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SAFETY INVESTIGATION REPORT

Serious incident

to the EMBRAER - ERJ170 registered **F-HBXK**
and to the AIRBUS - A320 registered **OO-SNE**
on 21 October 2020
at Paris-Charles de Gaulle (Val-d'Oise)

Time	Around 10:20[1]	
Operators	HOP! (ERJ170)	Brussels Airlines (A320)
Type of flights	Passenger commercial air transport	
Persons on board	Captain (PM), co-pilot (PF), 2 cabin crew members, 58 passengers	Captain (PF), co-pilot (PM), 4 cabin crew members, 35 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.		

Note: the definitions of the acronyms and abbreviations can also be found in the glossary available on the BEA website.

Windshear warning on final approach, flight path deviation during the missed approach, abnormal proximity with an aeroplane taking off from a parallel runway, TCAS resolution advisory

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on the Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) data from the ERJ170 and the FDR data from the A320, statements, and radio communication recordings.

The crew of the ERJ170 were flying from Brest Bretagne airport (Finistère) to Paris-Charles de Gaulle airport. During the preparation for the approach, they took into account the particular meteorological conditions of the day which included a strong crosswind and moderate to severe turbulence below 1,500 ft. In particular, the crew went through the *Windshear* procedure. They made sure that the reported wind was compatible with the maximum crosswind for landing and decided to land with the flaps in position five and an approach speed increased to 142 kt.

[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.

When the crew of the ERJ170 announced they were established on final for 26L, the LOC controller indicated the wind direction as being 190° with a speed of 22 kt gusting up to 32 kt, and cleared them for landing.

The crew of the A320, who were carrying out a flight out of Paris-Charles de Gaulle airport bound for Bruxelles-National airport (Belgium), contacted the controller and announced they were ready to depart. The controller cleared them to line up and wait on runway 26R.

On board the ERJ170, after flying through the Radio Altimeter (RA) height of 1,000 ft, the co-pilot, PF, disconnected the AutoPilot (AP).

While the ERJ170 was flying through the RA height of 500 ft, the controller informed the crew of the A320 that the wind was from 200° at 21 kt with gusts up to 36 kt and cleared them for take-off from runway 26R.

At the Decision Height (DH) of 200 ft, the indicated airspeed of the ERJ170 decreased from 139 kt to 125 kt in two seconds. The captain, PM, called out "speed". At the same time, the *Windshear* warning was triggered (see *Figure **1***, point 1). The PM called out "windshear". The PF did the same and initiated the actions of the corresponding procedure by moving the thrust levers to the MAX detent and applying a nose-up action with the control column. The WINDSHEAR mode of the Flight Director (FD) engaged.

At 10:21:38, the *Windshear* warning stopped, eight seconds after its activation as the aeroplane flew through 580 ft[2] in climb (point 2).

During the initial compliance with the *Windshear* procedure, the heading of the ERJ170 increased and was then held a few degrees to the right.

At 10:21:49, 11 s after the *Windshear* warning had ended, the PM announced the end of the windshear (point 3).

On board the ERJ170, the *Bleed 1 overpressure* and *Bleed 2 overpressure* alerts were triggered. The crew switched off the illuminated *Master Caution* pushbutton and postponed the processing of these alerts without verbalizing it.

During this time, the crew of the A320 initiated the take-off rotation.

[2] Unless otherwise stated, the altitude values given in the report are QNH altitudes.

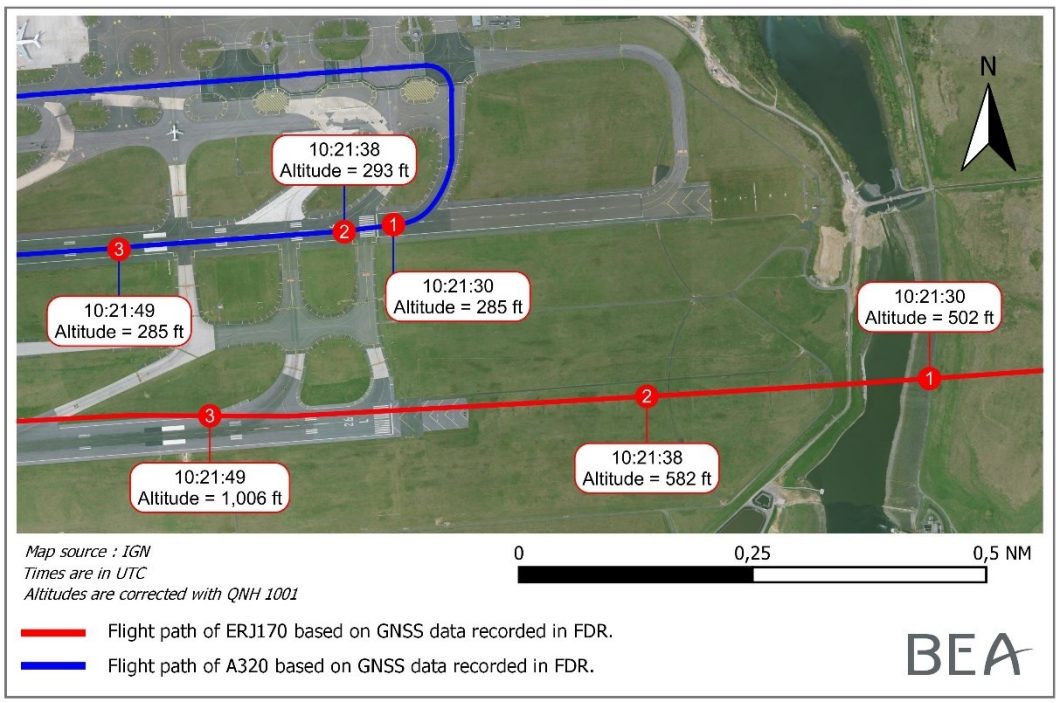


Figure 1: flight paths of the ERJ170 (red) and the A320 (blue)

At 10:21:57, eight seconds after the "end of windshear" call, when the ERJ170 was approaching 1,500 ft in climb, the PM told the PF he had changed to heading mode. At 10:21:59, he informed the controller that they had initiated a go-around straight ahead to 4,000 ft due to windshear (see *Figure* ***2***, point 4). The HDG mode was engaged with a selected heading of 259° corresponding to the current heading. The controller replied that he would call back.

Under the influence of the wind increasing with the altitude, and the changes in speed of the ERJ170 during the manoeuvre, the flight path deviated to the right and approached runway 26R.

The crew of the ERJ170 then retracted the flaps to position three, followed by the landing gear, in compliance with the end of the *Windshear* procedure. At 10:22:14, when they had finished reconfiguring the aeroplane, a Traffic Advisory (TA) was issued by the Traffic Collision Avoidance System (TCAS) on board the ERJ170, accompanied by the voice alert, "*Traffic Traffic*" (point 5). At the same time, the crew of the A320 received the same message. Simultaneously, the controller asked the crew of the ERJ170 to make an immediate left turn onto a heading of 240° (this message was transmitted 10 s after the previous one). The crew read this back, selected the 240° heading and initiated the left turn.

The controller coordinated with the Paris-Le Bourget air traffic control service in order to send the ERJ170 towards their airspace.

