

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY



United Arab Emirates

Air Accident Investigation Sector

Accident

- Final Report -

AAIS Case N°: AIFN/0003/2020

Severe Turbulence during Cruise

Operator:	Emirates
Make and Model:	Airbus A380-861
Nationality and Registration:	The United Arab Emirates, A6-EON
Place of Occurrence:	Airspace over Wyoming, Salt Lake City FIR
State of Occurrence:	United States
Date of Occurrence:	2 February 2020



This Investigation was conducted by the Air Accident Investigation Sector of the United Arab Emirates pursuant to Civil Aviation Law No. 20 of 1991, in compliance with Air Accident and Incident Investigation Regulation, and in conformance with the requirements of Annex 13 to the Convention on International Civil Aviation.

This Investigation was conducted independently and without prejudice. The sole objective of the investigation is to prevent future aircraft accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

The Air Accident Investigation Sector issued this Final Report in accordance with national and international standards and best practice. Consultation with applicable stakeholders, and consideration of their comments, took place prior to the publication of this Report.

The Final Report is publicly available at:

<http://www.gcaa.gov.ae/en/epublication/pages/investigationReport.aspx>

**The Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates**

P.O. Box 6558
Abu Dhabi
United Arab Emirates
E-mail: aai@gcaa.gov.ae
Website: www.gcaa.gov.ae



Occurrence Brief

Occurrence File Number	:	AIFN/0003/2020
Occurrence Category	:	Accident
Name of the Operator	:	Emirates
Manufacturer	:	Airbus SE
Aircraft Model	:	A380-861
Engines	:	Four, Engine Alliance GP7270
Nationality	:	The United Arab Emirates
Registration	:	A6-EON
Aircraft Serial Number	:	0188
Type of Flight	:	Scheduled Passenger
Flight Number	:	UAE216
State of Occurrence	:	United States
Place of Occurrence	:	Airspace over Wyoming, Salt Lake City FIR
Date and Time	:	2 February 2020, 0214 UTC
Total Crewmembers	:	28 (four flight crew and 24 cabin crew)
Total Passengers	:	333
Injuries to Passengers and Crew	:	One (passenger serious injury)

Investigation Process

The Air Accident Investigation Sector of the United Arab Emirates (AAIS) was notified of the Accident by phone call from the Operator to the Duty Investigator (DI) Hotline number +971 50 641 4667.

Notifications of the occurrence was sent on 4 February 2020 by AAIS to the National Transportation Safety Board of the United States (NTSB), being the investigation authority of the State of Occurrence, and the Bureau d'Enquetes et d'Analyses pour la securite de l'aviation civile (BEA) being the investigation authority of the State of Manufacture and State of Design of the Aircraft.

On 6 February 2020, the NTSB delegated the investigation to the AAIS, being the investigation authority of the State of the Operator and State of Aircraft Registry. The AAIS opened an investigation into this occurrence, and in accordance with the Air Accident and Incident Regulation and in line with the Annex 13 obligations, the AAIS appointed an investigator-in-charge (IIC), assigned Accident Investigation File Number AIFN/0003/2020, and formed an investigation team.

Due to a serious injury to one passenger, the AAIS classified the occurrence as an Accident.

Accredited Representatives were assigned by the NTSB and the BEA. The BEA Accredited Representative was assisted by Advisers from Airbus. In addition, the Operator assigned a technical expert to assist the IIC.



The scope of this Investigation was limited to the relevant flight operations, related aircraft systems, and cabin safety during the turbulence occurrence.

Notes:

1. Whenever the following words are mentioned in this Report with the first letter capitalized, they shall mean the following:
 - (Accident). This investigated accident.
 - (Aircraft). The aircraft involved in this accident.
 - (Commander). The commander of the flight.
 - (Copilot). The copilot of the flight.
 - (Investigation). The investigation into the circumstances of this accident.
 - (Report). This accident investigation Final Report.
2. Unless otherwise mentioned, all times in this Report are UTC time. Local time in the United Arab Emirates is UTC plus 4 hours.
3. Photos and figures used in this Report are taken from different sources and adjusted from the original for the sole purpose of improving the clarity of the Report.



