Proposed Deviation on Installations of side facing seats
Applicable to Large Aeroplanes fitted with a VIP or Executive interior

Introductory note:

The hereby presented Deviation to the EASA Certification Basis 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

Nearly all VIP interior cabin completions feature side facing seat or divan installations. In the past such installations were approved with a deviation to CS 25.562. During the last years the FAA conducted several research programmes to develop an acceptable method of compliance with CS 25.562 and CS 25.785(b) for side-facing-seat installations. That research has identified injury considerations and evaluation criteria in addition to those previously used to approve side-facing seats. See published report DOT/FAA/AR-09/41, July 2011.

In June 2012 the FAA issued a policy paper “FAA Policy No: PS-ANM-25-03” that is introducing additional injury criteria and by this introducing an equivalent level of safety for occupants that are placed on side facing seats during taxi take-off and landing.

Large Aeroplanes fitted with a VIP or Executive interior –Deviation D-XX
Installations of side facing seats

Based on the above mentioned background, EASA considers that compliance with the proposed criteria for side facing seats as detailed here below will demonstrate an equivalent level of safety for such side facing single seats and divan seats. Side facing seats covered by this Deviation are seats that are installed in the aircraft under an angle of 90° (+/- 18°) to the direction of flight.

Proposed Deviation

In addition to the requirements of CS 25.562, and CS 25.785, the following special condition numbers 1 and 2 are proposed as part of the type-certification basis of the aeroplane(s) with side-facing- seat installations. For seat place(s) equipped with an airbag system in the shoulder belt, additional special condition numbers 3 through 16 are proposed as part of the type-certification basis.

1. Additional requirements applicable to tests or rational analysis conducted to show compliance with CS 25.562 and CS 25.785 for side-facing seats:

    a) The longitudinal test(s) conducted in accordance with CS 25.562(b)(2) to show compliance with the seat-strength requirements of CS 25.562(c)(7) and

(8), and these special conditions must have an ES-2re anthropomorphic test dummy (ATD) (refer to US regulation, title 49 CFR part 572 subpart U) or equivalent, or a Hybrid-II ATD (refer to US regulation, title 49 CFR part 572, subpart B) or equivalent, occupying each seat position and including all items contactable by the occupant (e.g., armrest, interior wall, or furnishing) if those items are necessary to restrain the occupant. If included, the floor representation and contactable items must be located such that their relative position, with respect to the center of the nearest seat place, is the same at the start of the test as before floor misalignment is applied. For example, if floor misalignment rotates the centerline of the seat place nearest the contactable item 8 degrees clockwise about the aircraft x-axis, then the item and floor representations must be rotated by 8 degrees clockwise also to maintain the same relative position to the seat place, as shown in Figure 1. Each ATD's relative position to the seat after application of floor misalignment must be the same as before misalignment is applied. To ensure proper loading of the seat by the occupants, the ATD pelvis must remain supported by the seat pan, and the restraint system must remain on the pelvis and shoulder of the ATD until rebound begins. No injury-criteria evaluation is necessary for tests conducted only to assess seat-strength requirements.

b) The longitudinal test(s) conducted in accordance with CS 25.562(b)(2), to show compliance with the injury assessments required by CS 25.562(c) and these special conditions, may be conducted separately from the test(s) to show structural integrity. In this case, structural-assessment tests must be conducted as specified in paragraph 1a, above, and the injury-assessment test must be conducted without yaw or floor misalignment. Injury assessments may be accomplished by testing with ES-2re ATD (refer to US regulation, title 49 CFR part 572 subpart U) or equivalent at all places. Alternatively, these assessments may be accomplished by multiple tests that use an ES-2re at the seat place being evaluated, and a Hybrid-II ATD (refer to US regulation, title 49 CFR part 572, subpart B) or equivalent used in all seat places forward of the one being assessed, to evaluate occupant interaction. In this case, seat places aft of the one being assessed may be unoccupied. If a seat installation includes adjacent items that are contactable by the occupant, the injury potential of that contact must be assessed. To make this assessment, tests may be conducted that include the actual item, located and attached in a representative fashion. Alternatively, the injury potential may be assessed by a combination of tests with items having the same geometry as the actual item, but having stiffness characteristics that would create the worst case for injury (injuries due to both contact with the item and lack of support from the item).

