BEA
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INVESTIGATION REPORT

Accident to the BOEING 737-800 registered EI-DAC

on 25 February 2015
en route at FL 380 in Bordeaux FLIR

Time	Around 18:50[1]
Operator	Ryanair
Type of flight	Passenger commercial air transport
Persons on board	Captain (PF), co-pilot (PM), 4 cabin crew members, 158 passengers
Consequences and damage	Two cabin crew seriously injured

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in November 2021. As accurate as the translation may be, the original text in French is the work of reference.

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

Severe clear air turbulence, en route, injury to two cabin crew personnel, diversion

1 - HISTORY OF THE FLIGHT

Note: The following information is principally based on flight data recorder (FDR) data, cockpit voice recorder (CVR) data and crew statements.

The crew took off at 18:30 from Reus airport (Spain) for a scheduled commercial flight bound for Charleroi airport (Belgium). On climbing through FL 100, in accordance with the standard procedures, the pilots permitted the cabin crew to release their seatbelts to carry out the onboard service. Shortly before reaching FL 380, the planned en-route flight level, the crew contacted the controller of the Bordeaux air navigation en-route centre and asked him if turbulence had been reported in the sector. The controller replied that no turbulence had been reported.

From 18:48:57, on reaching FL 380, the aeroplane entered a zone of severe turbulence. Variations in pitch, roll and speed were observed by the crew who disengaged the autopilot (AP) and auto-thrust (A/THR) at 18:49:07. The activation of the stick shaker and the overspeed warning were perceived by the crew who were having difficulties in stabilizing the aeroplane. The crew descended to FL 360 and informed the controller of the situation. On approaching FL 360, and the flight path being stabilized, the crew re-engaged the AP and A/THR.

After being informed that two cabin crew members had been injured, they decided to divert to Bordeaux where they landed 35 minutes after the occurrence of the turbulence.

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2 - ADDITIONAL INFORMATION

2.1 Meteorological information

[(2)] The jet stream is a core of very strong winds travelling at an altitude of 8 to 12 km in the troposphere (source: Météo-France)

A strong high-pressure system off the coast of Portugal and a low-pressure system over Sicily were channelling a strong north jet stream[(2)] over France, the strongest jet core being east of the aeroplane's flight path, between FL 300 and FL 360.

The meteorological conditions estimated by Météo-France in the sector of the accident were: wind from 360° at 100 kt at FL 340 and from 360° at 90 kt at FL 380, clear sky above FL 300, temperature -58°C at FL 340 and -64°C at FL 380, severe turbulence.

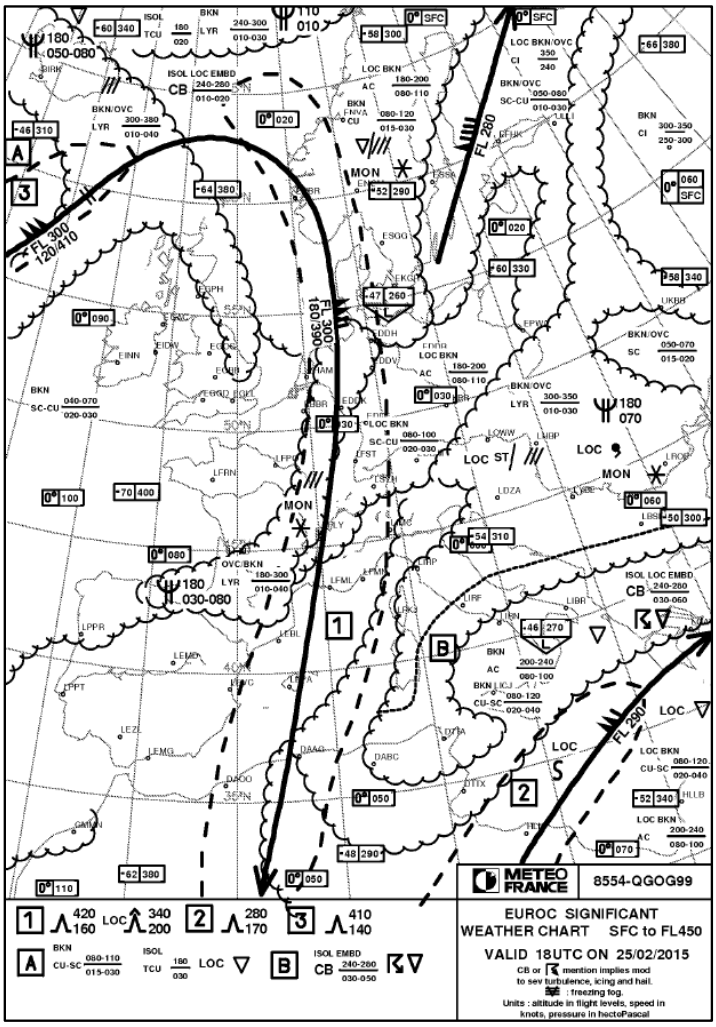
The following meteorological information was available before the accident:

- **SIGMET FIR Bordeaux**

LFBB SIGMET 6 VALID 251700/252000 LFPW-
LFBB BORDEAUX FIR/UIR SEV TURB FCST WI N4330 E00245 - N4215 E00230 - N4245 W00100 - N4300 W00100 FL350/430 STNR NC=

LFBB SIGMET 7 VALID 252000/252300 LFPW-
LFBB BORDEAUX FIR/UIR SEV TURB FCST S OF LINE N4315 E00230 - N4245 W00100 FL350/440 STNR NC=

- **Cartes TEMSI EUROC**



18:00 Europe SIGWX chart

2.2 Preparation of flight and flight path followed

While preparing the flight, the crew asked for a track modification due, in particular, to the shear rate value[3]. In the initial flight plan, the shear rate was 12 kt/1,000 ft for one of the sectors. With the new track, the crew would fly alongside the air mass concerned by SIGMET 6, at approximately three NM to the west.

The information collected during the investigation did not include information about the forecast shear rates on the new track.

The turbulence occurred at around 15 NM from the air mass concerned by SIGMET 6.

The crew indicated that, based on the weather information that they had at their disposal, they had not noted a particular risk of severe turbulence in the sector of the accident.

2.3 Detailed information concerning recorded data

From 18:48:57 and for 12 s, the analysis of the recorded data showed:

- Vertical accelerations between -0.38 g and +1.52 g.
- Longitudinal accelerations between 0 g and 0.125 g.
- Variations in pitch between +8.4° (nose up) and -2.5° (nose down).
- Variations in angle of attack between -9° and +10°.
- Variations in left and right bank, up to 19°.
- Variations in the indicated airspeed between 217 kt and 256 kt[4].

2.4 Assessment of clear air turbulence risk level

In its 2020 Annual Safety Review[5], EASA indicated that the majority of the injuries (other than fatal) recorded in commercial air transport, in the large aeroplane category, for the 2009-2019 period were the result of in-flight turbulence (whatever the nature of this turbulence). However, according to the ERCS[6] method, EASA assessed the risk associated with clear air turbulence as being low. EASA puts all the safety issues concerning commercial air transport by large aeroplanes into three safety level categories**.** In its risk map, EASA positions clear air turbulence in the second safety level category.

In 2020, the BEA published an investigation report into a serious incident resulting from clear air turbulence[7]. This report underlined the absence of reliable means for forecasting and detecting clear air turbulence.

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

While preparing the flight, the crew asked for a modification to the flight plan due, in particular, to the risk of severe turbulence on the planned track. The new track meant that the crew would fly to the west of and alongside the air mass where the risk of severe turbulence was forecast.

Shortly before reaching the en-route flight level, the crew asked the controller if turbulence had been reported in the sector. The controller replied that no turbulence had been reported.

[3] This is a turbulence indicator: severe turbulence can be expected when this figure is greater than or equal to 9 kt/1,000 ft, and even 5 kt/1,000 ft according to the references.

[4] The numerical value of the minimum speed was not recorded but a MIN SPD Boolean parameter was triggered on two occasions showing that the indicated airspeed had dropped below this threshold. The VMO was 263 kt.

[5] https://www.easa.europa.eu/sites/default/files/dfu/easa_asr_2020.pdf

[6] European Risk Classification Scheme: This model measures the risks according to 1) what the severity would have been if the occurrence being scored had escalated into a fatal accident and 2) how close the occurrence was to that fatal accident outcome based on a weighted barrier model.

[7] Serious incident to the Boeing 737 registered F-GZHM operated byTransavia on 13 February 2019 en_route

On approaching the air mass concerned by the SIGMET, the aeroplane entered a zone of turbulence. The suddenness and strength of the turbulence resulted in injury to two cabin crew members who were carrying out their customer-service duties.

Contributing factors

The new flight path obtained by the crew while preparing the flight, the absence of turbulence during the climb or the controller's information that there were no pilot reports concerning severe turbulence in the sector may have progressively led the crew to underestimate this risk. As a consequence, they authorized the cabin crew to start the customer-service duties during the climb, and then to continue with them until encountering severe turbulence close to a risk zone identified by a SIGMET.

Safety lessons

This accident confirms the difficulty of accurately predicting zones of clear air turbulence. The boundaries of an air mass with an identified risk, for example in a SIGMET, must be considered as relatively imprecise. If operational constraints lead to the aeroplane coming close to such an air mass, then the crew must take appropriate precautions to avoid the cabin crew and passengers being exposed to a risk of injury.

Pilot weather reports (PIREP) are encouraged to allow information to be shared with other pilots liable to be exposed to the same dangerous phenomenon in a nearby zone and a short time later. While the existence of a PIREP may lead the crew the reinforce its vigilance, the absence of a PIREP does not guarantee the absence of a risk.

4 - ACTIONS TAKEN SINCE THE ACCIDENT

Since the accident, the operator has supplemented the regulatory requirements with the introduction of electronic flight plans giving a more adapted display of weather information (use of colour and reorganization). A functionality has also been added which allows the geographical coordinates to be inserted and thus to display the zones concerned by the SIGMET, on the electronic documentation charts used to prepare the flight.