Deviation Request ETSO-2C197#5 for an ETSO approval for CS-ETSO applicable to Information Collection and Monitoring Systems (ETSO-2C197)
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 as amended by EASA Management Board Decision No 12-2007 products certification procedure dated 11th September 2007, 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-2C197#5 Information Collection and Monitoring Systems

2.1 Summary of Deviation

Deviates from EUROCAE ED-155 I-5.2.3 by adapting out-of-band input signals when the Recorder Pilot Audio Channel sampling rate and bandwidth exceeds the minimum rate.

2.2 Original Requirement

EUROCAE ED-155

I-3.2.4 Audio Noise Level – Signal to Noise
With no signal applied to any input channel, the reproduced signal shall be below the output level produced by an input Reference Signal by the value defined in Table I-3.1.

This requirement shall be met across the frequency band as defined in Table I-3.1 with the input both open and short circuited. The above Signal to Noise performance shall be met in the presence of out-of-band input signals at the Reference level when tested in accordance with paragraph I-5.2.3.

NOTE: If audio channels are specified with the audio frequency response of the area channel, the area channel out-of-band signal definition shall apply.

I-5.2.3 Audio Noise Level – Signal to Noise (paragraph I-3.2.4)

a Equipment Required:

Audio Signal Generator,
A-weighted Filter IEC 651(1979),
3rd Octave Filters IEC 225 (1966),
Audio Power Meter,
Replay equipment as specified by the manufacturer.

b Measurement Procedure:

Operate the CARS with all flight functions and aircraft interfaces active, i.e. image, data-link, etc., and apply the reference signal to each recording channel for 30 seconds. Replay the recordings and measure the output levels using the audio power meter.

Operate the CARS with all flight functions and aircraft interfaces active, i.e. image, data-link, etc., for 30 seconds for each of the following five different input conditions – open, shorted and with three separate out-of-band signals applied. For the out-of-band tests, connect the signal generator to each channel of the recorder under test and set the input signal to the Reference Signal Level. Select, in turn, frequencies of 31.5 kHz, 40.0 kHz and 50.0 kHz for the area microphone channel, and 8 kHz, 10 kHz and 12.5 kHz for the other audio channels. Replay the recordings measuring the un-weighted 22 kHz bandwidth noise level in 3rd octave bands for the area microphone channel, and A weighted noise level in 3rd octave bands for the pilots audio channel(s). Table I-5.1 and Table I-5.2 are examples for entering this data for the area microphone and audio channels respectively. Enter the calculated ratio in dB of the output for the reference signal input relative to the output for zero input. Record the lowest value in the last row of the table. This value should be greater than the specification given in Table I-3.1.

Characteristic	Cockpit Area Microphone	Cockpit Area Microphone Preamplifier	Recorder Cockpit Area Microphone Channel	Recorder Pilot Audio Channel
Frequency Response (minimum)	50 Hz to 17 kHz +/- 6 dB 17 kHz to 20 kHz +/- 10 dB	150 Hz to 20 kHz +/- 3 dB Below 150 Hz (f_c) - 2nd order roll off (-12dB/octave nominal)	150 Hz to 20 kHz +/- 3 dB Below 150 Hz (f_c) - 2nd order roll off (-12dB/octave nominal)	150 Hz to 5 kHz +/- 3 dB Below 150 Hz (f_c) - 2nd order roll off (-12dB/octave nominal)
	150 Hz to 20 kHz +/- 6 dB Below 150 Hz (f_c) - 2nd order roll off (-12dB/octave nominal) See Note1			
Dynamic Range (minimum)	94dB, max input level >= 120 dB SPL	116 dB (including 36 dB of selectable attenuation)	80 dB	116dB (including 36 dB of selectable attenuation)
Selectable Input Attenuation	N/A	36 dB in 6 dB steps	none	36 dB in 6 dB steps
Signal to Noise (minimum)	67 dB referenced at 94 dB SPL	80 dB referenced to signal equivalent to 120 dB SPL at microphone	80 dB referenced to signal equivalent to 120 dB SPL at microphone	80 dB referenced to 1 Vrms input level with 0dB selectable input attenuation.
Total Harmonic Distortion and Noise (THD+N)	< 1 % (-40dB) at 120 dB SPL 22 kHz BW un-weighted	< 0.1 % (-60dB) at signal equivalent to 120 dB SPL at microphone. 22 kHz BW un-weighted	< 0.1 %(-60dB) at signal equivalent to 120 dB SPL at microphone 22 kHz BW un-weighted	< 0.1 % (-60dB) at 1 Vrms input level with 0dB selectable input attenuation, ANSI A weighting < 0.1 % (-60dB) at 4 Vrms input level with 12dB selectable input attenuation, ANSI A weighting
Audio Channel Crosstalk (minimum)	N/A	N/A	-72 dB	-72 dB
Input Impedance (minimum)	N/A	Compatible with microphone output	Compatible with preamplifier output	2000 ohm minimum
Polar Response (directivity)	As required by installation location and cockpit configuration	N/A	N/A	N/A
Output Level	Compatible with preamplifier	Compatible with recorder input	N/A	N/A
Channel Sampling Rate	N/A	N/A	44.1 kHz minimum	11.025 kHz minimum

