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

Oman Transport Safety Bureau

Preliminary Report

OTSB Case File No: AIFN-003/05/2024

TCAS Resolution between

Two Salam Air Aircraft Airbus A320-200, A4O-OXD and

Airbus A320-200, A4O-OXB in the

Muscat FIR Next to OOMS

Operator: Salam Air
Make and Model: Airbus A320-200
Nationality and Registration Marks: Sultanate of Oman, A4O-OXD

Operator: Salam Air
Make and Model: Airbus A320-200
Nationality and Registration Marks: Sultanate of Oman, A4O-OXB

Location of the Occurrence: Muscat FIR, 20°32’58.39’’N059°59’05.57E
State of Occurrence: Sultanate of Oman
Date of Occurrence: 13th May 2024, 07:10 UTC
Date of Publication: 13th June 2024

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Purpose of the Investigation

The investigation was conducted by Oman Transport Safety Bureau pursuant to Civil Aviation Law (CAL) 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 preliminary 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
AMSL	Above Mean Sea level
AFL	Actual Flight Level
AAI	Air Accident Investigations
AIP	Aeronautical Information Publication
ANSIC	Air Navigation Service Incident Coordination
APW	Area Proximity Warning
ATC	Air Traffic Control
ATCO	Air Traffic Controller
AWY	ATC Airway
BEA	Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile
CAA	Civil Aviation Authority
CAL	Civil Aviation Law
CFL	Cleared Flight Level
CPA	Closest Point of Approach
CR	Central Radar
CVR	Cockpit Voice Recorder
FIR	Flight information Region
FL	Flight level
FMS	Flight Management System
FO	First Officer
FPL	Flight Plan
FPM	Feet Per Minute
Ft	Feet
ICAO	International Civil Aviation Organization
IIC	Investigator-in-Charge
LPC	License Proficiency Check
MATSOP	Manual of Air Traffic Standard Operating Procedures

MCT	Muscat
ND	Navigation Display
NM	Nautical Mile
OOMS	Muscat International Airport
OPC	Operator Proficiency Check
OTSB	Oman Transport Safety Bureau
PF	Pilot Flying
PFD	Primary Flight Display
PM	Pilot Monitoring
RA	Resolution Advisory
RDR	Radar
ROC	Rate of climb
ROD	Rate of descent
RVSM	Reduced Vertical Separation Minima
RWY	Runway
SEP	Separation
SOP	Standard Operating Procedures
STCA	Short Term Conflict Alert
SQK	Squawk
SQ	SSR Code Conformance alert
TA	Traffic Advisory
TAU	The Estimated Time
TCAS	Traffic Collision Avoidance system
VOR	VHF Omni-directional Range

Synopsis

Oman Transport Safety Bureau (OTSB) was notified of the occurrence by the operator through OTSB email on 14th May 2024 at 10:02 Local Time (LT) AM 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 15th of May 2024 at 13:11 LT PM.

On the 13th May 2024 at 06:39 UTC, Salam Air aircraft OMS258 with registration marks A4O-OXD, an Airbus A320-200 departed from Fujairah International Airport (OMFJ) on an international scheduled flight with intended destination Muscat International Airport (OOMS), Oman, Muscat. While another Salam Air aircraft OMS134 with a registration marks A4O-OXB, an Airbus A320-200 on the same morning at 06:24 UTC, departed from Duqm Airport (OODQ) on a domestic scheduled flight with intended destination Muscat International Airport (OOMS).

Aircraft OMS258 was coming from the North West, and after ATCO gave a heading clearance to avoid R7 restricted area, aircraft OMS258 continued to MCT VOR approaching it from the North. Around the same time Aircraft OMS134 was coming from the south to MCT VOR and cleared by ATCO to descend to 8000 feet (ft). After aircraft OMS258 was cleared from R7 restricted area, ATCO instructed it to descend to 7000 feet and to leave MCT VOR on a heading 290. The ATCO expected OMS258 to make a left turn to heading 290.

When OMS258 flow overhead MCT descending to 7000ft, it maintained its heading for few seconds, then started turning right while confirming with the ATCO on the turning direction. By the time the ATCO replied to turn left, OMS259 and OMS134 (which was coming from the south and descending to 8000ft) lost separation and RA was triggered. The closest distance between the two aircraft was 1 NM. The incident occurred over Muscat FIR, during day time. At the time of the incident, the ATCO reported that there were more than 10 aircraft in the vicinity.

Both aircraft continued to their destinations and landed safely without any further incident.

The OTSB instituted an investigation and classified the occurrence as a Serious Incident requiring investigation. The following parties were notified:

- State of Design and Manufacturer of Airbus A320-200 France-Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile (BEA), French Safety Investigation Authority.
- International Civil Aviation Organization (ICAO)
- Oman Civil Aviation Authority (CAA)

In line with OTSB Investigation procedures, the Director of OTSB appointed an Investigator-In-Charge (IIC) and an investigation team to assist the IIC with the investigation.

The following investigation authority is involved in the investigation by appointing accredited representatives and advisor to the investigation: -

- State of Design and Manufacturer of Airbus A320 France-Bureau d'enquêtes et d'analyses pour la sécurité de l'aviation civile (BEA), French Safety Investigation Authority

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.

1. Factual Information.

1.1. History of the Flight.

1.1.1. On the 13th May 2024 at 06:39 UTC, Salam Air with registration marks A4O-OXD, an Airbus A320-200 departed from Fujairah International Airport (OMFJ) on an international scheduled flight OMS258 with intended destination Muscat International Airport (OOMS), Oman, Muscat. While another Salam Air with a registration marks A4O-OXB, an Airbus A320-200 on the same morning at 06:24 UTC, departed from Duqm Airport (OODQ) on an international scheduled flight OMS134 with intended destination Muscat International Airport (OOMS).

1.1.2. At 06:55:50, aircraft OMS258 reported to Muscat radar controller that they were routing to MCT VOR at flight level (FL)160. The radar controller then contacted Muscat approach controller and handed over aircraft OMS258 who reported the QNH1008 and cleared it to descend to altitude 13000 ft direct to MUSANAH. At 06:56:05, ATCO contacted the crew of OMS258 and corrected the destination from MUSANAH to MCT and to expect vectors for ILS RWY 08L. The crew of OMS258 read back and acknowledged.

Figure 1 showing aircraft OMS258 34nm from north west (NW) of MCT (Source: Flight radar 24)

1.1.3 Aircraft OMS134 was flying to MCT from the South. At 07:00:31, the crew of OMS134 contacted MCT Approach who cleared the crew of OMS134 to descend to FL160. At this time aircraft OMS134 was 50nm from MCT descending to FL160 and aircraft OMS258 was 34nm from MCT maintaining altitude of 13000ft.

Figure 2 showing aircraft OMS134 was approaching MCT from the South
(Source: Flight radar 24)

1.1.4 At 07:03:09, the crew of OMS134 requested to descend and the ATCO responded and issued a clearance to the crew of OMS134 clearance to descend to altitude 8000 ft with QNH1008.

1.1.5 At 07:03:28, ATCO instructed the crew of OMS258 to avoid R7 restricted area, and to turn left heading (HDG) 110. The crew of OMS258 acknowledged and avoided R7 while maintaining altitude13000 ft.

1.1.6 At 07:05:00, ATCO requested the crew of OMS258 to leave MCT on HDG 290. At 07:05:13 the crew of OMS258 replied that they are not proceeding to MCT. ATCO responded “I will give you shortly HDG standby”. At 07:05:17, the crew of OMS258 informed ATCO that they were maintaining altitude 13000 ft on HDG of 110. At this time, meanwhile aircraft OMS258 was 13nm north of MCT at 230kt indicated airspeed and aircraft OMS134 was 24nm south of MCT at 277kt indicated airspeed descending through altitude 13500 ft for altitude 8000 ft.

Figure 3 showing aircraft OMS134 at 24nm south of MCT
(Source: Flight radar 24)

1.1.7 At 07:05:23, ATCO cleared aircraft OMS258 to route direct to MCT VOR and to expedite the descend to 10000 ft. Aircraft OMS258 which was 11 nm to MCT VOR at altitude 13000 ft started descending to MCT VOR at around 2500ft/min and increased speed to 278kt.