Abbreviations

AAIS	The Air Accident Investigation Sector of the United Arab Emirates
ATC	Air traffic control
BEA	Bureau d'Enquetes et d'Analyses pour la Securite de l'aviation civile
CVR	Cockpit voice recorder
EFIS CP	Electronic flight instrument system control panel
FCOM	<i>Flight crew operating manual</i>
FDR	Flight data recorder
FIR	Flight information region
FL	Flight level
ft	feet
G	G-load
GCAA	The General Civil Aviation Authority of the United Arab Emirates
IIC	Investigator-in-charge
km	kilometer
kt	knots
KLAX	Los Angeles Airport
m	Meter
Mach	Mach number is the ratio of true airspeed to the speed of sound
MCL	Maximum climb thrust
MMO	Maximum operating Mach
ND	Navigation display
NM	Nautical miles
NTSB	National Transportation Safety Board of the United States
OFP	Operational flight plan
OM	Operations manual
OMDB	Dubai International Airport
SEP	Safety and emergency procedures
SIGMET	Significant meteorological information
TURB	Turbulence
UTC	Coordinated universal time
WX	Weather radar mode
WXR	Weather radar



Synopsis

On 2 February 2020, an Emirates Airbus A380 Aircraft, registration A6-EON, operated a scheduled passenger long-range flight, UAE216, from Los Angeles Airport (KLAX), United States, to Dubai International Airport (OMDB), the United Arab Emirates. The flight had 361 persons onboard consisting of four flight crew, 24 cabin crew and 333 passengers. During cruise at flight level (FL) 330, in the airspace above Trout Peak, Rocky Mountains, Wyoming, the Aircraft experienced moderate to severe turbulence at around 0214 UTC, approximately 1 hour and 42 minutes after departure from KLAX.

The Commander was the pilot flying. Because there was neither any significant weather in the area nor air traffic control reports of any turbulence, the Commander had switched the seatbelt sign OFF after the Aircraft had passed FL100 during the climb. The turbulence started just after the Commander had initiated the climb to FL350 and he reacted by immediately turning the seatbelt sign ON and making a passenger announcement for cabin crew to take their seat.

During the turbulence, which lasted for about one minute and 54 seconds. the Aircraft airspeed increased but the maximum operating Mach (MMO) speed was not exceeded. The Aircraft autopilot and autothrust remained engaged during the turbulence. The vertical speed of the Aircraft varied between minus 580 feet per minute and positive 1,400 feet per minute with vertical gravitational g-loads between positive 0.44 G and positive 1.63 G.

Amongst all persons onboard the Aircraft, one passenger was injured which was classified as a serious injury. There was no reported damage to the Aircraft cabin.

The flight continued to the destination where the Aircraft landed uneventfully.



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1. Factual Information

1.1 History of the Flight

On 2 February 2020, an Emirates Airbus A380 Aircraft, registration A6-EON, operated a scheduled passenger long-range flight, UAE216, from Los Angeles Airport (KLAX), United States, to Dubai International Airport (OMDB), the United Arab Emirates. The flight had 361 persons onboard consisting of four flight crew, 24 cabin crew and 333 passengers and departed KLAX at approximately 0032 UTC.

The operational flight plan (OFP), which was produced by the Operator's flight dispatch, indicated that there was no significant weather within the flight information region (FIR) of the Salt Lake City air traffic control center. The planned flight route directed the Aircraft over the Rocky Mountains in the state of Wyoming airspace.

For this sector of the cruise, the Commander was the pilot flying (PF) occupying the left pilot's seat. At 0038 with the Aircraft climbing through flight level (FL) FL100, the Commander switched the seatbelt sign OFF.

At 0214, the Aircraft was at FL330 with a selected FL350. The selected speed was 0.85 Mach with a heading of 028 degrees. Autopilot 1 and both flight directors were engaged and the autothrust was active in Thrust Climb mode with the four thrust levers in maximum climb thrust (CL) detent. The thrust levers remained in this position throughout the turbulence encounter.

During the flight, the weather radar 'WXR' and 'TURB' functions were in AUTO mode and the 'WX' push button was selected on the electronic flight instrument system control panel (EFIS CP) which enabled the display of weather information on the navigation display (ND). The Commander's ND range was selected at 80 nautical miles (NM) and the Copilot's was 160 NM range.

Four seconds before the turbulence, the flight crew changed the autopilot and flight director longitudinal mode from climb (CLB) to vertical speed (V/S) mode.

