeoff run. He looked at the instructor, who told him "stop immediately", an instruction repeated by the student on the frequency. The airplane stopped near A2, by which time the marshallers were off the runway.

He was asked about the management of the strips in the board during the incident, which he described as follows:

1. *When he cleared the marshallers to enter the runway, he placed their strip below the runway designator.*
2. *When he cleared IBK2WH to line up and wait, he placed its strip cocked out[24] underneath the strip for the marshallers.*
3. *When he cleared IBK2WH to take off, he placed its strip correctly on the board, below the one for the marshallers.*
4. *When he cleared IBK5358 to line up and wait, he moved its strip from below the taxi designator to the runway designator, below IBK2WH, again cocked out.*

Therefore, when the incident occurred, the strips below the runway designator were the one for the marshallers (YELLOW), the one for IBK2WH (placed correctly) and the one for IBK5358 (cocked out). After the incident, the instructor took over the frequency.

As concerns the entries on the strips of the positions of the SPP vehicles, he stated that on the red strips, next to the word YELLOW, they place a white paper where they write down the positions to which they are cleared. In this case, it showed C9. When the vehicle is cleared to a new position and leaves C9, he crosses out C9.

As for the runway inspection, he stated that the length of time they last varies, depending on the traffic, and can range from 5 to 60 min, depending on how many times they are interrupted. He confirmed that he had no problems seeing the cars".

1.16.2 Interview with the instructor

The interview with the instructor yielded information in keeping with that provided by the student. Much of the information provided is already included in section 1.16.1, so only new information of relevance to the investigation is contained here.

"*He stated that his duties as instructor included that of evaluating the traffic. On the day of the incident, there were 17 movements planned per hour, which is why he decided to keep two positions open in the first 15 minutes and then go to a single position. By the time he did, they*

[24] Cocked out is the term used to indicate that the strip is not correctly lined up with the tracks on the bay. Associated with the "line up and wait" clearance.

had done the most complex part of the work, though they had just enough of a workload to keep them going.

It was his second day as an instructor, and the day before he had worked with the same student. He had read the student's record and knew him to be a very good student. He stated he was a perfectionist and that the day before he had noticed him looking outside a lot and that he never gave a clearance without checking the situation visually. The day before he had been talking to the student about the "stop immediately" instruction, though it corresponds to the final phase (phase 5) of the practical training, on emergencies.

He stated that at the time of the incident there were three aircraft taxiing to the runway, the marshallers were checking the runway and one arrival was still far away. After this:

1. *He saw the student line up IBK2WH on the runway, with its strip cocked out.*
2. *The printer output a strip for an aircraft (AEA), which the assistant placed on the board, in the "pending" area.*
3. *At that point, he went to speak with the assistant to explain to him that it was a slow aircraft, and not to put any strips on the controller's board, that the board was for the controller's use only. He was speaking behind the control position but far enough away so as not to bother the controller. He did not hear the controller issue the takeoff clearance because he was speaking with the assistant.*
4. *It was later that he heard the report from the marshallers, saying they were on the runway, and realized right away what had happened.*
5. *The student turned to look at him and he said "stop immediately", which the student repeated.*
6. *He then issued the instruction once more on the frequency.*

When the incident happened, he saw the marshaller's car vacating via C2 and the aircraft moving. The instruction to abort takeoff is given up to approximately taxiway A2 for aircraft of this type.

As for overhearing the clearance, he stated that he was standing with the headset on. By virtue of being a "broadcaster", he hears the controller's communications orally, not over the headset. Since he was speaking with the assistant, he did not hear the clearance.

He was highly critical of his own performance during the incident, stating that a student can make mistakes, but that that is why the instructor is there. He relied on the student's skills because of his training record and what he had seen the day before, and devoted too much time to the assistant.

As for the traffic representation on the strip board, he stated the same thing as the student controller.

As for the complexity of the traffic, he mentioned that the student's training phase requires scenarios in which learning can take place, and that perhaps the workload in that scenario with two positions would not have been of any benefit to a student like him".

1.16.3 Interviews with TOAM (PAPA1) and COAM (PAPA6)

The drivers of the two vehicles who were doing the check of the runway were interviewed separately. They provided similar information, which is thus presented jointly.

"*They began the check at the same time, with the COAM (PAPA6) driving on the left side of the runway and the TOAM (PAPA1) on the right so as to completely check the runway and taxiways. The TOAM found something and had to stop to pick it up. He continued driving and thus was further ahead.*

The COAM (PAPA6) continued along the left side of the runway and saw rubber debris. He went over to pick it up while continuing to monitor the communications, and with the door open and while leaning out of the vehicle to pick it up, he heard the takeoff clearance given to IBK2WH. He tried to call the tower but the controller was clearing another aircraft and he could not find a gap to make his report until later.

He vacated the runway immediately as fast as he could via C2, which was the nearest exit, without waiting to speak with the TWR. As for the TOAM, when he heard the takeoff clearance, he was near taxiway C4, which he quickly took to vacate the runway. The TOAM stated that he saw car PAPA6 diagonally on the runway when the event took place. They met at C4, where they discussed what had happened. They continued their shifts normally and completed the runway check later.

