SAE INTERNATIONAL

AEROSPACE STANDARD

AS8049™/1 REV. B

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Superseding AS8049/1A

(R) Performance Standards for Side-Facing Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft

RATIONALE

The original release of the document is directly linked to AS8049B. This revision updates the document to align with AS8049C.

AS8049/1B has been reaffirmed to comply with the SAE Five-Year Review policy.

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1. SCOPE

1.1 Purpose

This SAE Aerospace Standard (AS) defines Minimum Performance Standards (MPS), qualification requirements, and minimum documentation requirements for side-facing seats in civil rotorcraft, transport aircraft, and general aviation aircraft. The goal is to achieve comfort, durability, and occupant protection under normal operational loads and to define test and evaluation criteria to demonstrate occupant protection when a side-facing seat/occupant/restraint system is subjected to statically applied ultimate loads and to dynamic test conditions set forth in Title 14, Code of Federal Regulations (CFR) Part 23, 25, 27, or 29.

While this document addresses system performance, responsibility for the seating system is divided between the seat supplier and the installation applicant. The seat supplier's responsibility consists of meeting all the seat system performance requirements and obtaining and supplying to the installation applicant all the data prescribed by this document. The installation applicant has the final responsibility in assuring that all requirements for safe seat installation have been met.

1.2 Applicability

This document addresses the performance criteria for side-facing seat systems requiring dynamic testing to be used in civil rotorcraft, transport aircraft, and general aviation aircraft. This document applies to seats installed at 90 degrees ± 10 degrees from the longitudinal axis of the aircraft (installation angles between 80 to 100 degrees).

1.3 Seat Types

This document covers all passenger and crew seats except pilot and copilot seats for use in aircraft type-certified in the following categories shown in Table 1:

Table 1 - Seat type categories

Seat Type	Aircraft Category	Applicable Federal Regulations
A-T	Transport Airplane	14 CFR 25
B-N	Normal Rotorcraft	14 CFR 27
B-T	Transport Rotorcraft	14 CFR 29
C-N	General Aviation Aircraft - Normal	14 CFR 23
C-U	General Aviation Aircraft - Utility	14 CFR 23
C-A	General Aviation Aircraft - Acrobatic	14 CFR 23
C-C	General Aviation Aircraft - Commuter	14 CFR 23

1.4 Units

In this document, both U.S. customary units (in-pound) and International System of Units (SI) are provided. In all cases, the in-pound units take precedence and the SI (Metric) units provided are approximate and conservative conversions. Those who routinely use SI units in practice may make the conversions more precise.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply, except for AS8049C. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

This document is explicitly linked with and cannot be used without AS8049C. Requirements of each section of AS8049C apply to this document unless specifically modified by this document. This document utilizes the performance standards for aircraft seats defined in AS8049C, and the section numbers 1 through 7 directly correspond to those of AS8049C. Sections 3 through 7 of this document note only differences between the standards of this document and the standards of AS8049C. Sections 8 and 9 are reserved for future use and material specific to side facing seats begins with Section 10. Test pulse evaluation shall use the method defined in AS8049C Appendix A.

Future revisions to AS8049 shall not apply to this document unless this document is also revised to match that future revision of AS8049. In cases where AS8049C states requirements for pilot/copilot seating, such references shall be ignored as this document does not address side facing pilot/copilot seating.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J211/1 Instrumentation for Impact Test - Part 1 - Electronic Instrumentation

SAE J211/2 Instrumentation for Impact Test - Part 2: Photographic Instrumentation

SAE J826 Devices for Use in Defining and Measuring Vehicle Seating Accommodation

SAE J1733 Sign Convention for Vehicle Crash Testing

ARP5482 Photometric Data Acquisition Procedures for Impact Test

ARP5526 Aircraft Seat Design Guidance and Clarifications

AS8043 Restraint Systems for Civil Aircraft

AS8049C Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft

Gowdy, V., DeWeese, R., Beebe, M., Wade, B. et al., "A Lumbar Spine Modification to the Hybrid III ATD For Aircraft Seat Tests," SAE Technical Paper 1999-01-1609, 1999, doi:10.4271/1999-01-1609.

