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

# Oman Transport Safety Bureau (OTSB)

## Final Report

**OTSB Case File No: AIFN-006/10/2024**

# Salam Air A321-251N Ground Proximity Warning System (GPWS) Serious Incident


Name of The Operator: Salam Air
Make and Model of The Aircraft: Airbus A321-251N
Nationality and Registration Marks: Omani, A40-OXG
Location of the Occurrence: MCT, 20 Nautical Miles 230 Degrees from Muscat VOR
State of Occurrence: Sultanate of Oman
Date and Time of Occurrence: 30th September 2024, 12:15 UTC

## Purpose of the Investigation

The investigation was conducted by the Air Accident Investigation Section of the Oman Transport Safety Bureau (OTSB) pursuant to Civil Aviation Law 76/2019 Chapter 10, and in compliance with the Civil Aviation Regulation CAR-13.011 - Aircraft Accident & Incident Investigation & Reporting Procedures. The investigation was in conformance with the standards and recommended practices in Annex 13 - Aircraft Accident and Incident Investigation to the Convention on International Civil Aviation Organization (ICAO).

The sole objective of the investigation of an accident and incident is to prevent future aircraft accidents and incidents and not to apportion blame or liability.

Oman Transport Safety Bureau issues this Final Report in accordance with the national and international standards and industry best practice therefore concerned parties are invited to review this report and provide their significant and substantiated comments.

The Final Report is publicly available at:

http://www.mtcit.gov.om

Oman Transport Safety Bureau

Ministry of Transport Communications and Information Technology

The Sultanate of Oman

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Sultanate of Oman

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| Abbreviation | Description |
|---|---|
| ° | Degree |
| AAIS | Air Accident Investigation Section |
| AMSL | Above Mean Sea level |
| AFL | Actual Flight Level |
| AAI | Air Accident Investigation |
| ANSIC | Air Navigation Service Incident Coordination |
| AOC | Air Operator Certificate |
| APP | Approach |
| ATC | Air Traffic Control |
| ATCO | Air Traffic Controller |
| BEA | Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile |
| CAA | Civil Aviation Authority |
| CAL | Civil Aviation Law |
| CVR | Cockpit Voice Recorder |
| DFDR | Digital Flight Data Recording |
| EGPWS | Enhanced Ground Proximity Warning System |
| FDM | Flight Data Monitoring |
| FIR | Flight information Region |
| FL | Flight level |
| FO | First Officer |
| FPL | Flight Plan |
| FPM | Feet Per Minute |
| FT | Feet |
| GPWS | Ground Proximity Warning System |
| ICAO | International Civil Aviation Organization |
| IIC | Investigator-In-Charge |
| IMC | Instrument Meteorological Condition |
| ILS | Instrument Landing System |
| KTS | Knots |
| LPC | License Proficiency Check |
| MATSOP | Manual of Air Traffic Standard Operating Procedures |
| MCT | Muscat |
| MEM | Memory Item |
| MFA | Minimum Flight Altitudes |
| MOCA | Minimum Obstacle Clearance Altitude |
| MORA | Minimum Off-Route Altitude |

| | |
|---|---|
| MSA | Minimum Safe Altitude |
| ND | Navigation Display |
| OOMS | Muscat International Airport |
| OOSA | Salalah International Airport |
| OPC | Operator Proficiency Check |
| OTSB | Oman Transport Safety Bureau |
| PF | Pilot Flying |
| PM | Pilot Monitoring |
| RADAR | Radio Detection and Ranging |
| ROD | Rate of Descent |
| RWY | Runway |
| SIGMET | Information concerning en-route weather |
| SOP | Standard Operating Procedures |
| TAWS | Terrain Awareness and Warning System |
| VHF | Very Hight Frequency |
| VMC | Visual meteorological Conditions |
| VOR | VHF Omni Directional Range |
| V/S | Vertical Speed |

**Synopsis**

Oman Transport Safety Bureau (OTSB) was notified of the serious incident by the Operator, Salam Air, through OTSB email on 1st October 2024 at 10:05 LT and by Sultanate of Oman Civil Aviation Authority (CAA) -Directorate General of Air Navigation (DGAN) - Air Navigation Service Incident Coordination (ANSIC) through OTSB email on 5th of October 2024 at 05:47 LT PM. The incident occurred on 30th September 2024 at 12:15 UTC.

On the 30th September 2024 at 11:15 UTC, Salam Air aircraft with registration marks A4O-OXG, an Airbus A321-251N departed from Salalah International Airport (OOSA), Sultanate of Oman, on a domestic scheduled flight with intended destination Muscat International Airport (OOMS).

The aircraft tracked inbound MCT for ILS Runway 08L. The flight crew established communication with approach Air Traffic Controller (ATCO) and identified the traffic as OMS104 and informed the ATCO that they are descending to altitude (ALT) 11000 Feet (FT) passing through Flight Level (FL) 180. Then the flight crew requested left heading 340° for self-position on final which was approved by the ATCO.

While approaching 8000FT, ATCO cleared the flight crew to descend to 4000FT visually and the flight crew readback. The flight crew maintained 8000FT until visual and then commenced with the descent to 4000FT when they were visual with the terrain. Then, the flight crew corrected the heading to 355° to be further away from the terrain flying in the valley visually and closer to 4000FT. The flight crew started to reduce the vertical speed to green dot to minimize the Rate of Descend (ROD). The flight crew stated that while descending to 4000FT they received EGPWS caution “terrain ahead” warning to which they reacted and levelled off with Vertical speed of 0 even though they were visually clear away from terrain by more than 2000FT AGL. Flying straight and level at green dot, the EGPWS warning triggered to pull up terrain to which the crew applied the memory items as trained. Then the crew started climbing and they requested vector for Instrument Landing System (ILS) Runway RWY 08L. Normal operations thereafter. All procedures were followed and the safe conduct of the flight was ensured and the aircraft landed safely at OOMS.

Following the review of the occurrence, the OTSB classified the occurrence as a Serious Incident and the Director of OTSB appointed investigator in charge (IIC) and investigation team to conduct investigation. The following parties were notified:

- State of Design and Manufacturer, Airbus, France-Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile (BEA), French Safety Investigation Authority.
- International Civil Aviation Organization (ICAO)
- State of Operator, and Registry, Sultanate of Oman Civil Aviation Authority (CAA)

The investigation was conducted in conformance with the ICAO Annex13, CAR 13 and OTSB Investigation procedures. The Sultanate of Oman is the State of Occurrence. The following party was involved in the investigation through their appointed accredited representatives and advisers:

- State of Design and Manufacturer, Airbus, France-Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile (BEA), French Safety Investigation Authority.

This is the Final Report issued on 19th May 2025 and the Final Report is available at the below link:

www.mtcit.gov.om

Unless otherwise mentioned, all times in this report are UTC. Local Time in The Sultanate of Oman is UTC plus +4 hours. Photos and figures used in this report were obtained from DGAN, Salam Air and Directorate General of Meteorology (DGMET)-CAA weather services and were adjusted from the original for the sole purpose of improving the clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression, or enhancement of colour, brightness, contrast or insertion of text boxes, arrows or lines.

# 1. FACTUAL INFORMATION

## 1.1. History of Flight

1.1.1 On the 30th September 2024 at the time 11:15 UTC, Salam Air aircraft (OMS104) with registration marks A4O-OXG, an Airbus A321-251N departed from Salalah International Airport (OOSA), Sultanate of Oman on a domestic scheduled flight inbound with intended landing destination at Muscat International Airport (OOMS).

1.1.2 At the time 12:11:00 the flight crew reported to approach (APP) ATCO that they were passing through FL180 descending to ALT 11000FT. At the time 12:11:10, ATCO replied to the Flight crew to continue descend as cleared. At the time 12:11:15, the Flight crew contacted ATCO requesting ATCO to repeat what ATCO last clearance by saying “Say again OMS104”. At the time 12:11:16, ATCO replied “OMS104 continue as cleared”.

1.1.3 At the time12:11:20, the Flight crew read back the clearance to ATCO “Continue as cleared OMS104”.

1.1.4 At the time 12:12:36, the fight crew contacted APP ATCO requesting their sequence. At the time 12:12:45, ATCO replied “Number one” and then ATCO corrected the reply by adding the callsign “OMS104 number one”.

1.1.5 At the time 12:12:51, the Flight crew read back by saying ok, number 1 and then requested for left heading 340° for self-positioning on final OMS104. At the time 12:12:58, ATCO responded by saying “Roger approved”. At the time 12:12:59, the Flight crew contacted ATCO to confirm if left heading 340° is confirmed by saying “Confirm approved, left heading 340”. At the time 12:13:02, ATCO acknowledged by stating “Charlie-Charlie”. At the time 12:13:03, the Flight crew contacted ATCO” Confirm it's approved 340° for… (Transmission overlapped/not clear)” to confirm if their request was approved. At 12:13:05, a further descent clearance to 8000FT by ATCO was given to the Flight crew.

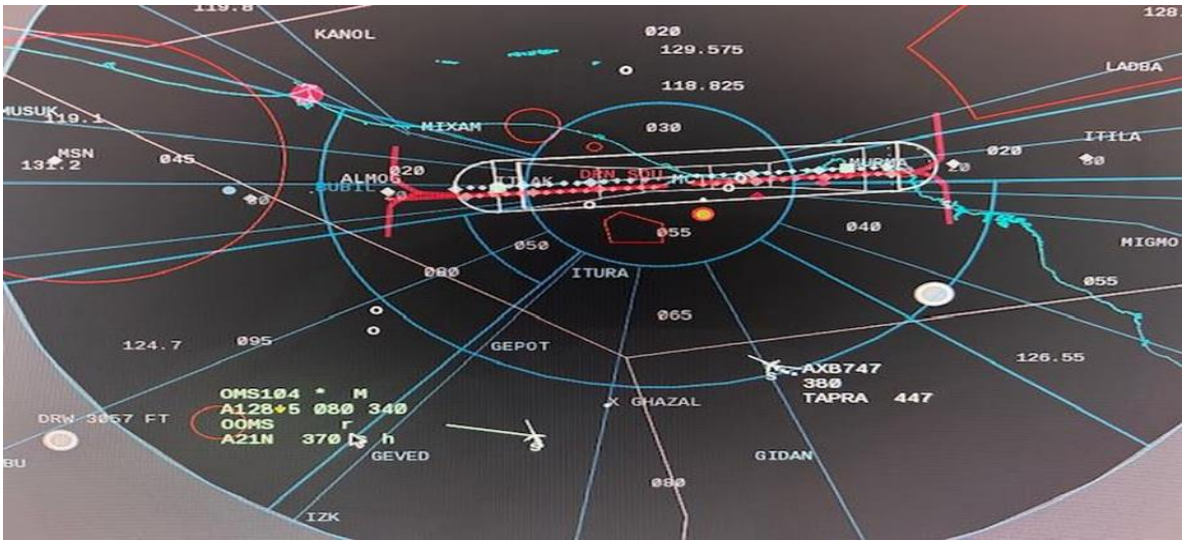


Figure 1: showing aircraft OMS104 observed on radar passing through 12800FT descending to 8000 FT at ROD 500 feet per minute (FPM) (Source: DGAN)

1.1.6 At the time 12:13:08, the Flight crew read back the clearance to ATCO, “Copied descend 8000FT and left heading 340°”. It was heard during the ATC playback the (Transmission overlapped/not clear) frequency was blocked or jammed and there was no reply from ATCO.

1.1.7 At the time 12:13:27, the Flight crew informed ATCO that they have been blocked (Transmission overlapped/not clear). At the time 12:13:46, the Flight crew asked ATCO to confirm left heading 340° approved? (Transmission overlapped/not clear was heard during playback) and there was no reply from ATCO.

1.1.8 At the time 12:14:17, ATCO received a call from Tower (TWR) ATCO informing that someone is calling APP ATCO and ATCO realized that the frequency was blocked. At the time 12:14:22, the Flight crew asked ATCO how do you read and ATCO replied “5 by 5 descend 8000”.

1.1.9 At the time 12:14:30, the Flight crew read back the clearance from ATCO to descend to ALT 8000FT on a heading 340° as previously requested.

1.1.10 At the time 12:14:37, ATCO replied to the Flight crew and asked them how do they read because the ATCO had approved their request to descend to ALT 8000FT. At the time 12:14:40, the Flight crew replied that they were not very sure because they had static on the frequency due weather and they just wanted to re confirm to descend to ALT 8000FT on a heading 340°.

