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Subject: **TCAS II, Change 7 Modifications**

ATTACHMENT. The 25 February edition of the TCAS Transition Program (TTP) Newsletter is attached to this cover letter. The Newsletter provides details on the Change 7 modifications to TCAS II.

BACKGROUND. The document entitled "TCAS II (Version 6.04) Operation in RVSM Airspace" was developed to inform pilots of Version 6.04 operating characteristics in RVSM airspace and to recommend aircraft operating practices to mitigate unnecessary RA events. Change 7 incorporates certain modifications that enhance TCAS II operation in RVSM airspace (i.e., 1,000 ft vertical separation between FL 290-410). For some time to come, pilots will fly aircraft equipped with TCAS II incorporating Version 6.04 and other aircraft equipped with TCAS II incorporating Change 7.

RECOMMENDED OPERATING PRACTICES. The following aircraft operating practices recommended for RVSM operations with Version 6.04 should be continued when operating with Change 7:

- a. **TCAS should be operated in the TA/RA mode during all operations in RVSM airspace and Transition Areas.**
- b. **Climb and descent rates in RVSM airspace and Transition areas should be limited to 1,000 fpm when operating within five (5) nm and 2,000 ft of other aircraft to minimize the generation of TAs and RAs.**

REVISED TA AND RA ALERT THRESHOLDS. The following are the existing and revised alert thresholds that apply to operations at high altitude. The only changes in the thresholds are reductions in the altitude threshold for the issuance of TAs and RAs. The values that change between FL 300 and FL 420 are highlighted in the following table.

TCAS Advisory	Range Threshold (Seconds)		Altitude Threshold (Feet)		Fixed Range Threshold Used with Slow Closure Rates (nmi)	
	V6.04a	V7	V6.04a	V7	V6.04a	V7
Traffic Advisory						
FL 200 – FL 300	48	48	850	850	1.3	1.3
FL 300 – FL 420	48	48	1200	850	1.3	1.3
Corrective RA						
FL 200 – FL 300	35	35	600	600	1.1	1.1
FL 300 – FL 420	35	35	700	600	1.1	1.1
Preventive RA						
FL 200 – FL 300	35	35	700	700	1.1	1.1
FL 300 – FL 420	35	35	800	700	1.1	1.1



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The TTP Newsletter is published and circulated to the aviation industry to provide periodic updates on the status of the TTP. TCAS Coordinators are encouraged to provide the widest possible dissemination of the information contained herein.

The TTP

The TTP was established in 1991 to assess the performance of TCAS as it was introduced to comply with the U.S. law requiring TCAS equipage. 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 improved guidance on the use of TCAS in various airspace.

One of the premises that has made the TTP a success is the agreement by the FAA that information provided to the TTP regarding TCAS use and performance could not be used to pursue enforcement action. These agreements continue to be in force and are expected to remain as new versions of TCAS are introduced.

During the past few months, TCAS suppliers have received FAA certification of the latest revision to the TCAS software – Version 7. Many of the changes contained in Version 7 are largely the result of inputs received from pilots and controllers via the TTP questionnaires.

TCAS Version 7 Data Collection

There have been no changes introduced to the TCAS software since the mid-1990's, 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 operation. However, with the introduction of Version 7, there is a need to re-energize the TTP reporting and data collection program to increase the amount of operational performance data that is 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.

To facilitate the data collection, new Pilot Questionnaires have been developed and are in the process of being distributed to operators. Controllers will continue to use the existing Controller Questionnaire that that was updated and distributed in 1999 and should be available in their facility. The pilot and controller questionnaires can also be obtained from on the ARINC web site at

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.

Version 7 Equipage

EUROCONTROL has issued a requirement for all aircraft with a MTOW 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. **This includes both passenger and cargo aircraft.** This requirement became effective on January 1, 2000, but there is a transition period for equipage that extends until March 31, 2001. EUROCONTROL has established specific procedures for requesting 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 occur during 2000. Details of these requirements can be found in the States' AICs.

In the United States, there are no current plans to mandate the upgrade to Version 7.

Because of the European mandate initial equipage with Version 7 will occur with aircraft operating in this airspace. TTP data collection activities during 2000 will initially focus on the international flights operated

by the U.S. carriers. These activities will be complemented by similar activities conducted by EUROCONTROL using inputs provided by operators based in Europe.

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.

Changes in TCAS with Version 7

The objectives of the Version 7 changes were to further increase the safety benefits of TCAS; make TCAS more compatible with the procedures used by ATC; and to address operational concerns identified by pilots operating the existing versions of TCAS.

Some of the changes will be obvious to pilots, while others will either be difficult to detect or transparent. The most obvious changes from the flight deck perspective are changes in the aural annunciations and on the RA display. Controllers should notice some reductions in the number of RAs issued and reductions in altitude displacements when aircraft respond to RAs. The following sections provide an overview of the changes to the aural annunciations and the RA display, and outline other Version 7 features.

