European Aviation Safety Agency

Deviations requests for an ETSO approval for CS-ETSO applicable to ETSO-C145
Consultation Paper

1. Introductory note

The hereby presented deviation requests shall be subject to public consultation, in accordance with EASA Management Board Decision No 7-2004[1] products certification procedure dated 30 March 2004, Article 3 (2.) of which states:

"2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency."

2. ETSO-C145#1 Airborne Navigation Sensors using the GPS augmented by WAAS

Requirement:

Deviate from ETSO-C145 to use RTCA DO-229**C** (as required in FAA TSO-C145a) instead of RTCA DO-229**A**.

Industry:

ELOS is provided by use of later revision requirement document. RTCA DO-229C is a successor document for RTCA DO-229A. RTCA DO-229C is referenced in TSO-C145a.

EASA:

Similar deviation to use RTCA DO-229C instead of RTCA DO-229B was already granted by EASA as a deviation to ETSO-C146 (published from 26.2.2007 to 16.3.2007). This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. There is already a draft of DO-229D RTCA Paper 093-06/SC-159-939. EASA also accepts the deviation as an alternate mean to meet the requirement for ETSO-C145.

3. ETSO-C145#2 Airborne Navigation Sensors using the GPS augmented by WAAS – RTCA DO-229C, Paragraph 2.5.9 (Integrity Monitoring Test Procedures)

Requirement:

Deviate from RTCA DO-229C, Paragraph 2.5.9: Integrity Monitoring Test Procedures (see details below).

Industry:

The following testing was conducted to ensure that the Receiver Autonomous Integrity Monitor/Fault Detection and Exclusion (RAIM/FDE) function in the on-target processor produces equivalent output data as that produced by the off-line algorithm for identical input data.

An alternate method, rather than the procedures defined in 2.5.9.5 of RTCA DO-229C, is used for the on-line verifications. The on-line verifications are performed in a black box

[1] Cf. EASA Web: http://www.easa.europa.eu/doc/About_EASA/Manag_Board/2004/mb_decision_0704.pdf

test environment with the fully integrated operational software. The GPS simulator scenarios are developed by examining the results of the detection and exclusion analysis of 2.5.9.3 (RTCA DO-229C). For each of the geometries, the average time to detect or exclude is calculated for the 1650 runs. Using the average time to detect/exclude, the scenarios are developed such that the beginning of the satellite ramp error time is (time of static geo) minus (average time to detect/exclude). The goal is to develop the scenarios such that the geometries when the detections/exclusions occurred are close to the static geometries of the detection/exclusion analysis.

Scenarios are developed for each geometry category.

- Detection (20 Cases)
- Exclusion (20 Cases)

During the on-line tests the Horizontal Integrity Limit (HIL), Horizontal Uncertainty Level (HUL), position error, satellite positions, satellite pseudo ranges, delta ranges, altitude inputs, integrity alarm and exclusion bit are recorded. The following data from the on-line tests are provided as inputs to the off-line software: line of sight, pseudo ranges, delta ranges, altitude, and sigmas. The off-line software outputs of HIL, HUL, position error, integrity alarms and exclusion bit, are compared to the on-line data. The goal for the average difference between the on-line and off-line comparisons is 0.1 meters or the equivalent of the least significant bit and one second for alerts. In these tests, the satellite orbital motion is simulated, as opposed to a static measurement. Some known sources for errors are due to the resolution limitation of the ARINC outputs, conversions (truncations) of the data from ARINC for HIL, HUL, position, etc. The least significant bit for HIL and HUL outputs is 0,226 meters.

These tests are considered more stringent than the testing defined in paragraphs 2.5.9.5.1 and 2.5.9.5.2 since they are run using the black box test environment with the dynamic (orbital motion simulated) satellite scenarios (as defined in 2.5.9.5.2), but with the much more stringent criteria as in 2.5.9.5.1 of DO-229C.

In addition to testing, a code walk-through is performed to identify any differences between the RAIM/FDE code in the off-line analysis and the RAIM/FDE code used in the target (Global Navigation Satellite System (GNSS) operational software). The RAIM/FDE code in the operational software is used to build the off-line analysis software. Both the off-line analysis software and the operational software are developed using Ada language and the Rational Apex development system.

There is no safety impact. All performance requirements are met (ELOS). A similar deviation has been previously approved by the FAA for the GLU-925 on 8/2/2004.

EASA:

The alternate method for the on-line verifications:

- is performed with the representative operational software;
- uses simulation scenarios for which the geometries when the on-line detections/exclusions are close to the static geometries of the detection/exclusion analysis;
- tests each geometry category (detection, exclusion) in the simulation scenarios;
- compares the off-line software outputs with the on-line tests with similarity thresholds calibrated to account for ARINC resolution and computations truncations.

Moreover, In addition to testing, a code walk-through is performed to identify any differences between the RAIM/FDE code in the off-line analysis and the RAIM/FDE code used in the target (Global Navigation Satellite System (GNSS) operational software).

This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this alternate method as an ELOS.

4. <u>ETSO-C145#3 Airborne Navigation Sensors using the GPS augmented by WAAS – RTCA DO-229C, Paragraph 2.5.4 (Initial Acquisition Time)</u>

Requirement:

Deviate from RTCA DO-229C, Paragraph 2.5.4: Initial Acquisition Time

Industry:

Instead of testing initial acquisition to the test procedures as defined in RTCA DO-229C, Paragraph 2.5.4, the GPS/WAAS unit was tested using the test procedures defined in draft of DO-229D RTCA Paper 093-06/SC-159-939, with the exception that the noise density spectrum was tested at a more stringent level of -173.3 dB/Hz instead of -175.4 dB/Hz.

