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pour la sécurité de l'aviation civile

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SAFETY INVESTIGATION REPORT

Accident to the AIRBUS A350-900 registered F-HNET on 5 December 2021 on approach to Cayenne Félix Éboué airport (French Guiana)

Time	Around 21:25[1]
Operator	Air Caraïbes Atlantique
Type of flight	Scheduled passenger commercial air transport
Persons on board	Captain (PF), co-pilot (PM), 9 cabin crew, 142 passengers
Consequences and damage	Purser seriously injured, 2 cabin crew members injured

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in December 2022. As accurate as the translation may be, the original text in French is the work of reference.

Note: a glossary is available at the end of this report.

Turbulence in descent, cabin crew member seriously injured

1 HISTORY OF THE FLIGHT

Note: the following information is principally based on statements, Quick Access Recorder (QAR) data, radio-communication recordings and radar data. The data from the Cockpit Voice Recorder (CVR) was not preserved.

The crew took off at 13:24 from Paris-Orly airport (Val-de-Marne) for a scheduled commercial flight bound for Cayenne-Félix Éboué airport (French Guiana).

Shortly after 21:00, at the end of the cruise phase at FL 400, the crew anticipated a first zone of turbulence. The food trays had been previously handed out and had not yet been cleared away. After exchanging with the cabin crew, the captain activated the "Fasten seatbelt" signs and informed the occupants in the cabin that they were going to fly through a zone of turbulence for five to ten minutes. A short time later, the aeroplane entered a zone of turbulence lasting around 30 s. The normal (vertical) acceleration varied between 0.43 G and 1.71 G with a maximum differential of 0.93 G and the lateral acceleration varied between -0.08 G and 0.09 G. The speed fluctuated between Mach 0.79 and Mach 0.88, the vertical speed increased to 1,400 ft/min before decreasing to – 1,250 ft/min. The autopilot (AP) and the auto-thrust (A/THR) remained engaged for this period.

[1] Except where otherwise indicated, the times in this report are in Coordinated Universal Time (UTC). Three hours should be subtracted to obtain the local time on the day of the event.