c) If a seat is installed aft of structure (e.g., an interior wall or furnishing) that does not have a homogeneous surface contactable by the occupant, additional analysis and/or test(s) may be required to demonstrate that the injury criteria are met for the area which an occupant could contact. For example, different yaw angles could result in different injury considerations and may require additional analysis or separate test(s) to evaluate.

d) To accommodate a range of occupant heights (5th percentile female to 95th percentile male), the surface of items contactable by the occupant must be homogenous 7.3 inches (185 mm) above and 7.9 inches (200 mm) below the point (centre of area) that is contacted by the 50th percentile male size ATD's head during the longitudinal test(s) conducted in accordance with paragraphs a, b, and c, above. Otherwise, additional head injury criteria (HIC) assessment tests may be necessary. Any surface (inflatable or otherwise)

that provides support for the occupant of any seat place must provide that support in a consistent manner regardless of occupant stature. For example, if an inflatable shoulder belt is used to mitigate injury risk, then it must be demonstrated by inspection to bear against the range of occupants in a similar manner before and after inflation. Likewise, the means of limiting lower-leg flail must be demonstrated by inspection to provide protection for the range of occupants in a similar manner.

e) For longitudinal test(s) conducted in accordance with CS 25.562(b)(2) and these special conditions, the ATDs must be positioned, clothed, and have lateral instrumentation configured as follows:

(1) ATD positioning:

Lower the ATD vertically into the seat while simultaneously (see Figure 2 for illustration):

a) Aligning the mid sagittal plane (a vertical plane through the midline of the body; dividing the body into right and left halves) with the middle of the seat place.

b) Applying a horizontal x-axis direction (in the ATD coordinate system) force of 20 lb (4.5N) to the torso at the intersection of the mid sagittal plane and the bottom rib of the ES-2re or lower sternum of the Hybrid-II at the mid sagittal plane, to compress the seat back cushion.

c) Keeping the upper legs horizontal by supporting them just behind the knees.

Once all lifting devices have been removed from the ATD:

a) Rock it slightly to settle it in the seat.

b) Separate the knees by about 4 inches (100 mm)

c) Set the ES-2re's head at the midpoint of the available range of z-axis rotation (to align the head and torso mid sagittal planes).

d) Position the ES-2re's arms at the joint's mechanical detent that puts them at approximately a 40 degree angle with respect to the torso. Position the Hybrid-II ATD hands on top of its upper legs.

e) Position the feet such that the centrelines of the lower legs are approximately parallel to a lateral vertical plane (in the aircraft coordinate system).

(2) ATD clothing:

Clothe each ATD in form-fitting, mid-calf-length (minimum) pants and shoes (size 11E) weighing about 2.5 lb (1.1 Kg) total. The colour of the clothing should be in contrast to the colour of the restraint system. The ES-2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.

(3) ES-2re ATD lateral instrumentation:

The rib-module linear slides are directional, i.e., deflection occurs in either a positive or negative ATD y-axis direction. The modules must be installed such that the moving end of the rib module is toward the front of the aircraft. The three abdominal-force sensors must be installed such that they are on the side of the ATD toward the front of the aircraft.

f) The combined horizontal/vertical test, required by CS 25.562(b)(1) and these special conditions, must be conducted with a Hybrid II ATD (49 CFR part 572 subpart B), or equivalent, occupying each seat position.

g) Restraint systems:

(1) If inflatable restraint systems are used, they must be active during all dynamic tests conducted to show compliance with CS 25.562.

(2) The design and installation of seat-belt buckles must prevent unbuckling due to applied inertial forces or impact of the hands/arms of the occupant during an emergency landing.

