



Deviations requests for an ETSO approval for CS-ETSO applicable to ETSO-C2d Consultation Paper

1. Introductory note

The hereby presented deviation requests shall be subject to public consultation, in accordance with EASA Management Board Decision No 7-2004¹ 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 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-C2d

Deviate from SAE AS8019A § 3.2.1 and from SAE AS8019A § 3.2.6.

Requirement: SAE AS8019A § 3.2.1 states, “Graduations: The graduations shall be arranged to provide the maximum readability consistent with the accuracy of the instrument. Graduations shall be as follows:

- a. The first graduation shall be at the lowest usable airspeed of the instrument, as specified by the manufacturer.
- b. From the 10 knot, 10 mph, or 20 km/h graduation nearest to the first graduation and continuing to 250 knots, 250 mph, or 400 km/h major graduations shall be at least every 10 knots, 10 mph, or 20 km/h, with minor graduations at least every 5 knots, 5 mph, or 10 km/h.
- c. Over 250 knots, 250 mph, or 400 km/h, graduations shall be at least every 50 knots, 50 mph, or 100 km/h.”

Industry: Applicant requests a deviation to allow the IDU software to follow current PFD convention and use 10 knot graduations with speed labeling every 20 knots and no minor graduations. The proposed airspeed scale labeling comports with recommended symbol 18 of SAE/ARP4102-7 App. A. Because the scale is used in conjunction with digital display of airspeed, airspeed can be read as accurately as with the graduations required in SAE AS8019A

Requirement: SAE AS8019A § 3.2.6 states, “Range: The range of operation of the instrument shall be marked on the nameplate.”

Industry: Applicant requests a deviation to delete the requirement for range marking of the EFIS display. The EFIS display has no inherent airspeed range limitation. The airspeed range of operation is solely a function of the range of the TSO-C106 Air Data Computer to which the IDU is connected. Applicant notes that TSO-C106 requires that the Air Data Computer be marked with an airspeed range (Ref: SAE AS8002A § 9.2(f)).

EASA: We accept the deviation as alternate means to meet the requirement.

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

ETSO-C6d

Deviate from SAE AS8013A § 3.6 and from SAE AS8013A § 3.13.

Requirement: SAE AS8013A § 3.6 states, “Malfunction Indication: Integral means shall be provided to indicate failures and/or existence of the following conditions:

- a. System in fast alignment mode, required of electrical instruments except manually caged indicators with automatic release.
- b. Gyro operating at speed below the minimum designated by the manufacturer for the instrument to meet the performance requirements herein. The requirement applies to electrical and remotely operated instruments.

Additionally, the indicator or display of the repeating or remote indicating type of gyroscopically stabilized instrument shall be provided with means to indicate the following failures:

- c. Loss of synchro excitation
- d. A mechanical obstruction in the indicator dial drive mechanism
- e. Primary power loss to the indicator or display
- f. Servo Amplifier power loss
- g. Electrical failure in the servo drive motor

The indicating means shall indicate the failure or malfunction in an unambiguous manner. The indicating means may be a single indication of any or all of the preceding conditions or failures.”

Industry: Applicant requests a deviation to substitute AHRS system monitoring and annunciation for the above malfunction indication requirement. The malfunctions listed in the requirement are not applicable to the new technology AHRS system used by the EFIS. Instead, the AHRS system features integral health monitoring and transmits a health message to the EFIS. The EFIS performs warning functions and removes unreliable symbology based upon the AHRS transmissions. This provides an equivalent level of safety.

Requirement: SAE AS8013A § 3.13 states, “Synchronization Provision: Automatic or manual means shall be provided to bring the indicated heading into alignment with the magnetic heading. An indication of alignment and/or failure to align shall be provided.”

Industry: Applicant requests a deviation to delete the requirement for synchronization provision. The new technology AHRS system used by the EFIS is a strapdown, solid-state device incorporating three orthogonal rate gyros, three orthogonal accelerometers, three orthogonal magnetometers, and a microprocessor. Deriving attitude and heading is a complicated mathematical process that continuously utilizes and combines input from all sensors. An out of synchronization condition is not possible with this device.

