سلطنة عُمان
وزارة النقل والاتصالات وتقنية المعلومات
Sultanate of Oman
Ministry of Transport, Communications and Information Technology

Oman Transport Safety Bureau

Final Report

OTSB Case File No: AIFN-001/10/2023

Oman Air B787 severe turbulence with minor injuries to some of the cabin crew

Operator: Oman Air
Make and Model: Boeing 787-9
Nationality and Registration Marks: Omani, A4O-SH
Location of the Occurrence: Muscat FIR, Radial 278, 77.5 nm from MCT
State of Occurrence: Sultanate of Oman
Date and Time of Occurrence: 18th October 2023, 10:37 UTC
Date of Publication: 21st JAN 2024

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Purpose of the Investigation

The investigation was conducted by the Air Accident Investigation Section of Oman Transport Safety Bureau (OTSB) pursuant to Civil Aviation Law 76/2019 Chapter 10, and in compliance with the Civil Aviation Regulation CAR-13 -, Sub Part CAR 13.070: Instituting and Conducting of Investigations as State of Occurrence, Accidents or Incidents in the Sultanate of Oman.

The sole objective of the investigation is to prevent future aircraft accidents and incidents and not to apportion blame or liability. Oman Transport Safety Bureau issued this final Report in accordance with the National and International standards, and Industry best practice.

Unless otherwise mentioned, all times in this Report are UTC time. Local Time in The Sultanate of Oman is UTC plus (+) 4 hours. Photos and figures used in this report were taken from different sources and adjusted from the original for the sole purpose of improving clarity of the report.

This Report will be publicly available at: -http://www.mtcit.gov.om

Abbreviations

AAIS	Air Accident Investigation Section
ACC	Air Traffic Control Center
ATC	Air Traffic Control
ATCO	Air Traffic Controller
CAA	Civil Aviation Authority
CAR	Civil Aviation Regulation
CB	Cumulonimbus Cloud
CD	Cabine Director
CFP	Computed Flight Plan
CofA	Certificate of Airworthiness
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
FDM	Flight Data Monitoring
FDR	Flight Data Recorer
FL	Flight level
FMS	Flight Management System
FO	First Officer
FPL	Flight Plan
FPM	Feet Per Minute
ICAO	International Civil Aviation Organization
IIC	Investigator-in-charge
ILS	Instrument Landing System
LFPG	Paris Charles de Gaulle Airpor
MCT	Muscat VOR
NTC	Notice To Crew
NTSB	National Transportation Safety Board
OMSD	Oman Air Safety Department

OOMS	Muscat International Airport
OTSB	Oman Transport Safety Bureau
PA	Public Announcement
PAPI	Precision Approach Path Indicatopr
PF	Pilot Flying
PIC	Pilot In Command
PM	Pilot Monitoring
PNR	Prior Notice Required
ROC	Rate Of Climb
SMS	Safety Management System
SOP	Standard Operating Procedure
TAF	Terminal Area Forcast
TAT	Total Air Tempreture
TC	Towering Cumulus clouds
RPA	Radioactive Protection Advisor
UTC	Universal Time Coordinated
WY	Oman Air
VOR	Omnidirectional Range Navigational aid (VOR)

Synopsis

Oman Transport Safety Bureau was notified of the occurrence by Oman Air through OTSB email on 23th of October 2023 at 07:07 UTC. The OTSB instituted an investigation and classified the occurrence as an Incident requiring investigation. The following parties were notified: -

- State of Operator, and Registry (Oman CAA)
- State of Design and Manufacturer United States (NTSB)
- ICAO

In line with OTSB Investigation procedures, the Director of OTSB appointed an Investigator-In-Charge (IIC) and investigation team to assist the IIC with the investigation. The following parties are involved in the investigation by appointing accredited representative and advisor to the investigation: -

- National Transportation Safety Board (NTSB) of United State of America
- Boeing: Organization responsible for type design and final assembly of the aircraft.

After the investigation is completed, OTSB will release and publish the final report, the Final Report will be made public at the below link: http://www.mtcit.gov.om.

The incident involved Oman Air aircraft with registration marks A4OSH, Boeing 787-9 that departed at 10:20 from Muscat International Airport (OOMS) on an international scheduled flight WY131 with 2 flight deck crew, 9 cabin crew and 150 passengers to Paris Charles de Gaulle Airport (LFPG). The aircraft took off from runway 08L and routed to point IVETO, LOPIL and thereafter point ITRAX during its climb to the cruising level. The aircraft encountered turbulence during climb and some of the cabin crew got injured during the turbulence and glasses and plates fell down and broke. The aircraft cleared turbulence and continued with the flight and landed safely at destination airport LFPG.

1. Factual Information.

1.1. History of the Flight.

1.1.1. On the 18th October 2023 Oman Air aircraft with registration marks A4OSH, Boeing 787-9 took off from Muscat International Airport (OOMS) on an international scheduled flight WY131with intended destination airport LFPG.

1.1.2. The aircraft took off from Runway 08L of OOMS with 2 cockpit crew, 9 cabin crew-members and 150 passengers. The Pilot In Command (PIC) was the Pilot Flying (PF) and the First Officer (FO) was the Pilot Monitoring (PM).

1.1.3. The flight crew filed the flight plan to fly the route MCT, Q978 (which includes IVETO, LOPIL and ITRAX).

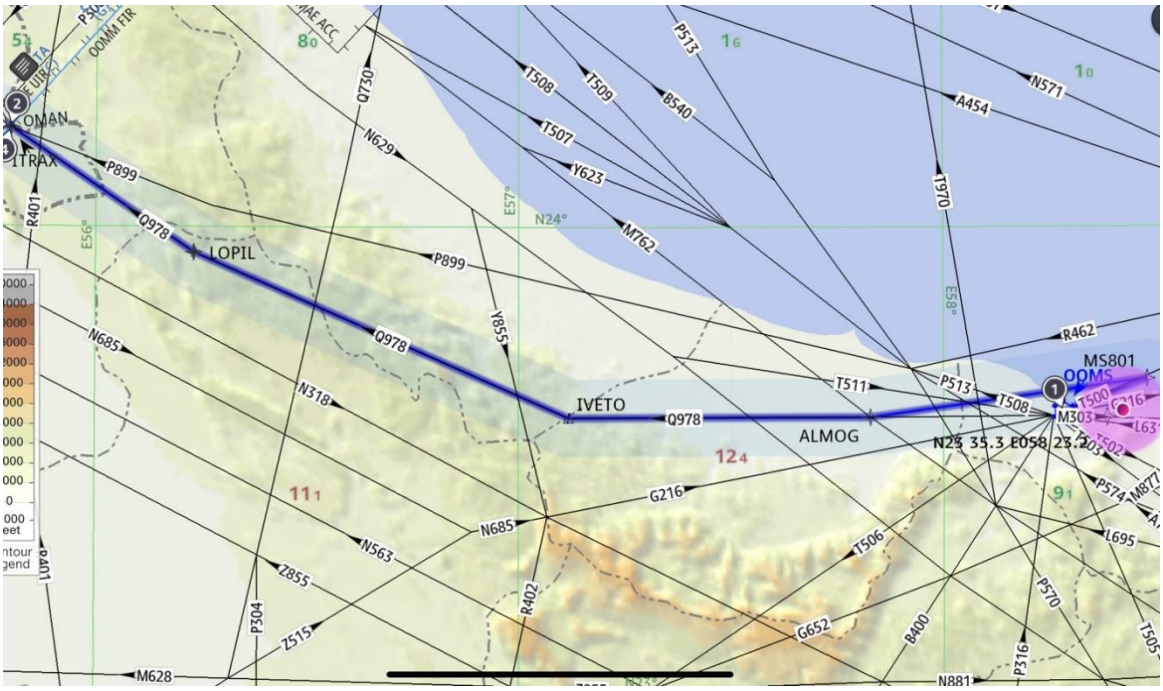


Figure 1: Solid blue line indicating the flight plan route of incident flight.

1.1.4. ATC instructed the flight crew of Oman Air aircraft A4OSH, to route to IVETO.

1.1.5. The take-off was uneventful with the seat belt sign switched “ON”. During climbing after passing altitude 10, 000 ft, the crew switched “OFF” the seat belts signs consistent with the operator’s Standard Operating Procedures (SOP). Following the seat belt signs switched “OFF”,

the cabin crew begin with beverage service to the passengers.