1.1.8 At 07:06:39, aircraft OMS258 was about 5.5nm to MCT VOR and the crew of OMS258 reported to ATCO that they were approaching MCT VOR. At 07:06:43, ATCO responded and cleared the crew of OMS258 to descend to 7000 ft. At this time, in the ATCO screen, the yellow Short Term Conflict Alert (STCA) was activated between aircraft OMS258 and aircraft OMS134. Aircraft OMS258 was descending through 10500 ft at a rate of descent of 1100ft/min, and aircraft OMS134 was descending through 10100 ft at rate of descent of 700ft/min. At 07:06:45, the ATCO cleared the crew of OMS258 to descend to 7000ft and the crew of OMS258 acknowledged and continued the descend. The distance between both traffic was 19 NM.

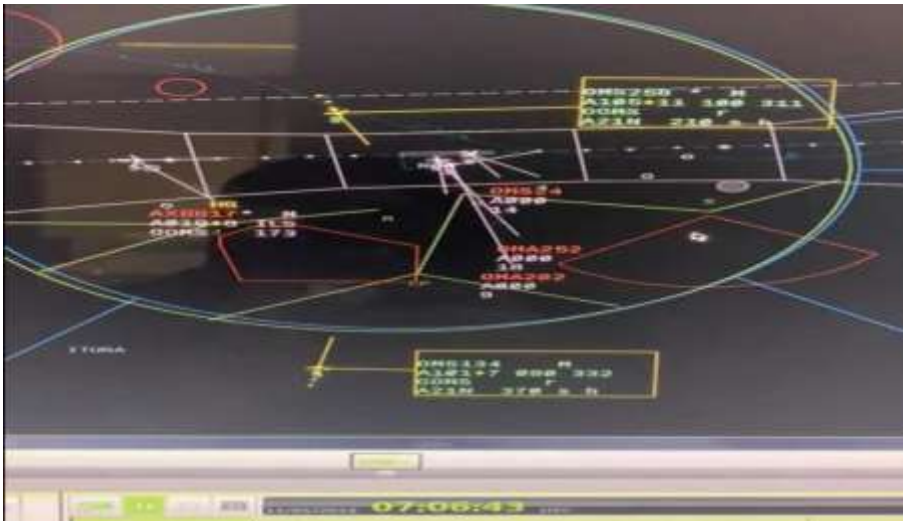


Figure 4 showing the yellow Short-Term Conflict Alert (STCA) was activated between aircraft OMS258 and aircraft OMS134 (Source: ATC radar)

1.1.9 At 07:06:52, ATCO reported to the crew of OMS134 to expect to hold over MCT.

1.1.10 At 07:07:02, the crew of OMS258 called clarifying the intention after MCT VOR by stating:
"To expect to left HDG after MCT OMS258"
The ATCO replied:
"258 290 HDG"
The crew of OMS258 acknowledged:
"290 after MCT OMS258"

1.1.11 At time 07:07:06, aircraft OMS258 was about 1.5nm north of MCT VOR at about 10400 ft descending to 7000ft at a speed of around 250kt. At the same time aircraft OMS134 was about 11nm south of MCT VOR at about 9800ft descending to 8000ft at a speed of 250kt.

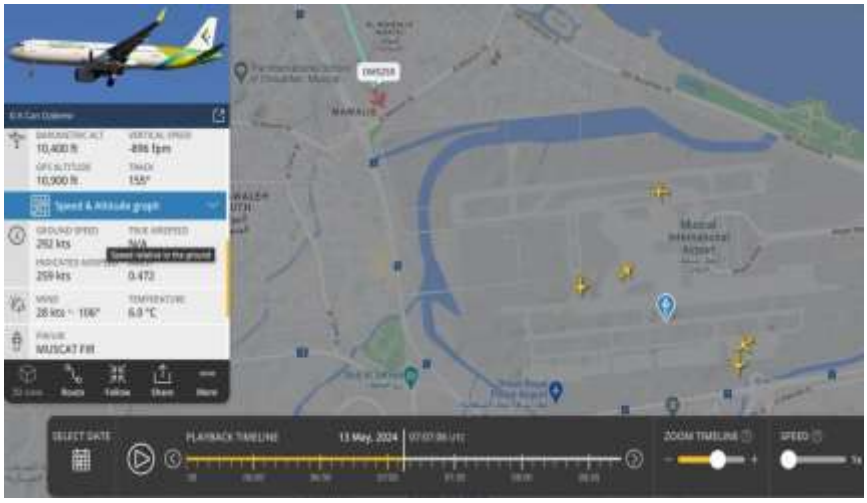


Figure 5 showing aircraft OMS258 1.5nm north of MCT at 10400 ft descending to 7000ft at a speed of around 250kt (Source: ATC radar)

1.1.12 At 07:07:24, aircraft OMS258 was overhead MCT VOR at track 155. Aircraft OMS134 was 9nm south of MCT VOR.

Figure 6 showing aircraft OMS258 overhead MCT at 9800ft descending to 7000ft and aircraft OMS134 9nm South of MCT at 9300ft descending to 8000ft

1.1.13 At 07:07:24, as shown below, aircraft OMS258 was at 9800ft descending at rate of descent 1400ft/min and aircraft OMS134 at 9300ft descending at rate of descent 900ft/min. Both at indicated speed of 250kt. The distance in time between the two aircraft is 46 seconds and in distance and 9nm. OMS258 maintained its heading for 8 seconds and then commenced a right turn aiming for heading 290. At the same time, called ATCO to confirm the direction of the turn.

Figure 7 showing both aircraft OMS258 and aircraft OMS134 descending with distance and time between was 9nm and 46 seconds

1.1.14 At 07:07:30, the crew of OMS258 contacted ATCO confirming turning direction to heading 290 by stating:
"OMS258 confirm right HDG 290"
The ATCO replied after 5 seconds:
"258 make it to ahhh turn left please expedite turn left"

While aircraft OMS258 was changing its turning direction from right to left, at 07:07:44, aircraft OMS258 had Traffic Advisory (TA) and at 07:07:46 aircraft OMS134 had TA. Both aircraft were at around 9000FT and the distance between them was 1.98 NM.

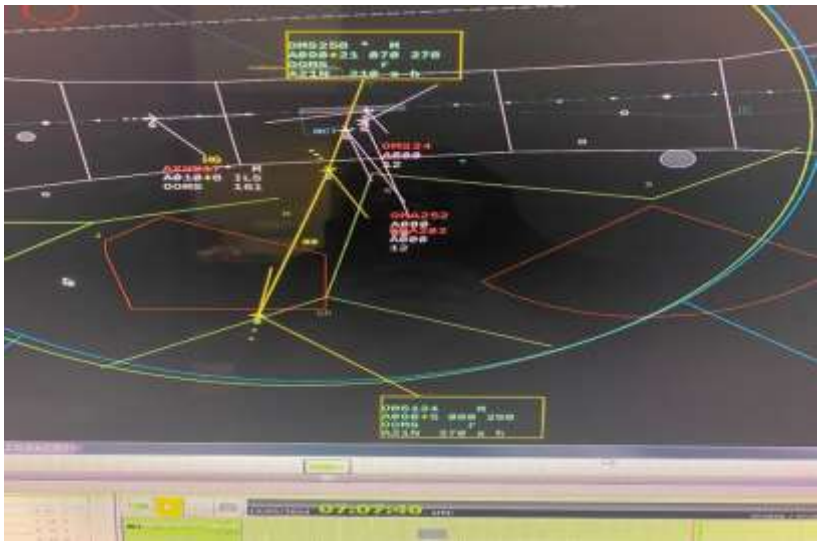


Figure 8 showing aircraft OMS258 and aircraft OMS134 both at 9,000ft and the distance between was 1.98 NM (33 seconds)

1.1.15 At 07:07:50, according to the FDM, aircraft OMS258's turn was changing from right to left. At 07:08:00, ATCO called OMS134 traffic to expedite descend to 8000ft. At this time OMS258 had Resolution Advisory RA and 2 seconds later aircraft OMS134 had RA. The distance between the two aircraft in seconds was 16 seconds as shown below.

