Special Condition on installation of oblique seats

Applicable to A330 NEO

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

JAR 25.785(a) at Change 13 requires general occupant protection for occupants of seats that are occupied during take-off and landing and therefore may experience the inertia forces specified in 25.562. The intent of 25.562 was to improve the level of safety provided to occupants of passenger and cabin attendant seats installed on large aeroplanes.
Because most seating on large aeroplanes is forward-facing, the pass/fail criteria developed in 25.562 focused primarily on these seats. With respect to seats other than forward-facing, the performance measures of 25.562(c) have proved to adequately address the injury criteria for occupants of aft-facing seats but not for occupants of side-facing seats, i.e. seats that make more than an 18º angle with the vertical plane containing the aeroplane centreline (ref. JAR 25.785(c) Change 13).

For single occupant side-facing seats equipped with an energy absorbing rest, EASA determined that a level of safety equivalent to that afforded to occupants of forward and aft-facing seating could be achieved by meeting the additional special conditions specified in dedicated CRIs.
It must be mentioned that in 2009, EASA certified for the first time the installation of side-facing seats not compliant with JAR 25.785(c), i.e. seats whose occupants are not protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. The certification approach was based on an Equivalent Safety Finding achieved mainly through the installation of inflatable restraint systems. The details of the ESF approach were documented by EASA in CRIs, which limited the ESF applicability to seats installed at 30 degrees or less with respect to the aircraft longitudinal axis.

More recently EASA has been extensively involved in the development of SAE ARP6316 which sets new occupant injury criteria for the certification of the installation of oblique seats on large aeroplanes. In the context of ARP6316, occupant facing direction is defined as follows:

Forward facing seats - Seats installed into the aircraft where the occupant facing direction is at 0 ± 18° relative to the aircraft longitudinal axis.

Aft facing seats - Seats installed into the aircraft where the occupant facing direction is at 180° ± 18° relative to the aircraft longitudinal axis.

Side facing seats - Seats installed into the aircraft where the occupant facing direction is at 90° relative to the aircraft longitudinal axis.

Oblique facing seats - Seats installed into the aircraft where the occupant angle relative to the aircraft longitudinal axis is other than those described above.

Special Condition D-07 – Installation of oblique seats

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Additional performance standards for oblique facing seats

This Appendix provides standards and information not provided in AS8049B necessary to run and evaluate dynamic tests on oblique facing seats. The test set ups and orientations are exactly as described in AS8049B. Test 1 is commonly referred to as the vertical test and is defined in AS8049B, section 5.3.1.1. Test 2 is commonly referred to as the horizontal test and is defined in AS8049B, section 5.3.1.2 and 5.3.1.3. Information relevant to the conducting of both these tests is contained throughout AS8049B, section 5.3.

Test 1 - Structural and Occupant Injury Evaluation (AS8049B, Section 5.3.1.1)

Occupant Simulation

For Test 1, a Hybrid II ATD, or equivalent, shall be used to simulate each occupant.

Contactable Items

Items contactable by the occupant shall be included in the test, replaced with a part shown to create a conservative test condition, or excluded based upon a rational analysis. Any replaced or excluded part shall be documented together with a rational analysis substantiating the action.

Items that do not influence the test such as trim, placards, wires, finishes, etc. may be omitted from the test article.

Occupant Injury Criteria

The injury criteria listed in AS8049B are applicable to this test.

Test 2 - Structural Evaluation (AS8049B, Section 5.3.1.2 and 5.3.1.3)

Occupant Simulation

For Test 2 (structural evaluation), a Hybrid II ATD, or equivalent, shall be used to simulate each occupant.

Contactable Items

Items contactable by the occupant shall be included in the test, replaced with a part shown to create a conservative test condition, or excluded based upon a rational analysis. Any replaced or excluded part shall be documented together with a rational analysis substantiating the action.

Items that do not influence the test such as trim, placards, wires, finishes, etc. may be omitted from the test article.

Selection of Test Conditions

Section 5.3.6, provides requirements applicable to all structural evaluation tests. In addition, due to the lack of seat symmetry about the load direction, both yaw directions (± 10 degrees), relative to the aircraft longitudinal axis, shall be tested to show structural integrity of the seat system, unless previous testing and/or rational analysis can demonstrate that a single yaw direction encompasses all critical structural aspects of the seat and its attachments.

Combining Structural and Occupant Injury Tests

Combining the structural evaluation test(s) with the occupant injury test(s) is not recommended. If the applicant decides to combine the tests, the additional set up to ensure the ATD contacts the supporting structure at the correct contact point to collect the necessary occupant injury criteria shall be documented. This document provides no guidance or recommendations on this topic.

