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SAFETY INVESTIGATION REPORT

Serious incident between the Embraer ERJ-175 registered PH-EXH and the Boeing 737-800 registered 7T-VKR on 5 September 2022 at Lyon-Saint-Exupéry (Rhône)

Time	Around 08:20[1]
Operators	Embraer ERJ-175: KLM Boeing 737-800: Air Algérie
Type of flight	Commercial air transport of passengers
Persons on board	KLM flight: Flight crew, cabin crew, passengers Air Algérie flight: Flight crew, cabin crew, passengers
Consequences and damage	None
This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.	

Landing on a runway occupied by an aeroplane taking off

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the two aeroplanes' QAR[2] flight data recorders, radio communication recordings, radar data, playback of the event on the A-SMGCS[3] ground radar display and statements.

Runway 17R at Lyon-Saint-Exupéry airport, which is normally used for departures, was unavailable for one hour due to work. The airport was operated in a single runway configuration on 17L.

At 08:14, the Boeing 737 operated by Air Algérie was established on ILS 17L and the TWR controller instructed the crew to continue on final. Approximately one minute later, the TWR controller cleared the crew of the Embraer ERJ-175, undertaking flight KLM1414 and departing from Lyon-Saint-Exupéry, to cross runway 17R. As the aeroplane crossed the runway, the RwyOcc A-SMGCS information (see para. 2.5) triggered on the controller's ground radar display screen (see **Figure 1**).

[1] Except where otherwise indicated, the times in this report are in Coordinated Universal Time (UTC). Two hours should be added to obtain the legal time applicable in Metropolitan France on the day of the event.
[2] The glossary of acronyms and abbreviations frequently used by the BEA is available on its website.
[3] Advanced Surface Movement Guidance Control System.

Figure 1: RwyOcc information associated with the Embraer as it crossed runway 17R, on the A-SMGCS screen (source: DSNA)

At 08:15:38, a landing Airbus A320, undertaking flight VOE25DM and operated by Volotea, crossed the threshold of runway 17L.

At 08:15:43, the TWR controller asked the Embraer crew if they were ready for immediate take-off. The crew replied in the affirmative. The TWR controller cleared them to line up on runway 17L from taxiway B4, saying "*Line up and wait be ready*". The Boeing was 4.3 NM from threshold 17L, at an altitude of 2,100 ft.

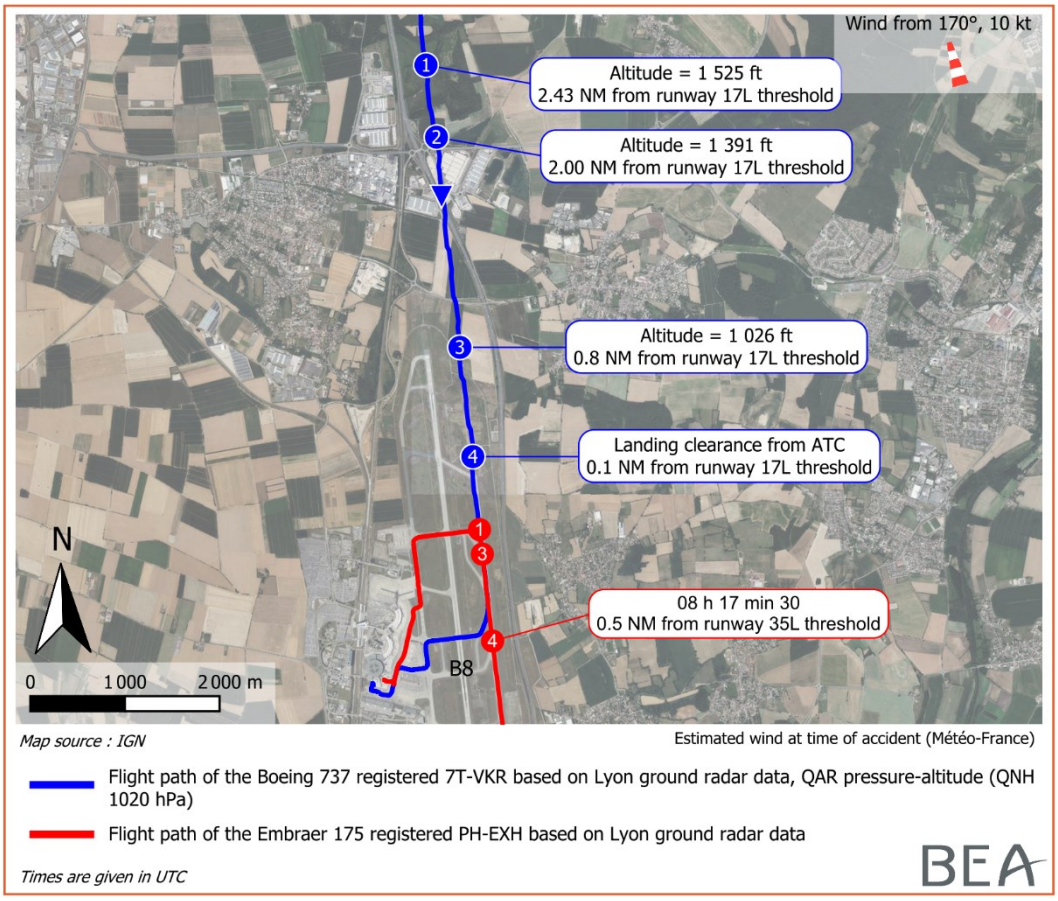


Figure 2: paths of the Boeing 737 registered 7T-VKR and of the Embraer 175 registered PH-EXH

At 08:16:25, the Airbus operated by Volotea vacated the runway via taxiway V8.