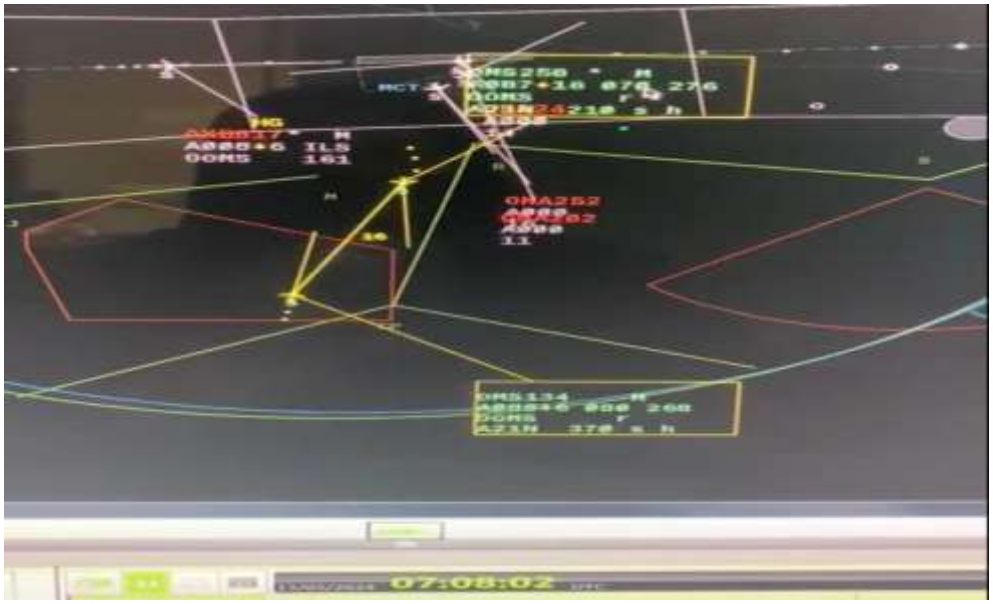


Figure 9 shows at 07:08:02 aircraft OMS258 and aircraft OMS134 had RAs 2 seconds apart and the distance were16 seconds

1.1.16 At 07:08:05 the crew of flight OMS258 called that they have a conflict. The ATCO radar showed that at 07:08:11 aircraft OMS258 was descending through altitude 8,500, with a rate of descend of 1100ft/min and a ground speed of 280kts. Meanwhile aircraft OMS134 was descending through altitude 8,800ft with rate of descend of 500ft/min and a ground speed of 271kts. The distance between both traffic in time was 5 seconds, 1 NM.

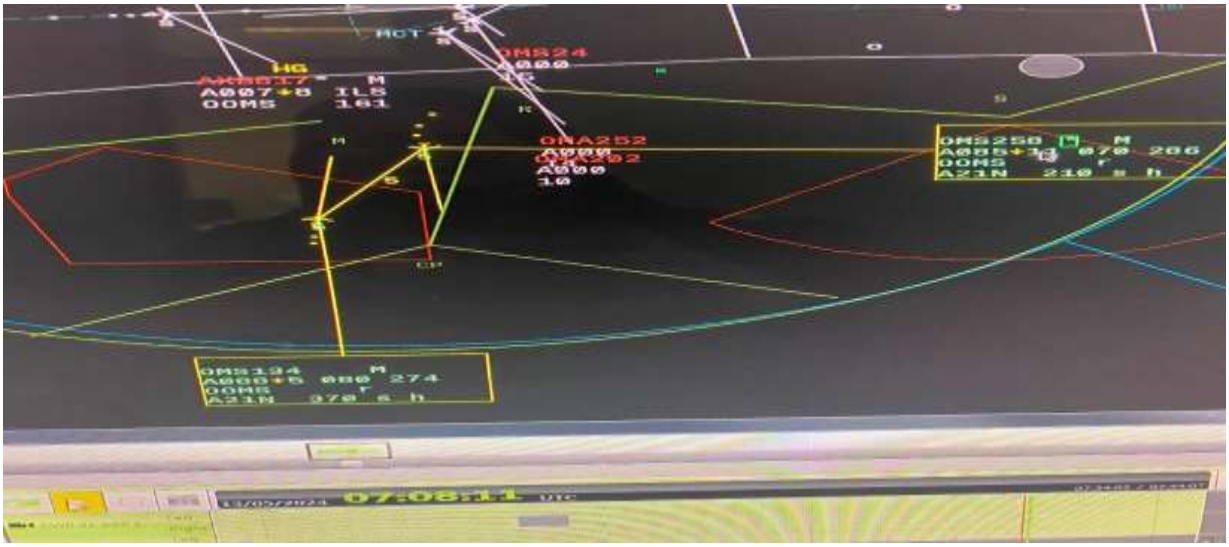


Figure 10 showing aircraft OMS258 was observed on radar at 8500ft descending to 7000ft while aircraft OMS134 was at 8800ft descending to 8000ft

1.1.17 At 07:08:12, aircraft OMS258 was observed on radar screen turning left. At 07:08:14, OMS134 reported they were clear of TCAS conflict.

1.1.18 The red STCA was activated for 36 seconds from 07:08:14 to 07:08:50. When deactivated OMS134 was descending through altitude 8300 ft with rate of descend of 400 ft/min and OMS258 descending through altitude 7700ft with rate of descend of 1100 ft/min.

Figure 11 showing the RED STCA activated between OMS134 and OMS258 while descending

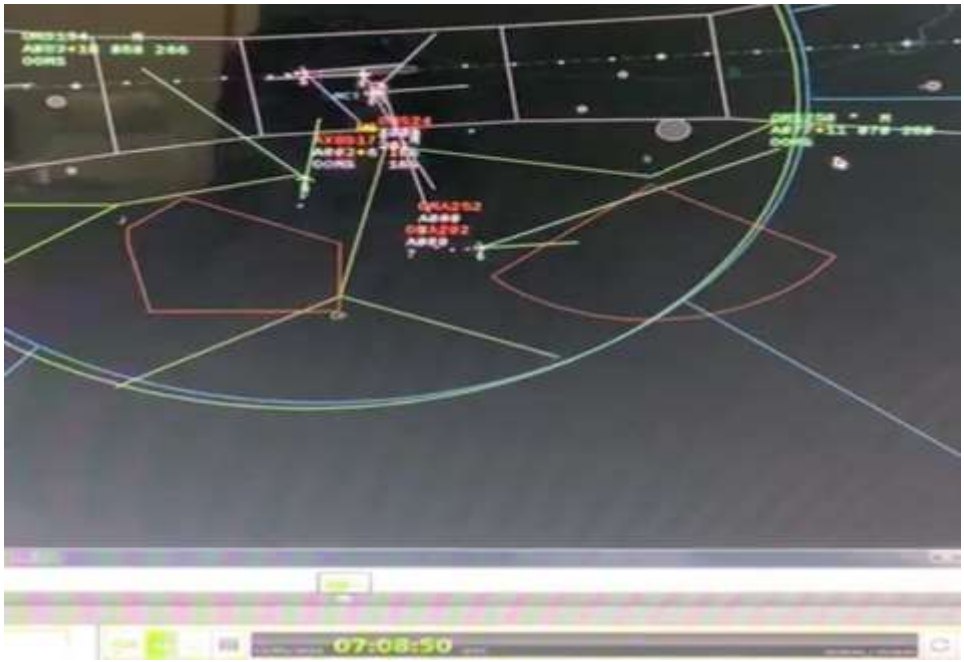


Figure 12 showing the RED STCA was deactivated between OMS134 and OMS258 while descending

1.1.19 At 07:08:52, ATCO cleared aircraft OMS258 to continue descending to altitude 6000 ft. Both aircraft OMS258 and aircraft OMS134 were radar vectored by the ATCO and landed safely in OOMSRWY08L.

1.2 Injuries to Persons OMS258.

Injuries	Pilot	Cabin Crew	Passengers	**Total on Board**	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	**-**	-	**-**	-
No Injuries	2	5	126	**133**	-
Total	**2**	**5**	**126**	**133**	-

Note: Other, means people on ground.

