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Report A–028/2014

Accident involving an Airbus A319-111 aircraft, registration G-EZIX, operated by EasyJet, in the Madrid FIR at FL150 on 21 September 2014

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO

Informe técnico

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SUBSECRETARÍA
COMISIÓN DE INVESTIGACIÓN DE ACCIDENTES E INCIDENTES DE AVIACIÓN CIVIL

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Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) nº 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1, 4 and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

Contents

Abbreviations

°	Sexagesimal degrees
°C	Degrees Celsius
A/THR	Autothrust
ATC	Air Traffic Control
ATPL(A)	Airline Transport Pilot License (Airplane)
CAS	Calibrated Airspeed
CPL(A)	Commercial Pilot License (Airplane)
DAR	Digital Access Recorder
EGGP	ICAO code for the Liverpool Airport
FA	Flight attendant
FAA	Federal Aviation Administration (USA)
FCOM	Flight Crew Operation Manual
FIR	Flight Information Region
FL	Flight Level
Ft	Feet
Ft/m	Feet per minute
Ft/s	Feet per second
G	Acceleration due to gravity (9.81 m/s^2)
hPa	Hectopascal
IAF	Initial Approach Fix
IATA	International Air Transport Association
IMC	Instrument Meteorological Conditions
JAR-FCL	Joint Aviation Requirements - Flight Crew Licensing
km	Kilometers
kt	Knots
LATG	Lateral acceleration
LEMD	ICAO code for the Madrid Airport
M	Meters
METAR	Aerodrome weather routine report
ND	Navigation Display
NM	Nautical Mile
OM	Operations Manual
QNH	Atmosferic pressure at nautical height
QRH	Quick Reference Handbook

SCAS	Selected calibrated airspeed
SHDG	Selected heading
TAFOR	Terminal Aerodrome Forecast
UTC	Coordinated Universal Time
V/S	Vertical Speed Mode
VRTG	Vertical acceleration
WAFC	World Area Forecast Center

Synopsis

Owner and Operator:	EasyJet Airline Co. LTD.
Aircraft:	Airbus A319-111
Date and time of accident:	21 September 2014 at 13:32[1] UTC
Site of accident:	Madrid FIR at FL150
Persons aboard:	159. 6 crew (1 seriously injured) and 153 passengers (no injuries reported)
Type of flight:	Commercial air transport – Scheduled – International - Passenger
Phase of flight:	En route – Normal descent
Date of approval:	May 31th, 2016

Summary of the event:

On 21 September 2014 at 13:32 UTC, an Airbus A319-111 aircraft, registration G-EZIX and operated by EasyJet Airlines, encountered turbulence during the flight that seriously injured one flight attendant (FA). The flight continued and landed without further incident.

During the descent before landing, and after passing through FL150, it crossed a layer of cumulus clouds some 2,000 ft thick that caused the aircraft to fall and shake sharply. As a result, the four flight attendants, who were securing the passenger cabin, fell to the floor, receiving bruises in the process. One of the flight attendants broke the scaphoid bone in her wrist while remained in the rear galley of the passenger cabin.

The report identifies the cause of the accident as encountering strong turbulence that was not detected by the flight crew.

[1] All times in this report are UTC. Local time= UTC+2.

1. FACTUAL INFORMATION

1.1. History of the flight

On 21 September 2014 at 13:32 UTC, an Airbus A319-111 aircraft, registration G-EZIX and operated by EasyJet Airlines, encountered turbulence during the flight that seriously injured one flight attendant (FA). The flight continued and landed without further incident.

The aircraft was on a scheduled commercial passenger transport flight between the Liverpool airport (EGGP), in the United Kingdom, and Adolfo Suárez Madrid-Barajas airport (LEMD), in Spain. While descending to make the approach, and in preparation for landing, the flight crew turned on the seat belt sign and instructed the flight attendants to secure the passenger cabin.

During the descent before landing, and after passing through FL150, it crossed a layer of cumulus clouds some 2,000 ft thick that caused the aircraft to fall and shake suddenly. As a result, the four flight attendants, who were securing the passenger cabin, fell to the floor, receiving bruises in the process. One of the flight attendants broke the scaphoid bone in her wrist while remained in the rear galley of the passenger cabin.

When the flight landed, she was attended by the medical service and transferred to her base on the return flight that same day.

