

**Deviations requests for an ETSO approval for CS-ETSO
Applicable to G1000 Avionic System by Garmin
Consultation Paper**

Introductory note

The hereby presented Deviations requests shall be subject to public consultation, in accordance with EASA Management Board Decision n°7-2004¹ 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 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.”

Identification of issue

Garmin submits to EASA several deviation requests against CS-ETSO for their integrated G1000 avionic suite with intelligent displays. The applicant has received already the related FAA TSO approval including the acceptance of the following deviations. Many of these deviations have been already accepted in Europe during previous certifications e.g. under JTSA umbrella.

The deviations apply mainly to the integrated multi function control and display elements. The main ETSO for this kind of unit is ETSO-C113. As the unit displays several instruments and has additional functionality e.g. Flight Management System, several further ETSOs are applicable as well.

Deviations requests

The deviations requested can be summarized as follows:

1. use of updated requirement standards.
2. use of newer environmental standard.
3. adapt the instrument viewing angle requirement to LCD pixel graphic technology.
4. autopilot commands limitation and engagement annunciation
5. adaptations related to supplemental GPS receivers
6. adaptations for the WAAS receivers

The details of these deviations are described below. The deviations are sorted by ETSO number. The detailed discussion will follow in annexes to allow the discussion of the same technical content at one place. Only specific deviations will be discussed in this section.

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

(1) Deviation ETSO-C2d#1 – Airspeed Instruments

Deviate from ETSO-C2d 3.1.1 to use SAE AS 8019A instead of SAE AS 8019 as the Minimum Performance Standard.

See Appendix 1.

(2) Deviation ETSO-C2d#2 – Airspeed Instruments

Deviate from ETSO-C2d to eliminate the requirement 3.2.3 in SAE AS 8019A that requires "the instrument face to be marked with 'Airspeed' or 'IAS' and also with the applicable units of measure."

See Appendix 3.2.

(3) Deviation ETSO-C2d#3 – Airspeed Instruments

Deviate from ETSO-C2d to modify the requirement 3.2.5 in SAE AS 8019A that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(4) Deviation ETSO-C3d#1 – Turn and Slip Instruments

Deviate from ETSO-C3d to modify the requirement 3.7 in SAE AS 8004 that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(5) Deviation ETSO-C4c#1 – Bank and Pitch Instruments

Deviate from ETSO-C4c 3.1.1 to use SAE AS 8001 instead of SAE AS 396B for Minimum Performance Standards and Environmental Standards.

See Annex 1.

(6) Deviation ETSO-C4c#2 – Bank and Pitch Instruments

Deviate from ETSO-C4c 3.1.2 and SAE Aerospace Standard AS 8001 to use RTCA DO-160D instead of RTCA DO-138 as the standard for Environmental Conditions and Test Procedures for Airborne Equipment.

See Annex 2.

(7) Deviation ETSO-C4c#3 – Bank and Pitch Instruments

Industry: Neither ETSO-C4c nor SAE Aerospace Standard AS 8001 specifies use of a standard for software development; RTCA DO-178B shall be used as the standard for Software Considerations in Airborne Systems and Equipment Certification.

EASA: EASA promotes to use the EUROCAE ED-12B/RTCA DO-178B software development process even though not required by the specific ETSO. Historically it had not been assumed to realise such a function by software.

(8) Deviation ETSO-C6d#1 – Direction Instrument, Magnetic (Gyroscopically Stabilized)

Deviate from ETSO-C6d 3.1.1 to use SAE AS 8013A instead of SAE AS 8013 as the Minimum Performance Standard.

See Annex 1.

(9) Deviation ETSO-C6d#2 – Direction Instrument, Magnetic (Gyroscopically Stabilized)

Deviate from ETSO-C6d to modify the requirement 3.10.2 in SAE AS 8013A that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction .

See Annex 3.1.

(10) Deviation ETSO-C8d#1 – Vertical Velocity Instrument (Rate-of-Climb)

Deviate from ETSO-C8d 3.1.1 to use SAE AS 8016A instead of SAE AS 8016 as the Minimum Performance Standard.

See Annex 1.

