BEA
Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

www.bea.aero

INVESTIGATION REPORT

Accident

to the Airbus A330-200 registered **F-GZCI**
operated by Air France
and to the Airbus A330-300 registered **N817NW**
operated by Delta Air Lines
on 31 October 2018
at Paris-Charles de Gaulle airport

Time	At 09:44[1]
Type of flight	Commercial air transport
Persons on board	**F-GZCI**: captain (PM); first officer[2] (PF); 8 cabin crew; 191 passengers **N817NW**: captain (PF); FO (PM); relief pilot[3] ; 10 cabin crew; 234 passengers
Consequences and damage	**F-GZCI**: aeroplane severely damaged **N817NW**: aeroplane slightly damaged

Collision between an aeroplane taxiing on a taxiway and an aeroplane at standstill, second in line at the holding point

1 - HISTORY OF THE FLIGHT

Note: the history of the flight is based on CVR and FDR[4] data from both aeroplanes along with the radiocommunication recordings, AVISO[5] data and witness statements.

On Wednesday, 31 October 2018, the Airbus A330 registered F-GZCI operated by Air France, was carrying out flight AFR498 from Paris-Charles de Gaulle (Paris-CDG) bound for Princess Juliana international airport at Saint-Martin. Take-off was planned from runway 08L of the south twin runways.

The Airbus A330 registered N817NW operated by Delta Air Lines, was carrying out flight DAL97 from Paris-CDG airport bound for Detroit in the United States. Take-off was planned from runway 09R of the north twin runways (see Figure 1 below).

The airport was operating "*easterly operations*"[6] and visibility was greater than 10 km.

[1] The times in this report are in Coordinated Universal Time (UTC). One hour should be added to obtain the legal time applicable in Metropolitan France on the day of the event.

[2] FO.

[3] Sat on the central seat.

[4] Cockpit Voice Recorder and Flight Data Recorder.

[5] The AVISO system is a ground traffic display tool used in particular by the Paris-CDG air traffic controllers. It constructs positions from the fusion of several sources, for aircraft (mode S multilateration, ground primary radars, approach primary radars and secondary radars) and for ground vehicles (ground primary radars and GNSS data).

[6] Use of runways 08L&R and 09L&R.