1.1.11 At the time 12:14:47, ATCO asked the Flight crew if they are happy, clearance can be given to them to descend visually. At the time 12:14:54, the Flight crew replied by saying “Ok we'll take the visual in a bit, we just clearing some weather as of right now we will advise once ready OMS104 continuing 8000FT thousand”. At the time 12:15:02, ATCO replied “Charlie-Charlie”.

1.1.12 At the time 12:15:07, ATCO asked the Flight crew if they were able for waypoint ILILA after ILILA to ITLAK no objection. At the time 12:15:14, the Flight crew informed ATCO that they are staying on heading 340° and they will advise once they are visual to commence visual positioning. ATCO responded and acknowledged the request.


Figure 2: showing aircraft OMS104 observed on radar passing through 9500FT at a ROD3300 FPM descending to 8000FT (Source: DGAN).


Figure 3: showing aircraft OMS104 observed on radar passing through 8500FT at ROD 1600 FPM descending to 8000FT (Source: DGAN)

1.1.13 The Flight crew maintained 8000FT till visual, at 12:16:43 the Flight crew completely visual and requested further descend. At 12:16: 52 the ATCO cleared the Flight crew to commence further descent to 4000FT. At the time 12:18:23, the Flight crew informed ATCO that they are taking heading 355°, which was then approved by the ATCO by stating “no objection self-position for final and no objection turn to the right or left”. At 12:18:53 the ATCO advised the Flight crew are cleared to descend 2000 FT and cleared for ILS r/W 08L to call established. The Flight crew accepted the message by replaying “Descend 2 thousand feet visually eh cleared ILS approach RWY 08 left next report once fully established OMS104”


Figure 4: showing aircraft OMS104 observed on radar on passing through 8000FT ROD of 800 FPM descending to 4000FT as cleared by ATCO (Source: DGAN)

1.1.14 As per the aircraft Flight Data Monitoring (FDM) recording between 12:15:00 and 12:20:00 the aircraft OMS104 got EGPWS caution message “terrain ahead” and the Flight crew selected vertical speed to zero while flying level at green dot.

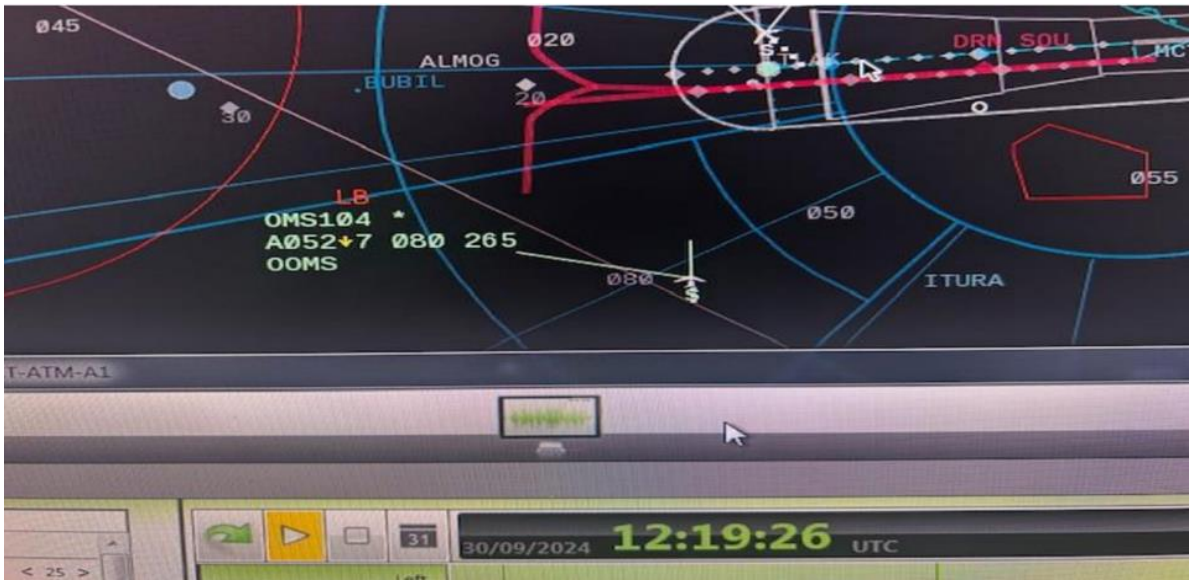


**Figure 5:** showing aircraft OMS104 observed on radar descending through 5200FT at ROD of 700FPM as cleared ALT by ATCO to 4000FT visually (Source: DGAN).

1.1.15 At the time 12:19:30, the EGPWS warning triggered to "Pull Up terrain" to which the Flight crew applied memory action procedures and the Flight crew advised ATCO that they were climbing.

1.1.16 At the time 12:20:03, the aircraft OMS104 was observed on the radar screen climbing through ALT 6800FT and they requested vectors for ILS 08L and normal operations were followed thereafter and the safe conduct of the flight was always ensured.


**Figure 6:** showing aircraft OMS104 observed on radar climbing to 8000FT passing through 6800FT at ROC of 3900FPM over an MSA sector of 8000FT (Source: DGAN)

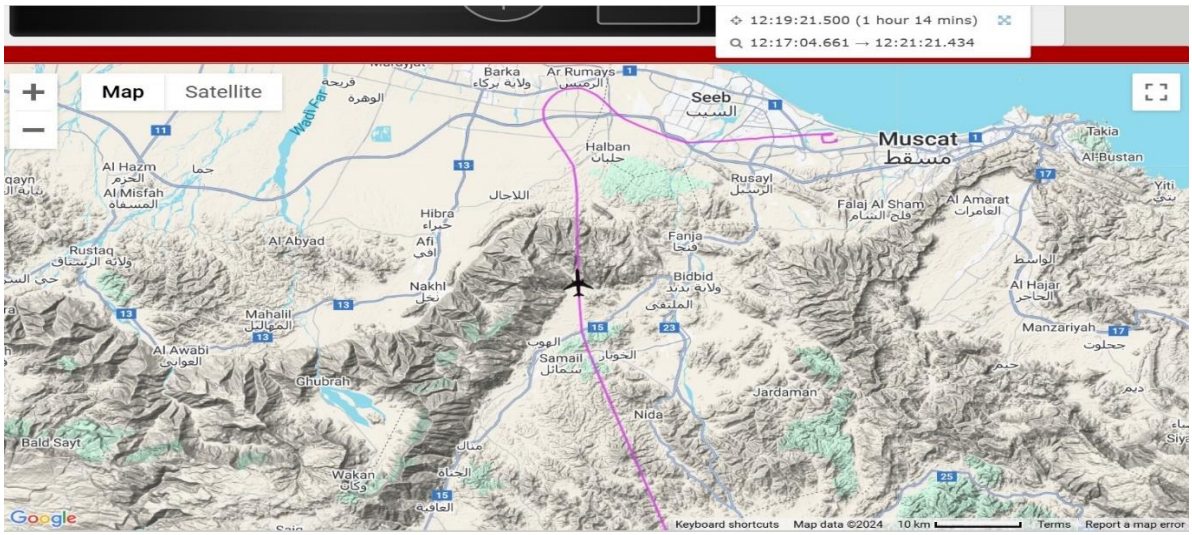


**Figure 7:** showing aircraft OMS104 observed on FDM flight path 5 seconds before approaching terrain GPWS CAUTION (Source: Salam Air)

1.1.17 At the time 12:20:37, ATCO asked the Flight crew of aircraft OMS104 if they had any weather by stating “OMS104 confirm do you have any weather”. At the time 12:20:40, the Flight crew asked ATCO to standby by stating “OMS104: Eh… standby OMS104”. At the time 12:21:08, the Flight crew asked ATCO and requested heading 060° and to cancel the previous request by stating” Ok radar OMS104 request heading 060° radar vectors ILS 08 left, cancel previous request”. At the time 12:21:16, ATCO replied to the request from the Flight crew by stating “Confirm requesting now radar vectors”.

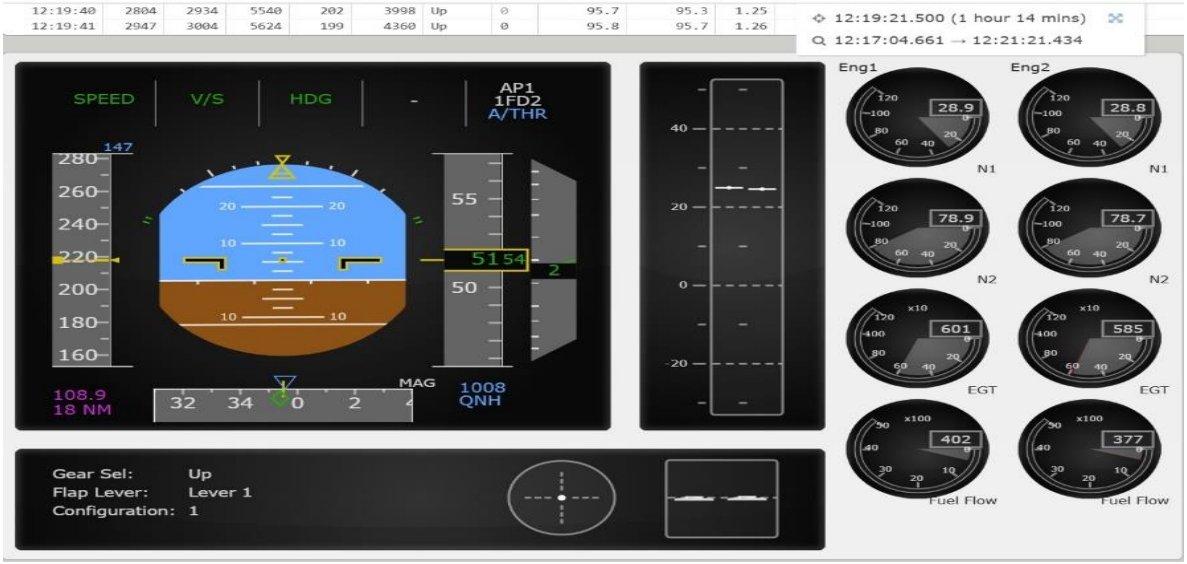


**Figure 8:** showing aircraft OMS104 observed on FDM climbing through ALT 5154FT to ALT 8000FT (Source: Salam Air)

1.1.18 During the interview, the Flight crew stated that during the descent they shallowed the ROD. As per the FDM the aircraft was observed climbing passing through 5154 FT as in figure 8. The Flight crew levelled off at around 5500FT as they were in Visual Meteorological Condition (VMC) with the terrain clearly insight and with sufficient terrain clearance (more than 2000 FT above the terrain highest point).

1.1.19 The Flight crew stated that while at RADAX to MCT they contacted ATCO while they were on left track deviation and requested to maintain HDG 340° to avoid weather (Wx) ahead. ATCO cleared the Flight crew to maintain HDG 340° and descend 8000FT with free speed as they were the only traffic and declared number 1 for the APP. The Flight crew was then

cleared by ATCO to descend to ALT 4000FT when visual with the terrain. Once the terrain was clearly visible, the Flight crew informed the ATCO and requested for HDG correction from 340° to 355° to stay clear of the high terrain and commenced the decent to ALT 4000FT with visual terrain clearance. At the time the Flight crew reported that they were clear of any terrain. The Flight crew reported that during the descent when GPWS warning came on, there was flat ground below, low terrain, airport on the right, cross runway in front, terrain to the left and the charts, the map, eyes and instruments were not showing any obstacle in front of the Flight crew. The Flight crew relied on the maps and the charts.

1.1.20 The Flight crew stated that during the descent they shallowed the ROD by decelerating and even slowed down to take flaps 1. The Flight crew got GPWS caution "Terrain Ahead" to which they adjusted their flight path by pushing to level off at around 5500FT as they were in VMC with the terrain clearly in sight and with sufficient clearance (more than 2000FT above). Shortly after they got GPWS warning "Pull up terrain" to which they promptly applied the memory actions of Pull up Take off / Go Around (TOGA) and followed the procedure till the warning stopped. The Flight crew reported that they performed the GPWS warning memory items and then requested radar vector for RWY08L approach which was granted by the ATCO. The GPWS Terrain Caution and Warning alerts lasted for a total of 26 seconds. ATCO was duly advised of the Flight crew manoeuvre and they requested radar vectors for the approach and it was normal operations thereafter, the Flight crew continued for a safe landing without further issues.

