SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP5526

REV. A

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Superseding ARP5526

(R) Aircraft Seat Design Guidance and Clarifications

1. SCOPE:

The goal of this SAE Aerospace Recommended Practice (ARP) is to promote a common understanding of terms, compliance issues and design criteria in order to facilitate certification of seat installations in an aircraft. This ARP does not specify specific designs or design methods for such certification.

2. REFERENCES:

2.1 SAE Publications:

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

2.1.1 AS8049, Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft

2.2 Code of Federal Regulations (CFR) Publications:

Available from 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 23 (14 CFR Part 23) Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes

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

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
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Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

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

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

2.2.5 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

2.3 Federal Aviation Administration Advisory Circular (AC):

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

2.3.1 AC 25-17, Transport Airplane Cabin Interiors Crashworthiness Handbook

2.4 Department of Transportation Technical Standard Order (TSO):

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

2.4.1 TSO-C39, Aircraft Seats and Berths

2.4.2 TSO-C127, Rotorcraft, Transport Airplane and Normal and Utility Airplane Seating Systems

2.4.3 TSO-C22, Safety Belts

2.5 Aerospace Industries Association (AIA) National Aerospace Standard (NAS):

Available from Aerospace Industries Association, 1250 Eye Street, NW, Suite 1200, Washington, DC 20005-3924 (202) 371-8400.

2.5.1 NAS 809, Specification - Aircraft Seats and Berths

2.6 National Air and Space Administration:

Available from MSIS Custodian/SP2, NASA-Johnson Space Center, Houston, TX 77058.

2.6.1 NASA-STD-3000 Man-Systems Integration Standards

3. DEFINITIONS:

FAR references can be considered valid across aircraft categories: 14 Code of Federal Regulations Parts 23, 25, 27 and 29.

3.1 Seat Back Handhold in Turbulence:

3.1.1 Application:

14 CFR Part 25.785 (j)
If the seat backs do not provide a firm handhold, there must be a handgrip or rail along each aisle to enable persons to steady themselves while using aisles in moderately rough air.

AC 25-17 par. 81.b (6) Crashworthiness Handbook
The seat back may serve as a firm handhold. Since many seats are capable of breaking over, the breakover load must be adequate to be considered firm. A load of 111 N (25 pounds) minimum, acting horizontally, is considered adequate when applied at the top center of the seat back.

3.1.2 Definition and Criteria: A handhold is defined as a means of providing a hand hold support for a person standing upright in an aisle during flight. If an adequate supplemental rail or handgrip is not provided in the interior, seat backs may be used as the handhold so long as they are spaced sufficiently close together to be within reach for an occupant using the aisle. For that purpose, a seat pitch of 165 cm (65 inches) or less is considered adequate in a typical commercial transport aircraft configured with forward or rearward facing passenger seats positioned along an aisle. Due to the unique and customized interior arrangement of forward, sideward or rearward facing passenger seats in business/private transport aircraft (not for hire) these configurations should be assessed individually. Divan seating and side facing seats do not normally place the seat back where it can be effectively used as a handhold.

To act as a handhold, the upper aisle-side corner of the seat back should provide either a surface to grip or push against. A seat back used as a handhold should not break over when a force of 111 N (25 pounds) in a direction perpendicular to the seat back is applied at the top center of the seat back. Seat backs with head rests that telescope more than three inches above the seat back may be used for a handhold if, in addition to all other requirements, no portion of the head rest, e.g. bendable ears and/or tilting head rest, can be moved more than 17.8 cm (7 inches) before a 111 N (25 pounds) resistive force is met.

The seat back handhold should be at least 84 cm (33 inches) above the floor, even if the seat back is reclined.

3.2 Seat Belt Misalignment/Disengagement:

3.2.1 Application:

Restraint
The term restraint in this section refers to any strap, webbing, or similar device designed to secure a person in an aircraft with the intention of minimizing injury, including all buckles or other fasteners, and all integral hardware.

14 CFR PART 25.601
The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

14 CFR PART 25.562
(a) The seat and restraint system in the airplane must be designed as prescribed in this section to protect each occupant during an emergency landing condition when -
(1) Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design;

TSO-C127a
2.1.2 Compliance with Section 3.1 Guidance: of SAE AS8049A is not required, except for Subsections 3.1.4, 3.1.8, 3.1.11, 3.1.14 (passenger seats only), 3.1.15 and 3.1.17 through 3.1.20.

