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INVESTIGATION REPORT

Serious incident between the Bombardier CRJ700 registered F-GRZG and the Boeing 717-200 registered EI-EXB

on 12 April 2019
at Strasbourg Entzheim airport (Bas-Rhin)

Time	Around 13:05[1]
Operator	Bombardier CRJ700: HOP! Boeing 717-200: Volotea
Type of flight	Commercial Air Transport
Persons on board	HOP! flight : 2 flight crew, 2 cabin crew and 73 passengers Volotea flight: 2 flight crew, 3 cabin crew and 113 passengers
Consequences and damage	Incapacitation of a cabin crew member of the HOP! flight

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in November 2020. As accurate as the translation may be, the original text in French is the work of reference.

[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.

Immediate departure, low-level missed approach, near collision

1 - HISTORY OF THE FLIGHT

Note: the following information is principally taken from the flight data recorders (FDR) of the two aeroplanes, statements, radio communication recordings and radar data.

The crew of the Boeing 717, operating the Volotea flight from Montpellier Méditerranée (Hérault), were carrying out an ILS approach to runway 05 (QFU 047) at Strasbourg Entzheim airport. Exchanges between the controller and the crew were in English. At 13:01, the LOC controller asked the crew to continue the approach, indicating that they were number two behind a light aircraft on the downwind leg for runway 05. Four minutes later, the captain of the CRJ700 operating the HOP! flight bound for Marseille Provence (Bouches-du-Rhône), and PM[2], contacted the LOC controller, at the GND controller's request, to advise that they were approaching holding point H and that they were ready for departure from runway 05. The exchanges between the controller and the CRJ700 crew were in French. At 13:05:14, the LOC controller asked them if they were ready to take off within the minute and gave them traffic information about an aircraft at 3 NM on final approach without specifying that it was a Boeing 717[3]. The PM of the CRJ700 accepted and at 13:05:23, the LOC controller cleared them for an immediate take-off from runway 05 (point ❶ Figure 1).

[2] Pilot Monitoring.

[3] The procedures for the units rendering air traffic services to aircraft operating under the rules of general air traffic (RCA/3) specify that a traffic information message must contain, when this is possible, various items of information such as the type of aircraft.

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[4] The airport's reference altitude is 505 ft.

The Boeing 717 was around 3 NM from the runway threshold on final approach at an altitude of 1,650 ft[4] and an indicated airspeed of 136 kt when the CRJ700 was around 30 m before holding point H. At 13:05:46, the captain of the Boeing 717, PM, announced that they were at 2 NM on final approach. The crew of the CRJ700 lined up on runway 05. The LOC controller informed the crew of the Boeing 717 of the departure of the CRJ700 and asked them to continue the approach. The PM of the Boeing 717 said "*unbelievable*" on the frequency. Five seconds later, the crew of the CRJ700 started the take-off run (point ❷ Figure 1).

At 0.90 NM from the threshold of runway 05, at an altitude of 890 ft and an indicated airspeed of 138 kt, the PM of the Boeing 717 informed the LOC controller that they may interrupt the approach. The LOC controller told the crew to continue the approach. Nine seconds later, at 13:06:28, at 0.58 NM from the threshold of runway 05 at a height of 240 ft (40 ft below the decision height (DH)), the crew of the Boeing 717 initiated a missed approach and announced this on the frequency. The CRJ700 was still on the runway at 0.42 NM (780 m) from the threshold of runway 05 at a speed of around 115 kt (point ❸ Figure 1).

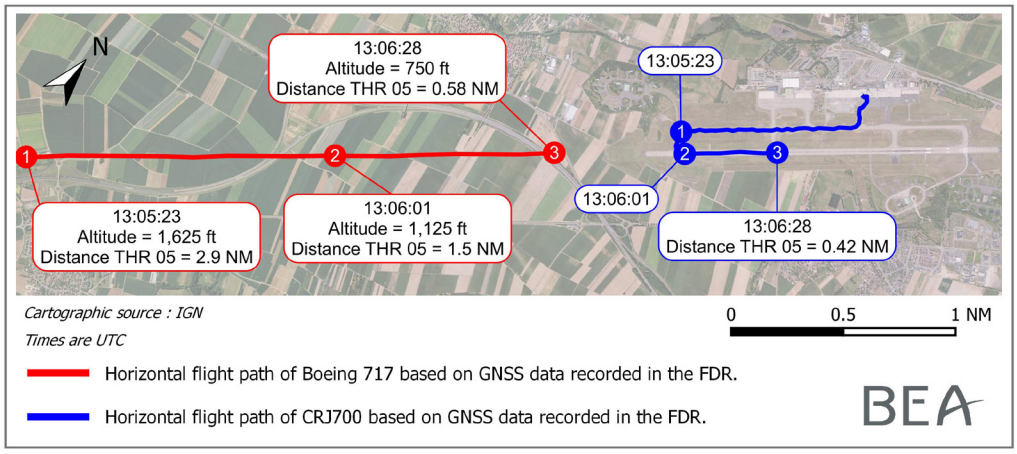


Figure 1: paths of the Boeing 717 (red) and the CRJ700 (blue)

The LOC controller asked the PM of the Boeing 717, who read this back, to keep straight ahead during the missed approach. The PF selected heading 042° and the Boeing 717 started to deviate to the left of the runway centreline. When the HOP! CRJ700 flew over threshold 23 at an altitude of 900 ft and a speed of 160 kt, the separation with the Boeing 717, whose speed was 163 kt and accelerating, was around 1 NM horizontally and 920 ft vertically (point ❹ Figure 2).