The TOAM and COAM did not communicate during the event. They stated there was nothing unusual involving their actions that day, that it was the third check of the runway that day and the second of their shift, and that they usually do the routine inspections at around the same time. As for the language, both stated they understood the controller's instruction to the aircraft perfectly, even though it was given in English.

Figure 3 (not to scale) shows their positions on the runway and their routes before and after the incident (as they indicated during their interviews).

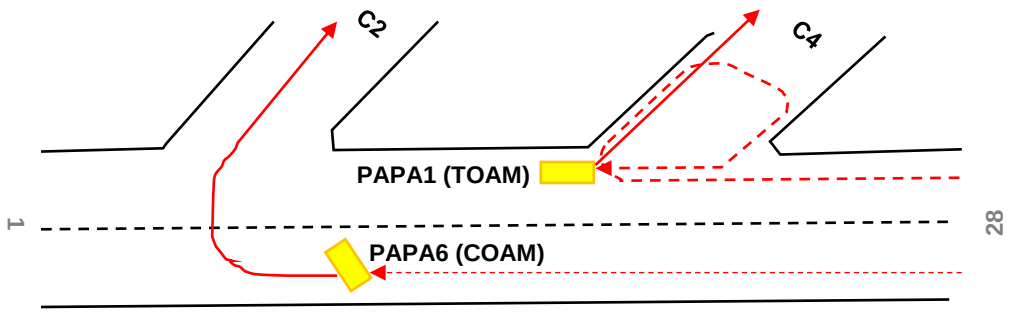

Figure 3. Position of cars PAPA1 and PAPA6 during the event

They also mentioned that it was the second similar event they were involved in. The previous one had been in February 2018 at 17:35, with an Air Algerie aircraft. They were checking the runway in use, 28, and ATC cleared an aircraft (Air Algerie) to take off while they were on the runway. In that case the aircraft did not start its takeoff run, and the vehicles also quickly vacated the runway"[25].

1.16.4 Statement from the crew of IBK2WH

The crew of IBK2WH provided the following statement:

"They were instructed to abort the takeoff after having reached a speed of about 80 kt.

They vacated the runway via the first exit (C2) and waited on the taxiway for several minutes, assessing their situation (braking energy and coordinating with the cabin crew). They decided to continue taxiing and take off again. They took off after approximately seven minutes.

In their statement, they indicated that the tower controller was handling all clearances at the airport.

As for whether they able to see the vehicles, they stated they had no visual contact with the vehicles. They also stated that they did not understand the communications in Spanish held earlier between the tower and the vehicles".

1.16.5 Strip management in single position

Figures 4 and 5 show the position in the control room from which single-position operations are carried out at the Alicante tower. They show how the board, which seeks to represent the airport, is arranged. Note:

- Designators: they represent the various positions or movement areas in the airport. They are dark green.
  - Startup and pushback designator.
  - Taxi designator: TWY 10 (or TWY 28)
  - Runway designator: RWY 10 (or RWY 28)
- Strips: represent each of the aircraft or other vehicles that move around the airport. They have three colors:
  - Green: departing traffic.
  - Yellow: arriving traffic.
  - Red: other vehicles operating at the airport. FERRONATS had identified each of these vehicles and had several pre-labeled strips. Specifically, for the SPP vehicles, it had a red strip with word "AMARILLO" (yellow).

[25] Taken from the occurrence reporting system (SNS). Occurrence 2018S03020.

- SPP stated that it was the crew of the aircraft who saw the SPP cars, which were near the 28 threshold (at C5), and informed ATC that the runway was occupied.
- The TWR stated that the event was detected by the instructor, who told the student on the frequency to cancel the clearance because the runway was occupied. The tower was in single-position operation with a 10-h student and an instructor. The aircraft had not yet entered the runway when the takeoff clearance was canceled.

The strips are moved from top to bottom in the bay and left to right (for departing aircraft) as clearances are issued by ATC. For landing aircraft, the strips are moved from top to bottom and right to left.

A given time before takeoff (or landing) time, the printer prints out a strip for each aircraft. This strip is placed in a strip holder (green for takeoff and yellow for landing) in the left of the bay, where pending aircraft are located. For departing aircraft, of interest to this investigation, when the controller issues the clearance, the strip is moved to the right, over the START UP designator. When the controller authorizes engine startup, the strip is moved down placing it underneath this designator. Once an aircraft is cleared to taxi, its strip is moved down until it is placed below the TWY taxi designator. And finally, when the aircraft is cleared to line up and take off, it is moved to the right and placed under the runway designator.

Traffic priority is determined by how close its strip is to the designator; that is, if there are three aircraft taxiing, number 1 to taxi will have its strip at the belower position.