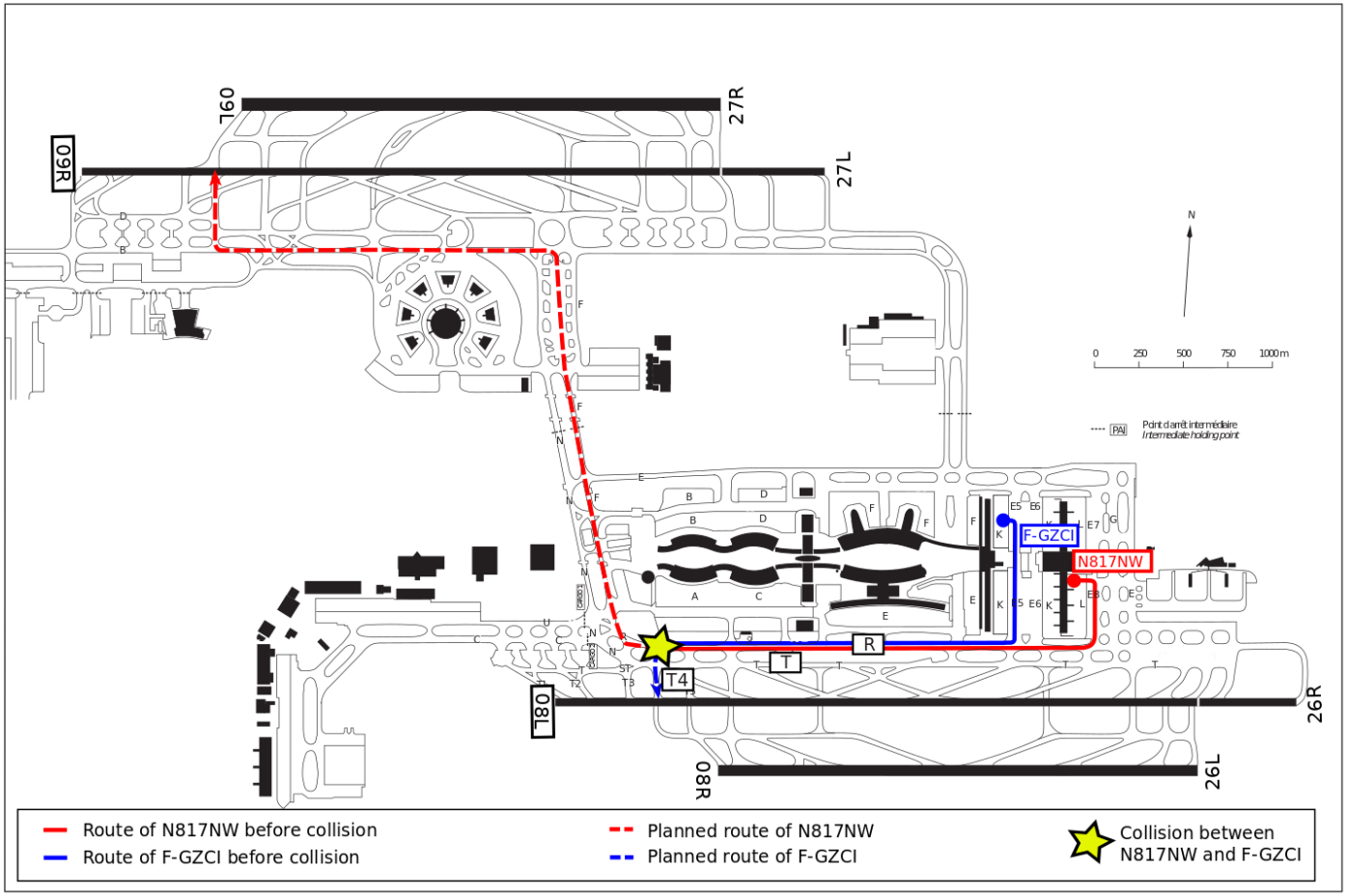


Figure 1: illustration showing the routes taken and the planned routes for the two aeroplanes

[7]The two south tower ground positions were degrouped into the south-west (SW) ground and south-east (SE) ground positions, this morning period being a time of dense traffic.

At 09:38:51, the SW[7] ground controller cleared the crew of flight AFR498 to taxi via taxiways R and T3 to the holding point of runway 08L.

At 09:41:02, the SW ground controller asked the crew of flight AFR498 to hold its position. Several aeroplanes were in fact taxiing on taxiway N, most of them with the intention of taking off from runway 08L via taxiway T3 (see excerpt of AVISO display in Figure 2; this display with the south at the top of the screen corresponds to what the ground controller saw from the south control tower).

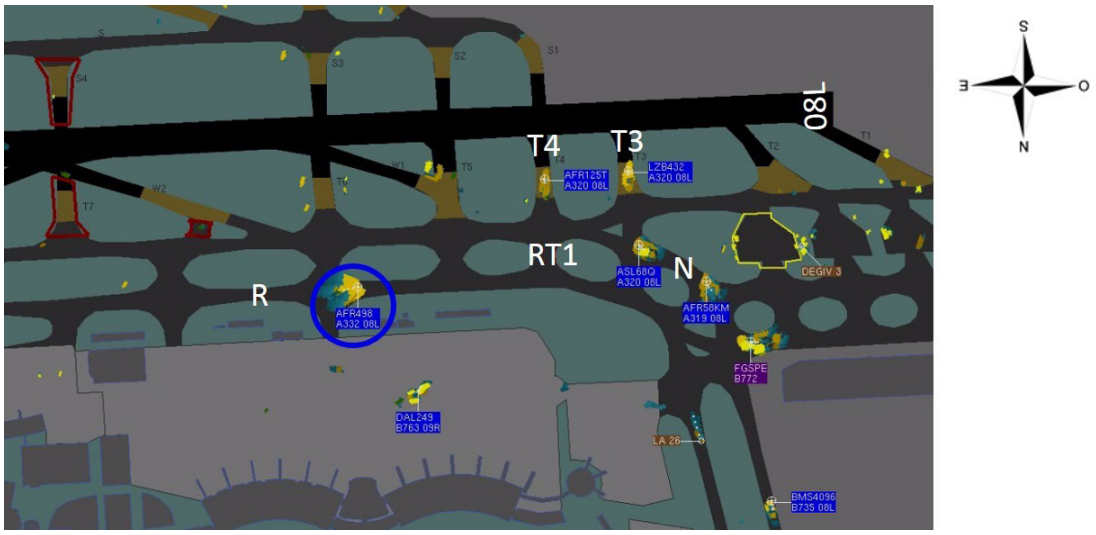


Figure 2: excerpt with annotations of the AVISO system display at 09:41:03 (AFR498 flight in blue circle)

Twenty seconds later, the crew of flight AFR498 proposed lining up via T4 to the controller. The SW ground controller gave his clearance and the crew started travelling towards T4.