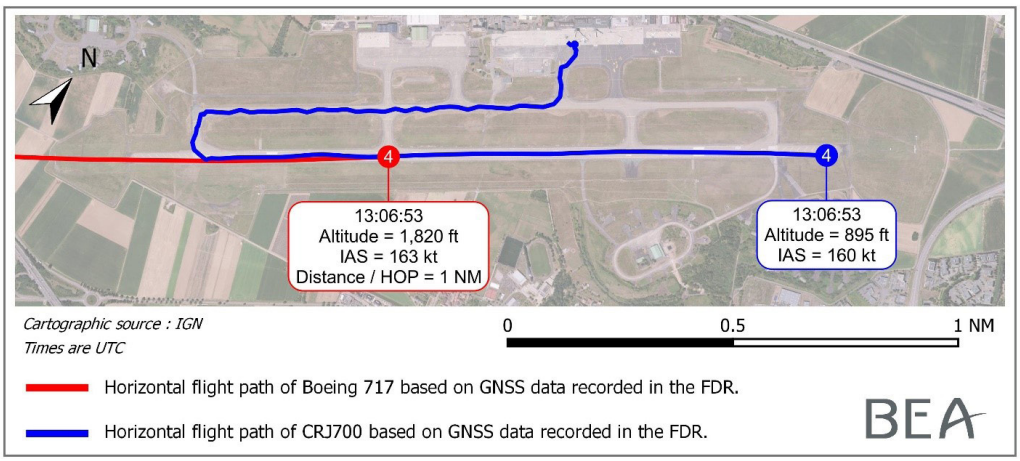


Figure 2: paths of the Boeing 717 (red) and the CRJ700 (blue)

[5] At this point, the autopilot of the CRJ700 was already engaged in the NAV lateral guidance mode and CLB vertical guidance mode.

The LOC controller asked (point ❺ Figure 3) the crew of CRJ700, at an altitude of 1,300 ft and climbing to 6,000 ft to directly turn left towards MIRGU, the last standard instrument departure point (SID)[5], and the crew of the Boeing 717, at an altitude of 2,300 ft and climbing to 2,500 ft, to immediately turn right to heading 050° (point ❻ Figure 3). The CRJ700 started turning at 2,100 ft. The horizontal and vertical separations between the aeroplanes were respectively 0.6 NM and 300 ft. The speed of the Boeing 717 was 60 kt higher than that of the CRJ700. The LOC controller asked the crew of the CRJ700 to stop climbing at 2,000 ft. The PM of the CRJ700 asked him to repeat the instruction. The CRJ700 flew through 2,400 ft and was climbing with a vertical speed of around 1,300 ft/min and the Boeing 717 was stable at 2,500 ft. At the same time, the TCAS of the two aeroplanes transmitted traffic advisories (TA). The LOC controller replied to the PM of the CRJ700 by telling him to immediately stop climbing at 2,000 ft. A second later, resolution advisories (RA) were generated on board each plane: MAINTAIN CLIMB for the CRJ700 and DESCENT for the Boeing 717 (points ❼ and ❼ Figure 3). The horizontal and vertical separations between the two aeroplanes were respectively 0.40 NM and 50 ft. The resolution advisory (RA) of the CRJ700 was reinforced to INCREASE CLIMB and the PF increased the rate of climb. Five seconds later, the separations were 0.28 NM and 95 ft. The minimum horizontal distance between the two aeroplanes of 0.17 NM was reached five seconds later with a vertical separation of 500 ft.

At 13:07:55, the path conflict had ended and the two crews continued their flights (points❽ and ❽ Figure 3).