The wind information from the flight data recorder (FDR) indicated that the average wind speed was 65 knots (kt) coming from 080 degrees with a tailwind component of 55 knots (kt) together with a crosswind component from the right of approximately 40 kt.

Approximately 1 hour 42 minutes after departure from KLAX, between 0214:42 and 0216:36, with the flight crew initiating a climb during the cruise from FL330 to FL350 beyond waypoint KU84Q, the Aircraft experienced moderate to severe turbulence.

See figure 1 for the approximate Aircraft location at the time of the turbulence encounter which occurred in the airspace above Trout Peak. This mountain rises to a height of 3,732 m and is part of several ridges comprising the Absaroka Range¹, Rocky Mountains.

During the turbulence encounter, the FDR indicated that the Aircraft speed varied between 0.812 and 0.876 Mach; the vertical speed varied between minus 580 and positive 1,400 feet per minute; pitch angle varied between positive 0.7 and positive 3.5 degrees nose up; and vertical g-load varied between positive 0.44 and 1.63 G. The FDR data indicated that the Aircraft had a tailwind component, which varied between 11 and 43 kt; left crosswind gust component

¹ The Absaroka Range is a mountain segment of the northern Rocky Mountains, in northwestern Wyoming and southern Montana, United States. Extending in a northwest-southeast direction, the range is 270 km long and 80 km wide. Eight summits exceed 3,700 m including Francs Peak (4,005 m), the highest point.

varying between 20 and 82 kt and vertical gust component between 14 kt (downdraft) and 31 kt (updraft).

Three seconds after the onset of the turbulence, the flight crew turned the seatbelt sign ON and made an announcement for the cabin crew to be seated.