The air traffic control service had not received reports of turbulence from any of the preceding traffic and the flight crew had adequate weather information when planning the flight.

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft	Others
Fatal				
Serious	1		1	
Minor	3		3	
None	2	153	155	
TOTAL	**6**	**153**	**159**	

1.3. Damage to aircraft

The aircraft was not damaged. A structural inspection was not required because the load factor was lower than that specified by maintenance.

1.4. Other damage

Not applicable.

1.5. Personnel information

The captain of the aircraft, a 48-year old national of New Zealand, had a JAR-FCL Airline Transport Pilot License (ATPL(A)) issued by the Aviation Authority of the United Kingdom, with an A320 rating that was valid until 31/01/2015. He also had class 1 and 2 medical certificates that were valid until 14/02/2015. He had a total of 14,800 flight hours, of which 455 had been on the type.

The first officer of the aircraft, a 24-year old national of Great Britain, had a JAR-FCL Commercial Pilot License (CPL(A)) issued by the Aviation Authority of the United Kingdom, with an A320 rating that was valid until 30/04/2015. He also had class 1 and 2 medical certificates that were valid until 13/04/2015. He had a total of 3,800 flight hours, of which 310 had been on the type.

1.6. Aircraft information

The aircraft, an Airbus A319-111, serial number 2605 and registration G-EZIX, was outfitted with two CFMI CFM56-5B5/3 engines. It had a certificate of airworthiness issued by the Civil Aviation Authority of the United Kingdom that was valid until 24/09/2014, and it had been maintained in accordance with its maintenance program. The last daily inspection did not reveal any problems affecting its airworthiness.

1.7. Meteorological information

1.7.1. Flight planning

While planning the flight, the crew had available to them the weather forecast and existing conditions at the destination airport, as shown below:

MAPS:

Significant maps at elevations in excess of FL100 from the World Area Forecast Center (WAFC).

Wind forecast maps.

Figure 1 shows the map forecast for 12:00 UTC from FL 100 to 450. This map calls for moderate turbulence between FL 290 and 410 in the LEMD approach area.

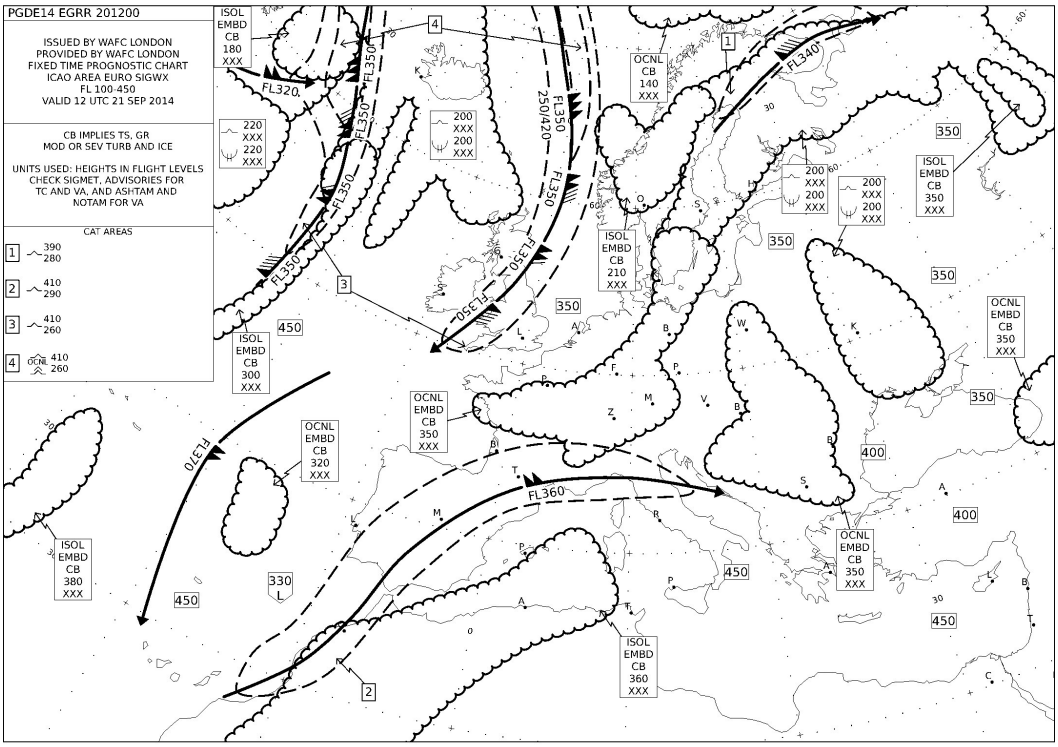

Figure 1. Significant weather map between FL100-450

10:00 UTC **METAR:**

Wind from 10° at 3 kt,

Visibility 10 km or higher,

Temperature 24° C and dewpoint 11°,

QNH 1020 hPa,

No significant changes.