1.1.21 During the interview, the ATCO initially reported that was the evening shift and later changed it to the day shift. There was weather from the south, the Flight crew of aircraft OMS104 requested heading 340° to avoid weather from the right side overhead MCT due to the buildup Cumulonimbus (CB) clouds. The ATCO reported that aircraft OMS104 was number 1 on APP and they were approved to descend to 8000FT. Once the Flight crew were visual with terrain they were given clearance to descend 4000FT visually however the Flight crew requested to climb to 8000FT. The ATCO approved the request to climb to 8000FT and asked the Flight crew, if there was any issue with level or weather. The Flight crew responded and asked the ATCO to standby before requesting radar vector for ILS08L. Normal operations followed until traffic landed safely.

1.1.22 The ATCO further reported that the weather was on the right side and not on the route or heading of aircraft OMS104. There was no other aircraft that reported weather around MCT. The ATCO reported that aircraft OMS104 was the first from the south since ATCO started the shift duty.

1.1.23 The ATCO also reported that frequency has an issue with the radio system when the aircraft are coming from the south and are below FL200. The ATCO indicated that ATCO can hear the Flight crew however the Flight crew cannot hear the ATCO which results on one-way communications.

### 1.2. Injuries to Persons

1.2.1 No injuries were reported.

| Injuries | Pilot | Crew | Pass. | **Total on Board** | Other |
|---|---|---|---|---|---|
| Fatal | - | - | - | - | - |
| Serious | - | - | - | - | - |
| Minor | - | - | - | - | - |
| None | - | - | - | - | - |
| No Injuries | 2 | 5 | 224 | **231** | - |
| **Total** | **2** | **5** | **224** | **231** | **-** |

Note: Other means people on the ground.

### 1.3. Damage to Aircraft

1.3.1. There was no damage reported.

### 1.4. Other Damage

1.4.1 No other damages were reported

### 1.5. Personnel Information

1.5.1 Pilot-in-Command (PIC) -Pilot Flying-(PF)

| | | | |
|---|---|---|---|
| Nationality | Indian | | |
| Medical Validity | 24th .03.2025 | Licence Type | ATPL |
| Licence Validity | 30th .04.2028 | Type Endorsed | Yes |
| Ratings | A320 -PIC. Multi Engines, Instrument Rating | | |
| English Language Proficiency Level, Issue and Expiry Date | | | Level 6, 01st.05.2023 |
| LPC Issue Date | 13th .07.2024 | OPC Issue Date | 13th 07. 2024 |
| LPC Expiry Date | 31st 07. 2025 | OPC Expiry Date | 31st 01.2025 |
| Restrictions | None | | |
| Previous Accidents | None | | |

Note: Previous accidents/incidents refer to past accidents/incidents the pilot was involved in, when relevant.

1.5.1.1 According to the reviewed records on the Flight crew qualifications the PF undergo EGPWS/GPWS manoeuvre training every 6 months in a simulator during recurrent training.

Flying Experience:

| | |
|---|---|
| Total Hours | 6084:01 |
| Total Past 24 Hours | 03:21 |
| Total Past 7 Days | 15:26 |
| Total Past 30 Days | 61:28 |
| Total Past 90 Days | 192:18 |

1.5.2 First Officer (FO)-Pilot Monitoring (PM)

| | | | |
|---|---|---|---|
| Nationality | Omani | | |
| Medical Validity | 27th-09-2027 | Licence type | Commercial Pilot Aeroplane |
| Licence Validity | 31.01.2028 | Type Endorsed | Yes |
| Ratings | A320 Co-pilot, Multi Engines, Instrument Rating | | |
| English Language Proficiency Level and Expiry Date | | | Level 5, 28 January 2028 |
| LPC Issue Date | 25th.07.2024 | OPC Issue Date | 25th .07.2024 |
| LPC Expiry Date | 31st 07. 2025 | OPC Expiry Date | 31st 01.2025 |
| Restrictions | None | | |
| Previous Accidents | None | | |

Note: Previous accidents/incidents refer to past accidents/incidents the pilot was involved in, when relevant.

1.5.2.1 According to the reviewed records on the Flight crew qualifications the PM undergo EGPWS/GPWS manoeuvre training every 6 months in a simulator during recurrent training.

**Flying Experience:**

| | |
|---|---|
| Total Hours | 1258:37 |
| Total Past 24 Hours | 03:21 |
| Total Past 7 Days | 12:17 |
| Total Past 30 Days | 57:07 |
| Total Past 90 Days | 189:16 |

1.5.3 **Air Traffic Controller (ATCO)**

| | | | |
|---|---|---|---|
| Nationality | Omani | | |
| Medical valid | 19th May 2025 | Licence type | Air Traffic Controller |
| Licence valid | 30th April 2027 | Type endorsed | Yes |
| Ratings | APP, APP RDR | ELP, Level | ELP Last test 27th Aug 2023, Level 5 |
| Restrictions | None | | |

1.5.3.1 The ATCO was issued with ratings to allow operating as a controller at OOMS as APP and APP RDR. The last proficiency test was conducted on 12th February 2024.

1.5.3.2 The ATCO medical assessment was conducted on 1st May 2024 and the ATCO was issued a Class three (3) medical certificate on 2nd May 2024 with an expiry date of 19th May 2025.

## 1.6. Aircraft Information

1.6.1 The aircraft Airbus A321 family is a series of narrow-body airlines developed and produced by Airbus. The A320 was launched in March 1984, first flew on 22nd February 1987, and was introduced in April 1988 by France. The first member of the family was followed by the stretched A321 (first delivered in January 1994) The A320 is 37.6 m (123 ft) long and can accommodate 150 to 186 passengers. The 44.5 m (146 ft) A321 offers 185 to 230 seats. The Airbus A321-251N has CFM LEAP 1A engines.

Airframe:

| | | |
|---|---|---|
| Manufacturer/Model | Airbus A321-251N | |
| Serial Number | A321-251N | |
| Year of Manufacture | 2018 | |
| Total Airframe Hours (At Time of Serious Incident) | 10348:24 | |
| Last Inspection (Date & Hours) | 29th September 2024 | 10340 |
| Last Inspection Airframe Cycles (CSN) | 5260 | |
| Airframe Hours Since Last Inspection | 8 | |
| Type of inspection preformed | 1A Check | |
| CRS Issue Date | 29th September 2024 | |
| C of A (Issue Date & Expiry Date) | 30th August 2018 | 06th June 2025 |
| C of R (Issue Date) | 07th June 2023 | |
| Operating Category | II-Transport (passenger) | |
| Type of Fuel Used | MOBIL JET A1 | |
| Previous accidents/incidents/serious incidents | None | |

Note: Previous accidents/incidents refer to past accidents/incidents the aircraft was involved in, when relevant to this incident.

**Engine 1:**

| | |
|---|---|
| Manufacturer/Model | CFM/ LEAP-1A |
| Serial Number | 59C195 |
| Part Number | LEAP1A-32 |
| Hours Since New | 2561:54 |
| Hours Since Overhaul | Not Applicable (New Engine) |
| Hours since last shop visit | Not Applicable |
| Cycles Available Before Next Shop Visit | 8743 FC |
| Oil type | NYCO TURBONYCOIL 600 |

**Engine 2:**

| | |
|---|---|
| Manufacturer/Model | CFM/ LEAP-1A |
| Serial Number | 59C199 |
| Part Number | LEAP1A-32 |
| Hours Since New | 2561:54 |
| Hours Since Overhaul | Not Applicable (New Engine) |
| Hours since last shop visit | Not Applicable |
| Cycles Available Before Next Shop Visit | 8743 FC |
| Oil type | NYCO TURBONYCOIL 600 |

## 1.7. Meteorological Information

1.7.1. The weather below was obtained from the FDM:

| | | | | | |
|---|---|---|---|---|---|
| Wind Direction | | 010° | Wind Speed 03 Kts | Visibility | More than 10km |
| Temperature | 30°C | Cloud Cover | 2500ft (SCT025) | Cloud Base | 9000ft (BKN090) |
| Dew Point | 25°C | QNH | 1009 HPA | | |

1.7.2 The weather information below is from the Meteorological Routine Aerodrome Report (METAR) on the 30th October 2024 at 12:00 UTC:

| | | | | | |
|---|---|---|---|---|---|
| Wind Direction | | 070° | Wind Speed 05 Kts | Visibility | 9999 |
| Temperature | 30°C | Cloud Cover | 2500ft (SCT025) | Cloud Base | 9000ft (BKN090) |
| Dew Point | 25°C | QNH | 1008 HPA | | |

1.7.3. **Satellite Image**

Satellite show convective cloud over area may be CB cloud as showed in figures 9 and 10. Expected low cloud and convective cloud over the area and during time of incident Figure 7. Convective cloud can be found CB extend up to 39000FT associated with Thundershower rain, downdraft wind, wind shear and turbulence.

