DATA SUMMARY

LOCATION

Date and time	**Saturday, 12 November 2011; 15:56 UTC**[1]
Site	**Tenerife South – Reina Sofía Airport (Spain)**

AIRCRAFT

Registration	**G-LSAI**	**EC-JMR**
Type and model	**BOEING B-757-21B**	**AIRBUS A321/B3**
Operator	**JET2**	**Iberia LAE, S.A.**

Engines

Type and model	**RB211-535E4**	**CFM 56-5B3/P**
Number	**2**	**2**

CREW

	Captain	Copilot	Captain	Copilot
Age	**49**	**55**	**46**	**40**
Licence	**ATPL**	**ATPL**	**ATPL**	**ATPL**
Total flight hours	**15,500 h**	**6,100 h**	**13,200 h**	**10,800 h**
Flight hours on the type	**570 h**	**2,760 h**	**5,797 h**	**6,818 h**

INJURIES

	Fatal	Serious	Minor/None	Fatal	Serious	Minor/None
Crew			**7**			**6**
Passengers			**208**			**153**
Third persons						

DAMAGE

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

FLIGHT DATA

Operation	**Commercial Air Transport – Scheduled – International – Passenger**	**Commercial Air Transport – Scheduled – International – Passenger**
Phase of flight	**Takeoff**	**Approach – Landing**

REPORT

Date of approval	**28 February 2013**

[1] All times in this report are in UTC unless otherwise specified.

1. FACTUAL INFORMATION

1.1. Description of the event

The A321 aircraft, callsign IBE3415, originating in Paris/Charles de Gaulle, was making an ILS Y approach to runway 08 at the Tenerife South Airport. Approach Control had authorized it to descend at its discretion as per the ILS procedure and had transferred it to the tower frequency (TWR).

The other aircraft, a B757-200, callsign EXS518, had been cleared to proceed to the runway 08 hold point at the same airport. The tower controller then asked the aircraft if it was ready for immediate takeoff, to which the crew of the aircraft replied in the affirmative. The controller cleared it to enter the runway via taxiway B1 for immediate takeoff.

Aircraft IBE3415 reported it was on short final and the controller informed it that there was an aircraft taxiing. He then authorized IBE3415 to land with the departing traffic in sight.

Aircraft IBE3415 landed on runway 08 as aircraft EXS518 became airborne. Both aircraft completed their respective maneuvers without any further incident.

1.2. Personnel information

The tower controller handling landings and takeoffs had 11 years of experience and had qualified at the airport tower in 2004, meaning he had seven years of experience at that post.

He had taken and completed the continuous training approved in the 2011 training plan. Said training included a six-hour simulator course. The simulator sessions did not include the tower controller position that authorized arrivals and departures.

1.3. Aircraft information

The B757 FCOM (Flight Crew Operations Manual) recommends a typical taxi speed of about 20 kt, a value that should be reduced to 10 kt when turning.

Given the conditions of that day, the performance calculations for the airplane yielded a value for the takeoff run of 4,095 ft (1,250 m) and a rotation speed (IAS) of 143 kt.

The speed during the final part of the approach (*Vapp* as per the terminology employed by Airbus) depends on the airplane's weight, its configuration, the wind and the use or absence of autothrust. For the Airbus A321, it usually oscillates between 125 and 155 kt for the range of weights typical for commercial operations (between 60 and 75 MT).

The A321 can be landed in a FULL FLAP configuration (corresponding to a 40° flap extension) or in the so-called CONF3 configuration (corresponding to a 24° flap extension). Landing in the latter requires an approach speed that is 5 to 7 kt higher than that used for the FULL FLAP configuration.

The A321's approach speed is classified within the ICAO's definition as being in the C category[2].

1.4. Meteorological information

The visibility at the time of the incident was in excess of 10 km. The surface winds were weak (2-3 kt) and from the south, atypical for this area, which usually sees relatively strong winds from the east.