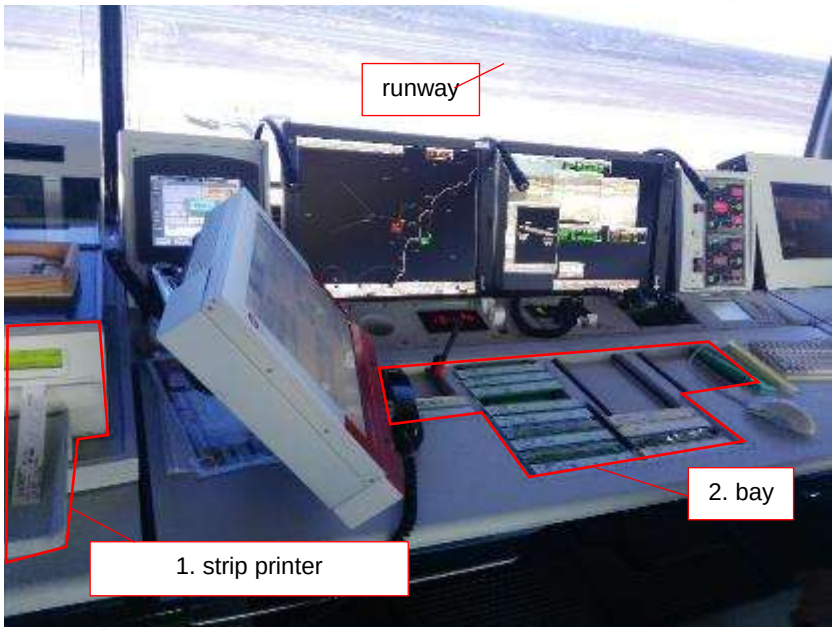

Figure 4. Control position at the Alicante TWR (in single position)

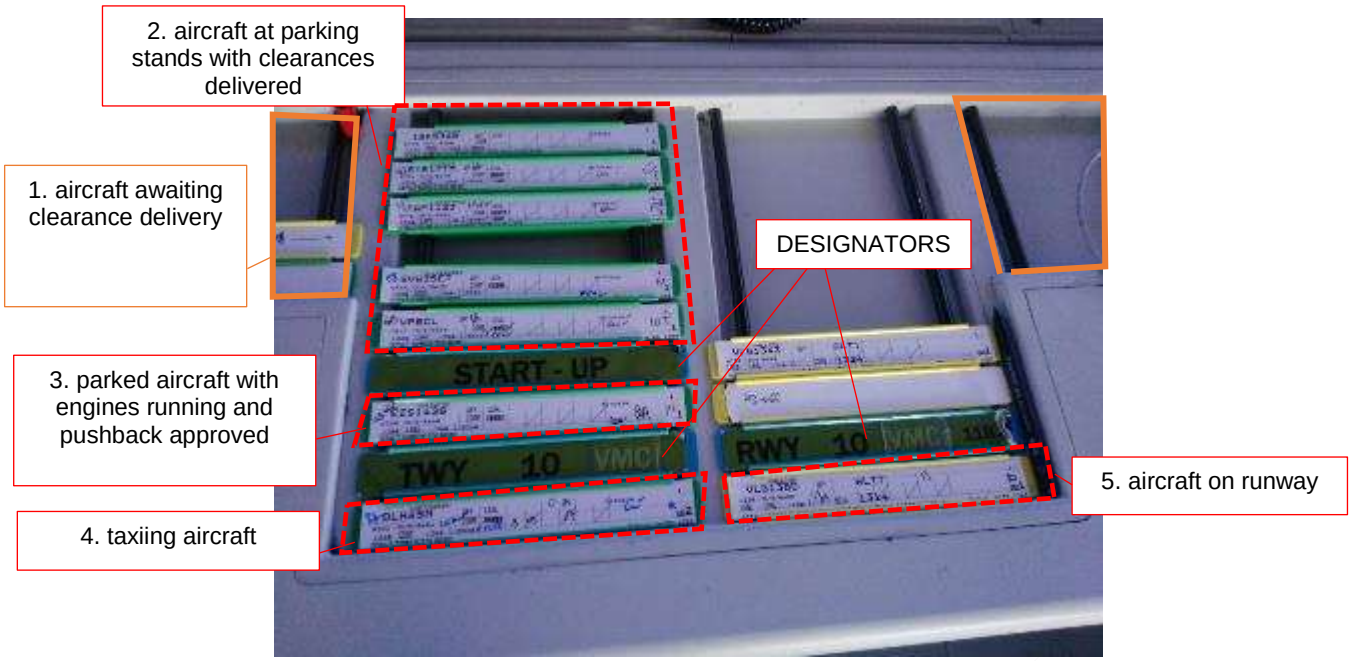

Figure 5. Strip management on the bay (for departing aircraft)

1.16.6 Surveillance camera recordings

The airport provided four recordings taken from the surveillance cameras located at the positions described in section 1. Despite the low resolution of the images, investigators were able to extract information of interest.

- The recording from the control tower camera looks out over the runway 10 threshold and rapid exit taxiway A2. It recorded the aircraft entering the runway. This recording lasts 31 s[26], and it confirmed that:
  - IBK2WH remained lined up on the runway for 6 s.
  - It then began its takeoff run.
  - During this process, an aircraft is seen waiting at A6 (AFL2523) and a second aircraft reaching holding point A5 (IBK5358).

- The recordings made by the camera on the terminal building roof show from the 10 threshold to C2. Two positions are identified:
  - Position 1 (t=0 s): when the recording starts, PAPA6 is at the beginning of rapid exit taxiway C2. At that point, the aircraft is moving, 1350 m away from the vehicle, approximately at the aiming point markings. Correlating this information with the QAR data shows that this moment corresponds to 16:30:52, and the aircraft had a GS of 76 kt.
  - Position 2 (t=5.6 s): the vehicle has traveled 130 m since t=0s, equivalent to a speed of about 83 kph. It is practically outside the runway strip. At this point, the aircraft is passing the point where A2 intersects the runway, having traveled 220 m. The straight-line distance between the two is 1270 m. Correlating this information with the QAR data shows that this moment corresponds to 16:30:58, and the aircraft had a GS of 86 kt.

