Proposed Equivalent Safety findings to CS 25-1443(c)
(Minimum Mass Flow Supplemental Oxygen)

Applicable to B787

Introductory note:

The following Special Condition has been classified as an important Special Condition and as such shall be subject to public consultation, in accordance with EASA Management Board decision 02/04 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."

Statement of Issue

Historically, Boeing has substantiated compliance with FAR/JAR 25.1443(c) by showing that the mass flow of oxygen at any given altitude corresponds with that determined through performance testing per AS 8025 as specified in TSO-C64a.

CS 25.1443(c) specifies minimum mass flow requirements for passenger supplemental oxygen systems in terms of mean tracheal partial pressure, breathing rate, and tidal volume per breath, BTPS, as follows:

Cabin Altitude	Mean Tracheal Oxygen Partial Pressure	Breathing Rate (constant time interval between respirations)	Tidal Volume
Above 3048m (10k feet) up to and including 5639m (18.5k feet)	100mm Hg	15 liters/minute	700cc
Above 5639m (18.5k feet) up to and including 12192m (40k feet)	83.8mm Hg	30 liters/minute	1100cc

The CS 25.1443(c) requirements correspond to constant flow oxygen technology and test methodologies available at the time of inception of the rule, and do not specifically correspond to how human subjects would respond if actually subjected to decompression conditions.

Boeing has developed parameters in conjunction with experts from the medical community and AS 8025 in lieu of direct compliance with the parameters specified in CS 25.1443(c).

B787 – Equivalent Safety Finding to CS 25-1443 (c)

- Minimum Mass Flow Supplemental Oxygen -

Design Proposal:

The B787 will utilise a pulse oxygen system to protect the passengers from harmful effects of hypoxia. The system will deliver a high concentration of oxygen to each passenger at the start of his/her inhalation cycle such that it will travel deep into the passenger's lungs where physiologically it is most efficiently absorbed by the alveoli. After the initial pulse of high oxygen concentration provided at the start of inhalation, the remainder of the breathing cycle will consist of ambient air.

Justification:

Providing the described high concentration of oxygen at the start of inhalation compensates for the previously certified design of constant flow oxygen by providing the oxygen during the phase in the respiratory cycle when it is most effectively used by the body.

The major advantage of the pulse oxygen system is that less oxygen needs to be installed on the airplane to protect passengers from the effects of hypoxia than would be needed to support current supplemental oxygen systems. This is because current systems deliver a significant amount of oxygen during points in the passenger's inhalation process when it cannot actually be used physiologically by the user.

Safety Equivalency Demonstration:

The intent of the requirements of § 25.1443(c) is to provide protection to cabin occupants from the effects of hypoxia by requiring safe physiological breathing environment. The requirement of § 25.1443(c) refers to the mean tracheal oxygen partial pressures as relevant measurement to set safe limit criteria. Historically, manufacturers have substantiated compliance with § 25.1443(c) by installing passenger oxygen masks that meet ETSO and or TSO C64a. Per the ETSO/TSO, individual masks must meet the standards set forth AS8025, "Passenger Oxygen Mask," dated February 24, 1988. The AS8025 provides method of interfacing the mask with test equipment that measures the partial pressure of oxygen being delivered through the mask while mechanically testing the mask's ability to deliver oxygen per the breathing rates and tidal volumes specified in § 25.1443(c). However, the latest Revision A of AS8025 introduces the evaluation of the effectiveness of the mask using human subjects and measuring minimum allowable blood saturation of oxygen (SaO2) levels for each subject.

An equivalent level of protection from hypoxia to be provided to cabin occupants while utilizing the pulse oxygen system is proposed to be demonstrated by performing human subject testing in an altitude chamber. While using the pulse oxygen system, each test subject shall be exposed to the range of altitudes for which the system is certificated for use. For altitudes equal to or less than 18.5k feet, the SaO2 levels must be equal to or greater than the SaO2 baseline level set at 10k feet. For altitudes greater than 18.5k feet, the SaO2 levels must be equal to or greater than the SaO2 baseline level set at 14k feet.