In the name of God

Islamic Republic of Iran
Aircraft Accident Investigation Board

Ref No; S000123A7ANO
Incident Investigation Report

A350, A7-ANO
Near Midair Collision and Speed Warning
around Position of PEKAM on April 12th, 2021

Issue date: 22 Aug, 2021

Summary:

On 12 Apr, 2021, IR of Iran Aircraft Accident Investigation Board was notified by Air Navigation service provider about an AIRPOROX containing TCAS RA occurrence for flight QTR8RF and CPN6984 in Tehran FIR. Related follow up was performed for gathering information about the occurrence from Caspian Airline and Qatar Airways as well as Tehran Area Control Center. After evaluation of data the occurrence category was rated as "Serious Incident". The investigation of the serious incident was conducted by Iranian Aircraft Accident Investigation Board about Airprox between Qatar Airways flight QTR8RF, Airbus350-1000, A7-ANO and CPN6984 MD83 EP-CAS dated on 12 Apr., 2021 , The draft final report was forwarded to Accredited Representatives of involved states (BEA,NTSB, and Qatar AAI) based on Annex 13 to ICAO convention and after receiving associated comments, Iran AAIB issues the final report. in accordance with Civil Aircraft Accident Investigation Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft serious incident for the prevention of incidents and not for the purpose to apportion blame or liability.

1. History of the flight:

On Monday, 12th April, 2021 at 06:40 UTC, an A350-1000 aircraft belonging to Qatar Airways with the call sign of QTR8RF and registration mark of A7-ANO on its flight from Hamad International Airport(OTHH) to Los Angeles International Airport(KLAX) maintaining FL340 and a MD83 aircraft belonging to Caspian Airline with the call sign of CPN6984 and registration mark of EP-CAS on its flight from Mehrabad International Airport (OIII) to Kish International Airport(OIBK) which was re-climbing to FL330, faced to TCAS/RA on UP574 RNAV5 Airway around waypoint PEKAM (332904N 0510118E). The A350 aircraft which was flying at FL340, received climb command and climbed up to FL354 (FDR data confirmed) while its maximum recommended altitude was FL351. Simultaneously the captain of MD83 aircraft on opposite direction which had lost 500 ft. altitude due to alternate longitudinal trim motor control relays malfunction and was trying to re-adjust altitude by disengaging AP to maintain FL330. Unfortunately, level bust occurred and the aircraft passed FL330 and climbed up to FL334. So, the captain received TCAS/RA and descent command was issued. Both traffic reported TCAS/RA to Tehran Area Control Centre (ACC). Afterward when the confliction was cleared, both aircraft returned to their assigned flight level and continued to their destinations normally.

2. Analysis of the data:

The analysis of the incident was based on radar data, FDR information of both aircrafts and pilots' statements as well as ATC voice communication however access to CVR was not possible due to duration of the flights to perform an in-depth analysis of crew actions, by the way Iran AAIB analyzed abovementioned occurrence based as below:

The pilot of CPN 6984 flight, with valid license and medical fitness certificate, commenced his flight with MD83 aircraft with alternate trim motor control malfunction based on Minimum Equipment List (MEL) item which was recorded in Deferred Defect List (DDF). The operation of the aircraft was extended for ten days from 04 Apr, 2021. At about 06:13UTC. the aircraft departed from Mehrabad airport and was cleared to climb to FL330 en-route UP574.

The FDR of MD83 aircraft showed that on the flight route at waypoint PEKAM magnetic track changed from 191° to 157° with engaged Autopilot. During turn, the aircraft started to loss altitude and reached to FL325. For overcoming prevailed situation, the captain disengaged auto-pilot and initiated climb maneuver to return FL330, so the aircraft ascended with rate of climb of 1800 ft/min. the FDR information showed that before reaching FL330, ROC increased to 2400 ft/min and MD83 pilot could not hold FL330 and passed desired

level. At this time, TCAS RA and descent command was issued but the aircraft continued climbing against the issued command and climbed to FL334.

Figure 1- MD83 received TCAS/RA descent clearance

Based on FDR analysis which done by Airbus company:

At 06:36:15 UTC, the Airbus A350 on the same route and opposite direction which have had performed a stepped climb from FL320 to FL340 and MD83 aircraft was visible on its TCAS display. AP1 and both FDs were engaged in ALTCRZ / NAV modes and A/THR was engaged in managed MACH mode and CAS was matching its target of 0.84 Mach.