[26] The reference time of the surveillance camera is at least 11 s ahead of the reference time provided by ATC. Since this mismatch could not be exactly determined, no reference times are given.

Figure 6. Relative positions between aircraft and PAPA6

1.17. Organizational and management information

The following information was obtained relative to the configuration at the control unit on the day of the event, considering the anticipated demand and the type of controller scheduled to be on duty[27]:

- The number of positions planned to be open during a certain period depends on the anticipated demand.
- The anticipated demand is provided by the CHMI tool[28].
- On the day of the incident, for the time period when the incident occurred (16:00 – 17:00), 17 movements per hour were scheduled. The actual demand processed was 17 movements/hour.
- The Alicante tower offers the option of opening three control positions: LCL (local), GND (ground) and CLR (clearance). The stated and maximum capacities (the latter is established by increasing the stated capacity by 20%) are as follows, depending on which positions are open:

Positions staffed	Stated capacity (movements/hour)	Maximum capacity (movements/hour)
3 (LCL/GMC/CLR)	36 (20+20)	43
2 (LCL/GMC)	26 (16+16)	31
1 (LCL)	14 (10+10)[29]	16

- The workload assessment (low, medium, high) for training propose the afternoon shift in June at the Alicante Airport was as follows:
  - Average no. of movements (usual traffic): 16 movements/hour
  - High workload (>120%): >20 movements/hour
  - Medium workload (70-120%): 11-20 movements/hour

[27] Information taken from various FERRONATS documents: “Alicante Control Tower Operations Manual”, “Plan to adapt capacity to demand at the Alicante control tower”, “Calculation of on-the-job training hours in Alicante” and “Unit Training Plan”.
[28] CFMU Human Machine Interface (CHMI) is an application that provides real-time traffic information.
[29] Capacity of 14 movements/hour with a single position in any combination of arrivals and departures, as long as there are no more than 10 arrivals or departures during that period.

- Low workload (<70%): <11 movements/hour

- A level-3 student will work in a scenario with the following conditions:
  - Medium traffic level.
  - The student will be aided by the instructor.

After the incident, on 20 July 2018, the Alicante tower chief issued a memo to the training staff requesting that the “on-the-job training periods be given during hours when the stated capacity is not going to be exceeded”.

1.18. Additional information

Not applicable.

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

The incident that occurred on 7 June 2018 at the Alicante Airport satisfies the characteristics of a runway incursion between the aircraft (IBK2WH), which had been instructed to take off, and two runway and apron service vehicles (PAPA1 and PAPA6), which were on the runway after having previously been cleared to enter it.

Of the possible scenarios that may result in a runway incursion (incursions induced by ATC, by aircraft, by vehicles or by a combination of these), this incident clearly satisfies the conditions of an ATC-induced runway incursion.

The analysis of this incident considers four areas:

- 2.1: analysis of the relative positions between the aircraft and vehicles during the incident
- 2.2: analysis of the aspects involving the SPP vehicles
- 2.3: analysis of the aspects involving the operation of IBK2WH
- 2.4: analysis of the aspects involving the actions by the Alicante control tower

2.1. Analysis of the relative positions between the aircraft and vehicles on the runway

The analysis of the surveillance camera footage and of the QAR data allowed investigators to determine the relative positions between the aircraft and car PAPA6 (the closest to threshold 10) at two points during the incident, and, moreover, to locate the aircraft during the two communications made by PAPA6, leading to the following conclusions:

- When the tower cleared the aircraft to take off, PAPA6 and PAPA1 were on the runway.
- By the time PAPA6 managed to communicate with the TWR, the aircraft was on its takeoff run at a GS of 38 kt and PAPA6 was still on the runway, close to C2. The distance between them was 1500 m.
- As PAPA6 was entering C2, the aircraft was 1350 m away from the vehicle at a GS of 76 kt, but it had not yet been instructed to reject the takeoff.
- At PAPA6 was completing its inspection of C2, the aircraft was a straight-line distance of 1270 m away (and 1100 m away from C2), already starting to brake. Its GS was 86 kt.

In other words, throughout the event, the distance between the IBK2WH and the closest vehicle (PAPA6) was in excess of 1000 m, and in excess of 1600 m with respect to the vehicle further away (PAPA1).

These data confirm the controller's and instructor's statement in terms of the positions of the aircraft and the vehicles during the event.

2.2. Analysis of the actions of the SPP vehicles

There was nothing about the SPP operation out of the ordinary. The reason for their presence and movement around the airport (3rd routine inspection of the day), the time of the inspection (between 16:00 and 17:00) and the runway use time (4 min) were all normal and part of the daily routine at the airport. Therefore, from the standpoint of analyzing the incident, any unusual

scenario involving the operation of the SPP vehicles that could have contributed to the incident can be ruled out.

