



# ACAS II Bulletin

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## ATC vertical rate and heading instructions

### WELCOME

In the crowded skies of core European airspace, pilots are often instructed by air traffic controllers to fly on a radar heading, climb/descend with a given rate or reach a certain flight level in a specific period of time. These instructions ensure that the aircraft stay separated (typically 5 NM horizontally in en-route airspace and 3 NM in TMAs) while traffic keeps flowing smoothly. Controllers not only separate air traffic in the immediate vicinity but also plan several minutes ahead, making sure that any conflicts are resolved in a timely manner.

However, recently a number of events have been reported in which, after receiving a Traffic Advisory (TA) or observing another aircraft on their TCAS traffic display, ATC vertical rate or heading instructions have been ignored and vertical or horizontal manoeuvres initiated. We will examine some of these cases and discuss why these actions were unnecessary.

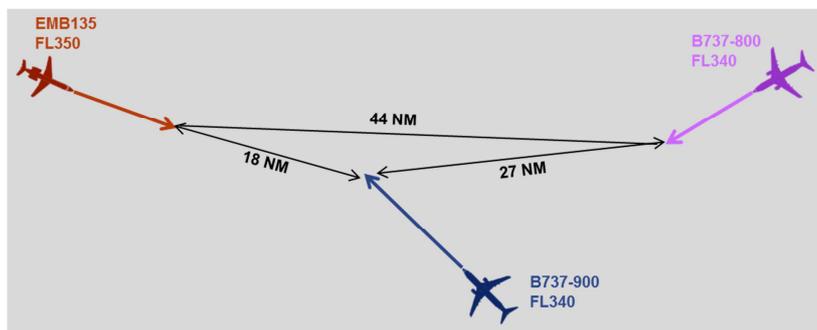
Unless a Resolution Advisory (RA) has been issued, the pilot must comply with ATC instructions, including any given heading and vertical rate. However, once an RA has been issued it must be immediately followed even if there is a conflict between the RA and an ATC instruction.

Similar topics have already been covered in ACAS Bulletins no. 6 ([Incorrect use of the TCAS traffic display](#)), no. 16 ([“Traffic, traffic” TCAS Traffic Advisories](#)), and no. 19 ([ATC matters](#)).

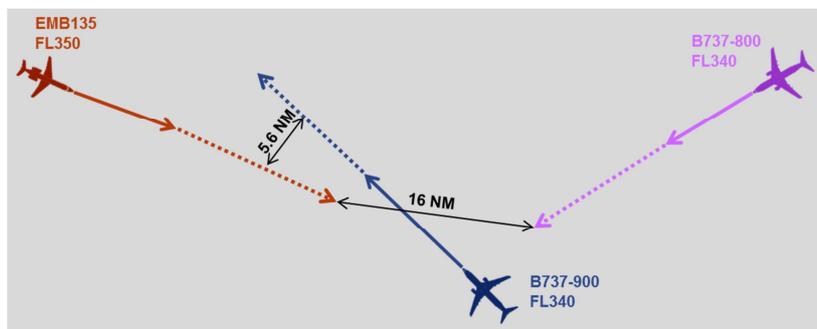
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### Event 1a: Vertical rate instruction not followed

Three aircraft are involved in the event illustrated below: an Embraer 135 at FL350 heading 110° (shown in brown), a Boeing 737-900 at FL340 heading 310° (blue) and a Boeing 737-800 also at FL340 heading 240° (purple). As the EMB135 is approaching its top of descent ATC instructs it to turn right 5° and descend to FL330 “to be level in 2 minutes”. The B737-900 is instructed to continue on its present heading.



The heading instructions are meant to maintain the predicted horizontal separation of over 5 NM between the EMB135 and the Boeing 737-900, while “to be level in 2 minutes” instruction is issued to ensure that the EMB135 is below the B737-800 before the horizontal separation is lost.

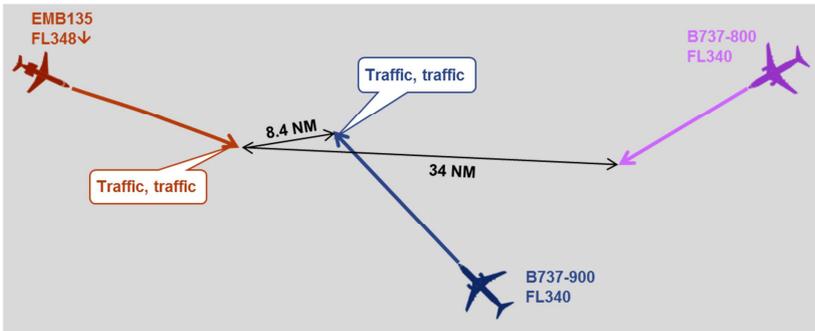


After 45 seconds, when the EMB135 is passing through FL348, both the EMB135 and B737-900 get TAs against each other. The TAs are issued because the aircraft are slightly converging and the time to Closest Point of Approach falls within the TA generation threshold.