1.1.6. There were some convective clouds (towering cumulus) ahead of the aircraft OMA131.

1.1.7. The flight crew switched on the seat belt sign “ON” at altitude 12800 ft while continuing to climb. The cabin crew continued with beverage service as there was no Public Address (PA) announcement from the cockpit following the seat belt sign on, neither was any PA announcement from Cabin Director regarding the seat belt sign on.

1.1.8. The Air Traffic Control (ATC) instructed the flight crew to route to LOPIL at FL 194.

1.1.9. At 10:32, while the aircraft was on climb passing FL194 routing track 266 to IVETO, the ATC instructed the flight crew to route to LOPIL. The aircraft was still in cloud with the new track of 285 towards LOPIL and ROC was approximately 1500 Feet Per Minute (FPM). Light turbulence was encountered.

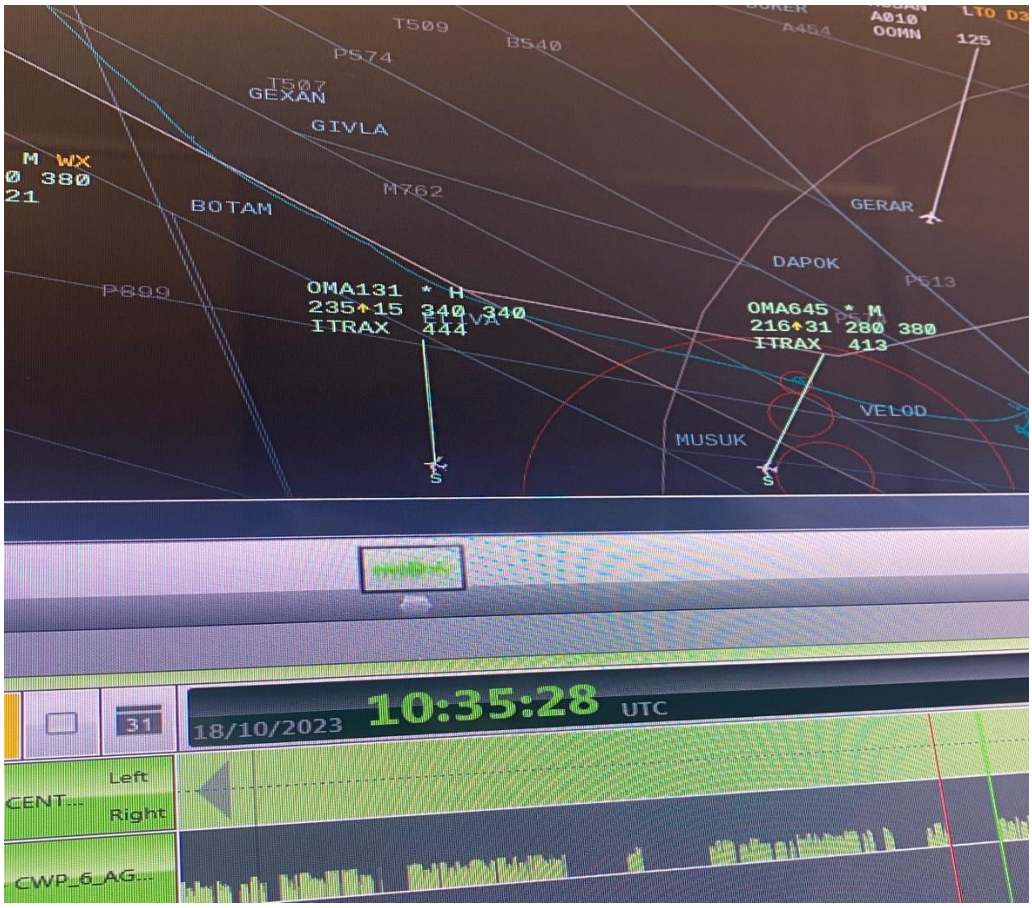


Figure 2: Indicating the incident flight passing FL194 routing track 266 to IVETO.

1.1.10. At 10:35:54 while climbing through FL246, aircraft encountered light turbulence. The Rate of Climb (ROC) was 3100 Feet Per Minute (FPM). This information was taken from the ATC radar.

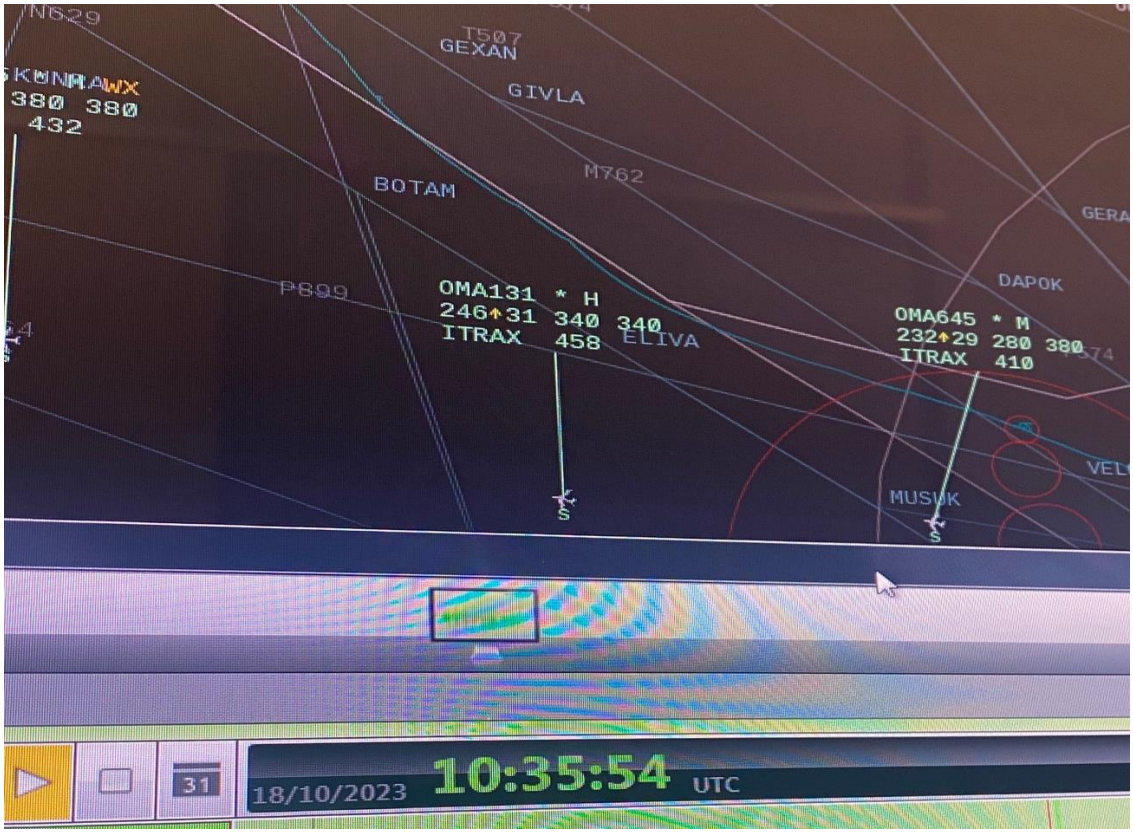


Figure 3: Indicating the incident aircraft climbing through FL246 at 10:35:54

1.1.11. Approximately 1 minute 29 seconds, the aircraft encountered another turbulence at 10:37:23, passing through FL278, the ROC was 3764 FPM This information was taken from Flight Data Monitoring (FDM)with a vertical acceleration of 2g.

1.1.12. At 10:37:50, while passing FL286, the aircraft recovered from the turbulence. The ROC dropped to 851 FPM with a vertical acceleration of 0.96g.

1.1.13. At the time the aircraft encountered turbulence, R3 cabin crew was serving the second row of the economy cabin section. R3(Cabin crew assigned number 3 right door) lost balance during the turbulence and fell down. R3 cabin crew was assisted by a passenger to stand up and quickly secured on an empty passenger seat and fastened the seat belt.

1.1.14. R4 cabin crew was standing in the galley when the light turbulence started. R4 cabin crew secured the galley and moved to stand next to L4 (Cabin crew assigned number 4 left door) headset waiting for a call from the Cabin Director (CD) to advise whether the passenger service should stop or continue. Approximately 1 minute and 29 seconds later, another turbulence occurred resulting in R4 (Cabin crew assigned number 4 right door) cabin crew falling down. Along the same corridor, L3(Cabin crew assigned number 3 Left door) cabin crew lost the service cart from hand and the cart came moving towards R4 cabin crew who stopped it by leg while was still on the floor. The cart then fell down beside the galley. Few seconds later R4 cabin crew moved to jump seat and made a quick PA announcement saying 'Take your seats" referring to the passengers.