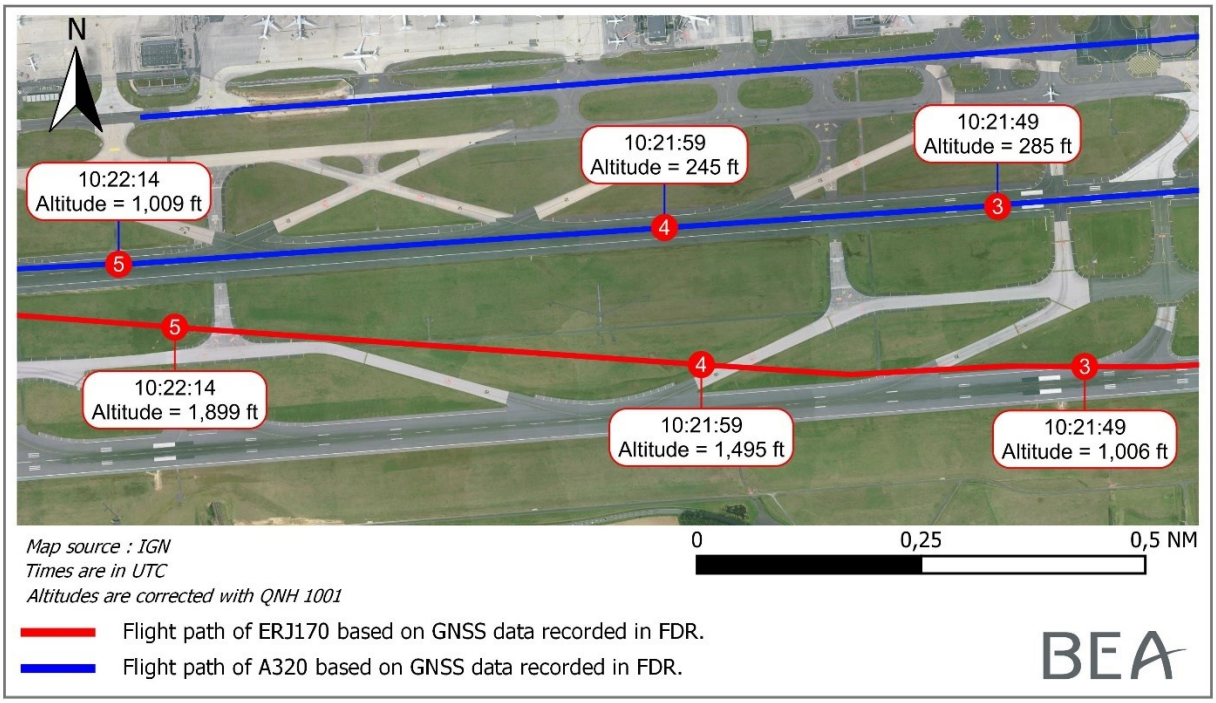


Figure 2: flight paths of the ERJ170 (red) and the A320 (blue)

On the controller's radar display, a Short Term Conflict Alert (STCA) was triggered, warning the controller of the potentially conflicting paths of the ERJ170 and the A320.

One second later, at 10:22:23, when the ERJ170 flew through 2,150 ft in climb, the TCAS issued a Resolution Advisory (RA) to climb with the voice alert, "*Climb Climb*" (see *Figure **3***, point 6). The PF of the ERJ170 executed the associated procedure and adjusted the attitude. In addition, she moved the thrust lever to the TOGA detent. She levelled the wings and held the 250° heading, with an average track of around 263°.

At the same time, when the A320 flew through 1,500 ft in climb, the TCAS issued a "*Level off*" RA. The crew disconnected the AP and adjusted the attitude by complying with the *TCAS* procedure and the instruction displayed on their PFD. They held the runway axis and an altitude of around 2,000 ft.

At 10:22:26, the controller asked the crew of the A320 to "*Stop climb altitude euh stop climb present altitude please*". The crew responded "*TCAS RA*".

The crew of the ERJ170 informed the controller that they had also received a TCAS RA.

After this exchange, the voice message, "*Clear of conflict*" (point 8) was generated on board the ERJ170.

Although the crew of the ERJ170 had not yet officially notified the controller of the end of the TCAS RA, the controller asked them to continue the left turn onto a heading of 200°. The crew read this back, selected the 200° heading and resumed the turn.

The controller then repeated his request to the crew of the A320 to stop climbing. The crew replied "Affirm". They did not inform the controller that they were still following a TA issued by their TCAS. The order to stop climbing was consistent with the TA. At the same time, the STCA alert on the controller's radar display stopped (point 9).

A few seconds later, the TA stopped on board the A320 (point 10). The crew did not inform the controller that this warning had stopped.

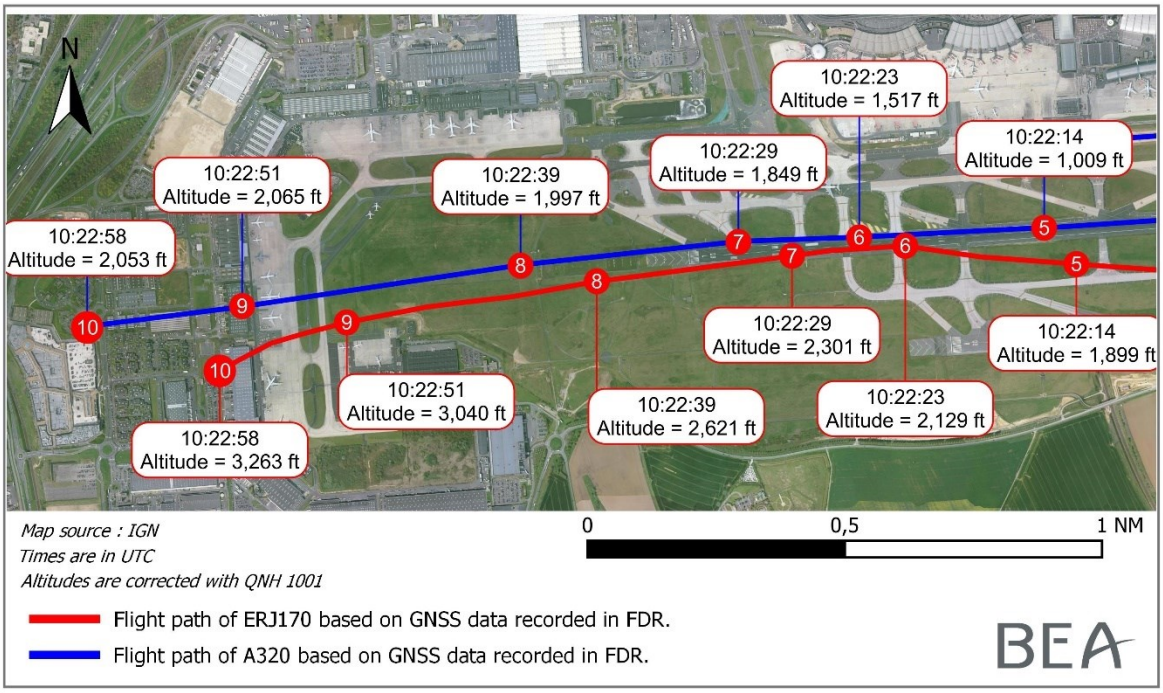


Figure 3: flight paths of the ERJ170 (red) and the A320 (blue)

