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EUROCONTROL

ACAS II Bulletin
Version 7.1 is coming…

WELCOME

This issue focuses on a forthcoming change to TCAS II – the introduction of the new version 7.1. A regulatory decision regarding implementation was published in the Official Journal of the European Union on 20 December 2011: all existing TCAS II version 7.0 installations must be upgraded before 1 December 2015 and new aircraft must be equipped with version 7.1 from 1 March 2012 to operate in European airspace.

The EU Implementing Rule sets an earlier equipage requirements than those published in ICAO Annex 10 (2014 new installations, 2017 existing units).

The development of version 7.1 was initiated by EUROCONTROL following the discovery of two safety issues with the current TCAS II version. Development was undertaken jointly by the RTCA in the United States and by EUROCAE in Europe with support and contributions from several other organizations, including airlines and ANSPs.

This bulletin explains the reasons behind the implementation of version 7.1 and introduces the new RA – the "Level off, level off" RA. It answers questions that pilots or controllers may have about the new version and provides references to additional training resources.

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Version 7.0 – problems with Adjust Vertical Speed RA

Since its introduction in Europe in 2000, TCAS II version 7.0 has been the subject of monitoring. In the course of analysing recorded and reported events, many cases – as many as 23 per year – were found in which pilots did not respond correctly to the "Adjust vertical speed, adjust" Resolution Advisories (RAs).

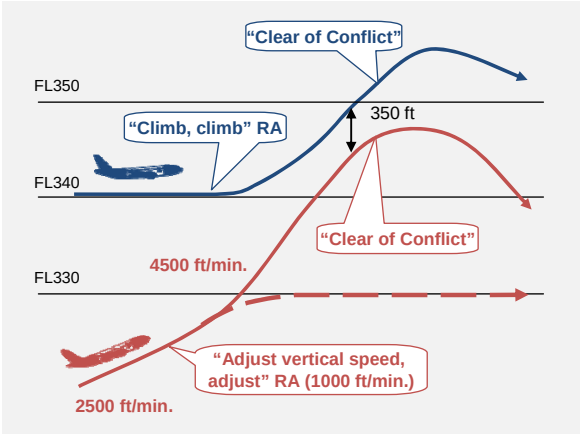


Figure 1: Incorrect response to an "Adjust vertical speed, adjust" RA

The "Adjust vertical speed, adjust" RA requires the reduction of vertical speed to 2000, 1000, 500, or 0 ft/min., as indicated on the flight instruments. In those cases involving an incorrect response, the pilots increased their vertical speed instead of reducing it, consequently causing a deterioration of the situation. The "Adjust vertical speed, adjust" RA is the only RA whose aural annunciation does not clearly communicate what exact manoeuvre is required. It is also the most common RA, representing up to two-thirds of total RAs, all of which increases the potential for incorrect pilot response. Case examples were discussed in ACAS Bulletins no. 3, 7, and 11 (see Figure 1).

Additionally, there have been numerous cases of level bust when pilots following the "Adjust vertical speed, adjust" RA went through their cleared level, often causing a follow up RA for the other aircraft above or below, and disrupting ATC operations (see Figure 2).

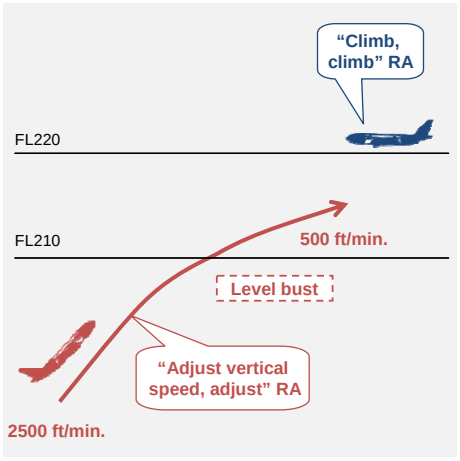


Figure 2: Level bust as a result of "Adjust vertical speed, adjust" RA

Version 7.1 solution – new "Level off, level off" RA

The issues mentioned on the previous page have led to the development of TCAS II version 7.1. Occasional pilot confusion with the "Adjust vertical speed, adjust" RA is resolved by replacing it with a new **"Level off, level off"** RA.

Currently, "Adjust vertical speed, adjust" RAs require a reduction of the vertical rate to 2000, 1000, 500 or 0 ft/min. The new "Level off, level off" RA always requires a reduction of vertical rate to 0 ft/min. The level off is to be achieved promptly, not at the next standard flight level (e.g. FL200, FL 210, etc.).

The aural message "Level off, level off" also has the benefit of being intuitive and the associated manoeuvre corresponds to the standard levelling off manoeuvre.