Injuries to Persons OMS134

Injuries	Pilot	Cabin Crew	Passengers	**Total on Board**	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	**-**	-	**-**	-
No Injuries	2	5	80	**87**	-
Total	**2**	**5**	**80**	**87**	-

Note: Other, means people on ground.

1.1. Damage to Aircraft.

1.3.1 No damages were reported.

1.2. Other Damage.

1.4.1 No other damages were reported

1.3. Personnel Information:

1.5.1 **Captain OMS258**.

Nationality	Tunisian		
Medical validity	Expiry: 31/12/2024	Licence type	Airline Transport Pilot Aeroplane
Licence validity	Expiry: 31/10/2025	Type endorsed	Yes
Ratings	Instrument Rating, Multi-Engine, A320		
English Language Proficiency	Level 4. Expiry date: 20th January 2026.		
Latest LPC Issue Dates	12/01/2024	Latest OPC Issue Dates	25/12/2023

The Line Proficiency Checks (LPC) was conducted by a CAA Authorized Flight Examiner. The LPC validity is 12 months.

Flying experience:

Total hours	10409
Last 24 hrs	5:53
Last 7 days	17:43
Last 30 days	TBA
Last 90 days	169:25

1.5.2 **First Officer (FO) OMS258.**

Nationality	Sudanese		
Medical valid	Expiry: 13/07/2024	Licence type	Commercial Pilot Aeroplane
Licence valid	Expiry: 13/08/ 2027	Type endorsed	Yes
Ratings	Instrument Rating, Multi-Engine, A320		
English Language Proficiency	Level 4. Expiry date: 13th August 2025		
Latest LPC Issue Dates	TBA	Latest OPC Issue Dates	19/02/2024

The Line Proficiency Checks (LPC) was conducted by a CAA Authorized Flight Examiner. The LPC validity is 12 months.

Flying experience:

Total hours	1590
Last 24 hrs	06:43
Last 7 days	12:33
Last 30 days	TBA
Last 90 days	148:21

1.5.3 **Captain (PIC) OMS134):**

Nationality	New Zealand		
Medical validity	Expiry: 14/06/2024	Licence type	Airline Transport Pilot Aeroplane
Licence validity	Expiry: 31/01/2025	Type endorsed	Yes
Ratings	Instrument Rating, Multi-Engine, A320		
English Language Proficiency	Level 5. Expiry date: 5th April 2029		
Latest LPC Issue Dates	22/01/24	Latest OPC Issue Dates	23/01/24

Flying experience:

Total hours	5613
Last 24 hrs	6
Last 7 days	19
Last 30 days	TBA
Last 90 days	179

1.5.3.1 The medical certificate had a limitations (VML) to wear corrective distant, intermediate and near vision and carry spare set spectacles.

The Line Proficiency Checks (LPC) was conducted by a CAA Authorized Flight Examiner. The LPC validity is 12 months.

1.5.4. **First Officer (FO) OMS134):**

Nationality	Pakistani		
Medical validity	Expiry: 24/12/2024	Licence type	Airline Transport Pilot Aeroplane
Licence validity	Expiry: 31/12/2024	Type endorsed	Yes
Ratings	Instrument Rating, Multi-Engine, A320		
English Language Proficiency	Level 4. Expiry date: 15th May 2026		
Latest LPCIssue Dates	22/06/2023	Latest OPC Issue Dates	12/06/2023

Flying experience:

Total hours	6563.08
Last 24 hrs	0
Last 7 days	0
Last 30 days	TBA
Last 90 days	138:42

The Line Proficiency Checks (LPC) was conducted by a CAA Authorized Flight Examiner. The LPC validity is 12 months.

1.5.5 **Air Traffic Controller:**

Nationality	Omani		
Medical valid	14th May 2025	Licence type	Air Traffic Controller
Licence valid	4/May/2025	Type endorsed	YES
Ratings	ADC, APP RDR	LPR	Level 5

1.5.5.1 The ATCO was issued with ratings to allow operating as a controller at OOMM as ADC, APP, Area RDR/INDRA.

1.5.5.2 The ATCO medical was assessed on 26th March 2024 and issued a Class three (3) medical certificate on 15th May 2024 with an expiry date of 14th May 2025. Although the medical assessment was conducted in March 2024, the medical certificate was issued on 15th May 2024, which is two days after the incident.

1.5.5.3 Civil Aviation Regulation requirements (Date of Issue: 20 July 2023):
CAR.ATCO.A.015 Exercise of the privileges of licences and provisional inability
(a) The exercise of the privileges granted by a licence shall be dependent on the validity of the licence, ratings, endorsements including ELP and the medical certificate.

(b) Licence holders shall not exercise the privileges of their licence when having doubts of being able to safely exercise the privileges of the licence and shall in such cases immediately notify the relevant air navigation service provider of the provisional inability to exercise the privileges of their licence.

1.6 Aircraft Information:

1.6.1 Airframe Information (**OMS258**)

Manufacturer/Model	Airbus/A321-253N	
Serial Number	7770	
Year of Manufacture	2017	
Total Airframe Hours (At Time of Incident)	10,974:27	
Last Inspection (Date & Hours (TSN))	30-Mar-2024	10,544:54
Last Inspection Airframe Cycles (CSN)	7885	
Hours Since Last Inspection	430	
Type of inspection preformed	3A Check	
CRS Issue Date	30-Mar-2024	
C of A (First/initial Issue Date)	06-Aug-2022	
C of A (Expiry Date)	05-Aug-2024	
C of R (Issue Date) (Present Owner)	28-Jul-2022	
Type of Fuel Used	JET-1A	
Operating Category	Transport (passenger)	
Previous Accidents	None	

Engine 1:

Manufacturer/Model	CFM/ LEAP-1A33
Serial Number	59C184
Part Number	LEAP-1A33
Hours Since New	456
Hours Since Overhaul	N/A
Hours since last shop visit	N/A
Cycles Available Before Next Shop Visit	9690
Oil type	NYCO TURBONYCOIL 600

Engine 2:

Manufacturer/Model	CFM/ LEAP-1A33
Serial Number	59C186
Part Number	LEAP-1A33
Hours Since New	456
Hours Since Overhaul	N/A
Hours since last shop visit	N/A
Cycles Available Before Next Shop Visit	9690
Oil type	NYCO TURBONYCOIL 600

1.6.2 Aircraft Information (OMS134):

Manufacturer/Model	Airbus/A321-253NX
Serial Number	10627
Year of Manufacture	2022
Total Airframe Hours (At Time of Incident)	10259:04
Last Inspection (Date & Hours (TSN))	12-Apr-2024
Last Inspection Airframe Cycles (CSN)	3032
Hours Since Last Inspection	391
Type of inspection preformed	1C Check
CRS Issue Date	12-Apr-2024
C of A (First/initial Issue Date)	24-Feb-2022
C of A (Expiry Date)	24-FEB-2025
C of R (Issue Date) (Present Owner)	24-Feb-2022
Type of Fuel Used	JET-A1
Operating Category	Commercial Air Transport Operation
Previous Occurrences	None

Engine 1:

Manufacturer/Model	CFM/ LEAP-1A33
Serial Number	599361
Part Number	LEAP-1A33
Hours Since New	11190
Hours Since Overhaul	1841
Hours since last shop visit	1841
Cycles Available Before Next Shop Visit	4953
Oil type	NYCO TURBONYCOIL 600

Engine 2:

Manufacturer/Model	CFM/ LEAP-1A33
Serial Number	599618
Part Number	LEAP-1A33
Hours Since New	12296
Hours Since Overhaul	4503
Hours since last shop visit	4503
Cycles Available Before Next Shop Visit	7266
Oil type	NYCO TURBONYCOIL 600

1.7 Meteorological Information:

1.7.1 The weather information below is from the Meteorological Routine Aerodrome Report (METAR) at 06:50 UTC.

Wind Direction	040°	Wind Speed	07 kts	Visibility	9km
Temperature	32°C	Cloud Cover	Sky Clear	Cloud Base	Sky Clear
Dew Point	25°C	QNH	1008 HPA		