EASA: We accept the deviation as alternate means to meet the requirement.

ETSO-C10b

Deviate from TSO-C10b(B)(2)(iii)(b) and from SAE AS392C § 4.2.1.

Requirement: TSO-C10b(B)(2)(iii)(b) states, “Marking. In lieu of the weight specified in Subpart A, the range shall be shown.”

Industry: Applicant requests a deviation to delete the requirement for range marking of the EFIS. The EFIS has no inherent altitude range limitation. The altitude range of operation is solely a function of the range of the TSO-C106 Air Data Computer to which the EFIS is connected. Applicant notes that TSO-C106 requires that the Air Data Computer be marked with an altitude range (Ref: SAE AS8002A § 9.2(f)).

Requirement: SAE AS392C § 4.2.1 states, “4.2.1 Increments: Markings shall be provided at intervals not exceeding 20 feet of altitude with major increment markings at 100 foot intervals.”

Industry: Applicant requests a deviation to allow the EFIS software to follow current PFD convention and use a combination of a tape and a digital readout for indicating altitude. Following current PFD conventions, the proposed tape shall have graduations every 100 feet with markings every 500 feet. The proposed altitude display comports with recommended symbols 39 and 40 of SAE/ARP4102-7 App. A.

EASA: We accept the deviation as alternate means to meet the requirement.

ETSO-C146

Deviate from RTCA DO-229C § 2.2.1.2.3, and from SAE AS392C ¶ 4.2.1.

Requirement: DO-229C § 2.2.1.2.3 states, “If the database is not available or fails a verification check, the equipment shall continue to function, preventing access to the invalid data (but still providing access to valid data, including user-defined waypoint functions).”

Industry: Applicant requests a deviation from the requirement for continuation of function after detecting a database verification error. The FMS function uses a variety of databases to perform various critical functions. The databases include navigation data, terrain data, obstruction data, and aircraft parameter data. During initialization, all databases are verified through use of CRC-32s. Verification failure causes the system to give a maintenance warning and not initialize. Applicant requests retention of this feature because:

1. The system performs a variety of critical functions, many of which have a higher criticality level than the TSO-C146a GPS/WAAS navigation functions;
2. Many of the critical functions are highly dependent upon properly functioning databases (i.e., TSO-C151b terrain warnings); and
3. Verification failure is indicative of an unknown hardware malfunction that could have various other effects.

Due to the above, applicant believes that it is unsafe to allow continued equipment operation after detection of a database failure.

Requirement: DO-229C § 2.2.1.4.4 states, “The equipment shall be capable of displaying the bearing in true or magnetic bearing as selected.”

Industry: Applicant requests a deviation from the requirement to provide a pilot selection to display bearings in degrees true. Applicant is unaware of any real operational need for display of bearings or directions in degrees true in the NAS. However, implementation of this feature would add complexity to equipment operation. Applicant believes that this is undesirable and therefore requests a deviation.

Requirement: DO-229C § 2.2.1.4.5.3 states, “The track angle error shall be displayed with 1° resolution.”

Industry: Applicant requests a deviation from the requirement to numerically display track angle error.

Aircraft track is displayed on the primary flight display with a track marker (green diamond) and by the position of the flight path marker. Desired track is shown on the primary flight display with a waypoint bearing marker (magenta waypoint star) and a perspective, highway-in-the-sky path depiction.

Aircraft track is displayed on the navigation display with a track marker (green diamond) and lubber line (segmented green line). Desired track is shown on the navigation display with a waypoint bearing marker (magenta waypoint star) and a depiction of the flight plan route with active leg shown in magenta and other legs shown in white.

Applicant submits that the displays provide a superior method for the pilot to understand the relationship between aircraft track and desired track and offer an equivalent level of safety to a numerical display of track angle error.

Requirement: DO-229C § 2.2.2.4.3 states, “When in oceanic/remote, en route, or terminal mode, the equipment shall provide either a display or electrical output of cross-track deviation with a range of at least ± 20 nm (left and right).”

DO-229C § 2.2.3.4.3 states, “When in nonprecision approach mode, the equipment shall provide either a display or electrical output of cross-track deviation with a range of at least ± 9.99 nm (left and right).”