2. Additional performance measures applicable to tests and rational analysis conducted to show compliance with CS 25.562 and CS 25.785 for side-facing seats:

a. Body-to-body contact: Contact between the head, pelvis, torso, or shoulder area of one ATD with the adjacent-seated ATD's head, pelvis, torso, or shoulder area is not allowed. Contact during rebound is allowed.

b. Thoracic: The deflection of any of the ES-2re ATD upper, middle, and lower ribs must not exceed 1.73 inches (44 mm). Data must be processed as defined in US Federal Motor Vehicle Safety Standards (FMVSS) 571.214.

c. Abdominal: The sum of the measured ES-2re ATD front, middle, and rear abdominal forces must not exceed 562 lbs (2,500 N). Data must be processed as defined in FMVSS 571.214.

d. Pelvic: The pubic symphysis force measured by the ES-2re ATD must not exceed 1,350 lbs (6,000 N). Data must be processed as defined in FMVSS 571.214.

e. Leg: Axial rotation of the upper-leg (femur) must be limited to 35 degrees in either direction from the nominal seated position.

f. Neck: As measured by the ES-2re ATD and filtered at CFC 600 as defined in SAE J211:

1) The upper-neck tension force at the occipital condyle (O.C.) location must be less than 405 lb (1,800 N).

2) The upper-neck compression force at the O.C. location must be less than 405 lb (1,800 N).

3) The upper-neck bending torque about the ATD x-axis at the O.C. location must be less than 1,018 in-lb (115 Nm).

4) The upper-neck resultant shear force at the O.C. location must be less than 186 lb (825 N).

g. Occupant (ES-2re ATD) retention: The pelvic restraint must remain on the ES-2re ATD's pelvis during the impact and rebound phases of the test. The upper-torso restraint straps (if present) must remain on the ATD's shoulder during the impact.

h. Occupant (ES-2re ATD) support:

1) Pelvis excursion: The load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of its seat's bottom seat-cushion supporting structure.

2) Upper-torso support: The lateral flexion of the ATD torso must not exceed 40 degrees from the normal upright position during the impact.

3. For seats with an airbag system in the shoulder belts, show that the airbag system in the shoulder belt will deploy and provide protection under crash conditions where it is necessary to prevent serious injury. The means of protection must take into consideration a range of stature from a 2-year-old child to a 95th percentile male. The airbag system in the shoulder belt must provide a consistent approach to energy absorption throughout that range of occupants. When the seat system includes an airbag system, that system must be included in each of the certification tests as it would be installed in the aeroplane. In addition, the following situations must be considered:

   a. The seat occupant is holding an infant.

   b. The seat occupant is a pregnant woman.

4. The airbag system in the shoulder belt must provide adequate protection for each occupant regardless of the number of occupants of the seat assembly, considering that unoccupied seats may have an active airbag system in the shoulder belt.

5. The design must prevent the airbag system in the shoulder belt from being either incorrectly buckled or incorrectly installed, such that the airbag system in the shoulder belt would not properly deploy. Alternatively, it must be shown that such deployment is not hazardous to the occupant, and will provide the required injury protection.

6. It must be shown that the airbag system in the shoulder belt is not susceptible to inadvertent deployment as a result of wear and tear, or inertial loads resulting from in-flight or ground manoeuvres (including gusts and hard landings), and other operating and environmental conditions (vibrations, moisture, etc.) likely to occur in service.

7. Deployment of the airbag system in the shoulder belt must not introduce injury mechanisms to the seated occupant, or result in injuries that could impede rapid egress. This assessment should include an occupant whose belt is loosely fastened.

8. It must be shown that inadvertent deployment of the airbag system in the shoulder belt, during the most critical part of the flight, will either meet the requirement of CS 25.1309(b) or not cause a hazard to the aeroplane or its occupants.

9. It must be shown that the airbag system in the shoulder belt will not impede rapid egress of occupants 10 seconds after airbag deployment.