At 08:16:31, the TWR controller cleared the Embraer crew to take off[4] (see **Figure 2**, point 1 coinciding with point 2). The Boeing was 2.4 NM from the threshold, at an altitude of 1,525 ft (see **Figure 2**, point 1). The Embraer crew immediately read this back[5] and applied the brakes. The engine thrust started to increase at 08:16:51.

Meanwhile, at 08:16:42, the RwyInc information associated with the Embraer triggered on the A-SMGCS display (see **Figure 2**, point 2, as well as **Figure 3**). The RwyInc information was not yet visible at this time over the Boeing label on the A-SMGCS screen.

Figure 3: RwyInc information associated with the Embraer – The Boeing was not yet visible on the A-SMGCS screen (source: DSNA)

*Note: on the playback video of the event on the A-SMGCS, the RwyInc information associated with the Boeing appeared at 08:16:57 (see **Figure 4**). However, the zoom scale used by the controller on the A-SMGCS screen was not recorded, so it was not possible to determine exactly when the RwyInc information was visible on the controller's display.*

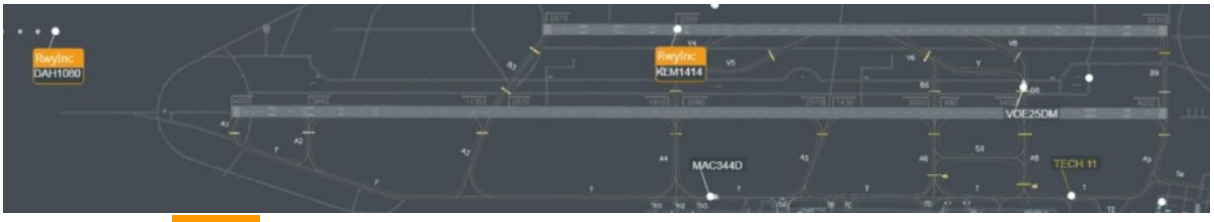


Figure 4: RwyInc information associated with the Boeing and the Embraer (source: DSNA)[6]

At 08:16:58, the Embraer's speed started to increase. The Boeing was then 1.3 NM from the threshold, at an altitude of 1,205 ft.

At 08:17:06, the RwyOcc information associated with the Airbus operated by Volotea appeared as the latter crossed runway 17R (see **Figure 5**).

Figure 5: RwyOcc information associated with the Airbus operated by Volotea (source: DSNA)

[4] Message lasting approximately six seconds.
[5] Message lasting approximately three seconds.
[6] Runway 17R displayed in orange on the A-SMGCS screen.

At 08:17:13, the RwyInc information concerning both the Embraer and the Boeing disappeared for 18 s (see **Figure 2**, points 3 and 3). At 08:17:14, the Boeing was 0.7 NM from the threshold and the TWR controller informed the crew that the landing clearance would be given late. At 08:17:30, at the same time as the Embraer's wheels lifted off the ground, the controller cleared the Boeing crew to land on runway 17L (see **Figure 2**, point 4). The Boeing was 0.11 NM from threshold 17L and at a height of 60 ft[7], while the Embraer was 0.5 NM from the opposite threshold (see **Figure 2**, point 4). At the same time, RwyInc alerts associated with both aeroplanes appeared on the A-SMGCS screen (see **Figure 6**). One second after these alerts appeared, the Boeing flew overhead threshold 17L.
The Embraer was then located 0.38 NM (700 m) before the opposite threshold, at an altitude of 14 ft.

Figure 6: RwyInc alerts associated with the Embraer which had just lifted off and the Boeing flying overhead threshold 17L (source: DSNA)

The Embraer crew continued with the take-off and the Boeing crew continued with the landing.

2 ADDITIONAL INFORMATION

2.1 Meteorological information

At the time of the incident, the wind was from 170° of 10 kt, varying from 130° to 200°, visibility was greater than 10 km, and the conditions were CAVOK.

2.2 Air traffic management on a single mixed-mode runway at Lyon-Saint-Exupéry

Lyon-Saint-Exupéry airport has two parallel runways, 17L-35R and 17R-35L, which are both paved. The published lengths of runway 17L for landing (LDA), take-off (TODA), take-off run (TORA) and accelerate-stop (ASDA) are all 2,670 m.

In nominal configuration, runway 17L is used for landings and runway 17R is used for take-offs. Single mixed-mode runway operation is uncommon on runway 17L (QFU not preferred and situations in which runway 17R is closed). The Lyon Air Navigation Services (SNA-CE) reported that single mixed-mode runway operations (all QFUs included) accounted for 16 % of the total operating time in the first half of 2022.

2.2.1 Operational procedures and methods

At the time of the event, the SNA-CE had not formalised any specific working methods for single mixed-mode runway operations at the airport in VMC and IMC conditions, except in the case of low visibility procedures (LVP). Traffic management was based on the controller's experience and

[7] Height in relation to the runway threshold. Decision height: 200 ft.

knowledge. The Operations Manual (OM) only mentioned a nominal interval of 90 s when there were arrivals only. No minimum interval was defined for inserting a departure, no aids (in particular approach fixes) were available to the controller for managing separations between arriving and departing aircraft, and no specific phraseology for warning the arriving crew of the presence of a departing aircraft, for example, as well as no reminders or instructions in the event of a go-around.

2.2.2 Controller training

The "LYNX" is a document used by instructors as part of the initial theoretical training of controllers. On a single mixed-mode runway, it recommends a nominal interval of 2 min and 30 s to insert a departure under ILS procedure. To prevent situations where the departing aircraft does not take off as quickly as required and where the arriving aircraft has no other choice but to go around simultaneously, it also recommends setting "approach fixes":

- clearance for the departing aeroplane to line up from the CAT I holding point can be given if the arriving aeroplane is at least 5 NM from the threshold;
- take-off clearance can be given if the arriving aeroplane is at least 4 NM from the threshold;
- if the arriving aeroplane is less than 3 NM from the threshold and the departing aeroplane has not started its take-off run, the take-off is cancelled and the arriving aeroplane is ordered to go around.