1.1.15. The CD was preparing the beverage for the business passengers' section when the aircraft encountered turbulence. Although the CD stayed in balance during the turbulence, CD witnessed one of the colleague falling down and further observed some glasses fell down and broke.

1.1.16. Another cabin crew who was serving in the business cabin, lost balance during turbulence and the cabin crew's arm was hurt.

1.1.17. Following the crew clearing the turbulence, the Captain called CD and the CD went to the cockpit and informed the flight crew that they are fine and few glasses got broken.

1.1.18. The aircraft continued to climb and cruised at FL340. The flight landed safely at its destination airport LFPG with no further reported abnormal events.

1.1.19. According to the route track of Flight WY131, OTSB Investigation team noticed that there were two aircraft observed on the same track as Flight WY131, one aircraft ahead of Flight WY131 and the other aircraft behind Flight WY131, both aircraft diverted on their route track due to the weather on track and turned right to heading 300 and 280 degrees respectively.

1.2. Injuries to Persons.

Injuries	Pilot	Cabin Crew	Passengers	Total on Board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	**3**	-	**3**	-
No Injuries	**2**	**6**	**150**	**158**	-
Total	**2**	**9**	**150**	**161**	-

Note: Other, means people on ground.

1.3. Damage to Aircraft.

No damages were reported.

1.4. Other Damage.

1.4.1 No other damages were reported

1.5. Personnel Information:

1.5.1. Pilot-in-command (Pilot Flying)

Nationality	Omani	Gender	Male	Age	49
Medical validity	Expiry: 26/07/2024	Licence type	Airline Transport		
Licence validity	Expiry: 30/09/2025	Type endorsed	Yes		
Ratings	Instrument rating, Multi-Engine B787-9				
Latest LPC	24/06/2023	Latest OPC	26/12/2022		

Flying experience:

Total hours	15701:19
Last 24 hrs	NIL
Last 7 days	15:19
Last 90 days	23:00

1.5.2. First officer (Pilot Monitoring)

Nationality	Omani	Gender	Male	Age	32
Medical valid	Expiry: 19/12/2023	Licence type	Airline Transport		
Licence valid	Expiry: 31/01/2027	Type endorsed	Yes		
Ratings	Instrument rating, Multi-Engine B787-9				
Latest LPC	27/07/2023	Latest OPC	27/02/2023		

Flying experience:

Total hours	2516:57
Last 24 hrs	NIL
Last 7 days	26:13
Last 90 days	160:25

1.5.3. Cabin Crew Director

Nationality	Omani	Gender	Male	Age	37
Medical valid	Expiry: 03/07/2026	Licence type	Cabin crew		
Licence valid	Expiry: 31/12/2024	Type endorsed	Yes		
Ratings	CRM, First Aid, Security, Safety Emergency Procedures, Dangerous Goods				

1.5.4. Cabin Crew R3 - Injured

Nationality	South Korean	Gender	Female	Age	24
Medical valid	Expiry: 28/05/2028	Licence type	Cabin crew		
Licence valid	Expiry: 30/06/2026	Type endorsed	Yes		
Ratings	CRM, First Aid, Security, Safety Emergency Procedures, Dangerous Goods				

1.5.5. Cabin Crew R4 – Injured

Nationality	Iranian	Gender	Female	Age	29
Medical valid	Expiry: 09/04/2028	Licence type	Cabin crew		
Licence valid	Expiry: 31/05/2028	Type endorsed	Yes		
Ratings	CRM, First Aid, Security, Safety Emergency Procedures, Dangerous Goods				

1.5.6. Cabin Crew L2 – Injured

Nationality	Tunisia	Gender	Female	Age	34
Medical valid	Expiry: 07/09/2026	Licence type	Cabin crew		
Licence valid	Expiry: 30/09/2026	Type endorsed	Yes		
Ratings	CRM, First Aid, Security, Safety Emergency Procedures, Dangerous Goods				

1.5.7. Air Traffic Controller (ATCO)

Nationality	Omani	Gender	Male	Age	36
Medical valid	Expiry: 07/05/2024	Licence type	ACC RDR		
Licence valid	Expiry: 11/06/2024	Type endorsed	Yes		
Ratings	ATCO AREA RADAR Indra				

1.6. Aircraft Information:

1.6.1. General Data:

Boeing-787-9-Omani-A4OSH Serial Number 38894

1.7. Meteorological Information:

1.7.1. Clouds:

The Satellite image at the time of the occurrence, shown below, reveals some convective clouds Towering Cumulus (TC) but still not Cumulonimbus (CB) clouds existed nearby the location of the occurrence. The Terminal Area Forecast (TAF) forOOMS, issued on the 18th Oct 2023 at 0500 UTC and valid

from the 18th at 06:00 UTC to the 19th at 12:00 UTC, indicated the forecast of CB clouds between 10:00 UTC and 14:00 UTC. No Sigmet was issued.

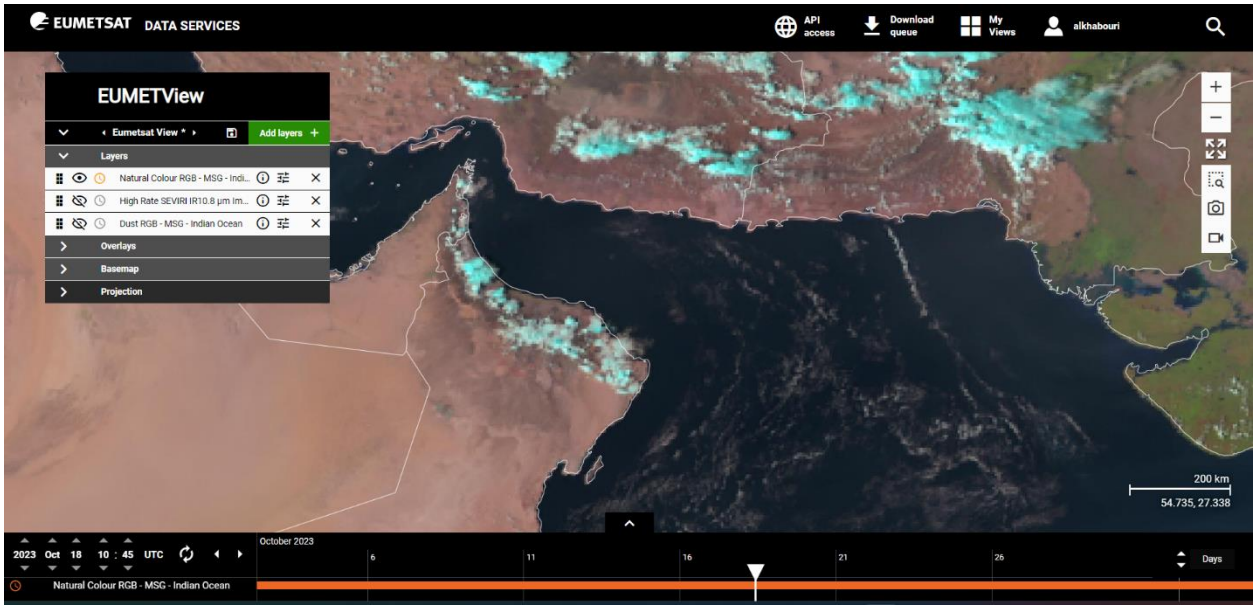


Figure 4: showing Clouds around the area where the aircraft experienced severe turbulence.