1.8 Aids to Navigation.

1.8.1 Both aircraft were 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.

1.9.1 Both aircraft were 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 (OMS258):

ICAO designation	Fujairah International Airport (OMFJ)
Aerodrome co-ordinates	25°06′44″N 056°19′27″E
Aerodrome elevation	153 feet (ft) mean sea level (MSL)
Runway designations	11/29
Runway dimensions	12303 x 148 ft
Runway used	11/29
Category for Rescue Fire Fighting	CAT 10
Approach facilities	ILS, RNP, GVA, Runway Lights, PAPI's
Aerodrome status	Licensed

Destination Aerodrome:

ICAO designation	Muscat International Airport (OOMS)	
Aerodrome co-ordinates	23°35′36″N 058°17′04″E	
Aerodrome elevation	25 feet (ft)mean sea level (MSL)	
Runway designations	08R/26L	08L/26R
Runway dimensions	4080 x 60 M	4000 x60 M
Category for Rescue Fire Fighting	CAT 10	
Approach facilities	ILS, RNP, VOR, Runway Lights, PAPI's	
Aerodrome status	Licensed Airport (Open)	

1.10.2 Aerodrome Information (OMS134):

Departure Aerodrome:

ICAO designation	Duqm Airport (OODQ)
Aerodrome Coordinates	19°30′00″N 57°38′35″E
Aerodrome elevation	383. FEET MSL
Runway designations	04/022
Runway dimensions	13130 x 197 Feet
Runway used	04
Category for Rescue Fire Fighting	CAT 10
Approach facilities	ILS, RNP, GVA, Runway Lights, PAPI's
Aerodrome status	Licensed

Destination Aerodrome:

ICAO designation	Muscat International Airport (OOMS)	
Aerodrome co-ordinates	23°35′36″N 058°17′04″E	
Aerodrome elevation	25 feet MSL	
Runway designations	08R/26L	08L/26R
Runway dimensions	4080 x 60 M	4000 x60 M
Runway used	08L	
Category for Rescue Fire Fighting	10	
Approach facilities	ILS, RNP, VOR, Runway Lights, PAPI's	
Aerodrome status	Licensed	

1.11 Flight Recorders.

1.11.1 Both aircraft were fitted with the Digital Flight Data Recording (DFDR), Flight Data Monitoring (FDM) and the Cockpit Voice Recording (CVR). OTSB will be relying on other flight information data such as Flight Data Monitoring (FDM), Air Traffic Services (ATC) communication records to assist in the investigation.

1.12 Wreckage and Impact Information.

1.12.1 Not relevant to the occurrence.

1.13 Medical and Pathological Information.

1.13.1 Not relevant to the occurrence.

1.14 Fire.

1.14.1 Not relevant to the occurrence.

1.15 Survival Aspects.

1.15.1 To be discussed in the final report.

1.16 Tests and Research.

1.16.1 To be discussed in the final report.

1.17 Organizational and Management Information.

1.17.1 Aircraft OMS258 was scheduled international passenger flight and aircraft OMS134, was scheduled domestic passenger flight.

1.17.2 The operator, Salam Air was issued an Air Operating Certificate (AOC) by the State of Registry and State of Operator, The Sultanate of Oman, CAA. The Expiry date is as per applicable Sultanate of Oman 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 Regulations. Both aircraft have valid certificates of Airworthiness at the time of the incident.

1.18 Additional Information

1.18.1 Salam Air A320/A321 Flight Crew Operating Manual: The Traffic alert and Collision Avoidance System (TCAS): Aircraft Systems
Surveillance
- Detects and displays surrounding aircraft that have a transponder
- Calculates and display possible collision threats

- Triggers vertical speed orders, in order to avoid collisions.

1.18.1.1The TCAS detection capability is limited to intruders flying within a maximum range of 30 NM on either sides and approximately 30 NM to 80 NM longitudinally (depending on aircraft configuration and external conditions), and within a maximum altitude range of 9 900 ft above and below the aircraft.

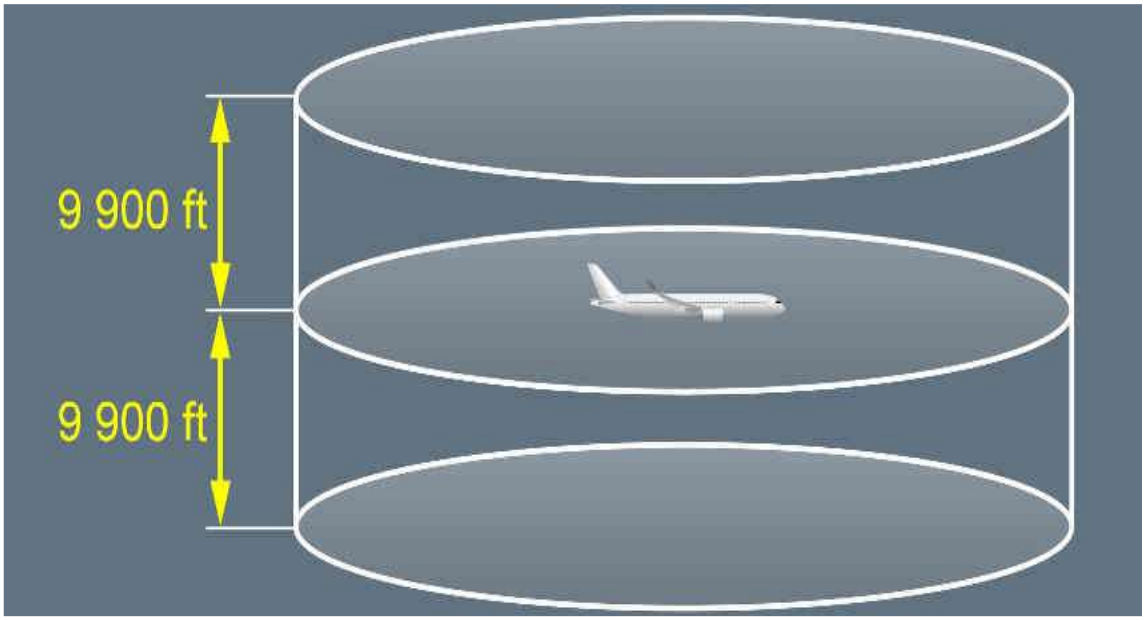


Figure 13 showing TCAS Range

1.18.1.2The TCAS obtains data transmitted by the transponders of nearby aircraft, and uses this data to evaluate possible collision threats.

The TCAS determines:
- The bearing of intruders, in relation to the bearing of the aircraft.
- The distance between the aircraft and intruders, and the rate of separation or closure.
- The relative altitude of intruders, if intruders report their altitude via a Mode-C or Mode-S transponder.

The TCAS then calculates the intruder trajectory, the Closest Point of Approach (CPA), and the estimated time (TAU) before reaching the CPA.
The TAU is the ratio between the distance that separates both aircraft, and the sum of their speed

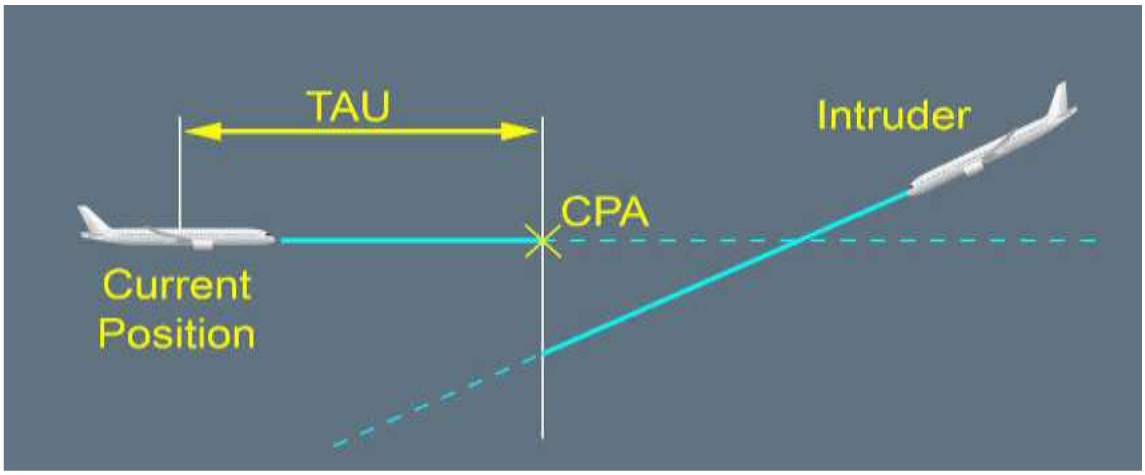


Figure 14 showing TAU Definition

1.18.1.3If the TCAS detects that the trajectory of an intruder may be a collision threat, it triggers:

- Audio and visual indicators
- Vertical speed orders, to ensure a sufficient trajectory separation and a minimal vertical speed variation considering all intruders.