As stated in the LYNX document, the SNA-CE Instruction sub-division specifies that these recommendations are based on the author's personal experience and are not "immutable" working methods.

Concerning practical training, TWR simulations of single mixed-mode runway operations are compulsory to obtain the initial TWR rating. As part of their refresher training, controllers can select these simulations from the catalogue of available simulations. The selected simulations are not monitored by the SNA-CE.

2.2.3 Immediate take-off

"*In the interest of expediting traffic, a clearance for immediate take-off may be issued to an aircraft before it enters the runway.*[8]" The Operations Manual and the technical summary sheet (FSE) indicate that, on acceptance of such a clearance, the aircraft should taxi out to the runway in one continuous movement.[9]

2.3 Regulatory references

At the time of the event, the following two European regulations regarding air traffic management were in force:

- Implementing Regulation (EU) No 923/2012[10], commonly known as SERA, laying down the common rules of the air and operational provisions regarding services and procedures in air navigation;

[8] GM1 of AMC17 relating to regulatory requirement ATS.TR.210(a)(3).
[9] As per GM1 of SERA.8005(a)(3).
[10] Version in force on the day of the incident.

- Implementing Regulation (EU) 2017/373[11], commonly known as IR ATM/ANS, laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight. The ATS (Air Traffic Services) section describes in particular the provisions relating to separations between aircraft.

These two regulations were amended on 27 January 2022 by Implementing regulation (EU) 2020/469. In France, the amendments were complemented by the adoption of the Order of 04 March 2022 laying down rules applicable to air traffic service providers. As well as adapting and supplementing the SERA, this Order repeals the *Règlement de la Circulation Aérienne* (Air traffic regulations RCA3), making the provisions of the aforementioned European regulations directly applicable.

2.4 Separation between aircraft using the same runway

2.4.1 Regulatory requirements – General case

As a general rule[12], an aerodrome controller should not permit a landing aircraft to cross the runway threshold on its final approach, or a departing aircraft to commence take-off, until:

"(a) the preceding departing aircraft has crossed the end of the runway-in-use; or
(b) the preceding departing aircraft has started a turn; or
(c) all preceding landing aircraft are clear of the runway-in-use."

In some cases, the separation can be reduced (see para. 2.4.2 below).

Thus[13], an aerodrome controller may issue a take-off clearance to a crew (or may clear a crew to land, respectively) when there is reasonable assurance that the separations prescribed (regulatory or reduced separation) will exist when the aircraft commences take-off (or when the aircraft crosses the runway threshold to land, respectively).

2.4.2 Regulatory requirements – Reduced separation

Air navigation services may decide, under certain operational conditions only (daytime, visibility greater than 5 km and ceiling higher than 1,000 ft, tailwind component less than 5 kt) and after a safety study, to apply reduced runway separation minima between departing and landing aircraft using the same runway. Suitable references or means should be available to air traffic controllers to assist them in assessing the distances between aircraft. After the departure of an aircraft with a maximum take-off weight of more than seven tons, a landing aircraft may cross the runway threshold, provided that the departing aircraft has taken off and has passed a point at least 2,400 m from the threshold[14].

The RCA3 previously in force established a minimum distance of 2,500 m, which could be reduced to 2,000 m if the preceding aircraft was taking off and had actually taken off[15].

[11] Version in force on the day of the incident.
[12] ATS.TR.210(c)(2)(i) - AMC7 and AMC8.
[13] ATS.TR.210(a)(3) – AMC17 and AMC18.
[14] ATS.TR.210(c)(2)(i) – AMC9.
[15] In the case of aircraft weighing more than seven tons.

The Studies and Control sub-divisions of the SNA-CE indicated that they were not sufficiently supported by the DSNA head office on these regulatory changes, which led to late changes to the Operations Manual and late transmission of information to controllers. The DSNA explained that, as part of the regulatory monitoring process, operational centres are informed about regulatory changes by the head office, which sends them FSE standardised sheets and/or updates thereof. These sheets are then integrated at local level. The FSE sheets associated with Regulation (EU) 2020/469 and the repeal of RCA3 (180 FSE sheets in total) were sent to operational centres in March 2022.

2.4.3 Runway separations applicable at Lyon-Saint-Exupéry

According to the Lyon-Saint-Exupéry Tower/Approach Operations Manual (TWR/APP OM), the TWR controller may apply a reduced runway separation minimum if the following conditions are met:

- daytime hours;
- dry runways;
- VMC conditions;
- tailwind component less than 5 kt.

The Operations Manual indicates that the reduced separation must be acquired at the same time that the clearance is issued.

Before the regulatory change in 2022, the reduced separation on runway 17L was 2,070 m, which corresponds to the distance between the threshold of runway 17L and abeam the exit taxiway B8. Therefore, an approaching aircraft could not be cleared for landing before the aircraft taking off on the same runway had passed taxiway B8.