Test 3 - Occupant Injury Evaluation (AS8049B, Section 5.3.1.2)

Occupant Simulation

For Test 2 (occupant injury evaluation), an FAA Hybrid III ATD shall be used. A floor under the ATD's feet shall be used.

Contactable Items and Occupant Injury Assessments

Items contactable by the occupant shall be included in the test, replaced with a part shown to create a conservative test condition, or excluded based upon a rational analysis. Any replaced or excluded part shall be documented together with a rational analysis substantiating the action.

The aircraft fittings, or track, need not be representative. Any bracing or reinforcement of items included in the test shall be documented and shown to create a conservative test condition.

Damage or failure of these items shall be assessed to ensure that valid results have been obtained and that no sharp edges, injurious protrusions or egress impediments have been produced.

Items that do not influence the test such as trim, placards, wires, finishes, etc. may be omitted from the test article.

Selection of Test Conditions

AS8049B, Section 5.3.6, and Section 10.3.4 in this document provide the requirements for all occupant injury evaluation tests. Data from previous tests, simulation, or rational analysis shall be used to determine the critical case(s). When determining the critical case(s) all yaw angles within the ± 10 degree range must be considered. Multiple tests may be necessary to examine all injury criteria. Tests that only evaluate injury criteria do not require floor deformation.

Occupant Injury Criteria

Body Part	Injury Criterion
Head	(1) HIC ≤ 1000 (AS8049B Section 5.3.9.4) in the event of head contact with seats, or other structure (including airbags),① *or* (2) HIC 15 ≤ 700 (49 CFR 571.208) in the event of head contact with an airbag *only* ② ① Following a test, calculate HIC. If this value is ≤1000, the test is successful. If HIC is > 1000, and contact is made with the seat or other structure, regardless of airbag usage, the test has failed. ② Use of HIC 15 is permitted as an alternate to HIC if the ATD head only contacts an airbag and makes no head contact with the seat or other structure. ATD head contact with the seat or other structure, through the airbag, or contact subsequent to contact with the airbag requires the use of HIC. HIC 15 is not applicable if head contact has occurred. The following evaluations of the test data should be used to determine if head contact has occurred: a. A review of the dynamic test videos and evaluation of the ATD head path movement, head contact, and head reaction at contact should be made. There should be a noticeable change in the head movement at the time of contact. A review and evaluation of the ATD head acceleration plots (x, y, z and resultant) should be made. The resultant ATD head acceleration plot during the time period in which the critical HIC calculation was made should show an abrupt change in the head acceleration.
Neck	Nij (49 CFR 571.208) (1) Nij shall be below 1.0, where Nij =Fz/Fzc + My/Myc, and Nij critical values: (a) Fzc = 1530 pounds (6805 N) tension (b) Fzc = 1385 pounds (6160 N) compression (c) Myc = 229 foot-pounds (310 Nm) in flexion (d) Myc = 100 foot-pounds (136 Nm) in extension (2) In addition, peak Fz shall be below 937 pounds (4168 N) in tension and 899 pounds (3999 N) in compression. (3) Rotation of the head about its vertical axis relative to the torso is limited to 105 degrees in either direction from forward-facing. (4) Concentrated loading on the neck is unacceptable during any phase of the test. The intent is that the neck should not be a load path in any ATD contact with the seat system, never the initial point of contact and for neck movement to be in unison with the head and shoulders. In particular, the front of the neck should

Body Part	Injury Criterion
	never be contacted, however incidental contact, such as a sliding motion against a flat surface, or a headrest, during rebound may be acceptable. [Visual evidence and loading data shall be collected during the test to show that neck contact is non-injurious.]
Shoulder	(1) Where upper torso straps are used, tension loads in individual straps shall not exceed 1750 pounds (7784 N). If dual straps are used for restraining the upper torso, the total strap tension loads shall not exceed 2000 pounds (8896 N). (2) The upper torso restraint straps (where installed) shall remain on the ATD's shoulder during the impact.
Thorax	Significant contact between the thorax and seat system structure is not permitted during initial impact, except for intentional contact with an airbag or shoulder restraint. For example, contact with a corner or protrusion would be significant contact and be unacceptable. Sliding along a smooth wall is not significant contact and could be acceptable, provided all other injury criteria is met. Rebound contact that produces an x direction acceleration exceeding 20g for more than 3ms is not permitted.
Abdomen	Significant contact between the abdomen and seat structure is not permitted except for intentional contact with an airbag or seat cushion.
Spine	(1) The lumbar spine force (Fz) cannot exceed 1200 pounds (5338 N) tension and 1500 pounds (6673 N) compression. (2) Spine forces and moments shall be recorded using a six axis load cell and shall be reported. This data is collected for knowledge gathering. There are no pass/fail criteria associated with this data except as noted above for Fz.
Pelvis	(1) The pelvic restraint shall remain on the ATD's pelvis during the impact and rebound phases of the test. Provided that the pelvic restraint remains on the ATD's pelvis, trapping of the belt between the ATD leg and the pelvis is acceptable. (2) Any part of the load-bearing portion of the bottom of the ATD pelvis shall not translate beyond the edges of its seat's bottom seat-cushion supporting structure.
Femur	(1) Where leg contact with seats or other structure occurs, the axial compressive load in each femur does not exceed 2250 pounds (10008 N). (2) Axial rotation of the upper leg shall be limited to 35 degrees in the strike direction from the nominal seated position. Evaluation during rebound is not biofidelic and need not be considered.
All	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.