NOTE 1: *The frequency response of the area microphone and area microphone preamplifier may be addressed as a combined value instead of individual bandwidth requirements.*

NOTE 2: *Columns represent functional boundaries and do not preclude physical combinations of these functions such as combining the preamplifier with the recorder.*

NOTE 3: *Unless otherwise noted, all specifications referenced to 1 kHz sinusoidal input.*

NOTE 4: *fc = nominal -3dB point.*

TABLE I-3.1: AUDIO QUALITY SPECIFICATION

2.3 Industry

The objective of the out-of-band signal test is to verify the performance of the anti-aliasing filter. To do so, out-of-bands signals are successively injected in the recorder audio channel, and the noise generated by these out-of-band signals on the recorded signal should not exceed the prescribed value when compared to recording of a reference signal defined as a 1 KHz sine (ED-155 I-3.1.1).

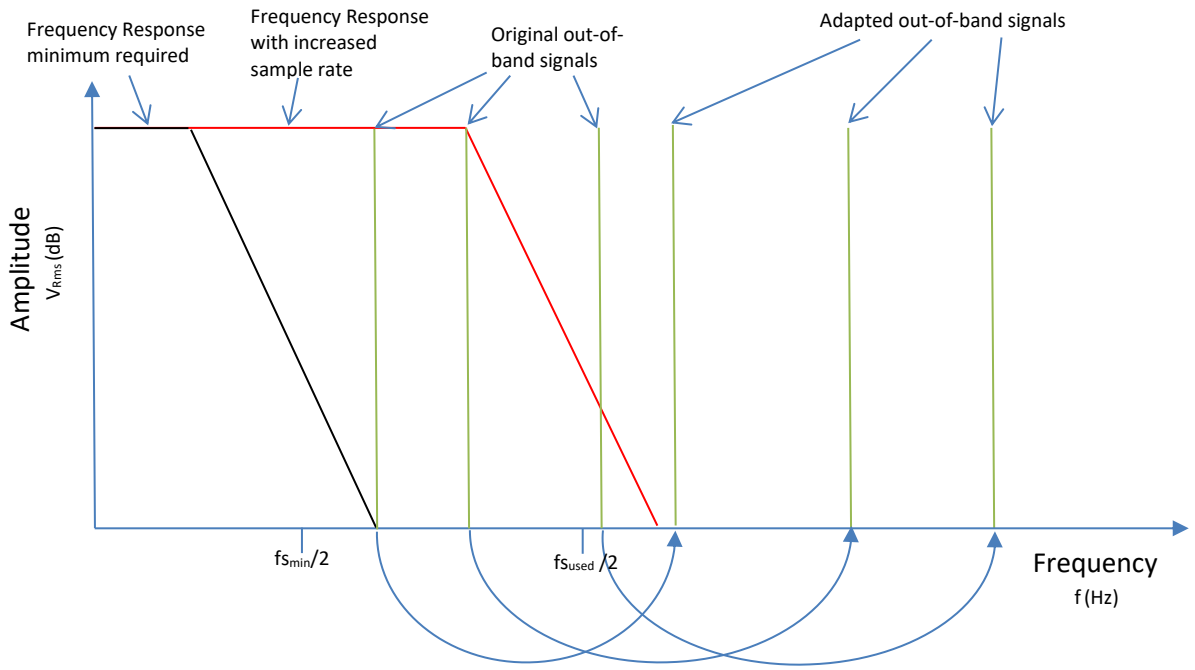
ED-155 specifies minimum frequency responses and sampling rates in Table-I-3-1 and therefore higher values are permitted.

However, the standard specifies the frequencies of the out-of-band signals assuming that the bandwidth is the minimum required one (150 Hz to 5 kHz) but these frequencies are incompatible of higher rates. Still, higher frequency responses require correspondingly higher sampling rates. This creates the situation where previously out-of-band signals specified at the frequency points in ED-155 now become in-band signals. This results in each of those signals being recorded (fully or attenuated depending on the frequency). The recorded signal then contains an accurate recording of the input 'out-of-band' signal, which is translated as noise value. The result is a signal-to-noise ratio exceeding the requirement.

In order to meet the original ED-155 objective, the out-of-band signals should be adapted proportionally to the higher bandwidth.

The target implementation uses a sampling frequency of 22.050 kHz instead of the minimum 11.025 kHz specified by ED-155 for recorder pilot audio channel. The corresponding out-of-band signals are transposed from 8 kHz, 10 kHz and 12.5 kHz to 16 kHz, 20 kHz and 25 kHz respectively i.e. doubling the sampling frequency doubles the out-of-band frequencies.

The following graph illustrates the relationship between frequency response and out-of-band signals:



fs_{min} = 11.025 kHz
fs_{used} = 22.050 kHz

2.4 Equivalent Level of Safety

This deviation provides an equivalent level of safety because the ED-155 objective is achieved by adapting the out-of-band frequencies proportionally to the increased sampling rate and bandwidth, and by the ability to record higher frequencies. Thanks to this increased bandwidth, the recorded signal therefore contains more information that can be analyzed by investigation authorities, compared to a recorder implementing only the minimum sampling frequency with the ED-155 out-of-band signals.

2.5 EASA position

We accept the deviation.