Piste	35R	35L		17L	17R	
Si ACFT n°1	Au décollage a passé **travers B4** et a décollé	Au décollage ou à l'atterrissage a passé travers seuil 17L	Au décollage a passé travers seuil 17L et a décollé	Au décollage a passé **travers B8** et a décollé	Au décollage ou à l'atterrissage a passé **A5**	Au décollage a passé **A8** et a décollé
Alors ACFT n°2 peut être autorisé à	Atterrir	Atterrir	Décoller depuis **A8 ou A9**	Atterrir	Atterrir	Décoller depuis **A1, A2 ou A3**

Figure 7: runway separation minimum at Lyon-Saint-Exupéry prior to August 2022 (source: TWR/APP OM)

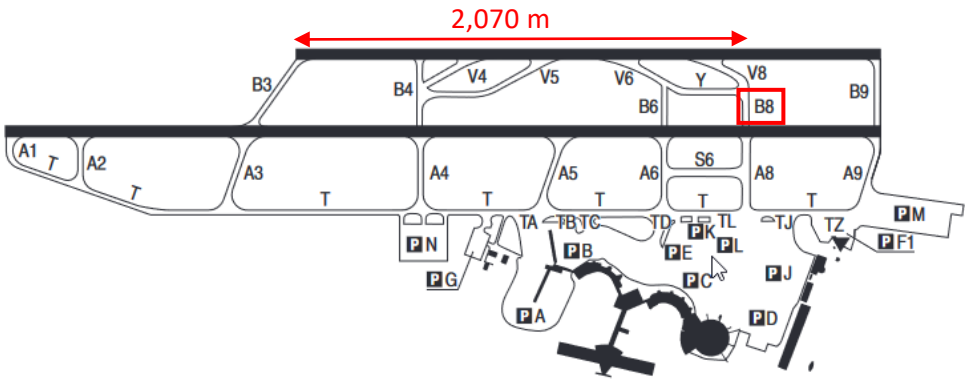


Figure 8: ground traffic chart, excerpt from LFLL VAC chart (source: AIS)

Regulatory changes led the SNA-CE to modify the reduced separation minima at Lyon-Saint-Exupéry. In particular, as the distance of 2,400 m did not correspond to any visual references on runway 17L, the SNA-CE considered it preferable to abolish the reduced separation for this runway.

Figure 9: separation minima at LFLL since August 2022 (source: TWR/APP OM)

Controllers were informed about these changes in a global operational directive for the annual update of the OM on 05 August 2022. The controllers questioned deemed that they were not sufficiently informed about the changes, which were not assimilated at the time of the event. The TWR controller on duty at the time of the event said that she knew about the directive but acted out of habit.

2.4.4 Separation between the Embraer and the Boeing during the event

To sum up, during the event:

- one minute and four seconds elapsed between the moment when the TWR controller issued the take-off clearance to the Embraer crew and the moment when the Boeing crossed threshold 17L;
- the actual separation distance between the Boeing and the Embraer was as follows:

	Separation distance when landing clearance issued	Separation distance when landing aeroplane crosses the threshold
In force at Lyon-Saint-Exupéry, prior to 05 August 2022	2,070 m (B8) (reduced separation)	N/A
According to the regulation in force since 27 January 2022	N/A	2,400 m (reduced separation)
In force at Lyon-Saint-Exupéry, since 05 August 2022 (OM update)	N/A	2,670 m (whole runway)
Observed during the event	1,947 m	1,970 m

Table 1: Separation between the Boeing and the Embraer in relation to applicable standards

2.5 A-SMGCS

The SNA-CE commissioned an A-SMGCS ground radar at Lyon-Saint-Exupéry in 2008. After a first initiative to improve this system in 2018-2019, the SNA-CE commissioned a new version of A-SMGCS ("A-SMGCS Type 2") on 19 July 2022, for a planned 15-week operational assessment phase prior to final commissioning.

2.5.1 Context

The DSNA's safety study[16] indicated that the implementation of the level 2 A-SMGCS was part of a process to manage obsolescence and improve safety, based on a contract managed by the Technical and Innovation Division (DTI) of the DSNA along with the manufacturer Thalès. The objective was to upgrade the existing A-SMGCS by installing a complete new system (with the exception of sensors) and to deploy an alert service aimed at adding another safety barrier to detect runway conflicts.[17]

2.5.2 System description

In addition to ground monitoring data regarding moving vehicles and aircraft, which is already available and used in the first version of the A-SMGCS, the new system provides an alert service on the A-SMGCS screen at the control position. This service prevents collisions between vehicles moving in the runway protection zone (RPZ)[18] and in the approach funnel. It provides the controller with additional information to help detect conflicts between moving vehicles and generates alerts in the event of potential conflicts based on the response level expected.

The Lyon-Saint-Exupéry tower is equipped with three screens located at the TWR controller, GND controller and Tower supervisor positions, as well as one screen in the IFR room.

Unlike the previous version, when changes are made to the runway configuration in the A-SMGCS tool for one of the control positions, these will now also be applied to the other control positions. The TWR position screen is located to the right of the TWR controller.

Various zoom levels are available to view the aerodrome on the screen, as well as an "Airview" window to view the traffic situation in the Control Traffic Region (CTR). Some of the controllers questioned during the investigation said that they did not use this window, which they considered to be impractical or even a hinderance.

The alert server provided with the level 2 A-SMGCS alerts the controller when:

- the use of the runway passes or risks passing below the runway standard according to the declared weather conditions (VMC, IMC or LVP);
- a runway is being incorrectly used in relation to its declared status (open, occupied or closed).

2.5.3 Types of notification and meaning

The alert server triggers two types of notification on the screen depending on the response level expected from the controller:

- the first type is informational, with an orange label being displayed over the moving vehicle(s) concerned, to notify the controller of a situation requiring increased vigilance. This situation may be normal or may develop into a conflict;

[16] See para. 2.5.6.

[17] DSNA's safety study, "*2021-02 – Mise en œuvre d'un A-SMGCS de niveau 2*" (2021-02 – Implementation of a level 2 A-SMGCS).

[18] The runway protection zone is a rectangle of variable width encompassing the runway. In VMC conditions, it is 90 m wide on either side of the runway.

- the second type is an alert, with a red label and an aural signal being triggered to warn of an imminent or ongoing conflict requiring immediate action.

Figure 10: overview of A-SMGCS notifications (source: Directive No 2022-032/SNA-CE/SE/C)

The nature of the potential conflict is indicated by the words displayed on the label:

- "RwyOcc" is used when the conflict is associated with a moving traffic on an occupied runway;
- "RwyClo" is used when the conflict is associated with a moving traffic on a closed runway;
- "RwyInc" is used in the event of a runway incursion associated with two moving traffic on an open runway.