Industry: Applicant requests a deviation from the requirement to provide a numeric cross-track deviation display.

Aircraft relationship to the desired track is graphically shown on the navigation display. Applicant submits that a moving map provides a superior method for the pilot to understand the relationship between aircraft position and desired track and offers an equivalent level of safety to a numerical cross-track deviation display.

Requirement: DO-229C § 2.2.3.3.4(c) states, “The equipment shall meet the requirements of Section 2.2.4.4.4 for non-numeric vertical deviation display.”

DO-229C § 2.2.3.4.3 states, “When in nonprecision approach mode, the equipment shall provide either a display or electrical output of cross-track deviation with a range of at least ± 9.99 nm (left and right)

Final approach segment vertical deviations (see Figure 2-17) are defined from the following” (Note: remainder of § 2.2.4.4.4 describing methodology for calculating vertical deviations omitted for brevity).

Industry: Applicant requests a deviation allowing use of “skyway” and other perspective symbols in lieu of a vertical deviation indicator.

Perspective symbols that inherently incorporate lateral, vertical and depth components have been shown to increase situational awareness and reduce flight technical error. Applicant submits that use of “skyway” and other perspective symbols for barometric VNAV has an equivalent level of safety to conventional vertical deviation displays.

Requirement: DO-229C § 2.2.3.4.4 states, “When in terminal or nonprecision approach mode, the distance to the missed approach waypoint shall be available for display until the MAWP is sequenced. The distance shall be

displayed with a resolution of 0.1 nm up to a range of 99.9 nm. If a moving map is provided, the map may obviate the need for a numerical output. **Note:** *Design consideration should be given to avoid confusion between the waypoint distance display and the MAWP distance display*”.

DO-229C § 2.2.3.4.5 states, “When in terminal or nonprecision approach mode, the bearing to the missed approach waypoint shall be available for display until the MAWP is sequenced. The bearing shall be displayed with a resolution of 1 degree. The equipment shall be capable of displaying the bearing in true or magnetic bearing as selected. If a moving map is provided, the map may obviate the need for a numerical output. **Note:** *Consideration should be given to the enhanced situational awareness that is provided by moving map displays.*”

Industry: Applicant requests a deviation from the requirement for display of distance and bearing to the MAWP.

Aircraft relationship to the MAWP is graphically shown on the navigation display. Applicant submits that a moving map provides a superior method for the pilot to understand the relationship between aircraft position and the MAWP and offers an equivalent level of safety to a separate display of bearing and distance to the MAWP. Applicant also notes that this deviation is contemplated within the text of the requirements.

EASA: We accept the deviation as alternate means to meet the requirement.

3. ETSO-C151a

Deviate from ETSO-C151a App. 1 § 4.7 and 4.9, from ETSO-C151a App. 1 § 10.2 and 10.3, from DO-161A § 1.6.1 and 2.3.1, from DO-161A § 2.1.2 and 2.1.3 and 2.1.4, from DO-161A § 2.3.1.1, from DO-161A § 2.3.2, from DO-161A § 2.3.2, and from DO-161A Appendix A Envelopes.

Requirement: ETSO-C151a App. 1 § 4.7 states, “The aural and visual alerts should be selectable to accommodate operational commonality among fleets of airplanes.”

ETSO-C151a App. 1 § 4.9 states, “As a minimum the TAWS shall be capable of providing aural alert messages described in Table 4-1. In addition to this minimum set, other voice alerts may be provided.”

Industry: Applicant requests a deviation from the requirement to provide multiple, selectable messages for certain alert conditions.

ETSO-C151a Appendix 1 Table 4-1 lists a variety of selectable voice alerts. The requirement to provide selectable voice alerts seems unneeded and likely to lead to confusion. It is not known whether the pilot makes the selection in flight, or whether the selectable voice alerts are set during installation or manufacturing. Applicant also notes that some of the voice alerts required in Appendix 1 conflict with those in proposed ETSO-C151a Appendix 4 Table 4-1. Thus, there seems to be a requirement for up to three sets of voice alerts. There doesn't seem to be a real operational need to justify the imposition of so much complexity. Further, ETSO-151a Appendix 1 § 4.7 is written with a “should” and therefore does not impose a strict requirement.