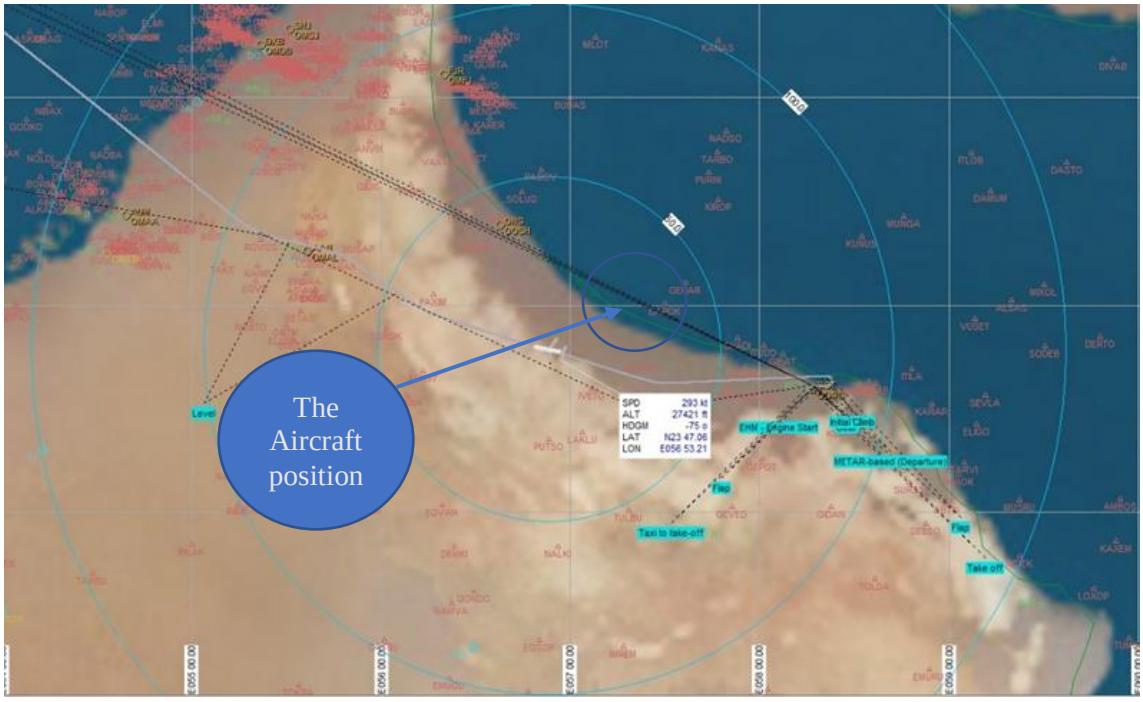


Figure 5: Satellite weather radar showing the position of the aircraft where the aircraft experience severe turbulence.

1.7.2. Upper winds and Total Air Temperature (TAT):

Intial wind direction changes at FL240 by 33kts causing a light turbulence and another change was happened approaching FL280 where the severe turbulence occurred, the wind shifted from 084° direction (tail wind) to 128° direction. Then at FL290, it went back to 094° direction.

ALT	TAT (deg c)	W/V
FL150	19	064/05
FL160	18	068/06
FL170	18	087/08
FL180	17	091/07
FL190	16	056/11
FL200	15	049/06
FL210	13	043/06
FL220	10	023/08
FL230	12	044/12
FL240	10	077/08
FL250	9	081/16
FL260	7	081/16
FL270	3	084/15
FL280	1	128/13
FL290	0	094/15
FL300	1	109/20
FL310	0	107/19
FL320	-2	113/20
FL330	-3	092/21
FL340	-7	092/19

(Table 1 wind during climb)

1.8. Aids to Navigation.

The aircraft was equipped with standard navigational equipment as approved by the Oman CAA. There were no records indicating that the navigation system was unserviceable prior to the serious incident.

1.9. Communications.

The aircraft was equipped with a standard communication system as approved by the Oman CAA. No defects that could render the communication system unserviceable were recorded before the flight.

1.10. Aerodrome Information.

1.10.1. Departure Aerodrome:

ICAO designation	OOMS (Muscat International Airport)	
Aerodrome co-ordinates	N23.60 E058.28	
Aerodrome elevation	49ft above mean sea level (AMSL)	
Runway designations	08L / 26R	08R / 26L (Closed)
Runway dimensions	4000 x 60 m	4080 x 45 m
Runway used	08L	
Category for Rescue Fire Fighting	10	
Approach facilities	ILS, VOR, RNP, PAPI's, runway lights	
Aerodrome status	Licensed Airport	

1.10.2. Destination Aerodrome:

ICAO designation	LFPG (Charles de Gaulle International Airport)	
Aerodrome co-ordinates	N49.01 E002.55	
Aerodrome elevation	392ft above mean sea level (AMSL)	
Runway designations	08L / 26R	08R / 26L
Runway dimensions	4142 x 45 m	2700 x 60 m
Category for Rescue Fire Fighting	10	
Approach facilities	ILS, RNP, PAPI's, runway lights	
Aerodrome status	Licensed Airport	

1.11. Flight Recorders.

The aircraft was fitted with both the Flight Data Recorder (FDR) and the Cockpit Voice Recorder (CVR) however, both flight recorders were over-ridden at the time the occurrence was reported to OTSB, none was downloaded for this investigation. OTSB relied on other flight information data such as FDM, ATC services communication records to assist in the investigation.

1.12. **Wreckage and Impact Information.**

1.12. 1 Not relevant to the incident.

1.13. **Medical and Pathological Information.**

1.13.1 Not relevant to the incident.

1.14. **Fire.**

1.14.1 Not relevant to the incident.

1.15. **Survival Aspects.**

1.15.1 Not Applicable

1.16. **Tests and Research.**

1.16.1 Not required for this occurrence.

1.17. **Organizational and Management Information.**

1.17.1 Oman Air is the operator issued with required approvals to conduct air service, at the time of the incident, the organization's Air Operating Certificate (AOC).
Oman Air did implement Safety Management System (SMS) and Oman Air dedicated a department titled Safety Department.

1.18. **Additional Information**

1.18.1 Not Applicable to the incident.

1.19 Useful or Effective Investigation Techniques.

1.19.1 The OTSB investigation team used website application "FlightRadar24" to study the track and the basic flight parameters such as time, track, rate of climb, altitude/flight level and speed of the incident aircraft. FlightRadar24 provided investigation team with valuable information and not only about incident aircraft flight WY131, but also about the aircraft that was before and after WY131 were studied.

2. Analysis

2.1 General

2.1.1 Oman Air is the airline approved by Oman CAA, issued with Air Operating Certificate (AOC) to conduct air service that it was being provided at the time of the incident, Oman Air has implemented Safety Management System (SMS), whereby by all personnel are required and encouraged to report any occurrence including Mandatory Occurrence Reporting (MOR), similarly the occurrences reported by crew during the operation of the aircraft, are reported to OTSB through Oman Air's Safety Department (OMSD).

2.1.2 Oman Air reports on occurrences on a weekly basis, and most of occurrences are reported within the required 72 hrs, as stipulated in CAR13.065 operators responsibility. The incident in question was unfortunately reported outside 72 hrs, and OTSB found during the investigation, the reason for the delay was that the PIC of the flight never filed incident report, it was only after the request of OASD, that the occurrence report was filed with OASD, and subsequently the report was filed with OTSB.

2.1.3 The late filing of the report by the PIC, was characterized by misunderstanding and/ or misinterpretation of the level of turbulence experienced during the incident, in the PIC's opinion the level of turbulence was categorized as light to moderate turbulence which didn't require any action from the PIC, eg filing of the occurrence report. Based on the category and classification of the level of turbulence, it was indeed possible for one to misinterpret the severe turbulence to moderate turbulence, more so for the crew in the cockpit, the level of turbulence experience in the cockpit will not necessary be the same with the level of turbulence experienced in the cabin interior of the aircraft.

2.1.4 The misinterpretation of the level of turbulence was further exacerbated by when the PIC inquired from the CD about the Cabin condition, and the PIC was told all is fine in the cabin, this was further confirmed by the CD during interview.

2.1.5 Oman Air has embraced and implemented safety management system and they have controls in place to ensure safe operation of the airline, and based on the analysis of the late reporting of the incident in question, Oman Air is in compliance of CAR13.065, and this occurrence was an isolated case as aforementioned the reason for late notification. However as soon as the OASD became aware of the cabin safety report, they investigated and requested the PIC of the flight to file an occurrence report as this is categorized

as severe turbulence according to Oman Air SOP. The details of the SOPs are discussed and analyzed under the operations section analysis.

2.2 Flight operations

2.2.1 **Crew qualifications:** Both the flight and cabin crew members were properly licensed and qualified to conduct the flight, their licenses were issued in acoordance with Oman CAA requirments.OTSB determined that the flight crew and cabin crew qualification was not a factor to the occurrence.

2.2.2 **Operational procedures** The details and analysis of operations procedures are discussed under section 2.8 of this section (Analysis).

2.2.3 **Weather** The weather information that OTSB received from the weather services, there was clouds expected on route or track of WY131, and this was further observed when two aircraft, one ahead of WY131 and the aircraft behind WY131 as they diverted on track avoiding the clouds. However WY131, didn't divert like the two mentioned aircraft and it went straight into the clouds, further analysis of the weather is contained under section 2.7.

2.2.4 **Air traffic control** ATC was properly licensed and did provide pertinent information to the crew in relation to the flight and the track. OTSB determined that ATC was considered not a factor to the incident.