[8]The exchanges between the air traffic controllers and the crew of flight DAL97 were in English.

At 09:42:11, the crew of flight DAL97 contacted the SW ground controller[8] and advised that they were on taxiway R. Three seconds later, the SW ground controller cleared them to taxi on taxiway F (see Figure 3).

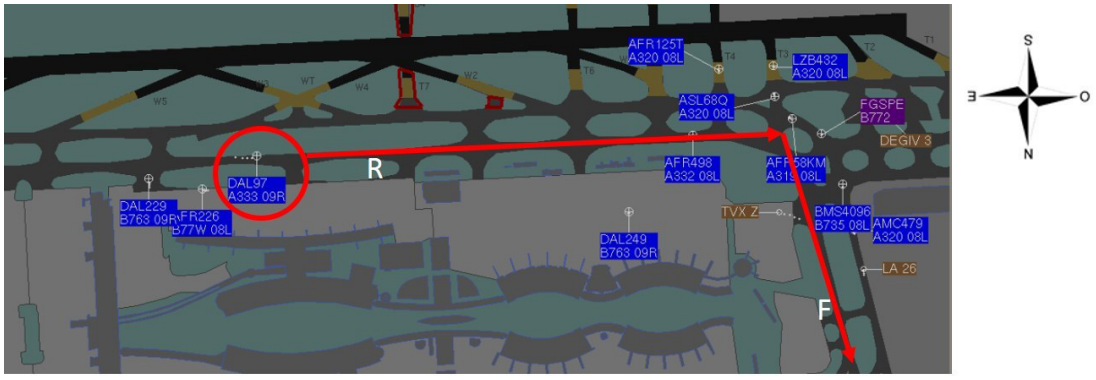


Figure 3: excerpt with annotations of the AVISO system display at 09:42:15 (DAL97 flight in red circle with planned route in red)

At 09:42:55, the crew of flight AFR498 were transferred to the Tower frequency. The aeroplane was at taxiway RT1 with its parking brake applied. It was No 2 at the T4 holding point, behind an Airbus A320.

Between 09:44:01 and 09:44:09, the crew of flight DAL97 discussed in the cockpit, the short distance separating them from the Air France Airbus A330 on their left side. The aeroplane was taxiing on the centre line of taxiway R.

At 09:44:08, the captain of flight DAL97 stopped behind flight AFR498 (see Figure 4), and then resumed taxiing at a very low speed. The relief pilot called attention to the small separation margin. The captain, judging that the margin was sufficient to pass, decided to continue taxiing.

Figure 4: excerpt with annotations of the AVISO system display at 09:44:12

At 09:44:24, the captain of flight DAL97 told the other members of the flight crew that he estimated the distance between the two aeroplanes as ten feet.

At 09:44:30, the FDRs of both aeroplanes recorded variations in acceleration on the body-fixed reference frame compatible with a collision. At the same time on the CVR, the crews of the two Airbus planes felt a jolt and discussed what could have caused it.

The AVISO system data and the examination of the aeroplane damage made it possible to determine the position of the aeroplanes at the time of the collision (see Figure 5)

Source: AVISO data

Figure 5: reconstitution of aeroplane positions on Google Earth

Between 09:44:33 and 09:44:50, the crew of flight AFR498 interpreted the jolt as a consequence of jet blast from the Airbus A320 in front of them at holding point T4. At 09:44:49, the latter moved forward to enter runway 08L and the crew of flight AFR498 then positioned themselves at holding point T4.

At 09:44:52, the crew of flight DAL97 received a call from the cabin. A member of the cabin crew informed them that a passenger had seen the left wing strike another aeroplane and that the wing was damaged.

At 09:45:14, the towing agent of a Boeing B777 call sign SPE situated at T3, advised in French on the SW ground frequency[9] that the Delta Air Lines aeroplane had a damaged wing. The SW ground controller asked other nearby aeroplanes to confirm the damage. Then at 09:45:52, he informed the crew of flight DAL97 that their left wingtip was damaged. The crew confirmed and said that they wanted to contact their operations and return to the parking area.