2.1.2 Code of Federal Regulations (CFR)

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

Code of Federal Regulations, Title 14 Part 21 (14 CFR 21) Certification Procedures for Products and Parts

Code of Federal Regulations, Title 14 Part 23 (14 CFR 23) Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes

Code of Federal Regulations, Title 14 Part 25 (14 CFR 25) Airworthiness Standards: Transport Category Airplanes

Code of Federal Regulations, Title 14 Part 27 (14 CFR 27) Airworthiness Standards: Normal Category Rotorcraft

Code of Federal Regulations, Title 14 Part 29 (14 CFR 29) Airworthiness Standards: Transport Category Rotorcraft

Code of Federal Regulations, Title 14 Part 121 (14 CFR 121) Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft

Code of Federal Regulations, Title 49 Part 572 (49 CFR 572) Anthropomorphic Test Dummies

Code of Federal Regulations, Title 49 Part 571.214, (14 CFR Part 571) National Highway Traffic Safety Administration (NHTSA) Federal Motor Vehicle Standard (FMVSS) No. 214; “Side Impact Protection”

ATD Drawing 3703: Available using instructions contained in 49 CFR 572

2.1.3 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

FAA Policy Memorandum PS-ANM-25-03-R1, "Technical Criteria for Approving Side-Facing Seats," November 20, 2012

2.1.4 Other Publications

Economic Commission for Europe (ECE) Regulation No. 95, Annex 6, "Technical Description of the Side Impact Dummy (EuroSID)"

Robert D. Huculak & Hamid M. Lankarani (2015), “Methods of evaluating ES-2 leg flail in dynamic evaluation and certification tests of side-facing aircraft seats,” International Journal of Crashworthiness, DOI: 10.1080/13588265.2015.1076586

2.2 Definitions

2.2.1 Occupant/ATD Characteristics

SAE J211/1 defines ATD coordinate system and provides descriptions of occupant movement. These definitions are reproduced here for convenience together with additional definitions.

ABDOMINAL: Of or pertaining to the region of the body that contains the internal organs (excluding the respiratory and cardiac organs). It is bounded by the diaphragm and the pelvis.

CERVICAL: Of or pertaining to the vertebrae in the neck that support the head and link the head to the spine.

NECK EXTENSION: The act of bending the neck backwards.

NECK FLEXION: The act of bending the neck forward such that the chin approaches the sternum.

NIJ: A measure of neck injury calculated in accordance with 49 CFR 571.208 S6.6 (a).

NECK LATERAL BENDING: Neck Lateral Bending is the act of bending the neck such that the ear approaches the shoulder.

NECK ROTATION: Neck Rotation is the act of moving the chin towards the shoulder.

OCCIPITAL CONDYLE: The points where the skull attaches to the first cervical (neck) vertebra.

PELVIC: Of or pertaining to the pelvis, which is commonly called the hip bone.

STERNUM: The Sternum is the long flat bone in the upper middle of the front of the chest linking the ribs and the collar bone. It is also called the breastbone.

THORACIC: Of or pertaining to the thorax, which is the region of the body that includes the ribs and the sternum between the neck and abdomen. The thorax contains the respiratory and cardiac organs.

2.2.2 General Definitions

AC: Advisory Circular

ARP: Aerospace Recommended Practice

ATD: Anthropomorphic Test Dummy

CFR: Code of Federal Regulations

ECE: Economic Commission for Europe

END CLOSURE: A seat feature or interior component installed adjacent to the seat that is used to limit the movement of the occupant under dynamic forward load. An end closure is part of the restraint system.

ES-2re SID: Euro SID 2 Side Impact Dummy with Rib Extension.

FLOOR DEFORMATION: A test condition that simulates the deformation of the aircraft floor during an emergency landing condition. The purpose of introducing floor deformation into a dynamic test is to demonstrate that the seat system will remain attached to the airframe and protect the occupant even though the aircraft and/or seat may be severely deformed by the forces associated with a dynamic event.

FR: Federal Register

HIC: Head Injury Criterion

LPA: Lateral Pelvic Acceleration

MONUMENT: Aircraft interior component installed in the aircraft cabin. A monument is not part of the restraint system.

MULTIPLE-OCCUPANT SEAT: An individual seat structure designed for two or more passengers.

OCCUPANT RESTRAINT SYSTEM: Any seat belt, airbag, surrounding structure (bulkhead, armrest, etc.), or any combination of those items that are required to restrain a seated occupant.

SID: Side Impact Dummy. This includes all types of SIDs.

SIDE FACING SEAT: Seats which are installed at 90 degrees ± 10 degrees with respect to the longitudinal axis of the aircraft.

SINGLE-OCCUPANT SEAT: An individual seat structure designed for one passenger.