06:00 UTC **TAFOR**

Variable wind, speed 5 kt,

Visibility 10 km or higher,

Scattered clouds at 7,000 ft,

Maximum temperature of 28° C at 15:00 UTC and minimum of 15° C at 06:00 UTC,

Forecast weather phenomena:

Between 10:00 UTC and 12:00 UTC wind from 10° at 10 kt,

40% chance of showers between 12:00 UTC and 06:00 UTC on the following day. Scattered clouds at 3500 with towering cumulus clouds

30% chance, for the same time, of storms with heavy downpours. Scattered cumulonimbus clouds at 2,000 ft

Forecast weather phenomena:

Between 19:00 UTC and 20:00 UTC, variable wind at 5 kt.

1.7.2. Meteorological information for the Iberian Peninsula

Spain's aviation weather service published the following map with the forecast for the time of the event:

MAPS:

The significant map from the surface to FL150 at 12:00 UTC showed: Figure 2

Isolated showers and storms,

Isolated cumulus and towering cumulus clouds with bases between FL 060-080 and tops above FL150.

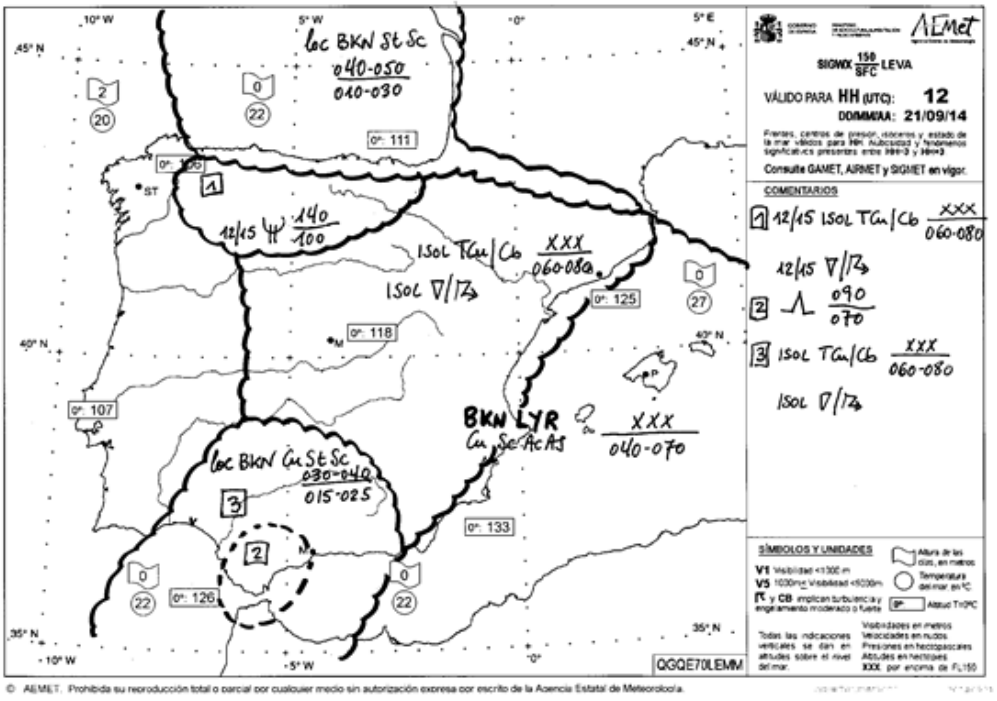

Figure 2. Significant map

METAR published for the LEMD airport:

LEMD 211330Z 15008KT 110V180 CAVOK 27/10 Q1018 NOSIG=

LEMD 211400Z 16008KT 110V190 CAVOK 27/09 Q1018 NOSIG=

WEATHER RADAR

Figure 3 shows the reflectivity weather radar image associated with the precipitation in the hours before 13:30 UTC. The area that the aircraft was flying through when it encountered the turbulence is circled in green.