The A-SMGCS user manual (see para. 2.5.4) includes a list of the conflicting situations that lead to the triggering of "RwyOcc" and "RwyClo" notifications only. The only situation described concerning an open runway (and therefore a "RwyInc" notification) refers to the presence of a vehicle in the RPZ. The conflicting situations associated with the notifications were not detailed in the operational instructions available to tower controllers.

2.5.4 Operational documentation available to controllers, working methods and training

The following A-SMGCS system documentation is provided to controllers:

- A-SMGCS user manual, V1.1 of 11 August 2022;
- operational directive No 2022-032/SNA-CE/SE/C, issued on 13 July 2022, describing the alert server, a new functionality introduced with the commissioning of the level 2 A-SMGCS, and the associated methods;
- operational directive No 2022-037/SNA-CE/SE/C, issued on 01 August 2022, providing details on how to use the alert server (management of false blips, declaration of occupied or closed runways, formation flying);
- chapter 7.6.2 of the OM regarding the previous A-SMGCS human-machine interface and chapter 3.3 regarding HMI failures.

Only operational directive No 2022-032/SNA-CE/SE/C contains provisions related to the working methods applied when using the alert server to manage air traffic. These methods are comprehensively described below:

- if an ALERT is triggered, the TWR controller analyses the causes to confirm its relevance. If such an analysis is not possible (lack of time or failure to determine the cause) or if required by the situation, the TWR controller orders a go-around for the aircraft on final and/or stops the take-off in progress. There are no instructions regarding the actions expected when an "INFO" type notification is triggered;
- the tower supervisor is responsible for updating runway status parameters and may delegate this task to the GND or TWR controller.

At the end of 2019, during the first initiative to improve the ground radar, the controllers underwent theoretical training, followed immediately by practical training of at least one hour in groups of two at a test position.

In May and June 2022, in preparation for the commissioning of the new version of the system in July 2022, the controllers underwent further theoretical training via e-learning, followed by a 45-minute practical training session including use of the tool, in groups of two or three controllers, on a test network supplied with real-time traffic at the time of the use.

The e-learning module described the system, its new functionalities and how to use the HMI. The training material then remained available to the controllers, who were encouraged to freely visit the test room to use the tool.

2.5.5 Alert server operation

2.5.5.1 Configuration parameters

For the alert server to operate correctly, the following parameters must be updated on the ground radar HMI:

- runway status: open, OCC = temporarily occupied (vehicle on runway, temporary closure less than 1 hour), CLO = closed (long-term closure);
- operating mode of QFUs in service (MIX (mixed-mode) or dedicated runway, DEP (departure) or ARR (arrival)). The selected value has no impact on the alert server in its current version;
- aerodrome status in relation to weather conditions: VMC, IMC, LVP;
- closed sections of taxiways located in RPZs;
- opened sections of a closed runway.

The operational documentation indicates that the tower supervisor is responsible for updating these parameters and may delegate this task to the GND or TWR controller.

This information is included in operational directive No 2022-032/SNA-CE/SE/C.

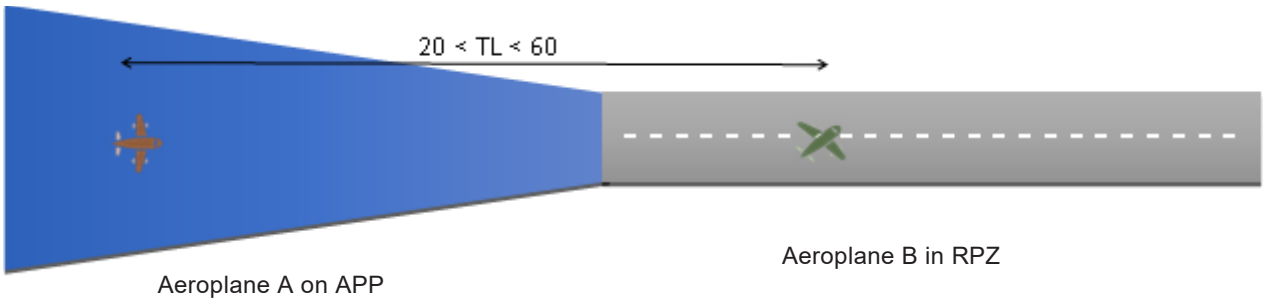
2.5.5.2 Triggering of notifications regarding separation between two aircraft on an open runway in VMC conditions

The “RwyInc” information triggers on the A-SMGCS screen based on the position of the aircraft and the Time Left (TL) between them. This time is calculated by the system based on the ground speeds derived from radar data.

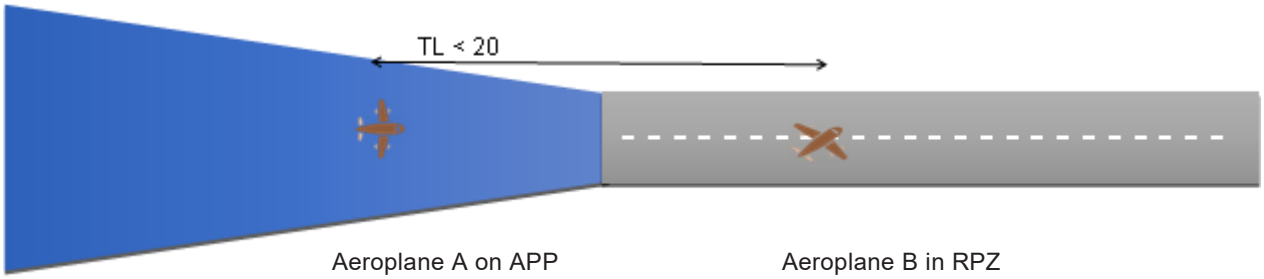
At the time of the event, and since its commissioning, the system’s settings for VMC conditions were based on the former reduced runway separation minima (see para. 2.4.2). The SNA-CE was not aware of this. After the event, on 07 September 2022, the SNA-CE transmitted the information in a memo to all controllers.

