

# Deviation Request ETSO-2C197#3 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#3 Information Collection and Monitoring Systems

#### 2.1 Summary of Deviation

Deviates from EUROCAE ED-155 by adapting Cockpit Area Microphone (CAM) and Preamplifier test approach during environmental qualification with analogy to DO-214A.

## 2.2 Original Requirement

### EUROCAE ED-155

#### I-4.1 INTRODUCTION

[...]

Compliance with the applicable performance requirements of this part for the cockpit area microphone and preamplifier shall be demonstrated as shown in Table I-4.2.

**TABLE I-4.2:**

TABLE I-4.2: ENVIRONMENTAL TEST MATRIX FOR COCKPIT AREA MICROPHONE AND PREAMPLIFIER

| ENVIRONMENT            | Test Reference<br>ED-14F/DO-160F   | MOPS PARAGRAPH NUMBER                   |   |                           |  |                              |                                      |                            |
|------------------------|--|---|---|---------------------------|--|------------------------------|--------------------------------------|----------------------------|
|                        |  | I-3.3.1<br>Mic<br>Frequency<br>Response | I-3.3.2<br>Mic<br>Frequency<br>Distortion | I-3.3.4<br>Mic THD +<br>N | I-3.3.5<br>Preamp<br>Frequency<br>Response | I-3.3.6<br>Preamp<br>THD + N | I-3.3.6<br>Preamp Signal<br>to Noise | I-3.3.7<br>Preamp<br>Level |
| Temperature            | 4  | R                                       | R   | R                         | R  | R                            | R                                    | R                          |
| Altitude               | 4  | R                                       | R   | R                         | R  | R                            | R                                    | R                          |
| Temp Variation         | 5  |   |   | R                         |  | R                            | R                                    |                            |
| Humidity               | 6  | R                                       | R   |                           |  | R                            | R                                    | R                          |
| Shock                  | 7  | R                                       | R   |                           |  |                              |                                      |                            |
| Vibration              | 8  |   |   |                           |  | R                            |                                      |                            |
| Power Input            | 16   |   |   |                           |  |                              |                                      |                            |
| Voltage Spike          | 17   |   |   |                           |  |                              |                                      |                            |
| AF Susceptibility      | 18   |   |   |                           |  |                              | R/E                                  |                            |
| Induced Susceptibility | 19   | R/E                                     | R/E                                       |                           |  |                              | R/E                                  |                            |
| RF Susceptibility      | 20   | R/E                                     | R/E                                       |                           |  |                              | R/E                                  |                            |
| Lightning              | 22   |   |   |                           |  |                              |                                      |                            |
| ESD                    | 25   |   |   |                           |  |                              |                                      |                            |
| Key                    | Blank = Manufacturer's Discretion E = Exceptions apply R = Test Required |   |   |                           |  |                              |                                      |                            |

**TABLE I-3.1: AUDIO QUALITY SPECIFICATION:**

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

**TABLE I-3.1: AUDIO QUALITY SPECIFICATION**

## 2.3 Industry

As a foreword, note that

- The original TABLE I-4.2 has incorrect chapter references . In addition, there is no paragraph “Mic Frequency Distortion” in the MOPS. The distortion is addressed directly by I-3.3.2 Total Harmonic Distortion plus Noise – Area Microphone. Below is the corrected version of the table:

| ENVIRONMENT            | Test Reference<br>ED-14F/ DO-160F  | MOPS PARAGRAPH NUMBER             |                       |                                      |                           |                                   |                         |
|------------------------|--|-----------------------------------|-----------------------|--------------------------------------|---------------------------|-----------------------------------|-------------------------|
|                        |  | I-3.3.1<br>Mic Frequency Response | I-3.3.2<br>Mic THD +N | I-3.3.4<br>Preamp Frequency Response | I-3.3.5<br>Preamp THD + N | I-3.3.6<br>Preamp Signal to Noise | I-3.3.7<br>Preamp Level |
| Temperature            | 4  | R                                 | R                     | R                                    | R                         | R                                 | R                       |
| Altitude               | 4  | R                                 | R                     | R                                    | R                         | R                                 | R                       |
| Temp Variation         | 5  |                                   | R                     |                                      | R                         | R                                 |                         |
| Humidity               | 6  | R                                 |                       |                                      | R                         | R                                 | R                       |
| Shock                  | 7  | R                                 |                       |                                      |                           |                                   |                         |
| Vibration              | 8  |                                   |                       |                                      | R                         |                                   |                         |
| Power Input            | 16   |                                   |                       |                                      |                           |                                   |                         |
| Voltage Spike          | 17   |                                   |                       |                                      |                           |                                   |                         |
| AF Susceptibility      | 18   |                                   |                       |                                      |                           | R/E                               |                         |
| Induced Susceptibility | 19   | R/E                               |                       |                                      |                           | R/E                               |                         |
| RF Susceptibility      | 20   | R/E                               |                       |                                      |                           | R/E                               |                         |
| Lightning              | 22   |                                   |                       |                                      |                           |                                   |                         |
| ESD                    | 25   |                                   |                       |                                      |                           |                                   |                         |
| Key                    | Blank = Manufacturer's Discretion E = Exceptions apply R = Test Required |                                   |                       |                                      |                           |                                   |                         |

- ED-155 permits the Area Microphone and preamplifier to be combined (see ED-155 table I-3.1 – note 1). Therefore, the test could be performed with both components assembled as a complete system, as opposed to testing the microphone and preamplifier separately.

ED-155 table I-4.2 requires testing the acoustic performance of the Cockpit Area Microphone (CAM) during environmental testing such as climatic or vibration testing. However, these tests are conducted using climatic chambers or vibration pots that generate a significant level noise. It is not possible to test the acoustic performance within the climatic, mechanical or EMI chambers because of the generated noise. Furthermore, such test means are not set up to act as an anechoic chamber as required to measure the ED-155 acoustic performance. This subject is currently under discussion by WG-118 working group that is creating the next release of ED-112 (minimum operational performance specification for crash protected airborne recorder systems) which has similar requirements.

There is no clear instruction in ED-155 how simultaneous environmental and acoustic tests should be performed and therefore it is suggested that alternative methods are used.

It is rather proposed to adopt the same approach as the one adopted by RTCA DO-214A which defines “Audio Systems Characteristics and Minimum Operational Performance Standards for Aircraft Audio Systems and Equipment” in order to demonstrate that ED-155 requirements can be met.

DO-214A defines separate tests for environmental and acoustic performance. For example, the operating low temperature test (DO-214A §2.5.1.1) is initially performed in a climatic chamber with equipment