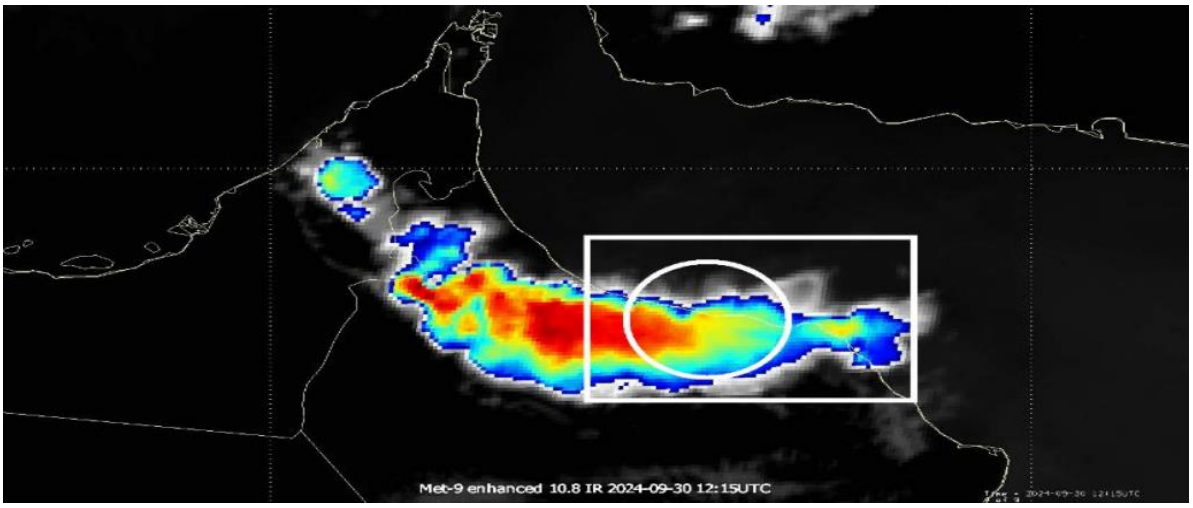


**Figure 9:** showing satellite image at the time 1200Z on the 30th September 2024 (Source: DGMET)

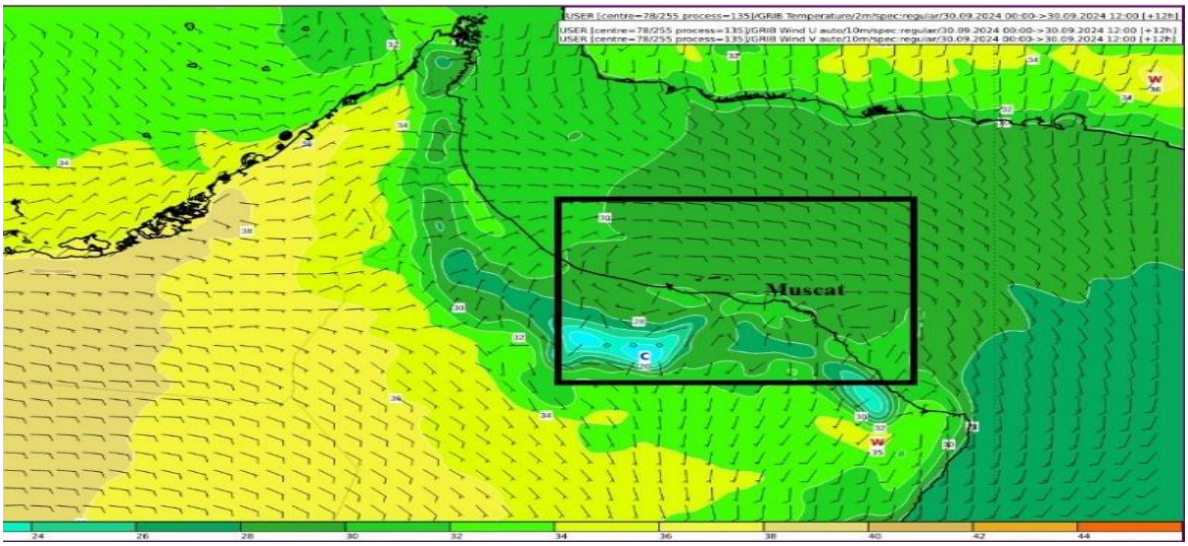


**Figure 10**: showing temperature and winds at the time 1200Z on the 30th September 2024 (Source: DGMET)

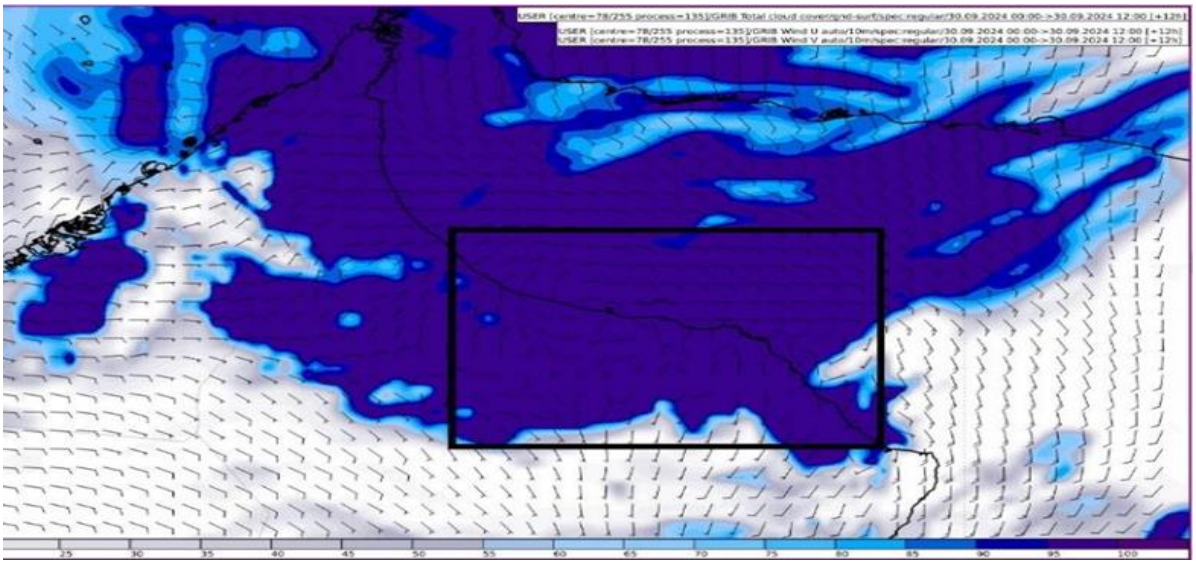

**Figure 11:** showing clouds with wind at the time 1200Z on the 30th September 2024 (Source: DGMET)

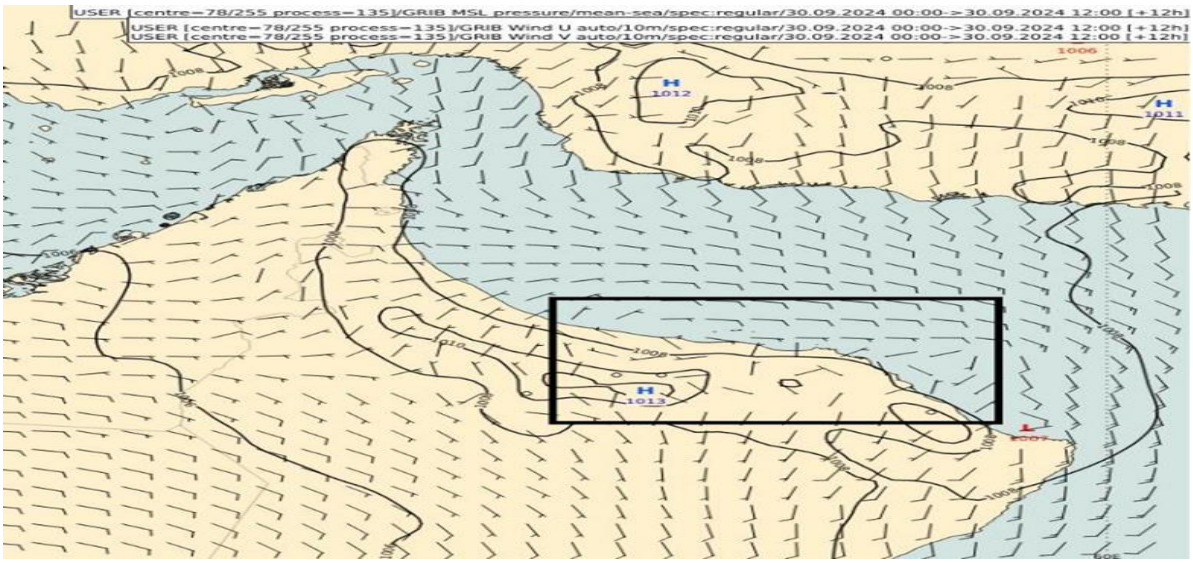


**Figure 12:** showing pressure with wind at the time 1200Z on the 30th September 2024 (Source: DGMET)

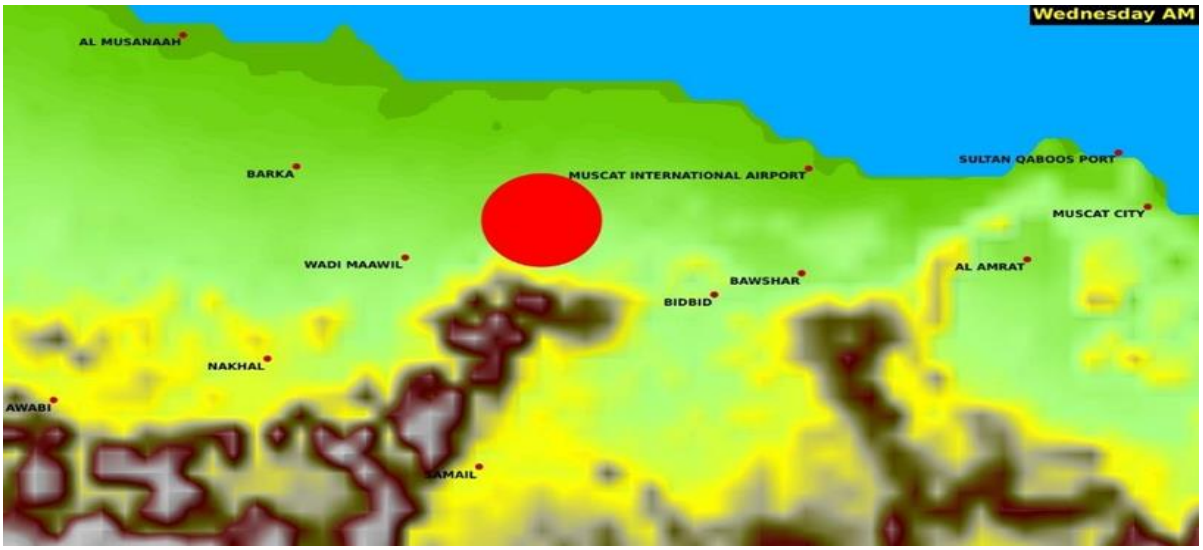


**Figure 13**: showing position of incident 23.415395N 057.992873 E-see red circle (Source: DGMET)

1.7.4. Significant weather condition was observed from the satellite image during the time of the incident over Oman FIR especially over Alhajar mountain at time (1215UTC) and covering the position of the serious incident. There was convective cloud around in the location of the serious incident and expected type of CB clouds which was extended up to 12000m (39000FT) approximately and associated thundershower rain, hail, downdraft, strong variable winds, strong wind shear, lighting and air turbulence.

1.7.5. According to the CAA DGMET weather report, a weather warning SEGMET over the incident location (23.23.04N 058.00.5 E) was issued. The warning SEGMET was about the expected CB cloud covering the incident location.

## 1.8. Aids to Navigation

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

1.8.2 The aircraft was equipped with EGPWS system which provided the Flight crew of aircraft OMS104 with a timely advisory, enabling them to avoid a potential catastrophic CFIT event. The system functioned as expected, proving its effectiveness in detecting terrain proximity and warning the Flight crew.

1.8.3 Open Descent Mode and Vertical Speed Management:

The flight was conducted in OPN DES mode, and the vertical speed was not actively selected which resulted in a variable rate of descent. Flying vertical speed manually may increase the risk of terrain proximity if vertical speed is not adequately monitored. In this serious incident, the Flight crew of aircraft OMS104 did not actively manage the descent rate, which led to the aircraft descending near high terrain before the GPWS caution was triggered.

## 1.9. Communication

1.9.1 The aircraft was equipped with a standard communication system as approved by the Oman CAA. There were no defects reported or records indicating that the communication system was unserviceable prior to the serious incident. The Flight crew were in contact with ATCO on frequency 121.2.

## 1.10. Airport Information

1.10.1. Departure Airport:

| | |
|---|---|
| Aerodrome Location | Salalah International Airport (OOSA) |
| Aerodrome Status | Licensed Airport (Open) |
| Aerodrome GPS coordinates | 17 02.3 N 054 05.5 E |
| Aerodrome Elevation | 73FT |
| Runway Headings/Designations | 07/25 |
| Dimensions of Runway Used | 3997m x 45m |
| Heading of Runway Used | 07 |
| Surface of Runway Used | Asphalt |
| Approach Facilities | ILS/RNAV APP |
| Category for Rescue Fire Fighting | CAT 9 |

1.10.2 Destination Aerodrome:

| | | |
|---|---|---|
| Aerodrome Location | Muscat International Airport (OOMS) | |
| Aerodrome Status | Licensed Airport (Open) | |
| Aerodrome GPS coordinates | 23°35′36″N 058°17′04″E | |
| Aerodrome Elevation | 25FT | |
| Runway Headings/Designations | 08R/26L | 08L/26R |
| Dimensions of Runway Used | 4080 x 60 M | 4000 x 60 M |
| Surface of Runway Used | Asphalt | |
| Approach Facilities | ILS, RNP, VOR, Runway Lights, PAPI’s | |
| Category for Rescue Fire Fighting | CAT 10 | |

## 1.11. Flight Recorders

1.11.1 The aircraft is fitted with Digital Flight Data Recorder (DFDR), Flight Data Monitoring (FDM) and Cockpit Voice Recorder (CVR). Both DFDR and CVR recorders were not downloaded as a result were over-written, therefore for the purpose of this investigation, OTSB relied on other flight information data sources such as FDM and Air Traffic Services (ATS) communication records to assist in the investigation. Figures below indicate the flight overview of the aircraft parameters as per the FDM.

**Minimum Safe Altitude (MSA):** 8500/9100FT
**Altitude at Trigger**: Approximately 5100FT

The Flight Data Monitoring (FDM) analysis of the GPWS warning event was conducted by the operator, and the following observations have been made regarding the aircraft's flight path, descent profile, and the crew's response. Figures below indicate the flight overview of the aircraft parameters as per the FDM for aircraft OMS104.