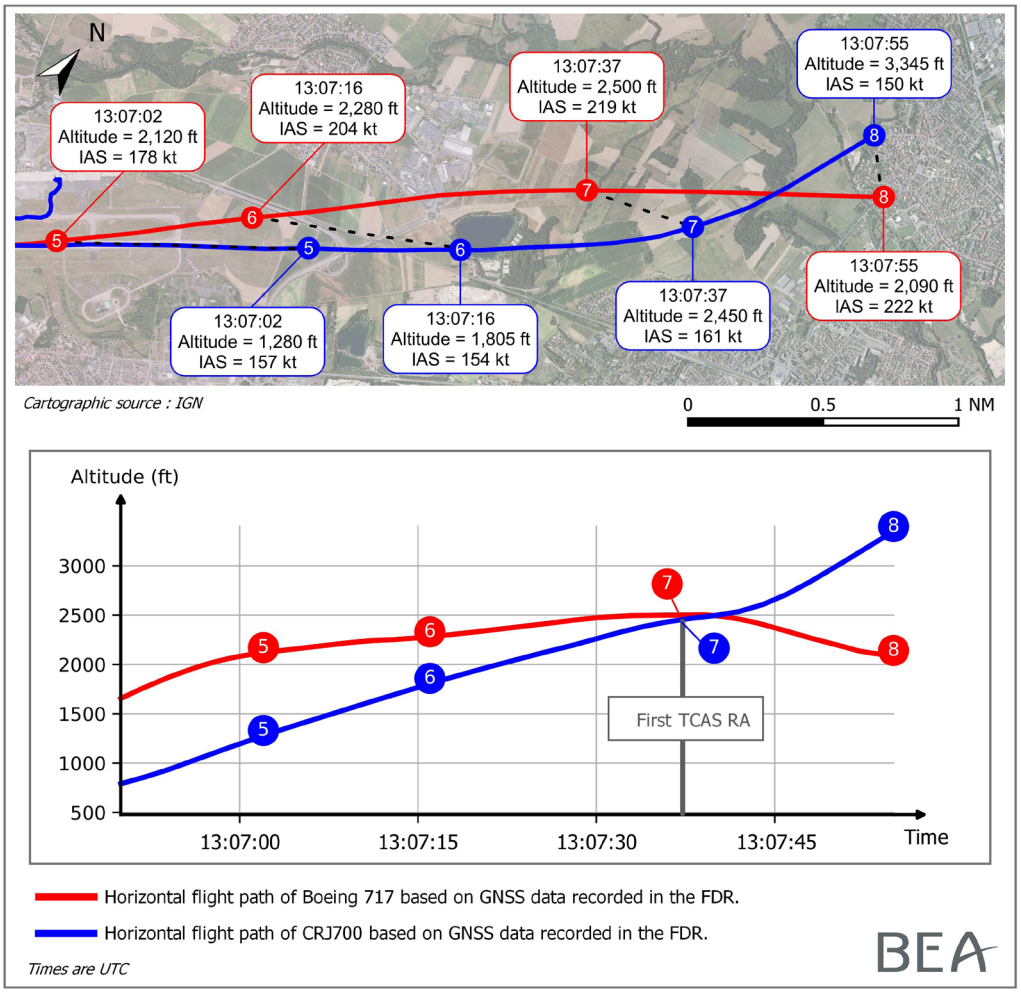


Figure 3: paths of the Boeing 717 (red) and the CRJ700 (blue)

2 - ADDITIONAL INFORMATION

2.1 Weather conditions

At the time of the incident: wind 030°, variable between 350° and 060°, 10 kt, CAVOK.

2.2 Aerodrome information

Strasbourg Entzheim airport has a paved runway 05-23. Four taxiways (E, F, G and H) situated to the west of the runway lead to it between thresholds 23 and 05. The magnetic heading of runway 05 is 047°. The published distances are the following:

- landing distance available (LDA) = 2,400 m;
- take-off run available (TORA) = 2,405 m;
- take-off distance available (TODA) = 2,695 m;
- acceleration-stop distance available (ASDA) = 2,670 m.

2.3 Crew statements

2.3.1 Crew of Boeing 717-200

The crew specified that it was the fourth and last rotation of the day and that they were running around one hour late due to a technical problem which had occurred between the second and third rotation.

The captain, of Spanish nationality, and the first officer, of French nationality, indicated that they heard the clearance to take-off given to the crew of the CRJ700 when the aeroplane had not yet arrived at the holding point. They were at around 3 NM from the threshold of runway 05. They found the CRJ700 a bit slow in lining up. At this point, they knew they would have to execute a missed approach taking into account a potential conflict in the initial climb. The weather conditions did not provide any difficulty. The captain was irritated by the way the situation was being managed as there were only two aeroplanes in the circuit. On approaching the DH, when the controller told them to "Continue" and the CRJ700 was still on the first third of the runway, the crew initially started a missed approach in manual control. The reason behind the selection of heading 042°, different from the runway magnetic heading, could not be explained.

The crew were expecting to turn right in order to avoid a conflict with the departing CRJ700 (which should turn left according to the standard departure procedure) but the controller asked them to keep straight ahead. They had to climb to an altitude of 2,500 ft. The first officer remained concentrated on the management of the path. The captain did not understand the controller's instructions given in French to the crew of the CRJ700 who were of French nationality. He was surprised that, in a potential conflict situation, the exchanges were not carried out in a shared language, in English only. Neither of the two crew members had visual contact with the CRJ700.

The first officer disconnected the autopilot in order to follow the TCAS resolution advisories. The pilots said that the orders were consistent with what they had already practised in simulation sessions. Nevertheless, the situation was dangerous and they had been afraid. They saw the CRJ700 pass in front of them in a left-hand climbing turn.

2.3.2 Crew of CRJ700

The crew indicated that they were concentrated on the actions and technical calls with a view to lining up and carrying out a rolling take-off. Even though there had been a lot of exchanges in English between the LOC controller and the crew of the Boeing 717, they were not aware that it was on final approach. They thought that the traffic mentioned by the controller, when they were asked whether they were ready to depart within the minute, was a local flight or a runway circuit under VFR[6].

[6] LOC controller: "*Air Hop Hotel Alpha vous êtes prêts pour un départ dans la minute, trafic 3NM finale derrière.*" (Air Hop Hotel Alpha, are you ready for departure within one minute, traffic 3 NM on final behind).

While climbing through 2,450 ft, the controller asked the crew to maintain 2,000 ft and the crew made a slight nose-down input. At the same time, the TCAS was activated, transmitting a MAINTAIN CLIMB and then INCREASE CLIMB resolution advisory. The indication on the aeroplane's vertical speed indicator required a high vertical climb speed (fully up), the dial of the vertical speed indicator being mainly red. The pilots were very surprised to have to take such a pitch attitude for the climb. They had been afraid and had expected to strike an aircraft. At this point, the crew were not aware that the Boeing 717 had executed a missed approach. The pilots specified that they had never had visual contact with the Boeing.