NAS 809
When anchorages for safety belts are provided, they should be of a type which will permit self-aligning of the belt or fitting.

AS8049A
3.1.11 Restraint system anchorages should provide self-aligning features. If self-aligning features are not provided, the static and dynamic tests in this document should be conducted with the restraints and anchorages positioned in the most adverse configuration allowed by the design. The anchorage system should minimize the possibility of incorrect installation or inadvertent disconnection of the restraints.

3.2.2 Definition and Criteria: Seatbelt misalignment is a condition where the seatbelt and/or shackle is positioned to give the impression that the belt has been properly tightened, when in fact there is slack in the system or the shackle is positioned so that it will not carry the force generated in an emergency landing or turbulence condition.

The seat belt installation should provide a self-orienting (free rotation and self-alignment) line of pull for the belt and be designed to minimize an incorrect installation.

The seat belt installation should not appear to the belted occupant to be properly adjusted (snug) while there is significant [2.54 cm (1 inch) or more] slack in the system which may pay out in an emergency landing situation. For example, the belt installation should not be able to be caught between seat features such that the occupant would not know there was slack in the belt which may allow the occupant to slide forward during emergency landing or turbulence.

To test the installed seat belt for misalignment, the seat should be positioned in its taxi, takeoff and landing condition. Installations on seats having bottom cushions that can be removed or incorrectly repositioned without tools should be evaluated with the cushions installed, removed and incorrectly repositioned. The belt and shackle combination should be manipulated with one hand in an attempt to place the restraint in a non-design configuration where it could carry the seatbelt adjustment forces. Particular effort should be made to place the restraint in a position that the restraint forces would not be applied to the hook of the shackle in the same manner as they would be applied in a straight tension pull on the belt. Attempts should be made with the restraint in its normal shape, a single twist of the webbing and/or a single fold of the webbing. Typical areas around the restraint shackle that should be checked are the plastic shrouding around the armrest, the hydraulic seat recline device, the seat pan, anti-rotation brackets/stops, seat pan supports and exposed fasteners. If a condition of potential misalignment is identified, the seatbelt and shackle, in that condition, should be loaded by a restorative force of 22.2 N (5 pounds) applied through the belt in the direction that it would be loaded in the emergency landing or turbulence situation. If the load is carried in the misaligned condition, the design is unacceptable. The examples in 3.2.3 illustrate various misalignment conditions that have been found to be unacceptable, as indicated. These examples are not intended to be all-inclusive.

To test the belt for inadvertent disengagement, the belt should be tested in all orientations with the seat in the taxi, takeoff and landing conditions with the seat cushions installed. Interaction of belts in adjacent seats, where the belts could be inadvertently crossed and used by occupants in those adjacent seats, must be evaluated for the possibility of disengagement.