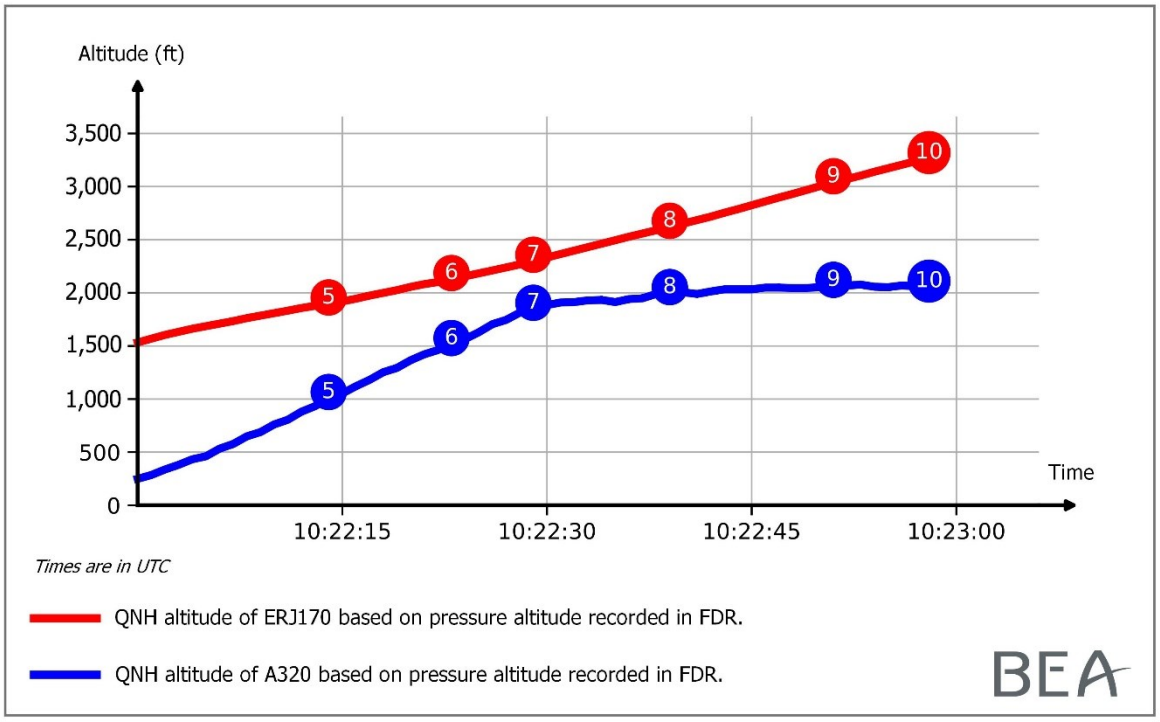


Figure 4: vertical separation between the ERJ170 (red) and the A320 (blue)
(The graph does not show the horizontal separation of the two aeroplanes)

At 10:23:01, the controller asked the crew of the A320 to turn right onto a heading of 360°. The crew read this back and continued their flight to their destination.

The crew of the ERJ170 carried out a second approach without further incident.

The minimum separation[3] between the two aeroplanes during the incident was 0.09 NM laterally and 460 ft vertically (point 7).

2 ADDITIONAL INFORMATION

2.1 Meteorological information

A marked area of low pressure was travelling from the Bay of Biscay towards the north sea, causing strong winds in the Ile-de-France region.

The Trappes radio altimeter showed the presence of a jet stream with winds reaching 45 to 50 kt from 1,500 ft. The speeds steadily increased to reach 70 kt at 10,000 ft. However, no sudden change in wind direction was observed between 0 and 10,000 ft.

The ATIS in force at the time of the incident included the following meteorological information:

- WIND 220/26 KT / 31 KT
- VIS 10 KM
- CLD FEW 3,300 FT BKN 4,000 FT
- T+20 DP+12
- QNH 1001
- MOD TO SEV TURB BLW 1,500 FT

2.2 Crew statements

2.2.1 Crew of the ERJ170

Note: the two members of the flight crew of the ERJ170 were interviewed.

The crew indicated that based on the analysis of the meteorological conditions, they had mentally prepared for the possibility of windshear during the approach.

The crew stated that they waited to reach 1,500 ft to initiate the actions subsequent to the *Windshear* procedure, in accordance with their Operations Manual.

During the TCAS advisory, the PF did not know what traffic was approaching them. One of the PM's monitoring tasks was to analyse the position of the traffic displayed on his ND screen. However, he did not understand what traffic was concerned by the advisory. He added that he thought that it was traffic from Paris-Le Bourget airport. This misunderstanding was not cleared up until after the flight.

They considered that this situation and its short timeframe required a lot of mental resources. The occurrence of the double *Bleed 1 overpressure* and *Bleed 2 overpressure* alerts at that time had been considered disconcerting but had rapidly been set aside in terms of priorities.

[3] These values were calculated based on the FDR recording of the GNSS position of both aeroplanes.

2.2.2 Crew of the A320

Note: the following information was taken from the report written by the crew of the A320.

The crew of the A320 highlighted the speed at which the successive events occurred during the incident, associated with the accumulation of normal tasks (management of the aeroplane's energy at take-off) and abnormal tasks (management of the TCAS-RA and changes to paths requested by the air traffic controller).

2.3 Management of a *Windshear* warning on the ERJ170

2.3.1 System Description

The windshear detection system on the ERJ170 is active between 10 ft and 1500 ft RA during the take-off, go-around and final approach phases.

On detection of windshear, the system issues a caution or a warning depending on the windshear characteristics. In the event of a warning, the text **WSHEAR** is displayed on the PFD screens and a voice alert, "*WINDSHEAR, WINDSHEAR, WINDSHEAR*" is generated.

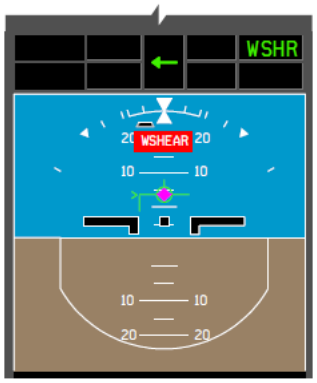


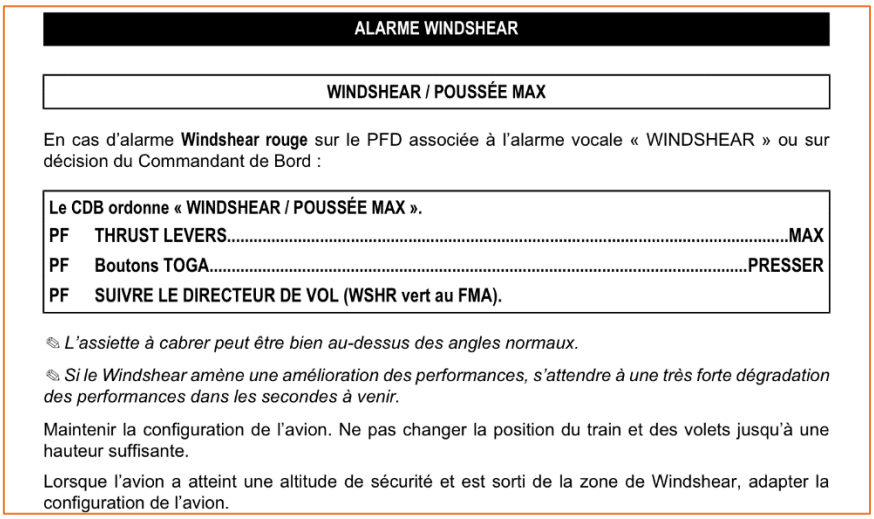
Figure 5: display of the Windshear warning and the associated FMA mode on the ERJ170 (source: Embraer)

When activated, the *Windshear Escape Guidance* mode issues a nose-up order and an order to keep the wings level via the Flight Director (FD), in order to limit loss of altitude and speed when flying through the windshear area.

When a *Windshear* warning is triggered, it remains current for eight seconds after the end of the detection of windshear conditions.