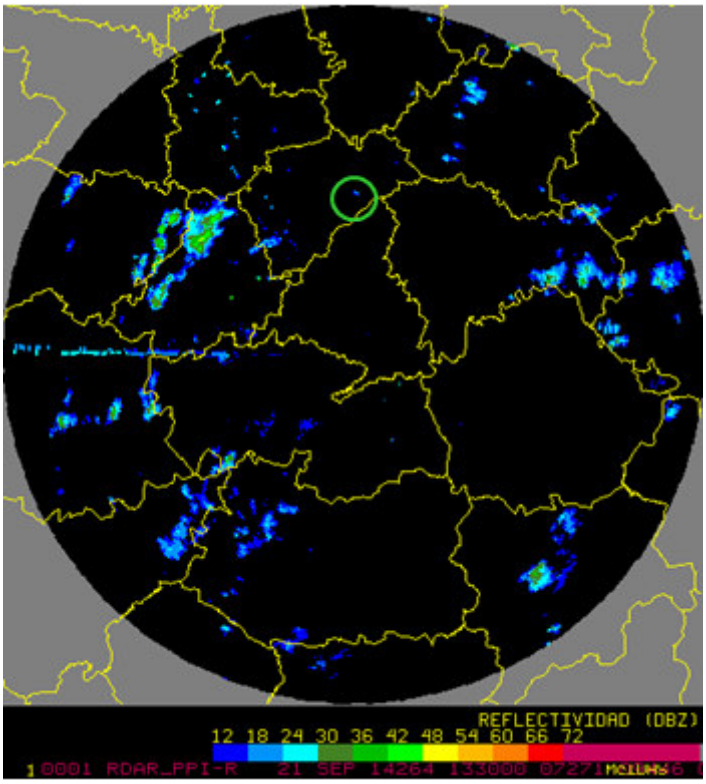

Figure 3. Weather radar image

1.8. Aids to navigation

Not applicable.

1.9. Communications

An analysis of the radio communications between ATC and the aircraft that flew through the same airspace around the time of the event, including the accident aircraft, did not reveal any references to the presence of turbulence in the area.

On the 128.700 approach frequency, however, while descending from the initial approach fix (IAF) LALPI to FL140, the crew requested to divert 10°left due to weather, which ATC approved. The time recorded by ATC was 13:30:51 UTC.

At 13:32:01 UTC, the crew were instructed to reduce speed to 220 kt, as specified for the standard terminal arrival route.

Investigators also found that during the communications following the event, the crew did not inform ATC of the presence of turbulence during the descent.

1.10. Airport information

Not applicable.

1.11. Flight recorders

The parameters in the Digital Access Recorder (DAR) were available to investigators to study the severity of the turbulence and the aircraft's performance.

With help from Airbus, it was determined that similar scales or ranges were set on both the captain's and first officer's Navigation Displays (ND). This value was 20 NM before entering the area of turbulence[2], having been previously set to a range of 80 to 40 NM.

The following timeline was developed:

- At 13:28:59, the seat belt sign was turned on in the passenger cabin.
- Between 13:29:30 and 13:30:00 UTC, the descent from FL200 to FL140 was started. At this same time the selected heading (SHDG) was changed from 180° to 140°.
- Between 13:32:00 UTC and 13:32:15 UTC, the aircraft, at an altitude of 14,084 ft and a CAS of 271 kt, entered an area of turbulence. During this time:
  - ~ The vertical acceleration (VRTG) ranged from +1.63 g to +0.68 g
  - ~ The lateral acceleration (LATG) ranged from -0.07 g to +0.1 g

[2] A suitable scale has to be selected on the ND in order to effectively detect adverse weather. The 40-NM scale is the maximum range at which to detect turbulence. However, current onboard weather radars can only detect precipitation (water drops, rain, hail, snow, etc.) inside clouds. Clear-air turbulence or turbulence inside storms with no precipitation cannot be detected by this equipment.