3.2.3 Examples: Examples of various causes of seat belt misalignment are illustrated below in Figures 1 and 2.

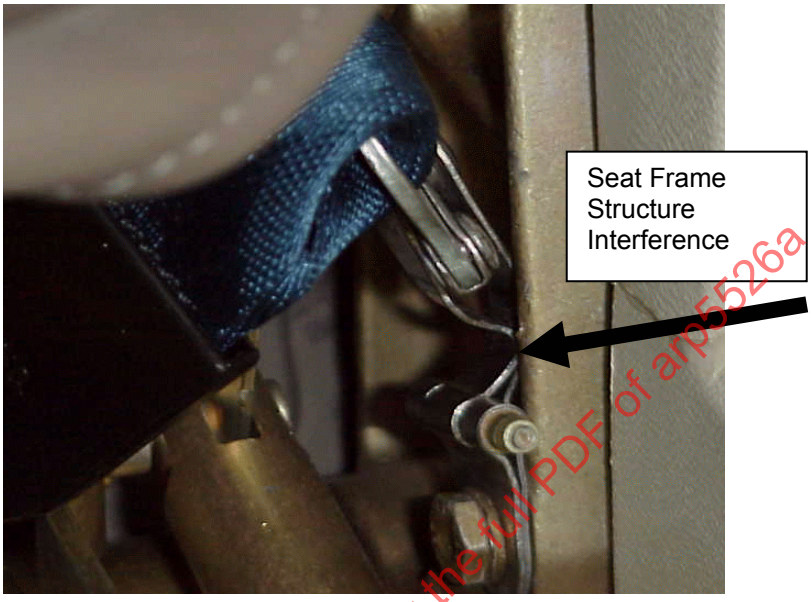

FIGURE 1 - Seat Belt Misalignment

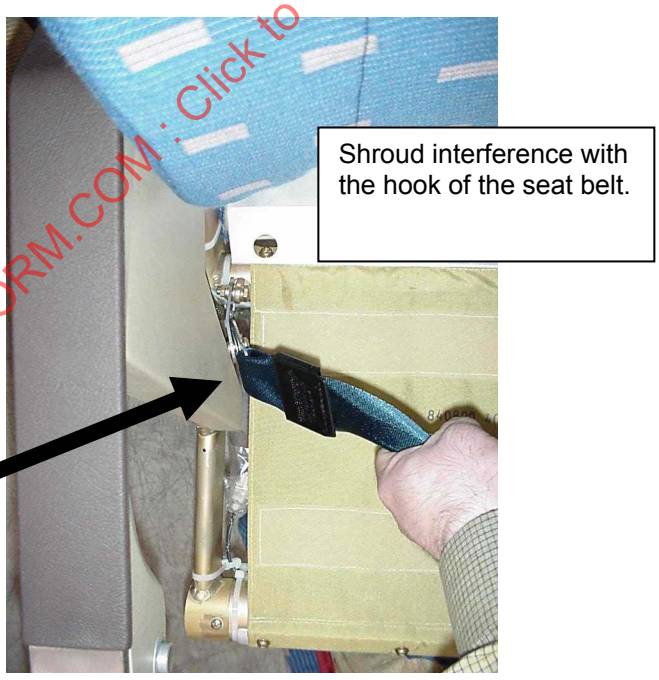

FIGURE 2 - Seat Belt Misalignment

3.2.3 (Continued):

Examples of designs to avoid are illustrated in Figures 3 through 6.