2.3.2 Procedure

The *Windshear* procedure described in part B of the HOP! Operations Manual for the ERJ170 is as follows:



ALARME WINDSHEAR

WINDSHEAR / POUSSÉE MAX

En cas d'alarme **Windshear rouge** sur le PFD associée à l'alarme vocale « WINDSHEAR » ou sur décision du Commandant de Bord :

Le CDB ordonne « WINDSHEAR / POUSSÉE MAX ».

PF THRUST LEVERS.....MAX

PF Boutons TOGA.....PRESSER

PF SUIVRE LE DIRECTEUR DE VOL (WSHR vert au FMA).

✎ *L'assiette à cabrer peut être bien au-dessus des angles normaux.*

✎ *Si le Windshear amène une amélioration des performances, s'attendre à une très forte dégradation des performances dans les secondes à venir.*

Maintenir la configuration de l'avion. Ne pas changer la position du train et des volets jusqu'à une hauteur suffisante.

Lorsque l'avion a atteint une altitude de sécurité et est sorti de la zone de Windshear, adapter la configuration de l'avion.

Figure 6: Windshear procedure (source: HOP!)

In the detailed version of the procedure, the manual specifies that the crew should keep the current configuration (landing gear and flaps) up to 1,500 ft AGL[4] when cleared of ground and obstacles.

The procedure in the Embraer manual for the ERJ170 stipulates keeping the initial configuration up to 1,500 ft AGL or for the time the *Windshear* warning is present.

2.3.3 Role of the PM in the event of windshear

The role of the PM in the specific case of windshear is not specified in the HOP! *Windshear* procedures for the ERJ170. The only indication associated with the role of the PM is the call-out of deviations. This is indicated in the following paragraph of the detailed version of the procedure in part B of the HOP! Operations Manual applicable to the ERJ170:

> Always be aware of the speed, direction and vertical speed. The crew must closely monitor the vertical flight path instruments, such as the vertical speed indicator and the altimeters for example. Call out each deviation.

By way of comparison, the detailed description of the HOP! *Windshear* procedure applicable to another type of aircraft published in the corresponding part B of the airline's Operations Manual includes the following aspects:

> **Role of the PM during windshear**
> - Carefully monitor on the instruments, changes to the vertical profile and consistency of the thrust displayed.
> - Call out any major variation in speed, the speed trend, the rate of climb/descent, the attitude, the thrust or the altitude.
> - If necessary, comment on or issue appropriate directives, such as, "altitude decreasing", "speed increasing", "raise aeroplane nose", etc.
> - Call out the end of windshear and, if necessary, make call-outs pertaining to the configuration, the aeroplane's attitude and the indicated airspeed.

[4] Above Ground Level.

This description sets out the PM's role as being more comprehensive and active when complying with the procedure, including the call-out pertaining to the end of the *windshear* situation and to the associated actions.

During the incident, the PM of the ERJ170 informed the PF of the end of the windshear, while the aeroplane was flying through 1,000 ft in climb, 11 s after the end of the warning, then initiated the end of procedure actions, eight seconds later, when flying through 1,500 ft.[5]

2.4 Managing a TCAS RA – pilot-controller interaction

2.4.1 Principle

In the event of a TCAS RA, the associated procedure stipulates that crews report the RA to the controller to ensure that the latter is fully aware of the situation. The controller is then no longer responsible for the separation of traffic. The controller no longer intervenes regarding the flight path of the aircraft involved in the conflict and allows the crews to follow the advisories issued by their respective TCAS.

When the TCAS warning is over, the crews must also notify the controller of this. The usual roles and responsibilities of the crew and the controller are then resumed.

2.4.2 Inhibition

The TCAS function issuing the RAs is inhibited below the radio altimeter height of 1,000 ft (± 100 ft).

2.4.3 Associated phraseology

According to the rules of the air laid down by the European Aviation Safety Agency (EASA)[6], when a crew deviate from an ATC clearance or instruction in order to comply with a TCAS RA, they must inform the controller with whom they are in contact, by announcing "TCAS RA".

If the crew receive a clearance or instruction in contraction with the current TCAS RA , the flight crew will follow the RA and inform the controller with the message "Unable, TCAS RA".

When the RA has come to an end, the crew must inform the controller with the message, "Clear of conflict".

[5] It is likely that there was some confusion at this time regarding which altitude reference to use as the criterion to end the procedure (AGL vs QNH).

[6] Section 14 – *Voice Communication Procedures*, Annex 1 to AMC SERA.14001

2.5 Air navigation services

2.5.1 Specialised simultaneous operations

2.5.1.1 Definition

According to the SOIR manual[7], simultaneous movements on specialised runways correspond to "*simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures*."

The European certification specifications pertaining to Aerodrome Design and applicable to Paris-Charles de Gaulle airport refers in the associated guide (GM1 ADR-DSN.B.055), to the SOIR manual as being one of the sources for "*guidance on procedures and facilities requirements for simultaneous operations on parallel [...] runways*".

2.5.1.2 Configuration at Paris-Charles de Gaulle

In the south parallel runway configuration at Paris-Charles to Gaulle, the French air traffic regulations (RCA) set out that specialised simultaneous operations can be carried out if the minimum distance between the runway centrelines is 850 m[8]. However, this regulation adds that parallel runways with a centreline-to-centreline distance below this value can be used simultaneously subject to approval by the competent air traffic services authority of a study taking into consideration the geometry of the runway layout and the associated control means.

Note: the RCA in force at the date of the occurrence was repealed in March 2022. Since this date, it is the requirement ATS.TR.255 set out in the ATM/ANS IR[9] which applies to aspects concerning parallel runway operations. The minimum distance standards between the runway centrelines in this regulation are identical to those previously defined by the RCA.

The ICAO standard also covers divergence between the departure and go-around flight paths but this aspect is not covered in this report as the ERJ170 did not follow the published go-around procedure as the crew complied with the *Windshear* procedure.

The distance between the centrelines of runways 26R and 26L is 384 m.

Questioned about this, the Paris-Charles de Gaulle airport air navigation services stated that when the parallel runways were put into service, safety studies in their current form did not exist. They were only introduced with the separation between service provider, regulator and certification and oversight services to ensure compliance with the Single European Sky regulations in the 2000s.

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[7] Doc 9643 published by the International Civil Aviation Organisation (ICAO), *Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR)*, second edition, 2020.

[8] This value is obtained by taking into account the displacement of the runway thresholds: the minimum distance of 760 m between the two runways must be increased by 30 m for each 150 m that the threshold of the landing runway is staggered away from the threshold of the take-off runway.

[9] Commission Implementing Regulation (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight (Version in force on the day of the incident).

In 1999, when the first set of parallel runways entered into service, procedures were updated by the creation of a file by the Air Traffic Studies services that was forwarded for approval to the air navigation services provider. This file was based on technical and statistical studies conducted internally or based on external studies (CENA[10]), including studies conducted during the introduction of similar procedures at foreign airports (studies by the FAA[11], MITRE, etc.). The file systematically includes draft operational instructions associated with updates to the procedures referred to in the file.
No document was provided by the air navigation services on the taking into account of the risk associated with windshear during the implementation of specialised simultaneous operations.

Bibliographic research showed that during studies conducted to implement the first simultaneous operations at international level, particular attention was paid to the risk associated with wake vortex. Crosswind conditions displace the wake vortex to the axis of the parallel runway. These studies contained no element reflecting on the risk associated with the application of the *Windshear* procedure, in which the onboard procedure restricts the freedom of movement in the lateral profile.