At 06:39:22UTC, while the MD83 aircraft was climbing on FL228 to return FL330, the separation of two aircraft reduced to 1200 ft vertically and 10 NM laterally traffic advisory (TA) triggered and TCAS mode armed for A350 crew.

At 06:39:36UTC when longitudinal and vertical separation reduced to about 6.5 nm. and 800 ft., traffic resolution advisory (RA) was triggered and Vertical speed target changed to +1500ft/min, Pitch started to increase from 2.6° to 7° nose up, N1 thrust command increased to 94% so aircraft climbed up first with 1500 ft/min ROC then +2500 ft/min by the auto pilot. (the flight crew-maintained AP and A/THR engaged as per the FCOM procedure.) At this time, calibrated airspeed (CAS) started to decrease from 0.84 Mach.

While MD83 passed FL330, the aircraft started to descent again and came back to FL330 as reaction of TCAS RA descend command accordingly.

At 06:40:06UTC, Altitude had increased to 35180ft , Speed had reduced to 0.8 Mach , TCAS mode changed from resolution advisory to traffic advisory , TCAS AP/FD mode disengaged , Target speed synchronized to current CAS value of 0.8 Mach ,Altitude target was 34000ft, Vertical speed was +2500ft/min and started to decrease towards target of -1000ft/min, Pitch started to reduce from 7° nose up.

the separation was 2300ft vertically and 1.2 NM laterally increasing. It had most likely passed the Airbus A350 by this point.

An audible "Clear of Conflict" should be triggered and the selected speed be synchronized with the current aircraft speed. A descent rate of -1000ft/min was targeted to regain the originally selected altitude. The flight crew might be required to adjust target speed as required.

5s later at 06:40:12UTC, low energy warning was triggered for 9s. AP1 and both FDs were engaged in VS / NAV modes. Altitude was 35336ft and vertical speed had reduced to

464ft/min, decreasing towards target of -1000ft/min. Pitch was 4° nose up reducing and CAS reduced to 0.792 Mach.

The LOW ENERGY warning is an aural "SPEED SPEED SPEED" alert repeated every 5s while the alert is active. As per FCTM, in the event of a low energy alert, aircraft energy should be increased via engine thrust or a pitch down (descent) action.

The TCAS AP/FD priority is to attain the required climb rate for collision avoidance. this may be at the consequence of speed if performance is limited. The aircraft was at 35336ft, which is above the REC MAX FL of 35100ft.

REC MAX FL is the maximum recommended altitude depending on aircraft weight and temperature conditions, and is the lowest of the:

- Maximum certified altitude
- Maximum cruise altitude
- 1.3g buffet limited altitude
- Climb ceiling

VLS was 268kts and CAS had fallen to 267kts, 1kt below the VLS threshold, triggering the low energy alert.

During this event the TCAS achieved the climb rate target for the required duration of 23s and at high altitude, while the speed transiently reduced to just below VLS, triggering the low energy alert. At this time the aircraft had started to descend back towards the selected altitude of 34000ft. aircraft behavior was normal.

At 06:40:14, Aircraft was at 35352ft and vertical speed was -256ft/min decreasing to selected altitude was 34000ft, CAS was 0.792 Mach, Speed target was 0.8 Mach, AP mode OPDES / NAV selected, Aircraft pitch continued to reduce from 3° nose up, A/THR mode changed to Thrust Idle.

TCAS also disengaged at this time as the traffic separation had increased to 3.3Nm laterally and 2400ft vertically. So, the aircraft had started to recover the cruise altitude after the TCAS RA maneuver and was targeting a descent rate of -1000ft/min. When open descent (OP DES) was selected, the engine thrust reduced to idle and the AP targeted the aircraft selected speed by adjusting the pitch. The vertical speed continued to decrease beyond -1000ft/min. The selected speed had synchronized to 0.8 Mach at 'clear of conflict', which was very close to VLS, and was adjusted by the flight crew 6s later. While the effect of selecting OP DES during this event was limited, selecting OP DES while in a low energy situation, and especially at high altitude, is not in line with the recommendation given in the FCTM where thrust and/or pitch must be adjusted to recover from low energy.

At 06:40:20, Selected speed changed to 0.84 Mach, CAS was 0.792 Mach, Altitude was 35252ft with a vertical speed of -1500ft/min decreasing, Target altitude was 34000ft , 1s later the speed had increased to 0.796 Mach . The low energy alert stopped due to the airspeed increase as the aircraft was descending to the selected altitude, and not as a direct result of the change to the selected speed.

The vertical speed reached -3400ft/min during the open descend.