(11) Deviation ETSO-C8d#2– Vertical Velocity Instrument (Rate-of-Climb)

Deviate from ETSO-C8d to modify the requirement 3.2.4 in SAE AS 8016A that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(12) Deviation ETSO-C9c#1 – Automatic Pilots

Deviate from ETSO-C9c 3.1.1 to use SAE AS-402B instead of AS-402A.

See Annex 1.

(13) Deviation ETSO-C9c#2 – Automatic Pilots

Deviate from AS-402B paragraph 4.4.1 to limit autopilot engagement to attitudes considered safe for the certified aircraft. Use Autopilot limitations that limit pitch and roll engagement to more conservative limits.

See Annex 4.1.

(14) Deviation ETSO-C9c#3 – Automatic Pilots

Deviate from AS402B paragraph 4.3.2 to not provide servo effort indications when the automatic pilot is not engaged.

See Annex 4.2.

(15) Deviation ETSO-C9c#4 – Automatic Pilots

Deviate from ETSO-C9c 3.1.2 to use DO-160D instead SAE AS 402A for specified environmental tests.

See Annex 2.

(16) Deviation ETSO-C10b#1 – Aircraft Altimeter, Pressure Actuated, Sensitive Type

Deviate from ETSO-C10b 3.1.1 to use SAE AS 8009A instead of SAE AS 392C as the Minimum Performance Standard.

See Annex 1.

(17) Deviation ETSO-C10b#2 – Aircraft Altimeter, Pressure Actuated, Sensitive Type

Deviate from ETSO-C10b to modify the requirement 3.7 in SAE AS 8009A that requires "Pointers and dial markings shall be visible from any point within the frustrum of a cone; the side of which makes an angle of 30 degrees with the perpendicular to the dial and the small diameter of which is the aperture the instrument case." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(18) Deviation ETSO-C10b#3 – Aircraft Altimeter, Pressure Actuated, Sensitive Type

Deviate from SAE AS 8009A Section 3.11 to not display ALTITUDE or ALT next to the tape indicating altitude.

See Annex 3.2.

(19) Deviation ETSO-C10b#4 – Aircraft Altimeter, Pressure Actuated, Sensitive Type

Deviate from ETSO-C10b 3.1.2 to use RTCA DO-160D instead of SAE AS 8009A as the standard for Environmental Conditions and Test Procedures for Airborne Equipment.

See Annex 2.

(20) Deviation ETSO-2C35d#1 – Radar Marker Receiving Equipment

Deviate from ETSO-2C35d which calls out EUROCAE 1/WG7 Section 3.16 to allow the visual indication of the Standard Test Signal to not flash synchronized with the

keying, but to flash at the following fixed rates while keyed: Outer 1.33 Hz, Middle 3 Hz, Inner 4 Hz.

See Annex 3.2.

(21) Deviation ETSO-C43c#1 – Temperature Instruments

Deviate from ETSO-C43c 3.1.1 to use SAE AS 8005A instead of SAE AS 8005 as the Minimum Performance Standard.

See Annex 1.

(22) Deviation ETSO-C44b#1 – Fuel Flowmeters

Deviate from ETSO-C44b 3.1.1 to use SAE AS 407C instead of SAE AS 407B to demonstrate compliance for Fuel Flowmeters.

See Annex 1.

(23) Deviation ETSO- C44b#2 – Fuel Flowmeters

Deviate from ETSO-C44b 3.1.2 to use RTCA DO-160D instead of SAE AS 407B as the standard for Environmental Conditions and Test Procedures for Airborne Equipment.

See Annex 2.

(24) Deviation ETSO- C44b#3 – Fuel Flowmeters

Deviate from ETSO-C44b to modify the requirement 4.2.5 in SAE AS 407C that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(25) Deviation ETSO- C44b#4 – Fuel Flowmeters

Deviate from ETSO-C44b to modify the requirement 4.1.1 in SAE AS 407C that requires "Type I Instruments: Rotating pointer with fixed graduated dial or counter type indication. Clockwise pointer motion shall indicate increasing rate of flow." The gauge is defined as a horizontal or vertical bar with fixed graduations, with a pointer motion to the right or up indicating an increase rate of flow.