2.5.1.3 Demonstration of conformity

Due to the implementation of the requirement ATS.TR.255 in March 2022, in particular the associated Acceptable Means of Compliance AMC4, related to the minimum distance between runway centrelines and the divergence between departure and go-around flight paths for specialised simultaneous operations, the French air navigation service provider (DSNA) submitted an Alternative Means of Compliance (AltMOC)[12] file, which was approved in June 2022 by the French civil aviation safety directorate (DSAC). This file[13] includes arguments that are supposed to demonstrate an equivalent level of safety in the particular runway configuration at Paris-Charles de Gaulle.

These arguments are based on the following points:

- Possibility, due to relatively low minimum vectoring altitude areas (1,500 and 2,000 ft) and the performance of the aircraft, of almost immediate resumption of radar vectoring in the event of a simultaneous missed approach and departure, with a turn, as soon as the go-around is detected.
- Possibility, due to relatively low minimum vectoring altitude areas, to regain vertical separation relatively quickly by stopping the climb of one of the aircraft at this minimum vectoring altitude.
- Application of an additional margin on the south parallel runways, in case of westerly operations, when weather conditions do not allow the LOC controller to see the aircraft on final at 1 NM.
- Analysis of missed approach paths from July 2020 to June 2021 based on the presence or absence of simultaneous departure.

[10] The French Air Traffic Studies Centre tasked with studies and applied research in the field of air traffic control up to 2005, at which time it was incorporated within the Technical and Innovation Division (DTI) of the DSNA.
[11] American civil aviation authority.
[12] The EASA regulation provides for the possibility for national authorities to authorise an operator to use an AltMOC to demonstrate compliance with a regulatory requirement.
[13] AltMOC 2022/06/21-IR ATM/ANS-AMOC FR No 015 related to the specific issue of compliance with AMC4 ATS.TR.255.

- Performance levels of the radar surveillance system:
  - horizontal positioning accuracy of the order of 72 m;
  - refresh cycle adapted to a visual perception of the evolution of the situation in the air in real time and to the reaction time of the controller for traffic surveillance.

If the previous points of these arguments are compared with the particular circumstances of this incident, linked to a missed approach due to windshear, the following contradictions can be noted: The conflict resolution strategy used by the controller was in line with the spirit of the arguments used in this demonstration.

- The effectiveness of the almost immediate resumption of radar vectoring with turn may be questioned in the case of an aircraft applying the *Windshear* procedure.
- In the case of the south parallel runways, the argument is based on almost immediate resumption of radar vectoring with turn which does not seem to take into account the delays caused by the coordination with the Le Bourget sector.

It can be noted, however, that the number of known similar occurrences is relatively small.

2.5.1.4 Comparison between simultaneous approach operations and specialised simultaneous operations

In the SOIR manual (Doc 9643), ICAO defines independent parallel approaches as simultaneous approaches to parallel or near-parallel instrument runways where separation minima between aircraft on adjacent extended runway centre lines are not prescribed.

In its PANS-ATM manual (Doc 4444, para. 6.7.3.3), ICAO recommends that independent parallel approaches to parallel runways spaced by less than 1,525 m between their centre lines shall be suspended under certain meteorological conditions, as prescribed by the appropriate ATS authority[14] (windshear, turbulence, downdrafts, crosswind and significant meteorological conditions such as thunderstorms) which might otherwise increase final approach track deviations to the extent that safety may be impaired. This recommendation is reiterated in the SOIR manual (para. 2.2.3.1 a)

In addition, ICAO considers in the SOIR manual (para. 1.1.1) that, "*Under instrument flight rules (IFR), however, the safety of parallel runway operations is affected by several factors such as the precision with which aircraft can navigate to the runway, the accuracy of the air traffic service (ATS) surveillance monitoring system, the ability of controllers to intervene when an aircraft deviates from the final approach course or track, and the controller, pilot and aircraft reaction times*."

Commission Implementing Regulation (EU) 2020/469 of 14 February 2020[15] as regards requirements for air traffic management/air navigation services, design of airspace structures and data quality, and runway safety, applicable on 27 January 2022, as well as the associated AMCs and GMs (Guidance Material), introduce the above notions in the European texts[16].

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[14] Appropriate authority designated by the State responsible for providing air traffic services in a given airspace.

[15] Commission implementing regulation as regards requirements for air traffic management/air navigation services, design of airspace structures and data quality, runway safety (Version in force on the day of the Incident).

[16] GM5 (safety assessment) and GM7 (suspension of operations due to meteorological conditions) of the AMC2 ATS.TR.255.

2.5.2 Procedures at Paris-Charles de Gaulle

The analysis of the procedures and operational instructions in force at Paris-Charles de Gaulle airport, brings to light the following points concerning the separation between traffic going around and taking off on parallel runways.

Outside of the conditions requiring the application of Low Visibility Procedures (LVP), take-off can be cleared regardless of the position of the traffic on approach, but in compliance nevertheless with the separation standards associated with wake vortex.
A missed approach conflicting with departing traffic is resolved by providing a radar vector (to rapidly obtain a minimum radar separation) and traffic information. The procedure also specifies coordinating with Le Bourget (preferably by intercom) in the event of a go-around from the south parallel runways interfering with Le Bourget traffic.

The Operations Manual indicates that a few rare situations may temporarily make it impossible to execute the missed approach procedure, such as difficulties linked with following the RNAV flight path. In this case, it is specified that the controller resumes radar vectoring as soon as possible, for example by asking the crew to temporarily hold the runway centreline[17].

The procedures include the possibility, in an emergency, of using a temporary minimum vertical separation of 500 ft in the case of a go-around on one runway while traffic is taking off on the parallel runway.

The air navigation services, questioned on this topic, highlighted the importance of traffic on short final being given information about departing traffic, with, if necessary, an advance issuance of instructions to be followed in the event of a go-around. However, they stipulated that this is a general practice based on the experience of the controller.

The above measures are applicable in all wind conditions. Strong wind conditions are included in the operational instructions. The procedures specify that the traffic going around should be offset by 30° minimum from the runway centreline and that the wind should be integrated in the heading given. Moreover, it is possible to defer a clearance to take-off pending the assured landing of traffic on short final or the effective deviation away from the departure runway centreline of traffic in a go-around.

If there is a crosswind of more than 25 kt, the Operations Manual provides for the possibility of suspending simultaneous departures if the tower supervisor observes that the safety conditions are no longer guaranteed. No similar mention is made for specialised simultaneous operations.

2.5.3 Windshear taken into account by air navigation services

As part of the implementation of the regulatory requirement "MET.OR.235 Aerodrome warnings and wind shear warnings and alerts" introduced by Implementing Regulation (EU) No 2017/373, it was determined following an analysis by Météo-France, that Paris-Charles de Gaulle airport should be equipped with windshear warning and alert systems.

[17] For the crew, the approach chart includes a similar instruction if they cannot follow the RNAV missed approach procedure.

The installation of such systems was planned for January 2023. At the time of the occurrence, these tools were not available. The controller could therefore only be aware of the presence of windshear via a PIREP (Pilot Report).

The system put in place to detect windshear to meet the above-mentioned regulatory requirement is based on current techniques which only detect windshear under precipitation. It does not predict windshear.

2.5.4 LOC controller statement

He was aware of the specific meteorological situation associated with the strong crosswind. He had no knowledge of a go-around before that of the occurrence, or of the announcement of windshear by other crews.

He saw the aeroplane make a go-around. He knew that, according to the operational instructions in force, the separation with the take-off in progress could be ensured as long as he gave a rapid instruction.

Being used to working with the two parallel runways in service, his plan of action was to ask the aeroplane in go-around to make a turn southwards. In order to turn the traffic, he considered it necessary to coordinate with the Paris-Le Bourget airport tower which covers the adjacent airspace, by transmitting a message over the intercom to check that there was no conflicting traffic. Concerned that the intercom was not working correctly and not having received a reply, he asked the crew of the ERJ170 to turn and then coordinated the turn by telephone. He considered that he lost “5 or 10 seconds” due to his concern that the intercom not working.

