Deviation Request ETSO-C116a#1 for an ETSO approval for CS-ETSO applicable to Crewmember Portable Protective Breathing Equipment (ETSO-C116a)
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-C116a#1 Crewmember Portable Protective Breathing Equipment

2.1 Summary of Deviation

Deviates from ETSO-C116a Appendix 1 paragraph 3.1.1.3. by permitting a moisture content of 10 µg/L of gas.

2.2 Original Requirement

ETSO-C116a paragraph *3.1.1.3 Breathable gas must meet the gas standard for purity, SAE AS8010 Rev C, Aviator's Breathing Oxygen Purity Standard. For air, compliance with the purity standards in AS8010C, Table 2, Constituent Maximum Concentrations for Chemical Oxygen, has to be shown.*
Type IV chemically-generated oxygen for emergency-use shall be used.

2.3 Industry

The PBE manufactured by Industry uses as breathable gas the aviation grade gaseous oxygen, which corresponds to Type I of oxygen supply as per SAE AS 8010 Rev C.

a. Oxygen concentration and minor constituents levels - **Compliance**

Regarding gaseous oxygen, AS8010C §3.1.1 requires:
"Gaseous type Aviator's Breathing Oxygen (Type I) must contain not less than 99.5% oxygen by volume. The oxygen must contain no objectionable odor. The remainder, except for moisture and minor constituents specified in table 1, may be argon, nitrogen or similar non-toxic inert gas.

TABLE 1 - Constituent Maximum Concentrations for Gaseous and Liquid Oxygen

	Type I - Gaseous	Type II - Liquid
Carbon Dioxide (CO_2)	10 ppm	5 ppm
Methane (CH_4)	50 ppm	25 ppm
Acetylene (C_2H_2)	0.1 ppm	0.05 ppm
Ethylene (C_2H_4)	0.4 ppm	0.2 ppm
Ethane (C_2H_6) and heavier hydrocarbons	6 ppm (C_2H_6 equivalent)	3 ppm (C_2H_6 equivalent)
Nitrous Oxide (N_2O)	4 ppm	2 ppm
Halogenated Compounds (Refrigerants, CFC's, HCFC's, etc.)	2 ppm	1 ppm
Solvents (Trichloroethylene, carbon tetrachloride, etc.)	0.2 ppm	0.1 ppm
Other (Each compound discernible from background noise)	0.2 ppm	0.1 ppm

Table 1 – Constituent Maximum Concentrations for Gaseous and Liquid Oxygen"

The aviation grade gaseous oxygen supplied to the Industry is compliant with this requirement and with the maximum concentrations of all constituents listed above.

b. Moisture level - **Deviation**

Regarding gaseous oxygen (Type I), AS8010C §3.2.1 requires:
" Moisture in gaseous (Type I) or liquid (Type II) oxygen must not exceed 5 µg/L of gas at a temperature of 21.1°C (70°F) and a pressure of 101.3 kPa (760 mm of Hg). This corresponds to a dew point of -63.3°C (-82°F).

The SAE AS8010C limits the moisture to a maximum of 5µg/L of gas, whereas Industry supply specification for aviation grade gaseous oxygen guarantees a moisture concentration below 10µg/L, in the same temperature and pressure conditions.

2.4 Equivalent Level of Safety

a. The PBE being a single-use equipment, it presents no risk of water accumulation in its system and piping over time. Therefore it presents no risk of ice-clogging in the system and piping. The cylinder will be tested at low ambient subfreezing temperature, as per RTCA DO-160, to demonstrate that the system is not susceptible to freezing at such proposed increased moisture level (10µg/L).

b. The PBE being a closed-circuit equipment, the wearer will be in a moisture-saturated environment from the first minutes of equipment's operation as he will naturally exhale water vapour (6.2% of water vapour in exhaled gas). With 6.2% of water vapour exhaled at an average breathing rate of 20L/min and a density of moisture at 1 bar of 0.590g/L, this corresponds to 0.73 g/min of water vapour released through breathing. Over the 15 minute period of PBE operation, this represents 10.94 g of water vapour released by the user breathing.

   This can be compared to the quantity of moisture released by the PBE oxygen cylinder during its operation. As per CS25.1439 (b) (5) applicable to breathing equipment: *"If a continuous flow open circuit protective breathing system is used a flow rate of 60 litres per minute at 2438 m (8 000 ft) (45 litres per minute at sea level) and a supply of 600 litres of free oxygen at 21°C (70°F) and 204 kPa (760 mm Hg) pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume."* With a moisture level of 10µg/L of oxygen released, with a considered oxygen supply of 600L, this represents 6mg of moisture released during the 15 min of PBE operation. With a moisture level of 5µg/L of oxygen released, with a considered oxygen supply of 600L, this represents 3mg of moisture released during the 15 min of PBE operation.

   The difference in moisture level induces 3mg of additional moisture in the PBE, to be compared with 10.94 g of water vapour released by the user, which represents a difference of 273 ppm during the 15 minutes of PBE operation. This is a conservative approach as the calculation is based on the oxygen supply of a continuous flow open circuit whereas the Industry PBE is of continuous flow closed circuit type, which induces an oxygen supply significantly lower, thus a moisture level lower than the calculation presented above. Therefore a maximum difference of 5µg/L on the moisture level of the breathable oxygen will not create a significant difference of moisture level inside the equipment and as experienced by the user.

c. Such aviation grade gaseous oxygen bottles are typically commercially available from gas suppliers and are used as breathable gas in aviation PBEs.

In conclusion, for the Industry, a maximum difference of 5µg/L on the moisture level of the breathable oxygen will not affect the performances of the equipment and will ensure an equivalent level of safety for the user.

2.5 EASA position

We accept the deviation.