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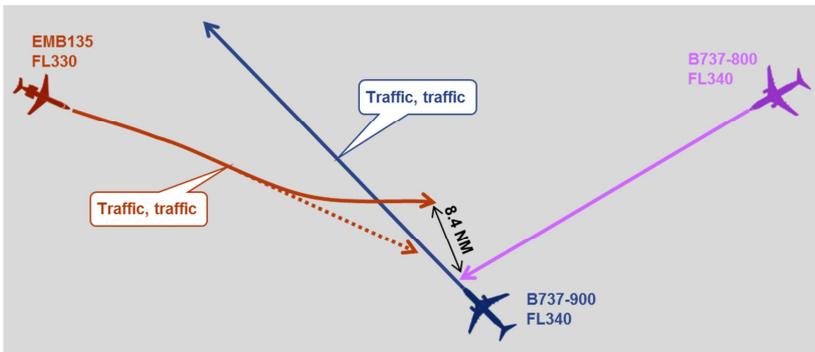
- 1: Event 1a: Vertical rate instruction not followed
- 2: Event 1b: Vertical rate instruction not followed ♦ ICAO Provisions concerning Traffic Advisories
- 3: Event 2: Traffic display misjudgement
- 4: Event 3: Descent reversed due to traffic below ♦ ICAO Recommendation concerning vertical speeds ♦ Key learning points

Event 1a: Vertical rate instruction not followed  
continued



As both aircraft are “locked” on their headings there is no loss of separation. Soon after receiving the TA, the EMB135 stops its descent and reports “unable rate due to TCAS TA”.

The controller again instructs the EMB135 to descend to FL330. Additionally, the EMB135 is given a left turn onto a heading of 090° to ensure the horizontal separation with the southwest bound B737-800 is maintained while the EMB135 is descending through its level.



The TAs, subsequently, terminate after 20 seconds.

The EMB135 continues its descent and when it reaches FL330 (i.e. it is below the B737-800 at the distance of 8.4 NM) is cleared on own navigation.

Without the turn, as the EMB135 crew reduced the vertical rate in response to the TA, the horizontal separation would have dropped below the required 5 NM.

**Conclusions:** The EMB135 crew did not follow the ATC instructions and reduced their vertical rate because of the TA. There was no risk of loss of separation with the aircraft against which the TA was issued (the B737-900) and the closure rate was such that no RA would have been triggered. As the EMB135 stopped descending at the instructed rate, the controller had to issue an additional turn instruction to the EMB135 crew to prevent a separation loss with the B737-800.

**Learning points:**

- The objective of a TA is to aid visual acquisition of an intruder and prepare the crew for a possible RA.
- ICAO provisions are quite specific – pilots shall not manoeuvre their aircraft in response to TAs.
- Chances are that a manoeuvre prompted by a TA may actually lead to a genuine loss of separation or RA which otherwise would not have occurred.
- Unless an RA has been issued, the pilot must comply with ATC instructions, including any given vertical rate and heading.

**ICAO PANS-OPS (Doc. 8168, volume I, Part III, Section 3, para. 3.2):**

The indications generated by ACAS shall be used by pilots in conformity with the following safety considerations:

- a) pilots shall not manoeuvre their aircraft in response to traffic advisories (TAs) only; [...]
- b) on receipt of a TA, pilots shall use all available information to prepare for appropriate action if an RA occurs; [...]

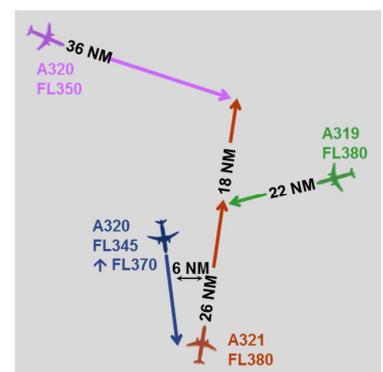
**ICAO ACAS Manual (Doc. 9863, 5.2.1.1):**

Respond to TAs by attempting to establish visual contact with the intruder aircraft and other aircraft that may be in the vicinity. [...] Do not deviate from an assigned clearance based only on TA information. [...] Slight adjustments in vertical speed while climbing or descending, or slight adjustments in airspeed while still complying with the ATC clearance are acceptable.