Shortly after the incident and not realising how it might affect the cabin crew, the flight crew explained to the cabin crew who had entered the cockpit, what had happened during the take-off.

2.4 Incapacitation of a cabin crew member of the CRJ700

The HOP! flight cabin crew were composed of a purser and another cabin crew member. They both perceived the abnormal situation shortly after take-off. The purser indicated that the other cabin crew member had joined him at the front of the aeroplane and that when the cockpit door was opened shortly after the incident, he saw that the faces of the two pilots were frozen. They had just requested an explanation from the approach controller. The captain then told them what had happened during the take-off and initial climb. The cabin crew member then recalled a serious incident which had occurred several years earlier when he had been a cabin crew member for another operator. The recollection of this memory greatly upset him. The purser noticed this, and informed the captain that the cabin crew member would no longer be able to carry out his tasks on both the flight underway and on the next flight (which as a consequence, gave rise to a limitation to 50 passengers).

Regulations require that there is a complement of a minimum of one cabin crew for every 50 passengers. With 73 passengers on board, and one cabin crew member incapacitated, cabin safety might have been impeded.

2.5 Strasbourg Entzheim airport air traffic control service information

2.5.1 Approach fix

The SE point (NDB marker beacon situated at around 4 NM on centreline before threshold 23) acts as an approach fix for the controllers for runway 23. When a pilot reports that he is ready for departure, the LOC controller clears him to line up on the runway, taking care to check, in particular, that no aircraft on an instrument approach has passed SE. Runway 05 did not have an approach fix at the time of the incident. The Air Navigation Service defined one after the incident. It is situated at 4 NM on the centreline of its threshold, like the one which exists for runway 23.

2.5.2 Minimum vectoring altitude

The minimum vectoring altitude (formerly the minimum radar safety altitude (MRSA)) is 2,500 ft in the vicinity of the aerodrome.

2.5.3 Control positions

On the day of the incident, the tower manager had manned all the control positions due to the work load generated by the general aviation airshow, AERO Friedrichshafen. The controllers in the following positions were in contact with at least one of the CRJ700 or Boeing 717 crews:

- GND controller: the ground controller provides information and alert services on the apron, and control, information and alert services in the manoeuvring area, except for the runway strip.
- LOC controller: the local controller occupies the position on the right side of the GND position in the control tower. He is responsible for the landing area and its vacation (runway strip) and the space between the ground and 2,500 ft in the CTR. At Strasbourg Entzheim, the LOC controller has a radar screen[7] as work tool, which displays an aircraft with a label to identify it, the present position of this aircraft[8], its past positions and its flight path vector.
- Approach controller: in the IFR room, the Strasbourg Entzheim approach control centre has a position for an approach radar controller.

[7] IRMA: Aircraft movement radar display.

[8] At Strasbourg Entzheim, the targets are only detected from an altitude of around 1,500 ft.

2.5.4 GND controller statement

The GND controller indicated that there were not many aircraft on the GND frequency and that he was thus receptive to the environment. He specified that in the absence of a radar image in the GND position, he was not, however, aware of the distances and speeds of the aircraft in flight. He asked the crew of the CRJ700 to contact the LOC controller on the associated frequency when the aeroplane was abeam taxiway G. He then heard the LOC controller propose a take-off within one minute to the crew of the CRJ700. When he looked for the Boeing on final approach, he was expecting to see its lights and was surprised that he could clearly see the aeroplane's outline. He then asked the LOC controller if he had seen that the Volotea was close. The LOC controller replied that it was ok, it was at 3.5 NM. He then saw the CRJ700 enter taxiway H and when it passed the holding point, he expressed his stupefaction to the LOC controller. It seemed to the GND controller from the messages on the frequency, that the captain of the Boeing 717 was exasperated.

2.5.5 LOC controller experience and statement

The LOC controller holds an air traffic controller licence with aerodrome control instrument (aerodrome radar control and tower control) and approach control surveillance ratings. He is also a simulator and position instructor. Before joining Strasbourg Entzheim in 2012 where he was qualified in 2013, he was first qualified as controller at Bâle Mulhouse airport in 2001.

The day of the incident he had started his shift in the LOC position at 12:30. He indicated that there must have been one or two VFR aircraft to be managed before the arrival of the CR700 and Boeing 717 crew on the frequency. He added that when the crew of the CRJ700 contacted him ready for departure on the LOC frequency, the CRJ700 was, according to him, nearly at holding point H and the Boeing 717 was stabilized on final approach to 05 at around 3.5 NM from the runway threshold. The LOC controller did not think that proposing an immediate take-off would give rise to any particular problem. The LOC controller considered that based on the decided tone of voice of the crew member of the CRJ700, the latter had clearly understood the constraint and that he shared the same understanding of the situation. The LOC controller considered that the CRJ700 had not lined up as quickly as hoped.

When the CRJ700 left the ground, the LOC controller considered that the Boeing 717 could land. He waited before giving the clearance to land to check the spacing. He confirmed that he would have been required to clear the crew of the Boeing 717 to land before the CRJ700 had crossed the end of the runway. He was surprised by the decision of the Boeing 717 crew to execute a missed approach. He added that in his opinion it was more dangerous to execute a missed approach behind the departing aeroplane than to land a bit too close behind it.