New Aural Annunciations

The aural annunciations used by TCAS when an RA is issued have been modified to provide additional information about the desired response shown on the RA display. These changes, coupled with changes in the RA display, should make the desired response to an RA more intuitive. A table comparing the existing and modified aural is provided at the end of this Newsletter. The shaded areas indicate those aural annunciations that have been modified.

RA Display Changes

Changes to the RA display and portions of the TCAS logic were developed to help reduce altitude excursions during an RA, and to provide pilots with continuous guidance throughout an RA by expanded use of the green "fly-to" arc. Currently, TCAS will display a green arc only for an initial RA requiring a change in vertical speed (e.g., Climb or Descend RA); a secondary RA requiring a stronger RA response (e.g., Increase Climb/Descend RA); or an RA reversal (e.g., Climb/Descend NOW). Version 7 retains the use of the green "fly-to" arc for these advisories. It also uses

the arc for an RA requiring the pilot to maintain an existing vertical speed and for any RA that is modified (weakened) when the response to the initial RA has provided adequate vertical separation from the intruder. Whenever an RA is weakened, Version 7 will call for the aircraft to be leveled by displaying the green arc beginning at 0 fpm and extending to ± 250 fpm.

Other Changes

Horizontal Miss Distance Filter (HMDF). New logic has been included with Version 7 that will recognize encounters with adequate horizontal separation between aircraft, and whenever possible, suppress an RA. Simulations and testing have shown that the HMDF will reduce the number of RAs by approximately 25% in U.S. airspace, and up to 40% of RAs in European airspace.

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.

Intruder Surveillance. There have been numerous improvements to the intruder surveillance functions 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. The 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 FL 300 where 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.

Altitude Crossing RAs. Version 7 contains additional biases to reduce the frequency of altitude crossing RAs.

Good Operating Practices

Past experience in the TTP has shown that the use of the following procedures or techniques will minimize

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any impacts of TCAS operation on the flight crew, the controller, or the airspace environment.

Do not place TCAS in TA Only or TA/RA until just prior to taking the runway for departure. On landing, place TCAS in Standby as soon as workload permits after clearing the active runway.

If an initial RA is weakened (for example, a Climb RA weakens to a Do Not Descend RA), pilots should respond to the weakening RA and adjust the aircraft's vertical speed accordingly but still keep the needle or pitch guidance symbol out of the red arc or outlined pitch avoidance area. With Version 7, the green arc will remain displayed for the weakened RA to provide a target vertical speed for the modified RA. Pilots are reminded that attention to the RA display and prompt reaction to the weakened RA will minimize altitude excursions and potential disruptions to ATC.

Communications regarding TCAS events and displayed information should be limited to that required to inform the controller that an aircraft is responding to an RA. Discretion should be used in using the infor-

mation provided via the TCAS traffic display to ask questions regarding the traffic in the vicinity of an aircraft.

TTP Contacts

Questions concerning the information in this Newsletter, Version 7, or other TCAS operational information can be addressed to the following individuals:

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TCAS Advisory	Version 7 Aural Annunciation	Existing Aural Annunciation
Traffic Advisory	Traffic, Traffic	Traffic, Traffic
Climb RA	Climb, Climb	Climb, Climb, Climb
Descend RA	Descend, Descend	Descend, Descend, Descend
Altitude Crossing Climb RA	Climb, Crossing Climb; Climb, Crossing Climb	Climb, Crossing Climb; Climb, Crossing Climb
Altitude Crossing Descend RA	Descend, Crossing Descend; Descend, Crossing Descend	Descend, Crossing Descend; Descend, Crossing Descend
Reduce Climb RA	Adjust Vertical Speed, Adjust	Reduce Climb, Reduce Climb
Reduce Descent RA	Adjust Vertical Speed, Adjust	Reduce Descent, Reduce Descent
RA Reversal to a Climb RA	Climb, Climb, NOW; Climb, Climb NOW	Climb, Climb, NOW; Climb, Climb NOW
RA Reversal to a Descend RA	Descend, Descend NOW; Descend, Descend NOW	Descend, Descend NOW; Descend, Descend NOW
Increase Climb RA	Increase Climb, Increase Climb	Increase Climb, Increase Climb
Increase Descent RA	Increase Descent, Increase Descent	Increase Descent, Increase Descent
Maintain Rate RA	Maintain Vertical Speed, Maintain	Monitor Vertical Speed
Altitude Crossing, Maintain Rate RA (Climb and Descend)	Maintain Vertical Speed, Crossing Maintain	Monitor Vertical Speed
Weakening of Initial RA	Adjust Vertical Speed, Adjust	Monitor Vertical Speed
Preventive RA (No change in vertical speed required)	Monitor Vertical Speed	Monitor Vertical Speed, Monitor Vertical Speed
RA Removed	Clear of Conflict	Clear of Conflict