SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS8049

REV. B

Issued 1990-07
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Superseding AS8049A

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

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1. SCOPE:

1.1 General:

This SAE Aerospace Standard (AS) defines minimum performance standards, qualification requirements, and minimum documentation requirements for passenger and crew 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 seat/occupant/restraint system is subjected to statically applied ultimate loads and to dynamic impact test conditions set forth in the applicable Federal Regulations 14 CFR 23, 25, 27, or 29.

Guidance for test procedures, measurements, equipment, and interpretation of results is also presented to promote uniform techniques and to achieve acceptable data.

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 ultimate system responsibility in assuring that all requirements for safe seat installation have been met.

1.2 Applicability:

This document addresses the performance criteria for seat systems requiring dynamic testing to be used in civil rotorcraft, transport aircraft, and general aviation aircraft.

1.3 Seat Types:

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

TABLE 1 - Seat Type Categories

Seat Type	Aircraft Category	Applicable Federal Regulations
A	Transport Airplane	14 CFR 25
B	Normal Rotorcraft	14 CFR 27
B	Transport Rotorcraft	14 CFR 29
C	General Aviation Aircraft	14 CFR 23

1.4 Units:

In this document 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:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. 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.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 SAE J211/1 Instrumentation for Impact Tests - Part 1 - Electronic Instrumentation

2.1.2 SAE J211/2 Instrumentation for Impact Tests - Part 2 - Photographic Instrumentation

2.1.3 SAE J1733 Sign Convention for Vehicle Crash Testing

2.1.4 SAE ARP5482 Photometric Data Acquisition Procedures for Impact Test

2.1.5 SAE Technical Paper 1999-01-1609 A Lumbar Spine Modification to the Hybrid III ATD for Aircraft Seat Tests

2.1.6 SAE ARP5526 Aircraft Seat Design Guidance and Clarifications

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

2.2 Code of Federal Regulations (CFR) Publications:

U.S. Government Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington, DC 20402-9328.

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

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

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

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

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

2.2.6 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

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

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

3. GENERAL DESIGN:

3.1 Guidance:

The guidance information previously contained in Section 3.1, including Sections 3.1.1 through 3.1.31, has been removed from this revision. Refer to SAE ARP5526 Aircraft Seat Design Guidance and Clarifications for this guidance.

3.2 Requirements:

This section provides requirements for a seat and restraint system design that are not described elsewhere in this document. The seat structure, cushions, and occupant restraint shall be considered to act as a total system. Any substitution of these elements shall be made only on the basis of additional tests or rational analysis based on test.

3.2.1 Seat systems shall be designed to provide occupant impact protection at seat adjustment positions, orientations, and locations allowed during takeoff and landing.

3.2.2 Seat elements shall be designed so that, when evaluated under the test conditions of this document, they do not generate hazardous projections that could significantly contribute to injury to occupants that are seated or moving about the airplane or that could impede rapid evacuation.

3.2.3 Quick-release type fittings, adjustment handles, and buttons shall be designed, installed, and protected such that their positions can be easily verified, and incorrect installation or inadvertent activation is unlikely.

3.2.4 [Intentionally left blank]

3.2.5 Electrical or electronic devices incorporated in a seat shall be supplied with grounding.

3.2.6 Adjustable features (seat swivel, back recline, and stowage of movable tables, armrests, footrests, etc.) shall be designed so that they can be returned by the occupant to the positions required for takeoff and landing without release of occupant restraints. In addition, these items shall not deploy under the dynamic impact test conditions of this document in a manner that could significantly contribute to serious occupant injury or impede rapid egress of any aircraft occupant.

3.2.7 When an under-seat baggage restraint is incorporated in a passenger seat, it shall be designed to restrain at least 9.1 kg (20 lb) or its placarded weight of stowed items per passenger place under the test conditions of this document in a manner that will not significantly impede rapid egress from the seat.

3.2.8 [Intentionally left blank]

3.2.9 [Intentionally left blank]

3.2.10 Rearward-facing seats shall be designed with a back height sufficient to provide 930 mm (36.5 in) of support for the occupant as measured from the seat reference point (SRP) to the top of the seat back. If a separate fixed headrest is provided, a maximum gap of 100 mm (4 in) can exist between the bottom of the headrest and the top of the seat back, provided that the height of the headrest is sufficient to provide head support for the intended range of occupant size. If there is a gap between the bottom of the seat back and the SRP waterline, it shall be no more than 100 mm (4 in). Measurements shall be taken along the seat back tangent line. (See Figures 1A and 1B for the definition, determination, and use of SRP.)

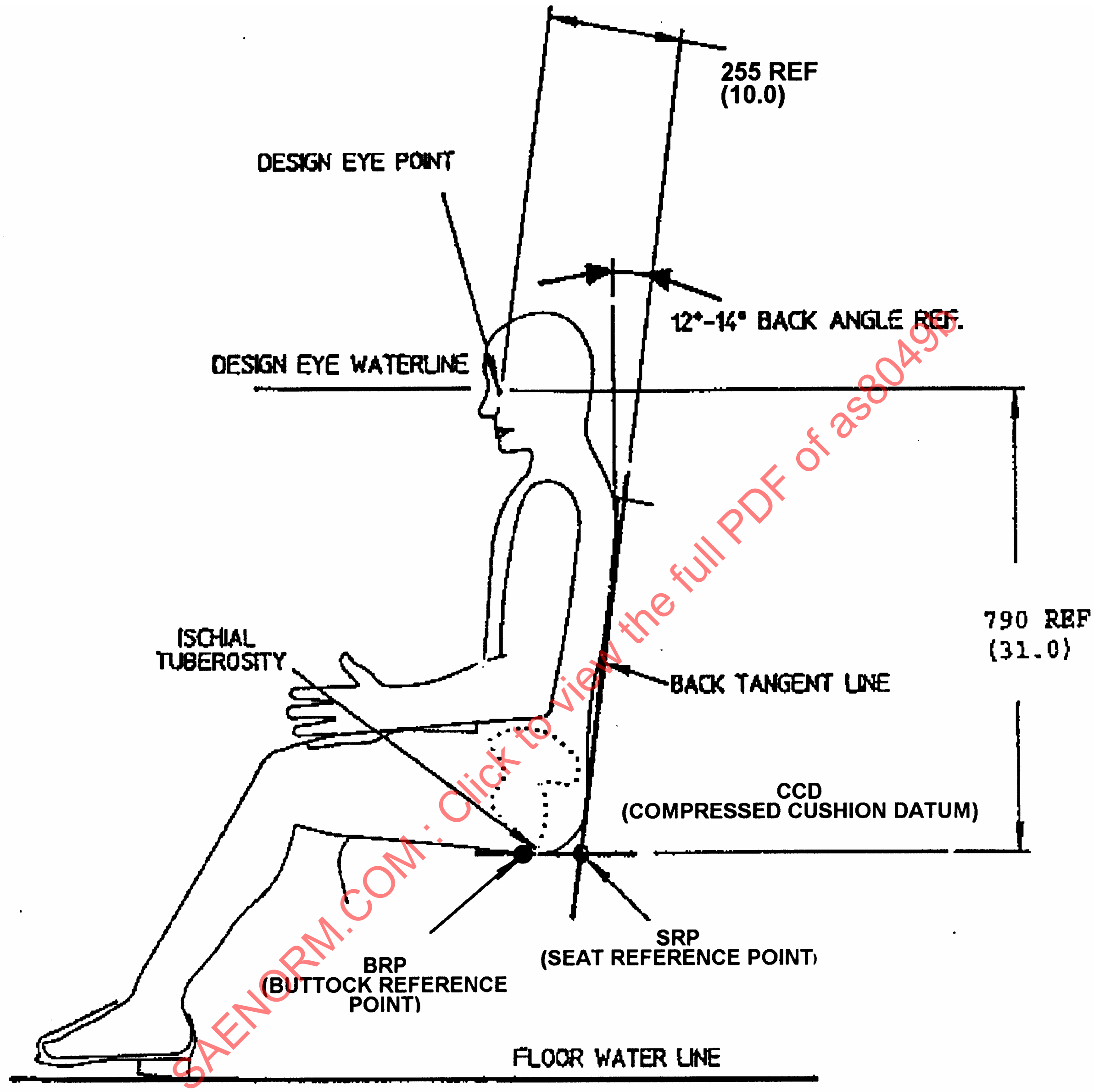
3.2.11 Seat track fitting locking devices shall readily indicate positive engagement and locking when installed in the aircraft environment (carpets, track covers, etc.).

3.2.12 The use of pure static friction between two or more flat or curved surfaces in direct contact as the sole means to restrain items of mass is not acceptable. Items restrained by mechanical fasteners such as screws, bolts, nuts, hook and loop fasteners, tape, hooks, springs, clamps, detents, rivets, etc., are not considered friction restrained items.

3.2.13 Seats equipped with foldup armrests shall incorporate means to preclude any armrest from extending beyond adjacent seat backs into any ingress/egress space behind the seat.

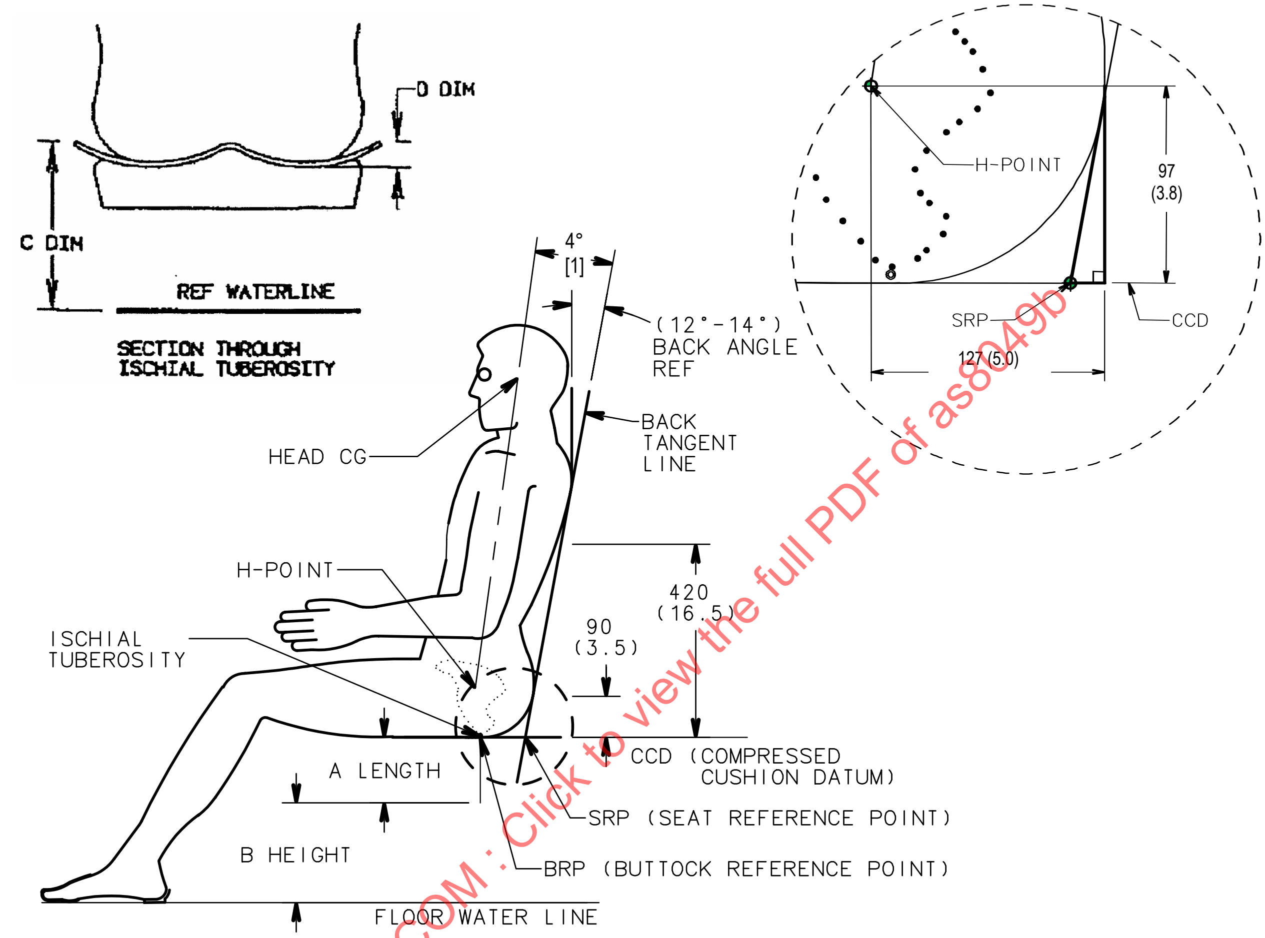
3.2.14 [Intentionally left blank]

3.2.15 Except for rearward facing seats, the pelvic restraint system shall be designed such that the vertical angle subtended by the projection of the pelvic restraint centerline and the seat reference point (SRP) water line shall not be greater than 55°. The SRP water line is a line/plane passing through the SRP parallel to the floor waterline. The pelvic restraint centerline is formed by a line from the pelvic restraint anchorage to a point located 250 mm (9.75 in) forward of the SRP and 180 mm (7.0 in) above the SRP water line.



NOTE:
DIMENSIONS ARE IN MILLIMETERS.
DIMENSIONS IN PARENTHESES ARE IN INCHES.

FIGURE 1A - Terminology and Dimensions for 50th Percentile Male



Note: Dimensions are in millimeters; Dimensions in parentheses are in inches.

[1] This angle is used only in the H-Point Method Using ATD

FIGURE 1B – Definition and Determination of SRP

Definition of SRP:

The Seat Reference Point (SRP) is the intersection of the Compressed Cushion Datum (CCD) and the back tangent line of a seat occupied by a 75 to 80 kg (160 to 180 lb) subject.

For purposes of this document, there are four accepted methods for determining the SRP of a seat (pin method, soft bar method and two variations of the H-point method). Each SRP measurement may give slightly different measurements; thus, a 6.4 mm (0.25 in) tolerance should be considered on the results. A consistent methodology is critical to minimize the actual deviation.

Figure 1B (Continued):

Pin Method - Procedure for Establishing SRP:

1. Place a 75 to 80 kg (160 to 180 lb) subject or 50% male anthropomorphic test dummy (ATD) on a seat (Figure 1B).
2. Locate and mark a point on the cushion directly under an ischial tuberosity (the BRP).
3. Drill a hole vertically through the seat pan cushion and structure at that point and insert a headed pin of length "A".
4. Place the subject on the seat and measure from a reference water line to the lower end of the pin ("B" height).
5. The addition of this height "B" and the pin length "A" establishes the CCD from the reference waterline.
6. Insert two round bars horizontally between the subject's back and the seat back cushion at 90 mm (3.5 in) and 420 mm (16.5 in) vertically above the CCD and determine their positions from a vertical datum. (Alternatively, soft bars may be used in a manner similar to that described in the soft bar method.)
7. Plot the two positions with the CCD and establish the SRP at their intersection.

Soft Bar Method – Procedure for Establishing SRP:

1. Place a 75 to 80 kg (160 to 180 lb) subject or 50% male anthropomorphic test dummy (ATD) on a seat (Figure 1B).
2. Locate and mark a point on the cushion directly under an ischial tuberosity (the BRP).
3. Place a soft bar (lead, soft solder, or functional equivalent), approximately 6 mm (0.25 in) diameter, across the seat at the mark on the seat pan cushion (located in step 2).
4. Place the subject on the seat ensuring that the soft bar deflects vertically.
5. Ensure that the top ends of the soft bar are at a common height and note the height from a reference water line (dimension "C").
6. Remove the subject and measure the deflection of the soft bar from the top at the ends to the point of maximum deflection (dimension "D").
7. The CCD is established by subtracting the deflection (dimension "D") from the end height (dimension "C"). (The CCD is at the bottom edge of the subject, so the bar thickness must be considered in the measurements and/or calculations).
8. Insert two soft bars horizontally between the subject's back and the seat back cushion at 90 mm (3.5 in) and 420 mm (16.5 in) vertically above the CCD and determine their positions from a vertical datum in the same manner as in steps 4-7.
9. Plot the two positions with the CCD and establish the SRP at their intersection.