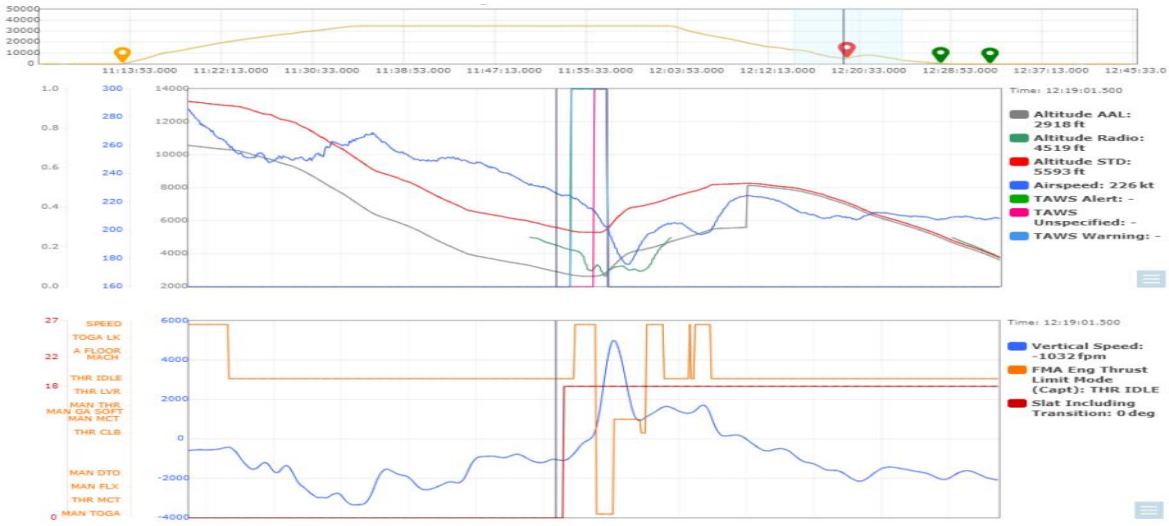


**Figure 14** indicates TAWS warning at 5593FT, Vertical Speed and Thrust Mode (aircraft OMS104-Source: Operator)

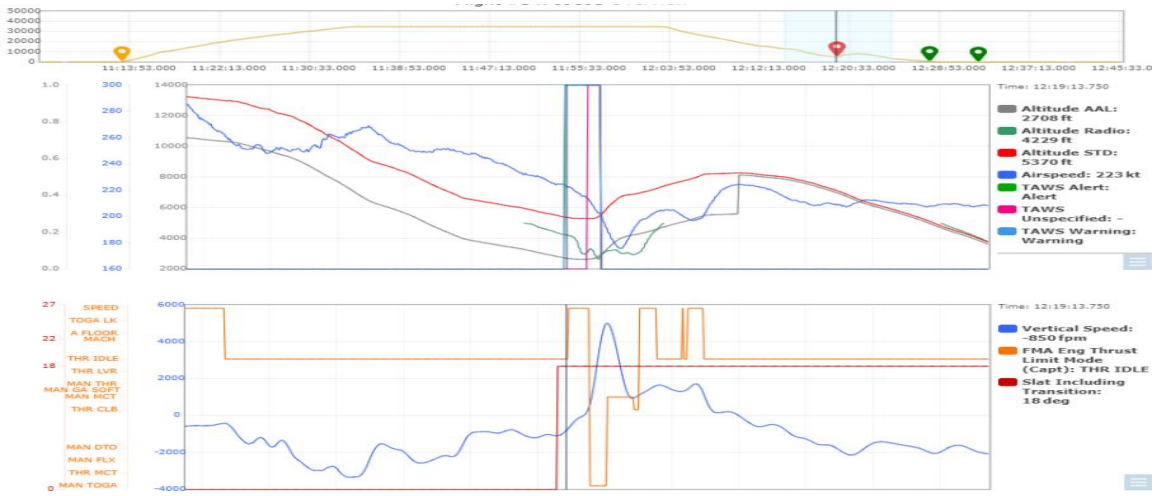


**Figure 15** indicates TAWS warning, Vertical Speed, Thrust Mode and Config 1 selected (aircraft OMS104-Source: Operator)


**Figure 16**: indicates GPWS recovery action (aircraft OMS104-Source: Operator)

## 1.12. Wreckage and Impact Information

1.12.1. Not relevant to the serious incident.

## 1.13. Medical and Pathological Information

1.13.1. Not relevant to the serious incident.

## 1.14. Fire

1.14.1. Not relevant to the serious incident.

## 1.15. Survival Aspects

1.15.1. Not relevant to the serious incident.

## 1.16. Tests and Research

1.16.1. Not relevant to the serious incident.

## 1.17. Organizational and Management Information

### 1.17.1 Salam Air:

1.17.1.1Aircraft OMS104 was operating as a scheduled domestic passenger flight.

1.17.1.2The operator, Salam Air was issued an Air Operating Certificate (AOC) by the State of Registry and State of Operator, the Sultanate of Oman CAA and revalidated on 29th January 2024. The Expiry date is as per applicable Sultanate of Oman Civil Aviation Regulations, which states that the certificate is valid until suspended or revoked. The certificate certifies that the SALAM AIR (S.A.O.C) is authorized to perform commercial air operations as defined in the operations specifications, in accordance with all applicable manuals and all the applicable Sultanate of Oman Civil Aviation Regulations. The aircraft OMS104 had valid certificate of Airworthiness at the time of the serious incident.

1.17.1.3The Operator, Salam Air have implemented Safety Management System (SMS), whereby occurrences are reported to the relevant authorities as and when they occur and they are reviewed, categorized, classified and investigated to identify the need for any gaps, risk assessment and risk management and remedial action that are required to be taken by the organization.

1.17.2 **Directorate General Air Navigation (DGAN):**

1.17.2.1The Air Navigation service provider, DGAN have implemented Safety Management System (SMS) which includes all its Air Traffic Services (ATS) units, whereby occurrences are reported to the relevant authorities as and when they occur and they are reviewed, categorized, classified and investigated to identify the need for any gaps, risk assessment and risk management and remedial action that are required to be taken by the organization. This occurrence was not reported by DGAN as the Flight crew did not report it to ATCO.

## 1.18. Additional Information

1.18.1 Salam Air Airlines: A320/A321 FLIGHT CREW OPERATING MANUAL
FLIGHT CREW OPERATING MANUAL
PROCEDURES ABNORMAL AND EMERGENCY PROCEDURES

| [MEM] EGPWS CAUTIONS |
|---|

❖ "TERRAIN TERRAIN" - "TOO LOW TERRAIN" - "CAUTION TERRAIN" - "CAUTION OBSTACLE"

❖ □ During night or IMC:

Simultaneously:

| |
|---|
| AP.....OFF |
| PITCH.....PULL UP |

L2

Pull to full backstick and maintain in that position.

L1

| |
|---|
| THRUST LEVERS..... TOGA |
| SPEED BRAKES lever.....CHECK RETRACTED |
| BANK.....WINGS LEVEL or ADJUST |

L2

Aircraft obtain the best climb performance when the wings are as level as possible. The Flight crew can adjust bank while climbing, provided that turning is the safest action.

L1

Note: For some airports, the operator may define a specific procedure.

| |
|---|
| DO NOT CHANGE CONFIGURATION (SLATS/FLAPS, GEAR) UNTIL CLEAR OF OBSTACLE. |

❖ □ **During daylight and VMC, with terrain and obstacles clearly in sight:**

| |
|---|
| FLIGHT PATH.....ADJUST |

L2

Adjust pitch, bank and thrust to silence the alert.

L1

Note: For some airports, the operator may define a specific procedure.

**"SINK RATE"**

□ **Above 1 000 ft AAL in IMC or above 500 ft AAL in VMC:**

| |
|---|
| FLIGHT PATH.....ADJUST |

L2
Adjust pitch and thrust to silence the alert.
L1
**Below 1 000 ft AAL in IMC or below 500 ft AAL in VMC:**

1.18.2 Salam Air Airlines A320/A321 FLIGHT CREW OPERATING MANUAL
AIRCRAFT SYSTEMS SURVEILLANCE
GPWS – DESCRIPTION

OVERVIEW

The purpose of the Ground Proximity Warning System (GPWS) is to warn the Flight crew of potentially hazardous situations, such as a collision with terrain. It detects terrain collision threats and triggers applicable aural and visual indications.

The GPWS includes:
- Five basic modes active up to radio height of 2 500 ft.
• Excessive rate of descent (Mode 1)
• Excessive terrain closure rate (Mode 2)
• Altitude loss after take-off or go-around (Mode 3)
• Terrain clearance not sufficient, if not in landing configuration (Mode 4)
• Excessive descent below the glide slope (Mode 5).
- A predictive GPWS  function, based on a GPWS database, to display terrain information. It can be provided:
• By Honeywell through Enhanced GPWS (EGPWS)
• By ACSS as Ground Collision Avoidance System (GCAS), through T2CAS or T3CAS.

The predictive GPWS is composed of:
• Mandatory functions such as the Forward Looking Terrain Alerting function
• Optional functions such as the obstacle database.
Note: The terrain data are displayed on the ND and the brightness is controlled via the weather radar brightness control knob. If the weather radar brightness was set to low (due to bad weather) and a terrain alert occurs, then the brightness of the terrain display will also below.

**PRINCIPLE**

The GPWS computes the geometric altitude of the aircraft by using:
- Pressure altitude
- Radio altitude
- Temperature
- Barometric references
- GPS altitude for predictive GPWS 
- Data from the GPWS database for predictive GPWS.

**MODE 1: EXCESSIVE RATE OF DESCENT**

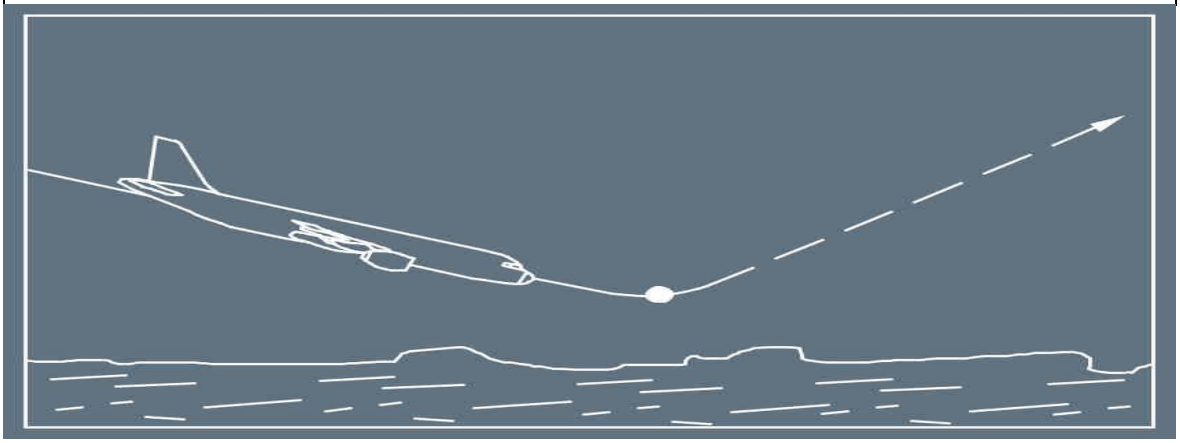

**Figure 17** showing Mode 1 excessive rate of descent (Source: Salam Air FOM)

Mode 1 triggers aural and visual alerts about excessive rates of descent, based on the radio height, and the rate of descent of the aircraft.
Mode 1 is active for all phases of the flight.

| | CAUTION | CAUTION |
|---|---|---|
| **AURAL ALERT** | "SINK RATE, SINK RATE" | "PULL UP" (repeated as long as MODE 1 is triggered) |
| **VISUAL ALERT** |  The GPWS amber lights come on |  The PULL UP red lights come on |

| MODE 2: EXCESSIVE TERRAIN CLOSURE RATE |
|---|

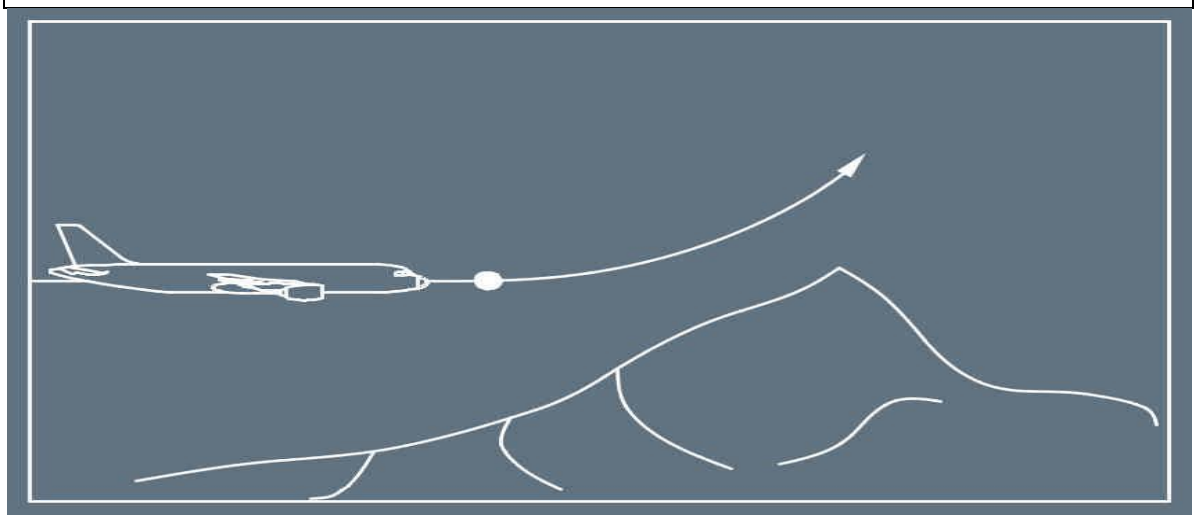

**Figure 18** showing Mode 2 excessive terrain closure rate (Source: Salam Air FOM)

Mode 2 triggers aural and visual alerts, based on the landing gear/flaps configuration of the aircraft, the radio height, and the RA rate of change.
There are two types of Mode 2 alerts, Mode 2A (active during climb, cruise, and initial approach), and Mode 2B (active during approach and 60 s after take-off).

| **CONFIGURATION** | **Flaps not in Landing Position + Landing Gear Up (Mode 2A) Flaps in landing position + Landing Gear Up (Mode 2B)** | | |
|---|---|---|---|
| | **CAUTION** | **WARNING** | |
| **AURAL ALERT** | "TERRAIN, TERRAIN" | "PULL UP" (repeated as long as MODE 2 is triggered in the warning conditions) | "TERRAIN" (repeated as long as MODE 2 is triggered after leaving the warning conditions) |
| **VISUAL ALERT** |  The GPWS amber lights come on |  The PULL UP red lights come on |  The PULL UP red lights come on |

### 1.18.3 Salam Air OPERATING PROCEDURES FLIGHT PREPARATION INSTRUCTIONS Visual Approach Minima (Appendix 1 to CAR-OPS 1.430 (k))

A Visual approach is an approach by an IFR flight when either part or all of an instrument approach procedure is not completed and the approach is executed in visual reference to the terrain.