The "Level off, level off" RA may be issued as an initial RA (as illustrated in Figure 3) or as a weakening RA (following, for instance, a "Climb, climb" or "Descend, descend" RA – see Figure 4) when the vertical distance between the aircraft increases after the initial RA has been issued.

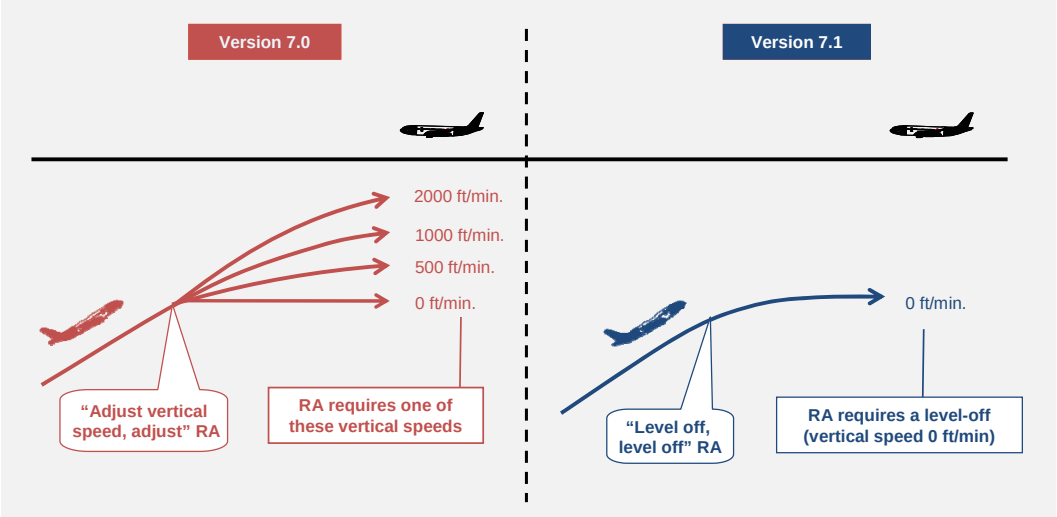


Figure 3: Comparison of "Adjust vertical speed, adjust" and "Level off, level off" RAs

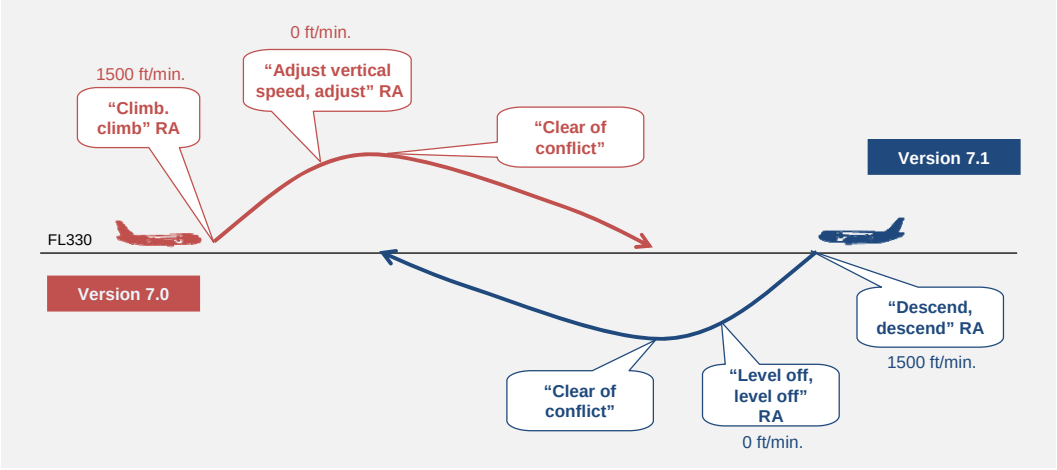


Figure 4: Comparison of weakening "Adjust vertical speed, adjust" and "Level off, level off" RAs