  - ~ The SHDG was increased from +140° to +150° during a controlled turn that reached a bank angle of +15°.
- At 13:32:06 UTC, the selected speed (SCAS) dropped to 220 kt[3]. The pitch angle started to increase and the CAS to decrease.
- At 13:32:08 UTC, the vertical speed V/S mode was selected to -500 ft/min, and the autothrust reverted in SPEED mode.
- Between 13:34:28 UTC and 13:34:51 UTC, the aircraft again encountered turbulence at an altitude of 11,300 ft:
  - ~ The vertical acceleration (VRTG) ranged from +1.29 g to +0.06 g
  - ~ The lateral acceleration (LATG) ranged from -0.09 g to +0.06 g
  - ~ The CAS ranged from 209 kt to 228 kt while the selected CAS was set to 220 kt.
- During the length of time the aircraft was in the area of turbulence, the changes in lateral or longitudinal acceleration were significant.

In Figure 4, the segment between points A and B shows the vertical acceleration, longitudinal acceleration and bank angle values recorded during the turbulence. In this segment, the aircraft descended some 2,700 ft from 14084 ft at around 2,000 ft/min. This rate quickly slowed to 480 ft/min, with instantaneous values of between 0 and 24 ft/min. Once below 12,000 ft (FL120), the descent rate again rose to normal values, though instantaneous vertical acceleration values of up to 48 ft/s were recorded in the seconds that followed.

[3] The "Severe Turbulence" section in the EasyJet OPS.01A Quick Reference Handbook recommends selecting a speed of 250 kt for FL150.

Figure 4. Graph of values recorded

1.12. Wreckage and impact information

Not applicable.

1.13. Medical and pathological information

All four flight attendants fell and/or impacted objects. The most serious injuries affected one of them, identified as CC4[4], who sustained a broken scaphoid bone in her right wrist and general bruising. After a medical check-up upon arriving at the destination airport, she flew back to the airport of departure on the following flight. A subsequent medical evaluation specified a minimum recovery period of eight weeks for the injured flight attendant.

The remaining flight attendants also sustained bruising of a general nature (neck, torso and limbs), and some of them vomited. They were required to rest a minimum of one day after the event.

1.14. Fire

There was no fire.

[4] Identifier used to refer to the FA described in point 1.15.

1.15. Survival aspects

The flight crew had instructed the cabin crew to secure the cabin. The seat belt light was on. It was in these circumstances that the airplane was shaken to varying degrees of intensity after entering an area of turbulence.

The four flight attendants who were carrying out the instruction were thrown against the furniture, ceiling and floor.

Their locations when the turbulence began were as follows, Figure 5:

CM: Aft lavatory

CC2: Row 20

CC3: Near the middle of the aircraft

CC4: Aft galley

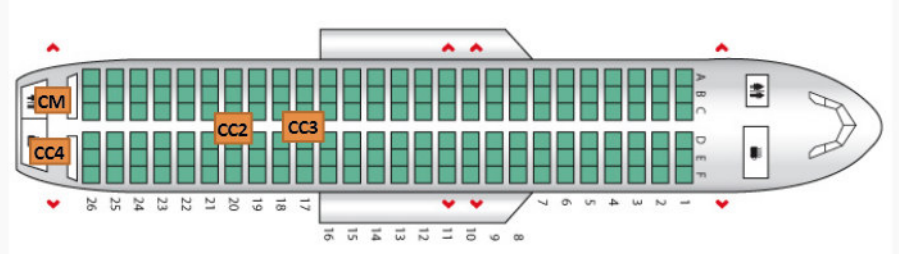

Figure 5. Positions of FAs

1.16. Tests and research

1.16.1. Location of the event

The yellow-shaded area in Figure 6 shows the final part of the area of turbulence, as the airplane was flying to point LALPI, the IAF for the instrument approach to runway 18R at LEMD.

The figure also shows a mountain chain that runs across the flight path taken by the aircraft, some peaks of which rise to elevations just over 2,000 m (6,561 ft).