Applicant proposes the aural and visual alerts in the following table to comply with the requirements of the TSO. These alerts are based upon the alerts in the TSO and offer an equivalent level of safety to providing multiple, selectable alerts.

Alert Type	Caution		Warning	
	Visual	Aural	Visual	Aural
FLTA	"TERRAIN"	"Caution, Terrain; Caution, Terrain"	"PULL UP"	"Terrain, Terrain; Pull Up, Pull Up"
PDA	"TOO LOW"	"Too Low Terrain"		
GPWS Mode 1	"SINK RATE"	"Sink Rate"	"PULL UP"	"Pull Up, Pull Up"
GPWS Mode 2	"TERRAIN"	"Caution, Terrain; Caution, Terrain"	"PULL UP"	"Terrain, Terrain; Pull Up, Pull Up"
GPWS Mode 3	"TOO LOW"	"Too Low Terrain"		
GPWS Mode 4	"TOO LOW"	"Too Low Terrain," "Too Low Gear," or "Too Low Flaps" depending upon aircraft speed and configuration		
GPWS Mode 5	"GLIDE SLOPE"	"Glide Slope"	"GLIDE SLOPE"	"Glide Slope"
500 Foot Wake-Up		"Five Hundred"		

Requirement: ETSO-C151a App. 1 § 10.2 states, "The Terminal Phase exists when the airplane is 15 NM or less from the nearest runway while the range to the nearest runway threshold is decreasing and the airplane is at or below (lower than) a straight line drawn between the two points specified in Table 10-1 relative to the nearest runway."

ETSO-C151a App. 1 § 10.3 (defining the Approach Phase) states, "Distance to nearest runway threshold is equal to, or less than 5 NM; and height above the nearest runway threshold location and elevation is equal to, or less than 1900 feet; and distance to the nearest runway threshold is decreasing."

Industry: Applicant requests a deviation from the requirement to use decreasing range to nearest runway threshold as part of the conditions for defining the Terminal or Approach Phase.

There are many situations in which the range to the nearest runway threshold is increasing yet it is undesirable to sensitize the TAWS to Enroute Phase limits. One example is a circling to land maneuver during an instrument approach. Another is flying a normal traffic pattern in VFR conditions. Yet another is a simple landing rollout. .

Applicant requests a deviation due to the fact that sensitizing based upon increasing range to the nearest runway threshold will lead to nuisance alerts.

Requirement: DO-161A § 1.6.1 states, “The aural warning for Modes 1 through 4 shall consist of the sound ‘Whoop-Whoop,’ followed by either ‘Pull-Up’ or ‘Terrain’ (or other acceptable annunciation) repeated until the hazardous condition no longer exists.”

DO-161A § 2.3.1 states, “The aural warning for Modes 1 through 4 consists of the sound ‘Whoop-Whoop,’ followed by either ‘Pull-Up’ or ‘Terrain’ (or other acceptable annunciation) repeated until the hazardous condition no longer exists.”

Industry: Applicant requests a deviation from the requirement to provide a “Whoop-Whoop” tone.

The provision of a “Whoop-Whoop” tone is not required by Appendix 1 of ETSO-C151a. In addition, the voice alerts specified in DO-161A conflict with those specified in ETSO-C151a. Applicant proposes the aural and visual alerts in the following table to comply with the requirements of the TSO. These alerts are based upon the alerts in the TSO and offer an equivalent level of safety to the alerts specified in DO-161A.