The unit was tested to the levels expected to be specified in RTCA DO- 229D. As these test procedures are equivalent to or better than those of RTCA DO-229C, there is no safety impact. ELOS is provided by the use of draft RTCA DO-160D.

EASA:

This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this ELOS which enhances performance.

5. <u>ETSO-C145#4 Airborne Navigation Sensors using the GPS augmented by WAAS – RTCA DO-229C, Paragraph 2.5.6 (Satellite Reacquisition Test)</u>

Requirement:

Deviate from RTCA DO-229C, Paragraph 2.5.6: Satellite Reacquisition Test

Industry:

Instead of testing satellite re-acquisition to the test procedures as defined in RTCA DO-229C, Paragraph 2.5.6, the GPS/WAAS unit testing was performed using the test procedures defined in draft of DO-229D RTCA Paper 093-06/SC-159-939, with the exception that the noise density spectrum tested was at a more stringent level of -172.4 dB/Hz instead of -174 dB/Hz.

The unit was tested to the levels and procedures expected to be specified in RTCA DO-229D. As these test procedures are equivalent to or better than those of RTCA DO-229C, there is no safety impact.

EASA:

This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this ELOS which enhances performance.

6. <u>ETSO-C145#5 Airborne Navigation Sensors using the GPS augmented by WAAS – RTCA DO-229C, Paragraph 2.1.4.2.2.4 (WAAS Precision Approach (PA) RAIM Availability) for Vertical Alert Limit (VAL) of 15m</u>

Requirement:

Deviate from RTCA DO-229C, Paragraph 2.1.4.2.2.4: Wide Area Augmentation System (WAAS) Precision Approach (PA) RAIM Availability for Vertical Alert Limit (VAL) of 15m.

Industry:

The availability of the fault detection function algorithm for GLS or Approach Operations Vertical Guidance 11 (APV-11) to meet the above requirements assuming a missed alert

rate of 0.1 and a vertical alert limit of 15m, when evaluated over the constellations and grids specified in the test procedures (section 2.5.10), using the same satellite selection algorithm used by the equipment, and using a mask angle of 5 degrees, shall be greater than or equal to 95%. The proposed requirement for RTCA DO-229D is with an alert limit of 25m.

The GPS/WAAS receiver can achieve 95% fault detection availability with a VAL of 25m and 80% fault detection availability for a VAL of 15m.

The 95% fault detection availability can be achieved by the GPS/WAAS receiver when VAL is 25m. Since this requirement is only intended to provide a means to assess the adequacy of the fault detection algorithms (Ref RTCA DO-229C, Paragraph 2.1.5.2.2.2.4), there is no safety impact. The 95% availability requirement for a VAL of 15m (RTCA DO-229C) is invalid and for that reason the draft of RTCA DO-229D has changed the requirement to 25m.

EASA:

EASA acknowledges the fact that there is already a draft of DO-229D RTCA Paper 093-06/SC-159-939 which updates RTCA DO-229C. This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this deviation.

7. ETSO-C145#6 Airborne Navigation Sensors using the GPS augmented by WAAS - DO-229C, Paragraph 2.5.9 (RAIM Test Procedures with Selective Availability (SA) Off)

Requirement:

Deviate from RTCA DO-229C, paragraph 2.5.9: RAIM Test Procedures with Selective Availability (SA) Off.

Industry:

For the GPS/WAAS unit, testing was performed to draft version of DO-229D (RTCA Paper 093-06lSC-159-939) with the exception of the offline comparisons discussed above in the Integrity Monitoring Test Procedures section (cf. section 3 above).

Since SA is no longer on, these tests show performance of RAIM in the actual environment and are considered equivalent or superior to those test conditions defined in RTCA DO-229C. No safety impact.

EASA:

EASA acknowledges the fact that this alternate mean fulfils the same objective as the requirement from RTCA DO-229C, paragraph 2.5.9. This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this deviation.

8. ETSO-C145#7 Airborne Navigation Sensors using the GPS augmented by WAAS - DO-229C, Paragraph 2.5.8 (Accuracy Test)

Requirement:

Deviate from RTCA DO-229C paragraph 2.5.8: Accuracy Test.

Industry:

Instead of testing range domain accuracy to the test procedures as defined in Paragraph 2.5.8 of RTCA DO-229C, the GPS/WAAS unit was tested using the test procedures defined in draft of DO-229D, RTCA Paper 093-06/SC-159-939. These procedures called for an additional level of intra-system interference beyond the levels stated in RTCA DO-

229C as well as the removal of the 100 kHz broad-band interference levels due to an update in the threat analysis.

The GPS/WAAS unit was tested to the levels expected to be specified in DO-229D. As these test procedures are equivalent or more stringent than those of DO-229C, there is no safety impact.

EASA:

EASA acknowledges the fact that there is already a draft of DO-229D RTCA Paper 093-06/SC-159-939 which updates RTCA DO-229C. This deviation was accepted by the FAA in Memorandum from AIR-130 dated January 30, 2007. EASA also accepts this ELOS which enhances performance.