ETSO-C119d
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRBORNE COLLISION AVOIDANCE SYSTEM II (ACAS II) Version 7.1 with Hybrid Surveillance

1 — Applicability

This ETSO provides the requirements which Airborne Collision Avoidance System II (ACAS II) Version 7.1 equipment that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 — Procedures

2.1 — General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 — Specific

None.

3 — Technical Conditions

3.1 —Basic

3.1.1 — Minimum Performance Standard

Standards set forth in EUROCAE Document ED-143, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II), dated September 2008, as modified by Change 1 dated April 2009, Change 2 (Version 7.1) dated April 2013, and by Appendix 1 to this ETSO and EUROCAE Document ED-221, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance, dated April 2013, Sections 2 and 3, as modified by Appendix 2 to this ETSO

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 — Specific resulting in misleading information

None.

3.2.1 — Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in misleading information is a hazardous failure condition.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in loss of function is a minor failure condition.

4 — Marking

4.1 — General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 — Specific

None.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM II (TCAS II) VERSION 7.1

AMENDMENT TO EUROCAE ED-143 CHANGE 2 REQUIREMENTS

This Appendix lists EASA modification to MPS for Traffic Alert And Collision Avoidance System (TCAS) Airborne Equipment, TCAS II Change 2, dated April 2013.

When own ship is on the ground, clarification is required to allow the system to limit the output of TCAS intruders to the display to those within 3 000 feet of own altitude. In lieu of section '2.2.2 System Performance' of EUROCAE ED-143 Change 2, substitute the following:

2.2.2 System Performance

Note: *When operating within the maximum aircraft transponder population and electromagnetic interference levels defined in subparagraph 2.2.1.2, TCAS II will provide a level of performance for active surveillance of targets-of-interest that will support the requirements for generation of collision advisory information.*

Specifically, TCAS II will generate a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below. This is to ensure that a correct resolution advisory can be issued in time for the pilot to maintain adequate vertical separation at closest-point-of-approach.

TCAS II will also generate, whenever possible, a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below such that a correct traffic advisory can be issued as a precursor to the resolution advisory.

In addition to the surveillance requirements to support generation of resolution and traffic advisories, TCAS II will display the range and, if available, the altitude and bearing position information on targets that generate advisories. The bearing position information will be generated according to the accuracy requirement specified below.

TCAS II will also generate for display, whenever possible, surveillance range, altitude and bearing position information on Mode C and Mode S aircraft that are within the range specified below and within ± 10 000 ft altitude relative to TCAS II when airborne, and within ± 3 000 ft altitude relative to TCAS II when on the ground.

It is acceptable to limit the output of TCAS intruders to the display to those within 3 000 feet of own altitude when own aircraft is on the ground. This is permitted (but not required) so that the altitude surveillance volume for TCAS Mode C intruders can be consistent with the Mode S surveillance altitude limits modified in EUROCAE ED-143 Change 2 (section 2.2.4.6.2.2.1). This allowance to limit the display to ± 3 000 feet does not modify surveillance altitude volumes which are defined in EUROCAE ED-143, section 2.2.4.6.

The system shall use the definition of on-ground as defined in EUROCAE ED-143, Volume II, 2.1.14. Alternatively, the system may use the definition of 'operating on Surface' in EUROCAE ED-221, section 2.2.8, for on-ground.

APPENDIX 2

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM II (TCAS II) VERSION 7.1

HYBRID SURVEILLANCE

AMENDMENT TO EUROCAE ED-221 REQUIREMENTS

This Appendix lists EASA modification to MPS for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance, dated April 2013.

Text from EUROCAE ED-221 is provided here as needed to provide context. Text to be added is underlined. Text to be removed is lined through.

1 To ensure proper revalidation when own aircraft is operating on the surface, in the first paragraph of EUROCAE ED-221, section 2.2.7.5 'Revalidation', insert the following new underlined text:

An established track that is under hybrid surveillance (per §2.2.7.1) **shall** be subject to revalidation. If a track under hybrid surveillance does not satisfy the first (altitude) condition of §2.2.6.1.4, it **shall** be subject to revalidation every 60th surveillance update interval; if it satisfies the first and second (altitude and range) conditions of §2.2.6.1.4 but not the third (airborne) condition, it shall be subject to revalidation every 10th surveillance update interval; if it satisfies the first condition of §2.2.6.1.4 but not the second (range) condition, it **shall** be subject to revalidation at intervals calculated according to the following procedure. The revalidation interval *t* **shall** be calculated at the time of the initial successful validation and at the time of each successful revalidation. It **shall** be used as the number of surveillance update intervals until the next revalidation attempt.

1.2 Because there is a requirement specifying creation of information which is never used, in EUROCAE ED-221, section 2.2.11 'Interface to the CAS Logic', delete existing ~~lined through~~ text from the first paragraph as follows:

Position data for tracks under passive surveillance may be provided to the CAS logic via the interface specified in Ref. A, §2.2.4.8.1. ~~If this is done, information **shall** be provided in addition to that required in Ref. A, §2.2.4.8.l(a) to distinguish a position report that resulted from a passive reception of an Airborne Position Message from one that resulted from an active interrogation.~~

1.3 Tests 2, 3a and 3b specified in EUROCAE ED-221, section 2.4.2.5 'Verification of Acquisition and Maintenance of Established Tracks Using Active Surveillance' (§2.2.6), do not need to be performed as their expected results are incorrect. Test coverage of the input conditions associated with those tests is provided, in aggregate, by other existing tests in EUROCAE ED-221.