When he asked the crew of the ERJ170 to turn, he used the emergency phraseology to tell the crew to take a left turn heading 240. Although his request was read back, he observed no change in the effective heading on his screen. He thought that this was due to the crosswind and that the 240 heading that he had given was insufficient for the track of the ERJ170 to head southwards.

The controller then considered stopping the climb of the aeroplane taking off. He remembered that he twice ordered the crew of the A320 to stop climbing and that the crew replied that there was a TCAS RA in progress. He explained that he had the impression that the A320 had not stopped its climb.

The controller stated that the two aeroplanes were so close together on his radar screen that he was unable to differentiate their labels. However, he specified that this confusion with regards to the display did not cause him to make a mistake.

The controller added that he felt powerless after the occurrence of the event. Although the crew of the aeroplane in go-around read back the order to make a left turn onto a heading of 240°, the aeroplane’s track had not taken them southwards. Furthermore, the crew taking off responded to his request to stop climb by announcing the TCAS resolution and he had had the impression that they maintained their rate of climb.

After the occurrence and after speaking on the telephone with the captain of the ERJ170, he remembered having seen, as part of his recurrent training, information pertaining to the topic of levelled wings in application of the *Windshear* procedure. He specified that, in the light of this occurrence, he realised that he had not understood the consequences of this information in an operational context.

The controller had never experienced a situation similar to this, either in a real situation or in a simulator during scheduled refresher training.

2.5.5 Similar events

The DSNA, asked about the recurrence of comparable events, did not provide any information on this topic.

A search of the DSAC occurrence database revealed three loss-of-separation events that had occurred during the last five years, presenting similar factors to that of the event of this report. Two events took place at Paris-Charles de Gaulle airport and the third one took place at Toulouse Blagnac airport (Haute-Garonne).

Date	Place	Information about the event
12/2020	LFPG	Go-around due to windshear on approach, STCA alert involving an aeroplane taking off from the parallel runway. ATIS info: wind 210°/24 kt max 32 kt, moderate turbulence on final.
12/2019	LFPG	Go-around due to windshear, STCA alert involving an aeroplane taking off from the parallel runway. Loss of separation, 0.42 Nm, 900 ft, closing speed zero. ATIS info: wind 190 / 22 kt, windshear on final.
10/2017	LFBO	Go-around, STCA alert involving an aeroplane taking off from the parallel runway. Weather conditions entailing successive QFU changes, wind very unsettled with strong windshear.

In all of these events, an aeroplane was going around whilst another aeroplane was taking off from a parallel runway, in particular wind conditions (reported strong crosswind and/or windshear).

In all cases, the STCA safety net was triggered on the controller's screen[18].

In one of these events, the controller had provided the crew of the aeroplane on approach with an advanced clearance for a non-standard path in the event of go-around which may have helped to minimise the seriousness of the loss of separation.

2.6 Eurocontrol Operational Safety Study - Low Level Go Around

Due to the identification in 2017 of the risk associated with loss of separation following a low level go-around, a safety study was conducted by Eurocontrol with the results published in 2019.

While this study does not specifically take into consideration the specific case of a missed approach due to windshear, this case has enough similarities with that of a go-around for the preventive barriers identified by the study to be assessed in the context of the event.

[18] The elements found with respect to these events do not indicate whether the crews received a resolution advisory on their TCAS.

This study systematically identifies conflict Preventive Barriers (PB) pre-GA (Go-Around) or post-GA and Mitigating Barriers (MB) with respect to the risk of collision during the conflict, as shown in *Figure **7*** below.

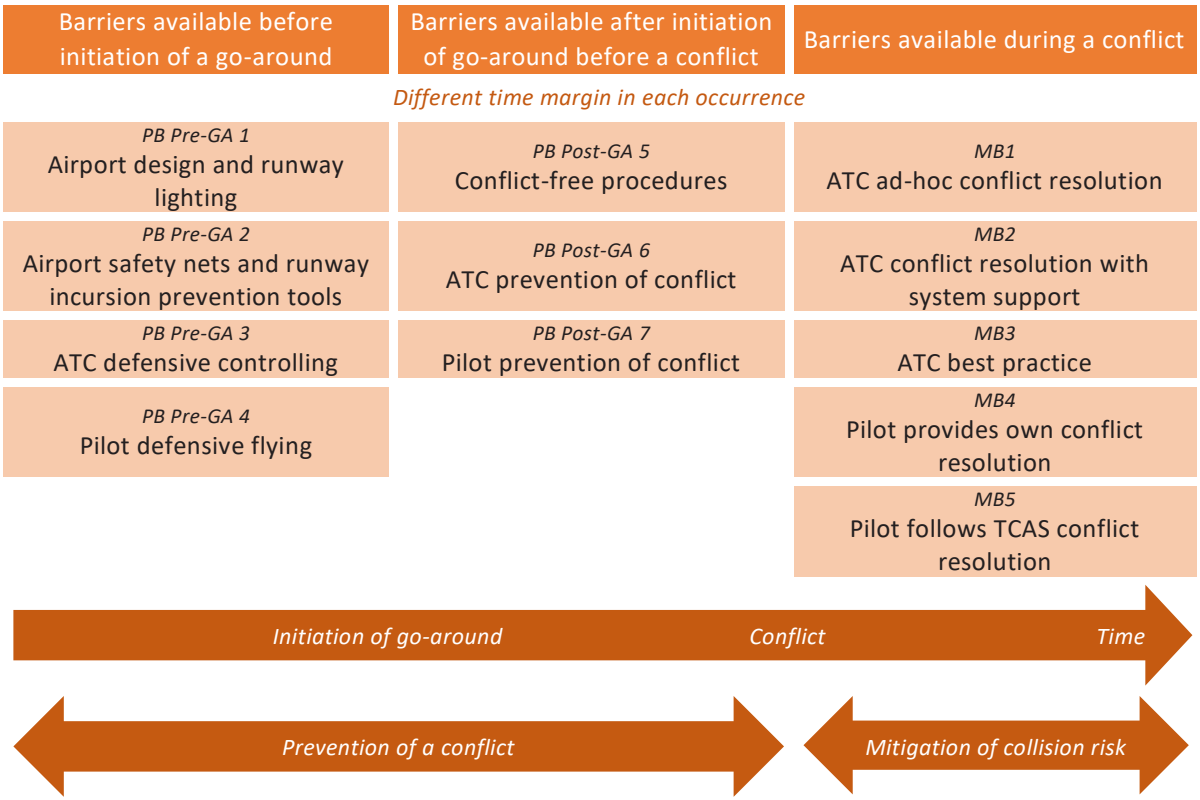

Figure 7: all risk of conflict preventive and mitigating barriers in the case of a low level go-around (adapted from the Eurocontrol document)

The Eurocontrol study specifies which preventive or mitigating barriers are applicable for different types of scenarios. One of the scenarios studied is that of a conflict between an aeroplane going around and an aeroplane departing from a parallel runway.

The risk preventive and mitigating barriers for this particular scenario are listed in the table below. Opposite each barrier is the BEA's analysis indicating whether the barrier was applicable or not in the specific case of the incident of 21 October 2020.