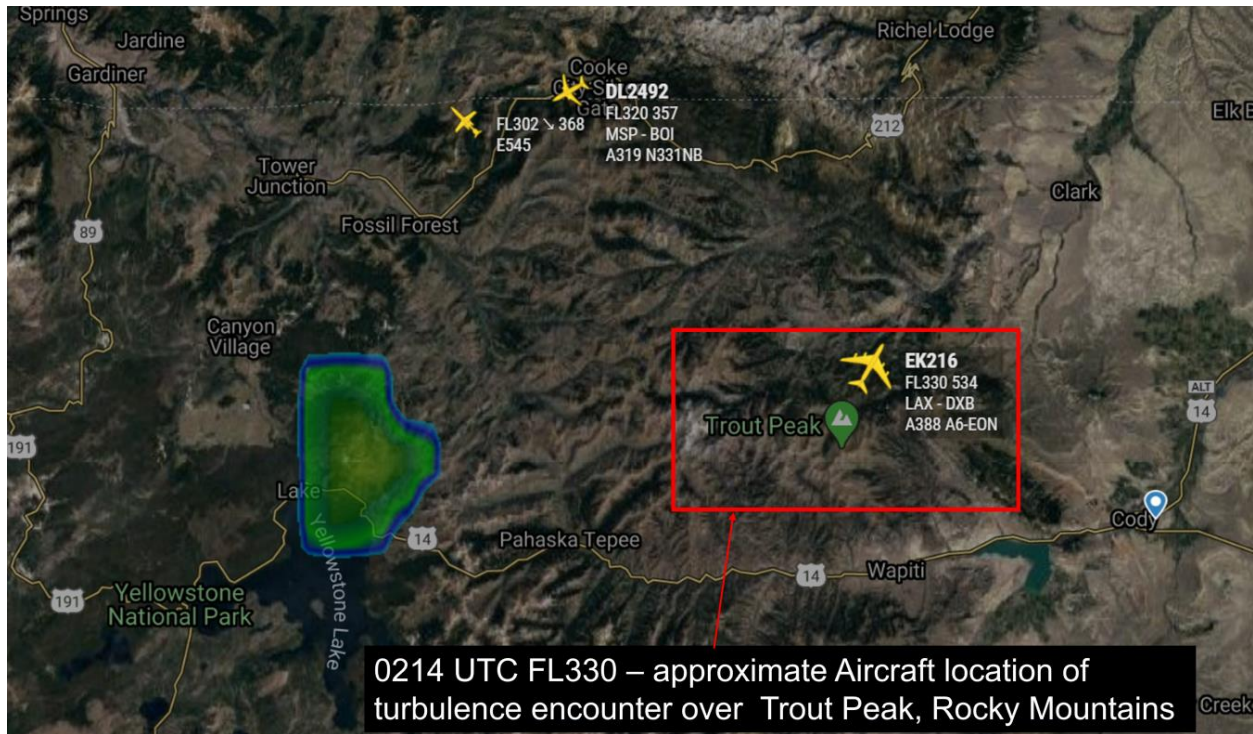


Figure 1. Approximate Aircraft location of the turbulence encounter

Autopilot 1 remained engaged during the turbulence encounter and there was no excessive altitude loss. No cockpit audio, visual warnings or alerts were generated. The maximum operating Mach (MMO) airspeed was not exceeded. The weather radar information recorded by the FDR confirmed that there was no TURB alert generated prior to the turbulence encounter which would have indicated turbulence within 40 NM and ahead of the Aircraft.

As the Aircraft was approaching waypoint KU84Q, the flight crew stated that other aircraft at a lower altitude, below FL290, had reported a “light level of turbulence” to air traffic control (ATC) in the same area, and that ATC “had not communicated to us any ‘ride reports’ or turbulence at our level or at FL350.” The Copilot stated that after hearing these communications from other aircraft, it prompted him to look at the shear rates on the OFP. Figure 2 illustrates the notes made on the OFP by the flight crew and the forecast shear rates at FL330 to FL350.

The flight crew stated that the flight was uneventful until the turbulence encounter, and the ND display of the weather radar echo returns did not detect any precipitation. Visibility was 10 kilometer (km) with no clouds, and the first hour of the flight was in daylight before sunset. There were neither any other aircraft ahead of nor in the opposite direction within $\pm 1,000$ ft of the flight level of the UAE216 Aircraft. The flight crew believed the Aircraft had encountered clear air turbulence.



		OFP Shear rates boxed in red square							
DCT	013	189	26/076	330	498	021	028		
KU84Q	+ 024		01/P01	142	P034	44	0136		✓
NRF	017	123	27/084		498		014		22
BIL	+ 028		00/M00	143	P039	45	0150		27
DCT		025	27/085	CLB		840	003		25
TOC			/M01	58	P065	44	0153		...
DCT	= 026	217	27/114	350	490	855	023		48
RUBVI	+ 036		00/M02	58	P066	40	0216		49

Figure 2. Operational flight plan shear rates in the area of waypoint KU84Q [Source; Flight crew copy of OFP]

The flight crew considered the turbulence encountered was “moderate up to but below the threshold of severe.” This was determined as the Aircraft did not experience large altitude, attitude or airspeed variations. After the turbulence, the flight crew reported to ATC that they experienced clear air turbulence and were informed by ATC that they had received turbulence reports from other aircraft in the area.

Amongst all persons onboard, one passenger in the main deck aft cabin sustained a serious injury.

The flight crew established contact with the Operator’s ground medical team to assess the passenger’s condition. The decision was made by the Commander to continue to OMDB as the passenger’s injury was not considered life-threatening and the Aircraft systems were not affected by the turbulence encounter.

The remainder of the flight and the landing at OMDB were uneventful.

1.2 Injuries to Persons

Table 1 shows the number of injuries.

Injuries	Flight crew	Cabin crew	Passengers	Total onboard
Fatal	0	0	0	0
Serious	0	0	1	1
Minor	0	0	0	0
None	4	24	332	360
TOTAL	4	24	333	361

1.2.1 Injuries of crewmembers

There were no reported injuries sustained by the crewmembers.



1.2.2 Injuries of passengers

The injured passenger was in the aft cabin lavatory adjacent to the ML5 passenger door. The cabin crew report stated that the passenger was “forced up in the air and when she touched the ground, customer twisted and hurt the ankle. It was very painful and she could not move her foot.”

The Investigation was unable to obtain a copy of the passenger’s medical report and was informed by the Operator that the injury was diagnosed as serious with a fracture to the left leg ankle.

1.3 Damage to Aircraft

There was no damage to the Aircraft.

1.4 Other Damage

There was no other damage reported.

1.5 Personnel Information

The flight crew and cabin crewmembers’ rosters indicated that they all met the rest period requirements of the Civil Aviation Regulations of the United Arab Emirates.

The pilot licenses and medical certificates of the flight crew were valid at the time of the Accident.

All the cabin crew licenses and medical certificates were valid at the time of the Accident.

In accordance with the Operator’s annual recurrent practical training schedule ‘Duties to be undertaken in the event of encountering turbulence’ had been attended every twelve calendar months by the flight and cabin crew.