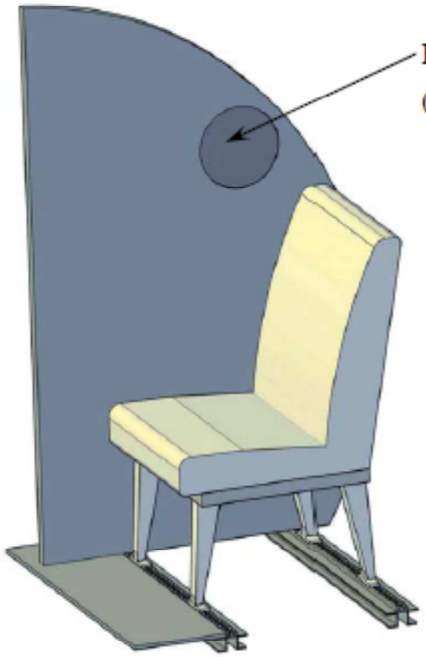
10. The airbag system must be protected from lightning and high-intensity radiated fields (HIRF). The threats to the aeroplane specified in existing regulations regarding lighting, CS 25.1316, and HIRF, CS 25.1317, are incorporated by reference for the purpose of measuring lightning and HIRF protection.

11. The airbag system in the shoulder belt must function properly after loss of normal aircraft electrical power, and after a transverse separation of the fuselage at the most critical location. A separation at the location of the airbag system in the shoulder belt does not have to be considered.

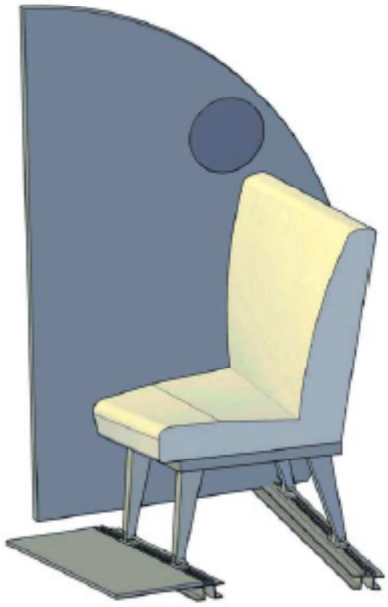
12. It must be shown that the airbag system in the shoulder belt will not release hazardous quantities of gas or particulate matter into the cabin.

13. The airbag system in the shoulder-belt installation must be protected from the effects of fire such that no hazard to occupants will result.

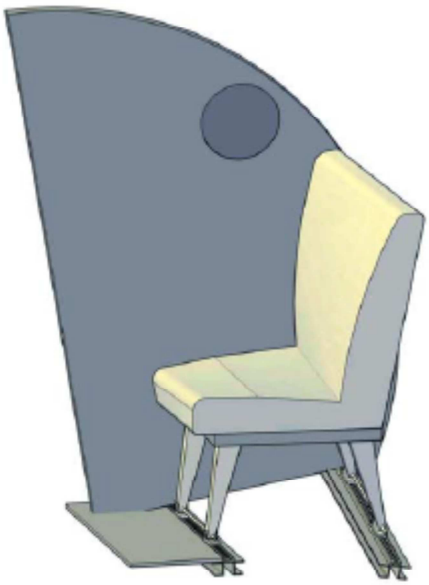
14. A means must be available for a crewmember to verify the integrity of the airbag system in the shoulder-belt activation system prior to each flight, or it must be demonstrated to reliably operate between inspection intervals. The Agency considers that the loss of the airbag-system deployment function alone (i.e., independent of the conditional event that requires the airbag system deployment) is a major-failure condition.
15. The inflatable material may not have an average burn rate of greater than 2.5 inches/minute when tested using the horizontal flammability test defined in CS-25, appendix F, part I, paragraph (b)(5).
16. The airbag system in the shoulder belt, once deployed, must not adversely affect the emergency-lighting system (i.e., block floor proximity lights to the extent that the lights no longer meet their intended function).



