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ACAS II Bulletin

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Notable recent operational events

WELCOME

In this ACAS II Bulletin we take a look at five recent events recorded in European airspace. They all are different in nature but all of them highlight the need for awareness of ACAS II operations and for recurrent training.

Although several RAs occur daily in European airspace, they are relatively rare events for individual pilots. In the vast majority of cases, the RAs are not newsworthy. However, a handful of recent cases – due to their circumstances – provide learning points for the benefit of the flying community. These cases include an RA while the aircraft was turning, an opposite reaction to an RA due to visual acquisition, an RA during a high vertical rate descent, a military interception, and finally a long duration RA.

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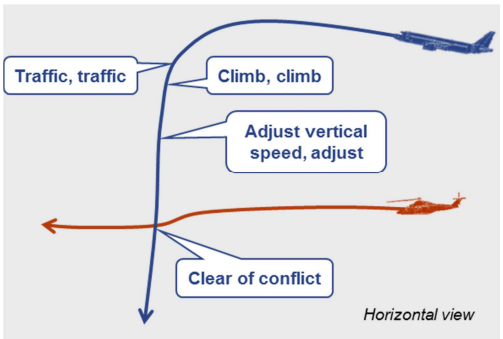
Event 1: RA while turning

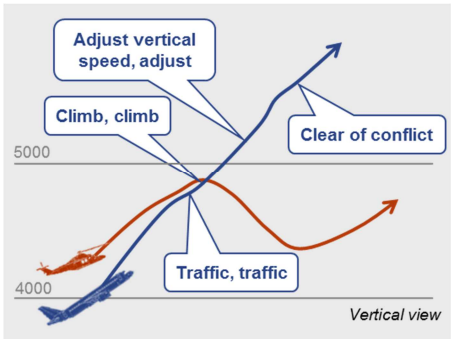
A helicopter takes off on an IFR flight from a helipad adjacent to a major airport and is instructed to follow a SID. Shortly after, an Airbus 320 reports ready for departure. The tower controller clears the A320 for take-off on a different SID, assuming that the A320 will soon be higher than the helicopter and at the time when the SIDs cross there will be no conflict. The SID which the A320 is following requires an approximately 90-degree left turn approximately 1 minute after take-off; on completion of the turn both SIDs intersect.

Soon after the A320 has departed, the tower controller passes traffic information to the helicopter about the departing Airbus.

When the A320 starts its left turn, the helicopter is at its 8 o'clock position, at a distance of 1.8 NM and 230 feet above. When the A320 is turning, its vertical rate decreases from 2000 ft/min. to approximately 1000 ft/min. while the flaps are being retracted. Meanwhile, the helicopter is climbing at 1000 ft/min. The spacing between the two reduces and when they are 1.4 NM and 43 feet apart (with the helicopter still being higher), a TA is generated on the A320. The helicopter is not TCAS equipped but the crew makes visual contact with the A320, stops the climb and starts a descent to avoid the conflict.

Five seconds after the TA, the A320 gets a Climb RA. At this time the vertical rate of the A320 is 1100 ft/min., so the RA requires an increase to 1500 ft/min. The helicopter is 1.1 NM away and 25 feet below the A320. The A320 crew complies with the RA by promptly disconnecting the autopilot and increasing the vertical speed but they also continue a left turn away from the SID. After 10 seconds, the RA weakens to Adjust Vertical Speed as the vertical spacing between the two increases to 440 feet and the helicopter is descending. After another 15 seconds, the A320 gets a Clear of Conflict annunciation when the helicopter is 1200 feet below and 0.8 NM away. At the closest point of approach the separation was 0.2 NM and 1000 feet.





Conclusions: The prompt response to the RAs by the A320 crew in combination with the *See and Avoid* manoeuvre by the helicopter crew helped to increase the vertical spacing. However, without the latter (which is a possible scenario as illustrated by Event 2) significantly less vertical spacing would have been achieved and TCAS would probably not have issued the weakening RA but would possibly even have issued a strengthening RA.

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To turn or not to turn during an RA?

Evidently, it is a dilemma that many pilots face as it is a recurring question in messages EUROCONTROL receives. The ICAO ACAS Manual (Doc. 9863) recommends that, *"if possible, comply with the controller's clearance, e.g. turn to intercept an airway or localizer, at the same time as responding to an RA."* With the exception of this provision, there are no procedures or regulations covering responses to RAs while the aircraft is turning. In any case, flying the RA should be the highest priority.