The LOC controller indicated that he did not wish to disturb the crew of the Boeing 717 during the execution of the missed approach. He thus asked them to keep straight ahead and asked the crew of the CRJ700 to turn towards the last SID point to ensure the separation. He added that he was convinced at this point that the crew of the CRJ700 were perfectly aware of the situation as they had been cleared for an immediate departure and had had the position information about the traffic in final approach. The LOC controller indicated that he had waited to have radar contact with the CRJ700 as visually, with the parallax, it was not easy for him to know its position. The radar blip appeared at around 1,600 ft and the LOC controller explained that it seemed to take a long time for it to appear. He added that when the CRJ700 appeared on the radar screen, his “heart jumped”: the Boeing 717 had deviated to the left of the runway centreline and not the CRJ700. The LOC controller thus saw that his instructions had not had the desired effect. This was an emergency situation for the LOC controller, which was not improving as there was a contradiction with the instructions he had given. The LOC controller considered that the crew of the CRJ700 were not at all on alert as they asked him to repeat the message to stop climbing. He then repeated the altitude limitation, this time using the emergency phraseology.

The LOC controller heard the crew of the Boeing 717 express their discontent on the frequency in this lapse of time and he considered that this contributed to increasing his emotional load. He asked the Boeing 717 crew to turn to heading 050° but he realised that this heading would not change anything as it was that of the runway centreline. During the TCAS resolution, he took no action, which is normal procedure and left the crews to manage the situation. He then transferred the two aeroplanes to the approach frequency.

The LOC controller indicated furthermore that:

- He had probably built up confidence from the day before when he had managed a lot of VFR traffic with the Aero 2019 general aviation air show at Friedrichshafen. He thought that this could have influenced his decision.
- He thought that the two crews were fully aware of the situation and that they had the same situational awareness as him.
- He thought that he was ready to manage this type of situation (due to, in particular, feedback and discussions with his colleagues) but ultimately, he realised that this was not the case and that he had little time to detect, analyse and decide in such a situation.
- He had the impression that seconds were lost because he could not see the radar blip of the CRJ700 on his screen which would not have been the case at Bâle-Mulhouse where he had worked.
- The rhythm at Bâle-Mulhouse where he had worked previously was higher than at Strasbourg Entzheim.

2.6 Standard departure route and ILS approach procedure for runway 05

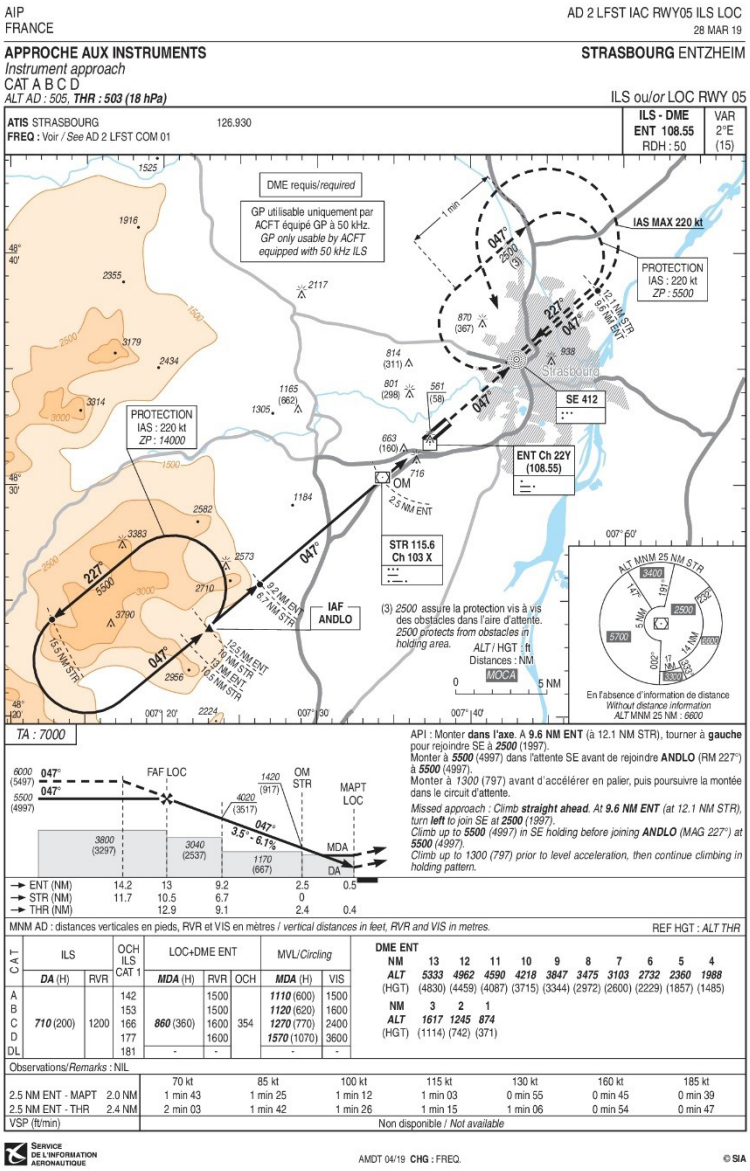
2.6.1 Standard departure route

The crew of the CRJ700 had received, before taxiing, instructions to follow the standard departure route EPIKO 7J which requires the crew to first climb straight ahead before turning left at NDB SE (situated at 048° at 5 NM from the DME of the ILS ENT for runway 05) by following a magnetic track 233° in order to intercept and follow the QDR 272 of this beacon.