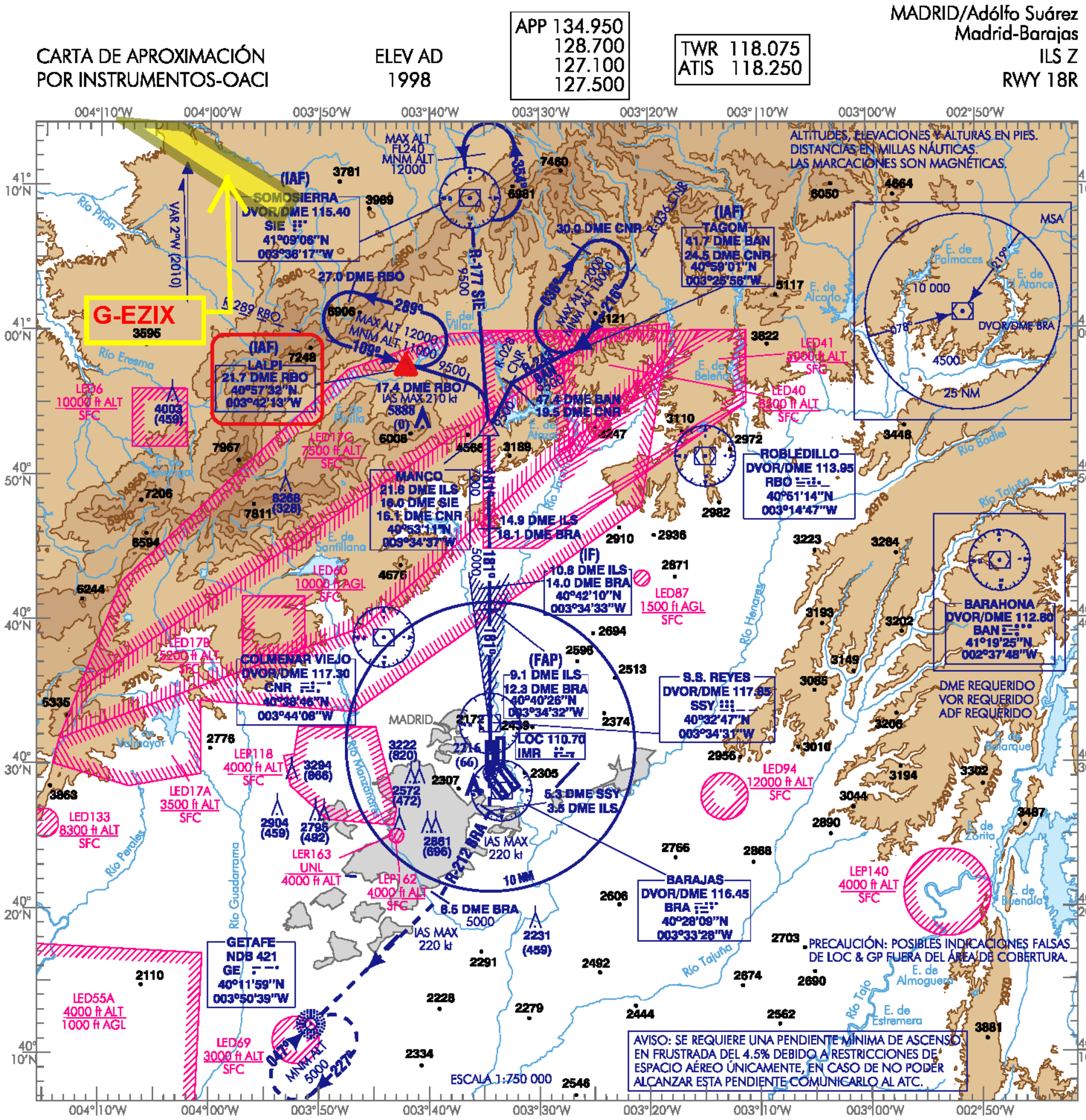

Figure 6. Location of the area of turbulence

1.16.2. Statements from the flight crew

"The cabin was secured early, approx. FL200 and 18 min to landing, in anticipation of a busy approach for the flight crew.

No turbulence of any significance was anticipated nor indicated by ATC.

On descent passing approx. FL150 the aircraft passed through a thin layer, about 2,000 ft thick, of cumulus cloud. While passing through this layer we experienced light chop and one sharp jolt. This jolt caused one of the cabin crew to fall in the back galley. It was later discovered that she had broken her wrist.

The remaining crew secured the cabin for landing. A doctor attended the crew member once the aircraft was on the gate.

Ops were advised, duty pilot also advised and he gave the clearance to operate the sector back to Liverpool with the 3 remaining crew."

The operator's reporting form also stated that at the time of the event, IMC weather conditions prevailed.

