

Proposed Special Condition on Airbag installation – Neck injury criteria

Applicable to Large Aeroplane category **(Issue 1)**

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 12/2007 dated 11 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."

Statement of Issue

In order to show compliance with CS 25.562(c)(5) & CS 25.785(b), applicants are proposing the installation of airbags as a means to reduce the potential for injury in the event of an accident. These airbags are designed either in the seat restraint systems or mounted in seat surrounding structure.

Airbag is a design feature that is not specifically addressed in CS-25. Therefore, Special Conditions are needed to address the installation of such systems on large aeroplanes.

However, recent design of seat angled at more than an 18-degree angle, as well as structure mounted airbag design have raised the Authority awareness with respect to neck injury. EASA has found reasonable to adopt in several programs the neck injury criteria recently proposed by the FAA listed in the FMVSS 571.208 using the FAA Hybrid III ATD. EASA considers now that these neck injury criteria are mature enough to be systematically added to the Special Conditions raised on any airbag design (either an inflatable restraint system or a structure-mounted airbag).

- Special Condition D-xx – Airbag installation – Neck injury criteria

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The installation of the airbag must protect the occupant from experiencing serious neck injury. The assessment of neck injury must be conducted with the airbag activated unless there is reason to also consider that the neck injury potential would be higher below the airbag activation threshold. If so, additional tests may be required.

The neck loads and moments during the entire impact event are limited to:

a) The N_{ij} must be below 1.0, where $N_{ij} = F_z/F_{zc} + M_y/M_{yc}$, and N_{ij} intercepts limited to:

$F_{zc} = 1530$ lb for tension

$F_{zc} = 1385$ lb for compression

$M_{yc} = 229$ lb·ft in flexion

$M_{yc} = 100$ lb·ft in extension

- b) In addition, peak F_z must be below 937 lb in tension and 899 lb in compression.
- c) Available biomechanics texts, citing relevant research literature¹, indicate that there is a high risk of injury for head rotation over 114 degrees. To account for the degree of uncertainty in determining the rotation angle from observation of test video, rotation of the head about its vertical axis relative to the torso is limited to 105 degrees in either direction from forward-facing.
- d) Impact of the neck with any surface could cause serious neck injury from concentrated loading and is not allowed.

¹ *“Accidental Injury, Biomechanics and Prevention”, Third Edition 2015, N. Yoganandan, A. Nahum, J. Melvin editors, Chapter 11 “Neck Injury Biomechanics”, R Nightingale, B. Myers, N. Yoganandan, Section 11.4.3 “Torsion”.*

In that section, 114 degrees is cited from a study by Myers as the “rotation required to produce injury in the cadaver”. The injury cited is “atlantoaxial dislocation” which is an AIS-3 (Serious) injury.

Appendix 1
Interpretative Material

For convenience, the Interpretative Material is provided for the information only, and is not supposed to be commented.

EASA considers that the neck injury criteria (N_{ij} , neck rotation) specified in the special conditions are appropriate to address serious injuries that could result from the interaction between the occupant and an airbag, regardless of the angle of installation of the seat. However, for forward-facing seats, EASA finds acceptable that the assessment of neck injury be based on evidence coming from HIC tests conducted using the Hybrid II ATD, in which the ATD head is shown to adequately interact with the airbag, i.e. it is demonstrated that the ATD head would never hit the side edges of the airbag in testing conducted considering the entire range of yaw angles prescribed by CS 25.562.