1.18.1.4The system includes:

- A single channel TCAS computer
- Two TCAS antennas
- Two mode S ATC transponders, one active the other in standby

These transponders allow:

• Interface between the ATC/TCAS control panel and the TCAS computer
• Communication between the aircraft and intruders equipped with a TCAS system.

- An ATC/TCAS control panel.

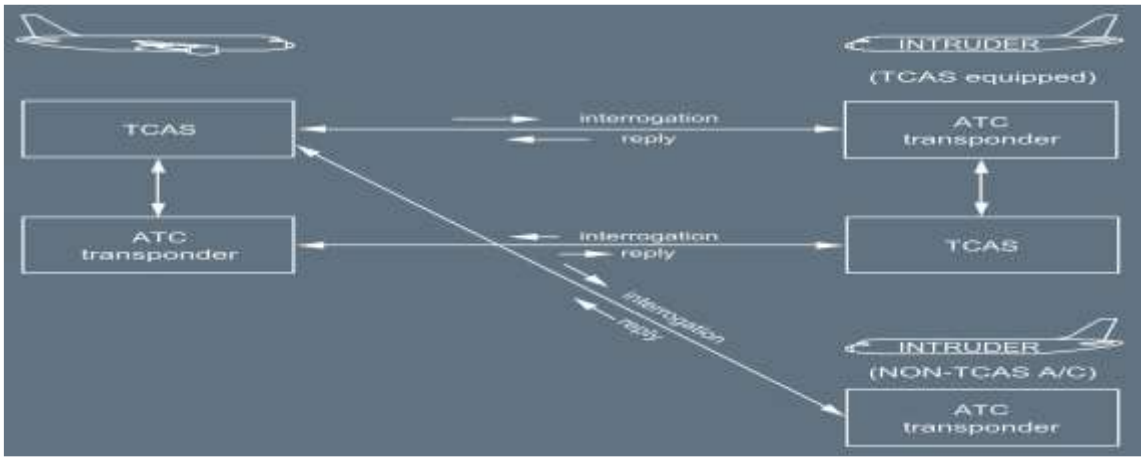


Figure 15 showing Aircraft Surveillance Systems

1.18.1.5The TCAS divides the space surrounding the aircraft into the following four zones, in order to evaluate and categorize possible collision threats:

- Resolution Advisory (RA)
- Traffic Advisory (TA)
- Proximate intruders
- Other intruders.

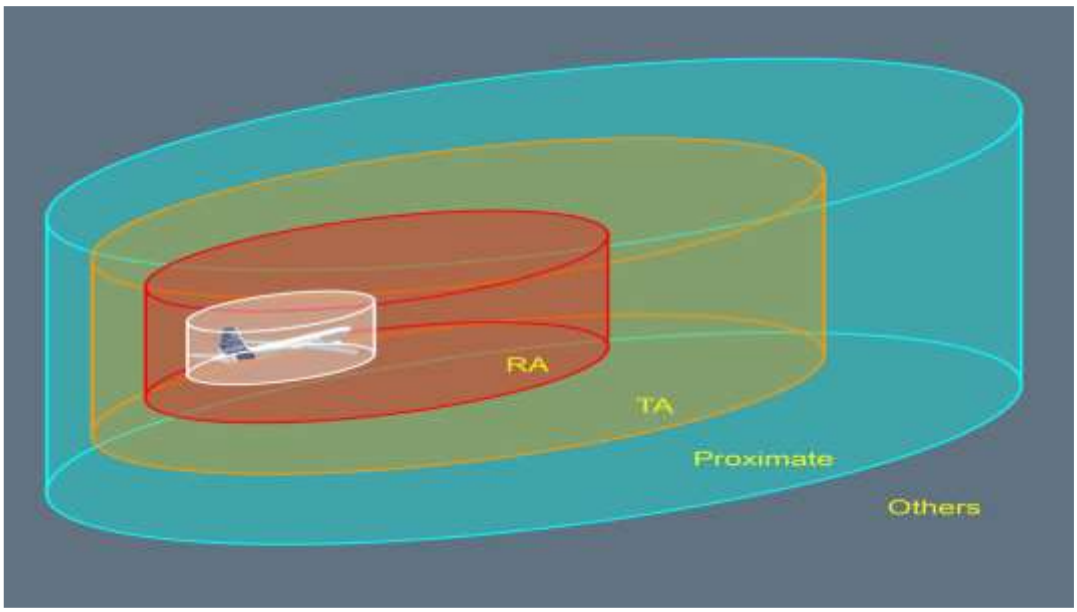
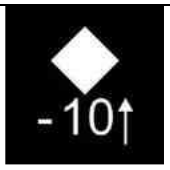


Figure 16 showing TCAS Envelopes

LEVEL	INTRUDER POSITION	DISPLAYED INFORMATION AND MESSAGE	
Proximate	- No collision threat - Intruder in the vicinity of the A/C (closer than 6 NM laterally and ±1200 ft vertically)	- ND: Intruder position	
Traffic Advisory (TA)	- Potential collision threat - TAU is about 40 s	- ND: Intruder position - Aural messages	

Traffic Advisory (TA)	- Potential collision threat - TAU is about 40 s	- ND: Intruder position - Aural messages	
Resolution Advisory (RA)	- Real collision threat - TAU is about 25 s	- ND: Intruder position - Aural messages - PFD: Vertical orders • Maintain actual V/S (Preventive Advisory) or • Modify V/S (Corrective Advisory)	

Figure 17 showing the level of the collision threat, the TCAS triggers audio and visual indicators

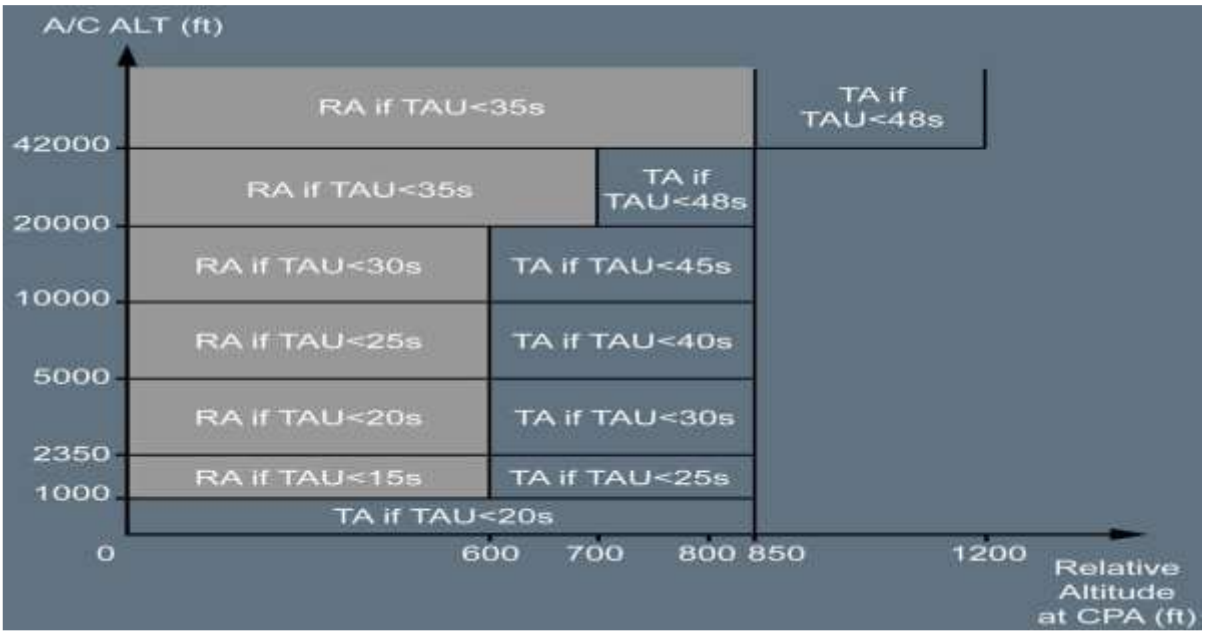


Figure 18 showing TA/RA thresholds

1.18.1.7TCAS MODES

The TCAS has three different modes of operations that can be selected on the ATC / TCAS control panel:

- The Traffic Advisory/Resolution Advisory (TA/RA) mode
- The Traffic Advisory Only (TA ONLY) mode
- The standby (STBY) mode.