2.6.2 Approach procedure

The initial approach fix (IAF) of the ILS procedure for runway 05 is situated on the runway centreline at 12.5 NM from the DME of the ILS ENT (DME situated at 079° and 303 m from the threshold of runway 05). From the final approach point (FAP), the approach slope has a gradient of 3.5° (i.e. 6.1%). The DH is 200 ft (altitude of 710 ft), at around 0.5 NM from threshold 05.

The missed approach procedure requires the crew to first climb straight ahead, to turn left at 9.6 NM from the DME of the ILS ENT to join the NDB SE at an altitude of 2,500 ft and to then climb in the established holding pattern at NDB SE before joining the IAF of the procedure at 5,500 ft. Volotea uses the information provided by LIDO whose approach chart regarding the ILS procedure for runway 05 has no differences with that of the AIP.



Source: AIP

Figure 4: excerpt of ILS approach chart for runway 05

2.7 Air traffic management

In France, the rules and procedures for the air traffic services (RCA3) are based on the European and French texts whose provisions were drawn up using the PANS-ATM[9] standards and recommended practices.

[9] ICAO Document 4444 - Procedures for Air Navigation Services - Air Traffic Management.

2.7.1 Separation between departing aircraft and arriving aircraft

If an arriving aircraft makes a straight-in approach (as was the case on the day of the incident), a take-off can be cleared except during the three minutes which precede the planned arrival of the aircraft or up until a determined point on the approach path has been crossed (RCA3 paragraph 4.4.4.2). The three-minute period allows the traffic to be managed according to the speed of the aircraft on approach. Approximately 1 min 20 s elapsed between the take-off clearance given by the LOC controller and the Boeing 717 flying over threshold 05.

2.7.2 Immediate take-off clearance

No aircraft can be cleared to enter a runway if a landing clearance has already been given to an arriving aircraft. The management of the lining up of aircraft for take-off must be carried out taking into consideration that an aircraft in the process of landing or in the final approach phases normally has priority over an aircraft which is on the point of leaving from the same runway or an intersecting runway (RCA3 paragraph 5.6.1.1). Moreover, an aircraft is only cleared to take-off if the specified or prescribed separation with the aircraft on approach is complied with at the time that the aircraft starts its take-off (RCA3 paragraph 5.6.7.2). However, in the scope of accelerating traffic and improving runway occupancy and movements, immediate take-off clearances (RCA3 paragraph 5.6.7.5) can be given to pilots before aircraft enter the runway. After accepting such a clearance, the transition from the taxiway to the runway and the take-off are carried out as a rolling take-off. It is expected that the pilots who cannot guarantee these conditions, advise the controllers of this. The procedure for the immediate take-off clearance does not permit the waiving of the separation rules between the departing and/or arriving aircraft.

Before giving an immediate take-off clearance, the probable time required before starting the take-off run, the duration and the taxiways available to allow an aircraft to vacate the runway if it is not possible to comply with the immediate take-off clearance must be taken into account. For the controllers, this thus means being ready to modify a planned sequence in a short period of time taking into consideration:

- the cancellation of the immediate take-off clearance;
- a possible rejection of the take-off during the take-off run;
- a possible instruction to vacate the runway;
- the resolution of a potential conflict with an aircraft with the execution of a go-around.

2.7.3 Landing clearance

RCA3 (RCA3 paragraph 5.6.6.1) indicates that a landing or take-off clearance must not be given to an aircraft all the while that the departing aircraft preceding it has not crossed the end of the runway in use or has not started a turn or all the while that all the arriving aircraft preceding it have not vacated the runway in service, without exception. The crew of an aircraft can, however, be cleared to land when the controller is reasonably sure that the above specified separation will be complied with at the time the aircraft crosses the runway threshold (RCA3 paragraph 5.6.6.4.1).

No reduced runway separation minimum is defined at Strasbourg Entzheim airport for the runway in service and for the aircraft operating under IFR.

The Strasbourg Entzheim airport operations manual indicates that the controller can use reporting points to give the landing clearance. For the runway 05 ILS procedure, these points are at 1,000 ft on final approach or at 4 NM from the DME of the ILS ENT[10].

[10] The LOC controller did not ask the crew of the Boeing 717 to call him back at a reporting point on final approach.

2.8 Controller training

2.8.1 General European regulation framework (EU regulation 2015/340)

The training of air traffic controllers is principally made up of:

- Initial theoretical and practical training provided by an approved training organization (ENAC in France).
- Training within the unit to which the air traffic controller has been appointed. It permits the transition between the controller autonomously manning his position and the initial training or the controller's previous appointment.

On successful completion of this training, an air traffic controller licence is issued. This licence includes different ratings such as the "*Aerodrome control instrument (ADI)*" rating which indicates that the licence holder is competent to provide an air traffic control service to aerodrome traffic at an aerodrome that has published instrument approach or departure procedures.

The training also includes the continuation training with refresher training and conversion training (e.g. instructor rating).

2.8.2 Aerodrome control instrument (ADI) rating

The Aerodrome control visual (ADV) rating and the Aerodrome control instrument (ADI) rating are the first two ratings in the initial training. The practical exams are carried out on a simulator and are designed to check that the trainees are capable of supplying the aerodrome control services and of complying with the aerodrome control techniques and the aerodrome traffic operational procedures.