1.5. *Aerodrome information*

The Tenerife South Airport has a single asphalt runway (08/26) measuring 3,200 × 45 m. There is a taxiway (called "T") parallel to the runway that has three accesses to the runway 08 threshold: B2, B1 and B0 (Figure 1). The control tower is some 500 m north of the runway's geometric center and approximately 1.5 km away from the 08 threshold.

Runway 08 has a category I ILS approach.

[2] The ICAO (Doc 8168 PANS-OPS) has specified a classification for aircraft that is used to define their maneuverability during instrument procedures. This classification is based on the speed above the threshold (V_{REF}), which is a function of the stall speed in a landing configuration for the maximum certified landing weight. The categories range from A (V_{REF} below 90kt) to E (V_{REF} above 166 kt). Most medium-range commercial transport jet airplanes fall within the C category (V_{REF} between 121 and 140 kt).

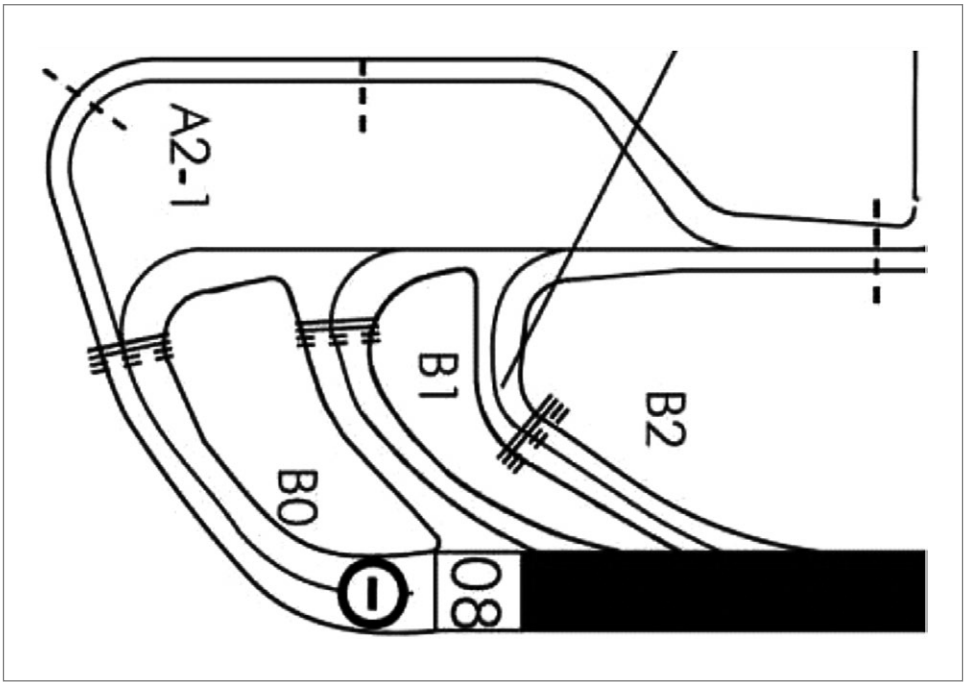

Figure 1. Entrances to the runway 08 threshold

1.6. Communications

Aircraft IBE3415 initially contacted the Tower at 15:51:58 to report that it was 14 NM away on final and lined up on the runway 08 ILS.

The crew of EXS518 contacted the Tower at 15:53:41 and, after confirming that they were ready for immediate takeoff, were cleared for said maneuver. The controller offered them the possibility of using the B2 or B1 access, and the crew opted to enter the runway via B1.

There were no more communications between the aircraft and ATC until 15:55:15, at which time aircraft IBE3415 reported that it was on short final, to which the controller replied that there was an aircraft taxiing. A few seconds later IBE3415 was cleared to land with the departing aircraft in sight. The crew acknowledged this information.

There were no further communications until airplane EXS518 was airborne.

1.7. Recorders

The parameters recorded on the QARs (Quick Access Recorder) on both aircraft were available to investigators. The information obtained was compared against the radar data in order to reconstruct the sequence of events.