TRAFFIC ADVISORY/RESOLUTION ADVISORY (TA/RA) MODE

The TA/RA mode is the normal TCAS operating mode that enables:

- The ND to display all intruders
- The PFD to display the vertical speed orders that indicate the vertical direction that the aircraft

should take, in order to avoid a collision.

TRAFFIC ADVISORY ONLY (TA ONLY) MODE
The TA ONLY mode can be selected:
- Manually in case of aircraft degraded performance (engine failure, landing gear extended), or in
specific airports, and for specific procedures (identified by operators) that may provide RA that are neither wanted nor appropriate (e.g. closely-spaced parallel or converging runways)
- Automatically, if TA/RA mode is previously selected and:
• The windshear alert is triggered
• The stall warning is triggered
• GPWS alerts are triggered
• Aircraft is below 1 000 ft AGL.
When the TCAS is operating in TA ONLY mode:
- All RAs are inhibited and converted into TAs
- TA threshold is set to TAU ≤20 s, irrespective of the aircraft altitude
- No vertical speed advisories are indicated on the PFDs
- “TA ONLY” is displayed on the NDs

STANDBY MODE
In the standby mode, the advisory generation and surveillance functions are not active. The TCAS does not trigger any alert. No TCAS information can be displayed on the PFDs and NDs.
MODE
The AP/FD TCAS mode is a vertical guidance mode of the AP/FD. In the case the TCAS generates a Resolution Advisory (RA) alert, this mode automatically engages to assist the flight crew to follow the RA orders, and to revert toward initial trajectory:

- Automatically if the AP is engaged, or
- Manually with the guidance of the Flight Director (FD), if the AP is not engaged.
The AP/FD TCAS mode optimizes the vertical speed for a rapid and appropriate response to an RA, and minimizes the deviations from the latest ATC clearance.
When the TCAS is operating in TA ONLY mode, the AP/FD TCAS mode is inhibited.

INTRUDER DETECTION
Based on the received information from the intruders, the TCAS may generate the following sequence of alerts:
If the TCAS considers the intruder to be a possible collision threat
- It generates a visual and aural Traffic Advisory (TA).
- In that case, the AP/FD TCAS mode automatically arms: TCAS appears on the FMA to inform the flight crew that the AP/FD TCAS mode will be available in the case a Resolution Advisory (RA) is subsequently triggered.

If the TCAS considers the intruder to be a real collision threat:
- It generates a visual and aural Resolution Advisory (RA).
- The AP/FD TCAS mode automatically engages: TCAS appears on the FMA. The flight crew has vertical guidance to fly the RA orders, automatically with the AP/FD, or manually with the FDs only (if AP was not engaged).

- If the A/THR is disconnected, it automatically becomes armed or active, depending on the

thrust lever position. When active, the speed/Mach mode engages, and the speed/Mach control becomes selected. For more information, Refer to DSC-22_30-40-100 Normal Operations - When a RA is triggered - Consequence on A/THR and Speed/Mach Control.
- The vertical speed scale on the PFD indicates the vertical speed range within which the aircraft should fly.

When the TCAS considers that there is no more collision threat:
- It triggers the "CLEAR OF CONFLICT" aural alert.
- In most of the cases, the AP/FD TCAS mode automatically reverts to V/S mode: The vertical speed target leads the aircraft toward the FCU selected altitude.
If the altitude capture conditions are met at the clear of conflict, the AP/FD TCAS mode can revert to an altitude acquire, or an altitude hold mode. Refer to DSC-22_30-40-100 Normal Operations - When a RA is triggered - Consequence on AP/FD Vertical Mode.

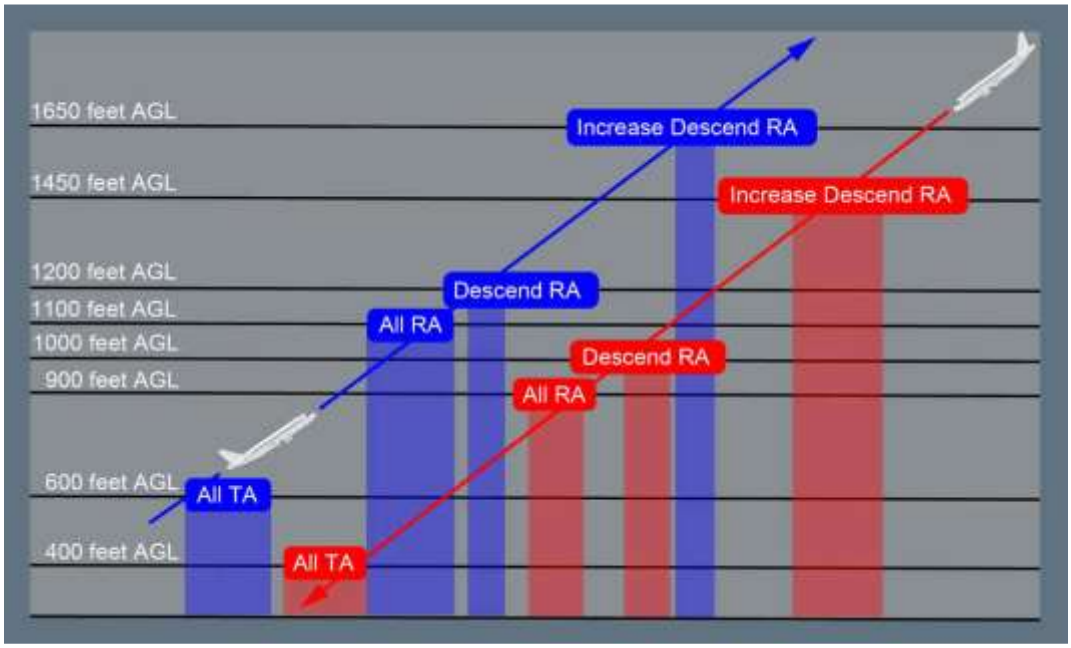


Figure 19 showing when a RA is triggered - Consequence on AP/FD Vertical Mode.

Some advisories are inhibited depending on the aircraft altitude:
- All intruders flying below 380 ft AGL when the own aircraft altitude is below 1 750 ft AGL in climb or 1 650 ft AGL in descent
- All TA aural messages below 600 ft AGL in climb or below 400 ft AGL in descent
- All RA aural messages below 1 100 ft AGL in climb or 900 ft AGL in descent. In this case, the RA are converted into TA
- “Descend” RA below 1 200 ft AGL in climb or 1 000 ft AGL in descent
- “Increase Descent” RA below 1 650 ft AGL in climb or 1 450 ft AGL in descent
- The AP/FD TCAS □ flight guidance mode is inhibited below 900 ft.

TCAS INTRUDER WITH NO REPORTED ALTITUDE

For intruders that do not report their altitude:

- The relative altitude does not appear on ND
- The TCAS never triggers any RA
- The TCAS inhibits the TA when own aircraft altitude is above 15500 ft.

