

## **Something New in TCAS**

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During the past few months, TCAS suppliers have received FAA certification of Version 7—the latest revision to the TCAS software. Depending on what aircraft type you fly, where you fly it, and your airline's decisions on retrofit, you may soon be operating this new version.

You could be flying an airplane equipped with Version 7 TCAS and not know it, because Version 7 has no readily visible means of identification in the cockpit. Unless your airline makes the installation of the new version known by entries in the aircraft logbook, CDL, etc., you might not know your TCAS logic version until you hear and see one of the new resolution advisory (RA) alerts. Even then, you will have to be up-to-date on both the old and new aural and advisories to notice any difference.

### **The TCAS Transition Program**

The FAA established the TCAS Transition Program (TTP) in 1991 to assess the performance of TCAS as it was introduced to comply with U.S. law. Because of the cooperation between pilots, controllers, airlines, industry organizations, and the FAA, the TTP has been very successful.

The data that have been collected and analyzed have resulted in modifications to the TCAS logic to address operational and technical issues, enhancements to TCAS training programs, changes in operational procedures and displays, and improved guidance on the use of TCAS in various types of airspace.

One of the premises that has made the TTP a success is that the FAA agreed that information provided to the TTP regarding TCAS use and performance would not be used to initiate or pursue enforcement action. These agreements have been upheld in the past, continue to remain in force, and are expected to remain as new versions of TCAS are introduced.

This TTP process has so far worked successfully and has resulted in three previous changes to the TCAS logic.

### **Changes in TCAS Version 7**

After the last system upgrade had been operational for a while, TTP data analysis showed that pilots and controllers believed that too many unnecessary or otherwise inappropriate RAs were still being issued. The list is lengthy and somewhat technical, but here are two examples:

- High-vertical-rate encounters between climbing and descending aircraft still produced too many unnecessary alerts.
- The introduction of reduced vertical-separation minimums in the North Atlantic produced many reports of repeated traffic alerts (TAs), some continuing for as long as 90 minutes.

The Version 7 changes should further increase the safety benefits of TCAS, reduce the number of unnecessary RAs, make TCAS more compatible with the procedures that ATC uses, and address operational concerns of pilots who use the existing versions of TCAS.

Some of the changes will be obvious to pilots, while others will be difficult or impossible to detect. For pilots, the most obvious changes are in the aural annunciations and on the RA display. Controllers should notice fewer RAs being issued and less altitude displacement when a flight crew responds to an RA.

Airlines equipping their airplanes with Version 7 will be required to provide differences training, and the changes should be covered in greater detail than they are in this article. Understanding these changes and being aware of which version of TCAS is installed on each flight will be beneficial.

#### New aural annunciations

The aural annunciations that TCAS uses when issuing an RA have been modified to provide more information about the desired response. These changes, coupled with changes in the RA display, should make the desired response to an RA more intuitive (see the table below).

#### RA display changes

Changes to the RA display and portions of the TCAS logic have been improved to help reduce altitude excursions during an RA and to expand use of the green “fly to” arc, thus providing pilots with continuous guidance throughout an RA. Currently, TCAS displays a green arc only for an initial RA requiring a change in vertical speed (e.g., Climb or Descend RA), for a secondary RA requiring a stronger RA response (e.g., Increase Climb/Descent RA), or for an RA reversal (e.g., Climb/Descend NOW).

Version 7 retains the use of the green “fly to” arc for these advisories, but it also uses the arc for an RA requiring the pilot to maintain an existing vertical speed. The arc is also used for any RA signal weakened when the response to the initial RA has provided adequate vertical separation from the intruder. Whenever an RA is weakened, Version 7 will require the aircraft to be leveled by displaying the green arc beginning at 0 fpm and extending to  $\pm 250$  fpm.

#### Other changes

Version 7 will also bring the following changes to TCAS:

- Horizontal miss distance filter (HMDF)—new logic included with Version 7 will, whenever possible, suppress an RA when adequate horizontal separation between aircraft exists during potential encounters. Currently, when two non-maneuvering aircraft are approaching each other at the same altitude and offset flight paths, an RA may result if the aircraft pass as close as approximately 3 miles. In the same scenario with Version 7, an RA may not result unless the two aircraft are closer than approximately 1.5 miles. (Note: The approximate distances cited above are only an example. The actual lateral separation between aircraft will vary with altitude and depends upon many other factors, including closure rate between the two aircraft.) Simulations and testing have shown that the HMDF will reduce the number of RAs by approximately 25 percent in U.S. airspace, and up to 40 percent in European airspace, further minimizing RAs that cause disruptions to ATC as well as reducing the number of RAs that flight crews and controllers view as unnecessary.
- RA reversals—Version 7 will allow TCAS to reverse an RA, e.g., change a Climb RA to a Descend RA, in a coordinated encounter with another TCAS aircraft, helping TCAS resolve an encounter between two TCAS-equipped aircraft if one of the flight crews does not respond to its initial RA.
- Intruder surveillance functions have been improved to provide more reliable tracking of intruders and to ensure that TCAS meets its design guidelines for operation with ground radars. This will

result in aircraft being more reliably tracked, and thus displayed, at longer ranges in high-density traffic areas.