See Annex 3.2.

(26) Deviation ETSO-C45a#1 – Manifold Pressure Instruments

Deviate from ETSO-C45a 3.1.1 to use SAE AS 8042 instead of SAE AS 411 for Minimum Performance Standards.

See Annex 1.

(27) Deviation ETSO-C45a#2 – Manifold Pressure Instruments

Deviate from ETSO-C45a to use RTCA DO-160D instead of SAE AS 411 as the standard for Environmental Conditions and Test Procedures for Airborne Equipment.

See Annex 2.

(28) Deviation ETSO-C45a#3 – Manifold Pressure Instruments

Deviate from ETSO-C45a SAE 8042 3.10.5 to use MAN as abbreviation instead of MANIFOLD PRESSURE or MANIF PRESS.

See Annex 3.2.

(29) Deviation ETSO-C45a#4 – Manifold Pressure Instruments

Deviate from ETSO-C45a to modify the requirement 3.10.9 in SAE AS 8042 that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(30) Deviation ETSO-C47#1 – Pressure Instruments – Fuel, Oil and Hydraulic (Reciprocating Engine Powered Aircraft)

Deviate from ETSO-C47 3.1.1 to use SAE AS 408C instead of SAE AS 408A for Minimum Performance Standards and Environmental Standards.

See Annex 1.

(31) Deviation ETSO-C47#2 – Pressure Instruments – Fuel, Oil and Hydraulic (Reciprocating Engine Powered Aircraft)

Deviate from ETSO-C47 to modify the requirement 4.1.5 in SAE AS 408C that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(32) Deviation ETSO-C47#3 – Pressure Instruments – Fuel, Oil and Hydraulic (Reciprocating Engine Powered Aircraft)

Deviate from ETSO-C47 3.1.2 to use RTCA DO-160D instead of AS 408C as the standard for Environmental Standards.

See Annex 2.

(33) Deviation ETSO-C49b#1 – Electric Tachometer: Magnetic Drag (Indicator and Generator)

Deviate from ETSO-C49b 3.1.1 to use SAE AS 404C instead of SAE AS 404B for Minimum Performance Standards and Environmental Standards.

See Annex 1.

(34) Deviation ETSO-C49b#2 – Electric Tachometer: Magnetic Drag (Indicator and Generator)

Deviate from ETSO-C49b to modify the requirement 4.1.2 in SAE AS 404C that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(35) Deviation ETSO-C49b#3 – Electric Tachometer: Magnetic Drag (Indicator and Generator)

Deviate from ETSO-C49b, SAE AS 404C requirement 4.1.3.2 second sentence which states, "The increment between graduations shall not exceed 2-1/2% of full scale, above 600 RPM." The tachometer gauge which incorporate a full time digital readout, multiple graduations on the dial are not needed in order for the correct reading to be obtained. The resolution of the digital readout will be 10 RPM which is less than 2-1/2% of full scale. A pointer with clockwise motion for increasing RPM, is provided.

See Annex 3.2.

(36) Deviation ETSO-C49b#4 – Electric Tachometer: Magnetic Drag (Indicator and Generator)

Deviate from ETSO-C49b 3.1.2 to use DO-160D instead of SAE AS 404B as the Environmental Standard.

See Annex 2.

(37) Deviation ETSO-C52b#1 – Flight Directors

Deviate from AS-8008 paragraph 3.6 to limit flight director operation to attitudes considered safe for the certified aircraft. The Autopilot limits pitch and roll engagement to more conservative limits.

See Annex 4.1.

(38) Deviation ETSO-C55#1 – Fuel and Oil Quantity Instruments (Reciprocating Engine Aircraft)

Deviate from ETSO-C55 3.1.1 to use SAE AS 405C instead of SAE AS 405B to demonstrate compliance for Fuel and Oil Quantity Instruments.

See Annex 1.

(39) Deviation ETSO-C55#2 – Fuel and Oil Quantity Instruments (Reciprocating Engine Aircraft)

Deviate from ETSO-C55 to modify the requirement 4.2.5 in SAE AS 405C that requires "The indicating means to be visible from all points on a surface defined as making an angle of 30 degrees with the perpendicular." The viewing envelope is defined (per ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction.