H-point Method Using H-point Machine – Procedure for Establishing SRP:

1. Place an H-point Machine in the seat in accordance with SAE J826 and measure the horizontal and vertical coordinate of a seat datum point (typically the front stud), the H-point, and note the indicated seat back angle.
2. Establish the back tangent line. The back tangent line is the line parallel to the seat back angle passing through a point 127 mm (5.0 in) directly behind the H-point.
3. Establish the Compressed Cushion Datum (CCD). The CCD is a line parallel to the floor water line 97 mm (3.8 in) below the H-point.
4. The SRP is located at the intersection of the CCD and the back tangent line.

Figure 1B (Continued):

H-point Method Using ATD – Procedure for Establishing SRP:

Note: The 4° angle shown in Figure 1B is for the purpose of deriving the back tangent line per this method. The actual seat back angle is not required to align with this line.

1. Mark the head CG and H-point on a Hybrid II anthropomorphic test dummy (ATD) (per drawing ATD 3703), or on a FAA Hybrid III ATD (per drawing 78051-58 and -60).
2. Place the ATD in the seat in accordance with AS8049B paragraph 5.3.8.3 and measure the horizontal and vertical coordinates of a seat datum point (typically the front stud), the H-point, and the head CG.
3. Establish the back tangent line:
    a. Establish a line at an angle of 4° from a line between the ATD H-point and head CG.
    b. The back tangent line is a line parallel to the line established in 3.a passing through a point 127 mm (5.0 in) directly behind the H-point.
4. Establish the Compressed Cushion Datum (CCD). The CCD is a line parallel to the floor water line 97 mm (3.8 in) below the H-point.
5. The SRP is located at the intersection of the CCD and the back tangent line.

3.3 Materials and Workmanship Requirements:

3.3.1 Materials shall be of a quality that experience or tests have demonstrated to be suitable for use in aircraft seats.

3.3.2 Workmanship shall be consistent with aircraft industry standard manufacturing practices.

3.3.3 Magnesium alloys shall not be used.

3.4 Fire Protection Requirements:

3.4.1 All materials used in the seat shall have self-extinguishing properties as specified in the applicable Federal Regulations.

3.4.2 Type A-Transport Airplane passenger, flight attendant, and observer seat cushion systems shall be tested to and shall meet the fire protection provisions of Part II of Appendix F of 14 CFR 25, as required in 14 CFR 25.853(c) effective March 6, 1995 , or the equivalent shall be demonstrated by similarity to provide equivalent protection.

Type B-Transport Rotorcraft passenger, flight attendant, and observer seat cushion systems shall be tested to and shall meet the fire protection provisions of 14 CFR 29.853(b) effective October 26, 1984, or the equivalent shall be demonstrated by similarity to provide equivalent protection.

Type B-Normal Rotorcraft upholstery shall be self extinguishing when tested to meet the fire protection provisions of 14 CFR 27.853(b) effective February 4, 1980.

3.4.2 (Continued):

Type C-General Aviation Aircraft seat cushions shall be self extinguishing when tested to meet the fire protection provisions of Appendix F of 14 CFR 23, as required in 14 CFR 23.853(d)(3)(ii) effective February 9, 1995.

3.4.3 If ashtrays are installed in or attached to the seat, they shall be self-contained, completely removable types. The ashtray housing shall be fire resistant and sealed to prevent burning materials from falling into seat structure in case the ashtray is missing. Ashtrays in folding armrests shall be designed to preclude release of burning material when the armrest is folded with or without the ashtray lid closed.

3.4.4 Electrical components in a seat shall have provisions to preclude initiation of a fire from overheating.

3.4.5 If oxygen generators are incorporated into a seat, provisions shall be made to preclude damage to the seat, including initiation of a fire due to the heat produced by the generator. The adequacy of the design shall be demonstrated.

3.4.6 [Intentionally left blank]

3.5 Allowable Permanent Deformations:

Allowable permanent deformations sustained by a seat subjected to the ultimate static tests or dynamic impact tests of this document are specified below. Permanent seat deformations shall be determined for a critically loaded seat after exposure to static and dynamic tests. Measuring points, as described in the following subparagraphs, shall be identified and marked on the test seat, and their positions measured in the lateral, vertical, and longitudinal directions relative to fixed points on the test fixture. These measurements shall be recorded before and after the tests. The difference between the pretest and posttest measurements shall be recorded and reported as permanent deformations.

For dynamic tests, if floor deformations are applicable, consistency in pretest and posttest measurements shall be maintained. If the pretest measurements are made before floor deformations are applied, the posttest measurements shall be made after floor deformations have been removed. Conversely, if the pretest measurements are made after floor deformations are applied, the posttest measurements shall be made before removal of floor deformations.

3.5.1 Longitudinal Direction: The longitudinal measurement in the forward direction shall be made at the forward-most hard point(s) of the seat at a height up to and including the armrest or 635 mm (25 in) above the floor for seats without armrests. If the seat exhibits longitudinal deformation in the aft direction, the maximum rearward longitudinal measurement shall be made at the aftmost point(s) of the seat and at a point where row to row clearance with an undeformed seat behind is at a minimum.

3.5.2 Downward Direction: There is no limitation on downward permanent deformation provided it can be demonstrated that the feet or legs of occupants will not be injured or entrapped by the deformation, and that adequate clearance for that deformation can be assured by the seat design, with full consideration of the potential presence of under seat baggage or stowed items.

3.5.3 Seat Rotation: The seat bottom rotational permanent deformation shall not result in an angle that exceeds 20° pitch down or 35° pitch up from the horizontal plane. This rotational deformation shall be measured between the fore and aft extremities of the seat pan at the centerline of each seat bottom (Figure 2A). Rotation of the seat pan shall not cause entrapment of the occupant.

3.5.4 Sideward Direction: The maximum sideward permanent deformations towards an aisle, shall be measured for heights below 635 mm (25 in) above the floor and for heights 635 mm (25 in) or more above the floor. The determination of which parts of the seat are at what heights is made prior to testing and before applying floor deformation.

3.5.5 Other Deformation Limits: The most forward surface of a seat back centerline must not deform to a distance greater than one half the original distance to the forward-most hard structure on the seat that supports the seat bottom cushion (see Figure 2B). The posttest measurement may be made with the seat back returned to its pretest upright or structurally deformed position using no more than 155 N (35 lb) force applied at the centerline of the seat back.

3.5.6 Stowable Seats: A stowable seat (manual or automatic) installed near exits or in exit paths must stow posttest and remain stowed without interfering with the exits or exit paths. The permanent deformation shall not exceed 40 mm (1.5 in) from the pretest upright position. For seats that are stowed manually, a posttest stowage force not to exceed 45 N (10 lb) above the original stowage force may be used to stow the seat prior to measurement of permanent deformation. For seats that stow automatically, a posttest stowage force no greater than 45 N (10 lb), applied at the centerline of the seat back, may be used to assist with automatic retraction prior to the calculation of permanent deformation.

3.5.7 Deployable Items: Certain items on the seat, such as food trays, legrests, arm caps over in-arm tray tables, etc., are used by passengers in flight and are required to be stowed for taxi, takeoff and landing. Deployment of such items should be treated as “permanent deformation” if the item deploys into an area that must be used by multiple passengers (in addition to the occupant of the seat) for egress. The location of the measuring point used for determining the deformation of the deployed item shall be either at the point of full deployment or at the point of the actual deployment if a partially deployed item resists further deployment upon application of a static load of 45 N (10 lb) along the direction of the inertial load path. Such deployments can be considered acceptable, even if they exceed the provisions of 3.5 and its subparagraphs, if they are readily pushed out of the way by normal passenger movement, and remain in a position that does not affect egress. Any items that remain in a position that would affect egress shall be reported as permanent deformation.

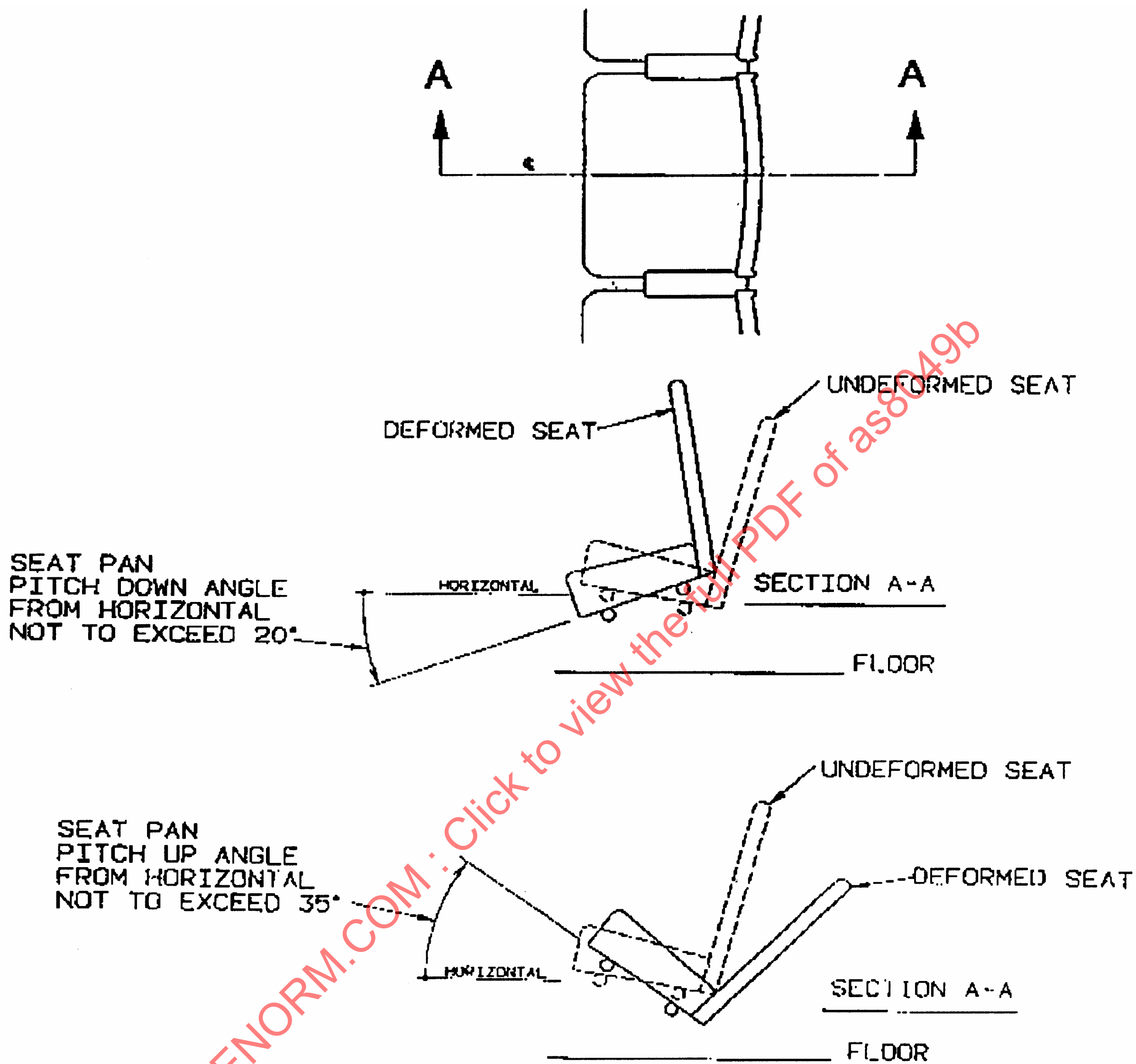
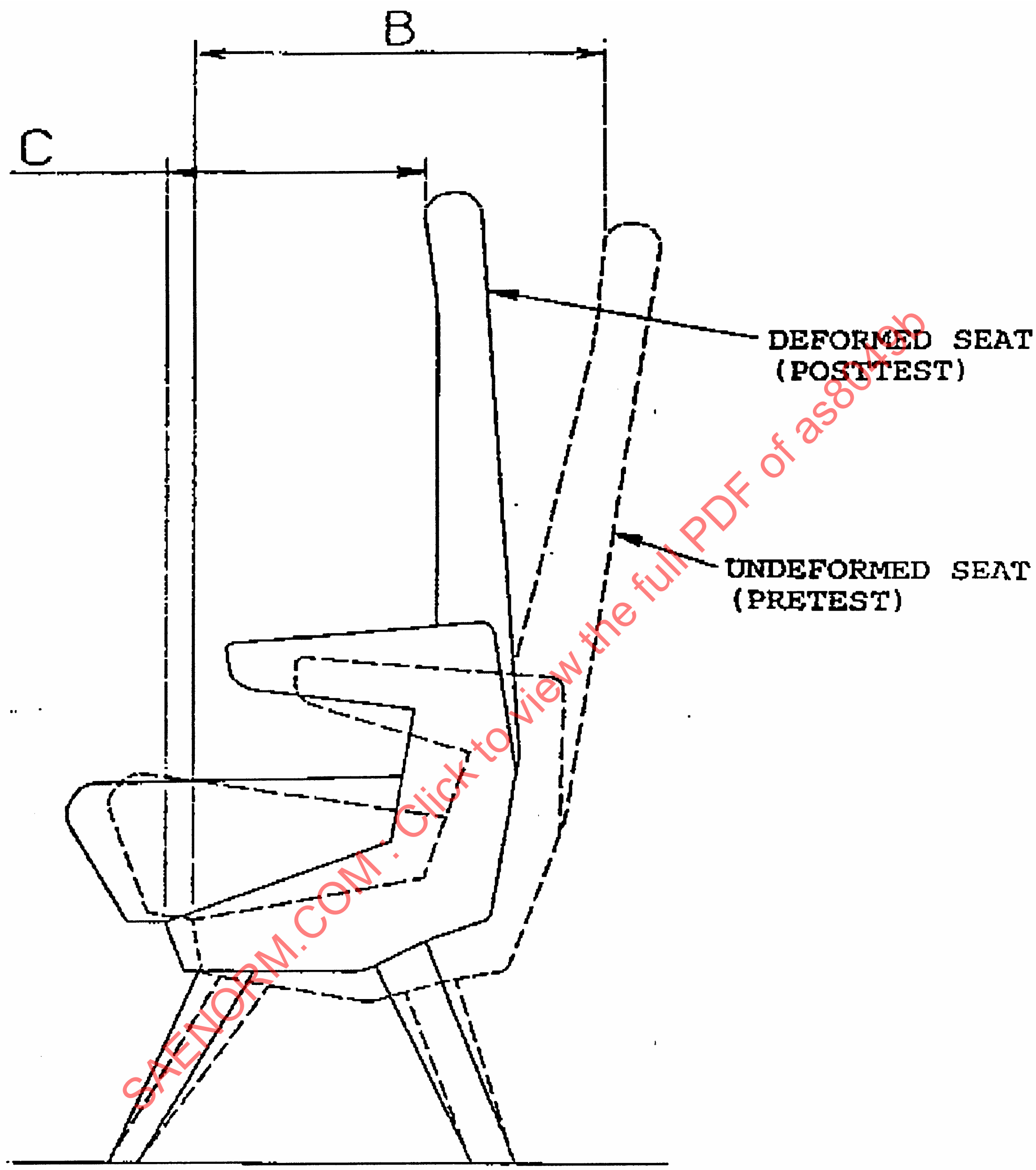


FIGURE 2A - Maximum Posttest Seat Pan Rotation



DIMENSION “C” MUST BE
AT LEAST 50% OF DIMENSION “B”

FIGURE 2B - Maximum Seat Back Permanent Deformation
(Note: Applicable for Forward Facing Seats Only)

4. STRENGTH:

All seats qualified for occupancy during takeoff and landing shall be capable of withstanding, within the criteria defined below, both statically and dynamically applied loading.