3. GENERAL DESIGN

This section outlines the general design requirements for the seat structure and restraint system for side-facing seats. For the purpose of this document, a side-facing seating system consists of the side facing seat, seat cushions, and restraint system. Any substitutions to these elements shall be made only on the basis of additional tests and/or rational analysis based on test.

3.1 Guidance

Paragraph 3.1 in AS8049C is not applicable.

3.2 Requirements

Requirements prescribed in AS8049C, paragraph 3.2, are applicable to all side-facing seats, with the following exceptions:

a. Paragraph 3.2.10 is not applicable to side facing seats.

b. Paragraph 3.2.15 is not applicable to side facing seats.

c. Paragraph 3.2.16 is not applicable to side facing seats.

3.3 Materials and Workmanship Requirements

Requirements prescribed in AS8049C, paragraph 3.3, are applicable to all side-facing seats.

3.4 Fire Protection Requirements

Requirements prescribed in AS8049C, paragraph 3.4, are applicable to all side-facing seats, with the following exceptions:

Paragraph 3.4.1 is modified by adding:

Inflatable airbag material shall not have an average burn rate of greater than 2.5 inches/minute when tested using the horizontal flammability test defined in part 25, appendix F, part I, paragraph (b)(5).

3.5 Allowable Permanent Deformations

Requirements prescribed in AS8049C, paragraph 3.5, are applicable to all side-facing seats, with the following exceptions:

a. Paragraph 3.5 is modified by adding:

   Deformation measurements are only required for structural tests. Tests that only evaluate injury criteria do not require deformation measurements.

b. Paragraph 3.5.1 is replaced by:

   The longitudinal deformation measurements shall be taken from the forward (aircraft relative) most hard point(s) of the seat, regardless of the height. If the seat exhibits longitudinal deformation in the aft (aircraft relative) direction, the maximum rearward longitudinal measurement shall be made at the aft most hard point(s) of the seat.

c. Paragraph 3.5.5 is modified by adding:

   Forward, for the purposes of this section, means the occupant facing direction rather than aircraft coordinates.

4. STRENGTHS

4.1 Static Strengths

Requirements prescribed in AS8049C, paragraph 4.1, are applicable to all side facing seats, with the following exceptions:

a. Paragraph 4.1.1 is not applicable.

b. Paragraph 4.1.2 is replaced by:

   Limit Loads: All seat systems shall be capable of withstanding aircraft specific limit loads without any detrimental permanent deformations.

c. Paragraph 4.1.5 is not applicable.

4.2 Dynamic Strengths/Occupant Protection

Requirements prescribed in AS8049C, paragraph 4.2, are applicable to all side facing seats, with the following exceptions:

a. Paragraph 4.2 is modified by adding:

In addition, the seat must meet the pass/fail criteria of 10.7 of this document.

5. QUALIFICATION TESTS

5.1 Static Qualification Tests

Requirements prescribed in AS8049C, paragraph 5.1, are applicable to all side facing seats, with the following exceptions:

a. Paragraph 5.1.4 is replaced by:

For forward or side loads, the body block shall be placed either on the actual bottom cushion or on a non-rigid foam block representative of the seat bottom cushion. Both forward and side load applications shall have either the actual back cushion or a non-rigid foam block representing the back cushion in place during testing.

b. Paragraph 5.1.5 is replaced by:

Side loads on side facing seats shall be applied by a body block as shown in Figure 3, or by a rigid block with the same back dimensions. The back cushion or an equivalent non-rigid foam block shall be placed between the body block and the back structure to distribute the load over the seat back rather than just the rigid boundary structure.

c. Paragraph 5.1.6, Table 5:

Regarding dimensional references stating "forward of SRP", forward means the occupant facing direction rather than aircraft coordinates.

5.2 Static Test - Pass/Fail Criteria

Requirements prescribed in AS8049C, paragraph 5.2, are applicable to all side facing seats.

5.3 Dynamic Qualification Tests

See additional requirements in Section 10.