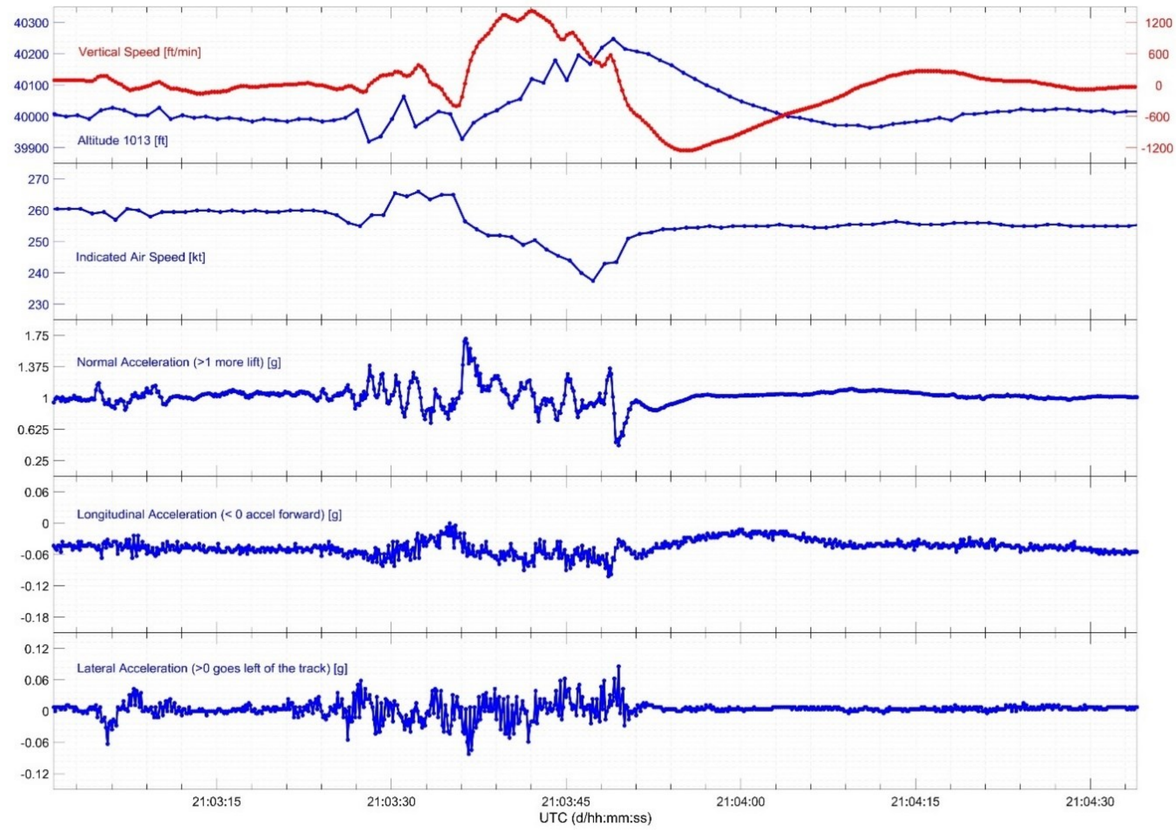

Figure 1*:* flight parameters for 1st zone of turbulence

Once they had cleared the turbulence, the captain announced to the cabin crew that they could resume their normal tasks and the latter started removing the food trays. The "Fasten seatbelt" signs remained lit for the passengers. The captain then announced to the cabin crew the start of descent.

The pilots indicated in their statements that during the descent, they visually avoided the cloud cells, by flying alongside the cloud masses and between two cloud layers.

On approaching a new zone of turbulence, the captain again announced to the cabin crew that they were entering turbulence and to sit down and fasten their seatbelts.

On approaching FL 100, the captain and the purser at the rear of the aircraft exchanged by interphone. Thinking that they were out of the zone of turbulence, the captain authorised the crew to leave their seats to finish preparing the cabin for landing. The purser transmitted this information to the cabin crew members at the rear of the cabin who finished checking and safetying the rear.

A short time later at around 21:25 and at an altitude of roughly 7,000 ft, the aeroplane encountered a brief zone of turbulence lasting a few seconds. According to the pilots, the visibility was good, it was not yet night, the aeroplane was outside the cloud layer and not by the edge of a cloud cell.

The vertical acceleration varied between 0.42 G and 1.82 G with a maximum differential of 0.95 G and the lateral acceleration varied between -0.14 G and 0.12 G with a maximum differential of 0.26 G. The Calibrated AirSpeed (CAS) fluctuated between 245 kt and 256 kt, the vertical speed increased from – 1,100 ft/min to 430 ft/min before returning to – 1,100 ft/min. The AP and A/THR remained engaged during the turbulence.