1.4 A new Test 11a is required in addition to the existing Test 11 specified in EUROCAE ED-221, section 2.4.2.6 'Verification of Maintenance of Established Tracks using Passive Surveillance' (§2.2.7). This new test is to verify the revalidation rate when own aircraft is operating on the surface. Perform this new test in addition to the existing Test 11; the new test does not replace Test 11. Insert the following new underlined text after existing Test 11:

Test 11a (Intruder Revalidation Rate when own aircraft is operating on the surface §2.2.7.5)

This test verifies the revalidation rate when own aircraft is operating on the surface based on the altitude and range criteria for active tracking (§2.2.7.5).

(The following tests may be performed using ADS-B reports or directly decoded ADS-B messages. TIS-B and ADS-R data is not permitted.)

Scenario Description

- Intruder 1 shows that when own aircraft is operating on the airport surface and an intruder is within the altitude and range criteria for active surveillance it will be tracked using hybrid surveillance with a 10-second revalidation rate (§2.2.7.5).
- Intruder 2 shows that when own aircraft is operating on the airport surface and an intruder is within the altitude but not the range criteria for active surveillance it will be tracked using hybrid surveillance with a variable revalidation rate according to the requirements in (§2.2.7.5).

TCAS Aircraft
Altitude = 0 ft (Ground Level)
Altitude Rate = 0 FPM
Position = Sydney
Radio altitude input = 0 ft
Ground Speed is valid and at 0 knots and TCAS Air/Ground (OOGROUN) indicates on-ground.

Intruder Aircraft #1
Altitude = 2 000 ft
Altitude Rate = 0 FPM
Range = 2 NM
Relative Speed = 0 kt
At T = 100 the intruder is terminated.

Intruder Aircraft #2
Altitude = 2 000 ft
Altitude Rate = 0 FPM
Range = 8 NM
Relative Speed = 0 kt
At T = 100 the intruder is terminated.

Success Criteria

For the tests in this section, the revalidation rate for each applicable success criteria was identified using the table in §2.2.7.5. If the implementation uses the equation method, then the revalidation interval can be longer by 10 to 20 seconds. Care should be taken to verify that the success criteria matches the value expected based on the implementation.

For each intruder:

The surveillance reports to the CAS logic are present for the duration of the track. Verify that the track is under passive surveillance.

Intruder 1

Verify that revalidation interrogations are transmitted every 10 seconds.

Intruder 2
Verify that revalidation interrogations are transmitted every 30 seconds.

The revalidation rate for each applicable success criteria was identified using the table in §2.2.7.5. If the implementation uses the equation method, then the revalidation interval can be longer by up to 10 to 20 seconds. Care should be taken to verify that the success criteria matches the value expected based on the implementation.

1.5 EUROCAE ED-221 removes a provision which allowed for larger range calculation errors above ± 60 degrees latitude from RTCA/DO-300, Section 2.2.7.6 (from which ED-221 is derived), but the associated tests were not updated accordingly. To account for the removal of that provision, delete the following ~~lined through~~ text from EUROCAE ED-221, sections 2.4.2.8 'Verification of Error Budget in Computing Slant Range from Passive Data' and 2.4.2.10 'Verification of DF17 Decoding', and insert as underlined below a clarifying note in Appendix A 'Conversion of Reported Positions to Slant Range', section A.1 'Overview'.

2.4.2.8 Verification of Error Budget in Computing Slant Range from Passive Data

(…)

If the test method is used to demonstrate compliance with the requirement, then this paragraph describes one potential scenario. Own aircraft and intruder aircraft are travelling towards each other at 600 kt at high latitude ~~(near 60 degrees)~~. If the error between the passive range estimate and active range measurement is less than 145 meters then the intent of the requirement is met. The error in range computation of tests at slower closure rates can be used to extrapolate or predict errors at the 1 200 kt closure rate.

(…)

2.4.2.10 Verification of DF17 Decoding

(…)

Success Criteria

All Intruders.
For all of the Intruders ~~with Latitudes within ±60 degrees~~, verify that the range for each intruder is within 145 m of the calculated range identified in Table 3.
For all of the Intruders ~~with Latitudes within ±60 degrees~~, verify that the bearing for each intruder is within 3 degrees of the calculated bearing identified in Table 3.
Verify that the error in range from the calculated range does not use more of the error budget allowed for range based on the completion of Test §2.4.2.8 (Verification of Error Budget in Computing Slant Range from Passive Data) Test 1.

(…)

A.1 OVERVIEW

This Appendix provides useful guidance on computing range from own and reported position data. This Appendix does not recommend a particular implementation and should be used for reference only.

Firstly, the exact conversion equations from position to slant range are given. The computational requirements for the exact conversion equations are reasonable and could be used as is for modern processors and typical TCAS traffic loads.

Secondly, several approximate conversion equations from position to slant range are presented. For circumstances where hybrid surveillance is implemented as a software upgrade to existing processors, it may be desirable to use approximations to the conversion equations to reduce the computational requirements. The errors in the approximate equations are presented and compared to the computational accuracy requirements of §2.2.7.6, which requires a maximum 145 m processing error when calculating slant range.

Note: The equations in A.2 provide an example of conversion equations which meet the accuracy requirements. The approximation equations provided in the Appendix may not provide the required accuracy.