The interaction between the SPP vehicles and ATC, as just another operator, was correct. The communication procedure employed with ATC was appropriate. They communicated their position at all times, reported their intentions and acknowledged the instructions issued by ATC. In fact, when they were unable to acknowledge their instruction to enter the runway at the 28 threshold, they stayed where they were. Their positions during the entire incident were known to ATC and were correctly annotated by the controller on the strip.

The practice by both drivers when picking up objects from the runway of driving as close as possible so as not to have to get out of and move away from the car, allowed the drivers to monitor the tower frequency constantly. When the aircraft was cleared to take off, PAPA6 was picking up some debris, but this did not prevent the driver from monitoring the tower frequency. The active listening by the drivers at all times while driving the SPP vehicles allowed them to identify the conflict and provided a barrier that kept the incident from becoming worse. Considering the speed and acceleration of an aircraft of these characteristics, which is airborne in 37 s (as the second takeoff showed), a delay in identifying the conflict may not have allowed the vehicles to vacate the runway on time.

Both drivers, the COAM and the TOAM, immediately detected the conflict. Their reaction was immediate and similar: to vacate the runway as quickly as possible. The frequency was busy, which prevented them from communicating with the TWR until 25 s after the conflict began, but by then they had already taken the initiative and vacated the runway. The reaction of the SPP vehicles was fast and appropriate.

Lastly, the use of English to give the takeoff instruction to the aircraft did not prevent the TOAM and COAM from understanding it. Thanks to this, they identified the conflict situation they were in and took measures that helped to mitigate the consequences of the incident. All communications between the tower and the SPP vehicles were held in Spanish, which kept the crew of the aircraft from understanding the instruction clearing the SPP vehicles to enter the runway. If this instruction had been given in English, it may have made it more likely for the aircraft crew to detect the conflict, and not just the SPP vehicle drivers.

However, there is no requirement to use English in communications between controllers and airport vehicles that are not aircraft. There is not even a requirement for controllers to communicate with aircraft crews in English, since Spain decided not to apply the requirement to use English in these communications[30].

The problem of using English has already been identified and decisions have been adopted, so this report does not issue any recommendation in this regard. However, for the purpose of explaining and describing the circumstances in which the incident took place, the use of Spanish is included as one of the factors that contributed to this event.

[30] SERA.14015, section b) Commission Regulation 2016/1185 of 20 July 2016. This requirement affected the Alicante Airport by virtue of having more than 50,000 international IFR movements.

2.3. Analysis of the actions of the crew of IBK2WH

From the standpoint of the aircraft and its actions during the incident, the main conclusion is that it did not contribute to the incident. As with the SPP vehicles, the communications held with the TWR were complete and correct, and each of the aircraft's position in the airport was known by the TWR. The movements made by the aircraft were authorized by the controller, and at no point was the aircraft in an unauthorized position.

The last paragraph of the previous section already mentioned how the use of Spanish on the frequency in use contributed to the incident, and how it prevented the crew of the aircraft from realizing that the runway was already in use.

There was no visual contact between the crew and the SPP vehicles, as confirmed by both the crew and the drivers. This was due not only to the gradient of the runway, but primarily to the distance separating them (in excess of 1000 m at all times).

Once the takeoff clearance was canceled, the crew initiated the RTO maneuver. The QAR data show that this maneuver was started immediately after receiving the cancelation instruction from ATC. The crew confirmed to ATC they had received the instruction and were executing it, as their inputs to the throttles show. The position of the aircraft on the runway shows that:

- The instruction to cancel the takeoff was issued 9 s after starting the takeoff run, 160 m away from the threshold markings.
- The aircraft's speed when the maneuver was started was 80 kt, meaning it was a low-energy RTO (in other words, the energy to be dissipated was low).
- The fact that the aircraft had been on its takeoff run, and thus accelerating, for 9 s, resulted in an inertia that caused the aircraft to reach a GS of 88 for two seconds.

In all, it may be concluded that the proximity to the start of the runway and the few seconds that elapsed from the start of the takeoff run allowed the RTO maneuver to be executed without any limitations or potential danger. There was sufficient runway and the speed was not high.

The execution of the first part of the procedure, in terms of the inputs to the throttle levers and the braking system, was immediate and complete.

This allowed the aircraft to decelerate in a short space and time and leave the runway via the first exit, C2. After vacating the runway, the crew, according to their statement, carried out the second part of the procedure, which involved evaluating the braking energy used during the RTO and calculating the required cooling time. The lack of a CVR recording made it impossible to confirm exactly what calculation was performed in the cockpit. The QAR suggests that it was done during the 52 s that the aircraft was stopped on the taxiway. This time implies that a brake cooling period must not have been necessary (since the minimum period is in excess of one minute), which is a possibility given the relatively low speed at which the maneuver was executed.

2.4. Analysis of the actions taken by the controllers in the Alicante tower

The situation that led to the incident was caused by ATC when, with the runway occupied, it cleared an aircraft to take off. The following actions by the TWR in this incident are considered:

- 2.4.1: Visual monitoring of the runway and check of the strip board
- 2.4.2: Workload of the student controller
- 2.4.3: Different way of handling aircraft and vehicles
- 2.4.4: Adaptation of the configuration in the tower to the controller
- 2.4.5: Situation in the control room: instructor and assistant
- 2.4.6: Conclusion

2.4.1 Visual monitoring of the runway and check of the strip board

The basic tools for controlling traffic are a combination of visual monitoring of the aerodrome and its surroundings and the strip board, which provides a visual representation of the actual situation that exists at the airport. The only source of information in this regard are the statements of the student controller and the instructor, who confirmed that the status of the strips on the board was correct, meaning the board indicated that the runway was occupied by the SPP vehicles (their strip was correctly situated below the runway designator) when the controller cleared IBK2WH to take off (its strip was below the one for the vehicles, initially cocked out and then placed correctly on the tracks once the clearance was given).