4.1 Static Strength:

Seats shall be designed and demonstrated by test or appropriate analysis to withstand the ultimate loads determined by using the load factors specified in Table 4. Forces representing the sum of each occupant weight of 77 kg (170 lb) unless otherwise noted, plus the complete seat weight (including all trim and accessories), plus the total weight of any item of mass (e.g., under-seat baggage, stowage compartment weight plus weight of contents, etc.) restrained by the seat, all multiplied by the appropriate load factor from Table 4, shall be applied to the seat (see 5.1.7 and 5.1.9). The forward, side, down, up, and aft loads shall be applied separately for at least 3 s without failure. Static strength shall be demonstrated under all variations of seat occupancy and positions that produce critical loading of any structural member. Ultimate loads need only be applied for allowed take off and landing positions.

4.1.1 Pilot and Copilot Loads: Pilot and copilot seats shall be capable of withstanding an ultimate rearward load of 4.45 kN (1000 lb) applied 200 mm (8 in) above the SRP to provide for the application of pilot forces to the flight controls. Consideration must be given to any seat adjustment position or configuration that the pilot may use while controlling the aircraft.

4.1.2 Limit Loads: All seat systems shall be capable of withstanding limit loads in the upward and downward directions without any detrimental permanent deformations. Pilot and copilot seats shall additionally be capable of withstanding a 3 kN (667 lb) rearward limit load applied 200 mm (8 in) above the SRP without any detrimental permanent deformation.

4.1.3 Attachments: The strength of the seat attachments to the aircraft structure and the pelvic restraint or upper torso restraint attachments to the seat or aircraft structure shall be 1.33 times the ultimate loads specified in Table 4 (except as noted for Type A seat sideward).

4.1.4 Casting Factors: If castings are used in the construction of the seat, the castings shall have a factor of safety and related inspection requirements in accordance with the applicable portions of sections of the Federal Regulations: 14 CFR 23.621, 25.621, 27.621, or 29.621. If a fitting is or contains a casting, the casting will be statically tested to the higher of the casting factor of safety or the 1.33 fitting factor for ultimate load conditions or the 1.15 factor for ground or flight loads, but not the combination of factors.

4.1.5 Headrest Loads: When a headrest is used on a rearward facing Type B seat, the headrest shall be capable of withstanding a forward ultimate load of 1.23 kN (277 lb).

TABLE 4 - Ultimate Load Factors

Direction (Relative to Aircraft	Type A Seat (Transport Airplane) Factor	Type B Seat (Rotorcraft) Factor	Type C Seat (4)(6) Factor
Forward	9.0	16.0	9.0
Sideward	4.0[(1)(2)]	8.0[(2)]	3.0[(2)(5)]
Upward	3.0[(2)]	4.0[(2)]	3.0[(2)(5)]
Downward	6.0[(2)]	20.0[(2)(3)]	3.0[(2)(5)(7)]
Rearward	1.5	1.5	

(1) Includes 1.33 fitting factor.
(2) Increase these load factors as necessary for reduced weight gust/flight loads or landing requirements. All seat adjustment positions and occupancy variations, including those used in flight, must be evaluated when using these increased load factors.
(3) Load to be applied after stroking of the seat energy absorbing system.
(4) Normal, Utility and Commuter Category.
(5) Use occupant weight of at least 98 kg (215 lb) for design of the seat/restraint system when subjected to the maximum load factors corresponding to the specified flight and ground load conditions, as defined in the operating envelope of the airplane. In addition, these loads must be multiplied by a factor of 1.33 in determining the strength of all fittings and attachment of each seat to the structure and each safety belt and shoulder harness to the seat or structure.
(6) Use occupant weight of 86 kg (190 lb) which accommodates passengers wearing parachutes, except that, if the seat is designed specifically for normal category airplanes and the seat is marked “for normal category aircraft only” in addition to the marking requirements of Section 6 of this document, occupant weight of 77 kg (170 lb) may be used. For Commuter Category airplane seats use occupant weight of 77 kg (170 lb).
(7) Factor of 6.0 when certification to the emergency exit provisions of 14CFR23.807 (d)(4) applies.

4.2 Dynamic Strength/Occupant Protection:

The seat structure, cushions, and occupant restraint, as a system, shall be designed and demonstrated by test or appropriate analysis based on test of similar seats to withstand the dynamic impact test conditions prescribed in 5.3 and meet the pass/fail criteria of 5.4.

5. QUALIFICATION TESTS:

Initial qualification of a seat shall be performed by static and dynamic tests. Subsequent qualifications related to design changes to seats of a similar design may be performed by rational analysis based on existing qualification test data.

5.1 Static Qualification Tests:

5.1.1 The test seat shall be complete to the extent that the primary structure, the occupant restraint system, and the seat attachment fittings to the aircraft are accurately represented. Items that are not part of the seat primary structure, the omission of which will not alter the test and pass/fail criteria, may be excluded from the test article, but their weight must be included when determining the static loads.

5.1.2 A body block shall be installed in each occupant place that will be loaded and shall be restrained by the occupant restraint. The body blocks shown in Figures 3, 4, 5A, and 5B are satisfactory for static test purposes. They may be refined or modified if desired; however, the resultant load application point for each static test shall comply with 5.1.6 (Table 5).

5.1.3 For the application of down loads, representative distributed loading of the seat pan (as opposed to loading rigid boundary members) must be achieved.

5.1.4 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 bottom cushion. For the side load, the back cushion or a non-rigid foam block representing the back cushion shall be in place.

5.1.5 Forward loads on seat backs of rearward-facing seats and rearward loads on seat backs of forward-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.

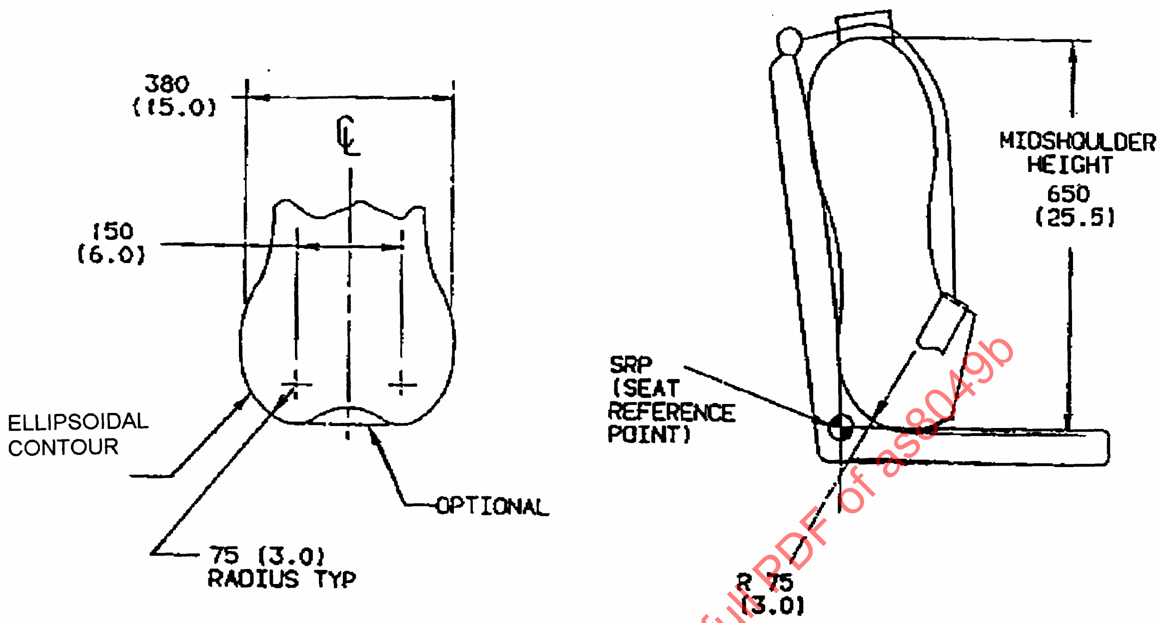


FIGURE 3 - Optional Body Block for Static Testing

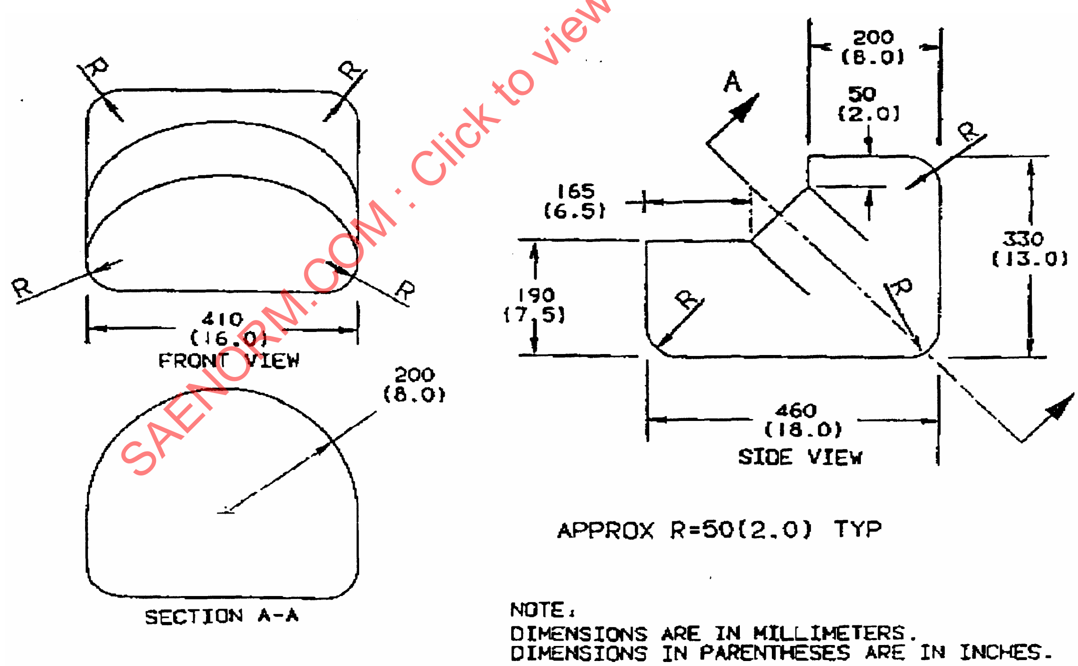
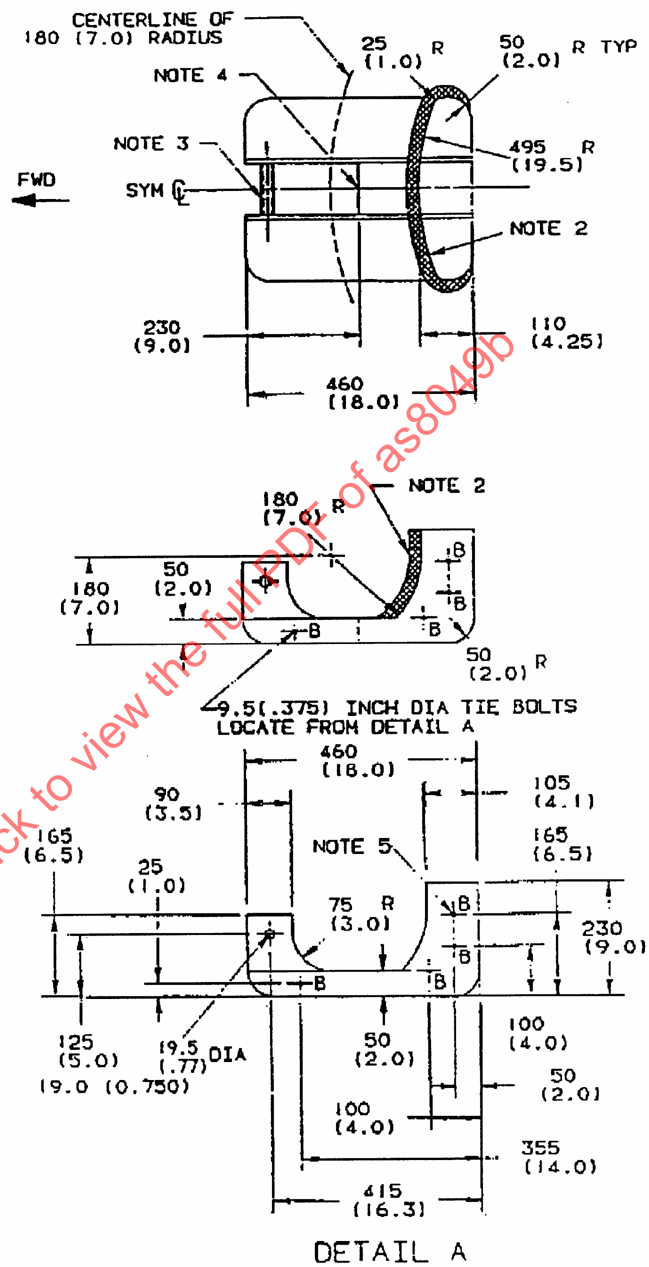
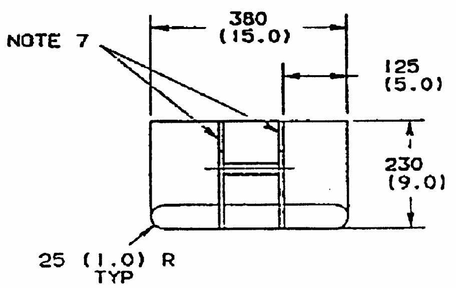


FIGURE 4 - Optional Body Block for Static Testing

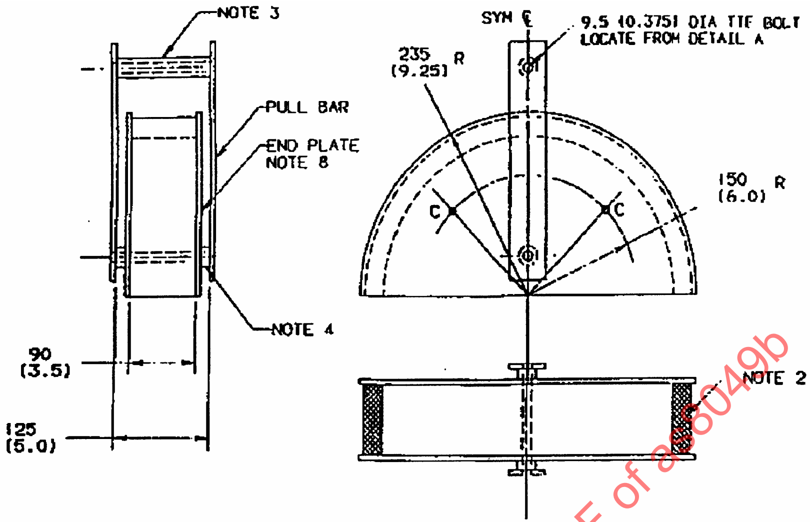


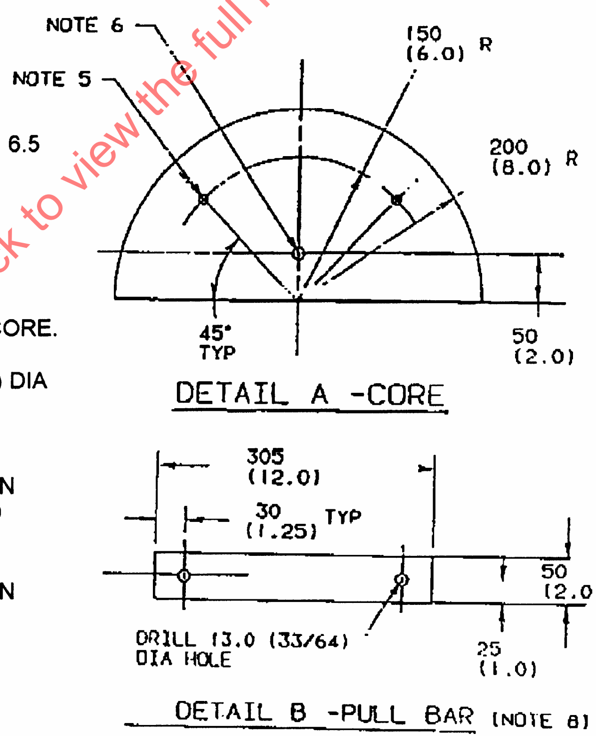


7. PULL PLATE MATERIAL: 9.5 (0.375) STEEL.
6. BLOCK MATERIAL: LAMINATED HARDWOOD
5. DRILL 10.0 (25/64) DIA HOLE AND COUNTERBORE AS REQUIRED FOR ATTACHMENT BOLTS AT LOCATIONS LABELED “B”.
4. REMOVE CENTER SECTION FORWARD OF THIS LINE AS REQUIRED FOR TESTS OF RESTRAINT SYSTEM WITH NEGATIVE - G STRAP.
3. 25 (1.0) O.D. STEEL SPACER OVER 19.0 (0.75) DIA BOLT.
2. THIS SURFACE COVERED WITH NYLON OVER 25 (1.0) THICK SLOW REBOUND FOAM PAD.
1. DIMENSIONS ARE IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES.