See Annex 3.1.

(40) Deviation ETSO-C55#3 – Fuel and Oil Quantity Instruments (Reciprocating Engine Aircraft)

Deviate from ETSO-C55 to modify the requirement 4.2.4 in SAE AS 405C to allow "FUEL QTY" to be used to abbreviate "Fuel Quantity".

See Annex 3.2.

(41) Deviation ETSO-C55#4 – Fuel and Oil Quantity Instruments (Reciprocating Engine Aircraft)

Deviate from ETSO-C55 3.1.2 to use DO-160D instead of SAE AS 405B as the Environmental Standard.

See Annex 2.

(42) Deviation ETSO-C118#1 – Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS I

Deviate from ETSO-C118 3.1.1 to use RTCA DO-197A instead of RTCA DO-197 as the Minimum Performance Standard.

See Annex 1.

(43) Deviation ETSO-C129a#1 – Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)

Deviate from ETSO-C129a (ED-72A 3.2.2.1f(3) and 3.2.2.4j(4)) to eliminate the annunciation for pending CDI scale change 3.0 NM from the FAF.

See Annex 5.

(44) Deviation ETSO-C129a#2 – Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)

Deviate from ETSO-C129a (ED-72A 3.2.2.1f(4), 3.2.2.3e(4), and 3.2.2.4j(2)) to eliminate the requirement to "alert the pilot of the need to manually insert the barometric pressure. ELOS is provided by the unit calibrating pressure altitude whenever RAIM is available en route.

See Annex 5.

(45) Deviation ETSO-C129a#3 – Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)

Deviate from ETSO-C129a (ED-72A 3.2.2.4j(8)) to modify the requirement to allow the approach mode to be deselected by performing a direct-to action on the unit. ELOS is provided by a two step operation that is consistent with the operational philosophies applied to the box in other areas. Consistent operation throughout the operation minimizes pilot error.

See Annex 5.

(46) Deviation ETSO-C129a#4 – Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)

Deviate from ETSO-C129a (ED-72A 3.2.2.3d(2)) to eliminate the requirement to provide a “means to manually identify a satellite that is expected to be unavailable at the destination” for the RAIM prediction process. ELOS is provided by eliminating pilot input error, low probability of satellite unavailability and the full satellite constellation with spares. Regardless of the destination RAIM availability status is correctly provided to the pilot upon arrival.

See Annex 5.

(47) Deviation ETSO-C129a#5 – Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)

Deviate from ETSO-C129a to change the requirement in ED-72A paragraph 4.16.2 to match the WAAS TSO-C145a and DO-229 requirements for Power input testing. ETSO C145 and DO-229a allow a system reset followed by satellite acquisition time of 5 minutes for abnormal operating conditions power input tests.

See Annex 5.

(48) Deviation ETSO-C146#1 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to use RTCA DO-229C instead of RTCA DO-229B.

See Annex 1.

(49) Deviation ETSO-C146#2 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to modify the requirement 2.2.1.1.4.3 in RTCA/DO-229C which states, "They [all displays] shall be fully readable up to a vertical viewing angle of 20 degrees from normal to the face of the display screen." This deviation uses a 10 degree vertical viewing angle below the lower display edge. DO-229C makes no distinction between upper and lower display edges for the requirement of a 20 degree vertical viewing angle.

See Annex 3.1.

(50) Deviation ETSO-C146#3 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to modify the requirement 2.2.1.4.9.c in RTCA/DO-229C which states, "BRG to or from a VOR: The bearing is based on the true-to-magnetic conversion at the waypoint location, using the same magnetic conversion as used to define the path." This conversion is based upon the present aircraft location instead, which is how other waypoint's magnetic variation is computed.

See Annex 6.

(51) Deviation ETSO-C146#4 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to eliminate the requirement 2.2.4.2.3 in RTCA/DO-229C which states, "If the aircraft is past the FPAP - (length offset), and the pilot has not already activated the missed approach, the receiver shall automatically transition to missed approach guidance."

See Annex 6.