At the ENAC, when the trainees start their air traffic controller training, a large majority of them have no aeronautical experience. The training for the ADV and ADI ratings takes place after numerous modules directed towards the acquisition of knowledge. The simulator sessions for these ratings take place in the following conditions:

- An approach fix is systematically present at 4 NM from the runway threshold.
- When the trainees are contacted by the IFR pilots on the frequency, they are expected to ask the pilots to call back at 4 NM on final approach and according to the runway occupancy, either to give the clearance to land or to ask the pilots to execute a missed approach.
- The missed approach must be considered as a departure. It is expected that the trainees comply with the missed approach paths and the minimum vectoring altitudes during the simulator sessions.

Immediate departures are only covered in a theoretical and not in a practical way on a simulator insofar as the approach fix is considered a sufficient margin.

After the ENAC trainees have obtained the ADV and ADI ratings, they spend four weeks on an "*Airport*" course to familiarize themselves with the aerodrome environment and possibly start on-job-training with an instructor.

2.9 Executing a low-level go-around

Eurocontrol carried out an operational safety study into low-level go-arounds which it published in 2019. Out of 187 incidents, 8 of these were identified as being linked to a conflict due to a go-around being executed at a low height (less than 400 ft from the ground). This is not a large number compared to the total number of incidents studied but the study also revealed that there were 6 occurrences (of the 187) where only "*providence*" had meant that a collision in flight was avoided and that two of these concerned a low-level go-around. This is why Eurocontrol decided to initiate this study which, in particular, identified six scenarios which could lead to a low-level go-around. For each scenario, the study lists the measures to:

- prevent conflicts before or after a low-level go-around,
- mitigate the collision risk after a low-level go-around.

One of these six scenarios concerns the conflict between an aircraft executing a low-level go-around and a departing aircraft on the same runway along with the proposed or available measures with the associated limitations:

<table>
<tr><td rowspan="2">Barriers to prevent a conflict</td><td>Before the go-around</td><td>Air traffic controllers
Adopt a “non-aggressive” approach sequence by avoiding positioning aircraft to close to each other in order to optimize runway use or focusing on a certain effectiveness (strategic management by taking margins without trying to reach the separation minimums).
Plan runway occupancy by taking margins (unexpected factors).
Inform pilots sufficiently early of possible constraints.
Continuously assess how what is planned evolves and adapt the action plan if the 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 and decide quickly and avoid letting situations get worse or hoping that everything will proceed without problem.
Inform the air traffic controllers sufficiently early of a possible go-around.
Inform the air traffic controllers if an immediate departure (or runway vacation) is impossible or difficult.
Limitations: difficult to anticipate actions undertaken by air traffic controllers.</td></tr>
<tr><td>After the go-around</td><td>Specific procedures
Missed approach and departure procedures guaranteeing a sufficient procedural separation between aircraft (procedures published in the AIP or in the local procedures of the aerodrome).
Standard ATC procedures in the event of a go-around allowing controllers to give path to be followed information to avoid any risk of collision.
Air traffic controllers
Tactical/strategic processing of potential conflicts.
Coordination between controllers.
Limitations: difficulty with maintaining visual contact with aircraft or with monitoring paths on available tools.
Pilots/crews
Awareness of potential conflict and independent actions to limit or avoid reducing safety margins.
Limitations: flight conditions for maintaining visual contact with another aircraft.</td></tr>
<tr><td colspan="2">Barriers to mitigate collision risk</td><td>Appropriate resolution of conflict by ATC
Impromptu decision making.
Limitations: difficulty with maintaining visual contact with aircraft or with monitoring paths on available tools, pilot/crew actions replacing controller actions.
Resolution of conflict by pilots/crews
Limitations: flight conditions for maintaining visual contact with another aircraft.
Resolution of conflict by pilots/crews with help of TCAS
Limitations: TCAS inhibited below a height of 1,000 ft, other TCAS limitations.</td></tr>
</table>

The study concluded with five recommendations:

- “*European airport authorities and ANSPs should review the identified potential barriers and the conclusions if they undertake operational safety analysis and improvement activities for conflicts on or following low-level go-around events.*
- *European airport authorities, ANSPs and the EUROCONTROL Safety Improvement Sub-Group (SISG) should monitor occurrences involving conflicts on or following low-level go-arounds to determine changes in frequency and severity.*
- *European airport authorities and ANSPs should note that no “one-size-fits-all” recommendations are made, and that a method of weighting the potential effectiveness of each barrier could be considered which takes account of the prevalent types of runway configuration and traffic mix at individual aerodromes.*

- *ANSPs and aircraft operators should note that ATC defensive controlling and the subsequent ad-hoc resolution actions by both controllers and pilots are currently the most effective barriers. It is therefore recommended that ab-initio and continuation training be reviewed and enhanced where appropriate in order to heighten awareness of best practice.*
- *All European aviation stakeholders should note that the current most effective methods of reducing the frequency and severity of such events rely on human performance. It is therefore recommended that all European aviation stakeholders support the development of tools and procedures which increase resilience and reduce the level of reliance on human performance."*

2.10 Use of English

The use of just English might have meant that the crew of the Boeing 717 were aware of the character of the instructions given in French to the crew of the CRJ700, and allowed them to adapt their path accordingly and thus avoid the activation of the TCAS resolution advisories.