NOTES:

FIGURE 5A - Lower Torso Block





8. END PLATE AND PULL BAR MATERIAL: 6.5 (0.25) STEEL
7. CORE MATERIAL: LAMINATED HARDWOOD.
6. DRILL 13 (33/64) DIA HOLE THRU END PLATE AND CORE.
5. DRILL 10 (25/64) HOLE AT LOCATIONS LABELED "C" THRU END PLATE AND CORE.
4. 13.0 (O.5) LONG X 25 (1.0) O.D. STEEL SPACER (2 PLACES) OVER A 13.0 (0.5) DIA bolt.
3. 127 (5.0) LONG X 25 (1.0) O.D. STEEL SPACER OVER A 12.5 (0.5) DIA BOLT.
2. THIS SURFACE COVERED WITH NYLON OVER 25 (1.0) THICK SLOW REBOUND FOAM PAD.
1. DIMENSIONS ARE IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE IN INCHES.

NOTES:

FIGURE 5B - Upper Torso Block

5.1.6 Static resultant load application points are summarized in Table 5.

TABLE 5 - Static Resultant Load Application Points

Load	Forward-Facing Seat	Sideward-Facing Seat	Rearward-Facing Seat
Down	Evenly over seat bottom	Evenly over seat bottom	Evenly over seat bottom
Side	270 mm (10.5 in) up from SRP 215 mm (8.5 in) forward of SRP	270 mm (10.5 in) up from SRP	270 mm (10.5 in) up from SRP 215 mm (8.5 in) forward of SRP
Up	215 mm (8.5 in) forward of SRP	215 mm (8.5 in) forward of SRP	215 mm (8.5 in) forward of SRP
Forward	270 mm (10.5 in) up from SRP	270 mm (10.5 in) up from SRP 215 mm (8.5 in) forward of SRP	270 mm (10.5 in) up from SRP
Rearward	270 mm (10.5 in) up from SRP	270 mm (10.5 in) up from SRP 215 mm (8.5 in) forward of SRP	270 mm (10.5 in) up from SRP

5.1.7 Loads due to stowed articles under the seat or due to other stowage compartments that are part of the seat, and their contents, shall be applied simultaneously with the loads due to the occupant and the seat.

5.1.8 Devices used for indicating applied static loads shall be calibrated by comparison with a certified standard.

5.1.9 The load due to any item of mass, including the seat, that is not restrained by the occupant restraint system may be applied in a representative manner at the c.g. of the mass.

5.1.10 If occupant restraint systems are not attached to the seat structure, the occupant restraint system shall be attached to the test fixture at points that are equivalent in location to those in the aircraft. The static loads shall then be applied as specified in this section.

5.1.11 When a seat is to be installed or adjusts to face in more than one direction, tests shall be conducted that substantiate the seat strength for all positions used for take off and landing. In addition, flight and gust loads shall be evaluated in all adjustable positions used in flight.

5.1.12 When testing a vertically or horizontally adjustable seat, the most critical seat position(s) shall be selected for each test condition.

5.1.13 The distribution of the forward static loads applied to a seat that uses upper torso restraint shall be 40% through the upper torso restraint and 60% through the pelvic restraint. These loads shall be applied using the body block shown in Figure 3, the test setup shown in Figure 5C, or an equivalent method.

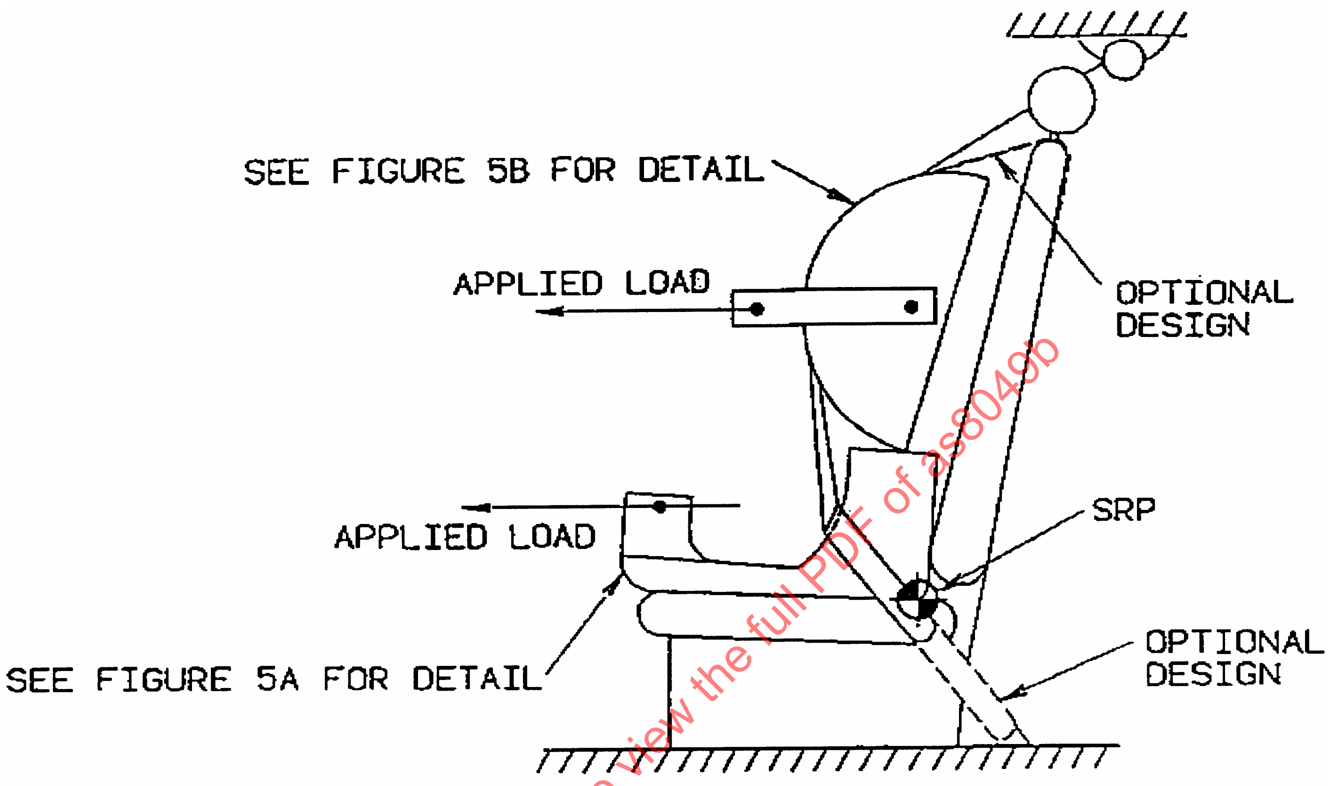


FIGURE 5C - Optional Combined Pelvic and Upper Torso Static Test

5.1.14 When a Type B seat incorporates pelvic and upper torso restraints, static testing or rational analysis shall be performed with only the pelvic restraint effective, as well as with both pelvic and upper torso restraints effective if the pelvic restraint is capable of being used without the upper torso restraints. In both cases the load application points shall be as specified in Table 5.

5.1.15 Prior to and after the application of each test load, measurements for determination of permanent deformation shall be recorded.

5.2 Static Test - Pass/Fail Criteria:

The static tests shall demonstrate the following:

5.2.1 The seat is capable of supporting the limit loads, as specified in 4.1.2, without detrimental permanent deformation or activating energy absorbing devices. At any load up to limit loads, deformation may not interfere with safe operation of the aircraft.

5.2.2 The seat structure must be able to support ultimate loads without failure for at least 3 s. If it can be shown that failure of an armrest on a seat assembly does not reduce the degree of safety afforded the occupant(s) or become a hazard, such failure will not be cause for rejection.

5.2.3 After application and release of ultimate loads, as described in 5.2.2, the seat permanent deformation limitations of 3.5 and its subparagraphs are met.

5.3 Dynamic Qualification Tests:

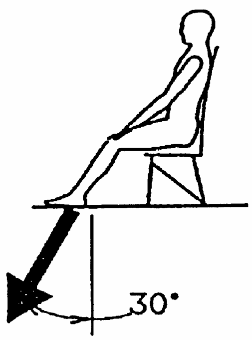
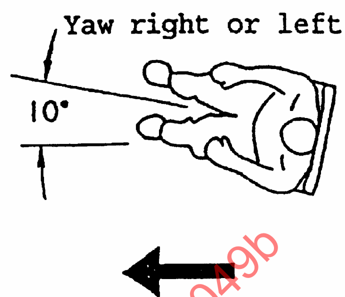
This section specifies the dynamic tests to satisfy the requirements of this document.

5.3.1 Dynamic Impact Test Parameters: A minimum of two dynamic tests is required to assess the performance of an aircraft seat, restraints, and related interior system. The seat and restraint are considered to act together as a system to provide protection to the occupant during a crash. The test facility shall provide a means of constraining the movement of the test fixture to translational motion parallel to the arrow indicating the inertial load throughout the test (Figures 6, 7A, or 7B).

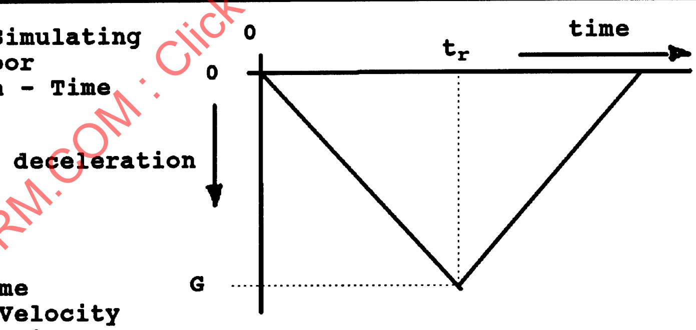
5.3.1.1 Test 1 (Figures 6, 7A, and 7B), as a single row test, determines the performance of the system in a test condition where the predominant impact force component is along the spinal column of the occupant, in combination with a forward impact force component. This test evaluates the structural adequacy of the seat, critical pelvic/lumbar column forces, and permanent deformation of the structure under downward and forward combined impact loading and may yield data on Anthropomorphic Test Dummy (ATD) head displacement, velocity, and acceleration time histories.

5.3.1.2 Test 2 (Figures 6, 7A, and 7B), as a single row seat test, determines the performance of a system in a test condition where the predominant impact force component is along the aircraft longitudinal axis and is combined with a lateral impact force component. This test evaluates the structural adequacy of the seat, permanent deformation of the structure, the pelvic restraint and upper torso restraint (if applicable) behavior and loads, and may yield data on ATD head displacement, velocity, and acceleration time histories and the seat leg loads imposed on the seat tracks or attachment fittings.

5.3.1.3 Test 2 for Type A and C seats and Tests 1 and 2 for Type B seats require simulating aircraft floor deformation by deforming the test fixture, as prescribed in Figures 6, 7A, and 7B, prior to applying the dynamic impact test conditions. The purpose of providing floor deformation for the test is to demonstrate that the seat/restraint system will remain attached to the airframe and perform properly even though the aircraft and/or seat may be severely deformed by the forces associated with a crash.

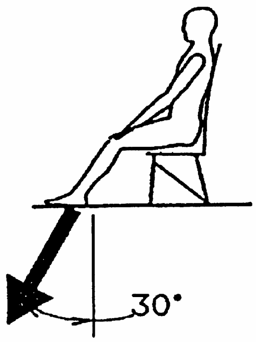
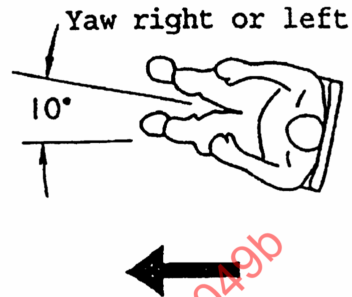
Illustration shows a forward facing seat Inertial load shown by arrow 	TEST 1 	TEST 2 
Min V m/s(ft/s)	10.67 (35)	13.41 (44)
Max. t_r s	0.08	0.09
Min. G	14	16
Deform floor:		
Degrees roll	0	10
Degrees pitch	0	10

Test Pulse Simulating Aircraft Floor Deceleration - Time History:

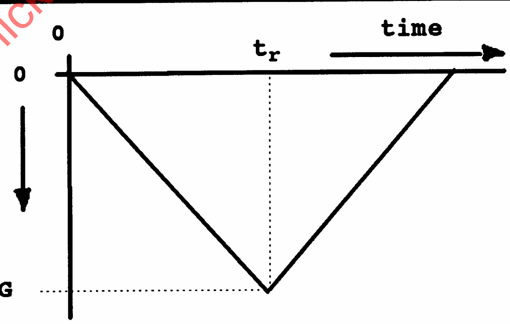


tr= Rise time
V = Impact Velocity
G = Deceleration measured on test fixture or sled near the seat position.

FIGURE 6 - Type A Seat/Restraint System Dynamic Tests

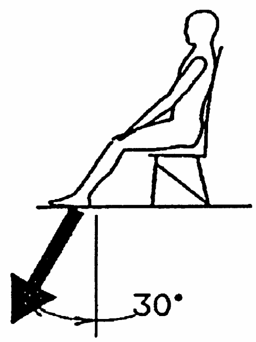
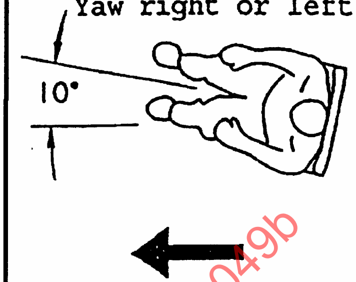
	TEST 1	TEST 2
Illustration shows a forward facing seat Inertial load shown by arrow		
Min V m/s(ft/s)	9.14 (30)	12.80 (42)
Max. t_r s	0.031	0.071
Min. G	30	18.4
Deform floor:		
Degrees roll	10	10
Degrees pitch	10	10

Test Pulse Simulating Aircraft Floor Deceleration-time History:



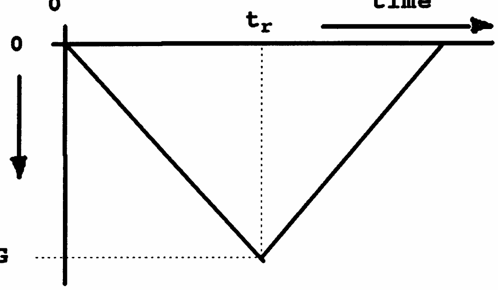
tr= rise time
V = Impact Velocity
G = Deceleration measured on the test fixture or the sled near the seat position

FIGURE 7A - Type B Seat/Restraint System Dynamic Tests

Illustration shows a forward facing seat Inertial load shown by arrow	TEST 1	TEST 2
		

	TEST 1 CREW *	TEST 1 PASSENGER	TEST 2 CREW *	TEST 2 PASSENGER
Min V m/s(ft/s)	9.45(31)	9.45(31)	12.80(42)	12.80(42)
Max. t_r s	0.05	0.06	0.05	0.06
Min. G.	19	15	26	21
Deform floor:				
Degrees roll	0	0	10	10
Degrees pitch	0	0	10	10

Test Pulse Simulating Aircraft Floor Deceleration-Time History:



tr= Rise time
V = Impact Velocity
G = Deceleration measured on the test fixture or the sled near the seat position

* Refers to seats installed in the front row of the airplane

FIGURE 7B - Type C Seat/Restraint System Dynamic Tests

5.3.1.4 For seats placed in repetitive rows, an additional test condition, using seats in tandem placed at representative fore and aft distance between the seats (seat pitch), similar to Test 2 with or without the floor deformation directly evaluates head and femur injury criteria (the floor deformation is required if the test also demonstrates structural performance). These injury criteria are dependent on seat pitch, occupant location, and the effect of hard structures within the path of head excursions in the -10° to +10° yaw attitude range of the Test 2 conditions. The test procedure using the appropriate data obtained from Test 2 as described in 5.3.6.6 may be an alternative to multiple row testing.