2.2.5 **Communications:** Communication between the crew and the ATC, was found to be according to the procedures, OTSB determined that the communication was not a factor to the incident.

2.2.6 **Aids to navigation:** The Navigational system was found to be serviceable and operated as required at the time of the incident. However, OTSB determined that the navigational aid was not a factor to the incident.

2.2.7 Aerodrome: The aedrome used by the incident aircraft, was found to be in compliance, and issued with the necessary approval. Therefore, OTSB determined that the aerodrome was not a factor to the incident.

2.3 Aircraft Maintenance

2.3.1 The aircraft held valid Certificate of Airworthiness. The investigation team did not identify any maintenance related issue, nor inherent aircraft defect that may have contributed to the incident. Therefore the investigation determined that aircraft maintenance was not a factor to the incident.

2.3.2 Following the aircraft experiencing severe turbulence, Oman Air SOP 8.3.8.3.7 requires that the aircraft should go for inspection by maintenance engineers to inspect any possible damage the aircraft might have suffered during the severe turbulence. The investigation established that due to uncertainty of whether it was severe turbulence or moderate turbulence, the aircraft was not inspected immediately after the severe turbulence, but it was inspected later where by the aircraft has conducted another flight without being inspected by maintenance engineers.
2.3.3 The Inspection conducted by maintenance personnel following the severe turbulence, revealed no structural nor any damage to the aircraft, as a result the aircraft was returned back to service.

2.4 Human Factors

2.4.1 The crew after passing flight level 10 000, they switched-off the seat belt sign-off, while continuing to climb and monitoring the aircraft instruments, the crew noticed some clouds on weather radar, and they switched seat belt sign on in anticipation of turbulence, at the time of the crew switching the seat belt sign on, the level of turbulence was not known and the duration of turbulence was not known, the crew stated that the seat belt sign was switched on, for the safety of the passengers as a caution as they always do leaving the seat belt sign on, just for caution to the passengers.

2.4.2 Although the crew stated that the seat belt sign at approximately 12800 feet was switched on as a norm of leaving the seat belt sign on even though there is no turbulence, that was inconsistent with Oman Air SOPs, which clearly stipulate the procedures to be followed by the PIC and CD whenever the seat belt sign is switched on. The complacency of the crew, switching on the seat belt sign way ahead of the anticipated turbulence, and going through turbulence without any injuries or damages to the cabin area of the aircraft, contributed to the crew, switching on the seat belt, and not following the Oman Air's Seat belt sign on procedure, which required the crew to make a PA announcement, regarding the reason behind the seat belt sign switched on. The details of Oman Air SOPs are discussed and analyzed in detail under operations section of the analysis.

2.4.3 The CD, also due to complacency, it is always been done where the seat belt sign is switched on, and without PA announcement and without the CD inquiring to the PIC about the reason for seat belt sign on, and nothing happened to the cabin and cabin crew, unfortunately in this occurrence, when the norm, the habit was once again done, this resulted in injuries to some

cabin crew. OTSB determine it was a norm or practice done by some crew, and the determination is further based on the interviews held with the crew and cabin crew, in particular the CD, who appeared to have seen nothing untoward for the seat belt sign was switched on without any PA announcement, and CD also never went to inquire why the crew switched on the seat belt sign on.

2.4.4 The OTSB established during the interview with the cabin crew, that another turbulence was experienced on the return flight from LFPG to OOMS, the seat belt sign was switched on from take-off and was left on through out the flight for approximately 2 hrs in the air.

2.5 Survivability

2.5.1 Rescue fire service response: There was no services required of Rescue fire, therefore Rescue fire was not a factor to the incident as there was no fire during and after the incident.

2.5.2 Analysis of injuries and fatalities: Three Flight Crew members suffered minor injuries, bruised arm and back pain. All injured crew members were never hospitalized, and they managed to continue with their work immediately after turbulence. On the next day, one of the injured cabin crew advised CD was having back pains, the cabin crew was advised to see a doctor and the cabin crew was booked off from schedule not to continue flying until the doctor can clear the cabin crew to fly again.

2.5.3 The Oman Air SOP requires the crew to switch seat belt sign-on and make a PA announcement whenever the turbulence is expected and the crew omitted to make PA announcement to alert the cabin crew of the expected turbulence, the crew did confirm during the interview that they did expect turbulence and it was for that reason the seat belt sign was switched on at approximately 12800 feet. The Oman Air SOP further require the CD to enquire from the PIC whenever the seatbelt sign is switched on, and that also was omitted by CD to enquire about the level of turbulence and the time it will take in order to make an informed decision of either discontinuing the services in the cabin, or continue the services with extreme caution.

2.5.4 Due to the omission of the PA announcement by the crew, and CD omitting to enquire about the seat belt sign switched on, the cabin crew were caught unaware and not prepared for the turbulence and that resulted in the minor injuries of some of the cabin crew.

2.5.3 Survival aspects (The incident was survivable by the crew and passengers, although the turbulence was severe in the cabin interior, the passengers were safely secured by seat belts and the cabin crew who were providing passenger service suffered minor injuries and they were able to immediately secure themselves until the aircraft was clear of turbulence.)

2.6 Weather Radar System

2.6.1 The Post Flight Report did not record any system failure relevant to the turbulence event. The Weather Radar System functioned normally at the time of the turbulence. The crew did observe the clouds on the weather radar system, and as they anticipated turbulence on track, they switched the seat belt sign-on at approximately 12800 feet, after it was switched off at 10 000 feet.

2.6.2 OTSB determined that the weather radar operation was normal and in occordance with manufacturer's requirements. No defects were raised by maintenance personnel regarding the aircraft weather radar system, therefore the OTSB determined that the weather radar system was not a factor to the occurrence, the required weather information was at the crew's display at all times.

2.7 Weather

2.7.1 The crew did observe the clouds on the weather radar system, and as they anticipated turbulence on track, they switched the seat belt sign-on at approximately 12800 feet, after it was switched off at 10 000 feet.

2.7.2 OTSB determined that the weather radar operation was normal and in occordance with manufacturer's requirements. No defects were raised by maintenance personnel regarding the aircraft weather radar system, therefore the OTSB determined that the weather radar system was not a factor to the occurrence, the required weather information was at the crew's display at all times.

2.7.3 Crew Weather Briefing

2.7.3.1 As it was required and expected to have a crew briefing prior to the crew boarding the aircraft, both flight crew and cabin crew met for the flight briefing in accordance with Oman Air SOP for the Flight Preparation OM-A 8.1.0.4 pre-departure crew briefing included departure and enroute and expected some of the significant turbulence after 2 hours from the departure, etc.

2.7.3.2 The injured cabin crew, during the interview with OTSB investigation team, confirmed that indeed the briefing was conducted by the captain and there was nothing mentioned about the weather and/or anticipated turbulence.

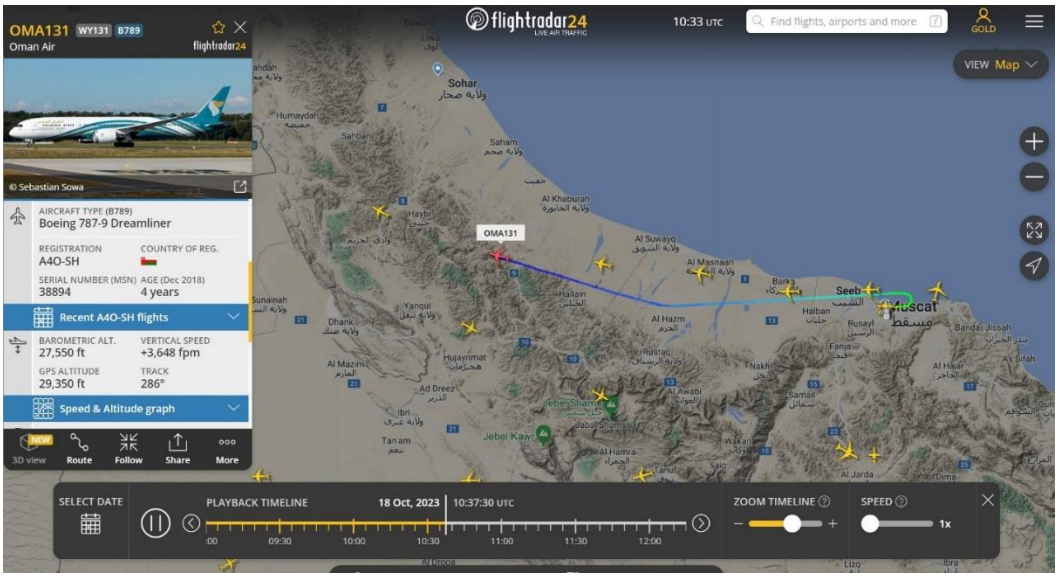
2.7.4 **Clouds during climb**

2.7.4.1 The satellite weather charts indicated some clouds formation through the flight track, during the interview with the crew, the flight crew was asked regarding the satellite weather charts indicating the clouds, the crew informed the OTSB investigation team that although they saw the clouds, but they just saw normal clouds and didn't have any effect on the operation of the aircraft. It should be noted that, although the crew stated that, the clouds were normal in their view, they did put the seat belt sign-on, and they stated that the seat belt sign-on was just for caution.