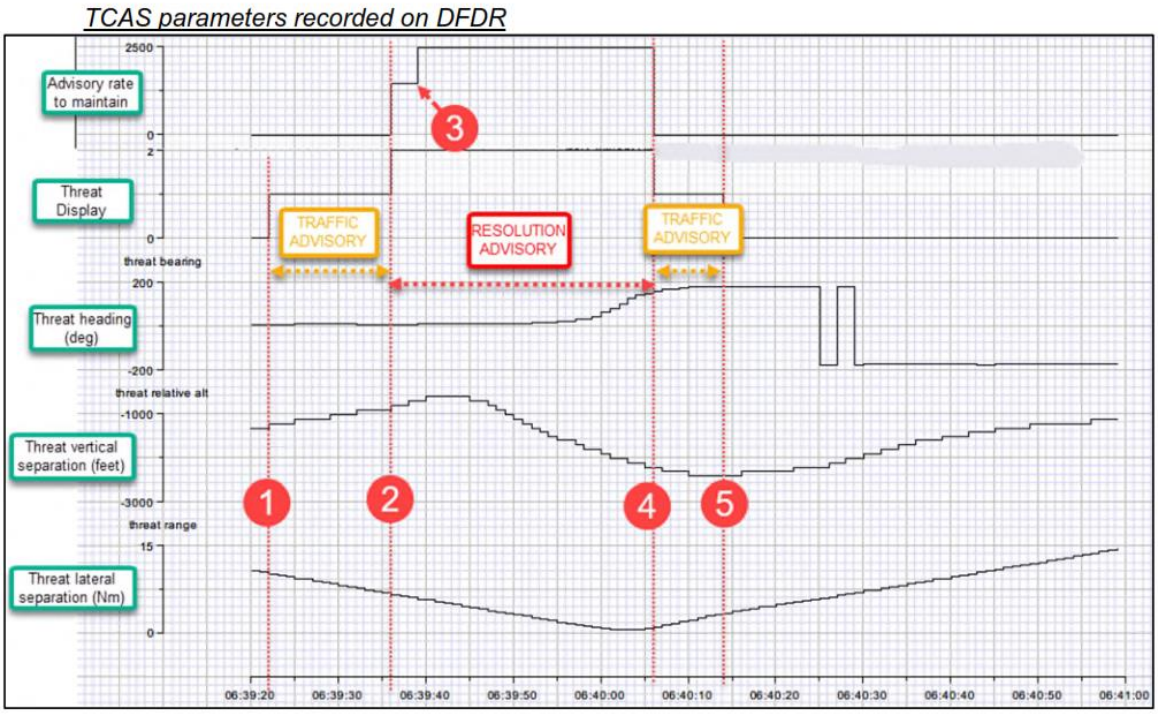

Figure 2, A350 FDR Graph made by Airbus Co.

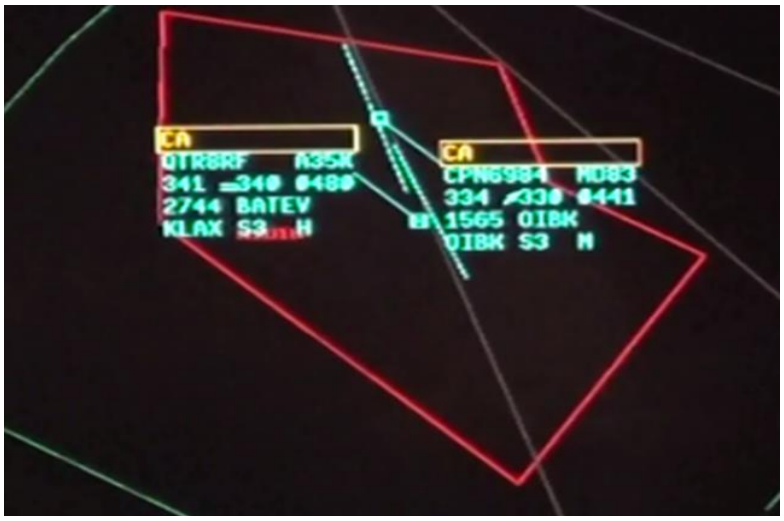

Figure 3, 5 NM separation at 06:39:46, A350 started to climb

Based on chapter 27-07 of MEL for aircraft MD83 and policy of the airline, the aircraft could depart with alternate trim motor control malfunction for 10 days (CAT C) and the pilot should follow procedure as:

1- Verify Manual Alternate Trim functions properly by moving Alternate Trim Switch Levers on the center pedestal and observing movement of the longitudinal trim position indicator.
2- Trim aircraft manually prior to engaging autopilot.
3- Monitor AP TRIM' OUT OF TRIM light while AP is engaged.
4- If light comes on, re trim by either of the following:
   a. Operation of the alternate longitudinal trim switch (which does not require AP disconnect)
      Or
   b. Disconnecting the autopilot, manually trimming with control wheel switches or LONG; TRIM handles, and then re -engaging the AP.