When the aircraft on final is not in the RPZ:

- no notification when TL is greater than 60 s;
- informational notification triggered when TL is between 20 and 60 s;



- alert notification triggered when TL is less than 20 s.



When the aircraft on final is in the RPZ: alert notification triggered if the distance between both aircraft is less than 2,000 m.

The time values (20 s, 60 s) were determined during the A-SMGCS design phase and were supposed to ensure compliance with the reduced separation distance (2,070 m) when the aircraft on final crosses the runway threshold.

During the event, the initial RwyInc information displayed on both aircraft (see **Figure *11***) disappeared when the Embraer crew started the take-off run, because the TL between the two aeroplanes became greater than 60 s (see **Figure 12**). The Boeing's entry into the RPZ then immediately triggered an RwyInc alert on both aircraft (see **Figure 13**).

The settings are the same in IMC conditions, for which reduced separation distances have never been applied.

Figure 11: RwyInc information on the Boeing and the Embraer (source: DSNA, BEA annotations)[19]

[19] Figures 11, 12 and 13: occupied runway 17R is displayed in orange on the controller's A-SMGCS screen (see **Figure 4**).

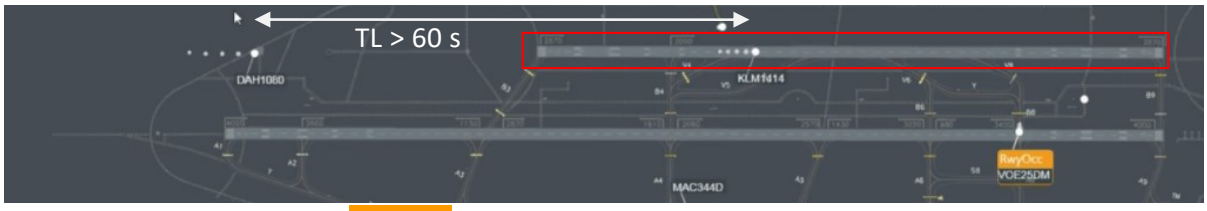


Figure 12: RwyOCC information on the Volotea when it crossed runway 17R (source: DSNA, BEA annotations)

Figure 13: RwyInc alert on the Boeing and the Embraer when the Boeing entered the RPZ (source: DSNA, BEA annotations)

2.5.6 Safety study

In accordance with the DSNA's risk assessment and mitigation procedure applied when implementing changes affecting the functional system, the level 2 A-SMGCS was the subject of a safety study prior to its commissioning ("*2021-02 – Mise en œuvre d'un A-SMGCS de niveau 2*"). The aim of the study was to demonstrate that the risks associated with the changes had been assessed and made acceptable in a sustainable way.

A first safety study was initiated in 2018 as part of the project's first initiative. The various DGAC divisions involved (DSNA DO, DTI, DSAC, STAC) took part in different discussions. Coordination meetings then resumed in autumn 2021. The safety study, conducted by the Safety, Quality and Security Management task force of the DSNA, was revised to take into account the DSNA's new risk assessment and mitigation procedures and methodologies, which had been updated following the entry into force of the new IR ATM/ANS regulation. The version of the safety study was validated internally within the DSNA on 13 July 2022 and then approved by the DSAC for an operational assessment phase of the new system starting on 19 July.

Concerning the impact of implementing the new system on the air traffic controllers' working methods, the safety study reported the following decisions (see chapter *Synthèse des impacts du changement sur le système fonctionnel DSNA*):

- adaptation of existing ground monitoring methods to the new tool;
- full review of the methods prescribed in the Lyon-Saint-Exupéry Operations Manual;
- creation of a working method for using the alert server.

Several hazards likely to cause a safety event were identified (see chapter *Identification des dangers*) such as the system not providing the information required to identify a conflict on the runway. Among the causes described, there was the case of an alert not being perceived by the controller for the following reasons:

- adjustment of the volume;
- lack of visibility of the alert displayed on the screen;
- failure by the controller to identify the meaning of the (visual or audio) alert signals.

With the following operational consequences:

- none, because the working methods used are not related to the A-SMGCS;
- risk of causing a runway safety event, if the situation cannot be managed using these methods.

The hazard relating to the incorrect use of the GND monitoring service by a controller was identified, but was not mentioned in the safety study, as the controllers' working method already included the use of an A-SMGCS. No credible hazard arising from the controllers incorrectly using the monitoring service provided was therefore mentioned.

The safety study did not include any further information on aspects relating to the controllers' working methods in connection with the new system.

2.6 Coordination between TWR controllers and TWR assistants

The role of TWR assistants and their expected coordination with TWR controllers in air traffic management are not defined in the Operations Manual.

Concerning the A-SMGCS, no rules were established regarding task distribution between TWR controllers and their assistants.

2.7 Statements

2.7.1 TWR controller's statement

The controller was in the TWR assistant position before taking the TWR position at around 08:00. According to her, traffic was low, but she knew from experience that it would increase.

Her experience with air traffic control, with the aerodrome and with the operators of the three aeroplanes concerned (Air Algérie, KLM and Volotea) led her to consider that she could insert a take-off between the two landings. She anticipated the fact that the Volotea Airbus would clear the runway via taxiway V6 after landing and cleared the Embraer to line up on the runway. She had to wait for the Volotea to clear the runway (finally via taxiway V8) before issuing the take-off clearance. The Embraer crew took more time to start the take-off run than she had estimated.