Requirements prescribed in AS8049C, paragraph 5.3, are applicable to all side facing seats, with the following exceptions:

a. Paragraph 5.3.1.4 is not applicable.

b. Figures 6, 7A, and 7B, Test 1 and Test 2 illustrations are clarified with the following Figure 6B:

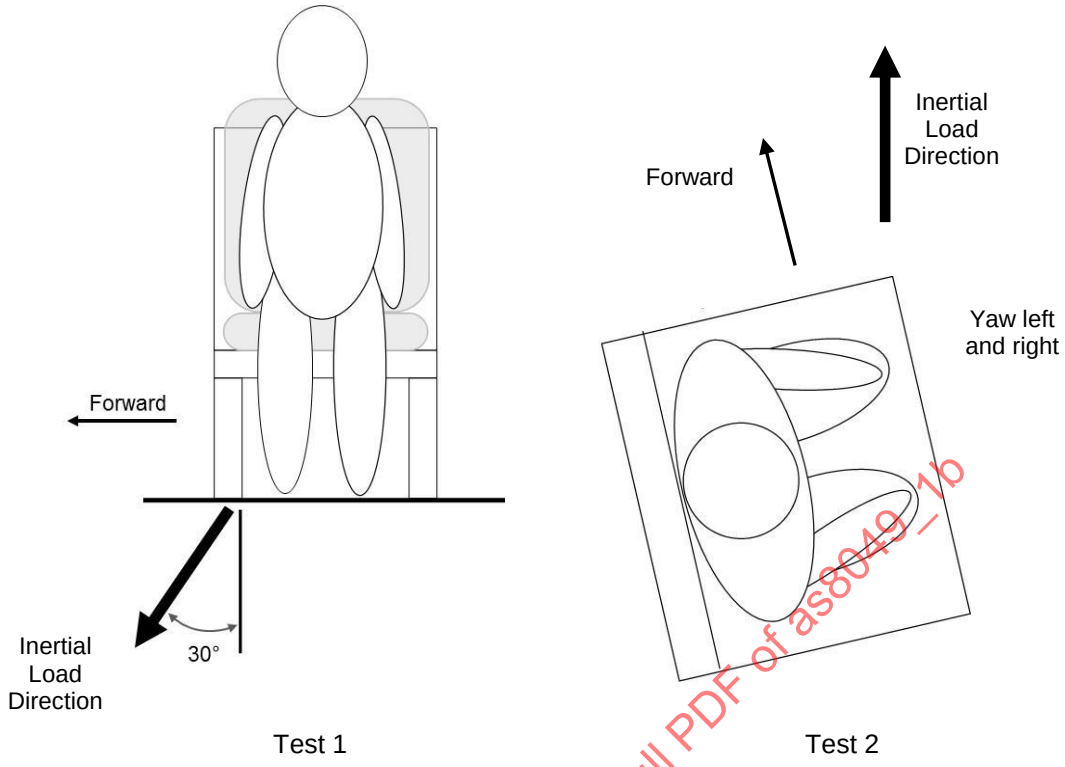

Figure 6B - Seat/restraint system dynamic tests

Paragraph 5.3.2 first paragraph is superseded by 10.1.1, 10.2.1, and 10.3.1 of this document.

Paragraph 5.3.2.6 is replaced by:

Each ATD should be clothed in form-fitting cotton stretch garments with short to full length sleeves, mid-calf to full length pants, and size 11E (45) shoes weighing about 2.5 pounds (1.1 kg) and having a heel height of about 1.5 inches (3.8 cm). The color of the clothing should be in contrast to the color of the restraint system and the background. The color of the clothing should be chosen to avoid overexposing the high speed photographic images taken during the test. The ES-2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.

Paragraph 5.3.3.5 is modified by adding the following after the first paragraph in this section:

a. Images and descriptions are not directly translated to side facing seats, but the general guidance and principle may be used on a case by case basis to support other mounting configurations (such as side wall attachments, bulkhead attachments, multiple leg attachments, etc.). For each separate seat structure, the entire length of track from the aft most attachment to the forward most attachment of the pitched track must be pitched down, regardless of the number of seat places or number of legs.

b. Figure 9B, 9C, 9D, and 9E are not representative of a side facing seat installation. See exception to paragraph 5.3.3.5.

c. Paragraph 5.3.3.6 is not applicable.

d. Figure 9A is completely replaced by the following Figure 9A for clarity:

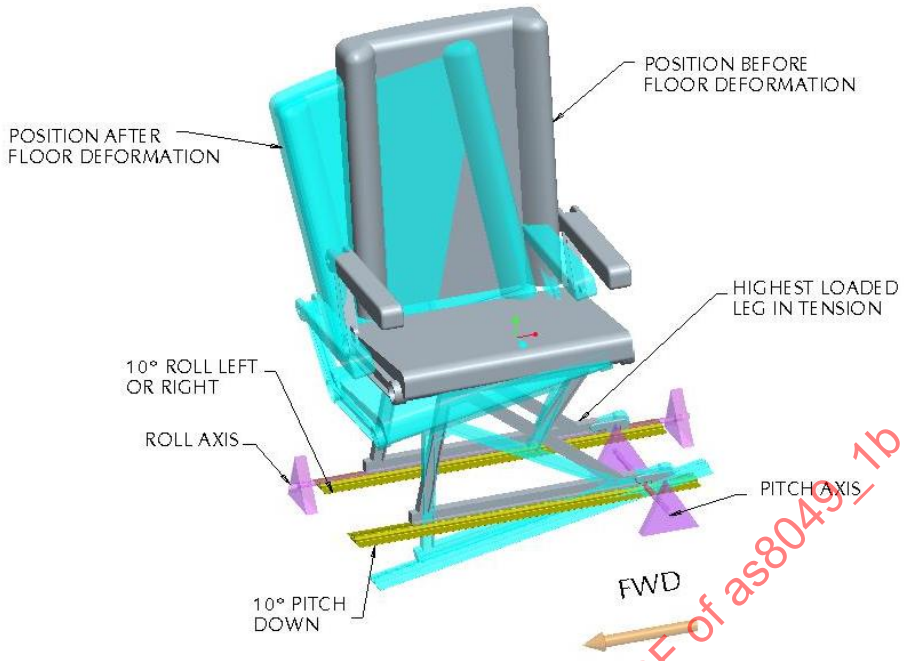

Figure 9A - Typical floor deformation - single-occupant, side facing seat

Paragraph 5.3.6.2 is not applicable.

Paragraph 5.3.6.3 is replaced by:

If a non-symmetrical upper torso restraint system (such as a single diagonal shoulder belt) is used in a system, it shall be installed on the test fixture in a position representative of that in the aircraft. The shoulder belt shall be designed to pass across the leading (forward) shoulder.

Paragraph 5.3.8.3 is replaced by the following:

Each ATD shall be placed in the seat in a uniform manner to enhance reproducible results. The following suggested procedures have been found to be adequate by previous experience.

a. Prior to seating the ATD, all seat adjustments and controls to the extent that they influence the injury criteria, shall be set as indicated in paragraph 5.3.6.4. Otherwise, seat adjustments and controls should be in the design position intended for the 50th percentile male occupant. If seat restraint systems are being tested that are to be used in applications where special requirements dictate their position for landing or takeoff, those positions should be used in the tests.

b. The friction in each limb joint shall be set so that it barely restrains the weight of the limb when extended horizontally. Friction adjustments to the ES2-re are applicable to the knee joint only.

c. When seating the ATD for horizontal tests or determining the nominal position for 60 degree tests, lower the ATD vertically into the seat while simultaneously:

    i. 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.

    ii. Applying a horizontal X-direction (in the ATD coordinate system) force of approximately 20 pounds (89N) to the torso to compress the seat back cushion. This force is applied approximately at the intersection of the midsagittal plane and the lower sternum of the Hybrid-II or FAA Hybrid-III, and the bottom rib of the ES-2re.

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

d. Once all lifting devices have been removed from the ATD, it should be rocked slightly to settle it in the seat.

e. The ATD's knees should be separated approximately 4 inches (100 mm).

f. Position the ES-2re's arms at the joint's mechanical detent that puts them at approximately a 20 to 40 degree angle with respect to the torso. Position the Hybrid-II ATD hands on top of its upper legs, just behind the knees. Set the ES-2re's head at the midpoint of the available range of z-axis rotation (to align the head and torso midsagittal planes).

g. The feet shall be in the appropriate position for the type and usage of a seat being tested, typically flat on the floor. The feet should be placed so that the centerlines of the lower legs are approximately parallel.

h. For test 1 (60 degree vertical), it is permissible to place the ATD such that the hip joints are in nominally the same position relative to the seat as when seated with a 1 g pre-load as shown in Figure 10. Achieving this position may require the lap belt be very tight and insertion of a shim behind the ATD's back and pelvis.

i. Auxiliary restraints may be required to ensure that each ATD will be in its proper position prior to the impact. The auxiliary restraint(s) must not interfere with the results of the test.

j. If application of floor deformation causes the ATD to move out of its nominal position with respect to its seat place, prior to conducting the test it shall be returned to that approximate nominal position.

k. If the movement of the ATD out of position or the act of returning the ATD to its nominal position causes an upper torso belt to become slack or fall off an ATD shoulder, then the upper torso belt may be replaced and/or readjusted in accordance with paragraph 5.3.8.5 prior to test.