5.3.2 Occupant Simulation: An ATD representing a 50th percentile male as defined in 49 CFR Part 572, Subpart B, or an equivalent shall be used to simulate each occupant. An equivalent ATD shall provide the same response to the test conditions of this document as the specified ATD. These "Part 572B" ATDs have been shown to be reliable test devices that are capable of providing reproducible results in repeated testing. However, since ATD development is a continuing process, provision was made for using "equivalent" ATDs (Refer to 5.3.2.4).

Anthropomorphic dummies used in the tests discussed in this document should be maintained to perform in accordance with the requirements described in their specification. Periodic teardown and inspection of the ATD should be accomplished to identify and correct any worn or damaged components, and appropriate ATD calibration tests (as described in their specification) should be accomplished if major components are replaced.

5.3.2.1 To measure the axial compressive load between the pelvis and lumbar column due to vertical impact as well as downward loads caused by upper torso restraints, a load (force) transducer shall be inserted into the ATD pelvis just below the lumbar column. A load cell compatible with a Part 572B ATD is commercially available for this application with no ATD modification necessary except installing shims as required to adjust the ATD seated height to the ATD specifications.

Prior to the commercial availability of this load cell some test facilities had to modify the ATD to install a femur load cell for this application. This modification is acceptable if it is done in accordance with the procedure outlined in AS8049 Revision A (Section 5.3.2.1 and Figure 8).

5.3.2.2 To prevent failure of the clavicle used in Part 572 Subpart B ATDs due to flailing, a clavicle of the same shape but of higher strength material can be substituted.

5.3.2.3 Submarining indicators such as electronic transducers, may be added on the ATD pelvis. These are located on the anterior surface of the ilium of the ATD pelvis without altering its contour and indicate the position of the pelvic restraint as it applies loads to the pelvis. These indicators can provide a direct record that the pelvic restraint remains on the pelvis during the test, and eliminate the need for careful review of high-speed camera images to make that determination.

(Section 5.3.2.1 revisions have made Figure 8 obsolete. The figure numbers have not been renumbered to preserve references to figures in this document that occur elsewhere.)

FIGURE 8 - (Intentionally Left Blank)

5.3.2.4 Equivalent ATDs: The continuing development of ATDs for dynamic testing of seating restraint/crash-injury-protection systems is guided by goals of improved biofidelity (human-like response to the impact environment) and reproducibility of test results. For the purposes of the tests discussed in this document, these improved ATDs can be considered the equivalent of the Part 572B ATD if:

a. They are fabricated in accordance with design and production specifications established and published by a regulatory agency that is responsible for crash injury protection systems;

b. They are capable of providing data for the measurements discussed in this document or of being readily altered to provide the data;

c. They have been evaluated by comparison with the Part 572B ATD and are shown to generate similar or improved response to the impact environment discussed in this document; and

d. Any deviations from the Part 572B ATD configuration or performance are representative of the occupant of a civil aircraft in the impact environment discussed in this document.

e. They are Hybrid III ATDs (49 CFR Part 572, Subpart E) modified in accordance with SAE Technical Paper 1999-01-1609 (Reference 2.1.5).

ATD drawings are available using the instructions provided in 49 CFR Part 572 (Reference 2.2.7)

5.3.2.5 ATDs shall be maintained at a temperature range between 19 to 26 °C (66 to 78 °F) and at a relative humidity from 10 to 70% for a minimum of 4 h prior to and during the test.

5.3.2.6 Each ATD should be clothed in form-fitting cotton stretch garments with short sleeves, mid-thigh length pants, and size 45 (11E) shoes weighing about 1.1 kg (2.5 lb). 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.

5.3.3 Test Fixtures: A test fixture is required to position the test article on the sled or drop carriage of the test facility and takes the place of the aircraft's floor structure. It does not need to simulate the aircraft floor flexibility. It holds the attachment fittings or floor tracks for the seat. If required for the test, it provides the floor deformation (also referred to as floor warpage or floor distortion); provides anchorage points for the restraint system; provides a floor or footrest for the ATD; and positions instrument panels, bulkheads, or a second row of seats.

5.3.3.1 Floor Deformation Fixtures: For the typical seat with four seat legs mounted in the aircraft on two parallel tracks, the floor deformation test fixture shall consist of two parallel beams: a pitch beam that pivots about a lateral (y) axis and a roll beam that pivots about a longitudinal (x) axis (see Figure 9A for a schematic representation). The beams can be made of any rigid structural form: box, I-beam, channel, or other appropriate cross section. The pitch beam shall be capable of rotating in the x-z plane up to ±10° relative to the longitudinal (x) axis. The roll beam shall be capable of ±10° roll about the centerline of floor tracks or fittings. A means shall be provided to fasten the beams in the deformed positions.

The beams shall have provisions for installing load transducers (see 5.3.3.2) that carry floor track or other attachment fittings on their upper surface in a manner that does not alter the above-floor strength of the track or fitting.

5.3.3.2 Load Transducer Installation: The pitch and roll beams shall have provisions for installing individual load transducers at each seat leg attachment point capable of measuring three reaction forces and, if following the alternate procedure of 5.3.3.3, three reaction moments. The load transducers shall have provisions to install floor track or other attachment fittings on their upper surface in a manner that does not alter the above-floor strength of the track or fitting.

In some cases the load cells cannot be physically centered under all the seat attachment points. For this situation, the load cells shall be centered under the critical seat attachment points that will be highest loaded during the test. For the remaining attachment points the load cells shall be positioned as close to the center of the attachment that physical space limitations allow.

5.3.3.3 Aircraft Floor Track or Attachment Fitting Simulation: The track or other attachment fittings must be representative in above-floor configuration and strength of those used in the aircraft. Structural elements below the surface of the floor that are not considered part of the floor track or seat attachment fitting need not be included in the installation. An example of the minimum required representation of a floor track is shown in Figure 9F for one type of seat track.

However, if representative track or attachment fittings are not used, three components of reaction forces and three components of reaction moments shall be measured during dynamic tests. These six components shall be applied simultaneously, by a separate static or dynamic test, to a track or attachment fitting used on the aircraft in which the seat is to be installed, or to a more critical track or attachment fitting than that used on the aircraft, to demonstrate that the loads measured in the dynamic impact test will not fail the track or attachment fitting used on the aircraft.

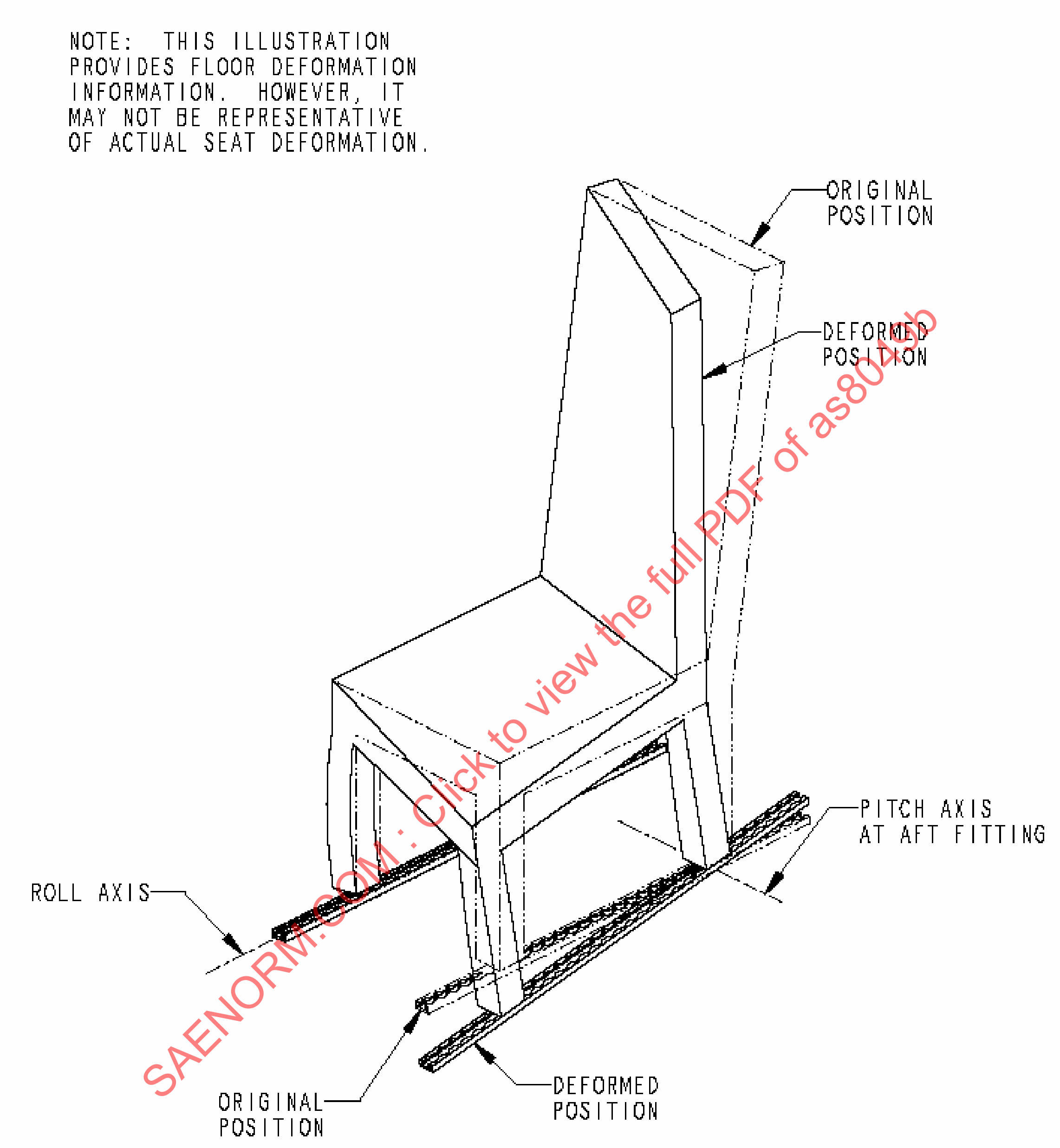


FIGURE 9A - Schematic of Floor Deformation: Seat Legs Attached at Floor Level

5.3.3.4 Seat Installation and Floor Deformation Procedure: The test seat shall be installed on the parallel beams of the deformation fixture so that the rear seat leg attachment point is near the pitch beam axis of rotation (see Figure 9A). The seat positioning pins or locks shall be fastened in the same manner as would be used in the aircraft, including the adjustment of anti-rattle mechanisms, if provided. The remainder of the test preparations shall then be completed (ATD installation and positioning, instrumentation installation, adjustment and calibration, camera checks, etc.).

The floor deformation shall be accomplished as the final action before the test. The roll beam shall be rotated 10° and locked in place, and the pitch beam(s) shall be rotated 10° and locked in place. The order in which the pitch and roll deformations are accomplished is arbitrary. Each direction of rotation shall be selected to produce the most critical loading condition on the seat and floor track or fitting (refer to Figure 9A).

Appropriate safety precautions should be taken while imposing floor deformation.

5.3.3.5 Other Mounting Configuration Constraints: The preceding discussion described the fixture and floor deformation procedure that would be used for a typical seat that uses four seat legs (i.e., four attachments to the aircraft floor). These test procedures are not intended to be restricted only to those seat configurations, but shall be adapted to seats having other designs. Special test fixtures may be necessary for those different configurations.

The following methods, while not covering all possible seat designs, shall be followed for the more common alternatives:

a. Aircraft seats with three legs (i.e., three floor attachment points) may have one central leg in front or back of the seat, and one leg on each side of the seat. The central leg shall be held in its undeformed position as deformation is applied to the side legs.

b. Seats that have more than two pairs of legs should be tested with the floor warpage condition that results in the most critically stressed condition. This typically involves warping adjacent pairs of legs. Seats that employ several pairs of legs, ganged together by common cross tubes, can be distorted so that one pair (the critical pair) of legs is rolled, while the remaining legs on one side of the critical leg are pitched in unison. The legs that are pitched should be selected to increase the load on the critical leg, and stress the floor or track fitting in the most severe manner as shown in Figures 9B and 9C.

c. Seats that are wall-mounted must be evaluated individually. There are several types of mounting schemes, some of which are discussed below. An important consideration is the retention of the seat under dynamic conditions, and the test setup should account for this in wall-mounted seats as well. Seats that mount solely to a wall will not be subject to deformation or warpage prior to test except as noted below. The following guidance has been established with this objective in mind.

5.3.3.5 (Continued):

1. Seats that are mounted to primary aircraft structure, such as a pressure bulkhead, need only be tested with the attachment fitting mounted to rigid structure, in a manner equivalent to the production installation.

2. Seats mounted to a structure such as a structural bulkhead, galley or lavatory, where integral structural members are used for attachment of the seat, need only be tested with the attachment fitting mounted to a rigid structure, in a manner equivalent to the production installation.

3. Seats mounted to a structure, such as a structural bulkhead, galley or lavatory, where no integral structural members are used for attachment, should be tested with the seat attached to segments of the mounting surface. These segments are typically eight inch by eight inch sections of the panel. These sections can, in turn, be mounted to a rigid structure.

4. Seats that are mounted to single panel furnishings, such as class dividers or windscreens, where the panel essentially fulfills the role of the legs, should be treated the same as floor mounted seats. For the purpose of conducting tests, the entire assembly, including the panel and its attachments, should be included in the test setup. In this case, floor warpage should be applied to track-mounted furnishings.

d. Seats that are attached to both the floor and a bulkhead should be tested on a fixture that positions the bulkhead surface in a plane through the axis of rotation of the pitch beam. The bulkhead surface should be located perpendicular to the plane of the floor (the aircraft floor surface, if one were present) in the undeformed condition, or in a manner appropriate to the intended installation. Either a rigid bulkhead simulation or an actual bulkhead panel can be used. If a test fixture with a rigid bulkhead simulation is used, the seat restraint system shall attach to fittings installed in a test panel equivalent to those used in the actual installation. The seat should be attached to the bulkhead and the floor in a manner representative of the aircraft installation, and the floor shall then be deformed as described in 5.3.3.4.