Eurocontrol study model			**BEA analysis**
Barrier code	Description	Explanation	Applicability/effectiveness in the context of the occurrence
PB Pre-GA 3	ATC defensive controlling	*ATC defensive controlling involves a range of ATC ways of working which can prevent low-level go-arounds primarily caused by less-than-optimum controlling.*	Not applicable as the go-around was not caused by less-than-optimum controlling.
PB Pre-GA 4	Pilot defensive flying	*Informing ATC of the likelihood of a go-around, thus providing an early warning and time for ATC to plan a conflict-free path.*	Applicable but was not implemented by the crew.
PB Post-GA 5	Conflict-free procedures	*Procedures may exist which provide sufficient separation between a go-around aircraft and other traffic such that safety margins are maintained.*	Procedure exists but is ineffective due to the crew of the ERJ170 not being able to follow the published path due to the application of the *Windshear* procedure combined with the crosswind.

PB Post-GA 6	ATC prevention of conflict	*Prevention of post-go-around conflicts involving a range of actions by one or more controllers to maintain safety margins on or following a low-level go-around.*	Carried out but with little effect in the context due to the time taken by the controller to give the first order to change the path. This delay was due to the time required to coordinate with the adjacent sector and the late realisation that the ERJ170 had drifted and was not following the go-around procedure.
PB Post-GA 7	Pilot prevention of conflict	*Awareness of potential conflicts and taking independent action in such a manner as to prevent safety margins being eroded. Pilot prevention of conflict is generally limited to VMC flight conditions in order to allow sufficient visual contact with the potentially conflicting traffic to be acquired and maintained.*	The application of the *Windshear* procedure reduced the freedom of movement of the ERJ170 crew to effectively prevent the conflict. Moreover, neither crew being sufficiently aware of the position of the other aeroplane, they did not have, in these dynamic phases, available resources or the possibility of acquiring sight of the other traffic. The position of the PM in each of the aeroplanes was also a contributing factor that prevented the crews from ensuring their own separation.
MB1	ATC ad-hoc conflict resolution	*Involves impromptu last minute action, once safety margins have already been eroded, by one or more controllers in order to remove the risk of collision and achieve as great a safety margin as practical.*	Carried out but with little effect in the context (see PB Post-GA6 in this table).
MB2	ATC conflict resolution with system support	*ATC ad-hoc conflict resolution with system support involves impromptu last-minute action, initiated after an alert signals a go-around in progress, e.g. Go Around Detection System (GARDS). Such alerts may draw the controller's/s' attention to a conflict and mitigation action may be earlier.*	The STCA system was triggered. However, the TCAS system issued a RA one second later on board the two aeroplanes, preventing any intervention on the part of the controller.
MB3	ATC best practice	*ATC conflict resolution actions may mitigate the reduction in safety margins more quickly if such actions and consequent flight profiles on each runway are documented, understood and practised among the ATCOs. * Best practice actions can only be identified for the most common situations, which are not complex.*	Not applicable as the situation was unusual and complex (refer to paragraph 2.5.4).
MB4	Pilot provides own conflict resolution	*Pilots can deviate from any ATC clearance to perform their own manoeuvres to avoid collisions with other conflicting traffic. Pilot collision avoidance is generally limited to VMC flight conditions in order to allow visual contact with the conflicting traffic to be acquired and maintained.*	Ineffective in the context (see PB Post-GA 7).
MB5	Pilot follows TCAS conflict resolution		Applied and effective.

The result of the analysis of the application of the study's preventive and mitigating barriers to the serious incident that occurred on 21 October 2020 shows that:

- The only barrier that was applied and was effective was that of the TCAS (MB5 - *Pilot follows TCAS conflict resolution*).
- Aside from the PB Pre-GA 4 (*Pilot defensive flying*), the pilot-based barriers were not applicable for different reasons, namely the workload in the associated flight phases (application of a *Windshear* procedure and, to a lesser extent, the intermediate take-off phases), the crews not knowing where the other aeroplane was and that in each aeroplane, the PM was on the opposite side to the other aeroplane.
- PB Post-GA 6 (*ATC prevention of conflict*): the controller, who tried to resolve the conflict, was unable to effectively do so due to the rapidity of the sequence of events, to the delay caused by coordination with the adjacent sector, and the late realisation of ERJ170's deviation from the path. In addition, the crews received RA from their respective TCAS very quickly after the controller's avoidance orders, and could no longer continue to follow the controller's instructions, in compliance with the TCAS procedure.
- As indicated in their statements, the crew of the ERJ170, who were prepared to carry out a go-around due to their awareness of the risk of windshear, could have informed the controller of this possibility (PB Pre-GA 4). This information could have alerted the controller and given him time to visualise and prevent the imminent conflict, or even to envisage holding back the take-off clearance for the A320. However, while this type of practice is envisaged in the Eurocontrol study, its applicability in reality was not assessed within the context of this report.

As a defensive control method, the application of an additional separation between traffic taking off and on approach could be added when there is a risk that the weather conditions may cause an increase in deviations from the published paths, to the extent that safety may be comprised. This preventive barrier is in line with ICAO and EASA recommendations to suspend parallel approaches in such conditions (refer to para. 2.5.1.4).

Furthermore, recourse to the practice of giving in advance, instructions to be followed in the event of a go-around could have constituted an additional preventive barrier (type PB Pre-GA3 *ATC defensive controlling*) by doing away with the time required to coordinate with the Paris-Le Bourget control services and the time required to coordinate with the crew of the aeroplane going around.

This would have meant that at the end of the *Windshear* procedure, this crew could have modified their path by initiating the turn towards a heading pre-cleared by the controller.

2.7 Measures taken

2.7.1 By HOP! operator

Following this incident, the *Windshear* procedure described in part B of the HOP! Operations Manual for the ERJ170 was modified. The termination of the *Windshear* procedure is no longer exclusively based on a height criterion. It is now based on the aircraft being out of the windshear zone and clear of obstacles.

This change makes the operator's procedure consistent with the Embraer procedure.

Furthermore, given that compliance with the *Windshear* procedure restricts the crew's freedom of movement in a lateral plane due to the instruction to keep the wings level, this change could allow them to recover this freedom of movement more quickly.

2.7.2 By the Paris-Charles de Gaulle air navigation services

Following this incident, the air navigation services at Paris-Charles de Gaulle informed the BEA that the following measures have been taken:

- Publication of a special safety bulletin on the windshear risk in the event of simultaneous operations on parallel runways.
- Reinstatement of the windshear topic in the initial training as part of a training day dedicated to meteorological phenomena.
- In the context of recurrent training, the case of windshear in the case of simultaneous operations on parallel runways is mentioned in the part of the training devoted to unusual situations.
- The threat of windshear in the case of simultaneous operations on parallel runways is incorporated in the Threat and Error Management (TEM) item during the shift handover.

3 CONCLUSIONS

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

Scenario

The landing and take-off operations at Paris-Charles de Gaulle airport were taking place on the south parallel runways, in particular weather conditions, with a strong crosswind and moderate to severe turbulence below 1,500 ft.

The ERJ170 was at 500 ft on short final on runway 26L when the crew of the A320 were cleared to take-off from runway 26R.

At a height of 200 ft, a *Windshear* warning was triggered on board the ERJ170. The crew applied the procedure associated with this warning by interrupting the approach and keeping the wings level.

After eight seconds, when the ERJ170 flew through 580 ft in climb, the *Windshear* warning stopped. The crew identified the end of the windshear situation when the aeroplane flew through 1,000 ft, 11 s after the end of the warning. The crew continued complying with the procedure by keeping the wings level for a further eight seconds up to an altitude of 1,500 ft, in accordance with the operator's operational instructions for the ERJ170 (refer to paragraph 2.3.3 note 5). They then notified the controller of the windshear and the go-around.