The visual approach requires ATC approval, and the minima shall be the lowest of:
a) Associated non-precision approach; or
b) Cloud ceiling of at least MSA and reported visibility shall not be less than 5 km.

A pilot, on an instrument approach, may revert to a visual approach:

a) If it is required by ATC separation procedures, ATC may also require the sighting and/or following of an airplane on approach to the same or adjacent runway. The Commander of the aircraft shall be responsible for ensuring that the spacing from a preceding aircraft of a heavier wake turbulence category is acceptable. If it is determined that additional spacing is required, the flight crew shall inform the ATC accordingly, stating their requirements.
b) If it becomes more efficient to continue with the visual approach rather that complete the full instrument approach requirements. Anytime a visual approach is flown, the following points shall be highlighted in addition to the requirements of a normal approach briefing:
a) The Missed Approach Procedure;
b) Terrain awareness including the possibility of GPWS alerts;
c) The required visual references must be maintained throughout the approach, including runway presentation on the final approach;
d) Significance of meteorological and/or terrain conditions that may cause optical illusions.

Where possible, instrument approach aids should be utilized for approach guidance.

### 1.18.4 Salam Air OPERATING PROCEDURES FLIGHT PREPARATION INSTRUCTIONS MINIMUM FLIGHT ALTITUDES (CAR-OPS 1.250 and 1.365)

#### 1.18.4.1 Determining Minimum Flight Altitudes

The Minimum Flight Altitudes (MFA) are established by the states concerned for the ATS routes promulgated by them. Where MFA established by the States over flown are higher than those established by SalamAir, the higher values shall apply.

The Commander or pilot to whom conduct of the flight has been delegated shall not fly below the specified minimum altitudes except when necessary for take-off and landings.

No flights shall be dispatched at altitudes below the minimum flight altitudes specified by the states - they are published in the en-route and approach charts.

It the responsibility of pilots to maintain terrain clearance. Therefore, the chosen altitude should respect the obstacles clearance criteria at all times. Taking the importance of this requirement, detailed guidelines are included in this sub-section for information and compliance.

In establishing the MFA, the following factors are to be taken into consideration:
a) Accuracy with which the position of the aircraft can be determined;
c) The probability of encountering unfavourable meteorological conditions (e.g. severe

turbulence and descending air currents);
f) Characteristics of the terrain along the route;
h) Any contingencies along the planned route.

The objectives behind the promulgation of these minimum flight altitudes are to provide adequate terrain clearance along the route and to indicate the lowest Flight Level below which Air Traffic Services are not provided by the states concerned.

**Definitions**
The terms specific to minimum flight altitude are define as follows:
a) Minimum Flight Altitude (MFA): Minimum Flight Altitude may be issued by States to define lowest permissible altitude in Airways with in their territory. When issued the MFA shall be given in the en-route chart.
b) Minimum Safe Altitude (MSA): The altitude depicted on the Instrument Approach Chart / Standard Instrument Departure (SID) and Departure Chart and identified as the Minimum Safe Altitude provides a 1000 feet obstacle clearance within a 25 NM radius from the navigation facility upon which the MSA is predicted.
c) Minimum Obstacle Clearance Altitude (MOCA): The lowest published altitude in effect between radio fixes on VOR airways, off airway routes or route segments which meets obstacle clearance requirements for the entire route segment.

The MOCA values are published by the individual states and their calculation criteria may be different from ICAO standards. In such cases Route Manual publishes the criteria in ATC state pages - refer to NAVBLUE Flight guide- ATC Section.

The MOCA is a true altitude above MSL. It does not take into account the means of measuring aircraft altitude. If pressure altimeter is used for this purpose, the reading must be corrected for temperature and pressure datum.

d) *Minimum Off-Route Altitude (MORA)*: The MORA is calculated for an area bounded by every or every second LAT / LONG square on the route facility chart / terminal approach chart and is based on terrain clearance as given below:
– Up to 6000 feet: Provides a clearance of 1000 feet above the highest terrain and obstructions.
– Above 6000 feet: Provides a clearance of 2000 feet above the highest terrain and obstructions.
e) *Minimum En-route IFR Altitude (MEA)*: The lowest published altitude between radio fixes that meet obstacle clearance requirements between those fixes and in many countries assures acceptable navigational coverage.
f*) Minimum Vectoring Altitude (MVA)*: The lowest MSL altitude at which an IFR aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures and missed approaches. The altitude meets IFR obstacle clearance criteria. It may be lower than the published MEA along an airway off-route segment. It may be utilized for radar vectoring only upon the controller's determination that an adequate radar return is being received from the aircraft being controlled. Charts depicting minimum vectoring altitude are normally available only to the controller not to pilots.

**Application of Minimum Flight Altitudes**
As a general principle, no flight shall (except for the take-off or approach or landing) be operated below the minimum safe altitudes. The establishment of these altitudes does not preclude an aircraft to approach below them provided:
a) Adequate visual reference can be maintained;
b) The aircraft's position is within an area where lower minimum altitudes are applicable;
c) Radar vectoring is provided by an ATS unit; and
d) The aircraft is in conformity with an established instrument approach procedure.

The charts, in designating safe altitudes, use the terms MEA, MOCA and MORA. The MEA is the lowest IFR altitude meeting the requirement of both terrain and obstruction clearances and line of sight reception and in some cases ATC clearance altitude at which an aircraft may fly en-route. If radio and obstruction clearance requirements differ considerably a separate MOCA or MORA is also established.

**General Instructions**

It is of utmost importance that the Commander / Flight Operations Officer to ensure that the flight is planned and performed with adequate terrain clearance.

One of the main reasons for collision with terrain would be pilot's complacency factor or lack of a sense of immediate danger in the cockpit. It is suggested that the best remedy lies in the area of cockpit procedures, particularly during initial approach. It is imperative, during descent and approach, Captain and the Co-pilot independently monitor the navigation of aircraft and thus eliminate the possibility of gross navigational errors.

**Safety Altitudes** - Navigation is three dimensional and altitude should be monitored as well as the geographical position. It is important, therefore, that Pilot Monitoring, does not allow supplementary activities to reach a pitch such that he loses orientation of the aircraft's position or of its altitude. Particular attention should be paid to Safety Heights in the following circumstances:

a) If emergency descents have to be made;
b) If steep rates of descent are requested by the ATC, en-route;
c) If any deviation from standard tracks occurs;
d) When using Radar positioning at airports situated near high ground;
e) When using Navigation aids in mountainous terrain (aids can be quite unreliable and misleading, particularly at low altitudes);
f) If ATC clearance conflicts with Company determined safety altitudes.

1.18.5 **Salam Air FLIGHT DECK COMMUNICATION PROCEDURES (OM PART C: ROUTE MANUAL):**

1.18.5.1 **Communication Procedures:**

The flight crew shall continuously maintain air-ground communication watch on the appropriate communication channel at all times and shall comply with Radio Listening Watch Policy stipulated in OM A Chapter 8.3.19.15. However, the air-ground voice communication requirement may be satisfied by the use of SELCAL, CPDLC, or ADS-B function, where applicable (OM A Chapter 12.4.1 refers).

**Note:** Both pilots must monitor the appropriate ATC frequency whenever a clearance is being requested or received.

The pilot monitoring will normally be responsible for communications with ATC and, if that responsibility should have to change due, for example, completion of an emergency drill, or when the pilot monitoring leaves the flight deck for physiological needs, the responsibility for communications with ATC must be clearly established by the use of the phrase "I/YOU HAVE THE RADIOS".

If for any reason a pilot has to leave the ATC frequency, the remaining pilot must check that his audio panel is set correctly to maintain communications with ATC. When the pilot has completed his other activities, he must recheck that his audio panel is set correctly to re-establish communication with ATC. The returning pilot will be briefed of any changes to communications by the remaining pilot by the use of the phrase above and the addition of the details of the changes or the phrase "NO CHANGE".

**Radiotelephony (R/T) Language**

Flight Deck Communication shall be maintained in accordance with the policy specified in OM A Chapter 8.3.19.8. The call-sign established for the flight and the ICAO phonetic alphabet will be used during all radio communications. Language and phraseology compliant with ICAO Annex 10 Volume 2 (Communications Procedures) and ICAO Document 9432, Manual of Radiotelephony (See below references) will be used at all times and the use of idiomatic or colloquial expressions should be avoided, especially when communicating with persons for whom
English may not be the native language.

**ICAO Document 9432, Chapter 2, General Operating Procedures:**

Transmitting Technique:

The following transmitting techniques will assist in ensuring that transmitted speech is clear and satisfactorily received:

a) before transmitting, listen out on the frequency to be used to ensure that there will be no interference with a transmission from another station;

c) use a normal conversational tone, and speak clearly and distinctly;

g) avoid using hesitation sounds such as “er”;

1.18.6 **MUSCAT APPROACH CONTROL OPERATIONAL MANUAL (MATSOP), Chapter 10; RADIO COMMUNICATION PROCEDURES & CONTINGENCIES (**Source**:** DGAN**):**

1.18.6.1**Communications Technique & Standard Phraseology General**

Radiotelephony provides the means by which pilots and ground personnel communicate with each other. Used properly, the information and instructions transmitted are of vital importance in assisting in the safe and expeditious operation of aircraft. However, the use of nonstandard procedures and phraseology can cause misunderstanding.

**Transmitting Technique**

According to the ICAO Doc 9432 Manual of Radiotelephony the following transmitting techniques will assist in ensuring that transmitted speech is clearly and satisfactorily received:

(a) A slight pause before and after numbers will assist in making them easier to understand.

(b) Avoid introduction of hesitation syllables, such as 'er' or 'ah'.

**Standard Phraseology**

The need for clear and unambiguous communication between pilots and Air Traffic Control (ATC) is vital in assisting the safe and expeditious operation of aircraft. It is important, therefore, that due regard is given to the use of standard words and phrases and that all involved ensure that they maintain the highest professional standards when using radiotelephony (RTF). This is especially important when operating within busy sectors with congested frequencies where any time wasted with verbosity and non-standard, ambiguous phrases could lead to flight safety incidents.

Phraseology has been carefully developed to provide maximum clarity and brevity in communications while ensuring that phrases are unambiguous. However, while standard phraseology is available to cover most routine situations, not every conceivable scenario will be catered for, and radio-telephony (RTF) users should be prepared to use plain language when necessary following the principle of keeping phrases clear and concise. The phraseology detailed in this section has been established in accordance with ICAO PANSATM Doc.4444, Chapter 12 PHRASEOLOGIES.