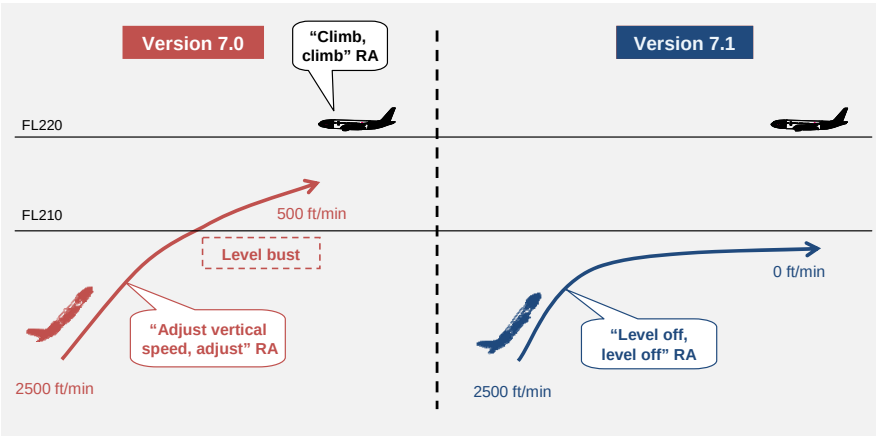


Figure 5: How the "Level off, level off" RA will reduce instances of level bust

A weakening "Adjust vertical speed, adjust" RA in the existing version 7.0 also always requires a reduction of vertical speed to 0 ft/min. (i.e. level off), so there is no change in pilot actions in these cases.

Additionally, replacing the multiple climb/descent rates of the "Adjust vertical speed, adjust" RA, the "Level off, level off" RA will minimise the altitude deviations induced by TCAS (level busts while "flying the green arc"), thus reducing the impact on ATC operations.

It will contribute to the overall reduction of RA occurrences because follow up RAs resulting from the "green arc level bust" should not occur any more (see Figure 5).

How the new RA "Level off, level off" RA is shown on a generic Electronic Flight Instrument System or Instantaneous Vertical Speed Indicator is shown in Figures 6 through 9.

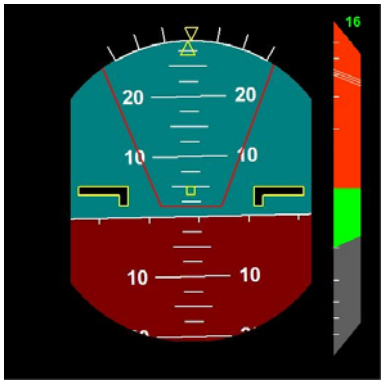


Figure 6: "Level off, level off" RA as shown on a generic EFIS display

"Level off, level off" RA
continued

Figure 7: "Level off, level off" RA as shown on a generic IVSI display

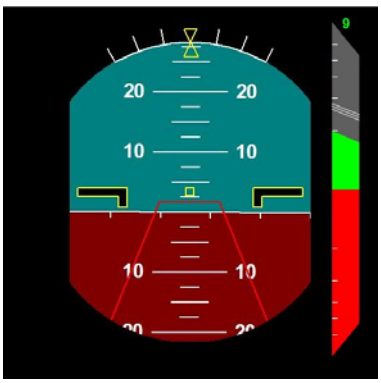


Figure 8: A weakening "Level off, level off" RA as shown on a generic EFIS display

Figure 9: A weakening "Level off, level off" RA as shown on a generic IVSI display

Learning points – new "Level off, level off" RA:

- **Response to "Level off, level off" RA:** Reduce the vertical rate to 0 ft/min (i.e. level off).
- The level off must be achieved promptly, not at the next flight level.
- "Adjust vertical speed, adjust" RAs will become defunct.
- Some aircraft will level off hundreds of feet before their cleared level while responding to this new RA. However, the RA will not result in more frequent conflicts with third party aircraft than is experienced with the current version of TCAS.

Version 7.0 – problems with the reversal logic

The design of the current TCAS II version 7.0 allows for reversal RAs (i.e. "Climb, climb NOW" and "Descend, descend NOW") to be issued when the current RA is no longer predicted to provide sufficient vertical spacing.

However, there have also been a number of cases in which TCAS II version 7.0 failed to reverse an RA when two converging aircraft remained within 100 feet.

This type scenario can occur when one aircraft is not following the RA or is not TCAS II equipped and follows an ATC instruction or performs an avoidance manoeuvre based on visual acquisition.

A number of these types of cases have been discovered each year – as many as 7 per year – the most notable events being the Yaizu (Japan) midair accident (2001) and the Überlingen (Germany) midair collision (2002).

Version 7.1 solution – improved reversal logic

Version 7.1 will bring improvements to the reversal logic by detecting situations in which, despite the RA, the aircraft continue to converge vertically.

A feature has been added to the TCAS logic which monitors RA compliance in coordinated encounters (i.e. when both aircraft are TCAS II equipped). When version 7.1 detects that an aircraft is not responding correctly to an RA, it will issue a reversal RA to the aircraft which manoeuvres in accordance with the RA.
In single equipage encounters (i.e. when only one aircraft is TCAS II equipped), version 7.1 will recognise the situation and will issue a reversal if the unequipped threat aircraft moves in the same vertical direction as the TCAS II equipped aircraft.

Although the reversal logic change is transparent to flight crews, it will, nevertheless, bring significant safety improvements.