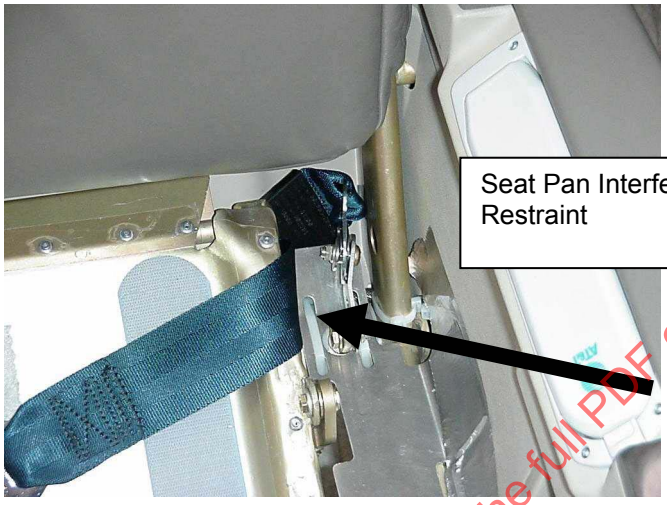

FIGURE 3 - An Example of a Design to Avoid

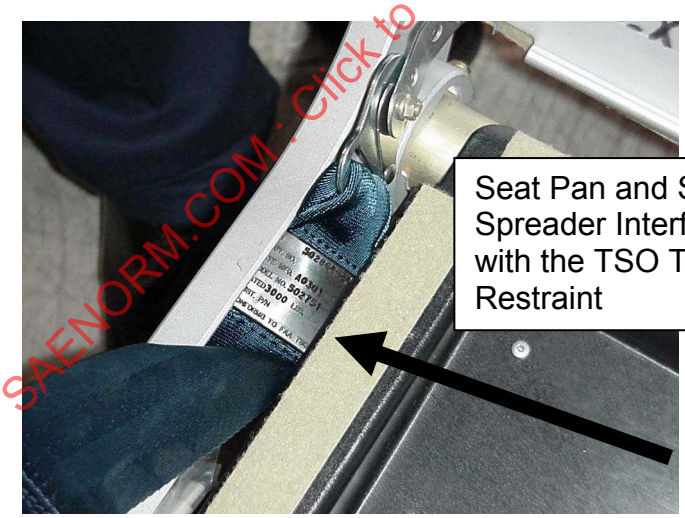

FIGURE 4 - An Example of a Design to Avoid

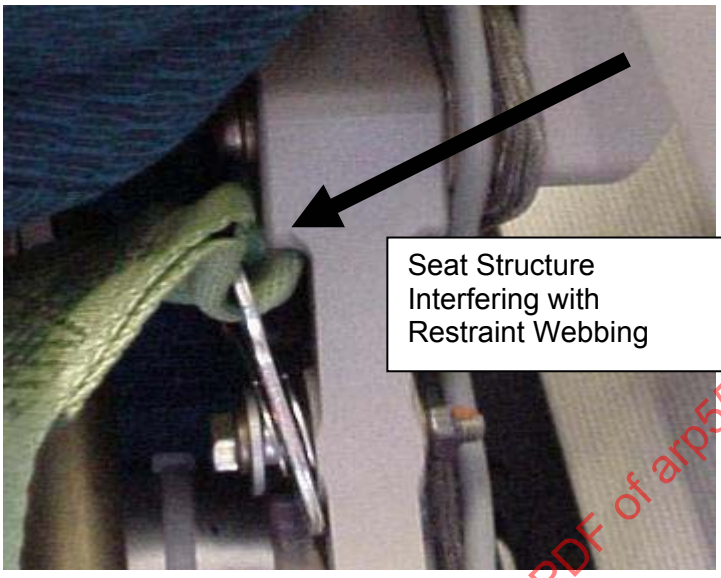

FIGURE 5 - An Example of a Design to Avoid

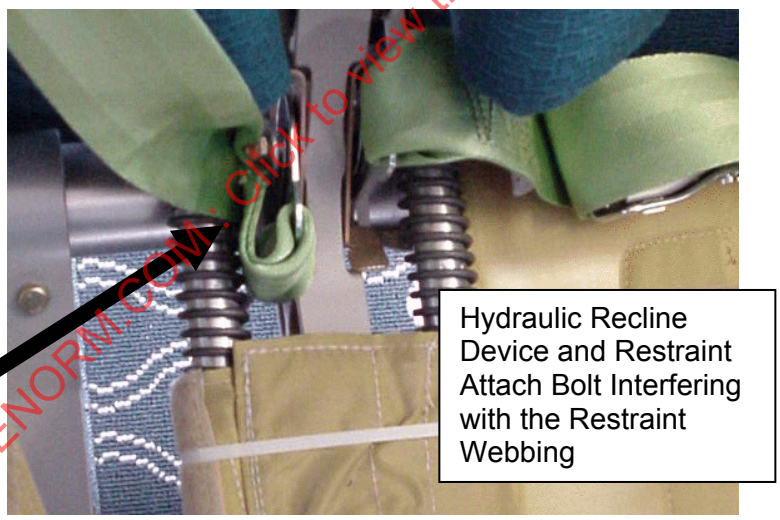

FIGURE 6 - An Example of a Design to Avoid

3.3 Life Vest/Lifejacket Retrieval:

3.3.1 Application:

14 CFR PART 25.1411

(f) Life preserver stowage provisions. The stowage provisions for life preservers described in Section 25.1415 must accommodate one life preserver for each occupant for which certification for ditching is requested. Each life preserver must be within easy reach of each seated occupant.

14 CFR PART 25.1541

(a) The airplane must contain -
  (1) The specified markings and placards; and
  (2) Any additional information, instrument markings, and placards required for the safe operation if there are unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section -
  (1) Must be displayed in a conspicuous place; and
  (2) May not be easily erased, disfigured, or obscured.

14 CFR PART 29.1411

(f) Life preservers. Each life preserver must be within easy reach of each occupant while seated.