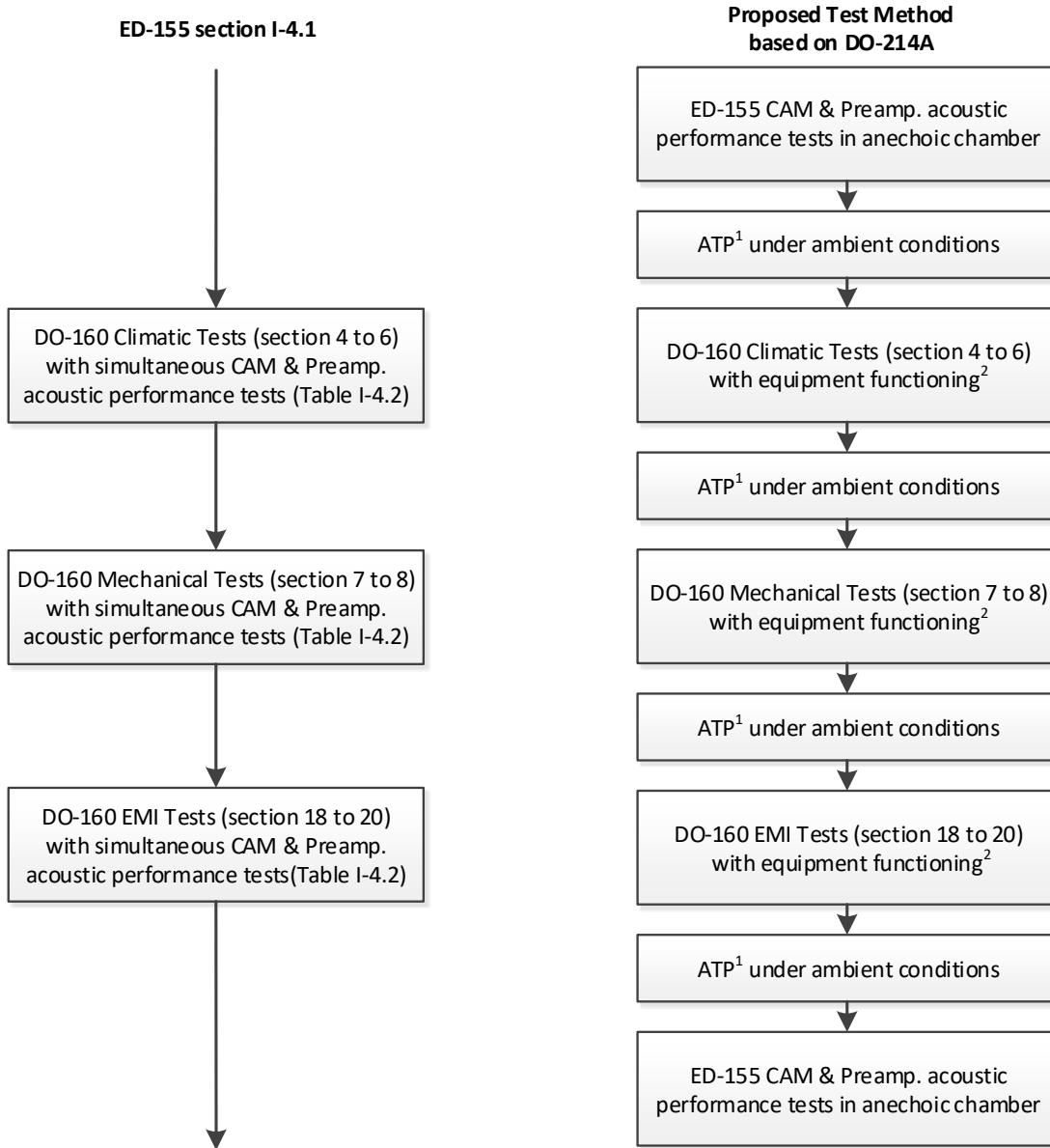
functioning (e.g. microphone functional test as per DO-214A §2.6.2.11) followed by an acoustic measurement under ambient conditions (e.g. Microphone – Frequency response as per DO-214A §2.2.1.1). This is the rationale for applying the same DO-214A test method as an equivalent means of compliance for the environmental and acoustic tests in ED-155.

ED-155 as well as DO-214A require multiple environmental tests, which may be run as a sequence. As it implicitly permits the use of different test articles, DO-214A foresees that the acoustic performance is verified after each environmental test. However, DO-214A does not require that this acoustic test is performed immediately after the environmental test, and on the opposite, it requires that the equipment is returned to ambient temperature before proceeding to the acoustic test. As a result, if the applicant is using a single article to perform a sequence of tests, it is acceptable to perform the acoustic tests at the end of each sequence, as a degradation of the acoustic performance will persist over the additional tests performed in the sequence.

As a conclusion, all the required audio quality tests according ED-155 table I-4.2 are performed under ambient conditions as per DO-214A both before and after the environmental test sequence.

In addition, during the environmental test, the Cockpit Area Microphone & preamplifier are operational, and the recordings are verified after each test.

The following figure illustrates the proposed test sequence based on DO-214A:



**Note 1:** The Acceptance Test Procedure (ATP) is a full functional test of the complete unit. After each DO-160 test with equipment functioning, an ATP will be performed.

**Note 2:** Cockpit Area Microphone and preamplifier are operational and recording during DO-160 tests. Recordings are then verified for the absence of intermittent or permanent loss of communication transmission (as per DO-214A §2.6.2.11 c)

## 2.4 Equivalent Level of Safety

An equivalent level of safety is provided by using an alternative test method, derived from DO-214A methodology for aircraft audio systems, which verifies environmental and acoustic performance without the practical limitations of anechoic test facility.

## 2.5 EASA position

We accept the deviation.