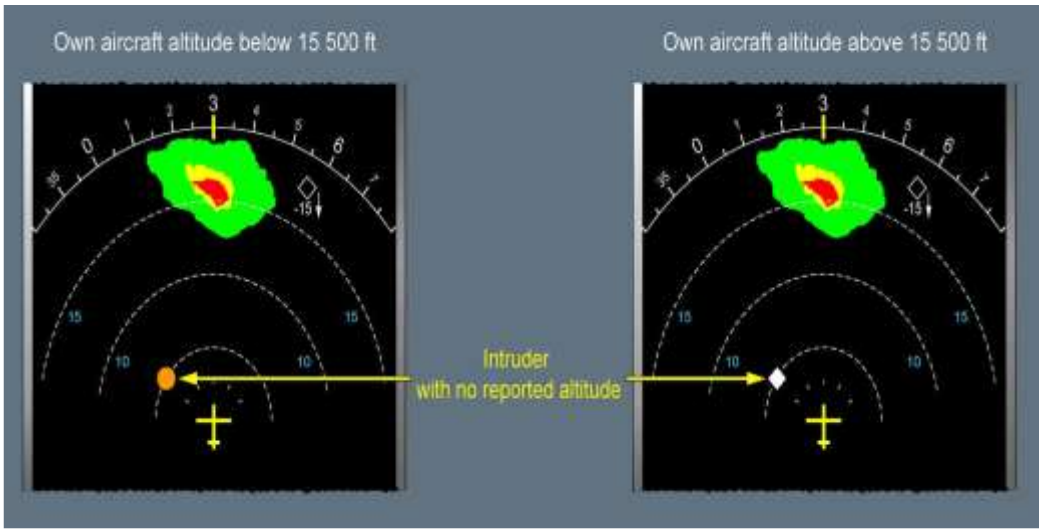


Figure 20 showing TCAS intruder with no reported altitude

1.18.2 Salam Air: /A320/A321 Flight Crew Operating Manual: Procedures Abnormal and Emergency Procedures

(MEM) TCAS CAUTION-RESOLUTION ADVISORY

L2

If the AP/FD TCAS mode is available, the TCAS mode arms on FMA.

L1

TCAS mode …… ……CHECK ARMED

L2

If the AP/FD TCAS mode does not arm, the flight crew must be prepared to disconnect the AP in the case of a RA, and manually follow the TCAS guidances.

L1

If the A/THR is off:

AUTOTHRUST.....ON

L2

It is recommended to set the A/THR to ON in order to avoid the AUTO FLT A/THR LIMITED alert at the automatic A/THR activation that occurs in the case of a RA.

L1

Do not perform a maneuver based on a TA alone.

[MEM] TCAS CAUTION - TRAFFIC ADVISORY

Do not perform a maneuver based on a TA alone.

	[MEM] TCAS WARNING - RESOLUTION ADVISORY	

Always follow RA orders, even if this results in crossing the intruder altitude, because these orders ensure the best altitude separation.

CAUTION	Be aware that the intruder may have a TCAS, and may maneuver in response to a coordinated RA order. Therefore, not following an RA order could compromise safe separation.

- If the AP/FD TCAS mode is available:

L2 The flight crew applies this procedure, when a RA is triggered, and the AP/FD TCAS mode engages. The AP/FD TCAS mode follows the RA orders.

L1 All RA, except any CLIMB RA during approach in CONF 3 or FULL:

- If the AP is OFF:

FD ORDERS.....FOLLOW The AP can be engaged.

VERTICAL SPEED.....MONITOR

L2 If a preventive RA was triggered: check that the vertical speed remains out of the red area of the vertical speed scale.
If a corrective RA was triggered: check that the vertical speed gets out of the red area, and remains in the green area of the vertical speed scale.

L1

CAUTION	If for any reason during a RA, the aircraft vertical speed does not reach the green area of the vertical speed scale, the PF should dis-connect the AP, and override the FD orders, in order to lead the aircraft vertical speed out of the red area of the vertical speed scale. If necessary, the PF must use the full speed range between Vαmax and VMAX.

- Any CLIMB RA during approach in CONF 3 or FULL:

GO-AROUND.....PERFORM

L2 The AP/FD TCAS mode disengages (the AP/FD does no longer follows the RA orders).

L1 Follow the SRS GA mode.

VERTICAL SPEED.....MONITOR

L2 Check that the vertical speed remains out of the red area of the vertical speed scale and take over if necessary.

L1 Respect stall, GPWS or windshear warnings.

ATC.....NOTIFY

- When the “CLEAR OF CONFLICT” aural alert sounds:

L2 The AP/FD TCAS mode, if engaged, disengages.

L1

AP/FD.....MONITOR/FOLLOW ATC.....NOTIFY LATERAL AND VERTICAL GUIDANCE.....ADJUST

L2 The flight crew should engage an appropriate vertical mode, or adjust the vertical speed target, in accordance with the latest ATC clearance.

L1

SPEED.....ADJUST

L2 The flight crew should adjust the speed target, and revert to managed speed, as appropriate.

L1 If the AP/FD TCAS mode is not available:

L2 The flight crew applies this procedure, when a RA is triggered, and the AP/FD TCAS mode does not engage.

L1 All RA, except CLIMB RA during approach in CONF 3 or FULL:

AP (if engaged).....OFF BOTH FDs.....OFF

Respond promptly and smoothly.

VERTICAL SPEED.....ADJUST or MAINTAIN

L2 Adjust or maintain the vertical speed as required, to reach the green area and/or avoid the red area of the vertical speed scale.

L1 Note: Avoid excessive maneuvers while attempting to maintain the vertical speed just outside the red area of the vertical speed scale, and within the green area. If necessary, use the full speed range between Vαmax and VMAX.

Any CLIMB RA during approach in CONF 3 or FULL:

GO-AROUND.....PERFORM

Follow the SRS GA mode.

VERTICAL SPEED.....MONITOR

L2 Check that the vertical speed remains out of the red area of the vertical speed scale and take over if necessary.

L1 Respect stall, GPWS or wind shear warnings.

ATC.....NOTIFY

When the “CLEAR OF CONFLICT” aural alert sounds:

ATC.....NOTIFY LATERAL AND VERTICAL GUIDANCE.....AD-JUST

L2 Adjust the lateral and vertical guidance to resume normal navigation, in accordance with ATC clearance.

L1

AP/FD.....AS RQRD

L2 If necessary, reengage the AP/FD.

[MEM] TCAS WARNING - RESOLUTION ADVISORY

Always follow RA orders, even if this results in crossing the intruder altitude, because these orders ensure the best altitude separation.

CAUTION	Be aware that the intruder may have a TCAS, and may maneuver in response to a coordinated RA order. Therefore, not following an RA order could compromise safe separation.

All RA, except any CLIMB RA during approach in CONF 3 or FULL:

AP (if engaged) .....OFF
BOTH FDs.....OFF

Respond promptly and smoothly.

VERTICAL SPEED.....ADJUST or MAINTAIN

L2 Adjust or maintain the vertical speed as required, to reach the green area and/or avoid the red area of vertical speed scale.

L1 Note: Avoid excessive maneuvers while attempting to maintain the vertical speed just outside the red area of the vertical speed scale, and within the green area. If necessary, use the full speed range between Vαmax and VMAX.

Any CLIMB RA during approach in CONF 3 or FULL:

GO-AROUND.....PERFORM

Follow the SRS GA mode.

VERTICAL SPEED.....MONITOR

L2 Check that the vertical speed remains out of the red area of the vertical speed scale and take over if necessary.

L1 Respect stall, GPWS, or wind shear warnings.

ATC.....NOTIFY

When the "CLEAR OF CONFLICT" aural alert sounds:

ATC.....NOTIFY
LATERAL AND VERTICAL GUIDANCE.....ADJUST

L2 Adjust the lateral and vertical guidance to resume normal navigation, in accordance with ATC clearance.

L1

AP/FD.....AS RQRD

L2 If necessary, reengage the AP/FD.

1.18.3 Surveillance Separation Minima: MISCELLANEOUS OPERATING INSTRUCTIONS Chapter 5 (APPROACH MATSOP)

1.18.3.1The horizontal separation used within Muscat TMA/CTR is 5NM.

1.19 Useful or Effective Investigation Techniques.

1.19.1 To be discussed in the final report.

2. Analysis

2.1 To be discussed in the final report.

3 Conclusions

3.1 General

The investigation is on-going and OTSB will be looking into other aspects of this serious incident investigation which may or may not have safety implications.

3.2 Findings

3.2.1To be discussed in the final report.

3.3 Causes and Contributing Factors

3.3.1 To be discussed in the final report.

4 Safety Recommendations

4.1 Although the Investigation is still on-going. Based on the aforementioned factual information, OTSB is anticipating issuing safety recommendations in due course.