1.8. Eyewitness statements

1.8.1. *Statement from the controller*

The controller stated that clearing an airplane for immediate takeoff with another airplane on approach is a typical practice that he has used on numerous occasions. In this case he did it of his own initiative to speed up traffic. There was no pressure from the crew of EXS518, which had ample time to comply with its assigned slot.

While he confirmed that he gave the takeoff clearance with the aircraft still in the taxiway, he could not say for certain how far away the aircraft was from the runway entrances, given his line of sight from the tower control room. It was his impression that the maneuvers carried out by EXS518 to enter the runway and takeoff were slower than usual.

The approach speed of the landing airplane also seemed to be noticeably higher than usual. In his opinion the concurrence of both factors contributed to the incident.

He stated that he was unaware of the existence of a written procedure establishing a minimum distance between a landing aircraft and the threshold with which an immediate takeoff clearance can be given to the preceding aircraft, though the common practice by tower controllers is to use 5 NM as the limit. The absence of such a guide or procedure was confirmed by other towers in the AENA network.

As he stated, as aircraft EXS518 was taxiing on B1 to enter the runway, he had doubts as to the suitability of the maneuver, but since he could not estimate whether the aircraft had crossed over the hold point or not, he chose not to amend the takeoff clearance.

1.8.2. *Crew statements*

The crew of IBE3415 stated that they heard the takeoff clearance for aircraft EXS518, which appeared to delay its takeoff, such that the controller cleared them to land with the preceding traffic still on the runway. They assessed the possibility of going around, but since weather conditions were good and the other aircraft was far along on its takeoff run when they were on short final, they continued with the approach, touching down on the runway as aircraft EXS518 was becoming airborne. They were able to complete the operation without having to deviate from normal procedures during the approach and landing phases.

When asked about the aircraft's landing configuration, they indicated that since the difference in speed between CONFIG3 and FULL FLAP on the A321 is very small, it is fairly common not to fully extend the flaps so as to save fuel.

The crew of aircraft EXS518 stated that they were aware that there was an aircraft on short final, since they were notified of this by ATC and had visual contact with it. They saw the landing lights of the approaching aircraft but did not think it was particularly close to the landing. They added that once cleared for takeoff, they did not stop the aircraft at any point and that the taxi and takeoff maneuvers proceeded normally. They did not notice any anomalies in the instructions given to either aircraft by the controller, which they described as efficient from the point of view of maximizing the airport's capacity.

1.9. Decelerated approach

The concept of a decelerated approach refers to a type of approach in which the crew delays extending the flaps.
Prolonging the flight profile in a clean configuration yields higher speeds, which can be useful if ATC issues an instruction in this regard, and it saves fuel by reducing the amount of energy dissipated by the higher aerodynamic drag.

The Iberia Operations Manual considers this type of approach, and recommends that it be used "whenever possible", though it restricts its application to situations with good visibility conditions. As a general rule, the Manual specifies that the airplane must initiate the final approach segment in CONF1 (10° flaps) at an airspeed (IAS) that, for the typical landing weights mentioned earlier, varies between 180 and 203 kt. This is so as to get to 1000 ft with the airplane configured for landing and established on the final approach speed.

1.10. Control of departures by the airport's ATC

The concept of an immediate takeoff clearance is considered in Spain's Air Traffic Regulations (RCA in Spanish):

> **"4.5.9.5.1.1.** So as to speed up traffic, an aircraft can be cleared for immediate takeoff before it is on the runway. By accepting said clearance, the aircraft shall taxi on the taxiway and onto the runway and shall take off without stopping on the runway."

The same regulation forbids, as a general rule, having an aircraft fly over the threshold of an occupied runway:

> **"4.5.10.1.1.** Except as specified in 4.5.11 and 4.5.15, a landing aircraft shall not, in general, cross over a runway threshold until the preceding departing aircraft has crossed the end of the runway in use (B), or has started a turn (C), or until the runway is clear of landing aircraft (D) (See Figure 4-35 A)."