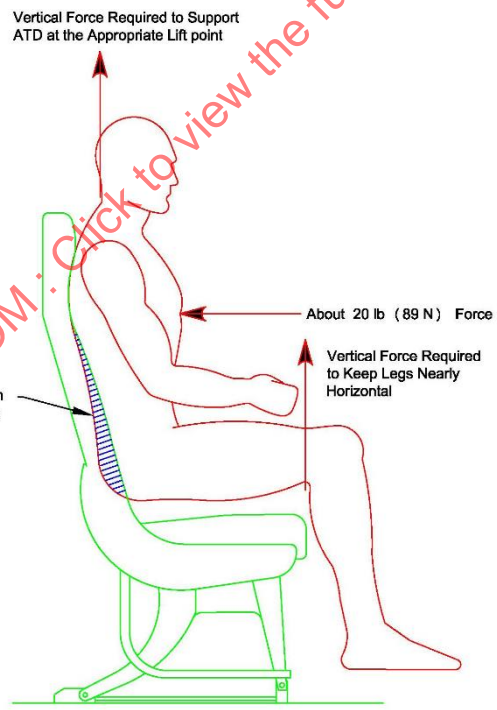

Figure 11 - ATD installation

Paragraph 5.3.9.7 is replaced by the following:

Retention of the upper torso restraint strap on the ATD's forward shoulder can be verified by observation of photometric or documentary camera coverage. The strap must remain on the ATD's shoulder until the ATD rebounds after the test impact and the upper torso restraint strap is no longer carrying any load.

Paragraph 5.3.9.9 is not applicable.

Paragraph 5.4.9 is not applicable.

6. MARKINGS

Requirements prescribed in AS8049C, Section 6, are applicable to all side facing seats, with the following exceptions:

Add the following:

Side facing seats shall be identified with applicable occupant limitations prescribed by 10.8.

7. NOT APPLICABLE

8. RESERVED

9. RESERVED

10. ADDITIONAL CRITERIA FOR SIDE FACING SEATS

This section provides standards and information not provided in AS8049C necessary to run and evaluate dynamic tests on Side facing seats. Test 1 is commonly referred to as the vertical test and is defined in AS8049C, paragraph 5.3.1.1. Test 2 is commonly referred to as the horizontal test and is defined in AS8049C, paragraph 5.3.1.2. Information relevant to the conducting of both these tests is contained throughout AS8049, paragraph 5.3.

10.1 Test 1 - Combined Horizontal/Vertical Test

10.1.1 Occupant Simulation

The combined horizontal/vertical test(s) conducted in accordance with Test 1 must be conducted with a Hybrid II ATD (49 CFR part 572 subpart B), or equivalent, occupying each seat position.

10.1.2 Contactable Items

Items contactable by the occupant (such as armrests, seats, furnishings, etc.) for Test 1 are not required for the test unless those items are used to restrain the occupant, have the potential to increase the peak lumbar load, or significantly influence the ATD position prior to peak lumbar loading. Such items must either be included in the test, or excluded based upon a rational analysis.

Only the portion of the item that is required to restrain the occupant need be included in the test, provided it is representative in strength and stiffness to the actual item, including structural attachments to the aircraft. Included items not used to restrain the occupant shall be representative, or a conservative substitute, in comparison to the strength and stiffness of the actual item. For these items, the structural attachments to the aircraft need not be representative.

For Type B seats only, 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 deformation is applied. For example, if floor deformation 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 10A. However, floor and contactable items are not subject to the floor deformation.

Each ATD's relative position to the seat after application of floor deformation must be the same as before deformation is applied.

10.2 Test 2a - Seat Structural Evaluation

The longitudinal impact test(s) conducted in accordance with Test 2, to show structural integrity of the seat system, may be conducted separately from the test(s) to show compliance with the injury assessments in 10.7. When conducted separately, occupant injury criteria listed in 10.7, paragraphs 1 through 7, need not be considered or evaluated for pass/fail during structural only tests. When occupant injury evaluation is combined with structural tests, all structural tests must comply with all injury criteria in 10.7.

Due to the lack of occupant and seat symmetry about the load direction for side facing seats, both yaw directions must 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.

Each ATD's relative position to the seat after application of floor deformation must be the same as before deformation is applied. To ensure proper loading of the seat by the occupants, the load bearing portion of the ATD's pelvis must remain supported by the seat pan through impact.