3.3.2 Definition and Criteria: When required, life vest stowage should be provided at each seating position in accordance with 14 CFR 25.1411 and 25.1541. If a seat can be occupied for taxi, takeoff, and landing, while facing in more than one direction, the life vest stowage provisions should be accessible for each of these positions. The life vest container should be located such that it does not hinder, in any way, the retrieval of the life vest by a seated and belted occupant. At a minimum the life vest container should be designed and located such that the following requirements are met:

a. The life vest location is readily apparent.

b. Life vest stowage should be located such that each occupant has access to a life vest, and the life vest is within easy reach of each seated and belted occupant in the aircraft during taxi, takeoff or landing.

c. The life vest is restrained under all applicable loading conditions.

d. The container and opening are correctly sized for the specified life vest.

e. The container opening is located to allow the life vest to be readily removed by the seated and belted occupant.

3.3.2 (Continued):

f. The method of opening is usable over a range of angles (e.g., unidirectional straps, snaps, etc. that can only be used by pulling one direction should be avoided). When pull straps are used, they should not be difficult to reach or operate. They should operate from all reasonably anticipated angles that would be used by a seated and belted occupant as limited by structure, cushions and seat pitch.

g. The retrieval path of the life vest should be free of obstructions due to seat or aircraft components and/or pouch movement (e.g., legs, cushions, baggage bars, shrouds, etc.)

h. The retention device should not allow the vest to come free during a heavy landing, normal seat activity (e.g., stowage and removal of under seat baggage), takeoff or other aircraft maneuver.

i. Normal seat operation should not sweep the pull strap into an unreachable location.

j. The life vest container should not present any sharp edges or points that could damage the life vest or cause injury.

k. The location of pull straps is recommended to be adequately marked per 3.8 of this document. Pull straps are recommended to be red or labeled "PULL" or "PULL FOR LIFE VEST" in contrasting color.

l. Life vest retrieval should not be prevented by constricting elastic at the life vest container opening.

3.4 Friction Fit Components:

3.4.1 Application:

14 CFR PART 25.789
Retention of items of mass in passenger and crew compartments and galleys.
(a) Means must be provided to prevent each item of mass (that is part of the airplane type design) in a passenger or crew compartment [or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b).

3.4.2 Definition and Criteria: The use of friction fit as the sole method of restraint for items of mass (with the exception of ash trays) is not considered good design practice.

A friction fit item is one that is restrained only by static friction between two or more flat or curved surfaces in direct contact with each other. Items restrained by mechanical fasteners such as screws, bolts, nuts, hook and loop tape, hooks, springs, detents, rivets, or similar devices are not considered friction fit items.

3.5 Fire Containment - Cavity Fully Enclosed/Open:

Reserved

3.6 Hinged Aisle Armrests - Discreet Latch:

3.6.1 Application:

14 CFR PART 25.789
Retention of items of mass in passenger and crew compartments and galleys.
(a) Means must be provided to prevent each item of mass (that is part of the airplane type design) in a passenger or crew compartment [or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b).

14 CFR PART 25.815
Width of aisle.
The passenger aisle width at any point between seats must equal or exceed the values in Table 1:

TABLE 1

Passenger Seating	Minimum Passenger Aisle Width (Inches)	
	Less than 25 inches from Floor	25 inches and more from Floor
10 or less	12	15
11 through 19	12	20
20 or more	15	20

3.6.2 Definition and Criteria: Hinged passenger seat aisle armrests should be retained in the down position by a discreet latch that is hidden or not obvious to a person in the seat or in nearby seats or standing in the aisle. The latch should not allow inadvertent or accidental operation under normal use of the seat.

3.7 Baggage Bar Loading and Retention of Items Under the Seat:

3.7.1 Application:

14 CFR PART 25.787
(b) There must be a means to prevent the contents in the compartments from becoming a hazard by shifting, under the loads specified in paragraph (a) of this section

AC 25-17 Para 102(b)(2)
Standard design criteria for underseat baggage restraint.

3.7.2 Definition and Criteria: Although it is expected that the under seat baggage area will store a variety of items, a standard bag or representative mass with the dimensions of 7.62 cm x 30.48 cm x 43.18 cm (3 inches x 12 inches x 17 inches) and a weight of 9.0 kg (20 pounds) may be used during analysis of the underseat baggage restraint system.