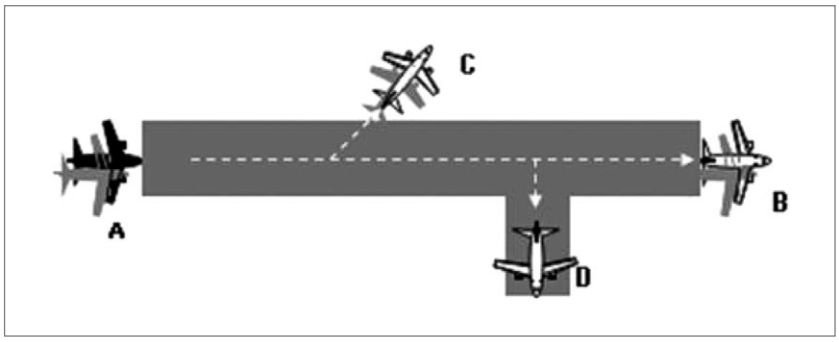

FIG 4-35 A

The landing can be authorized in advance, however, as long as adequate separation is assured when crossing over the threshold.

> **"4.5.10.1.1.1.** An aircraft can be cleared to land if there is reasonable assurance that the separation shown in 4.5.10.1.1, or that prescribed in accordance with 4.5.11, will exist when the aircraft crosses over the runway threshold, as long as the landing clearance is not granted until the preceding aircraft in the landing sequence has crossed over said threshold. So as to minimize the possibility of a misunderstanding, the landing clearance shall include the designator of the landing runway."

This concept is encompassed in the airport's procedures which, as included in the documentation published in the AIP, uses this type of early landing clearance:

> "Even if the runway is temporarily occupied by a landing or departing aircraft, the subsequent aircraft can be cleared to land as long as the aerodrome controller can be reasonably sure that when the landing aircraft crosses the runway threshold, sufficient separation will exist with respect to the preceding aircraft."
>
> When a "Landing Clearance based on Expected Separation" is issued, the following phraseology shall be used:
>
> "... (callsign) BEHIND THE (type of aircraft) LANDING/TAKING OFF, CLEARED TO LAND RUNWAY (number)."
>
> This procedure may be used from sunrise to sunset without prejudice to the requirements of the Air Traffic Regulations (paragraph 4.10.2.4, Book 4, Chapter 10) regarding the use of conditional sentences for movements affecting the active runway(s)."

On the other hand, the RCA also considers the use of speed adjustments as a radar control tool for separating aircraft, though this practice is restricted to the final phases of the approach:

"4.6.7.6.1. ... a radar controller can ask aircraft under radar control to adjust their speed to a certain extent so as to facilitate radar control or reduce the need for radar vectoring. An aircraft may be requested to maintain the maximum speed, the minimum speed, the minimum clean speed (meaning not extending any surfaces that increase drag to forward motion), the minimum approach speed or a specific speed...

4.6.7.6.2. An aircraft established on the intermediate and final phases of the approach shall only be required to make small speed adjustments, never in excess of ± 40 km/h (± 20 kt). No speed control shall be used once an aircraft on final approach is within 8 km (4 NM) of the threshold."

1.11. Tests and research

1.11.1. *Flight path reconstruction*

The information obtained from the surveillance radar and the QARs allowed investigators to reconstruct the flight paths of both aircraft and to characterize the most significant events (Fig. 2):