In some conflict geometries a turn during an RA may help to increase the horizontal spacing between the aircraft and, consequently, diminish the risk of collision. However, it is also likely that a turn would have just the opposite effect.

Pilots electing to execute a turn during the RA should be aware of potential inaccuracies of the TCAS II traffic display: the displayed bearing is not sufficiently accurate to support the initiation of horizontal manoeuvres based solely on the traffic display. Furthermore, the reference for the traffic display is own aircraft position which can lead to misinterpretation of the relative motion of other traffic on the display.

If an RA is issued while the aircraft is turning, which makes achieving the required vertical rate difficult or impossible, the turn should be stopped. It may happen that stopping the turn will put own aircraft in closer horizontal proximity to the threat aircraft but TCAS is evaluating the situation every second and it will change the RA if required.

Learning points:

- Always follow the RA. Follow the RA even if the RA is contradictory to ATC instructions or published route (terrain awareness should be exercised at lower altitudes).
- Whilst following the RA if possible, comply with the controller's clearance, e.g. turn to intercept an airway or localizer.

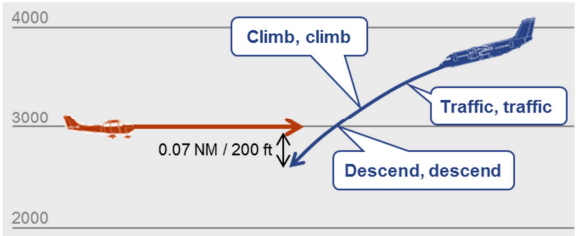
Event 2: Visual acquisition and RA not followed

An ultra-light single engine aircraft is on a VFR cross-country flight. It has obtained a clearance from the local tower to cross the control zone at 3000 feet.

Less than 2 minutes later, an Avro RJ100 calls the tower reporting established on ILS. At this time, the RJ100 is approximately 800 feet above the ultra-light. The tower controller informs the RJ100 crew about the traffic at their 11 o'clock position at a distance of 3 NM, moving left to right. The RJ100 crew responds that they have traffic in sight.

Twenty seconds later, the tower controller informs the ultra-light pilot of the RJ100 at his 2 o'clock position, 2 NM, descending through 3600 feet. The pilot responds that he does not see the RJ100.

When the RJ100 is passing through 3450 feet, it gets a TA. After 11 seconds, when the RJ100 is passing through 3200 feet it receives a Climb RA against the ultra-light. Based on visual acquisition, the RJ100 pilot judges that the ultra-light is already above. Therefore, he decides to descend to fly below the ultra-light rather than climb as advised by the RA. While RJ100 is descending, the RA changes to Descend.



The subsequent investigation of this incident established that at the time of the RA, the ultra-light was in fact 200 feet below the RJ100 at the distance 1.2 NM. The RA changed to Descend when both aircraft were at the same altitude at a distance of 0.64 NM. Shortly thereafter, the two flight paths crossed. At the Closest Point of Approach, the spacing between the aircraft was just 0.07 NM and 200 feet.

Conclusions: As illustrated by this case, sometimes it may be is difficult to assess the relative altitude of conflicting traffic as well as its range and heading. Avoidance manoeuvres based on visual acquisition may not always provide the appropriate means of avoiding conflicting traffic. Moreover, the traffic in visual contact may not be the threat that triggers the RA, especially in an area where some transponder-unequipped aircraft (e.g. gliders) may be operating. A visual manoeuvre relative to the wrong visual traffic may degrade the situation against the real threat.

Avoidance manoeuvres based on visual acquisition and, especially, manoeuvres contrary to the RA may not always ensure successful collision avoidance due to traffic mis-identification or traffic response to their RAs.

Learning points:

- Do not manoeuvre in the opposite sense to an RA.
- Visual assessment of traffic can be misleading.