10.2.1 Occupant Simulation

The structural only longitudinal impact test(s) conducted in accordance with Test 2 must have an ES-2re anthropomorphic test device (ATD) (49 CFR part 572 subpart U) or equivalent, or a Hybrid-II ATD (49 CFR part 572, subpart B), or equivalent, occupying each seat position.

Combined structural and Injury assessment tests shall be accomplished by performing one test with ES-2re ATD (49 CFR part 572 subpart U) or equivalent at all seat places. Alternatively, these assessments shall be accomplished by multiple tests that use an ES-2re at the seat place being evaluated, and a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in § 25.562) or equivalent used in all other seat places. All seat places must be occupied.

10.2.2 Interior Surroundings/Contactable Items Used for Restraint

Items that are used as part of the occupant restraint system (such as bulkheads, armrests, etc.) must be included in the structural test. Only the portion of the item that is required to restrain the occupant need be included in the test, provided it is representative in strength and stiffness to the actual item, including structural attachments to the aircraft. Portions of the restraining items that do not influence the test such as trim, placards, wires, finishes, etc., are not required. 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 deformation is applied. For example, if floor deformation 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 10A. However, floor and contactable items are not part of the deformation evaluation.

10.3 Test 2b - Occupant Injury Evaluation

The longitudinal impact test(s) conducted in accordance with Test 2, to show compliance with the injury assessments in 10.7, may be conducted separately from the test(s) to show structural integrity. If conducted separately, structural-assessment tests must be conducted as specified in 10.2, and injury-assessment tests must be conducted without yaw or floor deformation.

10.3.1 Occupant Simulation

Injury assessments must be evaluated for all seat places of a multiple occupant seat structure. Injury assessments shall be accomplished by performing one test with ES-2re ATD (49 CFR part 572 subpart U) or equivalent at all seat places. Alternatively, these assessments shall be accomplished by multiple tests that use an ES-2re at the seat place being evaluated, and a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in § 25.562) 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.

10.3.2 Interior Surroundings/Contactable Items (not part of restraint)

The injury potential of contact with items adjacent to the seat installation shall be assessed. The items shall be included in the test or a rational analysis justifying their exclusion shall be presented. This analysis should consider that injury may occur from contact with an item or injury due to sharp edge exposure.

If items are included in the test, they shall be representative in strength and stiffness to the actual item, and located and attached in a representative manner (however, the structural attachments to the aircraft need not be representative). Only the portion of the item that influences the injury response need be included in the test, provided it remains representative in strength and stiffness to the actual item. Those parts of the contactable items that do not influence the test such as trim, placards, wires, finishes, etc. are not required.

Alternatively, the injury potential shall be assessed by a combination of two tests with items having the same geometry as the actual item, but having stiffness characteristics that would create the worst case for injury. This includes injuries due to both contact with the item and lack of support from the item, if applicable. For example, to evaluate a honeycomb armrest end closure, one test may use a conservatively rigid steel and plywood fixture, while the second test may use a foam block or no end closure at all. Evaluating injury criteria from lack of support of a contactable item may be combined and evaluated with Test 2a structural tests, provided the ATD is an ES-2re as described in 10.2.1.

If a seat is installed aft of structure contactable by the occupant (e.g., an interior wall or furnishing) that does not have a homogeneous surface or uniform stiffness, additional analysis and/or test(s) are required to demonstrate that the injury criteria are met for the area which an occupant could contact.

10.3.3 Head Contact Assessment Area

The surface of items contactable by the occupant's head must be homogenous and not differ significantly in rigidity. If the surface is not homogenous, additional head injury criteria (HIC) assessments shall be substantiated by test and/or analysis. If the surface has significant differences in rigidity, striking the most rigid surface during a test will substantiate the less rigid surfaces.

The contactable surface is defined by vertical (upper/lower) boundaries and horizontal (left/right) boundaries.

The vertical boundaries for this evaluation include a line 7.3 inches (185 mm) above and 7.9 inches (200 mm) below the center point of initial head contact by the 50th percentile male size ATD's head during the longitudinal test(s) at zero degree yaw angle. The vertical boundaries are intended to accommodate a range of occupant heights from the 5th percentile female to the 95th percentile male, which will include the chin of 5th percentile female to top of head of the 95th percentile male.