Guidance for the dimensions and loading for the baggage restraint are given in AC 25-17. Installations that deviate from that guidance should restrain the baggage under the required loading conditions and should accommodate a step/abuse load of 1.3 kN (300 pounds) without failure (where applicable). The baggage restraint may yield and load the floor structure during step load testing:

The substantiation of the baggage restraint may be done by test or static analysis. Discontinuities in a baggage bar, as may be found when two double units make up a quad seat, should restrain items 7.6 cm (3 inches) in width; and allowance can be included for decompression vents.

3.8 Seat Safety Placards:

3.8.1 Application:

14 CFR PART 25.811(f)(2)
Each outside marking, including the band, must have color contrast to be readily distinguishable from the surrounding fuselage surface. The contrast must be such that if the reflectance of the darker color is 15 percent or less, the reflectance of the lighter must be at least 45 percent. “Reflectance” is the ratio of the luminous flux reflected by a body to the luminous flux it receives. When the reflectance of the darker color is greater than 15 percent, at least a 30 percent difference between its reflectance and the reflectance of the lighter color must be provided.

3.8.1 (Continued):

FAR 25.1411

(b) Stowage provisions. Stowage provisions for required emergency equipment must be furnished and must -

(1) Be arranged so that the equipment is directly accessible and its location is obvious;

FAR 25.1541

(a) The airplane must contain -

(1) The specified markings and placards; and

(2) Any additional information, instrument markings, and placards required for the safe operation if there are unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section -

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

AC 25-17 Para 1041(b)(1)

(1) Placards indicating emergency equipment should be approximately at eye level and should not blend in with the surrounding decor. A color contrast that complies with § 25.811(f)(2) is acceptable. If the emergency equipment is located in the upper or lower compartment, the eye level placard should have an arrow indicating the compartment. Each compartment containing emergency equipment such as life preservers, rafts, slides, slide/rafts, or fire extinguishers should be placarded as to its contents. For small executive airplanes which may not allow placards to be located at eye level, the placards should be located in as conspicuous a location as practicable.

3.8.2 Definition and Criteria: Safety placards on occupant seats should be permanently affixed, located such that they cannot be easily obscured and of a type that cannot be easily erased. The lettering height and color contrast should be sufficient to allow the placard to be read by the intended occupant (e.g., placards located on the back of the seat should be designed to allow the occupant seated behind to easily read it at the anticipated installed pitch.

Placards for life vest location should be sufficiently descriptive to direct the occupant to the life vest. Acceptable examples include LIFE VEST UNDER YOUR SEAT, LIFE VEST UNDER ARMREST (with an arrow pointing to the appropriate armrest), or LIFE VEST UNDER CENTER ARMREST.

3.9 Literature Pocket Stowage Capacity:

3.9.1 Application:

14 CFR Part 25.601
General.
The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

14 CFR Part 25.787
(a) Each compartment for the stowage of cargo, baggage, carry-on articles, and equipment (such as life rafts), and any other stowage compartment must be designed for its placarded maximum weight of contents and for the critical load distribution at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b), except that the forces specified in the emergency landing conditions need not be applied to compartments located below, or forward, of all occupants in the airplane. If the airplane has a passenger seating configuration, excluding pilot's seats, of 10 seats or more, each stowage compartment in the passenger cabin, except for under seat and overhead compartments for passenger convenience, must be completely enclosed.

14 CFR Part 25.789
(a) Means must be provided to prevent each item of mass (that is part of the airplane type design) in a passenger or crew compartment [or galley] from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b).

3.9.2 Definition and Criteria: The weight to be carried by each passenger seat back literature pocket can be determined by multiplying 1.4 kg (3 pounds) by the ratio of the pocket width to the width of a full width seat back pocket.

3.10 Tray Table Latch Retention:

3.10.1 Application:

14 CFR Part 25.813

(a) There must be a passageway leading from the nearest main aisle to each Type A, Type B, Type C, Type I, or Type II emergency exit and between individual passenger areas. Each passageway leading to a Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide. Unless there are two or more main aisles, each Type A or B exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions. If two or more main aisles are provided, there must be unobstructed cross-aisles at least 20 inches wide between main aisles.