- When the controller cleared aircraft EXS518 for immediate takeoff, the aircraft was approximately 300 m away from the RWY 08 hold point on B1 and aircraft IBE3415 was some 6 NM away from the runway on final at a ground speed (GS) of 232 kt. The wind was from the NW at around 10 kt (point 1).
- Aircraft EXS518 did not stop at any point after receiving its takeoff clearance, taxiing at speeds that varied between 20 kt on the taxiway after receiving the clearance, 15 kt when entering the runway via B1 and 8 kt during the last turn to line up with the runway centerline.
- 35 s after receiving the clearance, it reached the hold point, by which time the approaching aircraft was 3.8 NM away from the threshold at a GS of 210 kt (point 2).
- 25 s later, with the approaching aircraft 2.4 NM away from the threshold at a GS of 188 kt, EXS518 entered the runway (point 3), lined up and started its takeoff run, traveling some 1,350 m until it started its rotation with an IAS of 145 kt (point 4).
- At that moment aircraft IBE3415 was flying over the runway threshold. It landed five seconds later, just as the departing aircraft became airborne. At that time the separation between the two aircraft was at its minimum, 1,250 m (point 5).
- The profile of IBE3415 during the last 6 NM of the approach matched that of a "decelerated approach", with the initial extension of the flaps being delayed until the final approach point (FAP), located 5.7 NM away from the threshold, and the final extension taking place at 1000 ft. The IAS decreased constantly throughout the descent, from 215 kt at the FAP to 155 kt above the threshold. The aircraft's configuration at the point of contact was the so-called CONF3.