1.17. Organizational and management information

1.17.1. Operating procedures

Part A, Section 8.3.8 of the operator's Operations Manual (OM), in the section on Adverse and Potentially Hazardous Atmospheric Conditions, provides information on preventing damage and monitoring these conditions that are dangerous to flight safety.

Section 8.3.8.1 contains the following paragraph on the potential presence of turbulence:

"*Potentially hazardous turbulence is present in all thunderstorms. Strongest turbulence within the cloud occurs with shear between updrafts and downdrafts. Outside the cloud, shear turbulence has been encountered several thousand feet above and 20 NM laterally from a severe storm. A low-level turbulent area is the shear zone associated with the gust front. Often, a "roll cloud" on the leading edge of a storm marks the top of the eddies in this shear and it signifies an extremely turbulent zone. Gust fronts often move far ahead (up to 15 NM) of associated precipitation. The gust front causes a rapid and sometimes drastic change in surface wind ahead of an approaching storm.*

It is almost impossible to hold a constant altitude in a thunderstorm, and maneuvering in an attempt to do so produces greatly increased stress on the aircraft. It is understandable that the speed of the aircraft determines the rate of turbulence encounters. Stresses are least if the aircraft is held in a constant attitude and allowed to "ride the waves" (Refer to FCOM for guidance on flight in severe turbulence)."

The OM goes on to describe the phenomena associated with storms, which includes turbulence and its effects, and to provide guidelines on the actions to take to avoid storms.

Then, Section 8.3.8.3, which addresses turbulence directly as a flight hazard, provides the following information:

"*Turbulence is defined as a disturbed, irregular flow of air with embedded irregular whirls or eddies and waves. An aircraft in turbulent flow is subjected to irregular and random motions while, more or less, maintaining the intended flight path.*

Procedures for "Flight in severe turbulence" are developed in FCOM – "Procedures and Techniques Supplementary Techniques".

If the weather conditions and route forecast indicate that turbulence is likely, the Cabin Crew should be pre-warned, and passengers advised to return to, and or remain seated and to ensure that their seat belts are securely fastened. Catering and other loose equipment should be stowed and secured until it is evident that the risk of further turbulence has passed.

When encountering turbulence, pilots are urgently requested to report such conditions to ATC as soon as practicable."

1.17.2. Additional techniques

Section 05-OPS DATA of the A319 Quick Reference Handbook (QRH), provides a procedure for flying in severe turbulence, which includes the following guidance:

- SIGNS — ON
- AUTO PILOT — KEEP ON
- A/THR (When thrust changes become excessive) — DISCONNECT
- FOR APPROACH
  - ~ A/THR in managed speed — USE

1.17.3. Cabin crew training

The operator's training program includes a procedure for interactions between the flight and cabin crews when the seat belt light is turned on.

1.18. Additional information

Not applicable

1.19. Useful or effective investigation techniques

Not applicable.

2. ANALYSIS

2.1. Sequence of events

The facts available to investigators revealed that the aircraft's flight had been uneventful until the descent prior to the final approach to runway 18R at LEMD, during which the crew turned on the seat belt sign and instructed the cabin crew to secure the cabin in anticipation of a busy approach.

As the crew stated, the flight was taking place in instrument meteorological conditions. Just two minutes after turning on the seat belt sign, the flight crew asked ATC if they could turn 10° left due to weather, which ATC authorized. A minute later the aircraft was experiencing the initial effects of convective turbulence while flying at an altitude of 14,084 feet and crossing a layer of cumulus clouds. After three minutes and descending to 11,300 ft, the turbulence subsided.

When the turbulence started, the four cabin crew were busy in the middle and aft parts of the aircraft securing the cabin. The violence of the jolts was such that they were thrown into the furniture, and some even against the ceiling. The event injured one of the flight attendants who was in the aft part of the cabin, who was diagnosed with a broken right wrist.

2.2. Operational aspects of the flight

2.2.1. Weather conditions

The flight dispatch documentation contained the necessary weather information, which called for turbulence at levels above FL290.

The evidence shows that while descending to FL140, the flight crew turned on the seat belt sign and then asked ATC to turn left 10° due to weather. As the crew stated, they encountered the turbulence as they were crossing a layer of cumulus clouds that was some 2,000 ft thick. In these conditions, there is a likelihood of encountering turbulence, though its severity would be impossible to predict.