However, it is not possible to determine if the monitoring of the few exchanges which followed the take-off clearance, made by the crew of the CRJ700 during the take-off run, would have resulted in better situational awareness if only English had been used.

3 - CONCLUSIONS

The conclusions are solely based on the information which came to the knowledge of the BEA during the investigation. They are not intended to apportion blame or liability.

Scenario

When a Boeing 717 on an ILS approach was at 3 NM from the threshold of runway 05, and without other traffic to be managed on the frequency, the LOC controller proposed an immediate take-off to the crew of the CRJ700 who were approaching the holding point. Despite the information concerning the Boeing 717's distance from the threshold and the GND controller's comment which suggested that the separation between the two aeroplanes would not be ensured, the LOC controller remained confident in his choice to give priority to the take-off of the CRJ700 rather than to the landing of the Boeing 717. Observing that the CRJ700 would not have crossed the opposite end of the runway by the time they landed, the crew of the Boeing 717 executed a missed approach at a height of 240 ft and at 0.58 NM from the threshold of runway 05. The initial strategy of the LOC controller mainly relied on the capability of the crew of the CRJ700 to immediately follow his instructions. In the dynamic flight phases with a high workload and with a difference in acceleration between the two aeroplanes, it was difficult for the crews to perceive, analyse and follow the instructions from the LOC controller, especially since they were given in different languages. The difficulty with following the progress of each aeroplane from the control tower and the late appearance of the information on his radar screen did not allow the LOC controller to adapt his strategy. Moreover, the Boeing 717's deviation to the west due to the crew selecting a heading which was different to the runway magnetic heading, accentuated the horizontal closing in of the two aeroplanes after the left turn made by the CRJ700.

The compliance with the TCAS resolution advisories by the two crews resolved the conflict.

Contributing factors

The following factors may have contributed to the crew of the CRJ700 being issued with an immediate take-off clearance although the Boeing 717 was at 3 NM on final approach:

- The LOC controller's wish to optimize the use of the runway, without any particular reason and without anticipating the risks in the event of something unexpected happening, meant that the prescribed separations between the arriving and departing aircraft were not complied with.
- At the time of the incident, the absence of means, practices or systematic procedures at Strasbourg Entzheim airport, such as the setting up of an approach fix for runway 05.
- The aircraft type not being mentioned by the LOC controller when giving the traffic information to the crew of the CRJ700 with a view to an immediate take-off. This meant that the crew did not have all the information to allow them to judge whether they could guarantee the immediate take-off conditions and did not share the same situational awareness with the controller and the crew of the Boeing 717.

The following factors may have contributed to the activation of the TCAS resolution advisory between the CRJ700 which was taking off and the Boeing 717 which was in a go-around:

- The LOC controller not anticipating and developing action plans in the event of a potential conflict following a low-level missed approach or a delay with the immediate take-off.
- The situational awareness between the LOC controller and the two crews not being shared.
- The initial paths for the departure and missed approach, to the NDB at 2,500 ft, not guaranteeing sufficient separation between the aircraft.

Safety lessons

One of the tasks of the airport controller is to "expedite and maintain an orderly flow of air traffic". He may do this by approaching the regulatory minima when this is necessary, but this should not be done systematically due to the ensuing risk of exceeding them. Thus, the optimization of the use of the runway and the search for operational efficiency must not take precedence over the prevention of collisions which requires the controller to continuously carry out a strategic analysis of the risks.

After an in-flight incident, it is particularly complex for a captain to synthesize the useful information to explain it and continue the flight. The emotional load makes it difficult to be objective about the incident that has occurred, even if there are no more consequences for the rest of the flight, for both the flight crew and the cabin crew. Sharing information with the crew can, however, affect certain crew members according to their sensitivity and their experience.

4 - RECOMMENDATIONS

Note: in accordance with the provisions of Article 17.3 of Regulation No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation in no case creates a presumption of fault or liability in an accident, serious incident or incident. The recipients of safety recommendations report to the issuing authority in charge of safety investigations, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

4.1 Preventing a conflict between aircraft in the event of a low-level missed approach

The execution of a missed approach on either the crew's initiative or on request from a controller, for whatever reason, can occur at any moment and at any height. When it results in an insufficient separation with a departing aircraft, the risk of collision between two aircraft in dynamic phases and with similar paths becomes difficult to manage for both the controller and the crews, as was the case for this serious incident. The Eurocontrol study published in 2019 also shows that even if the number of incidents associated with low-level go-arounds is small, they represent one third of the potentially catastrophic occurrences analysed in the study. The controller gave priority to the departing aeroplane rather than to the aeroplane which was at 3 NM on final approach, without there being any specific constraint. This decision, probably motivated by a desire to optimize runway occupancy, was based on the controller's confidence in his interpretation of the situation and on his experience and he did not reassess this decision when the GND controller expressed his surprise.

The BEA recommends that:

- **in the absence of means or procedures such as runway approach fixes,**
- **whereas the management of aircraft lining-up and landing sequences mainly relies on the experience, assessment and judgement of the position controller, despite the criteria specified by the regulations,**
- **whereas this absence of means or procedures creates a difference between the initial training for the aerodrome control instrument (ADI) rating, which relies on the use of such means, and the continuation training or conversion training,**

  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.
  Recommendation FRAN-2020-013