Restraint Systems

General Design

The design and installation of restraint systems shall prevent unbuckling or detachment due to applied inertial forces or impact of the hands/arms of the occupant during Test 1 and Test 2.

Airbags

Airbag systems include inflatable restraints and structure mounted airbags.

For seats with airbag systems, it shall be shown that the system will deploy and provide protection under crash conditions where it is necessary to prevent serious injury. The system shall provide a consistent approach to energy absorption throughout the range of occupants two year old child to 95th percentile male, whether it is designed to manage injury parameters (HIC, Nij, Neck Rotation, etc) or occupant motion. The system shall be included in each of the certification tests as it would be installed in the airplane. If airbag systems influence the test results, they shall be active during the test.

Airbag systems may also be used to control occupant motion. The intended function of the airbag system shall be demonstrated during each applicable test.

Airbag systems, depending on their design and performance, may provide to the occupant of an oblique seat a level of safety equal or higher than that provided by an energy absorbing rest directly meeting the requirements of 14 CFR 25.785(d).

Oblique seating systems including airbags shall be shown to meet the occupant injury criteria of section 10.3.4 throughout the entire range of yaw that encompasses the installation angle ± 10 degrees relative to the aircraft longitudinal axis.
Other considerations for airbag systems are outside the scope of this document.

Other Considerations

Recording of Shoulder Harness Loads

If a shoulder belt incorporating an airbag is used, care shall be taken when placing the webbing load cell to ensure that an accurate measurement is made and that the load cell does not affect the performance of the airbag.

ATD Placement

As an alternative to AS8049B section 5.3.8.3(b) through (e), the following procedure has been found to be adequate from previous experience for placing the ATD in a consistent manner for Test 2 and to determine the nominal (1g) seated position for Test 1:

1) Lower the ATD vertically into the seat while simultaneously (see Figure 10.5.2 for illustration):
    a) Aligning the midsagittal 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 about 89N (20 pounds) to the torso at the intersection of the midsagittal plane and lower sternum of the HII or FAA HIII at the midsagittal plane, to compress the seat back cushion.

c) Keeping the upper legs as horizontal as possible by supporting them just behind the knees, or using an equivalent procedure.

2) Once all lifting devices have been removed from the ATD:
   a) Rock the ATD slightly to settle it in the seat.
   b) Separate the knees by about 100 mm (4 inches).
   c) Position the HII or FAA HIII hands on top of its upper legs.
   d) Position the feet such that the centerlines of the lower legs are approximately parallel to a lateral vertical plane (in the aircraft coordinate system).

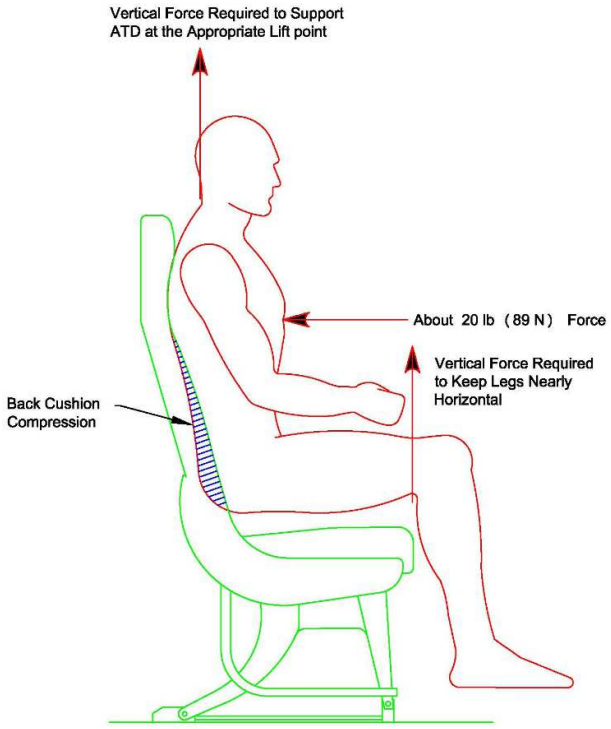

FIGURE 10.5.2 - ATD Placement