(52) Deviation ETSO-C146#5 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to modify the requirements 2.2.4.6.4 and 2.2.5.6.4 in RTCA/DO-229C, pertaining to the low altitude alerting function. The TAWS capabilities of the aircraft shall be used.

See Annex 6.

(53) Deviation ETSO-C146#6 –Stand-Alone Airborne Navigation Equipment using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)

Deviate from ETSO-C146 to modify the requirement 2.2.1.1.6 in RTCA/DO-229C states: "If a function is implemented as a discrete action, the equipment shall use the labels or messages in the Table". The table (TABLE 2-5 LABELS AND MESSAGES), states that the function "Indication that there is a message" shall be labeled as "MSG" or "M". Instead the terms "ADVISORY" and "ALERTS" in addition to "MSG" may be used depending upon the installation.

See Annex 6.

Annex 1 Use of updated standards

ETSO-C2d#1: Use SAE AS 8019A instead of AS 8019.
ETSO-C4c#1: Use SAE AS 8001 instead of AS 396B.
ETSO-C6d#1: Use SAE AS 8013A instead of SAE AS 8013
ETSO-C8d#1: Use SAE AS 8016A instead of AS 8016
ETSO-C9c#1: Use SAE AS-402B instead of AS-402A
ETSO-C10b#1: Use SAE AS 8009A instead of AS 392C
ETSO-C43c#1: Use SAE AS 8005A instead of AS 8005
ETSO-C44b#1: Use SAE AS 407C instead of AS 407B
ETSO-C45a#1: Use SAE AS 8042 instead of AS 411
ETSO-C47#1: Use SAE AS 408C instead of AS 408A
ETSO-C49b#1: Use SAE AS 404C instead of AS 404B
ETSO-C55#1: Use SAE AS 405C instead of AS 405B
ETSO-C118#1: Use RTCA DO-197A instead of DO-197
ETSO-C146#1: Use RTCA DO-229C instead of DO-229B

Industry Position: ELOS (Equivalent Level of Safety) is provided by use of later revision of the requirement document.

EASA: Often there is an update to a standard available but the reference in the ETSO has not been changed. Especially many SAE documents have been reaffirmed and been reissued without technical modification. In other cases the updated documents provide more precise information to avoid misinterpretation. It is planned to update the ETSOs in the frame of the long term rulemaking program to the most accurate version.

Annex 2 Use of environmental standard

ETSO-C4c#2, ETSO-C9c#4, ETSO-C10b#4, ETSO-C44b#2, ETSO-C45a#2, ETSO-C47#3, ETSO-C49b#4, ETSO-C55#4,

Industry: ELOS is provided by use of later revision requirement document. RTCA DO-160D is the successor document for RTCA DO-138.

EASA: For the environmental standard in general CS-ETSO request the use of EUROCAE ED-14D / RTCA DO-160D change 3. For some ETSOs specific environmental requirements apply especially to reflect specifics of the sensor. In this case only the display and the associated computer are affected and consequently one common set of requirements should be used reflecting the assumed installation environment in the cockpit. There is no need having specific requirements for the displaying of one instrument.

Annex 3 Use of LCD Technology

3.1 Viewing Angle

ETSO-C2d#3, ETSO-C3d#1, ETSO-C6d#2, ETSO-C8d#2, ETSO-C10b#2, ETSO-C44b#3, ETSO-C45a#4, ETSO-C47#2, ETSO-C49b#2, ETSO-C55#2, ETSO-C146#2

The viewing angle definition is not unique in the several applicable ETSOs but all instruments are displayed on one screen.

Industry: ELOS is provided by defining the viewing envelope (in accordance with ETSO-C113 and SAE AS8034 Section 4.2) as 45 degrees in both horizontal directions, 45 degrees in the up vertical direction, and 10 degrees in the down vertical direction. The 45 degree down vertical viewing requirement is not practical or needed for panel mount displays. This requested envelope is consistent with TFT LCD display technology.

EASA: The viewing angle for the LCD display should be defined by ETSO-C113. It is not required to provide a circular view as a 45 degree vertical down view is not needed for the typical installation place in front of the pilot. The limitations are provided to the installer and consequently could be taken into consideration during installation. One consistent requirement shall apply for the unit.