1.6 Aircraft Information

1.6.1 General data

The Aircraft, an Airbus A380-861, is a Very Long Range (VLR), subsonic, civil transport aircraft that has two passenger decks certified for a maximum of 853 passengers. It was configured for 489 passengers with 14 first-class and 76 business seats on the upper deck, and 399 economy seats in the main deck.

All Aircraft records and maintenance records were valid and current with no significant technical defects at the time of the Accident.

1.6.2 Aircraft systems

1.6.2.1 Weather radar system

The Aircraft was fitted with a Honeywell RDR-4000 volumetric buffer model weather radar (WXR).

The WXR functions included weather (WX) display, predictive windshear, turbulence (TURB) detection and a ground mapping.

The turbulence detection (TURB) function is based on the Doppler effect² and detects wet turbulence in a volume of space ahead of the aircraft. This function is based on the movement of precipitation. The TURB detection function scanned ± 60 degrees in azimuth, between 0 ft and 60,000 ft mean sea level (MSL), up to 40 NM ahead of and 20 NM on either side of the aircraft and 5,000 ft above and below the aircraft.

The cockpit ND indicates areas of wet turbulence on-path and ahead of the aircraft in magenta as noted in figure 3 within the white box (the white box is used for illustration purpose only). Figure 3 also illustrates off-path detected wet turbulence that is displayed as hashed magenta.



Figure 3. TURB area indication (magenta) on ND
[Source: FCOM A380]

The TURB function does not detect clear air turbulence or dry turbulence.

1.7 Meteorological Information

The Investigation confirmed that no significant meteorological information (SIGMET) warnings had been issued by the Salt Lake City air traffic control center over the area of the State of Wyoming, United States.

No significant weather forecast was issued, as noted on the OFP that was effective at 0000 on 2 February 2020, which is illustrated in figure 4. The approximate area of the turbulence encounter is indicated by the red dot within the red square.

1.8 Aids to Navigation

The Aircraft was equipped with the required navigational equipment. All ground and onboard navigation equipment were serviceable.

1.9 Communications

The flight crew Aircraft communications while in the Salt Lake City flight information region were uneventful. The Investigation was unable to retrieve the ATC communication with UAE216 prior to and after the turbulence encounter.

1.10 Aerodrome Information

Not applicable to this Investigation.

² The Doppler effect is the change in frequency of a signal caused by relative motion between the source of the signal and the receiver.