Due to compliance with the *Windshear* procedure and the strong crosswind, the ERJ170 deviated northwards and closed in on the A320 taking off from runway 26R.

The controller attempted to resolve the conflict by using the emergency phraseology to order the ERJ170 to turn onto a heading of 240°, around 10 s after the ERJ170 had reported the go-around. The crew read back the instruction but the controller's order to change the heading was not followed. In fact, complying with the TCAS procedure, the crew stopped the turn as they passed

through a heading of 250° which resulted in a track of 263°. The crew of the ERJ170 did not immediately inform the controller of the TCAS resolution advisory due to the frequency being busy.

The controller then asked the crew of the A320 to stop climbing without using the emergency phraseology. The latter replied that they were following a resolution advisory emitted by their TCAS.

The crew of the ERJ170 then ambiguously informed the controller that they had also had a TCAS resolution advisory.

The crews followed the orders of the resolution advisory provided by their respective TCAS systems. The minimum separation reached during the incident was 0.09 NM and 460 ft.

Neither of the crews informed the controller of the end of their respective TCAS resolution advisories using the standard message set out in the phraseology rules. The use of the past tense in the non-standard message made by the crew of the ERJ170 stating that they had also had a TCAS may have led the controller to believe that the resolution advisory had ended. The controller therefore issued orders to the crews despite the ongoing resolution advisories.

Contributing factors

The following factors may have contributed to the abnormal proximity between the two aeroplanes and to the issuance of the TCAS resolution advisories:

- Insufficient consideration given, in the implementation of procedures associated with specialised simultaneous operations, to the combination of risks associated with a strong crosswind and the crew's compliance with a *Windshear* procedure.
- Compliance with the *Windshear* procedure up to an altitude of 1,500 ft, irrespective of the effective presence of windshear conditions, which may have delayed the subsequent separation actions by the parties involved.

Safety lessons

TCAS phraseology

The TCAS-related phraseology and the procedures to be followed are generally well known by crews and controllers. This incident illustrates that in some situations, due to the workload and the rapid unfolding of events, the parties involved do not make appropriate use of the standard phraseology. Whilst this did not have an impact in this incident, this may decrease awareness of the situation for some parties, or even provide them with an incorrect awareness of it.

Role of the PM in the event of windshear

The PM's role is essential for flight safety. In particular, while complying with a *Windshear* procedure, the PM must actively contribute to the PF's situational awareness through the monitoring of instruments, the call-out of deviations and the call-out of the end of windshear.

The detailed version of the *Windshear* procedure in part B of the HOP! Operations Manual applicable to the ERJ170 provides general information regarding the role of the PM in these circumstances. This procedure could be added to by describing in a more comprehensive and active way the role of the PM while complying with the procedure, including the call-out pertaining to the end of the windshear situation.

Following this incident, the operator informed the BEA that it had decided to modify its Operations Manual in line with these comments.

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 shall report to the safety investigation authority which issued them, on the measures taken or being studied for their implementation, as provided for in Article 18 of the aforementioned regulation.

4.1 Risk of abnormal proximity in the event of a go-around during specialised simultaneous operations, in the case of an aircraft complying with a *Windshear* procedure and strong crosswind situations

The distance between the centrelines of the south parallel runways at Paris-Charles de Gaulle airport is below the minimum centreline-to-centreline value set out in the RCA in the case of specialised simultaneous operations.

However, this regulation stipulates that parallel runways with a centreline-to-centreline distance below this value can be used simultaneously subject to the approval by the competent air traffic services authority, of a study taking into consideration the geometry of the runway layout and the associated control means.

The BEA has no knowledge of a study that takes into account the combined risk associated with an aircraft flying a missed approach due to a windshear warning and a strong crosswind situation when specialised operations were introduced at Paris-Charles de Gaulle.

Due to the implementation in March 2022 of requirement ATS.TR.255 of Regulation (EU) No 2017/373 laying down common requirements for providers of air traffic management/air navigation services[19], the French air navigation service provider (DSNA) submitted the Alternative Means of Compliance (AltMOC) 2022/06/21-IR ATM/ANS-AMOC FR No 015 to demonstrate an equivalent level of safety in the particular runway configuration at Paris-Charles de Gaulle. This file was approved by the French civil aviation safety directorate (DSAC) in June 2022.

The arguments for demonstrating compliance presented in the DSNA AltMOC are undermined by this event in the specific case of a missed approach due to a windshear situation.

In such a situation, in accordance with the operational procedure, the crew must keep the wings level and the horizontal profile of the aircraft's flight path will depend on the surrounding conditions. Due to strong crosswind, the aeroplane's track will deviate from the published go-around path. This deviation could result in a loss of separation with an aeroplane taking off from the parallel runway. This situation may become critical when runway spacing is below the standards prescribed by ICAO and the European regulation.

The BEA has brought to light at least three loss-of-separation events that occurred over the last five years and presenting similar factors.

[19] Version in force at this date.

Consequently, the BEA recommends that:

- ***whereas while complying with a Windshear procedure, the crew must keep the wings level and cannot respond to any possible lateral vectoring instruction issued by the controller;***
- ***whereas the arguments for demonstrating compliance presented in the Alternative Means of Compliance (AltMOC) file 2022/06/21-IR ATM/ANS-AMOC FR No 015 to demonstrate an equivalent level of safety in the particular runway configuration at Paris-Charles de Gaulle are undermined in the specific case of a missed approach due to a windshear situation;***

  the DSNA revise the demonstration of compliance with regulatory requirement ATS.TR.255 of Regulation (EU) No 2017/373, in particular the point relating to the minimum distance between runway centrelines and the divergence between departure and go-around paths for specialised simultaneous operations, so that it takes into account the observations highlighted by this incident; [Recommendation FRAN 2023-013]

  the DSAC reassess its decision to approve the AltMOC submitted by the DSNA on the specific issue of the alternative means of compliance to AMC4 ATS.TR.255. [Recommendation FRAN 2023-014]

4.2 Adaptation of specialised operations

In the documents that it has published on parallel or near-parallel runway operations, the International Civil Aviation Organisation (ICAO) recommends that independent parallel approaches to parallel runways spaced by less than 1,525 m between their centre lines shall be suspended under certain meteorological conditions, as prescribed by the appropriate ATS authority (windshear, turbulence, downdrafts, crosswind and significant meteorological conditions such as thunderstorms) which might otherwise increase final approach track deviations to the extent that safety may be impaired.

It does not make an equivalent recommendation for the case of specialised operations on parallel or near-parallel runways.

The serious incident of this report shows that weather conditions can be the cause of path deviations that can result in losses of separation between traffic during specialised operations on parallel or near-parallel runways.

The BEA has brought to light at least three loss-of-separation events that occurred over the last five years and presenting similar factors.

Although the runway centreline-to-centreline distance at Paris-Charles de Gaulle is less than the ICAO recommended standard, a similar scenario is still possible for operations on runways meeting this standard. In such a case, the runway centreline-to-centreline distance provides greater margins, but the BEA is not aware of any study that demonstrates that the loss of separation would be avoided regardless of the runway centreline-to-centreline distance and weather conditions.

Consequently, the BEA recommends that:

- *ICAO assess the appropriateness of recommending the adaptation of specialised simultaneous operations when certain meteorological conditions prescribed by the appropriate ATS authorities (windshear, turbulence, downdrafts, crosswind or other significant meteorological conditions such as thunderstorms) might cause an increase in deviations from the published flight paths to the extent that safety may be impaired. [Recommendation FRAN 2023-015]*

The BEA investigations are conducted with the sole objective of improving aviation safety and are not intended to apportion blame or liabilities.