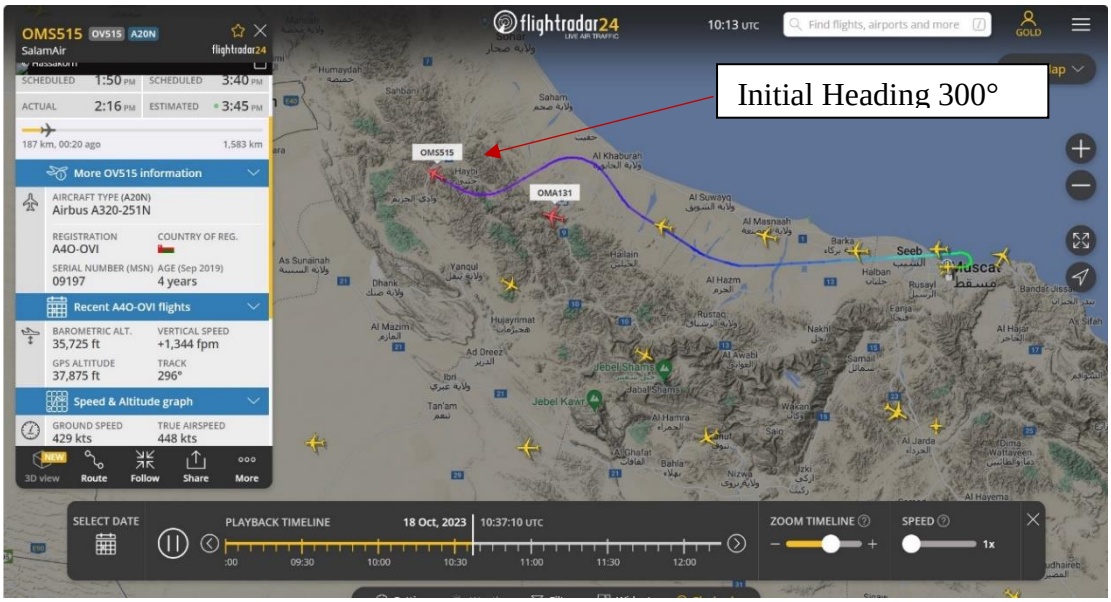
2.7.4.2 This was inconsistent with the Oman Air SOP which requires the flight crew to use PA Announcement whenever the seat belt sign is switched on, and also the CD to enquire from the captain whenever the seat belt sign is switched on in order to establish the level of expected turbulence and the duration of the turbulence.

2.7.4.3 The charts that have been provided by the weather service indicates some confected cloud – Towering Cumules - over the mountains and when these cloud gets to the mature stage they normally turn in to Cumulonimbus cloud and it was expected that it would cause turbulence for OMA131 flight track (Fig 4), this type of clouds creates up current and evidence from ATC records and flight radar 24 as in (Fig5) OMS515 indicates that the aircraft diverted to the right of track taking heading 300° avoiding the clouds and in (Fig6) OMA645 initially took a heading 280° to also avoid the clouds and the rest of the flight behind doing the same.

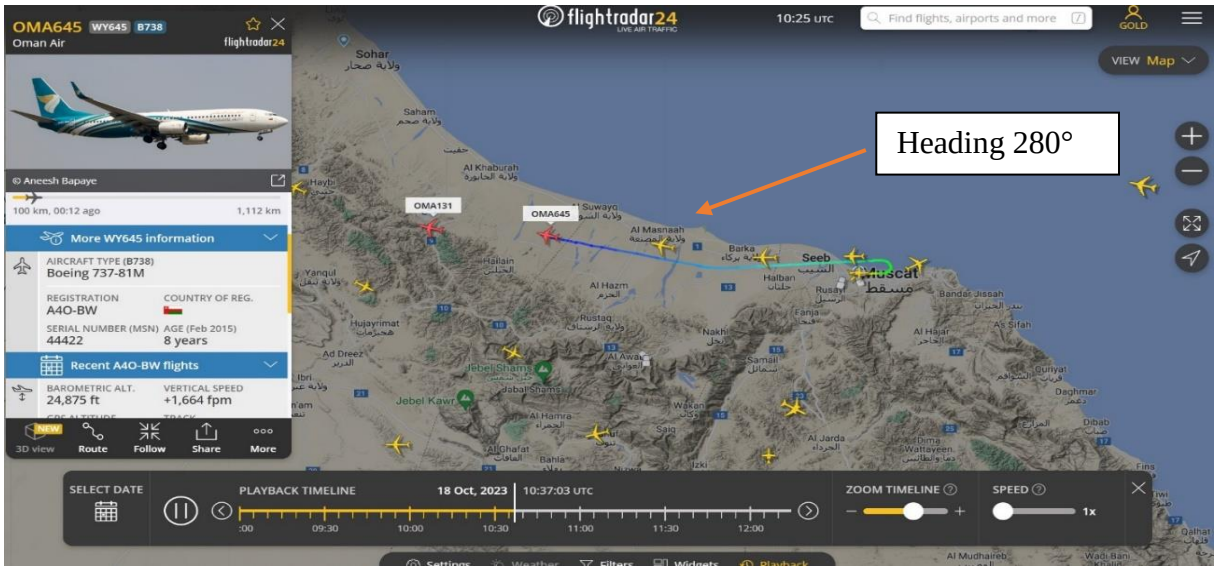
2.7.4.4 During interview with the crew, the visual screen of the weather the flight crew stated the observation of the cloud to the left and ahead of the aircraft that it looks like building up but nothing shown in the radar screen as an indication of CB's. Although, they try different set up but still is not convincing their thought that they might have a sever turbulence and as a precautionary measure they switch the seat belt sign on without making any PA announcement to the passengers and cabin crew to secure themselves.



(Fig 6 OMA131 track)



(Fig 7) Aircraft Ahead of OMA131



(Fig 8) Aircraft behind OMA 131

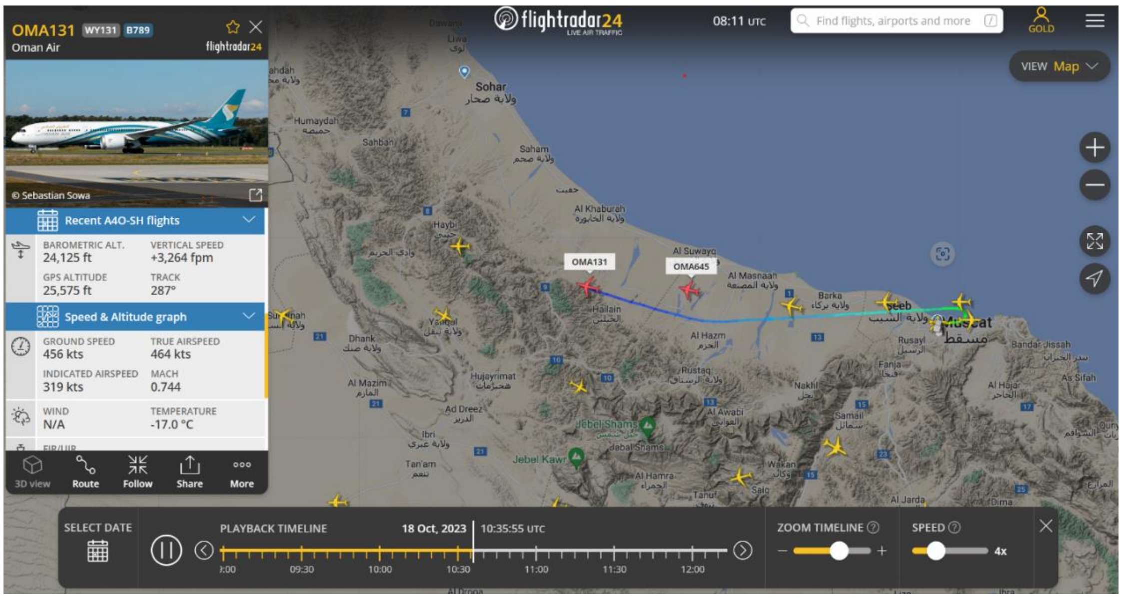
2.7.5 **Wind condition.**

2.7.5.1 The wind was shown from the aircraft FDM in (Table1) that the aircraft experienced adverse wind conditions during climb and the turbulence area revering to (Fig 2). Turbulence Area Referring to (Fig Table1) significant wind variations are recorded in the flight raw data during the turbulence period started from FL240 upwards as the wind had veared about initially 33 causing uplift of the aircraft up to 3300 FPM according to fig 9).