Alert Type	Caution		Warning	
	Visual	Aural	Visual	Aural
FLTA	“TERRAIN”	“Caution, Terrain; Caution, Terrain”	“PULL UP”	“Terrain, Terrain; Pull Up, Pull Up”
PDA	“TOO LOW”	“Too Low Terrain”		
GPWS Mode 1	“SINK RATE”	“Sink Rate”	“PULL UP”	“Pull Up, Pull Up”
GPWS Mode 2	“TERRAIN”	“Caution, Terrain; Caution, Terrain”	“PULL UP”	“Terrain, Terrain; Pull Up, Pull Up”
GPWS Mode 3	“TOO LOW”	“Too Low Terrain”		
GPWS Mode 4	“TOO LOW”	“Too Low Terrain,” “Too Low Gear,” or “Too Low Flaps” depending upon aircraft speed and configuration		
GPWS Mode 5	“GLIDE SLOPE”	“Glide Slope”	“GLIDE SLOPE”	“Glide Slope”
500 Foot Wake-Up		“Five Hundred”		

Requirement: DO-161A § 2.1.2 states, “Warnings shall be provided by the equipment when the combination of the rate of change in height above the terrain and the height above the terrain is within the applicable portion of envelope prescribed for Modes 2A and 2B in Appendix A.” The test for

selecting between the Mode 2A and 2B envelopes is whether flaps are in landing configuration.”

DO-161A § 2.1.3 states, “Warnings shall be provided by the equipment when the combination of barometric altitude sink rate and height above terrain is within the envelope prescribed for Mode 3A in Appendix A, OR when the combination of barometric altitude loss and height above terrain is within the envelope prescribed for Mode 3B in Appendix A, regardless of landing gear position and with flaps not in landing configuration.”

DO-161A § 2.1.4 states, “Warnings shall be provided for the ‘gear and/or flaps other than in landing configuration portion of the [Mode 4] envelope when a configuration other than for landing has been selected for either flaps or landing gear or both.”

Industry: Applicant requests a deviation from the requirement to determine landing intent of pilot based upon flap position for certain aircraft types.

DO-161A is written for transport category aircraft that have a defined landing flaps position. However, most Part 23, 27 and 29 aircraft lack a defined landing flaps position. Thus, determining GPWS mode based upon flaps being in a landing configuration is not possible in most potential EFIS-II system installations.

Accordingly, Applicant proposes the following logic for Mode 2 envelope selections:

Aircraft Type	Mode 2A	Mode 2B
Airplane RG + F	Flaps NOT in landing configuration.	Flaps in landing configuration.
Airplane RG	Landing Gear UP	Landing Gear DOWN
Airplane FG + F	Flaps NOT in landing configuration	Flaps in landing configuration
Airplane FG	AGL Altitude > 500' OR IAS > Note 1	AGL Altitude < 500' AND IAS < Note 1
Rotorcraft RG	Landing Gear UP	Landing Gear DOWN
Rotorcraft FG	AGL Altitude > 200' OR IAS > 80KIAS	AGL Altitude < 200' AND IAS < 80KIAS

Notes: RG + F = Retractable Gear with Defined Landing Flaps Position

RG = Retractable Gear

FG + F = Fixed Gear with Defined Landing Flaps Position

FG = Fixed Gear

1. Normal Landing Pattern Speed + 15KIAS

Applicant also proposes to change the arming logic of Mode 3 from being based upon flap configuration to being based upon mode-of-flight. This is possible due to the availability of multiple system inputs for determining take-off and missed approach conditions. As proposed, GPWS Mode 3 is armed by either being in ground mode (defined as indicated airspeed less than V_s (airplanes) / 40KIAS (rotorcraft) AND AGL altitude less than 75 feet) or by being on the first leg of a missed approach procedure (as determined by the FMS function) with distance to the active runway threshold increasing. As proposed, GPWS Mode 3 is disarmed upon climbing through 700 feet AGL, traveling more than 6NM from the last point at which the ground mode existed (this will be near the liftoff point), or transitioning to the second leg of a missed approach procedure.

Finally, Applicant proposes the following logic for generating Mode 4 alerts:

Aircraft Type	Mode 4A	Mode 4B
Airplane RG + F	Landing Gear UP	Landing Gear UP OR Flaps not in landing configuration.
Airplane RG	Landing Gear UP	Landing Gear UP
Airplane FG + F	Not Applicable	Flaps not in landing configuration
Airplane FG	Not Applicable	Not Applicable
Rotorcraft RG	Landing Gear UP	Not Applicable
Rotorcraft FG	Not Applicable	Not Applicable

Notes: RG + F = Retractable Gear with Defined Landing Flaps Position

RG = Retractable Gear

FG + F = Fixed Gear with Defined Landing Flaps Position

FG = Fixed Gear

Applicant submits that the logic described offers an equivalent level of safety to, and covers a far broader array of aircraft than, the transport-category algorithms in DO-161A

Requirement: DO-161A § 2.3.2 states, “The visual warning for Modes 1 through 4 shall be red and include, in distinctive letters, the letter GPWS (or other acceptable legend).”