At 09:46:01, the crew of flight AFR498 received a call from the cabin. A member of the cabin crew told them that both they and a passenger situated at the rear had felt an impact a short time ago. The crew told them that they had received a jet blast from the aeroplane situated in front of them.

At 09:46:54, the FO of flight DAL97 contacted the Delta Air Lines operations to inform them of a collision with another aeroplane which had damaged their left wingtip and that they needed to return to the parking area[10].

At 09:47:26, i.e. nearly three minutes after the collision, the SPE towing agent told the SW ground controller that the bottom of the THS[11] of the Air France aeroplane on T4 was damaged and that it was perhaps connected to the impact with the Delta Air Lines aeroplane. The SW ground controller replied that the aeroplane was on another frequency and that he was going to take the necessary steps to warn them so that they do not take off.

At 09:48:45, the TWR controller informed the crew of flight AFR498, still holding on T4 and waiting for clearance to align on runway 08L, that an aeroplane had struck the rear of their aeroplane and requested that they maintain position.

After a few exchanges with other aeroplanes present in the vicinity, the TWR controller informed the crew of flight AFR498 that the APU[12] was damaged and that it must not be started up.

The two crews of flights AFR498 and DAL97 cancelled their departures and taxied back to the parking area.

[9] At this moment, flight AFR498 is on the frequency with the TWR controller and flight DAL97 with the SW ground controller.

[10] In their witness statement, the crew of flight DAL97 said that they were not conscious that they omitted to report the collision with the other aeroplane to air traffic control, because of the numerous exchanges with the cabin, operations, the air traffic controller and the other aeroplanes confirming the damage on the frequency.

[11] Trimmable Horizontal Stabilizer.

[12] Auxiliary Power Unit.

2 - ADDITIONAL INFORMATION

2.1 Aeroplane damage

The collision between the two aeroplanes caused the following damage:

- F-GZCI: THS, tail cone and compartment of APU damaged (see Figure 6). The temperature sensors present in the tail cone were also damaged.

Source: BEA

Figure 6: damage to F-GZCI

Supplementary examinations and analyses were carried out by the manufacturer, Airbus. It considered that the APU doors would have probably come off during or just after take-off. The asymmetry of the tail cone along with the damage to the THS caused by the collision would not have affected the handling of the aeroplane but would have led to over consumption of fuel. This over consumption would have been compensated for by the extra fuel taken on board by the captain in addition to the regulatory reserve fuel.

- N817NW: damaged tip of left wing (see Figure 7).

Source: BEA

Figure 7: damage to N817NW

2.2 Aerodrome Information

Figure 8 presents an excerpt from the ground movements chart of Paris-CDG airport operating "*easterly operations*" and shows the expected route to be taken to align on runway 08L and to head to the north twin runways via taxiway R.