Since the runway is completely visible from the controller's position in single-position operations, that makes it possible to identify the vehicles on the runway, and since visibility on the day of the incident was ideal, and assuming the information on the strip board was true, there are two possibilities:

- The takeoff clearance was given without looking at the strip board (that is, looking outside), or
- The takeoff clearance was given while looking at the strip board (that is, looking inside).

The first option would mean that the student did not visually scan the entirety of the runway (from one threshold to another), since in that case he would have seen the SPP vehicles. The second option would mean that he did not assimilate the information he was seeing on the strip board. The ATC communications showed that the takeoff clearance was issued as the aircraft was entering the runway, before lining up with the centerline. That clearance, at that moment, implies that the controller must have been looking at the aircraft. It thus seems likely that the clearance was given with the controller looking at the runway, but only focusing on the threshold.

As for the board, the statements were consistent in that the strip for IBK2WH was placed on the tracks, meaning the controller had the strip in his hands. Moreover, he would have had to write the takeoff time on it, meaning that at some point his eyes must have focused on the bay, and specifically, on the area of the runway designator, but without taking in the information it was showing (despite the presence of the strip for the vehicles, in a conspicuous color, immediately above). The section below (2.4.2) analyzes the reasons that might have caused the controller to ignore this information.

In conclusion, this case must have resulted from a combination of both situations: the clearance was issued while looking only at the runway threshold without scanning the entirety of the runway, and the controller did not take in the information that the strip board was showing him, even though he must have necessarily looked at the board at some point during the clearance process.

Due to the seriousness of the situation involved in issuing a clearance to use a runway that is occupied a recommendation is issued to the service provider at this unit in terms of:

- The need to visually monitor the entirety of the runway (from one threshold to another) before issuing a takeoff clearance.
- The need to check the strip board, as a basic graphical tool that represents the actual situation at the airport, before issuing a takeoff clearance.

2.4.2 Workload of the student controller

The ATC communication in the 20 minutes prior to the event showed high use of the frequency. The student controller's actions were correct (use of phraseology, acknowledgments, situational awareness and proactivity). His English level was very high, and this is not thought to have been a factor that influenced the incident.

The controller's faster speaking speed as time went by was obvious in his communications, no doubt a result of the increased activity at the airport, and to offset the long time needed for clearance delivery (11 to 17 s) and the pushback and start up clearances (7 and 11 s) he had to issue, in comparison to the other clearances (taxi, line up and wait, takeoff and transfer to APP, lasting 3 to 6 s).

The number of aircraft handled during this 20-minute period was 10 departing and 1 arriving aircraft, along with other activities (CECOA and SPP vehicles). The listing of tasks (section 1.9) carried out during the time the controller was on watch indicates that the activity on the frequency was high. The workload increased above what was expected when an aircraft requested to reposition, which doubled the number of communications and coordination required. The increased delay in issuing clearances (from being issued immediately at the start of the shift from being delayed 2-3 minutes) is indicative of the controller's increasing workload.

Potential evidence of the increase in workload, in addition to the high use of the frequency, the faster speaking speed and the need to delay clearances, is the fact that in the takeoff clearance issued to IBK5358, the controller forgot to include wind data.

To the above we must add the fact that the controller on the frequency was a controller in training, whose cognitive effort is higher than that required of a more experienced person. The student was also a perfectionist, who was in training, who had made two mistakes that the instructor had pointed out to him, one of which was the focus of the training phase he was in. The focus that the student himself mentioned on achieving the proper takeoff sequence, while ignoring the strip board and the lack of visual monitoring, could be the result not only of a lack of experience, but of the student's abilities being undermined by the increase in workload.

In short, there are indications that the student could have been subjected to a workload during the incident that was too high for him, which affected his ability to focus on and execute tasks that he normally carried out very meticulously.

2.4.3 Different way of handling aircraft and vehicles

At 16:18:33, the controller cleared the SPP vehicles to enter the runway, but they did not do so because they were unable to acknowledge their instruction. The controller, unlike what had happened with an aircraft moments earlier, did not request an acknowledgment of the instruction and also did not realize that the vehicles were not carrying out his instruction, indicating a lack of visual oversight. At 16:26:27, the controller cleared the vehicles to enter the runway, and 4 minutes later he cleared an aircraft to take off while said vehicles were on the runway.

The two events that took place were related with the operation of the SPP vehicles and indicate that:

- The controller's attention was focused on the aircraft, to the detriment of other vehicles.
- The entire runway was not being monitored visually, as indicated in point 2.4.1.

In a high workload setting, certain tasks are subconsciously prioritized over others. In an airport setting, where the goal is to move aircraft efficiently, the activity of "other vehicles" takes less priority (they are not the ultimate goal of the activity), and thus these vehicles tend to be given less attention. However, the operation of these vehicles entails the same risks to safety as aircraft by virtue of sharing the same physical space, as evidenced by this incident.