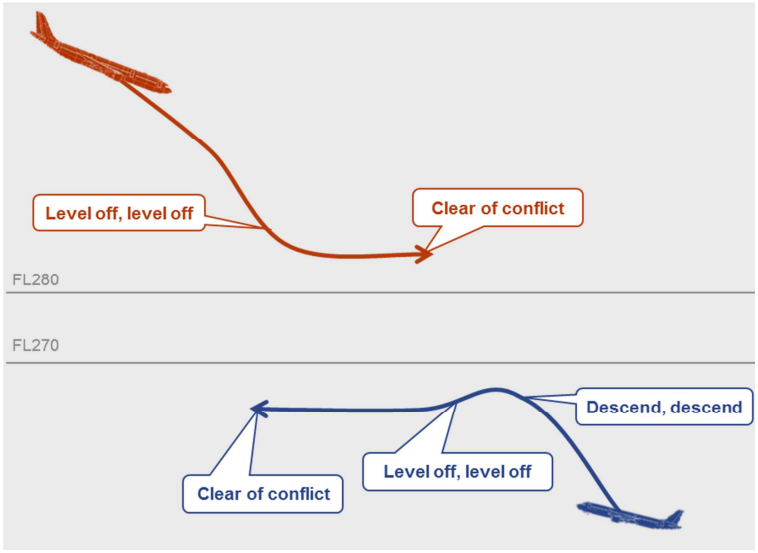
Event 3: High vertical rate

An Airbus 330 is maintaining FL400. On reaching the top of descent, the crew requests a descent clearance. ATC clears the A330 to FL280, providing information that further descent will be given once clear of crossing traffic, an Airbus 321, climbing to FL270. The predicted horizontal separation is just under 1 NM.

The A330 commences its descent at approximately 2000 ft/min. When the A330 passes FL355, its rate increases to 3500 ft/min. At this time, the A321 is passing through FL234 at 2600 ft/min.

When the A330 is passing through FL320, it increases its rate of descent to 7600 ft/min. Then, the descent rate is reduced again. When the A330 is passing through FL301 at 5200 ft/min., it gets a TA against the A321 below. Simultaneously, the A321 (passing through FL261 at 2800 ft/min.) also receives a TA.

After the TA, the A330 reduces the vertical rate to 4000 ft/min. and when the A330 is passing through FL290, it receives a Level Off RA. At the same time, the A321 receives a Descend RA which weakens to Level Off after 10 seconds. Both crews respond to their RAs promptly: the A330 levels off at FL285 while the A321 levels off at FL264. Once the horizontal spacing is established, TCAS issues a Clear of Conflict annunciation and both crews receive further ATC clearances.



Conclusions: While high vertical rates provide operational benefits (in terms of fuel or time savings), aircraft climbing/descending with high vertical rates are prone to receive RAs which in hindsight would be deemed operationally unnecessary. This is because TCAS does not know aircraft intentions – autopilot or flight management system inputs are not taken into account by TCAS II – RAs are issued when TCAS calculates a risk of collision based on the closing speed and vertical rates. Sometimes, when the vertical rates are particularly high, these RAs can be generated several hundreds of feet before the cleared level. This in turn may lead to unnecessary workload for flight crews and can be disruptive for ATC.

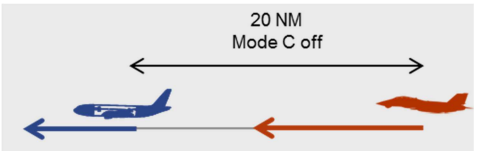
Learning point:

ICAO recommends that, in order to avoid RAs in level-off situations, vertical rates are reduced to 1500 ft/min or less at least 1000 feet before your cleared level. Local or company regulations may impose different restrictions.

Event 4: Military interception

Following a transfer from one sector to another, a Boeing 737 suffers communication problems and is unable to establish contact with ATC. Therefore, as it is standard procedure in cases like this, a decision is taken to send a military fighter jet to intercept the B737 to assess the situation and offer assistance, if required. ATC makes a blind transmission on 121.5 MHz to advice the B737 crew of the forthcoming interception and the B737 crew is able to hear this message, so they are expecting the interception.

The fighter approaches the B737 without switching its Mode C (altitude reporting) off. Due to the proximity, TCAS on the B737 assesses the fighter to be a collision threat and issues an RA against it. The B737 crew has already sighted the military jet and having information from ATC about the interception, elects not to follow the RA. Following the interception, regular communication with ATC is re-established and the B737 continues to its destination.



Conclusions: If the intercepting military aircraft does not switch off its altitude reporting, then an intercepted aircraft equipped with TCAS II may perceive the interceptor as a collision threat and the crew might perform manoeuvres in response to an RA. Such manoeuvres could be misinterpreted by the interceptor as an indication of unfriendly intentions, which in turn may lead to the escalation of the situation.

Learning point:

The intercepting aircraft's Mode C should either be inhibited or Intercept Mode selected (if available) within 20 NM of the target aircraft, to prevent unnecessary RAs. Intercepted aircraft are expected to follow RAs in all cases.