2.7.5.2 Another wave of sefer turbulances at FL278 where the wind veered about 44 causing uplift of 3700 FPM (Fig 6). Accourding to the flight crew interview the was no attentioned given to the A/C FMS to cheack the wind states. As the wind had changed at FL240 for the first wave of the turbulence that had incountered this an indication to have more turbulence ahead and the warning could be intercipated to cabin crew to take their seat and stop the service.

2.7.5.3 The investigation team notice that the Crew Flight Plan (CFP) doesn't contain any shear records during climb where it can this be useful information for the flight crew during there planning phase and this could be calculated in the CFP by the weather providers as in example in (Fig 10).

2.7.5.4 The flight crew had been asked regarding the observation of the wind components in the AC FMS during climb but they replay during interview that they were not perring any attention to that as they thought will not help to indicate anything for the turbulence which in the investigation team opnion that it could help inidicate an expectation for a turbulence that had encountered.



(Fig 9 ROC 3300 FPM)

WPT AWY	FL MEA	LAT LONG	TROP SH	WIND TAS/GS	OAT HDG	TTK MTK	DST DTG	ZT TET	ETA ATA	E/F A/F
MCT										
MCT	CLB	N2335.5	049	325/005		249	0001	001	...	0137
..	...	E05815.6	00	254/253	248	248	1239	00.01	...	...
MIXAM	CLB	N2341.7	050	280/030		288	0020	004	...	0131
T508	124	E05755.4	06	343/313	285	288	1219	00.05	...	...
TOC	400	N2411.4	051	257/074		308	0019	002	...	0124
P574	124	E05713.8	01	488/438	299	306	1170	00.12	...	...
EMATA	400	N2423.2	051	257/074	M57	308	0019	003	...	0123
P574	124	E05657.4	01	488/438	299	306	1151	00.15	...	...
SOLUD	400	N2432.4	051	257/077	M57	308	0015	002	...	0121
P574	080	E05644.4	00	488/436	299	306	1136	00.17	...	...
PUXIL	400	N2441.3	052	257/079	M57	308	0014	002	...	0121
P574	080	E05631.8	01	488/434	299	306	1122	00.19	...	...

(Fig 10) Wind Shear

2.8 **Cabin Crew and Cockpit Crew Operations Procedures.**

2.8.1 The cabin crew were on their first flight of the day from OOMS and the crew had adequate rest prior to undertaking to conduct the flight. The cabin crew normally commence with the service of passengers immediately after the seat belt sign is switched off, and is very common for both short and long sectors unless they receive instruction from the CD not to commence with the passenger service, this was confirmed by the Cabin crew during the interview.

2.8.2 It is also common that Cabin crew do provide service with the seat belt sign-on, however that requires confirmation by CD if it is safe to do so, On this incident flight, the crew switched on the seat belt sign-on prior to departure, and once the aircraft reached 10 000 feet, the captain switched off seat belt sign and this was done in accordance with Oman Air SOPs.

2.8.3 As it was a normal procedure, and expected of the cabin crew to commence with passenger service since the seat belt sign was switched off, while the cabin crew was preparing for passenger services with their carts, at 12800 feet, the captain switched the seat belt sign on in anticipation of turbulence, although the captain switched the seat belt sign well in advance before turbulence, the captain omitted to make a PA announcement about the anticipated turbulence, the CD also never inquired about the reason for the flight crew to switch the seat belt sign on, this then left the cabin crew to continue with preparations for passenger service without preparing themselves for anticipated turbulence.

2.8.4 Some of the cabin crew did indicate that they never noticed that the seat belt sign was on, it was only after the aircraft experience the turbulence, and when they checked at that time, they saw seat belt sign, however still no PA announcement was made by neither the PIC nor the CD. According to Oman Air SOP 8.3.11.1 (Fig 9) it is stated that whenever the seat belt sign is switched on, the passengers and the crew shall return to their seats and secure themselves with seat belt.

2.8.5 On the incident flight, the cabin crew continue with preparations for service as it was a norm that sometimes the flight crew switch on the seat belt sign on, just for caution without any announcement, it is for that reason that the cabin crew continued with the service of passengers since there was no PA announcement from the PIC nor any instructions from the CD. Figure 10, Oman Air SOP 8.3.11.3 (Fig 10) it is referenced regarding what was expected of the CD to do when the flight crew switched the seat belt sign on.

2.8.6 The omission by the flight crew to do PA announcement, and the CD not inquiring to the PIC regarding the reason for switching the seat belt sign on, resulted on the cabin crew being unprepared for the severe turbulence and as a results some cabin crew suffered minor injuries. Below are the procedures as outlined in the Oman Air SOPs.

8.3.11 Use of Safety Belts for Crew and Passengers

8.3.11.1 Safety Belts

Rev. 32.0 - 15 MAR 2023

Every occupant should fasten his seat belt:

1. During take-off and landing;
2. En-route in case of turbulence;
3. Each time the SEAT BELT sign is illuminated; and
4. Whenever deemed necessary by the Commander in the interest of safety.

During take-off and landing, and when deemed necessary by the Commander, each crew member shall use seat belts and shoulder harness.

During other phases of flight each flight crew member in the flight deck shall keep his safety belt fastened while at his station.

As long as the SEAT BELT signs are illuminated, cabin crew should make frequent checks that passenger seat belts remain fastened.

Before take-off and landing, and during taxing, and whenever deemed necessary in the interest of safety, the Commander shall ensure that each passenger on board occupies a seat with his safety belt, or harness where provided, properly secured.

The SEAT BELT switch is to be selected to the "ON" position:

1. During the cockpit preparation. Once airborne and after crossing 10,000 ft AFE and conditions permitting, the SEAT BELT switch should be selected to the "OFF" or AUTO position. An announcement should be made by the Cabin Director noting that although the seat belt sign has been turned off, passengers should keep their seat belts fastened whenever they are in their seats;
2. Whenever turbulence is anticipated or encountered. Seat belts signs shall be switched "ON". Additionally, an appropriate PA announcement is made requiring the passengers/crew to fasten their seat belts. For anticipated turbulence the PA is made by the Cabin Director. If unanticipated turbulence is encountered, conditions permitting, the PA is made by the flight deck; and/or
3. At Top of Descent, PA shall be made by the Cabin Director.

8.3.11.3 Reporting to Commander

Rev. 32.0 - 15 MAR 2023

The Cabin Director has been instructed to report immediately to the Commander when the "Seat Belt" sign is switched on in flight. Commander instructs the Cabin Director whether catering / bar services may continue and whether Cabin Crew must fasten their own seat belts.

8.3.11.4 Multiple Occupancy of Aeroplane Seats

Rev. 32.0 - 15 MAR 2023

The Cabin Director shall ensure that multiple occupancy of aeroplane seats may only be allowed on specified seats (due to the availability of additional oxygen masks) and does not occur other than by one adult and one infant who is properly secured by an infant restraint device (infant seat belt). Cabin crew are required to ensure compliance and report to the Commander.

2.9 The definition of the turbulence in Oman Air SOP

2.9.1 The Oman Air SOP clearly define and described different types of turbulence in section 8.3.8.5 Turbulence, Rev 32.0 dated 15 March 2023 as:

2.9.1.1 Convective turbulence
2.9.1.2 Orographic turbulence
2.9.1.3 Clear air turbulence
2.9.1.4 Wake turbulence

2.9.2 In Section 8.3.8.5.5 of Oman Air SOP Levels of Turbulence, Oman Air has defined levels of turbulence as follows:

2.9.2.1 Light Turbulence
2.9.2.2 Moderate Turbulence
2.9.2.3 Severe Turbulence

The Oman Air SOP also note the effect of turbulence by aircraft reaction and the conditions inside the aircraft. The investigation team understand the effect of aircraft reaction will be visible and experienced by the flight crew and

the conditions inside the aircraft will be visible and experienced by cabin crew and passengers. It is also understanding that it is possible that the turbulence can be felt to be light by cockpit crew and same turbulence be severe turbulence felt by cabin crew and passengers, hence there are two categories to define the level of turbulence being aircraft reaction and the conditions inside the aircraft.