(c) The following must be provided for each Type III or Type IV exit -

(1) There must be access from the nearest aisle to each exit. In addition, for each Type III exit in an airplane that has a passenger seating configuration of 60 or more

(i) Except as provided in paragraph (c)(1)(ii), the access must be provided by an unobstructed passageway that is at least 10 inches in width for interior arrangements in which the adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width for interior arrangements in which those rows contain three seats. The width of the passageway must be measured with adjacent seats adjusted to their most adverse position. The centerline of the required passageway width must not be displaced more than 5 inches horizontally from that of the exit.

(ii) In lieu of one 10- or 20-inch passageway, there may be two passageways, between seat rows only, that must be at least 6 inches in width and lead to an unobstructed space adjacent to each exit. (Adjacent exits must not share a common passageway.) The width of the passageways must be measured with adjacent seats adjusted to their most adverse position. The unobstructed space adjacent to the exit must extend vertically from the floor to the ceiling (or bottom of sidewall stowage bins), inboard from the exit for a distance not less than the width of the narrowest passenger seat installed on the airplane, and from the forward edge of the forward passageway to the aft edge of the aft passageway. The exit opening must be totally within the fore and aft bounds of the unobstructed space.

3.10.1 (Continued):

(2) In addition to the access -

(i) For airplanes that have a passenger seating configuration of 20 or more, the projected opening of the exit provided must not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including any seatback in the most adverse position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the airplane.

(ii) For airplanes that have a passenger seating configuration of 19 or fewer, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit.

3.10.2 Definition and Criteria: To prevent inadvertently deployed tray tables from blocking escape paths or interfering with door motion, the seat back table latch should prevent the table from deploying following a moderate bump on the upper surface of the seat back, or by a person brushing past.

The following design features may aid in meeting that objective:

- The tray table latch is independently locked.

  The latch has an independent locking feature that is out of the plane of motion. This locking feature must be independently released for the latch to be opened and must automatically lock the table latch when the tray table is stowed.

- The tray table latch motion is in a direction other than that of passenger egress.

  The passengers will predominantly generate the inadvertent release force in the direction of travel. If the tray table latch must be moved in a direction perpendicular or opposite to that travel in order to release the table, inadvertent release will be less likely.

- The tray table latch is recessed below surrounding structure.

  Maintain the latch below a plane of surrounding structure. If the latch cannot be contacted by a straight edge as it is slid over the tray latch area, then the latch is sufficiently recessed so that inadvertent release is unlikely.

3.11 Finger Pinch:

3.11.1 Application:

14 CFR Part 25.601
General.
The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

14 CFR Part 25.785
(b) Each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in Sections 25.561 and 25.562.

3.11.2 Definition and Criteria: Moving parts accessible to the occupant (e.g., legrests, deployable video, integral tables, etc.) should have restricted motion, or be shielded so that pinching and/or shearing hazards are minimized.

3.12 Sharp Edges:

3.12.1 Application:

14 CFR Part 25.601
General.
The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

14 CFR Part 25.785
(b) Each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in Sections 25.561 and 25.562.

3.12.2 Definition and Criteria: Edges that could cut skin during normal use or maintenance should be eliminated. (In addition, the seat should not have any feature whose edges or corners are exposed when deployed, that presents a potential to impede occupant egress (e.g., cocktail table, seat back and in-arm video, flip-out PCU, ashtray, etc.)

NASA Standard 3000 Man-Systems Integration Standards provides design criterion which may aid in preventing a hazardous condition.

3.13 Delethalization of Seat Features:

3.13.1 Application:

14 CFR Part 25.601
General.
The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

14 CFR Part 25.785
(b) Each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in Sections 25.561 and 25.562.
(d) Each occupant of a seat that makes more than an 18° angle with the vertical plane containing the airplane centerline must be protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head, and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. Each occupant of any other seat must be protected from the head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following:
    (1) A shoulder harness that will prevent the head from contacting any injurious object.
    (2) The elimination of any injurious object within striking radius of the head.
    (3) An energy absorbing rest that will support the arms, shoulders, head, and spine.

Letter TAD-96-002 Appendix A

3.13.2 Definition and Criteria: The goal is to prevent serious injury if an occupant were to strike any part of the seat during an emergency landing or turbulence. To aid in meeting that goal, edges capable of cutting, sharp corners and structure that could cause penetrating injuries should be eliminated from potential contact areas on the seat (even if located behind the seat fabric).