Event 5: Long duration RA

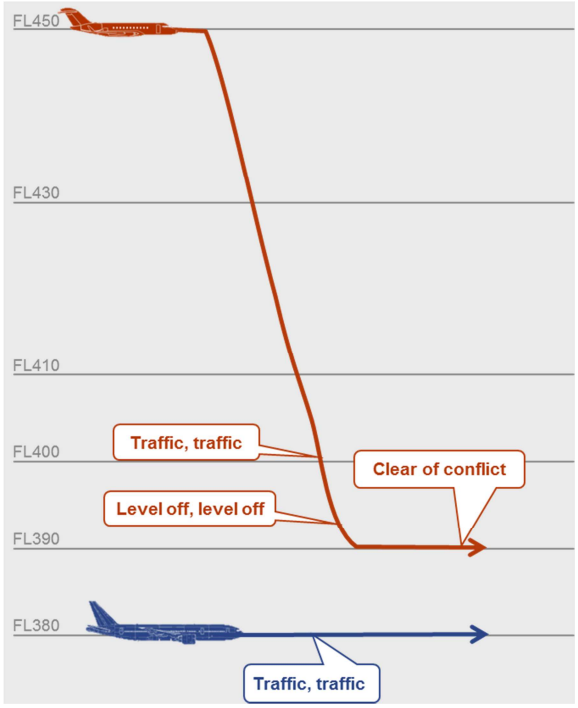
A Bombardier Global business jet cruising at FL450 is reaching the top of descent. ATC clears the Bombardier to FL390. At the same time, a Boeing 777 is directly underneath at FL380, flying in the same direction along the same airway as the Bombardier. The Bombardier commences its descent and when it is passing FL401 descending at 2500 ft/min. it receives a TA against the B777 below.

The Bombardier crew reduces the vertical rate to 1800 ft/min. after the TA but when they are passing through FL392 they receive a Level Off RA. The crew responds to the RA levelling the Bombardier off at FL390. The B777 underneath has received a TA against the Bombardier but no RA.

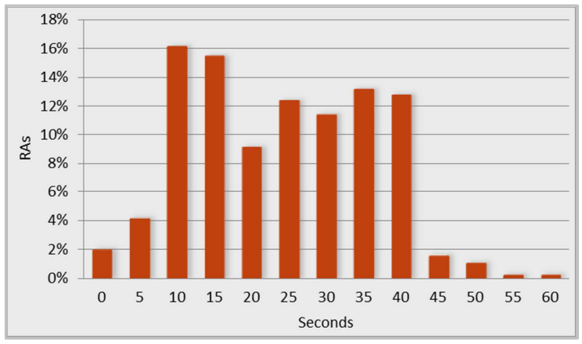
Although, the Bombardier has levelled off at FL390, the RA continues to be displayed to the crew. Only 2 minutes and 45 seconds later when the B777 makes a turn to follow the flight plan route does the Bombardier crew gets a Clear of Conflict annunciation.

Conclusions: The Level Off RA was triggered for the Bombardier as its vertical rate was 1800 ft/min. just a couple of hundred feet from the cleared level. The RA remained active for a total of 2 minutes 45 seconds.

The RA was of an unusually long duration. Data collected on almost 750 RAs in core European airspace shows that the majority of RAs last 10-40 seconds (see the adjacent graph). RAs that last less than 10 seconds or significantly longer than 40 seconds are not common but they can occur in some geometries.

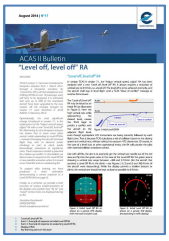


In the encounter described above the two aircraft were flying on the same track, at nearly the same speed, in level flight and virtually one above the other. That prevented the RA termination because one of the internal TCAS tests was continuously satisfied in this geometry. The RA was allowed to terminate only when the B777 changed its heading. Also, a change in a speed of either of the aircraft could have caused the RA termination as well.



Learning point:
Although the majority of RAs will last between 10 and 40 seconds, short or long duration RAs may occasionally occur in some geometries.

ACAS training resources on www.eurocontrol.int or www.skybrary.aero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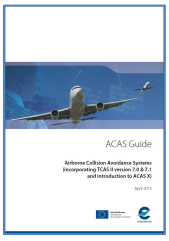

ACAS II Guide
(updated May 2015)

Overview of ACAS II (incorporating version 7.1)

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