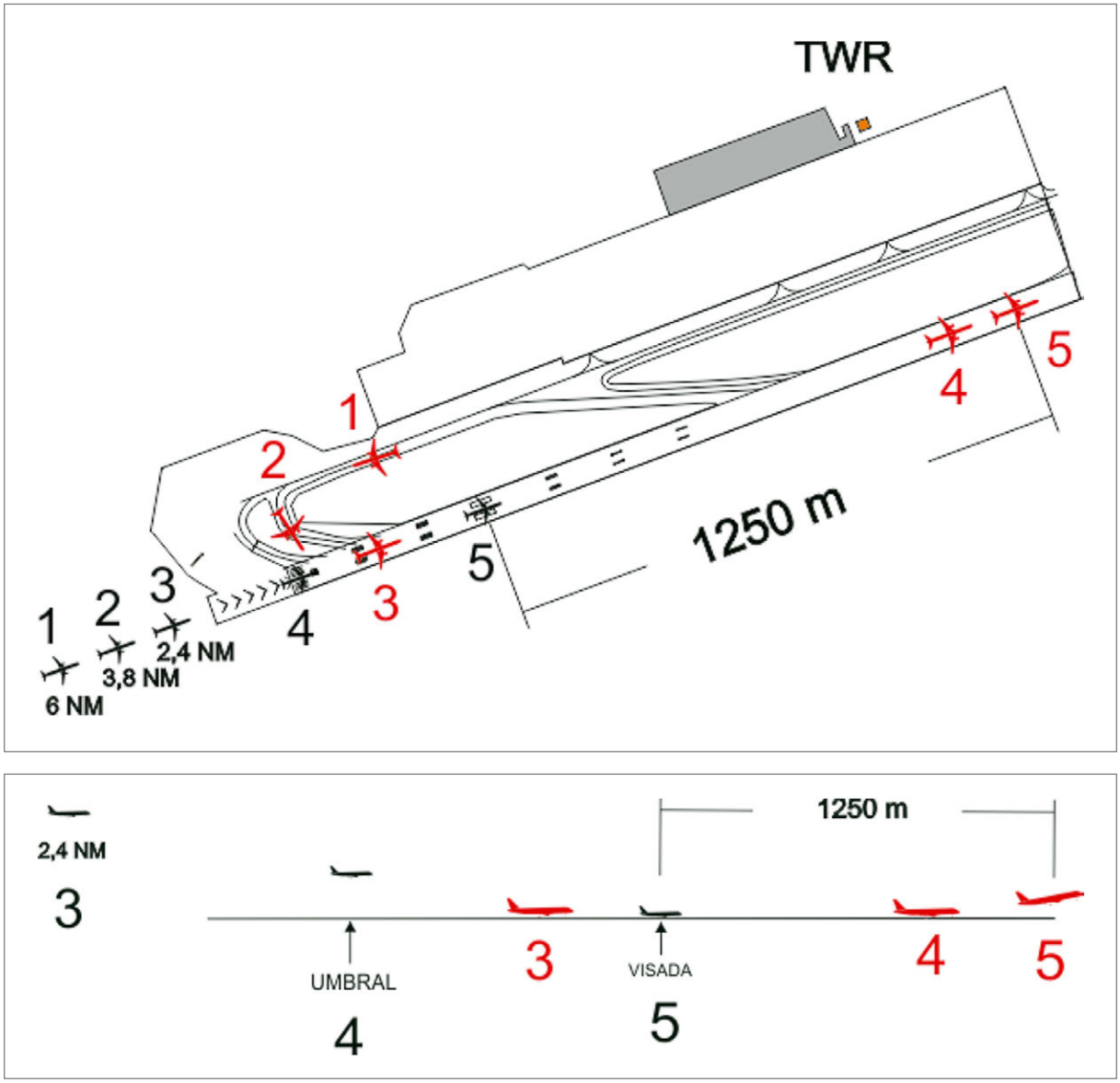

Figure 2. Relative positions of the two aircraft

2. ANALYSIS

Aircraft IBE3415 was 14 NM away from the airport when it contacted the Tower. Shortly thereafter aircraft EXS518, which was taxiing to the runway threshold, did the same and informed the controller that it was ready for takeoff. In light of the approaching airplane's location, the controller opted to clear EXS518 for immediate departure ahead of IBE3415.

Immediate departure clearances are provided in the Air Traffic Regulations as a tool for speeding up traffic. During this maneuver, the departing aircraft must taxi to the

threshold and start its takeoff run without delay, which is what aircraft EXS518 did, as evidenced by the data from its onboard recorder.

Beyond the rapidity exhibited by the aircraft cleared for immediate takeoff, a maneuver of these characteristics forces the controller to weigh several circumstances such that the separation between the departing aircraft and the following traffic is ensured.

The departing aircraft has to taxi to the runway threshold from whatever its location is at the time it is given the clearance. In the case of the Tenerife South Airport, the view from the tower of the taxiway in the vicinity of the threshold does not allow for an accurate estimate of the distance between a given aircraft and the three possible entrances to the threshold (B0, B1, B2). The controller has no additional resources (such as SMR) to aid in this regard.

This situation was confirmed by the controller's statement that, on the day in question, he authorized the takeoff when the aircraft was some distance away from the threshold (about 300 m away from the hold point), without being cognizant of this fact. It took the airplane over half a minute to reach the hold point, during which time the approaching airplane covered a distance of over 2 NM.

The approach speed is a key parameter when designing instrument approach procedures. That is why aircraft are classified into several groups depending on their reference speed above the threshold. The A321 belongs to an intermediate group. As such, when considering its flight characteristics, its approach speed is not expected to deviate significantly from the average value typical of medium-range transport airplanes.

In addition to considerations regarding the aircraft type, airline policies translate into different ways of conducting the approach and of configuring the aircraft for landing, and thus into different approach speed profiles. Specifically, airlines typically resort to the so-called decelerated approaches as part of their fuel savings policies. Such approaches translate into shorter times to the threshold as compared to conventional approaches. This is the case with Iberia, which not only considers them in its Operations Manual, but recommends their use "*whenever possible*". In this regard, and as stated by the crew, it is also common not to fully extend the flaps as part of the landing configuration.

In order to control the separation between approaching aircraft, controllers have the possibility of imposing speed adjustments on them, though with certain limitations.

In this particular incident, the speeds (IAS) recorded for IBE3415 while on final approach reveal values that were considerably higher than expected, even for a decelerated approach profile. Since apparently the tower controller was aware of this circumstance, which could affect the separation with the departing airplane, an action by ATC to limit the speed of the incoming aircraft would have been justified in this case.

Any step taken in this regard would have required coordination between the tower and approach controllers, the latter of which is ultimately responsible for maintaining separation during the approach phase.

This situation was aggravated by the wind conditions present on that day, there being practically no wind, in contrast to the steady easterly winds normally present and to which the controller would have been accustomed and that slow approaches to runway 08.

The criterion used by the controller to maintain separation between the incoming and departing aircraft was the former's distance to the threshold (6 NM at the time of the clearance).