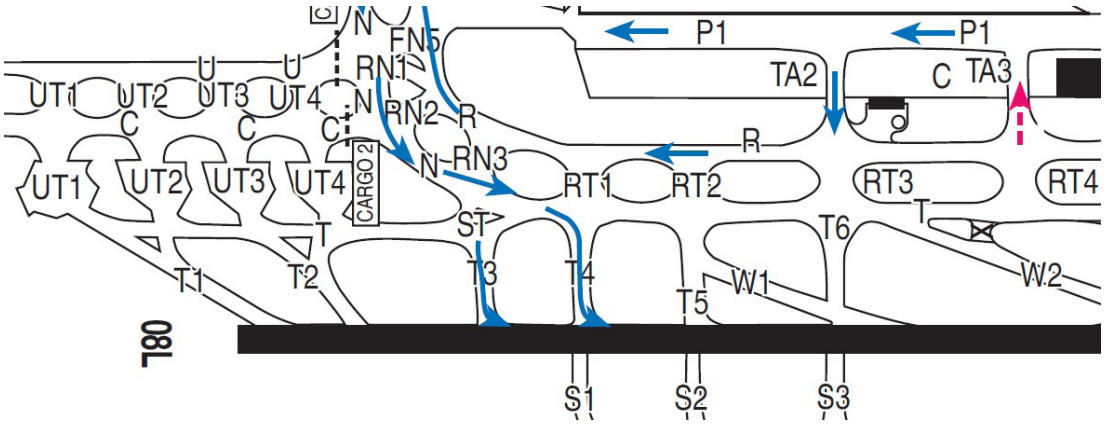


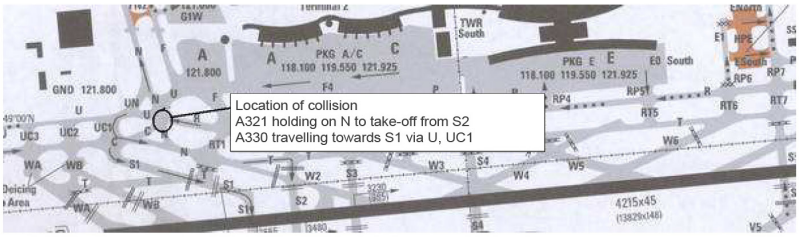
Figure 8: excerpt from AIP AD 2 LFPG GMC 01 centred on taxiway RT1 (version of 11/10/2018)

The routes taken and to be taken by the two aeroplanes were consistent with this information.

2.3 Similar events

Since 1999, eight collisions on the ground between two aeroplanes[13] have occurred at Paris-CDG airport. Amongst these, three (including the collision between N817NW and F-GZCI) concerned collisions between two aeroplanes on taxiways.

- Collision between the Airbus A321 registered F-GTAM and the Airbus A330 registered F-GZCP on16 August 2006[14].



Source: Air France

Figure 9: diagram of collision on 16 August 2006

The airport was operating "*easterly operations*". The A321 was at a standstill with the parking brake applied, at the junction between taxiways N and W2, number 8 in the queue to take off from runway 08L via taxiway S2[15]. Taxiway N was congested by several medium-haul aeroplanes holding for runway 08L. The A330 taxied from F to S1 via N and UC1. The crew of the A330 slowed down and then stopped behind the A321. They then very slowly started taxiing again to pass behind it and continue on taxiway U. During the manoeuvre, the left wingtip struck the tail of the A321.

[13] In accordance with the definition for investigations into aviation accidents and incidents, only an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, is taken into consideration.

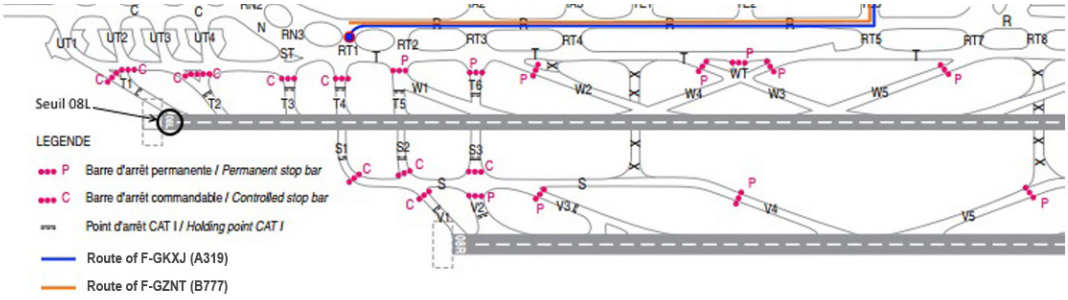
[14] The BEA did not publish an investigation report about this event but collected the preliminary factual information and the final analysis of the event by the operator.

[15] The configuration of the taxiways in 2006 was different to that in 2018.

The captain of the A330 explained that he thought that he had enough space to pass behind the A321 and decided to continue taxiing while monitoring the tip of his left wing. It was only when the collision occurred that the crew saw that they had made an error of judgement.

- Collision between the Boeing B777 registered F-GZNT and the Airbus A320 registered F-GKXJ on 11 May 2016[16].

[16] https://www.bea.aero/uploads/tx_elydbrapports/BEA2016-0277.pdf



Source: BEA

Figure 10: Diagram of collision of 11 May 2016

The airport was operating "*easterly operations*" in LVP[17] conditions with a RVR[18] of 250 m. The A320 was at a standstill with the parking brake applied, at RT1, number 2 for take-off from runway 08L via T4. The B777 was being towed on taxiway R and stopped shortly before passing behind the A320 on taxiway RT1. There were exchanges between the ground controller, the B777 attendant and the towing agent about the planes passing each other. The towing agent finally carried out the manoeuvre and the left wing of the B777 struck the tail of the A320.

[17] Low Visibility Procedure.

[18] Runway Visual Range.

These collisions at Paris-CDG were the result of an error in judging the distances, in contexts which did not allow for precise assessments.

2.4 Management of anti-collision between two aircraft on taxiways

The European airport certification rules ensure that there can be no collision between two aircraft taxiing on parallel taxiways. However, there are no requirements in these rules to prevent collision between aircraft taxiing on intersecting taxiways. Thus, precisely following the centre line of a taxiway does not protect an aircraft from colliding with other moving vehicles on taxiways which are not parallel to it.