Event 1b: Vertical rate instruction not followed

A northbound Airbus 321 (shown in brown on the adjacent figure) is maintaining FL380 while a southbound Airbus 320 (blue) is passing through FL345 climbing to FL370. Further north, an Airbus 319 (green) is heading west also at FL380 and another A320 (purple) heading east is maintaining FL350.

The controller instructs the northbound A321 (brown) and southbound A320 (blue) to continue on their headings to ensure that the predicted horizontal separation of 6 NM is maintained. Then, the controller instructs the A321 to descend to FL340 with a vertical rate of 1000 ft/min. or more. The vertical rate is given due to the two aircraft on crossing tracks further north: by following the descent rate the A321 will get below both aircraft before horizontal separation is lost.



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### Event 1b: Vertical rate instruction not followed

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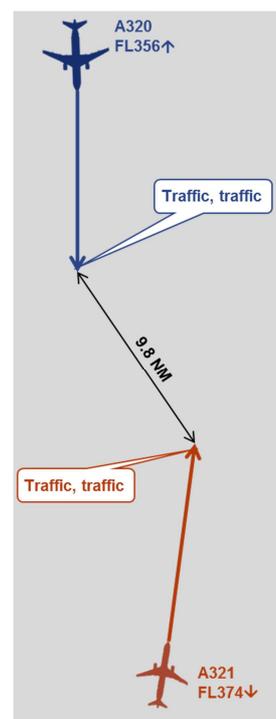
When the A321 and A320 are 9.8 NM apart and passing through FL374 and FL356 respectively, they both get TAs. Soon after, the A321 crew reports that they have reduced their rate of descent due to the TA and ask for traffic information, which the controller provides.

After 26 seconds, when the A321 passes FL369 and A320 FL362, the aircraft pass each other at a distance of 5.9 NM, and the TAs terminate. Subsequently, the A321 resumes its descent as instructed and there is no loss of separation with the two other aircraft further north on the crossing tracks.

**Conclusions:** This event illustrates the importance of following ATC instructions since they are issued taking into account all surrounding traffic, including those aircraft which may be on another frequency or still some distance away. In this case the vertical speed reduction by the A321 had no significant negative consequences as both the crossing aircraft were still some distance away and separation recovery was possible. However, there was no justification for the reduction of the ATC instructed vertical rate because of a TA. In this geometry no RA would have been triggered.

#### Learning points:

- **Pilots:** Always comply with vertical rates and headings instructed by ATC. Controllers use them to achieve separation. Controllers anticipate delays in reaching the assigned rate and a level off manoeuvre and apply some margin when calculating the required rate.
- Air traffic controllers base their actions on the complete traffic picture to provide safe and expeditious flow of aircraft.
- **Controllers:** If workload and frequency occupancy permit, provide pilots with traffic information, so the reasons for heading/vertical speed instructions are known to flight crews.



### Event 2: Traffic display misjudgement

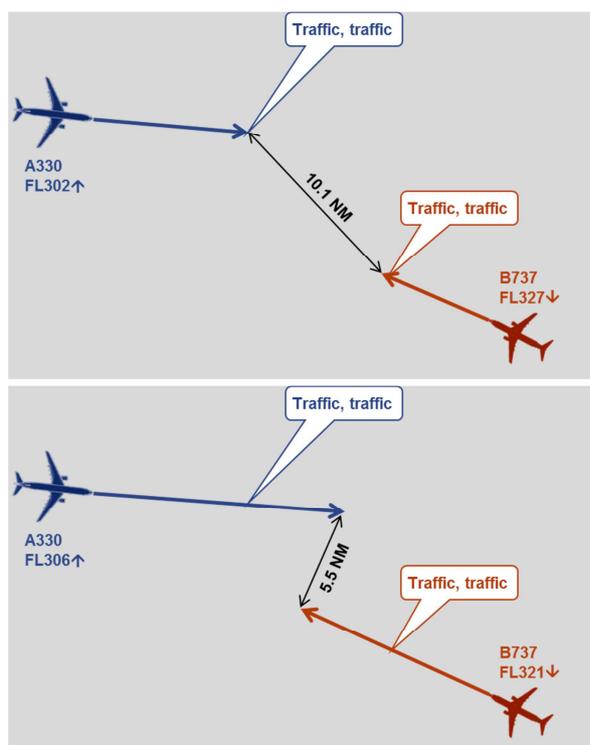
A westbound Boeing 737-800 is at FL340 at the top of descent. To facilitate its descent the controller instructs the crew to turn left 10° and clears them to FL260 with the rate of 2000 ft/min. The vertical speed instruction is meant to bring the B737 below a stream of north-south traffic several miles away in the adjacent sector while the left turn is to provide horizontal separation with an Airbus 330 which is climbing to FL370 in the opposite direction. Both aircraft are “locked” on headings and expected to pass more than 5 NM apart.