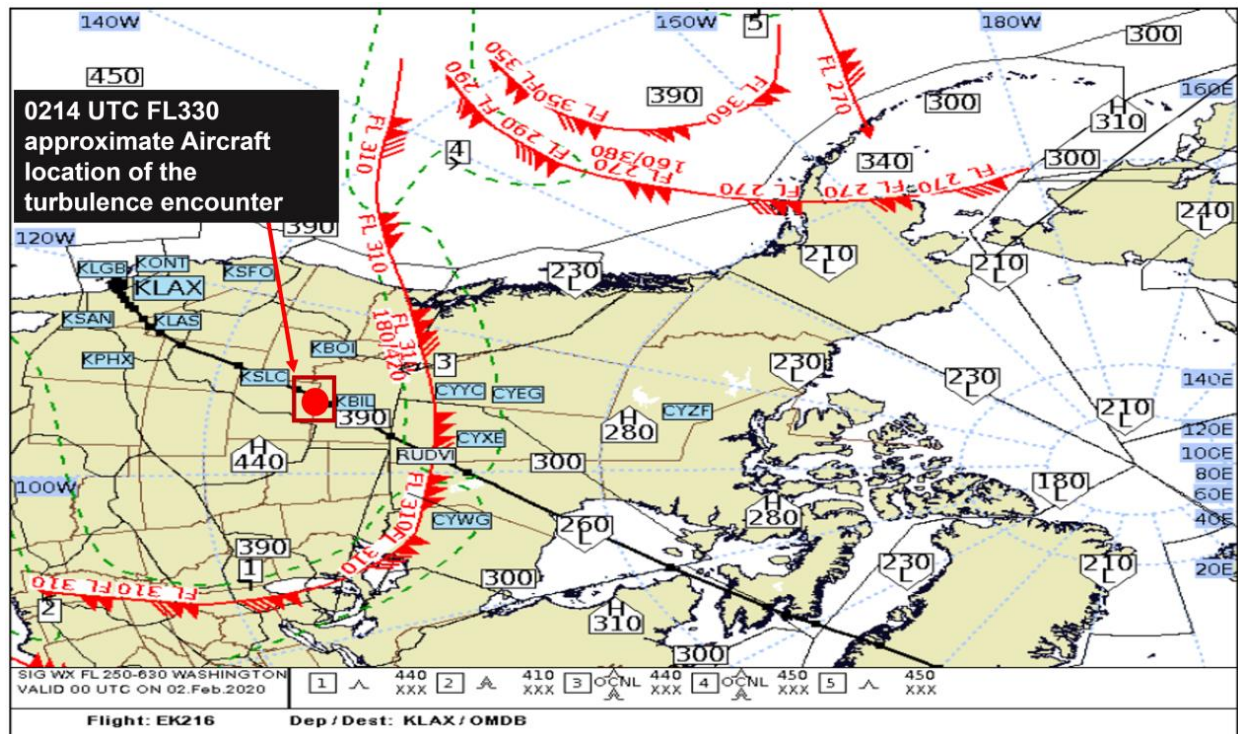


Figure 4. OFP significant weather chart over Wyoming, United States [Source: Operator]

1.11 Flight Recorders

The Aircraft was fitted with a flight data recorder (FDR) and a cockpit voice recorder (CVR). The FDR data was successfully downloaded and provided to the Aircraft manufacturer for analysis.

Because the CVR recorded only the last two hours of the flight, the data from the turbulence encounter had been overwritten and was not available to the Investigation.

The Aircraft manufacturer provided a summary report, which contained factual FDR data related to the turbulence encounter.

1.12 Wreckage and Impact Information

Aircraft landed uneventfully at OMDB.

1.13 Medical and Pathological Information

There was no evidence that physiological factors or incapacitation had affected the performance of the flight crew.

1.14 Fire

There was no sign of fire.

1.15 Survival Aspects

The injury sustained by the passenger was survivable and medical attention was provided during the flight.



At the time of the passenger injury, the person had occupied the lavatory adjacent to the ML5 passenger door located in the aft cabin of the main deck. The Investigation noted that in case of turbulence, a passenger can make use of the single handhold. However, this handhold is easily reachable only if the person is seated on the toilet.

1.16 Tests and Research

Except for the Aircraft manufacturer's analysis of the environmental conditions and Aircraft performance during the turbulence encounter, no tests or research was carried out.

1.17 Organizational and Management Information

1.17.1 Seatbelt policy

The policy of the Operator, in accordance with the Operator's Operations Manual (OM), states that the seatbelt sign must be switched ON and a seatbelt is to be worn by each passenger who is over two years of age, under several conditions including, "in turbulent conditions or when turbulent conditions are expected", and "at the Commander's discretion or as required by abnormal or emergency procedures". The OM states that "whenever passenger seatbelts are to be fastened, each person who is aged 2 years or more must wear a safety belt or be strapped in a child restraint device, which is acceptable to the Authority."

1.17.2 Turbulence

As part of the Operator's annual flight and cabin crew recurrent training, as well as the safety and emergency procedures (SEP) training, theoretical and practical instructions include duties to be undertaken in the event of encountering turbulence.

The Operator's OM gives guidance to the crewmembers on the criteria required in the classification of turbulence levels of light, moderate and severe and relevant crew actions.

Flight crew are reminded in the Operator's OM to be aware of turbulence, and "act accordingly", in accordance with the formation on mountain waves contained in the section on *Adverse and Potentially Hazardous Atmospheric Conditions*. The OM states that mountain waves can form in the lee of a range of mountains, and are usually in the form of standing waves, with several miles between peaks and troughs that can extend to 10,000 or 20,000 ft above the range and for up to 200 or 300 NM downwind.

1.18 Additional Information

On the Operator's A380 aircraft, lavatories for people of determination had multiple handholds at different heights, which were easily reachable in all circumstances.

Other lavatories had either one or two handholds. The orientation in lavatories with a single handhold was either horizontal or vertical, and those with two were oriented one horizontal and the other vertical. The handles were placed on the lavatory wall and within reachable distance and height only for a person who was seated on the toilet. None of the lavatories had handholds adjacent to the lavatory sink. In some lavatories, if the occupant was using the sink, the installed handhold was behind their back. In case of turbulence, there were no placards in the lavatory to alert the passengers to make use of the available handhold/s.