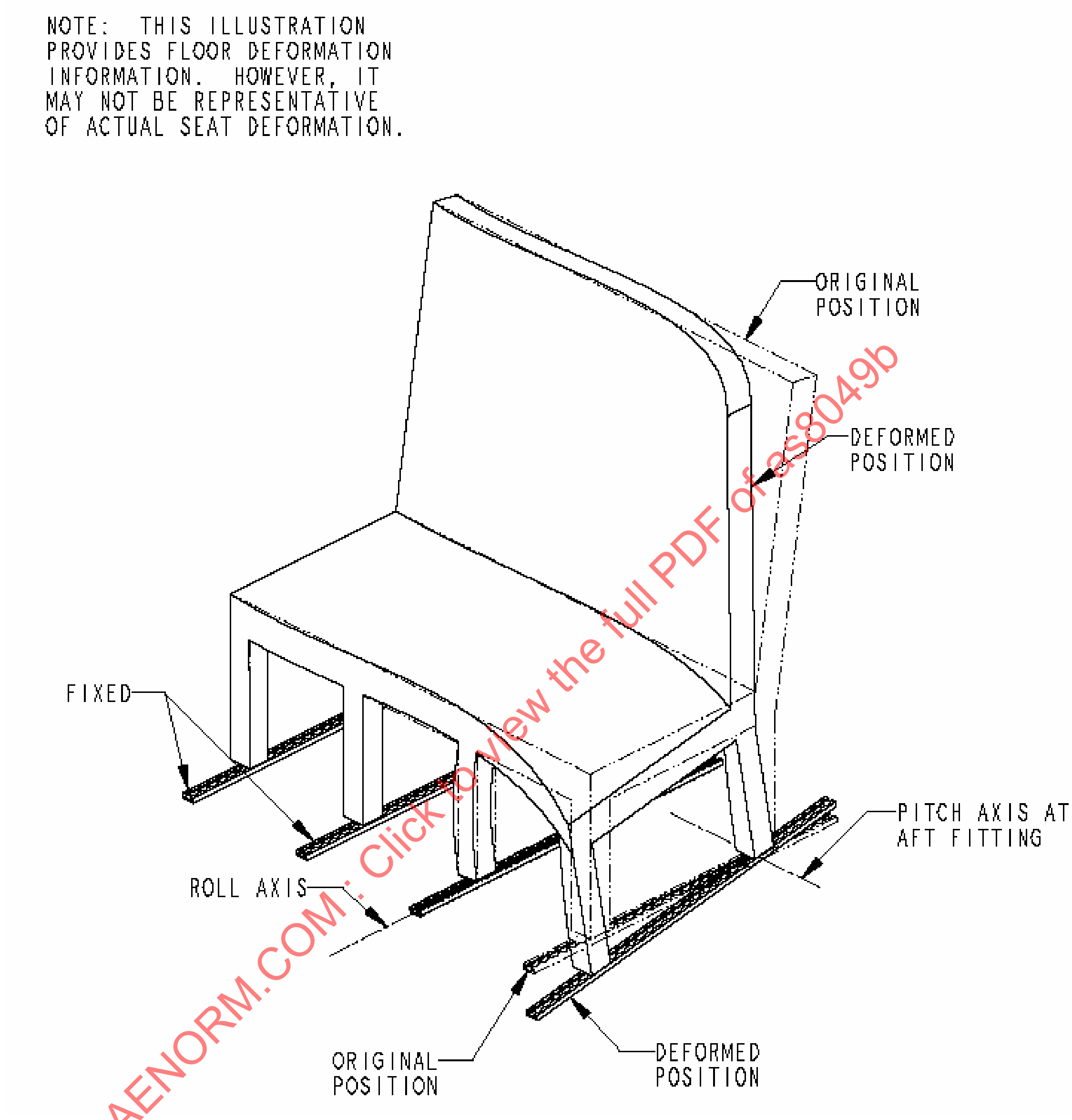


FIGURE 9B - Schematic of Floor Deformation: Multiple Leg Seat

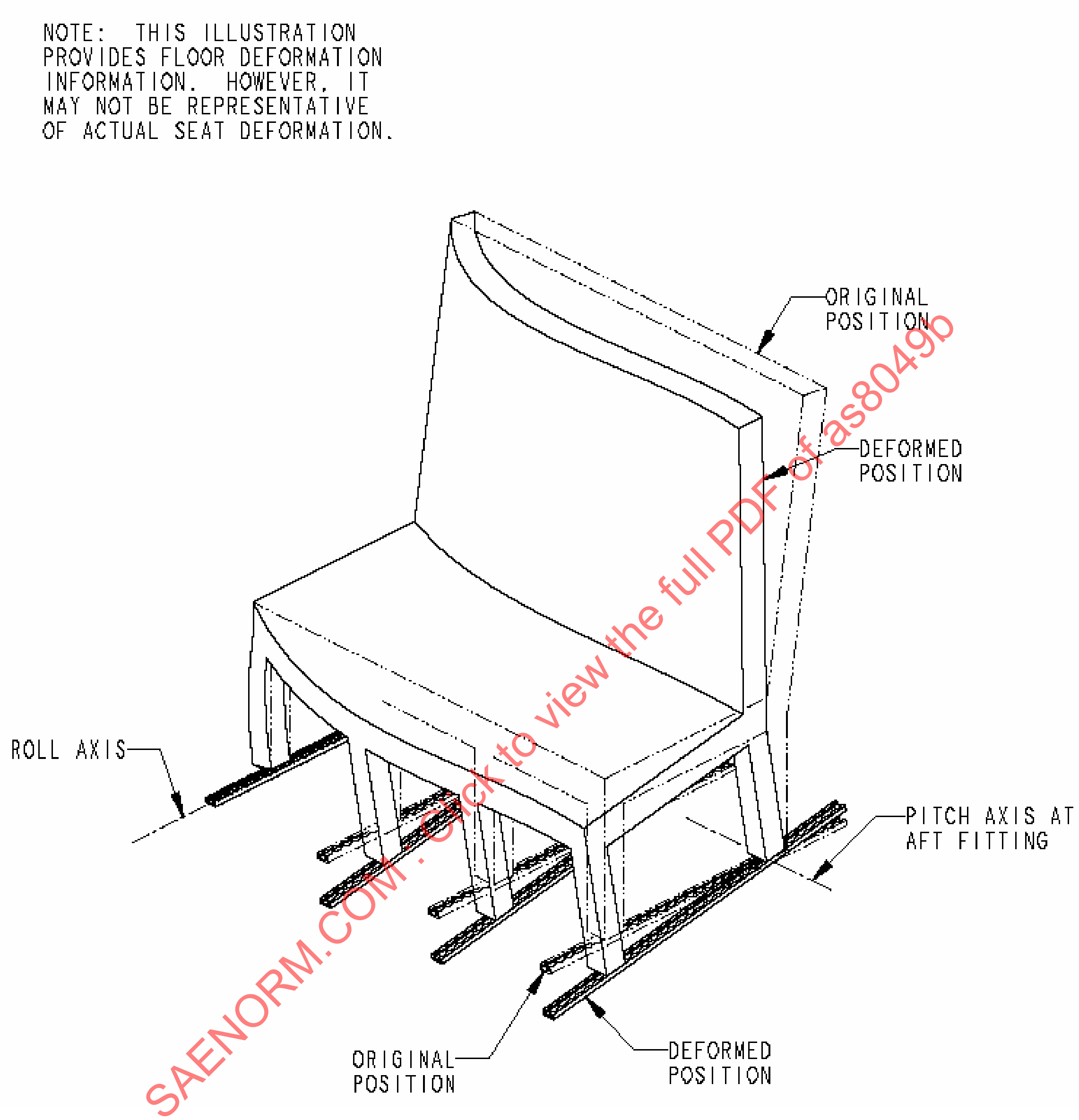


FIGURE 9C - Schematic of Floor Deformation: Multiple Leg Seat

5.3.3.5 (Continued):

e. Seats that incorporate attachments to the aircraft sidewall must be evaluated taking into consideration the expected aircraft fuselage cross-section deformation during a crash. The seat could be mounted between sidewalls or to the sidewall and the floor. The test fixture shall allow either a pitch beam or a roll beam to be installed at the outboard attachment structure of the seat. The seat positioning pins or locks shall be fastened in the same manner as would be used in the aircraft, including the adjustment of anti-rattle mechanisms, if provided. The following two seat attachment cases incorporating sidewall attachment will be considered.

   1. For the case where there are both sidewall and inboard floor attachments, two tests may be required.

      To substantiate the seat and sidewall attachment structure, the roll beam will be installed on the sidewall attachment and the pitch beam will be installed on the inboard floor location as shown in Figure 9D. The test shall be conducted with the roll beam rotated simulating the sidewall rotating outboard as shown in Figure 9D. The pitch beam rotation and the yaw angle direction of the seat shall be selected to produce the critical loading condition for the sidewall attachment structure.

      To substantiate the seat and inboard floor attachment structure, the roll beam will be installed on the inboard floor attachment and the pitch beam will support the sidewall attachment as shown in Figure 9E. The pitch and roll directions of the test fixture and the yaw direction of the seat shall be selected to produce the critical loading condition for the inboard attachment structure.

      Both tests are required unless it can be shown by rational analysis that testing one attachment structure in its critical condition substantiates the other attachment structure.

   2. For the case where the seat is mounted between aircraft sidewalls wih no floor attachment structure, the roll beam shall be installed at the critical outboard attachment structure while the pitch beam is located at the other outboard attachment structure. The test shall be conducted with the roll beam rotated simulating the sidewall rotating outboard as shown in Figure 9D. The pitch beam rotation and the yaw angle of the seat shall be selected to produce the critical loading condition for the outboard attachment structure.

f. Seats that are cantilevered from one sidewall without connection to other structure are not subject to floor deformation. A determination shall be made whether sidewall deformations could be expected that could generate a condition critical for seat performance in a crash. If sidewall deformation is likely, the entire sidewall attachment plane, or the attachment points, shall be deformed in a manner to represent the sidewall deformation. Either a rigid sidewall simulation or an actual sidewall panel may be used. If a test fixture with a rigid sidewall simulation is used, the seat/restraint system shall be attached to fittings installed in a test panel equivalent to those used in the actual installation.

5.3.3.5 (Continued):

g. Floor mounted adapter plates that have single seat assemblies (whether single or multiple place) attached to them should be considered part of the seat assembly. The adapter plate and its attached seat should be deformed as described in 5.3.3.4. Any items of mass attached to the adapter plate need to be represented and included in the dynamic testing.

h. Adapter plate installations involving multiple seat assemblies may be considered part of the floor structure of the airplane, but delineating factors have not been established at the time of this document.

i. Side-Facing Seats. Intentionally left blank

5.3.3.6 Multiple Row Test Fixtures: In tests of passenger seats that are normally installed in repetitive rows in the aircraft, head and knee impact conditions are best evaluated through tests that use at least two rows of seats. These conditions are usually critical only in Test 2. This test allows direct measurements of the head and femur injury data.

a. The fixture shall be capable of setting the aircraft longitudinal axis at a yaw angle of -10° and +10°. The fixture should also allow adjustment of the seat pitch.

b. To allow direct measurement of head acceleration for head injury assessment for a seat installation where the head of the occupant is within striking distance of structure, a representative impact surface may be attached to the test fixture in front of the front row seat at the orientation and distance from the seat representing the aircraft installation.

5.3.3.7 Other Fixture Applications: Test fixtures shall provide a flat floor for positioning the ATD's feet in tests using passenger seats and crewmember seats that are not provided with special foot rests or foot operated controls. The floor shall be at a position representative of the undeformed floor in the aircraft installation. Floors should not influence the behavior of the seat or unduly restrict the movement of the ATD's feet, especially when floor distortion is applied. A floor is not required when Test 2 is conducted only for the purpose of providing structural evaluation of the seat. Test fixtures used for evaluating crew seats that are normally associated with special foot rests or foot operated controls shall simulate those components. Test fixtures may also be required to provide guides or anchors for restraint systems or for holding instrument panels, sidewalls, or bulkheads if necessary for the planned tests. If these provisions are required, the installation shall represent the configuration of the aircraft installation and be of adequate structural strength.