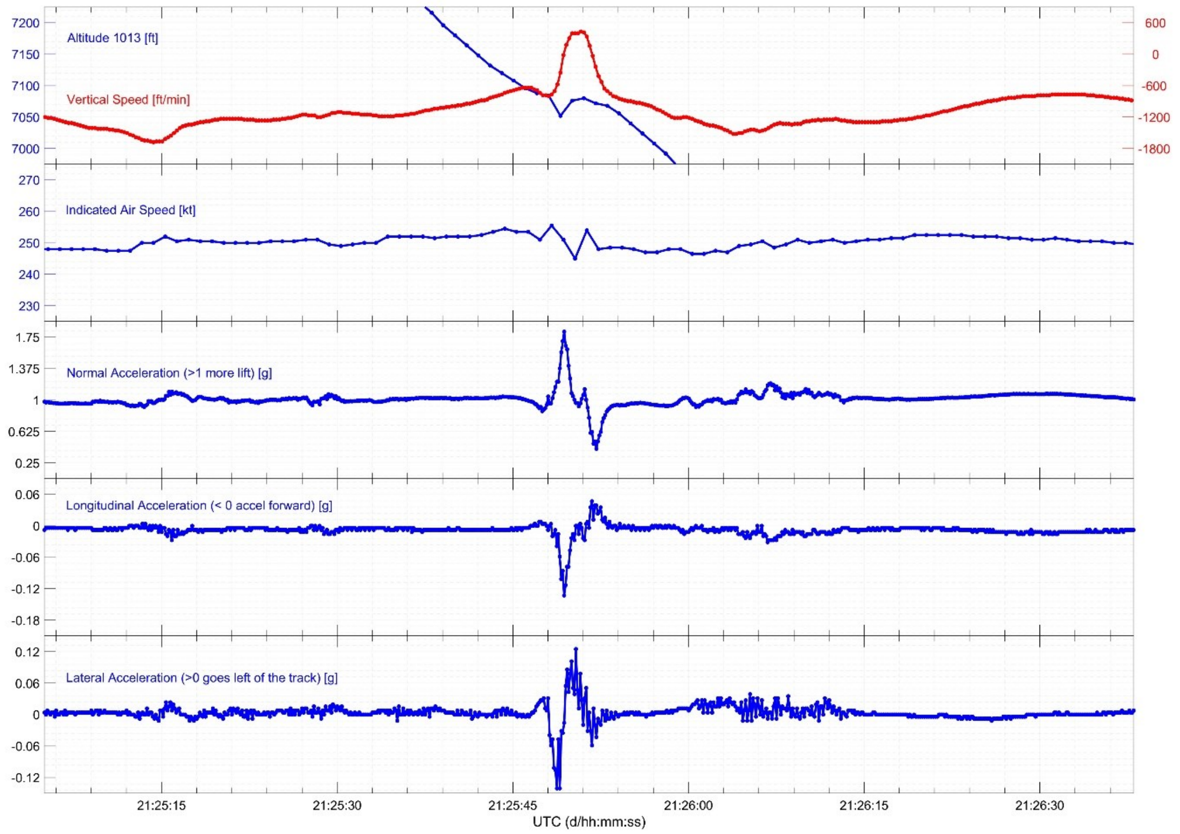

Figure 2*:* flight parameters for 2nd zone of turbulence

The purser and the cabin crew members in the rear of the aeroplane felt a quick, rough jolt and fell over. The purser suffered an ankle injury and two cabin crew members suffered back and head injuries respectively. The purser was replaced by another cabin crew member for the end of the approach. Medical assistance was requested at the plane's arrival.

The landing was carried out without further incident.

After landing, the Aircraft Rescue and Fire Fighting service on aerodromes (ARFF) intervened and examined the injured persons. The responders decided that the two cabin crew members did not require an additional examination but that the purser was to go to hospital by their own means, where it was diagnosed that they had a double ankle fracture[2].

[2] According to regulation EU No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation, a fracture of any bone (except simple fractures of fingers, toes, or nose) is included in the definition of serious injuries, thus classifying the occurrence as an accident. A BEA investigation is mandatory in the case of an accident in a certified aircraft of more than 2,250 kg (version in force on the day of the accident).

2 ADDITIONAL INFORMATION

2.1 Crew information

The captain held an Airline Transport Pilot License (ATPL(A)) along with FI, TRI and TRE ratings. The day of the event, he had logged around 10,000 flight hours.

The co-pilot held an ATPL(A). The day of the event, he had logged more than 5,000 flight hours.

Concerning the analysis of the meteorological situation at the end of the cruise phase and the descent, the captain and co-pilot specified that:

- They observed differences between the onboard weather radar information (see paragraph 2.3) and what they could observe outside. Zones displayed as active on the screen were not visible outside and convective cells visible from the cockpit were not shown on the screen[3].
- The weather application available on their EFB (see paragraph 2.4) displayed convective zones on the flight path in “forecast” mode but not in “observation” mode.
- No pilot report (PIREP) drew their attention to the risk of turbulence.

2.2 Meteorological information

During the flight planning and briefing, the crew noted the storms, Towering Cumulus (TCu) and Cumulonimbus (Cb) forecast on the arrival to Cayenne. Several SIGWX charts were current around Cayenne for severe icing and storms.

During the arrival briefing, the crew indicated that they had identified and mentioned the presence of convective zones and turbulence.

The captain indicated in his statement that when they encountered the second zone of turbulence, the aeroplane was flying between two cloud layers. He added that they were not at the edge of a cloud cell and that they were in fact avoiding active cells.

The French met office, Météo-France, indicated that at the end of the day the meteorological situation was a standard situation for this season in French Guiana, of moist unstable weather which resulted in a marked diurnal evolution on the continent along with unstable advections near the ocean.

The precise time and position of the aircraft which were provided located the aeroplane at the edge of a line of rainfall (see point ❷ below), at the point where the convection was strongest according to the rainfall radar images. These cloud limits, downstream of the line of movement of convective clouds, could be the site of significant vertical movements, strong turbulence and wind shear.

[3] The two weather radars were set to auto-tilt, the captain had selected a gain of 100% and the co-pilot, an automatic gain. They each varied the radar range.