This observation by the Investigation was also noted during a previous AAIS investigation; reference AIFN/0009/2019, when a passenger on another A380 aircraft suffered a



serious injury as they occupied the lavatory in the aft cabin during a turbulence occurrence on 10 July 2019.

1.19 Useful or Effective Investigation Techniques

The Investigation was conducted in accordance with the Legislation and Air Accident and Incident Investigation Regulation of the United Arab Emirates, in accordance with the AAIS approved policies and procedures, and the Standards and Recommended Practices of Annex 13 to the Convention on International Civil Aviation.



2. Analysis

2.1 General

The flight and cabin crewmembers were appropriately licensed and medically fit to operate the flight.

The Aircraft was maintained in accordance with the maintenance program approved by the General Civil Aviation Authority of the United Arab Emirates (GCAA), and there were no technical anomalies prior to the turbulence. The Aircraft systems and engines performed as designed.

During the turbulence encounter that lasted for one minute 54 seconds, the Aircraft was always controllable. The airspeed and altitude variations did not exceed any operational limitations with the Aircraft automation remaining engaged. The flight data recorder (FDR) data, related to the gravitational loads encountered, revealed that the turbulence momentarily reached the level classified as severe, causing the unsecured passenger to be forcefully lifted against the lavatory furnishings.

2.2 Flight Crew Performance

The flight was operated in accordance with the Operator's standard operating procedures with the flight crew making appropriate making use of all relevant Aircraft automation capabilities and the weather radar system, together with the operational flight plan (OFP), to determine the suitability of the planned route as the Aircraft flew north over the state of Wyoming within the flight information region (FIR) of the Salt Lake City.

Upon hearing that other Aircraft were reporting to air traffic control (ATC) that there was light turbulence below FL290, the flight crew were aware that the OFP indicated insignificant shear rates of either 'zero' or 'one' for any turbulence between FL330 and FL350 over the Rocky Mountains, Wyoming. In addition, ATC had not communicated to UAE216 any pilot reports or turbulence beyond FL290. Thus, the flight crew did not believe that there was any threat to the Aircraft as it followed the planned route.

The Investigation concludes that the turbulence encounter was not associated with wake vortices as there was no other aircraft close to the flight level of UAE216. Because there was no active weather system over the ridges of the Absaroka Range, it is possible that the unanticipated clear air turbulence encountered by the Aircraft was related to the formation of mountain waves. Within a few seconds of the onset of the turbulence, the flight crew reacted appropriately by immediately turning the seatbelt sign ON and directing the cabin crew to be seated. The Operator's standard operating procedures for a turbulence encounter were followed, including reporting the turbulence to ATC and communicating with the Operator's medical support team to determine whether to continue the flight to OMDB, taking into consideration the passenger injury.

2.3 Cabin Safety

In case of unanticipated turbulence, for a person occupying a lavatory, except for lavatories specifically equipped for use by people of determination, there was no standardization of handholds in terms of number and orientation. Some lavatories had one handhold and others had two with the handholds oriented either horizontally or vertically. For a person standing and facing the sink, there was no handhold within easy reach in case of turbulence.



Similar to the turbulence occurrence of 19 July 2019 (AIFN/0009/2019)³, the injury was sustained by a passenger in the aft cabin⁴. Thus, without placarded instructions and sufficient handholds or other means for occupants to secure themselves during unanticipated significant turbulence, injuries will most likely reoccur.

The Investigation could not determine whether the deficiencies related to the lavatory handholds contributed to this Accident as it was not possible to interview the injured passenger. However, the description by the passenger of being “forced up in the air” during the turbulence indicates that, most likely, the passenger was unable to make use of the single handhold in the lavatory to secure themselves.

Handholds should be located such that in case of unanticipated turbulence, they are easily accessible when the person is seated or standing and when using the lavatory sink. The Investigation believes that the repeated injuries to persons occupying the lavatory may suggest that the placement of the handhold are insufficient and not easily reachable.

The Investigation recommends that the Operator standardize and improve the accessibility of the lavatory handholds, having regard to optimum ergonomic design requirements, and also include simple placarded instructions on the use of the handholds in case of turbulence.