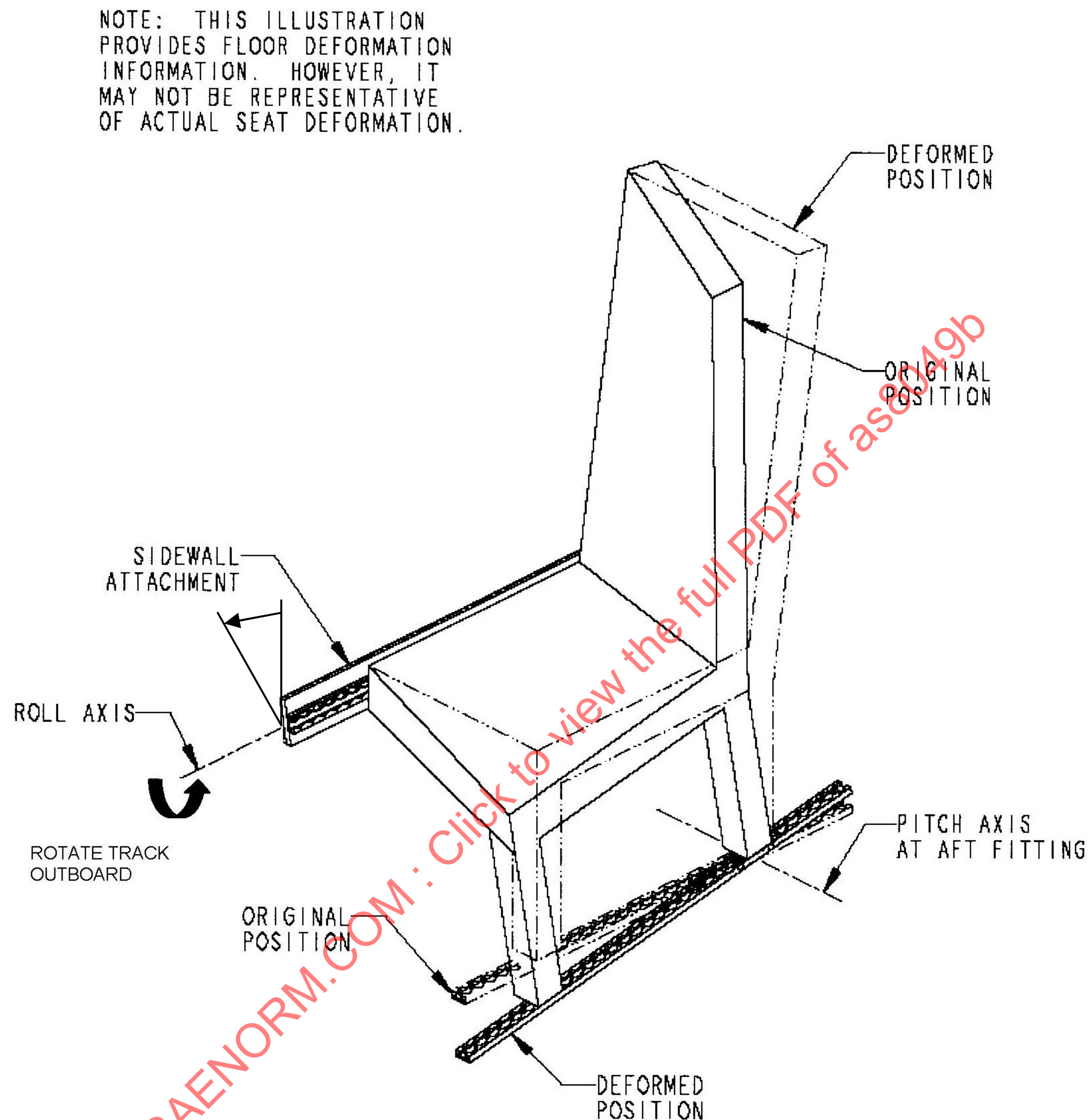


FIGURE 9D - Schematic of Floor Deformation: Side Wall Mounted Seat

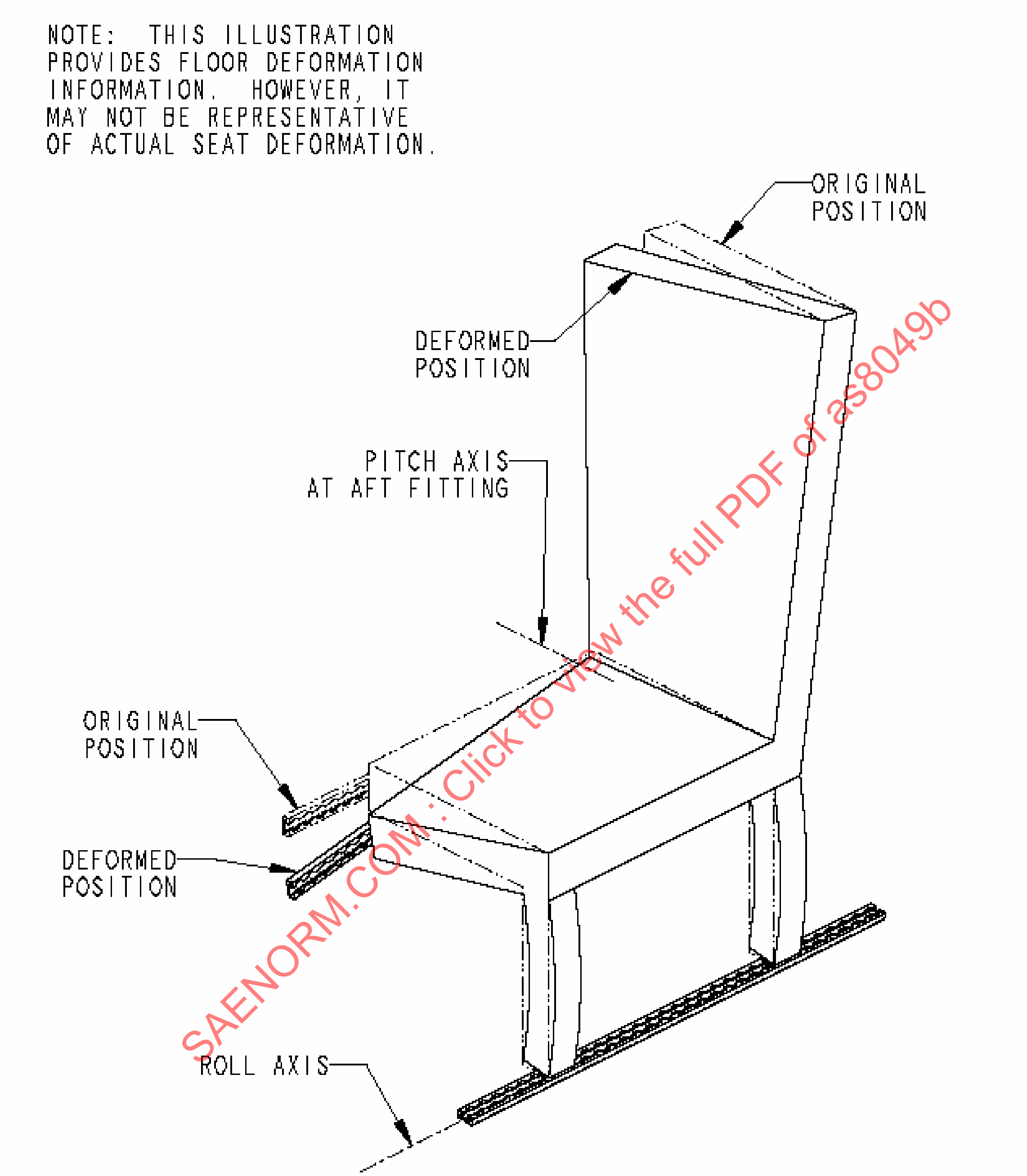


FIGURE 9E - Schematic of Floor Deformation: Side Wall Mounted Seat

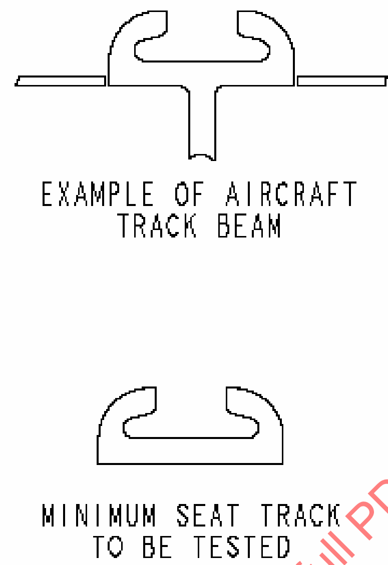


FIGURE 9F – Example of Minimum Seat Track for Testing

5.3.4 Instrumentation: Electronic and photographic instrumentation systems shall be used to record data for qualification of seats.

Electronic instrumentation shall measure the test environment, and measure and record data required for comparison of performance to pass/fail criteria.

Photographic instrumentation shall document overall results of tests, confirming that the pelvic restraint remains on the ATD's pelvis, that the upper torso restraint strap(s) remain on the ATD's shoulder(s) during impact, that the seat does not deform as a result of the test in a manner that would impede rapid evacuation of the aircraft by the occupants, and that the seat remains attached at all points of attachment.

5.3.4.1 Electronic Instrumentation: Electronic instrumentation shall be accomplished in accordance with SAE J211 using the sign convention specified in SAE J1733. In this practice, a data channel is considered to include all of the instrumentation components from the transducer through the final data measurement, including connecting cables and any analytical procedures that could alter the magnitude or frequency content of the data. Each dynamic data channel is assigned a nominal channel class that is equivalent to the high frequency limit for that channel, based on a constant output/input ratio versus frequency response plot which begins at 0.1 Hz (+1/2 to -1/2 dB) and extends to the high frequency limit (+1/2 to -1 dB). Frequency response characteristics beyond this high frequency limit are also specified. When digitizing data, the sample rate should be at least five times the -3 dB cutoff frequency of the presample analog filters. Since most facilities set all presample analog filters for Channel Class 1000, and since the -3 dB cutoff frequency for Channel Class 1000 is 1650 Hz, the minimum digital sampling rate would be about 8000 samples per second. For the dynamic tests discussed in this document, the dynamic data channels shall comply with the following Channel Class characteristics:

a. Sled or drop tower vehicle acceleration data measurements shall be in accordance with Channel Class 60 requirements. Velocity change obtained from the measured acceleration by integration shall require acceleration data measured in accordance with Channel Class 60 or 180 requirements.

b. Belt-restraint system and seat attachment reaction loads (when required) shall be measured in accordance with the requirements of Channel Class 60. Loads in restraint systems that attach directly to the test fixture can be measured by three-axis load cells fixed to the test fixture at the appropriate location. These commercially available load cells measure the forces in three orthogonal directions simultaneously, so that the direction as well as the magnitude of the force can be determined. If desired, similar load cells can be used to measure forces at other boundaries between the test fixture and the test item, such as the forces transmitted by the legs of the seat into the floor track. It is possible to use independent, single axis load cells arranged to provide similar data, but care should be taken to use load cells that can withstand significant cross axis loading or bending without causing errors in the test data.

c. ATD head accelerations used for calculating the Head Injury Criterion (HIC) shall be measured in accordance with the requirements of Channel Class 1000.

d. ATD femur forces shall be measured in accordance with Channel Class 600.

e. ATD pelvic/lumbar column force shall be measured in accordance with the requirements of Channel Class 600.

f. The full scale calibration range for each channel shall provide sufficient dynamic range for the data being measured.

g. Digital conversion of analog data shall provide sample resolution of not less than 1% of full scale input.

5.3.4.2 Photographic Instrumentation: Photographic instrumentation shall be used for documenting the response of the ATDs and the test items to the dynamic test environment. Both high speed and still image systems should be used. SAE ARP5482 provides recommended practices for photometric data acquisition.

a. Photographic instrumentation shall be in accordance with SAE J211, Part 2. High speed cameras that provide data used to calculate displacement or velocity shall operate at a minimum nominal speed of 500 frames per second. Photo instrumentation methods shall not be used for determination of acceleration. The locations of the cameras and targets or targeted measuring points within the field of view shall be measured and documented. Targets shall be at least 1/100 of the field width covered by the camera and shall be of contrasting colors or shall contrast with their background. The center of the target shall be easily discernible.

   A description of photographic calibration boards or scales within the camera field of view, the camera lens focal length, and the make and model of each camera and lens shall be documented for each test. Appropriate digital or serial timing shall be provided on the image media. A description of the timing signal, the offset of timing signal to the image, and the means of correlating the time of the image with the time of electronic data shall be provided.

   Rectilinearity of the image shall be documented in accordance with SAE J211, Part 2. If the image is not rectilinear, as indicated by an Overall Error in excess of 1%, appropriate correction factors shall be used in the data analysis process. A rigorous, verified analytical procedure shall be used for data analysis. The accuracy of the procedure is considered adequate if the difference between the measured and derived distance separating the Validation Target Pair, as defined in SAE J211, Part 2, is not greater than 1.0 cm (0.4 in).

b. Cameras operating at a nominal rate of 200 frames per second or greater may be used to document the response of ATDs and test items if measurements are not required. For example, actions such as movement of the pelvic restraint system webbing off of the ATD's pelvis can be observed by documentation cameras placed to obtain a "best view" of the anticipated event. These cameras should be provided with appropriate timing and a means of correlating the image with the time of electronic data.

c. Still image cameras shall be used to document the pretest installation and the posttest response of the ATDs and the test items. At least four pictures shall be obtained from different positions around the test items in pretest and posttest conditions. Where an upper torso restraint system is installed, posttest pictures shall be obtained before moving the ATD. For additional posttest pictures, the ATD's upper torso may be rotated to its approximate upright seated position so that the condition of the restraint systems may be better documented, but no other change to the posttest response of the test item or the ATD shall be made. The pictures shall document that the seat remained attached at all points of attachment to the test fixture.

5.3.4.2 (Continued):

Still pictures may also be used to document posttest yielding of the seat for the purpose of showing that it would not impede the rapid evacuation of the aircraft occupants. The ATD should be removed from the seat in preparation for still pictures used for that purpose. Targets or an appropriate target grid should be included in such pictures, and the views should be selected so that potential interference with the evacuation process can be determined. For tests where the ATD's head impacts a fixture or another seat back, pictures shall be taken to document the head contact areas.

5.3.5 Selection of Test Articles: Many seat designs comprise a family of seats that have the same basic structural design but differ in detail. For example, a basic seat frame configuration can allow for several different seat leg locations to permit installation in different aircraft. If these differences are of a nature that their effect can be determined by rational analysis, then the analysis can determine the most critical configuration. As a minimum, the most highly stressed configuration shall be selected for the dynamic tests so that the other configurations could be accepted by comparison with that configuration.

There are two factors that must be considered in selecting the critical structural test configurations. First, the seat to aircraft interface loads (undeformed seat) can be determined by rational analysis for the seat design and load configurations. The rational analysis can be based on static or dynamic seat/occupant analytical methods. The rational analysis can form the basis for selecting the most highly stressed critical configuration based on load. Additionally, the effects of seat deformation should be considered. As noted, a family of seats typically includes seat models with varied seat leg locations. The effects of floor deformation are more critical for narrowly spaced legs. Thus, a test or rational analysis of the seat model with the minimum seat leg spacing must be conducted to evaluate the most highly stressed critical configuration based on deformation.

5.3.5.1 In all cases, the test article must be representative of the final production article in all structural elements, and shall include the seat, seat cushions, restraints and armrests. It must also include a functioning position adjustment mechanism and correctly adjusted break over (if present).

Weights simulating luggage carried by luggage restraint bars [9.1 kg (20 lb) per passenger place] need only be representative masses.

Items 0.15 kg (0.33 lb) or greater carried by the seat that affect the dynamic performance of the seat, including occupant injury and egress, must be representative of the production item and production means of attachment on the test article.

Items 0.15 kg (0.33 lb) or greater carried by the seat that do not affect the dynamic performance of the seat may be representative masses, but the production means of attachment must be on the test article.

5.3.5.1 (Continued):

Items less than 0.15 kg (0.33 lb) and their means of attachment are not required to be on the test article. However, the mass of the item must be included on the test article as ballast.

Wiring harnesses, regardless of weight, may be represented on the test article by ballast weights. The production means of attachment need not be included in the test.

Life vests must be installed on the test article, if provisions are provided, but are not required to be the production life vest. Any life vest of equivalent weight, or greater, may be included on the test article. The life vest may be ballasted to substantiate heavier life vests.

In any case, the separation of an item of mass should not leave any sharp or injurious edges. Function of equipment or subsystems after the test is not required. Once it has been demonstrated that an item can be retained in its critical loading case, subsequent tests may be conducted with the item secured for test purposes.

5.3.5.2 The following additional items shall be considered in choosing test articles and the manner of loading:

a. If a multiple place seat incorporates energy absorbing or load limiting features that are necessary to meet the test criteria or other requirements, a partially occupied seat may adversely affect the performance of that seat. In such a case it shall be shown, by rational analysis or additional testing, that the seat will continue to perform as intended even with fewer occupants.

b. If different configurations of the same basic design incorporate load-carrying members, especially joints or fasteners, that differ in detail design, the performance of each detail design shall be demonstrated in a dynamic test. Experience has shown that small details in the design often cause problems in meeting the test performance criteria.

c. Additional dynamic impact testing may be required for a seat with features that could affect its performance even though the test may not be the most critical case based on structural performance; e.g., if in one of the design configurations the restraint system attachment points are located so that the pelvic restraint is more likely to slip above the ATD's pelvis during the impact, that configuration shall also be dynamically tested even though the structural loading might be less than the critical configuration in a family of seats.

5.3.5.2 (Continued):

d. Typical dress cover materials, including synthetic and natural fabrics, and leather, can be used on a seat without testing more than one material, or substituted on an already certificated seat. Evaluation of such materials has shown that their effect on test results is small, particularly considering other factors such as occupant clothing. Unusual seat surfaces, such as hard plastics that exhibit very low friction coefficients, may require some additional substantiation.

5.3.6 Selection of Test Conditions: The tests shall achieve the most critical conditions.

5.3.6.1 For multiple place seats, a rational structural analysis shall be used to determine the number and seat location for the ATDs and the direction for seat yaw in Test 2 to provide the most critical seat structural test. This will usually result in unequally loaded seat legs. The floor deformation procedure shall be selected to increase the load on the highest loaded seat leg and to load the floor track or fitting in the most severe manner. Section 5.3.3.5(b) provides a procedure for use with seats having more than two pairs of legs.

5.3.6.2 If multiple row testing is used to gather data to assess head injury protection in passenger seats, the seat pitch shall be selected so that the head would be most likely to contact a hard structure in the forward seat row. The effect of the 10° yaw in Test 2, the seat back breakover, and front seat occupancy shall be considered. Results from previous tests or rational analysis may be used to estimate the head strike path of similar seats in similar installations. The front row may be unoccupied. This test methodology may also be used to assess femur injury protection.

5.3.6.3 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. For a forward-facing seat equipped with a single diagonal shoulder belt, the Test 2 yaw direction should be selected such that the belt passes over the trailing shoulder.

5.3.6.4 If a seat has vertical or horizontal adjustments, it shall be tested in the position that produces the most critical loads on the seat structure (typically the highest vertical position). Only positions allowed for takeoff and landing need be considered. Seat adjustments that do not have a significant effect on structural loading (e.g., thigh support angle, lumbar support, armrest and headrest positions) shall be tested in the design positions for the 50th-percentile male occupant, unless special requirements dictate the positions allowed for takeoff and landing. In addition, height adjustment should be relative to the interior envelope as it relates to the upper contour (ceiling) of the aircraft whenever a specific seat design is approved in a particular aircraft. Therefore, the seat need not be raised to a position that causes a 50th percentile male occupant to extend outside the confines of the aircraft interior.

5.3.6.5 Floor deformation need not be considered in assessing the consequence of seat deformation relative to the possible impairment of rapid evacuation of the aircraft. After a test, the pitch and roll floor beams may be returned to their neutral positions and the necessary measurements made to determine possible impairment of the evacuation process.