In order to provide a reminder that all other vehicles (that are not aircraft) that operate in the airport environment need the same type of oversight and monitoring from ATC, from a safety standpoint, as aircraft, a safety recommendation is issued.

2.4.4 Adaptation of the configuration in the tower to the controller

A review of the information provided has shown that when setting up the tower service, FERRONATS takes into consideration the anticipated demand on the one hand, and on the other the type of controller who is going to staff the frequency.

On the day of the incident, a medium workload was expected[31] (17 movements/hour), which is an adequate setting for a student at the training level of the student controller involved in this case.

However, based on the service provider's own criteria, the number of positions that should have been staffed for this expected number of movements should have been two, since it exceeded the stated capacity by 3 movements/hour and the maximum capacity by 1 movement/hour[32]. These values were taken into account by the instructor when setting up the unit, and for the first ten minutes, he in fact staffed two positions. The decision to close one was due, according to the instructor's statement, to the subsequent reduction in traffic and to the fact that keeping two

[31] The operator considers 11 to 20 movements/hour to be a medium workload. See section 1.17.
[32] Stated capacity: 14 movements/hour. Maximum capacity: 16 movements/hour. See section 1.17.

positions open for the entire hour would not benefit the student, because the workload would be too low for him.

The reality of the incident is that the amount of work in a single-position configuration was too much for the student, and while the decision may have been correct, it may have required more active oversight from the instructor.

As a safety measure after the incident, the tower chief decided that during on-the-job instruction periods, the stated capacity values (not the maximum capacity values) would be considered. This measure, had it been in effect on the day of the incident, would have meant staffing two positions, since the number of movements expected per hour exceeded the single-position capacity by three.

This measure improves the safety margin in cases such as this one, where the cognitive resources of a student controller are more limited by virtue of being in training, and where the student is more prone to fatigue due to the increased workload.

2.4.5 Situation in the control room: instructor and assistant

Because he was a controller in training, there was an instructor in the control room to help with and supervise the controller's actions. In this incident, the instructor's oversight was evident in two observations he made to the student (when the SPP vehicles did not enter the runway the first time, and when he sequenced the three departing aircraft incorrectly before the incident), and when he corrected the assistant's mistake when placing a strip on the bay.

As his statement showed, he was tracking the sequence of events and was aware of the situation with the vehicles and aircraft, so he knew immediately what had happened when he heard PAPA6 report the event. The immediate instruction he gave the student to cancel the takeoff shows that he was perfectly cognizant of the traffic situation at the airport.

However, at the last second, he did not exercise this oversight, and the incident occurred. Based on the information gathered during the investigation, this distraction was due to:

- Excess confidence in the abilities of the student controller.
- Lack of experience as an instructor, since it was his second day acting in that capacity.
- Excessive attention to the assistant, to whom he was giving explanations at the time of the incident.
- Lack of experience of the assistant, who was on his first day on the job.

As concerns the interaction with the assistant in the control room, said assistant's lack of experience led him to place a strip in the strip board and to excessive conversation or interaction in the control room, as the controller himself noted. The ability to limit the interactions with the assistant is directly related to the lack of experience of the instructor, who, perhaps in different circumstances, would have been more assertive and been more effective in limiting his interaction with the assistant.

The instructor's lack of experience also led him to place too much trust on the student's abilities and to forget that he was precisely that, a student, and that as such, his resources were limited and he could have been more affected by the increased workload.

Even though the instructor was highly self-critical of his actions and recognized his mistakes in this incident, it is necessary to remind FERRONATS instructors and assistants of the situations that occurred in this incident:

- The need to exercise constant oversight of student controllers they are tasked with supervising, without forgetting that they are more susceptible to increases in workload, even when operating in conditions within the limits, since their abilities and resources are less than those of a qualified controller. A student controller will also be hard pressed to be assertive enough to recognize his inability to undertake the workload assigned, and so instructors must be alert to any symptoms or signs that may indicate that these situations are taking place.
- The need to limit any type of personal interaction in the control room, in terms of noise and potential distractions, so as to maintain an ideal working environment for the student controllers.
- The need for interactions with assistants in the control room to be as unintrusive as possible for the controller on the frequency and the instructor, as well as to reinforce their training in terms of ensuring they know that the strip board should only be handled by the controller.

2.4.6 Conclusion

In summary, as concerns the ATC aspects, in this incident:

- The takeoff instruction was given to the aircraft after establishing visual contact with only a part of the runway (threshold), without the student checking the runway in its entirety and without being able to process the information that was reflected in the strip board, which indicated that the runway was occupied.
- There were signs that the student was exposed to an excessive workload, which affected his attention span and his ability to carry out tasks that he normally performed with meticulous attention to detail.
- The tower was operating in single-position.
- The SPP vehicles were not being supervised and monitored in the same way as the aircraft at the airport were.
- At the time of the incident, the instructor did not exercise the oversight duties assigned to him, though he had done so earlier.
- The assistant carried out an action involving the strip board that resulted in the instructor failing to supervise the instructions given by the student at the time of the incident.
- The instructor was overconfident in the student's abilities due to the latter's good training record.
- The instructor's relative inexperience contributed to his being distracted at the time of the incident.