When MD aircraft initiated turning, the aircraft flight level decreased due to malfunction of trim motor so pilot tried to trim elevator manually that caused high rate of climb which was sensed by TCAS transponder of A350 resulting TCAS RA finally. Results of the of the cockpit crew reaction shows they did not follow above procedures correctly.

Boeing believes, however, that when dispatching an MD-83 utilizing MEL Item27-7 and the operations requirements of this MEL Item, And the associated Dispatch Deviation Guide Item27-7, are followed:

- The airplane can be safely operated
- The autopilot typically is not expected to allow an altitude loss during a heading change
- A qualified pilot typically can be expected to manually fly the airplane to regain 500 feet of altitude, without an altitude/level bust

In accordance with Qatari pilot's report which has confirmed by A350 FDR data, when the aircraft was cleared from other conflicted aircraft at FL351, by the time "speed, speed" warning was heard in the cockpit and with consideration of maximum recommended altitude, aircraft speed reduced to Lowest Selectable Speed (VLS) situation. Regarding to the A350 gross weight (303.2T) and high ROC, the aircraft continued to climb and after passing FL354 finally when the aircraft speed reduced to M.792, the aircraft continued for open descent to FL340. Finally, aircraft speed back to normal speed (M.85) and level off at FL340. information shows that when the A350 was passing FL351, the MD83 was at FL329.

In accordance with BEA comments, the performance of the A350 aircraft was not degraded at any time but performance was limited due its gross weight and high altitude.

The low energy alert was a consequence of the extended TCAS resolution alert requiring the Airbus to climb at 2500 ft/min while it was already close to REC MAX FL. The climb rate was achieved but the performance limitation at that altitude resulted in a loss of speed, transiently to below VLS. Loss of speed is acceptable during a TCAS manoeuver, where the priority is to achieve the required vertical rates.

3. Conclusions:

3.1 Findings:

- There was not any reported contributive technical problem for A350 but MD83 has departed with alternate trim motor control malfunction based on minimum equipment list (MEL) item.
- The reaction of the pilot for MD aircraft against flight level decrease was excessive manual trimming of the elevator which caused high rate of climb that finally resulted to level bust and TCAS activation for both aircraft.
- The A350 firstly received a Traffic Advisory and 7 seconds later, a Resolution Advisory (RA). The TCAS resolution required a climb rate of 1500ft/min which increased to 2500ft/min 3 seconds later.
- The A350 crew retained the Autopilot, Flight Directors and Auto thrust engaged as per FCOM procedure. The TCAS AP/FD followed the resolution orders and attained the required climb rates to clear the conflicting traffic, during which the aircraft reached an altitude of 35336ft. Consequently, the aircraft speed reduced.
- As the conflict cleared, the speed transiently dropped below VLS (Lowest Selectable Speed), triggering the low energy alert for 9 seconds. The flight crew

selected Open Descent by pulling the ALT knob, leading the engine thrust to reduce to idle.

- While its effect may have been limited during this event, selecting OP DES while in a low energy situation, and especially at high altitude, is not in line with the recommendation given in the FCTM, where thrust and/or pitch must be adjusted to recover from low energy.

3.2 Causes:

The Aircraft Accident Investigation Board (AAIB) determined that the main cause of serious incident was incorrect reaction of pilot for MD83 about malfunction of alternate trim motor control and excessive manual trimming of the aircraft which caused level bust and generating TCAS RA for both aircraft.

Cockpit crew of A350 did not follow FCTM recommendation and selected OP DES in a low energy situation, and especially at high altitude that caused *"Low Energy"* warning.

4. Safety Recommendations:

Considering the final results of the investigation to prevent similar incidents, the following safety recommendations were issued:

To Iran and Qatar Civil Aviation Authorities:

1- To focus on the findings of the report and take remedial actions to improve the measure for overseeing effectiveness of crew training.

To FAA as relevant authority of MD aircraft:

2- To add a safety note on aircraft MEL for the operators to prevent level bust in the case of alternate longitudinal trim motor control relay malfunction