3.2 Pixel Graphic

ETSO-C2d#2, ETSO-C10b#3, ETSO-2C35d#1, ETSO-C44b#4, ETSO-C45a#3, ETSO-C49b#3, ETSO-C55#3

Industry: The system, as do many other Electronic Flight Instrumentation Systems (EFIS), presents a scrolling altitude tape with digital readout in a standardized format and location that does not need the specific label of ALTITUDE or ALT. The altitude tape is presented directly to the right of the attitude indication on the primary flight display.

The display will indicate Airspeed or TAS but the face of the instrument will not be marked.

The Marker signal shall flash at fixed rates but not synchronized with the keying of the transmitter. For the pilot it is important that the transmitter is received but the synchronisation of the flashing does not provide further information.

Instead of using a rotating pointer with a fixed dial or counter type indication the gauge can be defined as a horizontal or vertical bar with graduations with a pointer motion to the up or right indicating an increase of the value.

To avoid overloading of the display short abbreviations associated with the presented value shall be used.

EASA: Using a pixel oriented graphic provides more freedom to display values by combining trend indicators with numbers. Further the need to use common abbreviations is necessary. EASA agrees to those deviations allowing introducing a modern instrument presentation already established in many EFIS applications. Due to the unique presentation of e.g. Altitude bar, the need to label the instrument representation is no longer applicable.

It is important that the kind of information displayed can be identified without any doubt. Using display technology it is not necessary to mark the equipment itself as the relationship between marking and the display content would not be obvious.

It is important that the marker signal can be identified by flashing. It is not necessary to be synchronized with the keying but flashing at a fixed rate to indicate the received signal.

The pixel or vector graphic allows generating instrument styles different from a circle. Those kinds of instruments can be seen as meeting the intent of the original requirement.

The introduction of short abbreviations is acceptable.

Annex 4 Automatic pilots

4.1 Limitations

ETSO-C9c#2, ETSO-C52b#1

Industry: Deviate from AS-402B paragraph 4.4.1 to limit autopilot engagement to attitudes considered safe for the certified aircraft. Use Autopilot limitations that limit pitch and roll engagement to more conservative limits.

EASA: EASA considers that an autopilot pitch and roll engagement limitation which is more conservative than the attitudes considered safe for the certified aircraft meets the intent of the requirement to limit the autopilot engagement to attitudes considered safe for the certified aircraft. It can be debated if a deviation is needed at all but we accept the deviation as it provides more clarification.

4.2 Servo Effort Indication

ETSO-C9c#3

Industry: Deviate from AS402B paragraph 4.3.2 to not provide servo effort indications when the automatic pilot is not engaged. ELOS is provided by design which does not allow servo effort when the autopilot is not engaged and, therefore, this indication is unnecessary.

EASA accepts not presenting signals representative for the servo signals in case the autopilot is not engaged. In case the autopilot is not engaged this kind of signal is of limited use as it does not reflect the aircraft status but could only be used by pilots to receive help for the magnitude of their interaction to be able to act as if being the actuator.

Annex 5 GPS navigation

ETSO-C129a#1

Deviate from ETSO-C129a (ED-72A 3.2.2.1f(3) and 3.2.2.4j(4)) to eliminate the annunciation for pending CDI scale change 3.0 NM from the FAF.

Industry: This provides a reduction in pilot workload during critical phases of flight.

EASA agrees that the CDI scale change is done automatically while approaching the final approach fix (FAF). This reduces work load and suits the need of higher position accuracy during approach.

ETSO-C129a#2: Deviate from ETSO-C129a (ED-72A 3.2.2..1f(4), 3.2.2.3e(4), and 3.2.2.4j(2)) to eliminate the requirement to “alert the pilot of the need to manually insert the barometric pressure.

Industry: ELOS is provided by the unit calibrating pressure altitude whenever RAIM is available en route.

EASA: With the high number of available satellites the RAIM function is available during most times. Consequently the GPS height may be used to calibrate the pressure altitude instead of entering the calibration parameter manually. Following this principle barometric altitude can be used to determine sudden GPS inconsistencies without manual intervention.