2.9.3 The conditions inside the aircraft for moderate and severe turbulence level are not clear and open to misinterpretation, the Captain defined the encountered turbulence as moderate as per the Captain's statement received by the investigation team, while the conditions in the cabin suggest severe turbulence according to the Oman Air SOP Section 8.3.8.5.5-1, which define severe turbulence in the inside of the aircraft as follows:

2.9.3.1 Items are falling over, unsecured
2.9.3.2 Objects are tossed about
2.9.3.3 Walking is impossible
2.9.3.4 Carts are unable to be controlled
2.9.3.5 Passengers are forced violently against seat belts

2.9.4 Based on the crew statements received and reviewed by the investigation team, including the interviews conducted regarding the conditions in the cabin during and after turbulence, the conditions were as following:

2.9.4.1 Plates and glasses fell down and breake.
2.9.4.2 The Cabin crew couldn't walk and had to use the nearest seat available to seat down (walking was impossible).
2.9.4.3 Cabin Crew fell down as a result of turbulence.
2.9.4.4 Cabin crew were unable to control Carts, as a results one cart almost hit the cabin crew and the cart was blocked by the cabin crew when the cabin crew extended the leg to block the cart.

Based on the above conditions that occurred in the cabin during and post turbulence, is clear that according to Oman Air SOP Section 8.3.8.5.5-1, it was severe turbulence encountered.Also note that according to Oman Air SOP section 8.3.8.5.5-1, when a severe turbulence is encountered, the maintenance write-up and aircraft inspection is required.

3 Conclusions

3.1 General From the evidence available, the following findings, causes, and contributing factors were made with respect to this Incident. 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:-

3.1.1 Findings. Are statements of all significant conditions, events, or circumstances in this Incident. The findings are significant steps in this Incident sequence but they are not always causal or indicate deficiencies.

3.1.2 Causes. Are actions, omissions, events, conditions, or a combination thereof, which led to this Incident.

3.1.3 Contributing factors. Are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided, or absent, would have reduced the probability of the Incident occurring, or mitigated the severity of the consequences of the Incident. 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. The crew and ATCO were properly liscened to conduct the flight, their license was issued by Oman CAA.

3.2.2 The crew and ATCO held the required medical which was valid at the time of the incident, the medical was issued by Oman CAA..

3.2.3. The aircraft was properly registed and issued with the Certificate of Airworthiness which was valid at the time of the incident, the CofA was issued by Oman CAA.

3.2.4. The aircraft ought to have been inspected after the severe turbulence flight, and this was not done due to the uncertanty of the Captain whether it was severe turbulence or moderate turbulence.

3.2.5. Three Cabin Crew members suffered minor injuries

3.2.6. The seat belt sign-on procedures followed by the Captain and Cabin Director was inconsistent with Oman Air SOP.

3.2.7. The Oman Air Categorization of the level of turbulence between severe and moderate is not clear and it requires to be reviewed.

3.2.8 The Crew resources management between the Cockpit crew and Cabin Director, was found to be lacking, with respect to the procedures to be followed on Seat Belt Sign-On.

3.2.9 The flight crew penetrated the towering cloud, without observing Oman Air procedures for penetrating the clouds.

3.2.10. The wind sheer levels were not available in the CFL during climb out.

3.2.11. The Cabin Crew suffered minor injuries due to severe turbulence that caught them unprepared.

3.2.12 The Flight Crew and CD omitted to prepare the cabin crew regarding the anticipated turbulence, and this should have been done when the seat belt sign was switched on by the crew at 12800 feet.

3.2.13. The Flight Crew and CD were complacent with Oman Air SOP regarding Seat-Belt Sign-On.

3.3 Probable cause of the incident

3.3.1 The flight crew operating flight WY131 with registration marks A4OSH entered clouds and experience severe turbulence without preparing the cabin crew and passengers for turbulence, as a results some cabin crew members suffered minor injuries as they were not safely secured during turbulence.

3.4 Contributory Factors

3.4.1 The flight crew switched the seat belt sign-on well in advance, however omitted to follow Oman Air procedure which required PA Announcement to Passengers and Cabin Crew.

3.4.2 At the time the flight crew switched the seat belt sign-on at approximately 12800 feet, the CD omitted to follow Oman Air Procedure to

enquire from the PIC, about the level of turbulence and duration in order to prepare the cabin.

3.4.3 The crew resource management was found to be lacking between the CD and Flight Crew.

4. Safety Recommendations

OTSB issued safety recommendations during the investigation, and the Operator has already taken an action on the issued safety recommendations.

4.1 **SR 22 /2023** It is recommended to Oman Air to enforce and encourage the crew to follow the established seat belt sign on and turbulence avoidance guideline of the SOP. Should the crew had followed the required PA announcement following switching on the seat belt signs, the impact of the turbulence could have been reduced and injuries possibly avoided.

Action taken by Oman Air on the issued safety recommendation:

Oman Air accepted OTSB recommendation and issued Notice To Crew (NTC) dated 10/12/23 Titled Oman Air- Turbulence Information to Passengers. Also the CRM training syllabus has been amended to incorporate the recent incident for the purpose of training and awareness.

4.2 **SR 23 /2023** It is recommended that Oman Air Review Crew Resource Management (CRM) Training with the emphasis on the seat belt signs switch on and the responsibilities of the flight crew and cabin director. The CRM between the flight crew and cabin director was not consistent in relation to the SOP procedures to be followed on seat belt sign “ON” and turbulence.

Action taken by Oman Air on the issued safety recommendation:

Oman Air accepted OTSB recommendation and issued Notice To Crew (NTC) dated 10/12/23 Titled Oman Air- Turbulence Information to Passengers.

4.3 **SR 24 /2023** It is recommended that Oman Air review the SOP section 8.3.8.5.5-1, the level of turbulence between moderate and severe is not clear and it can be misinterpreted as it was the case with this incident. The captain defined

the turbulence as moderate, yet the conditions in the cabin clearly shows that it was severe turbulence.

Action taken by Oman Air on the issued safety recommendation:

Oman Air accepted OTSB recommendation and issued Notice To Crew (NTC) dated 10/12/23 clarifying the level of turbulence required to be reported as mandatory occurrence report.

4.4 **SR 25 /2023** It is recommended that Oman Air, if that has not been done yet, the aircraft be inspected by maintenance as required by Oman Air SOP section 8.3.8.5.5-1 under severe turbulence.

Action taken by Oman Air on the issued safety recommendation:

OTSB determined that Oman Air did inspect the aircraft following severe turbulence, although the inspection didn't happen on the date of the occurrence the 18th October 2023, but on the 24th October 2023.

4.5 **SR 26 /2023** It is recommended that Oman Air encourage safety occurrence reporting by either flight crew and cabin crew in order to attend to safety related occurrences immediately, Oman Air reported the occurrence outside of allowed 72 hrs. This could have been as a result of misinterpretation of the level of turbulence encountered.

Action taken by Oman Air on the issued safety recommendation:

Oman Air accepted OTSB recommendation and issued Notice To Crew (NTC) dated 10/12/23 clarifying the level of turbulence required to be reported as mandatory occurrence report.

4.6 **SR 27 /2023** It is recommended that Oman Air include the wind shear calculation during climb as part of the Crew Flight Plan for early anticipation of turbulence by the crew.

Action taken by Oman Air on the issued safety recommendation:

Oman Air accepted OTSB recommendation and considered that a cost analysis will be conducted to determine if is feasible to implement the recommendation, also Oman Air will be monitoring the recent actions taken if they have mitigated the risk, and if actions already taken and implemented are adequate in mitigating the reoccurrence of the incident, there will not be a need to further implement the recommended safety recommendation. OTSB accepted the Oman Air response and it is appropriate.

In conclusion OTSB is satisfied with the action(s) taken by Oman Air on the safety recommendations issued by OTSB. OTSB further noted that Oman Air actioned all safety recommendations within a short space of time and the action and notices were issued with immediate effective, from the date of issue 10 December 2023.

The Incident Investigation Report is released by:

Oman Transport Safety Bureau