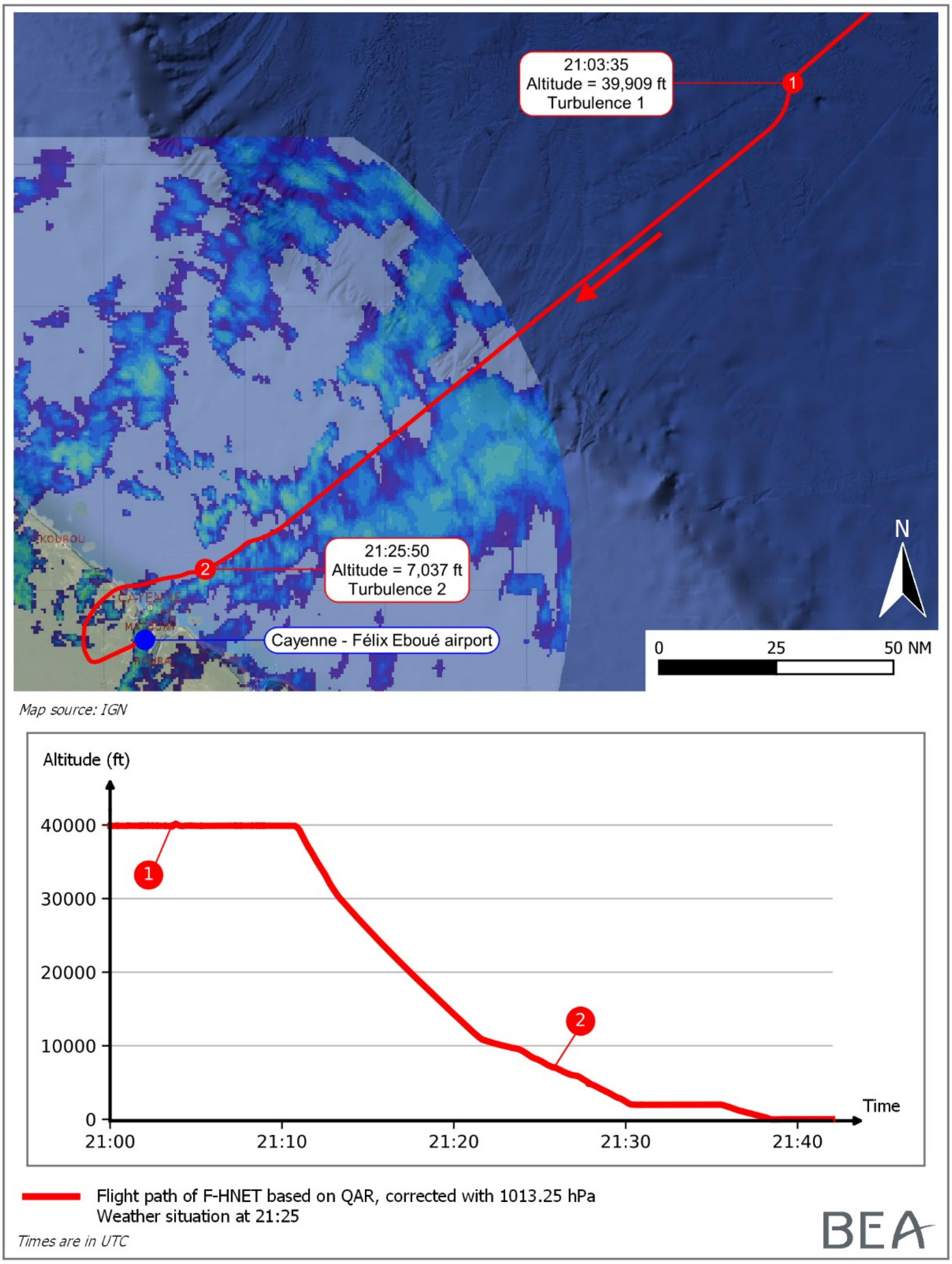

Figure 3: end of flight path of F-HNET

2.3 Weather radar and detection of turbulence

The Airbus A350 was equipped with a Honeywell RDR-4000 onboard weather radar which was one of the new generation weather radars.

When it is activated in the automatic mode, the radar takes into account a vertical trajectory envelope (nominally +/- 4000 ft) along the vertical flight path of the aircraft based on the flight path angle. It then defines if the weather echo is inside this envelope (relevant, ‘ON PATH’) or not (secondary, ‘OFF PATH’) depending on the flight profile.