ETSO-C129a#3: Deviate from ETSO-C129a (ED-72A 3.2.2.4j(8)) to modify the requirement to allow the approach mode to be deselected by performing a direct-to action on the unit.

Industry: ELOS is provided by a two step operation that is consistent with the operational philosophies applied to the box in other areas. Consistent operation throughout the operation minimizes pilot error.

EASA accepts to have a two step operation to enter a Direct To command. To abort the Approach mode on an exceptional basis to allow applying a consistent user interface.

ETSO-C129a#4 Deviate from ETSO-C129a (ED-72A 3.2.2.3d(2)) to eliminate the requirement to provide a “means to manually identify a satellite that is expected to be unavailable at the destination” for the RAIM prediction process.

Industry: ELOS is provided by eliminating pilot input error, low probability of satellite unavailability and the full satellite constellation with spares. Regardless of the destination RAIM prediction, RAIM availability status is correctly provided to the pilot upon arrival.

EASA: Having a high number of satellites available the manual deselecting of satellites for the RAIM process is of limited use. In case that RAIM fails it can be assumed that the airport could be approached using a different procedure not related to GPS.

ETSO-C129a#5: Deviate from ETSO-C129a to change the requirement in ED-72A paragraph 4.16.2 to match the WAAS TSO-C145a and DO-229 requirements for Power input testing.

Industry: The GPS WAAS ETSO C145 and DO-229a allows a system reset followed by satellite acquisition time of 5 minutes for abnormal operating conditions power input tests.

EASA: It is accepted that the recovery time from a full system reset after abnormal power operating conditions is greater than 10 seconds and are harmonized with ETSO-C146 to five minutes.

Annex 6 GPS augmented by WAAS

ETSO-C146#3: Deviate from ETSO-C146 to modify the requirement 2.2.1.4.9.c in RTCA/DO-229C which states, "BRG to or from a VOR: The bearing is based on the true-to-magnetic conversion at the waypoint location, using the same magnetic conversion as used to define the path".

Industry: This conversion is based upon the present aircraft location instead, which is how other waypoint's magnetic variation is computed.

EASA agrees that it is important to handle True respective Magnetic Heading in a consistent manner in one system.

ETSO-C146#4: Deviate from ETSO-C146 to eliminate the requirement 2.2.4.2.3 in RTCA/DO-229C which states, "If the aircraft is past the FPAP - (length offset), and the pilot has not already activated the missed approach, the receiver shall automatically transition to missed approach guidance."

Industry: This requirement is not implemented since it is being eliminated in DO-229D.

EASA agrees that automatic leg sequencing to the missed approach leg is not required. The additional pilot work load may be compensated by the fact that a clear action increases the awareness for the specific situation.

ETSO-C146#5: Deviate from ETSO-C146 to modify the requirements 2.2.4.6.4 and 2.2.5.6.4 in RTCA/DO-229C, pertaining to the low altitude alerting function.

Industry: The TERRAIN or TAWS capabilities of the aircraft shall be used to avoid CFIT when TERRAIN or TAWS are enabled and not in one of the following states: FAIL, N/A, TEST, or INHIBIT. The low altitude alert described in DO-229C 2.2.4.6.4 and 2.2.5.6.4 shall be used when neither TERRAIN nor TAWS is enabled, or when one is enabled but the current state is FAIL, N/A, TEST, or INHIBIT.

EASA agrees to harmonise the low altitude alert function with the TAWS function to have a clear indication of the alarm source.

ETSO-C146#6: Deviate from ETSO-C146 to modify the requirement 2.2.1.1.6 in RTCA/DO-229C states: "If a function is implemented as a discrete action, the equipment shall use the labels or messages in the Table". The table (TABLE 2-5 LABELS AND MESSAGES), states that the function "Indication that there is a message" shall be labeled as "MSG" or "M".

Industry: The terms "ADVISORY" and "ALERTS" in addition to "MSG" may be used depending upon the installation. The system provides full aircraft alerting in its installations. Per OEM request, some installations use the nomenclature "ADVISORY" and "ALERTS" to encompass message advisories.

EASA agrees to use the naming convention of the airframe manufacturer for message classifications.