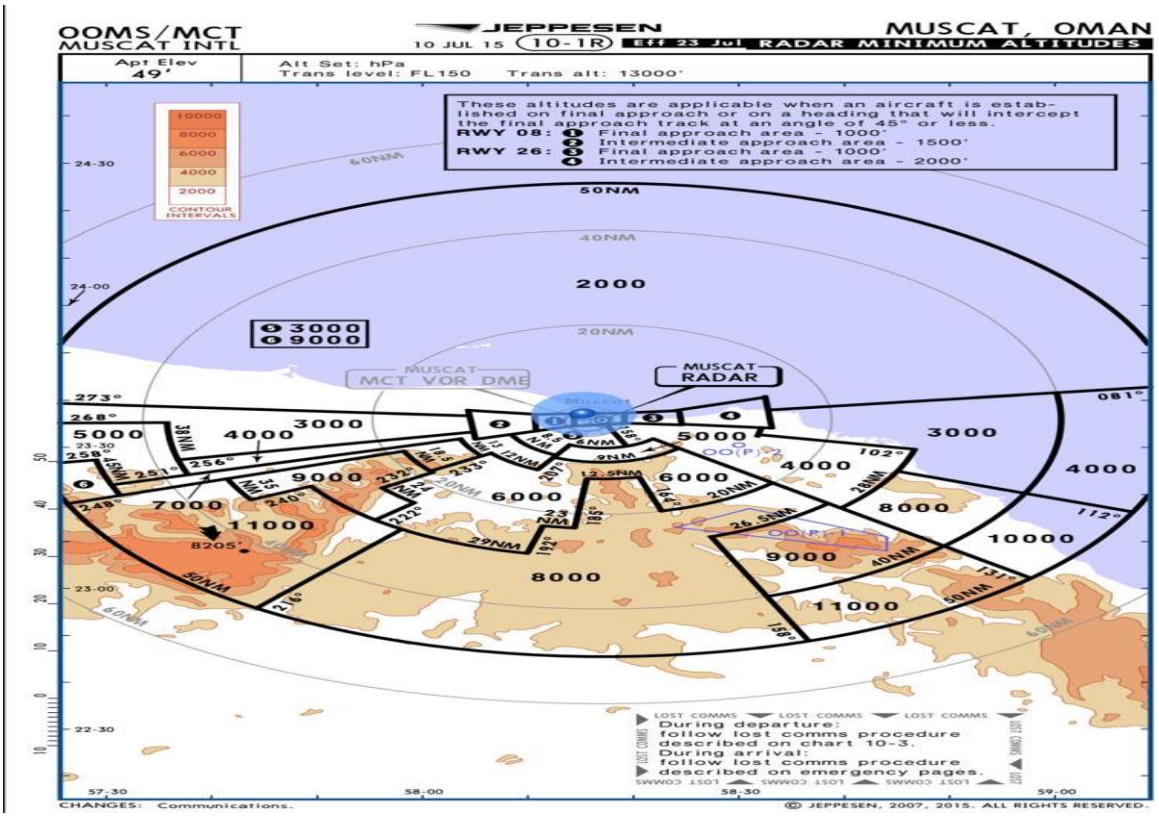


**Figure 19** indicates Jeppesen Chart Minimum Safety Altitude (MSA) 6000FT/8000FT for OOMS

## 1.19. Useful or Effective Investigation Techniques

1.19.1. Not relevant to the serious incident.

## 2. ANALYSIS

### 2.1 General:

From the available evidences, the following analysis were made with respect to this serious incident. This shall not be read as apportioning blame or liability to any organization or individual.

2.1.1 Aircraft OMS104 is owned by the operator, Salam Air. The operator is properly licensed by Oman CAA. The OTSB investigation team noted that the Operator (Airline) and the Air Navigation Service Provider, DGAN have implemented Safety Management System (SMS), whereby occurrences are reported to the relevant authorities as and when they occur and they are reviewed, categorized, classified and investigated to identify the need for any remedial action that are required to be taken by the organization. The operator has GPWS procedures in place, which the flight crew have promptly applied following the GPWS "pull up" terrain warning by applying the memory actions of Pull up TOGA and followed the procedure till the warning stopped. There were no anomalies identified with the safety culture of reporting occurrences from the Operator and DGAN. OTSB investigation team concluded that the organization of the operator was not a factor into the Serious incident. The operator, Salam Air had notified the DGCAR in Oman CAA and OTSB of the GPWS incident within the specified period as required by CAR13 and the operator's SMS procedures.

2.1.2 The investigation established that the serious incident was likely as a result of the flight crew lack of situational awareness due to high work load in avoiding weather, resulting in descending below minimum safe altitude triggering the EGPWS warning due to high terrain proximity.

2.1.3 The communications between the flight crew and the ATCO was characterized by frequency transmission overlapped/not clear) frequency was blocked or jammed however both the ATCO and the flight crew were able to confirm and verify the clearances and instructions, therefore communication was not a factor to the serious incident.

## 2.2 Flight operations

### 2.2.1 Flight crew Qualifications

2.2.1.1 The flight crew were properly licensed to operate the aircraft and their medical records didn't show any limitations or restrictions. At the time of the serious incident, both flight crew medical certificates were valid for the flights conducted. There was no issue with regard to the rest period of the flight crew, the flight crew were well rested prior to undertaking the operation of the incident flight. The investigation team concluded that flight crew was not fatigued, therefore fatigue was not a factor to the serious incident.

2.2.1.2 According to the reviewed records on the crew qualifications the flight crew of aircraft undergo EGPWS/GPWS manoeuvre training every 6 months in a simulator during recurrent training. The purpose of the training is to ensure that the flight crew are prepared to handle such alerts. The maneuvers required in response to these warnings are memory items in accordance to the manuals. The flight crew's actions reflected their adherence to the training, which effectively mitigated the risk of control flight into terrain (CFIT).

2.2.1.3 It is likely that the flight crew's attention became more focused on following the valley without concentrating in the surrounding high terrain as the aircraft transit, leading to an over-reliance on the aircraft's automated systems (i.e. "OPEN DESCENT" mode) and a lack of manual intervention to manage vertical speed or ensure terrain clearance. The focus could have reduced or distracted the flight crew ability to monitor the surrounding terrain and external environmental factors, such as weather and high ground to the northwest.

### 2.2.2 Operational procedures:

2.2.2.1 At the time 12:15:14, while proceeding inbound to OOMS for the ILS RWY08L, the flight crew informed ATCO that they are maintaining a heading 340° to avoid weather and ATCO approved it while on descent to 8000FT and the flight crew will advise once they are visual to commence visual positioning. ATCO acknowledged the request.

2.2.2.2 The Flight crew maintained 8000FT until visual, after that the flight crew commenced further descent to 4000FT. At the time 12:18:23, the flight crew informed ATCO that they are taking heading 355° to maintain terrain clearance, which was then acknowledged by the ATCO by stating "no objection self-position for final and no objection turn to the right or left".

2.2.2.3 Based on the FDM analysis and the observed flight path of the aircraft, it is likely that the increased workload on the flight crew and focus on visual descent and landing procedures contributed to a loss of situational awareness. The flight crew believed that the aircraft OMS104 was clear from the high terrain, however the aircraft was in close proximity to the terrain, resulting in a GPWS caution followed by the warning alert. OTSB determined that, it is most likely that during the descent through ALT 5100FT to 4000FT, the flight crew did not manage the descent rate which led the aircraft descending to close proximity of high terrain resulting in the GPWS caution followed by the warning alert. As a result, the flight crew reported that they are climbing and taking heading 060° followed by Radar vectors ILS RWY08L and cancelled visual approach following the GPWS warning in an attempt to correct and avoid the risk of terrain proximity.

2.2.2.4 During the interview, the flight crew stated that they had both the aural and visual warnings of the aircraft's proximity to high terrain warnings and the initial thought that could the warning be coming due to some tolerance in aircraft system believing that the aircraft was clear of the high terrain and reduced the rate of descend towards the high ground, resulting in a GPWS caution warning for 26 seconds. This may have been exacerbated by the demands of descent management resulting to non-adherence to the MSA during the critical phase of flight.

2.2.3 **Weather**

2.2.3.1 The information from the flight crew and the weather report from DGMET CAA indicated significant weather condition was observed from the satellite image during the time of the serious incident over Muscat FIR especially over Alhajar mountain during the time (12:15UTC) and covering the position of incident. There was convective cloud around in the location of the serious incident and expected type of CB clouds which was extended up to 12000m (39000ft) approximately and associated thundershower rain, hail, downdraft, strong variable winds, strong wind shear, lighting and air turbulence. Significant weather was observed during the time of the serious incident, the OTSB investigation team concluded that weather was a factor into the incident and it is likely that weather contributed to an increased workload of the flight crew, which contributed to a loss of situational awareness.

2.2.4 **Air traffic control**

2.2.4.1 The APP ATCO held the required licence and medical that was valid at the time of the serious incident which was issued by Oman CAA. ATCO provided pertinent information to the flight crew in relation to the flight and the track as the crew accepted the visual approach. OTSB investigation team determined that the ATCO qualifications were not a factor to the incident.

2.2.5 **Communications**

2.2.5.1 Although there were reported frequency transmission overlapped/not clear, frequency was blocked or jammed prior to the serious incident, there were no records or reported defects indicating that the communication system was unserviceable prior and after the serious incident flight, therefore communication equipment was not a contributing factor to the serious incident. Both the ATCO and the flight crew were able to confirm and verify the clearances and instructions and they were able to communicate prior to the serious incident even though they were experiencing radio transmission blockage, distortion, and jamming. During and after the serious incident the ATCO and the fight crew were able to communicate effectively, therefore communication including phraseology were not a contributing factor to the serious incident however the following communication and phraseology issues were observed:

2.2.5.1.1 At the time 12:11:00 the flight crew reported to ATCO that they were passing through FL180 descending to ALT 11000FT. At the time 12:11:10, ATCO replied to the flight crew to continue descend as cleared. At the time 12:11:15, the flight crew contacted ATCO requesting ATCO to repeat what ATCO last clearance by saying "Say again OMS104". At the time 12:11:16, ATCO replied "OMS104 continue as cleared".

2.2.5.1.2At the time12:11:20, the flight crew read back the clearance to ATCO "Continue as cleared OMS104".

2.2.5.1.3 At the time 12:12:36, the fight crew contacted Radar ATCO requesting their sequence. At the time 12:12:45, ATCO replied "Number one" and then ATCO corrected the reply "OMS104 number one".and then ATCO corrected the reply "OMS104 number one".

2.2.5.1.4At the time 12:12:59, the flight crew contacted ATCO to confirm if left heading 340° is confirmed by saying "Confirm approved, left heading 340". At the time 12:13:02, ATCO acknowledged by stating "Charlie-Charlie". At the time 12:13:03, the flight crew contacted ATCO" Confirm it's approved 340° for… (Transmission overlapped/not clear)" to confirm if

their request was approved. At 12:13:05 a further descent clearance to 8000FT by ATCO was given to the flight crew.

2.2.5.1.5 At the time 12:13:08, the flight crew acknowledged and replied to ATCO, “Copied descend 8000FT and left heading 340°” for .... (Transmission overlapped/not clear).

2.2.5.1.6 At the time 12:13:27, the flight crew informed APP ATCO that they have been blocked (Transmission overlapped/not clear). At the time 12:13:46, the flight crew asked ATCO to confirm left heading 340° approved? (Transmission overlapped/not clear)

2.2.5.1.7 At the time 12:14:17, APP ATCO received a call from TWR ATCO informing that someone is calling and APP ATCO realized that the frequency was blocked. At the time 12:14:22, the flight crew asked APP ATCO how does it read and APP ATCO replied “5 by 5 descend 8000”. The flight crew did not read back ATCOS reply and the ATCO did not challenge the flight crew for not reading back. It is possible that during this period the radio was blocked.

2.2.5.1.8 At the time 12:14:30, the flight crew acknowledged the clearance from ATCO to descend through to ALT 8000FT on a and heading 340° heading as previously requested.

2.2.5.1.9 At the time 12:14:37, ATCO replied “Roger OMS104 how do you read, we approved it for you once”. At the time 12:14:40, the flight crew replied “We were not sure because we had static on the frequency due weather OMS104, we just wanted to reconfirm”

2.2.5.1.10 At the time 12:14:47, ATCO asked the flight crew if they are happy, in order to clear them to descend visually. At the time 12:14:54, the flight crew acknowledged by saying “Ok we'll take the visual in a bit we just clearing some weather as of right now we'll advise once ready OMS104 continuing 8000FT” and the flight crew continued their descent to 8000FT.

2.2.5.1.11 At the time 12:15:02 ATCO acknowledged “Charlie-Charlie”. At the time 12:15:07, ATCO asked the flight crew if they were able for waypoint ILILA after ILILA to ITLAK no objection.

2.2.5.1.12 At the time 12:15:14, the flight crew informed ATCO that they are staying on heading 340° and they will advise once they are visual to commence visual positioning. At the time 12:15:07 ATCO acknowledged the request by stating “Charlie-Charlie”.