³ Reference AAIS accident investigation file AIFN/0009/2019, on 19 July 2019, one of the Operator’s A380 aircraft experienced severe turbulence during cruise. Twenty-seven persons onboard suffered injuries. These included thirteen passengers and thirteen cabin crewmembers who sustained minor injuries, and one passenger whose injury was assessed as serious after hospitalization. Several cabin ceiling panels were damaged. The injured included the four cabin crew assigned to upper deck business class who suffered injuries when they “flew up” and impacted the ceiling of the aft cabin galley. The seriously injured passenger was in the main deck aft cabin washroom at the time of the severe turbulence encounter and was lifted off her feet impacting her head on the washroom ceiling.

⁴ Airbus *Flight Operations Briefing Notes – Turbulence Threat Awareness* states that “On large aircraft, it is possible that the forward section of the aircraft will experience less turbulence than the aft section of the aircraft. Therefore, the flight crew may not be aware of the level of turbulence experienced in the aft section of the cabin.”



3. Conclusions

3.1 General

From the available evidence, the following findings, causes, and contributing factors were determined with respect to this Accident. These shall not be read as apportioning blame or liability to any particular organization, or individual.

To serve the objective of this Investigation, the following sections are included in the Conclusions heading:

- **Findings.** Statements of all significant conditions, events or circumstances in this Accident. The findings are significant steps in the Accident sequence but they are not always causal nor do they indicate deficiencies.
- **Causes.** Actions, omissions, events, conditions, or a combination thereof, which led to the Accident.
- **Contributing factors.** Actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the Accident occurring, or mitigated the severity of the consequences of the Accident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

3.2.1 Findings relevant to the Aircraft

- (a) The Aircraft was certified, equipped, and maintained in accordance with the Civil Aviation Regulations of the United Arab Emirates.
- (b) The Aircraft was airworthy when dispatched for the flight, and there was no evidence of any defect or malfunction that could have contributed to the Accident.

3.2.2 Findings relevant to the flight crew

- (a) The flight crew were licensed and qualified for the flight in accordance with the Civil Aviation Regulations of the United Arab Emirates.
- (b) They were medically fit and rested for the flight.
- (c) The flight crew had attended the annual recurrent safety and emergency procedures (SEP) training, which included actions required in the event of encountering turbulence.

3.2.3 Findings relevant to the cabin crew

- (a) The cabin crew were licensed and qualified for the flight in accordance with the Civil Aviation Regulations of the United Arab Emirates.
- (b) They were medically fit and rested for the flight.
- (c) The cabin crew had attended the annual recurrent SEP training, which included actions required in the event of encountering turbulence.

3.2.4 Findings relevant to flight operations

- (a) The flight was conducted in accordance with the Operator's operational procedures.



- (b) The operational flight plan (OFP) shear rates indicated 'one' and 'zero' for the planned flight route in the airspace over the Rocky Mountains, Wyoming.
- (c) The flight crew turned the seatbelt sign ON as soon as the turbulence encounter started.
- (d) During the turbulence, the Aircraft autopilot and autothrust remained engaged, and the Aircraft remained controllable.
- (e) The Aircraft operational limitations were not exceeded during the turbulence encounter.

3.2.5 Findings relevant to the Operator

- (a) Except for the lavatory for persons of determination, the handholds located inside the cabin lavatories are not standardized and are not easily reachable in case of unanticipated turbulence.
- (b) There were no placarded instructions alerting the occupant in the lavatory to the availability of the handhold(s) in case of turbulence.

3.3 Causes

The Air Accident Investigation Sector determines that the cause of the Accident was the acceleration forces imposed on the Aircraft as it flew through an area of clear air turbulence, which resulted in an unsecured passenger forcefully impacting cabin furnishings in the lavatory.

3.4 Contributing Factors

Lack of placarded instructions and inaccessibility of the handholds within the lavatory for use in case of turbulence.



4. Safety Recommendations

4.1 General

The safety recommendations listed in this Report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation, and are based on the conclusions listed in part 3 of this Report. The Air Accident Investigation Sector of the United Arab Emirates (AAIS) expects that all safety issues identified by the Investigation will be addressed by the receiving States and organizations.

4.2 Final Report Safety Recommendations

4.2.1 Safety recommendations addressed to Emirates

Emirates is recommended to:

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Standardize and improve the accessibility of the lavatory handholds and include placarded instructions on the use of the handholds in case of turbulence.