There are no written guidelines or procedures for orienting controllers on how to choose this distance, though the 5 NM value is accepted by tower controllers as standard.

Though this may be a valid criterion in most cases, the circumstances presented call into question the validity of generalizing this criterion to all scenarios.

Since the immediate departure clearance is a useful tool that is typically used by tower controllers, proceduralized criteria should be made available to them to manage said clearances not only at Tenerife South, but at other control towers in the AENA airport network.

As a result, a recommendation is issued to AENA to develop some type of guide or procedure and to instruct controllers on the factors to consider when handling these situations.

Although he could not specify when exactly, the controller stated that as the aircraft was entering the runway, he doubted whether his handling of the situation ensured the proper separation distance. Since he could not tell whether the airplane had gone past the hold point, he opted to let both aircraft continue with their maneuvers. Changing the takeoff clearance before the hold point would have allowed the other airplane to land without incident. Once past the hold point, any change to the takeoff clearance has to be accompanied by a go-around instruction to the incoming aircraft.

The controller missed the opportunity to rectify the situation once aircraft EXS518 started its takeoff run, a situation in which an instruction to abort the takeoff is always very difficult and perhaps even impossible to comply with by the airplane once the decision speed is exceeded.

As for the crew of aircraft IBE3415, it was aware that EXS518 had been cleared for immediate takeoff and it was in visual contact with EXS518 during the last stages of the final approach and landing. At one point the crew realized the gravity of the situation and considered the possibility of going around, though they eventually decided

to continue with the landing. This decision was based on the fact that they had the other airplane in sight at all times and that, in their opinion, it was traveling on the runway at a speed that would make aborting the takeoff dangerous. Initiating a go-around while another aircraft is taking off is also an undesirable scenario.

Despite the doubts the situation created for both the crew of the landing airplane and the controller, there was no exchange of information in this regard, which would have contributed to both sides' understanding of the situation with a view to a possible evasive maneuver.

3. CONCLUSIONS AND CAUSES

3.1. Findings

- Aircraft EXS518 was cleared for immediate takeoff while it was on the taxiway some 300 m away from the RWY 08 hold point on B1. At that moment aircraft IBE3415 was some 6 NM away on final at a ground speed of 230 kt.
- The crew of aircraft IBE3415 was aware of the immediate takeoff clearance given to aircraft EXS518 and was in visual contact with said aircraft during the final approach and landing phases.
- The crew of aircraft EXS518 was in visual contact with aircraft IBE3415 before entering the runway to start its takeoff run.
- Aircraft EXS518 did not stop at any point during the taxi phase. The length of the takeoff run and the rotation speed were consistent with the performance expected under the existing conditions.
- The approach of IBE3415 during the final 6 NM of its approach was consistent with a "decelerated approach", with the delayed extension of the flaps. The aircraft was in a CONF3 configuration (24° flap extension) when it made contact with the ground.
- There were no communications between the aircraft and the control tower in the interval between the issuance of the immediate takeoff clearance and the landing clearance.
- When aircraft IBE3415 landed on runway 08 at GCTS, aircraft EXS518 was airborne but had not yet crossed the opposite end of the runway. The minimum distance between the two aircraft was 1,250 m.

3.2. Causes

The incident was caused by the improper handling of the immediate takeoff clearance by ATC. The distance between the aircraft cleared to take off and the runway threshold on the one hand, and ATC's failure to adjust the speed of the incoming aircraft on the other, resulted in a reduction in the separation such that aircraft IBE3415 touched down on the runway just as aircraft EXS518 became airborne.

4. SAFETY RECOMMENDATIONS

REC 07/13. It is recommended that AENA ensures that the personnel in their control towers have specific procedures and training to manage immediate departure clearances with an airplane on approach, considering the following factors: type or airplane on approach, position and ground speed at the time of the clearance, position of the departing aircraft in the maneuvering area at that instant, local wind conditions and the possibility that once the clearance is issued, a situation might foreseeably arise that reduces separation below minimums.