3. CONCLUSIONS

3.1. Findings

General:

- The incident was a runway incursion involving one aircraft and two SPP vehicles.
- The distance between the aircraft and the two SPP vehicles was in excess of 1000 m throughout the incident.

Involving the SPP vehicles:

- The SPP vehicles had been cleared, in Spanish, to enter the runway 4 min before the aircraft was cleared, in English, to take off.
- The SPP vehicles identified the conflict and alerted the TWR.
- The actions of the vehicles did not affect the incident.
- The operation of the SPP vehicles was routine and unexceptional in all regards.
- The vehicles' interaction with the TWR was appropriate and fully compliant with procedures.
- The movements of the SPP vehicles were authorized by the TWR.
- The vehicles monitored the operating frequency at all times.
- The SPP vehicles identified the conflict and took immediate measures that were appropriate for the situation.
- The SPP vehicles perfectly understood the takeoff instruction issued in English to the aircraft.
- All communications between the TWR and SPP vehicles took place in Spanish.

Involving aircraft IBK2WH:

- The actions of IBK2WH did not have any effect on the incident.
- The position of IBK2WH was reported to the TWR at all times.
- The aircraft's movements in the airport were cleared by the TWR.
- The distance and gradient impeded visual contact between the aircraft and the SPP vehicles.
- The crew of the aircraft did not understand Spanish and did not understand the clearance given in Spanish by the TWR to the SPP vehicles.
- The instruction to reject the takeoff was issued 9 s after the takeoff run was started, with the aircraft 160 m away from the threshold.
- The RTO maneuver was started immediately at a speed that allowed the aircraft to carry out the maneuver with sufficient runway remaining to stop the aircraft.
- The actions taken in the cockpit were in keeping with the RTO procedure.
- After rejecting the takeoff, the aircraft vacated the runway via the first exit taxiway, C2, and took off 7 min later without further incident.

Involving the control tower service:

- The tower was in single-position operation.
- The controller on the frequency was a student with 96 h of experience who was under instruction.

- There was an instructor in the TWR with little training experience (one day) overseeing and helping the student controller.
- There was an assistant in the TWR who was on his first day on the job.
- The weather conditions did not have any effect on the incident. Maximum visibility conditions prevailed at the airport.
- The visibility from the control position on the day of the incident provided an unobstructed view of the runway and the vehicles on it.
- As per the controllers' statements, the strip board represented the actual conditions at the airport.
- The takeoff clearance was issued, despite the runway being occupied, without doing a full visual scan of the runway.
- The takeoff clearance was issued, despite the runway being occupied, without considering the information shown by the strip board.
- Traffic conditions required the control tower to be in a two-position configuration, as per the unit's own documentation.
- The instructor did not carry out the supervisory duties assigned to him at the time of the incident, though he did so afterward.
- At the time of the incident, the instructor was speaking with an assistant, who had just made a mistake involving the strip board.

3.2. Causes/Contributing factors

The incident occurred because aircraft IBK2WH was issued an incorrect takeoff clearance by the tower when the runway was occupied by two runway and apron service vehicles that had previously been cleared to enter the runway.

The following contributed to the incident:

- The possible excessive workload for a student controller.
- The single-position configuration in the tower when, based on the demand anticipated at that time, two positions should have been staffed.
- The lack of effective supervision by the instructor at the time of the incident.
- The use of Spanish to communicate with the SPP vehicles, which prevented the crew of the aircraft from understanding their content.

4. SAFETY RECOMMENDATIONS

This was the second incident to have occurred at the Alicante Airport in 2018 in which an aircraft was cleared to take off while the runway was occupied by two SPP vehicles. The deficiencies identified by this investigation in terms of the control tower service provided involve the procedures and skills inherent to the controller, controller instructor and assistant positions. As a result, a safety recommendation is issued to FERRONATS to have it incorporate into its training modules the results and findings contained in this report.

REC 54/18. It is recommended that FERRONATS, as the control tower service provider at the Alicante Airport, incorporate into its training modules for instructors, controllers and assistants, the results and findings contained in this investigation report in order to reinforce the following aspects:

For controllers, involving the checks prior to authorizing the use of the runway:

- The need to visually monitor the entirety of the runway (from threshold to end of runway) before issuing a clearance to use the runway.
- The need to check the strip board, as a basic graphic tool representing the actual situation at the airport, before issuing a clearance to use the runway.

For controllers, involving the need to treat vehicles and aircraft equally:

- The need to apply to the vehicles that operate at the airport the same supervision and monitoring practices and techniques that are used with aircraft.

To the instructors, involving their supervision of controllers in training:

- The need to exercise constant oversight of the student controllers under their supervision, keeping in mind that they are more prone to increases in workload, even when operating in conditions within limits, since their skills and resources are lower.
- The need to identify symptoms or signs that a student might be affected by the workload, considering that a student controller will be hard pressed to be assertive enough to recognize his inability to undertake the workload assigned.

To assistants, involving their interactions in the tower:

- The need for their interaction in the tower to interfere as little as possible with the controllers on duty.
- The consequences of a drop in situational awareness by controllers of actions taken involving the strip board when this action is not known to and approved by the controller himself.