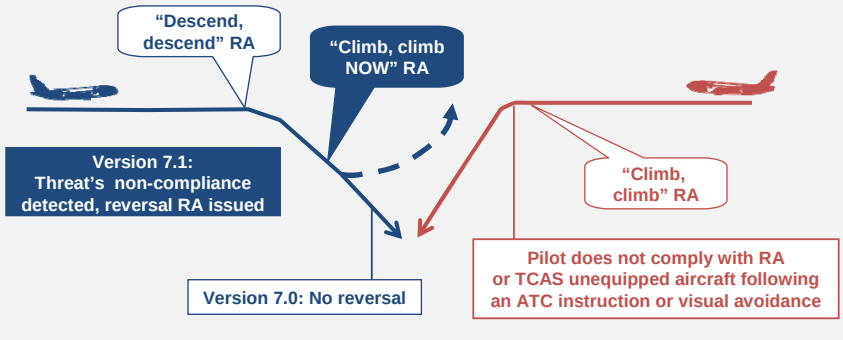


Figure 9: TCAS II version 7.1 improved reversal logic

Learning points – improved reversal logic:

No change in pilot actions:

- **Always follow the RA:** Follow the RA even if the RA is contradictory to ATC instructions
- Respond to reversal RAs within 2.5 seconds. Reversal RAs require a 1500 ft/min. climb or descent rate.

Version 7.1 Frequently Asked Questions

1. What aircraft are subject to the version 7.1 mandate?
The mandate is applicable in European Union airspace as of 1 March 2012 to all aircraft above 5,700 kg Maximum Take-off Mass or authorised to carry more than 19 passengers. An extended deadline, i.e. 1 December 2015, is granted to aircraft with an individual certificate of airworthiness issued before 1 March 2012 and equipped with version 7.0. See the European Commission Implementing Rule.

The EU Implementing Rule sets an earlier equipage requirements than those published in ICAO Annex 10 (1 January 2014 new installations, 1 January 2017 existing units).

2. Is version 7.1 compatible with earlier TCAS versions?
Yes, version 7.1 is compatible with all existing versions being operated today; i.e. version 7.0 as well as version 6.04a (which is still in use by a small population of aircraft, mainly outside Europe).

3. What actions are required by aircraft operators?
Aircraft operators should ensure that TCAS II version 7.1 is deployed on their fleet according to the mandate.

Aircraft operators should also ensure that their flight crews understand the new features version 7.1 brings and are trained on correct responses to "Level off, level off" RA.

4. What pilot training is required?
Before the new version of TCAS is deployed to its fleet aircraft operators should ensure that crews are:
• aware of the TCAS version upgrade
• trained on the new "Level off, level off" RA and understand how to respond to this RA correctly.

There are no other differences (visible to pilots) between version 7.0 and version 7.1

6. What controller training is required?
Before the new version of TCAS mandate takes effect (i.e. before 1 March 2012) ANSPs should ensure that air traffic controllers are:
• aware of the TCAS version upgrade
• understand the effect that the new "Level off, level off" RA will have on ATC operations (i.e. some aircraft may level off hundreds of feet before the cleared level as a result of the "Level off, level off" RA.

Besides that there are no differences (visible to controllers) between version 7.0 and version 7.1.

7. As a controller, how would I know which version of TCAS the aircraft operates?
There is no need for ATC to know which version of TCAS the aircraft operates. TCAS versions are compatible, so proper TCAS-TCAS coordination will take place in coordinated encounters. In Europe there is no requirement to indicate in the flight plan which version of TCAS the aircraft operates.

The provision of air traffic services to aircraft equipped with TCAS shall be identical to those that are not equipped.

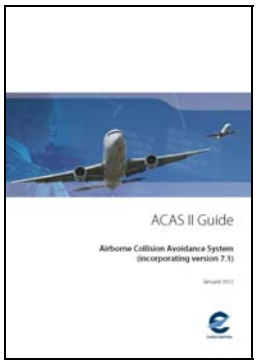
8. More Frequently Asked Questions
More FAQs can be found on www.eurocontrol.int/acas

Additional training resources

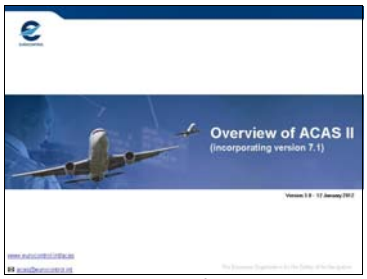
Available from www.eurocontrol.int/acas or click on the picture below to access the publication directly:

TCAS II version 7.1 overview for pilots (presentation)

TCAS II version 7.1 overview for air traffic controllers (presentation)



ACAS II Guide (incorporating version 7.1)



Overview of ACAS II incorporating version 7.1 (presentation)

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Previous ACAS Bulletins
www.eurocontrol.int/acas