At the same time and throughout the rest of the event, the TWR controller's attention remained mainly focused on the various notifications triggering on the A-SMGCS screen and on trying to understand the causes of these notifications.

She initially thought that the notification associated with the Embraer was linked to the Airbus operated by Volotea. She did not understand why the notification persisted. Due to the default zoom setting and the absence of the "Airview" window, she could not see the Boeing on final approach on the A-SMGCS screen. Considering that the notification could be due to the runway 17L parameter being set to "ARR" (setting used for arrivals only), she asked the TWR assistant to change the parameter to "MIX". The notification disappeared, leading her to believe that the problem was resolved. She then looked outside the tower and saw the Boeing. She realised at this point that the separation distance with the departing Embraer would potentially not be observed. She considered the safer option to be to allow the take-off to continue and to give a late landing clearance once she observed the wheels of the Embraer lift off the ground, fully aware that she would have to ask the Boeing crew to go around if the Embraer crew aborted

the take-off.
The RwyInc alert then triggered just before the Boeing crossed threshold 17.

The TWR controller indicated that sufficient proficiency was not acquired in the training in use of the new A-SMGCS prior to commissioning of the tool. Like the assistant and the tower supervisor at the time of the event, she indicated that she had not assimilated the fact that the runway configuration parameter (ARR/DEP/MIX) had no impact on the alert server operation. In addition, these controllers were not aware that the alert server settings were based on the former separation minima. They added that they were hindered by the large number of notifications.

The TWR controller explained that, in single-runway operations, she managed traffic using her experience, and that she was not informed of any working methods recommended or defined by the SNA-CE. She had not assimilated the changes made to reduced separation minima and regulations.

She indicated that she was aware of the directive to abolish reduced separation on runway 17L but acted from experience. Like the tower supervisor, she felt that she had not received adequate support regarding the implementation of this new directive. The tower supervisor added that new directives are not always distributed in an appropriate manner and are sometimes lost in the flow of communication.

The LOC assistant described the same sequence as the TWR controller. He added that during the event sequence, he too was focused on the various notifications that were triggered.

2.7.2 Crew statements

The Boeing crew indicated that they heard the TWR controller ask the Embraer crew if they were ready for immediate take-off. When they heard the line-up clearance, the Boeing crew considered that the Embraer crew was cleared for immediate take-off. They noticed that the Embraer paused for a moment on the runway. The TWR controller warned them that the landing clearance would be given late. They added that they carefully observed the Embraer's take-off.

After being instructed to line up on runway 17L, the Embraer crew noticed that an aeroplane had just landed and that another was on final, and they thought that traffic management would be tight. The co-pilot added that the time which elapsed between the line-up and take-off clearances was longer than expected, given the prior request for a potential immediate take-off. Once lined up on the runway, the crew applied the take-off procedure and waited for the take-off clearance before starting the take-off run.

2.8 Similar events and safety recommendations

This event is reminiscent of the serious incident that occurred in April 2019 at Strasbourg between a CRJ700 cleared for immediate take-off and a landing B717-200, during which the crew of the B717 executed a missed approach at a height of 240 ft and 0.58 NM from the runway threshold, having observed that the CRJ700 would not have crossed the opposite end of the runway by the time they landed. The sequence resulted in a loss of horizontal and vertical separation and generated a TCAS Resolution Advisory (RA).

In its investigation report, the BEA recommended to the DSNA that (Recommendation FRAN-2020-013):

- *"the DSNA take into account the specific aspects at each aerodrome where there is commercial air traffic in order to define all measures which will improve the management of the separation between departing aircraft and arriving aircraft in order that a landing clearance to an aircraft on approach is given sufficiently early and in order to limit the risk of a low-level missed approach*."

On 19 February 2021, in response to this safety recommendation, the DSNA informed the BEA that it was going to draw up, for each aerodrome where there was commercial air traffic, an action plan aimed at implementing all measures (including approach fixes) required to improve the management of the separation between departing and arriving aircraft, in order that a landing clearance to an aircraft on approach is given sufficiently early.

The DSAC, which monitors the implementation of the DSNA's responses to the recommendations issued to it, informed the BEA that it had no information regarding the progress of the action plans at the time of the event.

In addition, in 2019, Eurocontrol conducted a study on the risks associated with low-level go-around, which identified several conflict prevention barriers, and in particular the following barriers before the initiation of a go-around:

Before the initiation of a go-around	**Air traffic controllers** ▪ Adopt a "non-aggressive" approach sequence, avoiding positioning aircraft too close to each other in order to optimise runway utilisation or to prioritise "efficiency" (strategic management by taking margins, without trying to reach the separation minima). ▪ Plan runway occupancy by taking margins (unexpected factors). ▪ Inform pilots sufficiently early of possible constraints. ▪ Constantly evaluate the progress of the plan and adapt the action plan if safety margins have been reduced. ▪ Communicate with pilots to share a joint situational awareness and limit the risk of a low-level go-around. ▪ *Limitations: difficult to anticipate actions undertaken by pilots or runway incursions.* **Pilots/crews** ▪ React quickly and decisively, not letting the situation run or hoping that things will work. ▪ Inform air traffic controllers sufficiently early of the likelihood of a go-around. ▪ Inform air traffic controllers if an immediate departure (or runway vacation) is impossible or difficult. ▪ *Limitations: difficult to anticipate actions undertaken by air traffic controllers.*

Figure 14: adaptation of the Eurocontrol study on the risks associated with low-level go-around

3 CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation.

Scenario

Lyon-Saint-Exupéry airport was operated in a single-runway configuration on 17L, under VMC conditions. The TWR controller asked the Embraer 175 crew if they were ready for immediate take-off. The crew replied that they were ready and the controller asked them to line up, wait and be ready, without mentioning any immediate take-off. The Embraer crew were surprised by this request and the absence of an immediate take-off clearance. As for the crew of the Boeing, on final, about 4.3 NM from threshold 17L, they indicated that they considered the take-off clearance given to the Embraer as being for an immediate take-off. Without the volume of traffic requiring it, the LOC controller, based on her experience, inserted an aeroplane for take-off between two landing aeroplanes, probably focused on optimisation and efficiency. She did not adjust the Boeing's approach speed and then belatedly informed the crew of the Boeing (located 0.7 NM from the threshold and at a height of 250 ft in relation to the threshold) that the landing clearance would be given late.