5.3.6.6 In some cases, it may not be possible to measure data for head impact injury during the basic test of the seat and restraint system. The design of the surrounding interior may not be known to the designer of the seat system, or the system may be used in several applications with different interior configurations. In such cases, the head strike path and the head velocity along the path shall be documented. This will require careful placement of photo instrumentation cameras and location of targets on the ATD representing the ATD's head center of mass so that the necessary data can be obtained. These data can be used by the interior designer to ensure either that head impact with the interior will not take place or that, should any unavoidable head impacts occur, they can be evaluated using HIC measurements in subsequent subsystem tests.

5.3.7 Installation of Instrumentation: Professional practice shall be followed when installing instrumentation. Care shall be taken when installing the transducers to prevent deformation of the transducer body which could cause errors in data. Transducer lead-wires shall be routed to avoid entanglement with the ATD or test article, and sufficient slack shall be provided to allow motion of the ATD or test article without breaking the lead-wires or disconnecting the transducer. Cables and wires shall be sufficiently secured to inhibit the introduction of cable whip errors. Calibration procedures shall consider the effect of long transducer lead-wires. When needed, head accelerometers and femur load cells shall be installed in the ATD in accordance with the ATD specification and the instructions of the transducer manufacturer. The load cell between the pelvis and the lumbar column shall be installed in a manner that will provide equivalent data (5.3.2.1).

5.3.7.1 If an upper torso restraint is used, the tension load shall be measured in a segment of webbing between the ATD shoulders and the first contact of the webbing with hard structure (the anchor point or a webbing guide). Restraint webbing shall not be cut to insert a load cell in series with the webbing, since that will change the characteristics of the restraint system. Load cells that can be placed over the webbing without cutting are commercially available. They shall be placed on free webbing to minimize contact with hard structure, seat upholstery, or the ATD during the test. They shall not be used on double-reeved webbing, multiple-layered webbing, locally stitched webbing, or folded webbing unless it can be demonstrated that these conditions do not cause errors in the data. These load cells shall be calibrated using a length of webbing of the type used in the restraint system. If the placement of the load cell on the webbing causes the restraint system to sag, the weight of the load cell can be supported by light string or tape that will break away during the test.

5.3.7.2 Since load cells are sensitive to the inertial forces of their own internal mass, to the mass of fixtures located between them and the test article, as well as to forces applied by the test article, it may be necessary to compensate the test data for that inaccuracy if the error is significant. Data for such compensation will usually be obtained from an additional dynamic test that replicates the load cell installation but does not include the test article.

5.3.8 Procedure to Set Up the Test: Preparation for the tests will involve positioning and securing the ATD, the ATD restraint system, the seat, and the instrumentation. This will be done for the specific critical condition being tested. Preparations that pertain to the normal operation of the test facility, such as safety provisions and the actual procedures for accomplishment of the tests, are specific to the test facility and will not be addressed in this document.

5.3.8.1 The test fixture shall be oriented as required for the given test conditions.

5.3.8.2 Each seat shall be installed in the test fixture and secured in a manner representative of its intended use.

5.3.8.3 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. The friction in a limb joint shall be set so that it barely restrains the weight of the limb when extended horizontally.

b. The ATD should be placed in the center of the seat, in as nearly a symmetrical position as possible.

c. The ATD's back should be against the seat back or the shim described in paragraph h of this section without clearance. This condition can be achieved if the ATD legs are lifted as it is lowered into the seat. Then, the ATD is pushed back into the seat back as it is lowered the last few inches into the seat pan. Once all lifting devices have been removed from the ATD, it should be rocked slightly to settle it in the seat.

d. The ATD's knees should be separated approximately 100 mm (4 in).

e. The ATD's hands should be placed on the top of its upper legs, just behind the knees. If tests on crew seats are conducted in a mockup that has aircraft controls, the ATD's hands should be lightly tied to the controls.

f. All seat adjustments and controls shall be set as indicated in 5.3.6.4. To the extent that they influence the injury criteria, all 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.

5.3.8.3 (Continued):

g. The feet shall be in the appropriate position for the type and usage of a seat being tested (flat on the floor, on control pedals or on a 45° footrest for flightcrew systems). The feet shall be placed so that the centerlines of the lower legs are approximately parallel, unless the need for placing the feet on aircraft controls dictates otherwise.

h. If the seating system is tested in other than a “horizontal floor” orientation, it is recommended that the ATD be placed 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. If necessary, auxiliary restraints may be used 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.

5.3.8.4 For tests where the ATD's head is expected to impact a fixture or another seat back, the head and face of the ATD may be treated with a suitable material to mark head contact areas. The material used must not reduce the resulting HIC values.

5.3.8.5 The restraint system adjustment shall be made as follows. The restraint system shall not be tightened beyond the level that could reasonably be expected in use and the emergency locking device (inertia reel) shall not be locked prior to the impact. Automatic locking retractors shall be allowed to perform the webbing retraction and automatic locking function without assistance. Care shall be taken that emergency locking retractors that are sensitive to acceleration do not lock prior to the impact test because of preimpact acceleration applied by the test facility. If comfort zone retractors are used, they shall be adjusted in accordance with instructions given to the user of the restraint system.

If manual adjustment of the restraint system is required, slack shall be removed, and the restraint system should be snug, but not excessively tight, about the ATD. For Test 2, this can normally be determined when two fingers will fit snugly between the belt and the pelvis of the ATD. The restraint system shall be checked and adjusted just prior to the floor deformation phase of the test.

5.3.8.6 Floor deformations, if applicable, shall be applied with the load measuring instrumentation functioning so that the measured loads will include the loads due to floor deformation as well as those resulting from the dynamic test.

5.3.8.7 A floor is not required for Test 2 structural tests, but if a floor is installed, it should not influence the behavior of the seat, or unduly restrict the movement of the ATD’s feet. This is a concern especially when floor distortion is applied. A floor should be used for tests conducted to gather head path data.

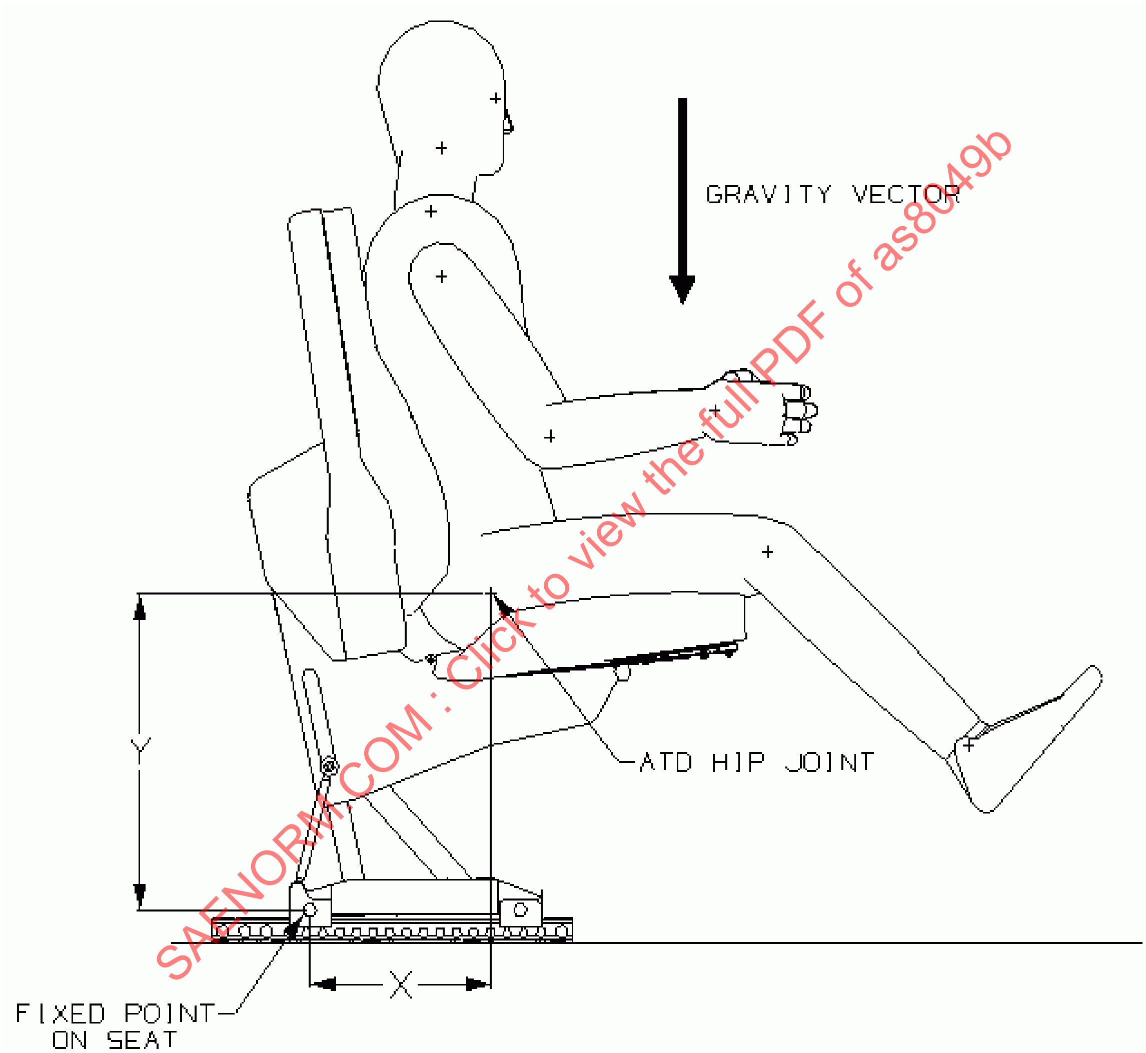


FIGURE 10 - Measurement of 1 g Preload

5.3.9 Data Analysis:

5.3.9.1 General: All data obtained in the dynamic tests should be reviewed for errors. Baseline drift, ringing, and other common electronic instrumentation problems should be detected and corrected before the tests. Loss of data during the test is readily observed in a plot of the data versus time and is typically indicated by sharp discontinuities in the data, often exceeding the amplitude limits of the data collection system. If these occur early in the test in essential data channels, the data should be rejected and the test repeated. If they occur late in the test, after the maximum data in each channel has been recorded, the validity of the data should be carefully evaluated, but the maximum values of the data may still be acceptable for the tests described in this document. The HIC does not represent simply a maximum data value, but represents an integration of data over a varying time base. The head acceleration measurements used for that computation are not acceptable if errors or loss of data are apparent in the data at any time from the beginning of the test until the ATD and all test articles are at rest after the test.

5.3.9.2 Impact Pulse Shape: Data for evaluating the impact pulse shape are obtained from an accelerometer that measures the acceleration in the direction parallel to the inertial response shown in Figures 6, 7A, and 7B. The impact pulses intended for the tests discussed in this document have an isosceles triangle shape. These ideal pulses are considered minimum test conditions. Since the actual acquired test pulses will differ from the ideal, it is necessary to evaluate the acquired test pulses to insure the minimum requirements are satisfied.

The five properties of the ideal pulse that must be satisfied by the acquired test pulse are (referring to Figures 6, 7A, and 7B, and as discussed in Appendix A):

Pulse shape: isosceles triangle

Greq: peak deceleration required by test condition

Treq: rise time required by test condition

V: total velocity change required by test condition

Vtr: velocity change required during Treq (Vtr = V/2)

A graphical technique can be used to evaluate pulse shapes that are not precise isosceles triangles. Appendix A presents the graphical method of evaluating the acquired pulse (the recorded test sled acceleration versus time).

5.3.9.2 (Continued):

For the acquired pulse to be acceptable, the following five criteria must be met:

a. The magnitude of the peak value for the acquired pulse, Gpk, must be greater than or equal to Greq.

b. The actual rise time, $Tr = T_2 - T_1$, must be less than or equal to Treq.

c. The result of integrating the acquired pulse during the interval from $t = T_1$ to $t = T_3$ must be equal to or greater than Vtr, which is one-half of the required velocity change for the specified test. If the magnitude of the acquired pulse is greater than the ideal pulse during the entire Interval from T_1 to T_3, this requirement is automatically met.

d. The result of integrating the acquired pulse during the interval from $t = T_1$ to $t = T_1 + 2.3(Treq)$ must equal or exceed the required test velocity change, V, of the test condition. If the acquired pulse returns to zero G's at $t = T_4 < (T_1 + 2.3(Treq))$, the end of the interval of integration is reduced to $t = T_4$.

e. If the magnitude of the acquired pulse is greater than the ideal pulse during the entire interval of $t = T_1$ to T_2, and the parameters of (a), (b), (c), and (d) above are satisfied, then the acquired pulse is acceptable.

If the magnitude of the acquired pulse is not greater than the ideal pulse during the entire interval $t = T_1$ to $1.33(T_3 – T_1)$, the difference between the acquired pulse and the ideal must be no greater than 2.0 G's at those times when the acquired pulse is less than the ideal. Parameters of (a), (b), (c) above must also be satisfied for the acquired pulse to be acceptable.

5.3.9.3 Total Velocity Change: Impact velocity can be obtained by measurement of a time interval and a corresponding sled displacement that occurs just before or after (if appropriate) the test impact and then dividing the displacement by the time interval. When making such a computation, the possible errors of the time and displacement measurements shall be used to calculate a possible velocity measurement error, and the test impact velocity should exceed the velocity shown in Figure 6, 7A or 7B by at least the velocity measurement error. If the sled is not changing velocity during the immediate preimpact or postimpact interval, the impact velocity is the total velocity change. If the sled is changing velocity during the immediate preimpact or postimpact interval or if the facility produces significant rebound of the sled, the total velocity change can be determined by integrating the plot of sled acceleration versus time as described in Appendix A. If this method is used, the integration shall be performed on acceleration data measured in accordance with Channel Class 180 requirements (see 5.3.4.1a).

5.3.9.4 Head Injury Criterion (HIC): Data for determining the HIC need to be collected during the tests discussed in this document only if the ATD's head is exposed to impact on aircraft interior features (not including the floor or the ATD's own leg) during the test. The HIC is calculated according to the following equation:

$$HIC = \left\{ (t_2 - t_1) \left[(1/(t_2 - t_1)) \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\}_{max} \quad \text{(Eq. 1)}$$

where t_1 and t_2 are any two points in time (in seconds) during the head impact, and a(t) is the resultant head acceleration (expressed in g's) during the head impact.

The HIC is a method for defining an acceptable limit; i.e., the maximum value of the HIC shall not exceed 1000 for head impact against interior surfaces in a crash. The HIC is invariably calculated by computer based data analysis systems, and the discussion that follows outlines the basic method for computation. The HIC is based on data obtained from three mutually perpendicular accelerometers installed in the head of the ATD in accordance with the ATD specification. Data from these accelerometers are obtained using a data system conforming to Channel Class 1000, as described in SAE J211. Only the data taken during head impact with the aircraft interior need be considered; this is usually indicated by a rapid change in the magnitude of the acceleration data. Film of the test may show head impact that can be correlated with the acceleration data by using the time base common to both electronic and photographic instrumentation. Simple contact switches that do not significantly alter the surface profile could also be used to define the initial contact time.

In many cases, a full system sled test to evaluate specific occupant injury conditions may not be needed to evaluate a redesign of the seat system that affects only HIC. In such cases, the photometric head path data can be gathered and used to ensure no contact will occur, or to define the head angle and velocity at impact. These data can then be used in a component test of severity comparable to the whole system sled test. Other factors, such as the inertial response of the impact target, must be accounted for in the component test condition so that the impact condition is representative. Component testing methods used for HIC measurement must be demonstrably equivalent to whole system sled test HIC measurements.

Additionally, a seat may be designed for use in multiple locations where head contact against a range of unknown bulkhead targets is anticipated (e.g., front row seats). For these seats, HIC may be measured using a representative impact target mounted in front of the seat at the installation setback, or range of setbacks. This target will represent typical fixtures such as galleys, partitions, lavatories, and closets, and its stiffness will be representative for those monuments. If contact occurs, the HIC must not exceed 1000.