Industry: Applicant requests a deviation from the requirement to provide a red “GPWS” visual warning for Modes 1 through 4.

The visual alert specified in DO-161A conflicts with those specified in ETSO-C151a. Applicant proposes the aural and visual alerts in the following table to comply with the requirements of the TSO. These alerts are based upon the alerts in the TSO and offer an equivalent level of safety to the alerts specified in DO-161A.

Alert Type	Caution		Warning	
	Visual	Aural	Visual	Aural
FLTA	“TERRAIN”	“Caution, Terrain; Caution, Terrain”	“PULL UP”	“Terrain, Terrain; Pull Up, Pull Up”
PDA	“TOO LOW”	“Too Low Terrain”		
GPWS Mode 1	“SINK RATE”	“Sink Rate”	“PULL UP”	“Pull Up, Pull Up”
GPWS Mode 2	“TERRAIN”	“Caution, Terrain; Caution, Terrain”	“PULL UP”	“Terrain, Terrain; Pull Up, Pull Up”
GPWS Mode 3	“TOO LOW”	“Too Low Terrain”		
GPWS Mode 4	“TOO LOW”	“Too Low Terrain,” “Too Low Gear,” or		

		"Too Low Flaps" depending upon aircraft speed and configuration		
GPWS Mode 5	"GLIDE SLOPE"	"Glide Slope"	"GLIDE SLOPE"	"Glide Slope"
500 Foot Wake-Up		"Five Hundred"		

Requirement: DO-161A § 2.6.4 states, "Mode 5 shall be armed when the landing gear is selected to the landing position and disarmed either when the flaps are retracted from the landing position or the landing gear is selected to the non-landing position."

Industry: Applicant requests a deviation from the requirement to arm and disarm Mode 5 based upon landing gear and flap position.

DO-161A is written for transport category aircraft that have a defined landing flaps position and retractable landing gear. However, most Part 23, 27 and 29 aircraft lack a defined landing flaps position and some also lack retractable landing gear. Thus, arming and disarming GPWS Mode 5 in the specified manner is not possible in most potential EFIS installations.

Accordingly, Applicant proposes to change the arming logic of Mode 5 from being based upon gear and flap configuration to being based upon various other detectable flight conditions. This is possible due to the availability of multiple system inputs for determining when Mode 5 should be armed on an ILS approach. As proposed, Mode 5 is armed when a valid glideslope signal is being received AND the aircraft's 5 second filtered descending glidepath is greater than 1° AND the aircraft is below 1000' AGL.

Applicant submits that the logic described offers an equivalent level of safety to, and covers a far broader array of aircraft than, the transport-category algorithms in DO-161A..

Requirement: The envelope drawings for Modes 1, 2A, 3, 4 and 5 in Appendix A of DO-161 each include a "Descent Inhibit Height" of 50 feet ± 10 feet.

Industry: Applicant requests a deviation from the requirement of a descent inhibit height of 50 feet ± 10 feet when terrain database derived AGL altitude is used.

The TAWS system is capable of using terrain database derived AGL altitude as an input to the GPWS warning functions when radar altitude is not available. Terrain database derived AGL altitude is based upon the difference between MSL altitude (either GPW/WAAS geodetic height or temperature-corrected barometric altitude) and terrain elevation from a terrain database. There are various potential error sources in terrain database derived AGL altitude stemming from inaccuracies in determining MSL height as well as inaccuracies in the terrain database.

Due to these potential error sources, a larger descent inhibit height is appropriate for preventing nuisance warnings when using terrain database derived AGL altitude. Applicant proposes a descent inhibit height of 100 feet when the source of AGL altitude is terrain database derived.

EASA: We accept the deviation as alternate means to meet the requirement.