A. Prior to Test Setup



B. Inboard Seat Tracks Twisted 10° down and Outboard Seat Tracks Rolled 10° Outboard



C. Partition Rotated to maintain Head Target Area Relationship.

Figure 1

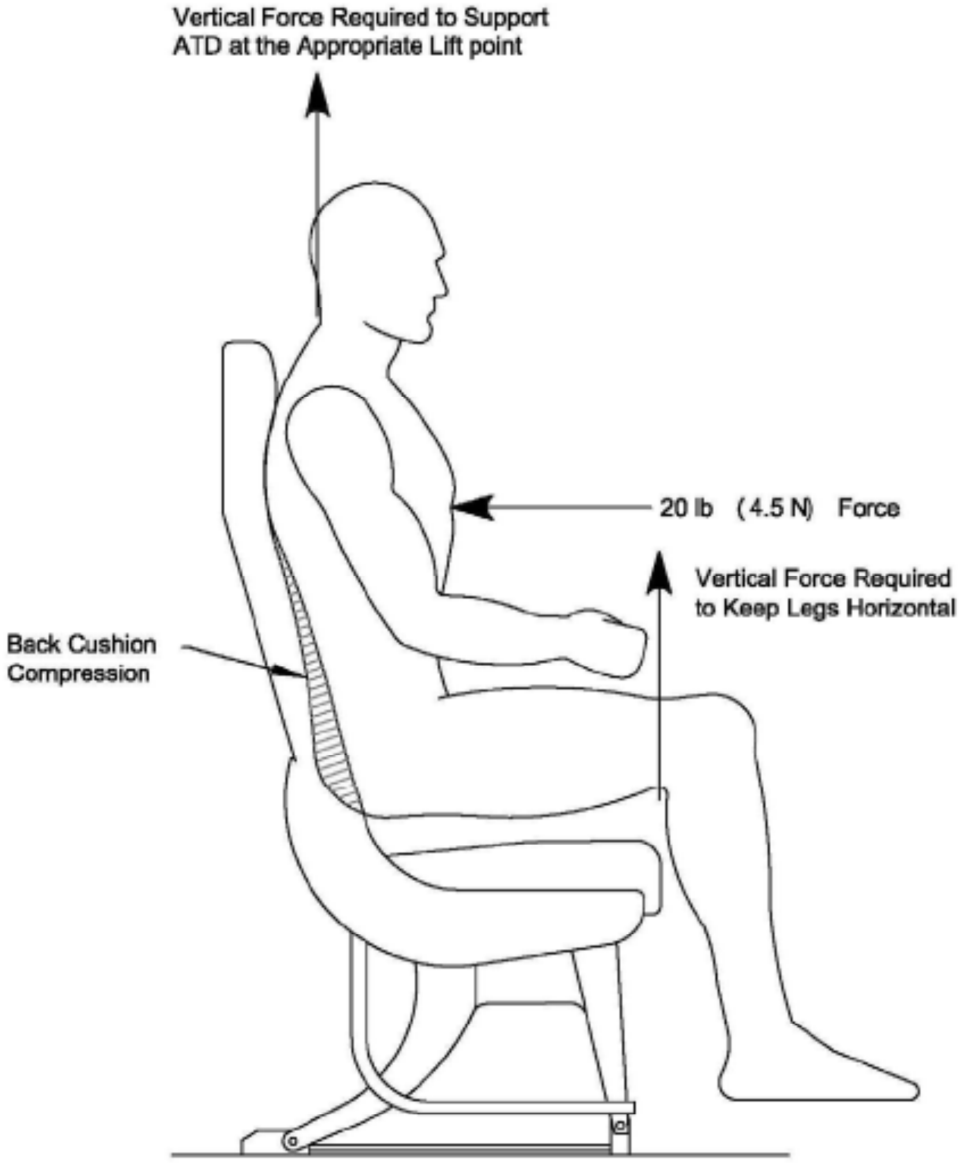

Vertical Force Required to Support
ATD at the Appropriate Lift point
20 lb (4.5 N) Force
Vertical Force Required
to Keep Legs Horizontal
Back Cushion
Compression

Figure 2