The weather information gathered by investigators shows a storm cell in the area where the turbulence occurred, Figure 3. Spain's aviation weather service had also published a significant low-level weather chart that called for the presence of cumulus and towering cumulus clouds. This significant chart was not part of the information used to plan the flight, though it is made available to all operators in general.

2.2.2. Actions during the descent

In response to the seat belt sign being turned on, there were communications between the flight and cabin crews involving securing the cabin. It was during this task that the aircraft experienced the turbulence that led to the results discussed earlier.

The operator has procedures detailing the steps to take when the seat belt sign is turned on, and the precautions to take to avoid the hazards associated with storms, including guidelines to stay clear of storms. The flight crew's statement indicates that the seat belt sign was turned on not because of the presence of clouds, but because the approach was going to be, in their own words, "busy".

As for the contents of the communications between the crew and ATC, no references were made to any requests for information on turbulence in the area. After the event, the crew did not think to relay the information on the turbulence they had encountered to ATC, in violation of the best practices given by the operator.

2.2.3. Flight procedure

When the aircraft first encountered the turbulence, it was at an altitude of 14,084 ft and a CAS of 271 kt. In light of these data, its speed was above the recommended penetration speed, and it was subsequently reduced by selecting a SCAS of 220 kt, as instructed by ATC for the approach.

Just after the CAS reduction, the pilot selected V/S at 500 ft/min and as a consequence the A/ATH reverted in SPEED mode.

2.3. Risks facing cabin crew personnel

Turbulence has resulted in a large number of accidents involving the cabin crews of commercial aircraft. By way of example, between 2005 and 2014 the CIAIAC received reports of six events involving minor and serious injuries to 13 cabin crew, 1 flight crew and 9 passengers.

This can be compared to an FAA Fact Sheet from March 2014, which gives the following figures reported by commercial aviation operators on the number of minor and serious injuries caused by turbulence between 2002 and 2013: 214 passengers and 216 cabin crew.

Organizations like the International Air Transport Association (IATA) recognize that the wide range of injuries affecting cabin crews and passengers due to turbulence requires proper management in the cockpit, as a result of which it published a specific guide on managing turbulence[5].

This event, however, along with those investigated in the past, once again serves to underscore the risk from turbulence that affects cabin crew, who are often required to stand during many phases of the flight, not only to provide essential safety services, but to engage in other services of a more commercial nature that are also of great importance to the airlines.

The circumstances observed require being mindful of procedures in the cabin, and they require flight crews to anticipate and report these events, and to coordinate with the rest of the onboard personnel.

[5] Guidance on Turbulence Management. ISBN 978-92-9252-700-6.

3. CONCLUSIONS

3.1. Findings

A. General:

i. The crew were qualified for the flight in question.

ii. The aircraft had a valid certificate of airworthiness.

iii. During the descent, the aircraft was affected by the turbulence from convective currents present while crossing a cloud layer.

iv. As a result of the aircraft's motion due to the turbulences, one flight attendant sustained a broken scaphoid bone in her right wrist.

v. The aircraft was subjected to a vertical acceleration between +1.68 g and -0.68 g.

vi. The loads experienced by the aircraft did not require any maintenance tasks.

B. Involving the weather conditions:

i. The crew had sufficient weather information to plan the flight.

ii. The forecasts published by Spain's aviation weather service indicated the likely presence of isolated cumulus and towering cumulus clouds at the altitude at which the aircraft was flying. These forecasts, however, were not part of the documentation used to plan the flight.

iii. Instrument (IMC) conditions were in effect at the time of the event.

iv. Before entering the turbulence, the crew asked ATC to change their heading by 10° due to weather.

v. At the time of the event the aircraft was crossing a cloud layer.

vi. There was no reference made by ATC or the flight crew to the presence of turbulence in nearby airspace.

vii. In light of the information gathered, the presence of turbulence is considered likely.

i. The flight crew instructed the cabin crew to secure the cabin in anticipation of a busy approach.

ii. The evidence does not show that the flight or cabin crews took any kind of precaution due to the presence of turbulence.

iii. The flight procedure used after entering the area of turbulence reflected the procedure contained in the flight manual.

3.2. Contributing causes/factors

The accident was caused when the airplane encountered strong turbulence that had not been detected by the flight crew.

4. SAFETY RECOMMENDATIONS

Not applicable.

5. APPENDICES

None.