The strategy applied offered no margins and did not take into account any unexpected events (such as the time necessary for the preceding aeroplane to vacate the runway, for the aeroplane taking-off to start the take-off run, or even for the aeroplane on final to go around).

Moreover, the controller's strategy was based on an obsolete minimum separation value, as the operating procedures had been altered one month earlier pursuant to a change in regulations.

The LOC controller and her assistant, whose attention was focused on the warnings from the A-SMGCS ground radar, realised at a late stage that the reduced separation distance (which they thought was applicable) between the Embraer that was taking-off and the Boeing that was landing would potentially not be observed when the Boeing 737 crossed the runway threshold on landing.

The controller gave the landing clearance to the crew of this aeroplane when they were at a height of approximately 60 ft and about 200 m from the threshold, after seeing the wheels of the Embraer ERJ 145 lift off the ground. When the Boeing crossed the runway threshold, the Embraer was still 700 m from the opposite threshold. This represented a loss of separation in relation to the operating procedures in force at the time of the event, which require the aeroplane to have crossed the opposite threshold.

To prevent any conflict from arising between the Boeing making a go-around and the Embraer taking-off, the controller decided to let the landing and take-off continue.

Contributing factors

The following factors contributed to traffic management decisions that led to the non-observance of the runway separation distance applicable at the time of the event:

- the search for optimisation of air traffic in the absence of working methods for managing traffic on a single mixed-mode runway, more specifically in the absence of means to help the controller ensure that the separation distance would be observed when the arriving aircraft crossed the runway threshold. A recommendation (FRAN-2020-013) was issued in 2020 by the BEA in this regard (see para. 2.8);
- a lack of assimilation by the controller of the new procedures abolishing reduced separation on runway 17L.

The lack of assimilation of the new standards was probably linked to:

- insufficient support from the DSNA to its local operational centres in implementing regulatory changes;
- insufficient assessment of the impact of regulatory changes on the controllers' working methods;
- insufficient awareness-raising actions and transmission of information from the SNA-CE to its controllers regarding changes made to operational procedures.

The following factors contributed to the controllers' late detection of a shorter-than-expected separation distance:

- the LOC controller and her assistant being focused on the A-SMGCS notifications to the detriment of monitoring the progression of the aeroplane on final and of the departing aeroplane;
- a lack of instructions regarding the coordination and distribution of air traffic and A-SMGCS management tasks between the LOC controller and her assistant.

Lastly, the presence of the A-SMGCS did not help to resolve the conflict, while at the same time increasing the controllers' workload. This was due to inadequate management of the changes arising from the introduction of the A-SMGCS, in particular:

- limited practical training in use of the A-SMGCS (in real-time traffic conditions only) and incomplete operational documentation;
- alert server settings which, on the one hand, did not take into account the abolished reduced separation on runway 17L and, on the other hand, were likely to lead to incorrect awareness of the situation;
- insufficient assessment of the impact of the new system on the controllers' working methods during the safety study conducted prior to commissioning;
- the absence of restrictions (partial use, limited to certain traffic conditions, etc.) in connection with the commissioning and use of a new system in operational conditions.

Measures taken by the DSNA since the serious incident

A-SMGCS

Since the event, the SNA-CE has issued several information bulletins and directives containing:

- reminders of how the alert server works;
- some conditions of use of the A-SMGCS (suspension of the VMC status, modification of "Airview" display settings).

The SNA-CE also:

- requested that the A-SMGCS settings be modified to take into account the abolition of reduced separation distances on the outer runway;
- modified the A-SMGCS display parameters (contrast, font, brightness, sound differentiation based on the notification type, etc.);
- organised additional training in the A-SMGCS;
- confirmed the objectives of the A-SMGCS information and alerts and the associated settings required.

Management of arrivals and departures on a single mixed-mode runway

Since the event, the SNA-CE:

- planned to specify the methods for managing immediate departures;
- specified the methods for managing traffic on a single mixed-mode runway (directive dated 11 April 2023): in single runway operations, a departing aircraft must have started the take-off run before the arriving aircraft is less than 2 NM on final. Failing this, the take-off clearance must be cancelled and a go-around must be initiated by the LOC controller. The directive also requires a three-minute interval between two arrivals in order to insert a departure;
- organised traffic management training simulations on a mixed-mode runway in the spring of 2023.

Lastly, the SNA-CE considered that any regulatory changes should be the subject of a specific directive, independent of any other topics.

Moreover, the DSNA's regulatory monitoring process (identify regulatory changes, transmit them to operational centres, integrate them at local level and monitor them at national level) has been evolving since the beginning of 2022.

Recommendation FRAN-2020-013 (see para. 2.8)

The DSNA indicated that it is working on drawing up national directives, which will include the provisions of the CHEA[20] Order (separations to be used by an ATS unit in LVP conditions, CAT II/CAT III training conditions).

It also launched a WG regarding "approach fixes", which will study a methodology outside LVP conditions.

Moreover, the DSNA's regulatory monitoring process (identify regulatory changes, transmit them to operational centres, integrate them at local level and monitor them at national level) has been evolving since the beginning of 2022.

[20] Order of 28 August 2003 pertaining to conditions of approval of aerodromes and aerodrome operating procedures (Version in force on the day of the serious incident).