The radar can also be used in manual mode (elevation mode) as a tool for analysing weather conditions at user selected altitudes and thus, assess the vertical expansion and structure of convective clouds.

In the Flight Crew Techniques Manual (FCTM), Airbus recommended avoiding convective cells laterally rather than vertically, into the wind rather than downwind, and if possible avoiding the area of greatest threat by at least 20 NM if such a zone has been identified.

It should be noted that the weather radar on aeroplanes is based on the reflectivity of water in liquid form and cannot be compared to visual observations. Thus Cb or TCu may be visible although the water concentration means that they are not detected by the radar. In addition, ice crystals which are sometimes present in Cb have a low level of reflectivity and may also not be identified.

Clear sky turbulence cannot be identified with the weather radar as it does not contain water droplets. Convection in the cloud layer may not be easily detected by the onboard weather radars, even the latest generation ones. Moreover, it may not be visually detectable outside the aeroplane. This category of convective activity may thus act as a hidden source of turbulence inside an apparently inoffensive cloud mass.

2.4 Supplementary meteorological information provided to crew during flight

The operator provided its crews with the eWAS application on their EFB. This application provided weather forecasts and/or reports coming from various sources in the form of an interactive map with a display in the vertical and horizontal profiles.

On the operator’s Airbus A350, this information was updated in real time by SATCOM.

The company marketing the eWAS application was contacted but the investigation was not able to determine all the information which might have been displayed to the crew by means of this application in the minutes which preceded the accident.

2.5 Similar events

Air accidents related to or caused by turbulence are regularly the subject of targeted studies by investigation authorities. In particular, there is the 2008 BEA study (in French), the 2015 Japan Transport Safety Board (JTSB) study and more recently, the National Transportation Safety Board (NTSB) study analysing cases between 2009 and 2018.

It transpires from these studies that:

- Turbulence-related accidents correspond to more than one third of accidents.
- The majority of these accidents resulted in one or more serious injuries but with no damage to the aeroplane.
- More than half of these accidents occurred during the descent or approach.
- The majority of those injured were in the rear of the aeroplane.
- The cabin crew are the most exposed to being injured.
- Having your seatbelt fastened is the most effective way of avoiding turbulence-related injuries.

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

During the flight, and in particular, the minutes preceding the accident, the pilots had effectively identified the risk of turbulence and had complied with the appropriate procedures by asking all the occupants, including the cabin crew, to remain seated with their seatbelts fastened which meant that possible injuries were avoided. The first zones of turbulence were flown through without incident.

On flying through FL 100, outside of clouds and thinking that the turbulence was behind them, the captain authorised the cabin crew at the rear of the cabin to finish preparing the cabin for landing.

A few minutes later, a sudden brief turbulence caused accelerations which resulted in the purser losing balance and sustaining serious injuries and in two cabin crew sustaining injuries. This zone of turbulence was probably generated by a convective cell close by. The crew may not have been able to detect or may have underestimated the distance or extent of the zone of influence of this cell.

Safety lessons

Airbus has published guides for pilots concerning turbulence and the optimum use of weather radars.

On 25 July 2021, a Boeing 737 operated by Norwegian Air Sweden, registered SE-RPE, en route over the Italian Alps bound for Nice, experienced cruise turbulence which resulted in a cabin crew member being seriously injured and required an emergency landing at destination. The BEA has published its investigation report in which it makes two safety recommendations concerning the presentation of weather information on the air traffic control screens, and improving the weather information provided on board.

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Glossary

Abbreviation	English version
A/THR	Auto THRust
AP	AutoPilot
ARFF	Aircraft Rescue and Fire Fighting service
ATPL	Airline Transport Pilot Licence
CAS	Computed Air Speed
Cb	Cumulonimbus
CVR	Cockpit Voice Recorder
EFB	Electronic Flight Bag
FCTM	Flight Crew Techniques Manual
FI	Flight Instructor
JTSB	Japan Transport Safety Board
NM	Nautical Mile
NTSB	National Transportation Safety Board
PF	Pilot Flying
PIREP	PIlot REPort
PM	Pilot Monitoring
SIGMET	SIGnificant METeorological phenomena
TCu	Towering Cumulus
TRE	Type Rating Examiner
TRI	Type Rating Instructor
UTC	Universal Time Coordinated

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