The horizontal (left to right) boundaries for this evaluation are determined by projecting the 50th percentile male head form from the initial pretest position, 10 degrees left and right of the longitudinal axis of the aircraft, forward onto the contactable surface. The furthest point away from the centerline on the head projection contacting the surface determines the left and right boundary lines.

10.4 Installation Angles

Side facing seats are defined as seats installed at installation angles of 90 degrees ± 10 degrees, from the longitudinal axis of the aircraft. For seats with installation angles inside this range, the seat shall be tested at the actual installation angle for occupant injury criteria, and yawed ±10 degrees from the actual installation angle for the structural tests.

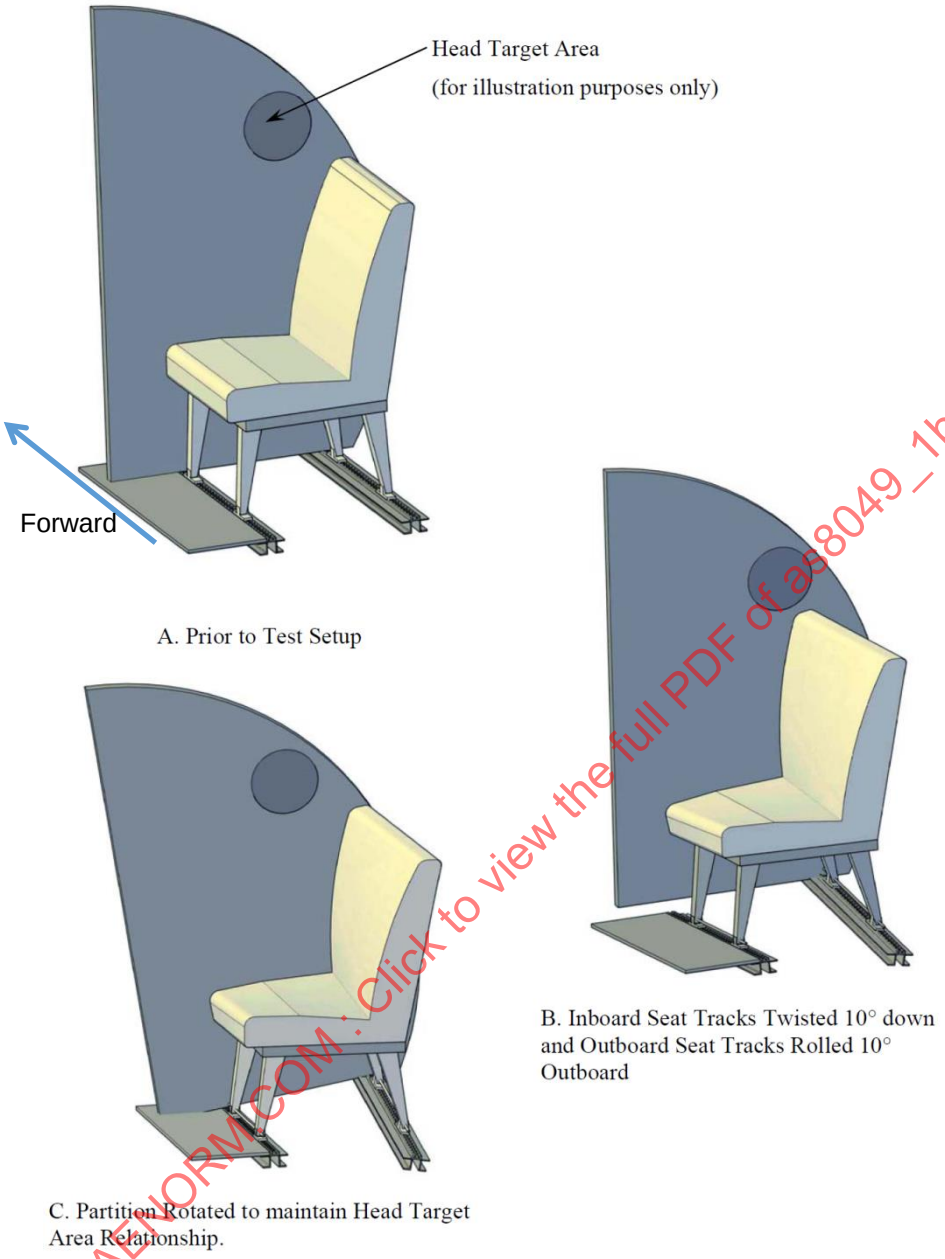

Figure 10A - Adjusting contactable objects

10.5 Instrumentation

10.5.1 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.

The ES-2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.