The B737 starts to descend and as the aircraft get closer the B737 crew observe the A330 on their TCAS traffic display and determine they are in conflict as the A330 appears to be on their 12 o’clock position. Soon after, they get a TA against the A330 and reduce their descent rate to 200 ft/min. At the time when the TA is issued the aircraft are separated by 10.1 NM and 2500 feet. The TA terminates after 16 seconds and after another 20 seconds the aircraft pass with the horizontal separation of 5.5 NM and vertical separation of 1500 feet.

**Conclusions:** The B737 crew reduced the vertical speed contrary to the ATC instruction as they determined (based on the TCAS traffic display) that the A330 was on a collision course. In fact, the A330 was on an almost parallel opposite direction track. Their assessment of the A330 position was incorrect as sufficient horizontal spacing with the A330 was provided by ATC.

#### Learning points:

- TCAS Traffic Display must not be used for self-separation as it can be misinterpreted. It has limited bearing accuracy ( $\pm 30^\circ$ ) and it is based upon a moving reference. As the trajectory and intentions of other aircraft are not known, avoidance manoeuvres based solely on a TA may create a problem or cause a situation to deteriorate.
- Nominally, TCAS surveillance range is to 30 NM and 10,000 feet; however, in high-density airspace the TCAS surveillance range might be reduced to as little as 5 NM to reduce undesired interference with other systems (without compromising the collision avoidance capability). Consequently, not all aircraft in the vicinity will necessarily be shown on the traffic display.



## Event 3: Descent reversed due to traffic below

A Boeing 787 is maintaining FL360 above an Embraer 190 at FL300. Both aircraft are proceeding to the same destination. When the B787 asks for descent it is cleared to FL310.

When the B787 is approaching FL320 at the rate of 3000 ft/min., the crew asks the controller about the traffic below. The controller provides traffic information and confirms that B787 has been cleared 1000 feet above the aircraft below. The B787 crew confirms the clearance to FL310 but at the same time they stop the descent and start to climb until the aircraft levels off at FL324.

Subsequently, the B787 crew reports that the reason for their climb was “*information about traffic below*”. After brief level off, the B787 continues its descent to FL310.

**Conclusions:** A post incident analysis showed that the crew started to climb soon after receiving a TA against the EMB190 below. As no RA has been issued there was no justification for a manoeuvre contrary to ATC instruction.



### Vertical rate reductions prior to level-off

Most pilots are aware that excessive vertical rates, especially close to their cleared level, may lead to an unwanted RA with an aircraft at the adjacent flight level.

To limit the occurrences of these unwanted RAs, ICAO recommends (see the green box below) a reduction of the vertical rate to no more than 1500 ft/min. throughout the last 1000 feet of climb or descent (when the pilot knows of another aircraft at the adjacent level) **unless** otherwise instructed by ATC. A **TA does not authorise pilots to deviate from the ATC vertical rate instruction**. Air traffic controllers use vertical rate instructions to ensure that all aircraft remain separated while traffic is flowing efficiently.

If pilots are unable to comply with the ATC vertical rate instruction for aircraft performance reasons, they should notify ATC as soon as possible.

### ICAO Annex 6 (4.4.10):

Aeroplane operating procedures for rates of climb and descent  
Recommendation.— Unless otherwise specified in an air traffic control instruction, to avoid unnecessary airborne collision avoidance system (ACAS II) resolution advisories in aircraft at or approaching adjacent altitudes or flight levels, operators should specify procedures by which an aeroplane climbing or descending to an assigned altitude or flight level, especially with an autopilot engaged, may do so at a rate less than 8 m/sec or 1 500 ft/min (depending on the instrumentation available) throughout the last 300 m (1 000 ft) of climb or descent to the assigned level when the pilot is made aware of another aircraft at or approaching an adjacent altitude or flight level.

### Key learning points this issue:

- **Pilots must comply with ATC vertical rate instruction and heading instructions.** Controllers use them to provide separation from all nearby controlled traffic.
- **Any deviation from ATC instructions can result in a loss of separation.** If pilots are unable to comply with the instructions, ATC must be informed as soon as possible.
- **Pilots must not respond to TCAS Traffic Advisories.** A TA is an indication that an aircraft is in the vicinity and a conflict may develop.
- **A deviation from ATC clearance is authorised only in a response to Resolution Advisories.** All RAs must be followed promptly as indicated.
- **Pilots must not manoeuvre or make self-separation decisions solely based on traffic display indications** (due to its limited accuracy).
- **If controllers use heading/vertical speed instructions for separation, they should strive to provide traffic information, so pilots are aware of the reasons for these instructions.** This will help to prevent unexpected manoeuvres.