- RVSM compatibility issues—the TA thresholds between FL300 and FL420 have been reduced to eliminate nuisance TAs while operating in RVSM airspace.
- Aural inhibit altitude has been returned to 500 feet AGL to increase the awareness of TAs issued while on approach.
- “Bump-up” encounters—Version 7 contains software that recognizes encounters between 10,000 feet and FL300 when an aircraft is climbing or descending to level off 1,000 feet away from the TCAS aircraft and slightly delays the issuance of an RA. This change is similar to one introduced several years ago to reduce the frequency of these types of encounters in major terminal areas.
- Altitude crossing RAs—Version 7 contains additional biases to reduce the frequency of altitude crossing RAs.

#### Version 7 equipage

Eurocontrol has, since January 1, required all aircraft, both passenger and cargo, with a MGTOW greater than 15,000 kg (33,000 lbs), or with more than 30 passenger seats, to be equipped with Version 7 while operating in European airspace. A transition period for equipage extends until March 31, 2001.

Eurocontrol has granted numerous exemptions to this requirement to allow equipage to take place during the transition period. Other States outside of Europe have also mandated TCAS carriage, but none of these mandates will take effect during 2000.

The FAA has no current plans to mandate the upgrade to Version 7. Some airlines may decide to retrofit domestic aircraft, some may get Version 7 in new aircraft deliveries, and aircraft equipped to comply with the European mandate may operate over domestic routes. Because of the European mandate, aircraft operating in this airspace will receive TCAS Version 7 first. TTP data collection activities during 2000 will initially focus on the international flights that the U.S. carriers operate. These activities will be complemented by similar activities that Eurocontrol conducts using inputs that Europe-based operators provide. In addition, the TTP will focus on identifying aircraft being delivered with TCAS Version 7, and as operators begin to modify their domestic aircraft with Version 7, the TTP will seek to collect data from pilots operating these aircraft as well.

#### TCAS Version 7 data collection

No other changes have been introduced to the TCAS software since the mid-1990s; and the emphasis on collecting operational data on TCAS performance, as well as the amount of data received during the past 18–24 months, has been significantly less than during the earlier years of TCAS. With the introduction of Version 7, however, the TTP reporting and data collection program needs to be reenergized to increase the amount of operational performance data collected.

During the remainder of 2000, ARINC will be collecting data from pilot and controller questionnaires to verify that the changes contained in Version 7 are performing as intended and to ensure that no new operational issues have been introduced. Some airlines will also be carrying a limited number of TCAS data recorders supplied by the William J. Hughes Technical Center (WJHTC) to collect quantitative data on TCAS performance. ARINC and the WJHTC have been collecting and analyzing TCAS data since the initial introduction of TCAS.

To facilitate the data collection, new pilot questionnaires have been developed and are being distributed to operators. The updated pilot questionnaires can also be obtained from the ARINC website at [www.arinc.com/Products\\_Services/tcas/index.html](http://www.arinc.com/Products_Services/tcas/index.html)

Organizations, individual pilots, and individual controllers are strongly encouraged to renew their participation in the TTP to ensure that Version 7 provides its intended benefits and that potential problems are identified.

#### TTP contacts

Questions concerning Version 7, the information in this article, or other TCAS operational information can be addressed to the following individuals: at ARINC, Sean Reilly, 410-266-2904 or [SREILLY@arinc.com](mailto:SREILLY@arinc.com); Rick Stead, 410-266-4852 or [RSTEAD@arinc.com](mailto:RSTEAD@arinc.com); Dan Tillotson, 215-493-8016 or [DTillots@arinc.com](mailto:DTillots@arinc.com); at ALPA, Bob Striegel, 1-800-424-2470 or [striegelr@alpa.org](mailto:striegelr@alpa.org)

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#### Summary of Aural Annunciation Changes

(Advisories and aural annunciations that have been modified are in italics.)

TCAS advisory	Existing aural annunciation	Version 7 aural annunciation
Traffic Advisory	Traffic, Traffic	No change
Climb RA	Climb, Climb, Climb	Climb, Climb
Descend RA	Descend, Descend, Descend	Descend, Descend
Altitude Crossing Climb RA	Climb, Crossing Climb; Climb, Crossing Climb	No change
Altitude Crossing Descend RA	Descend, Crossing Descend; Descend, Crossing Descend	No change
Reduce Climb RA	Reduce Climb, Reduce Climb	Adjust Vertical Speed, Adjust
Reduce Descent RA Adjust	Reduce Descent, Reduce Descent	Adjust Vertical Speed,
Descend RA	Climb, Climb NOW; Climb, Climb NOW	No change
Reversal to a Climb RA		
Climb RA	Descend, Descend NOW;	No change
Reversal to a Descend RA	Descend, Descend NOW	
Increase Climb RA	Increase Climb, Increase Climb	No change
Increase Descent RA	Increase Descent, Increase Descent	No change
Maintain Rate RA	Monitor Vertical Speed	Maintain Vertical Speed,

Altitude Crossing, Maintain Rate RA (Climb or descend)	Monitor Vertical Speed  Crossing Maintain	Maintain Vertical Speed,
Weakening of Initial RA	Monitor Vertical Speed	Adjust Vertical Speed, Adjust
Preventive RA (No change in vertical speed required)	Monitor Vertical Speed  Monitor Vertical Speed	Monitor Vertical Speed
RA Removed	Clear of Conflict	No change