There is no material or operational rule concerning the positioning of an aircraft behind another aircraft on taxiways.

From the control tower, the air traffic controllers cannot visually guarantee anti-collision on all of the aerodrome. In addition, the accuracy of the display of the blips on the ground positioning screens (see Figure 2 for example) is not sufficient to ensure against collision. In this context, the main role of the controller is to ensure an aeroplane sequencing order where taxiways cross.

From a passenger plane cockpit, it may be difficult, or even impossible, according to the model of the aeroplane, to make out the tip of the wing situated aft of the cockpit and possibly at more than 30 m from the pilot's eyes[19] .

[19] On the A330, only the pilot in the left seat can see the tip of the left wing, it is, however, situated more than 45 m from his seat.

Although having its own limitations, the main barrier against ground collisions between two aircraft on intersecting taxiways is therefore based on the flight crews, with the principle of stopping before the possible conflict and until the crew is certain that there is no risk of collision.

Lastly, if there is a collision and it is detected by one of the crews, immediately informing the air control services prevents the risk of another accident, such as a damaged aeroplane taking off.

2.5 Safety recommendations related to the prevention of collisions while taxiing

The BEA investigation report concerning the collision between the Boeing B777 registered F-GZNT and the Airbus A320 registered F-GKXJ on 11 May 2016 gave the following information:

In September 2012, the American investigation authority, the National Transportation Safety Board (NTSB) sent two safety recommendations[20] to the FAA and EASA[21] based on the 12 accidents which they had investigated between 1993 and 2012 in which the wingtip of a large aeroplane collided with another aeroplane or object while taxiing on a taxiway. The NTSB recommended the installation of an anticollision aid, such as a camera system, for all large aeroplanes and for aeroplanes where the wingtips cannot be easily seen from the cockpit, to help pilots determine the wingtip path while taxiing.

As none of the accidents investigated had resulted in injuries, both the FAA and EASA considered that the limited safety benefit of an anti-collision aid while taxiing did not justify the cost of its installation and consequently decided not to follow the NTSB recommendations.

Consulted by the BEA during the investigation into the accident on 31 October 2018 and the subject of this report, both the FAA and EASA said that they had not modified their position.

Following a ground collision between two aeroplanes at Dublin on 7 October 2014, the Irish investigation authority, the Air Accident Investigation Unit (AAIU) also sent a similar recommendation to the ICAO[22] in 2015. The institution decided not to follow the AAIU's recommendation[23], using arguments similar to those used by the EASA and FAA.

[20] https://www.ntsb.gov/safety/safety-recs/recletters/A-12-050-051.pdf

[21] Federal Aviation Administration & European Aviation Safety Agency.

[22] International Civil Aviation Organization.

[23] http://www.aaiu.ie/sites/default/files/SRs/IRLD2015016-20160113.pdf

3 - CONCLUSION

While taxiing, the crew of flight DAL97 identified a possible conflict with flight AFR498 at a standstill on a perpendicular taxiway. After stopping before the junction and considering that they had enough of a margin, the crew started taxiing again. The left wingtip of the Delta Air Lines aeroplane then came into contact with the tail of the Air France aeroplane.

The crew of flight DAL97 were aware of the collision with the Air France aeroplane (impact, then information about the collision via a call from the cabin). The FO in charge of radiocommunications reported the collision with another aeroplane to Delta's operations but simply confirmed the damage to his aeroplane to the air traffic controller, without mentioning the collision with the Air France aeroplane. This may be explained by the increased work load following the collision.

The interpretation by the crew of flight AFR498, of the weak signals received (impact, then cabin call) meant that they did not realise that there had been a collision with another aeroplane.

Only the intervention on the frequency of an agent towing another aeroplane, to advise of the damage to the Delta Air Lines aeroplane and then to the Air France aeroplane finally allowed the air traffic controller to identify the actors of the collision and to thus prevent flight AFR498 from taking off.

When at least one of the crews involved in a collision between two aircraft is aware of the accident, its immediate declaration to the air traffic control service will ensure that the latter is aware of the complete situation, can rapidly identify the actors of the collision and prevent an additional accident.

What's more, this event is a reminder that precisely following the centre line of a taxiway does not protect an aircraft from colliding with other moving vehicles on taxiways which are not parallel to it.