2.2.5.1.13 The flight crew maintained 8000FT till visual, at 12:16:43 the flight crew completely visual and requested further descend. At 12:16: 52 the ATCO cleared the flight crew to commence further descent to 4000FT. At the time 12:18:23, the flight crew informed ATCO that they are taking heading 355°, which was then approved by the ATCO by stating “no objection self-position for final and no objection turn to the right or left”. At 12:18:53 the ATCO advised the flight crew are cleared to descend 2000 FT and cleared for ILS r/W 08L to call established. The flight crew accepted the message by replaying “Descend 2 thousand feet visually eh cleared ILS approach RWY 08 left next report once fully established OMS104” Although ATCO approved and cleared the flight crew to descend to 2000FT visually for self-position R/W 08 L and the flight crew readback the clearance from the ATCO the interview the flight crew indicated that the ATCO did not inform them about the proximity of high terrain along their flight path and that the responsibility for the descent profile was delegated to the flight crew, and did not account for terrain risks. According to the operators operating procedures on minimum flight altitudes the responsibility to maintain terrain clearances during a visual approach is the responsibility of the flight crew and the chosen altitudes shall respect the obstacles clearance and terrain criteria at all times. The procedures further states that where the Minimum Flight Altitude (MFA) established by states over flown are higher than those established by Salam Air, the higher values shall apply. Therefore, OTSB determined that the ATCO provided the required instruction and it was the responsibility of the flight crew to ensure that the aircraft is flown within and to maintain terrain clearance and obstacles clearance criteria at all times.

2.2.5.1.14 At the time 12:19:00 the EGPWS warning triggered to "Pull Up terrain" to which the flight crew applied memory action procedures and the Flight crew advised ATCO.

2.2.5.1.15 At the time 12:20:02 the Flight crew set climb to above Minimum Safe Altitude (MSA) 8000FT and they requested vector for ILS RWY08L and normal ops thereafter. However, when the serious incident occurred the aircraft was at ALT 5100FT instead of MFA/MSA of 8000FT as required by the procedures. The operator operating manual states where MFA established by the States over flown are higher than those established by the operator, the higher values shall apply. The Commander or pilot to whom conduct of the flight has been delegated shall not fly below the specified minimum altitudes except when necessary for take-off and landings. The operating manual further states that when establishing the MFA, the Flight crew shall take into consideration the accuracy with which the position of the aircraft can be determined and the characteristics of the terrain along the route.

2.2.5.1.16 The Flight crew asked ATCO to standby by stating “OMS104: Eh… standby OMS104”. The Flight crew used the incorrect phraseology as per the operator’s communication procedures which refers to ICAO DOC 9432 on radio telephony language which requires that the use of hesitation syllables, such as 'er' or 'ah' should be avoided and not be introduced during the radio telephony.

2.2.5.1.18 ATCO asked the Flight crew if they had any weather by stating “OMS104 confirm do you have any weather” during their climb to the MSA and the Flight crew asked ATCO to standby by stating “OMS104: Eh… standby OMS104”. After 1 to 3 seconds the Flight crew requested ATCO heading 060° and cancelled the previous request. The Flight crew before this conversation were handling the GPWS warning however they did not report the serious incident to the ATCO as per the operator SMS manual nor explain the reason for cancelling the visual descent and requesting heading 060° radar vectors ILS08L.

2.2.6 **Aids to navigation**

2.2.6.1 The navigational system onboard aircraft was found to be serviceable and operated as required at the time of the serious incident. Therefore, OTSB investigation team determined that the navigational aids were not a factor to the serious incident.

2.2.7 **Aerodrome**

2.2.7.1 The serious incident happened in flight during descent on approach, therefore, OTSB investigation team determined that the aerodrome was not a factor to the serious incident.

## 2.3 Aircraft

2.3.1 The aircraft was issued with valid Certificate of Airworthiness (CoA) and Certificate of Registration (CoR), the maintenance records of the aircraft did not reveal any abnormality in the maintenance standard requirements. The aircraft was certified and maintained in accordance with existing regulations and approved procedures. There was no pre-existing defects or conditions that contributed to the occurrence.

2.3.2 The aircraft was equipped with EGPWS system which provide the Flight crew with a timely advisory, enabling them to avoid a potential catastrophic CFIT event. The system functioned as expected, proving its effectiveness in detecting terrain proximity and warning the Flight crew.

## 2.4 Human Factors

2.4.1 Based on the FDM analysis and the Flight crew interviews and statements revealed that the Flight crew thought they were clear of high terrain, despite being aware of the high terrain in the southern region descending towards an area of high terrain hence the GPWS warning. The GPWS caution triggered at approximately 1000FT AGL, prompting the Flight crew to disengage the autopilot and execute the EGPWS memory items, avoiding the terrain. It is likely that the serious incident was as a result of lack of situational awareness due to the

Flight crew workload caused by weather and visual approach and descend procedures to maintain the terrain MSA during the descent where the MSA was 9100FT.

2.4.2 The Flight crew thought that the aircraft OMS104 was clear of terrain but actually were descending towards high ground, resulting in a GPWS caution warning. It is most likely that during the descent to 4000FT the Flight crew were having ambiguity in height of the terrain that they thought it was lower than it should be, which led to the aircraft descending close to the high terrain. The Flight crew continued their descent towards the southwest sector, where the MSA was significantly higher at 9100FT resulting on the GPWS caution and then warning being triggered. The Flight crew requested to take heading 060° Radar vector ILS RWY08 and cancelled visual approach in an attempt to correct and avoid the risk of terrain proximity.

2.4.3 The Flight crew indicated that the ATCO cleared the aircraft to descend to 4000FT, however during the interview the Flight crew, indicated that the ATCO did not inform the Flight crew about the proximity of terrain along their flight path". The Flight crew acknowledged the response from ATCO.

2.4.4 According to the operator's operating procedures on MFA the responsibility to maintain terrain clearances is the responsibility of the pilots and the chosen altitudes shall respect the obstacles and terrain clearance criteria at all times. The procedures further states that where the MFA established by states over flown are higher than those established by Salam Air, the higher values shall apply. Therefore, OTSB determined that the ATCO provided the required instruction and it was the responsibility of the Flight crew to ensure that the aircraft is flown within and to maintain terrain and obstacle clearance criteria at all times.

2.4.5 There was no evidence that incapacitation or physiological factors affected the Flight crew and ATCOs performance. There was no evidence that the Flight crew suffered any sudden illness or incapacity which might have affected the Flight crew's ability to control the aircraft.

### 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 serious incident as there was no fire during and after the serious incident.

## 3. CONCLUSION

### 3.1. General

From the available evidence, 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 organization or individual.

To serve the objective of this investigation, the following sections are included in the conclusion heading:

- **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.

### 3.2. Findings

3.2.1 The Flight crew were properly licensed to conduct the flight. Their licenses were valid and issued by Oman CAA.

3.2.2 Aircraft was properly registered and issued with Certificate of Airworthiness and Certificate of Registration by Oman CAA and both certificates were valid at the time of the incident.

3.2.3 The ATCO was issued with Air Traffic Controller license by Oman CAA on the 21st December 2011 and a proficiency check was conducted on the 18th Feb 2024 with an expiry date of the 31st December 2026.

3.2.4 There was no evidence that incapacitation or physiological factors affected the Flight crew and ATCOs performance. There was no evidence that the crew suffered any sudden illness or incapacity which might have affected Flight crew's ability to control the aircraft.

3.2.5 During approach to OOMS for the ILS RWY08L, the Flight crew, requested a deviation to avoid weather (HDG 340°), which was approved by ATCO along with a descent to 8000FT. A further adjustment to heading 355° was requested by the fight crew in order to maintain terrain clearance.

3.2.6 The Flight crew experienced radio static on the frequency due to weather.

3.2.7 At the time 12:13:08, the Flight crew read back the clearance to the ATCO, "Copied descend 8000FT and left heading 340°". It was heard during the ATC playback the (Transmission overlapped/not clear) frequency was blocked or jammed.

3.2.8 The Flight crew informed ATCO that they have been blocked (Transmission overlapped/not clear). The Flight crew asked ATCO to confirm left heading 340° approved? (Transmission overlapped/not clear was heard during playback). Frequency was blocked or jammed and there was no reply from ATCO.

3.2.9 ATCO received a call from TWR ATCO informing that someone is trying to call him APP ATCO and APP ATCO realized that the frequency was blocked. The Flight crew asked ATCO how do you read and ATCO replied "5 by 5 descend 8000".

3.2.10 The Flight crew had been cleared by ATCO to descend to ALT 4000FT after they reported visual of the terrain.

3.2.11 The Flight crew elected to descent visually despite the reported weather conditions at the serious incident site.

3.2.12 The ATCO cleared the Flight crew to descent visual to 4000FT, ATCO did not to update the Cleared Flight Level (CFL) on the ATC radar system from 8000FT to 4000FT on the Radar system which resulted in activating the LB function.

3.2.13 ATCO asked the Flight crew if they had any weather by stating "OMS104 confirm do you have any weather" and the Flight crew asked ATCO to standby by stating "OMS104: Eh… standby OMS104". Therefore, the Flight crew did not inform ATCO regarding the presence of weather neither did the ATCO challenge the Flight crew.

3.2.14 The Flight crew used the incorrect phraseology as per ICAO DOC 9432 which requires that the use of hesitation syllables, such as 'er' or 'ah' should be avoided and not be introduced during the radio telephony.

3.2.15 The Flight crew requested from ATCO heading 060° and to cancel the previous request without mentioning the reasons for the cancellation nor reporting the GPWS warning to ATCO.

3.2.16 The Flight crew, reported that as they were approaching 4000FT and while reducing vertical speed and received a GPWS "Terrain Ahead" caution the Flight crew had adjusted the flight path via push to level off.

3.2.17 The flight was conducted in OPN DES mode, which resulted in a variable rate of descent. This mode may increase the risk of terrain proximity if vertical speed is not adequately monitored. In this case, the crew did not actively manage the descent rate, which led to the aircraft descending near high terrain before the GPWS caution was triggered.

3.2.18 There were no records or reported defects indicating that the communication system was unserviceable prior and during the incident flight.

### 3.3. Cause

3.3.1 The probable cause of the serious incident was likely as a result of the Flight crew lack of situational awareness resulting in descending below minimum safe altitude triggering the EGPWS warning due to high terrain proximity.

### 3.4. Contributing Factors

3.4.1 The Flight crew thought they were clear of high terrain.

3.4.2 The Flight crew descending below MSA.

3.4.3 The Flight crew did not adequately monitor and manage the vertical speed.

## 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 heading 3 of this report. The OTSB expects that all safety issues identified by the investigation are addressed to the receiving States and organizations/entities.

### 4.2. Safety Recommendations

4.2.1 Following the serious incident the operator took the following corrective safety measures by providing the crew with Ground Refresher Training focused on the following areas:

4.2.1.1 Increased Terrain Awareness and proactive vertical speed management.

4.2.1.2 Workload Management and Weather Considerations.

4.2.1.3 Procedures for EGPWS Avoidance and Awareness.

4.2.1.4 Crew Resource Management (CRM) Enhancements.

4.2.2 In the interest of aviation safety OTSB recommends the following:

4.2.2.1.1 The flight crew used the incorrect phraseology as per ICAO DOC 9432 which requires that the use of hesitation syllables, such as 'er' or 'ah' should be avoided and not be introduced during the radio telephony. OTSB recommends the operator to issue a notice to the Flight crew regarding the importance of using standard phraseology.

4.2.2.1.2 The operating manual state that when establishing the Minimum Flight Altitude (MFA), the flight crew shall take into consideration the accuracy with which the position of the aircraft can be determined and the characteristics of the terrain along the route. Therefore, OTSB recommends the operator to issue safety notice to the flight crew to comply with the Standard Operating Procedures (SOPs) regarding flying below the specified MFA.

4.2.2.1.3 The ATCO asked the flight crew if they had any weather by stating “OMS104 confirm do you have any weather” and the flight crew asked ATCO to standby by stating “OMS104: Eh… standby OMS104”. Therefore, the Flight crew did not inform ATCO regarding the presence of weather neither did the ATCO challenge the Flight crew. The Flight crew responded to the GPWS warning by initiating the climb and requested radar vectors without advising the ATCO for the reason to climb as the ATCO thought the climb was due to weather and the flight crew advised ATCO to standby. Therefore, the ATCO was not aware that OMS104 actions were due to a GPWS warning.OTSB recommends for Salam Air to consider developing procedures for flight crew to report to ATC after encountering GPWS.

## 5. APPENDICES

5.1 Not applicable.

**This report is issued by:**
Oman Transport Safety Bureau (OTSB)
Sultanate of Oman