The demonstration of compliance should be done in two parts:

a. Analysis or analysis supported by tests:

1. Determine the head impact area

A 88.9 cm (35 inch) arc (specific for pelvic restraints only) from the Cushion Reference Point (the centerline of the intersection of the back cushion and the bottom cushion). The top of the head impact area is located where the 88.9 cm (35 inch) arc first intersects the seat back. The sides of the head impact area are defined by the insides of the armrests in the aft seat projected forward onto the seat back in front.

For seats certified on the basis of dynamic testing, the head impact area is defined by the dynamic test. The center of the head impact area is the strike point (first contact) of the 50-percentile Anthropomorphic Test Device head with the seat back. The sides of the impact area are defined by a ±10° yaw from the strike point.

2. Assessing the impact area

Possibly hazardous features noted above should be shown to be delethalized. This can be done in two or more ways. The first is to perform testing per 14 CFR 25.562(c)(5) and show that HIC < 1000 in addition to the criteria noted above for eliminating sharp edges/corners.

An alternate method is to use the bowling ball as described in AC 25-17 or a head component tester as approved by the Federal Aviation Administration. Other alternatives could be proposed if they are shown to be adequate in comparing the potential occupant injury between acceptable seat features and those in question.

b. Design Review:

Rational approach to this requirement by means of a design review and service history of similar designs may determine if the design is a hazard.

For seats that are not subject to dynamic testing requirements, a comparative analysis is not required if the object in the impact area is padded with one inch thick Ensolite foam (type AH or HH), Klegecell, Airex 4070, or other FAA approved materials.

3.14 Seat Features Adjusted With/Without Tools:

3.14.1 Application:

14 CFR PART 25.561

(d) Seats and items of mass (and their supporting structure) must not deform under any loads up to those specified in paragraph (b)(3) of this section in any manner that would impede subsequent rapid evacuation of occupants.

14 CFR PART 25.789

(a) Means must be provided to prevent each item of mass (that is part of the airplane type design) in a passenger or crew compartment or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b).

14 CFR Part 25.813

(b) There must be a passageway leading from the nearest main aisle to each Type A, Type B, Type C, Type I, or Type II emergency exit and between individual passenger areas. Each passageway leading to a Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide. Unless there are two or more main aisles, each Type A or B exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions. If two or more main aisles are provided, there must be unobstructed cross-aisles at least 20 inches wide between main aisles.

(c) The following must be provided for each Type III or Type IV exit -

(1) There must be access from the nearest aisle to each exit. In addition, for each Type III exit in an airplane that has a passenger seating configuration of 60 or more

(i) Except as provided in paragraph (c)(1)(ii), the access must be provided by an unobstructed passageway that is at least 10 inches in width for interior arrangements in which the adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width for interior arrangements in which those rows contain three seats. The width of the passageway must be measured with adjacent seats adjusted to their most adverse position. The centerline of the required passageway width must not be displaced more than 5 inches horizontally from that of the exit.

3.14.1 (Continued):

(ii) In lieu of one 10- or 20-inch passageway, there may be two passageways, between seat rows only, that must be at least 6 inches in width and lead to an unobstructed space adjacent to each exit. (Adjacent exits must not share a common passageway.) The width of the passageways must be measured with adjacent seats adjusted to their most adverse position. The unobstructed space adjacent to the exit must extend vertically from the floor to the ceiling (or bottom of sidewall stowage bins), inboard from the exit for a distance not less than the width of the narrowest passenger seat installed on the airplane, and from the forward edge of the forward passageway to the aft edge of the aft passageway. The exit opening must be totally within the fore and aft bounds of the unobstructed space.

(2) In addition to the access -

(i) For airplanes that have a passenger seating configuration of 20 or more, the projected opening of the exit provided must not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including any seatback in the most adverse position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the airplane.

(ii) For airplanes that have a passenger seating configuration of 19 or fewer, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit.

3.14.2 Definition and Criteria: Seat settings, such as seat back upright position, maximum recline position, etc., approved during aircraft certification should be designed so that they are adjustable only with the use of tools. Any adjustment that can be made without the use of tools must be inaccessible and not visible to the occupant or designed so that incorrect adjustment is conspicuous to the flight crew. For example if the adjustable element were under the bottom cushion and the seat pan/fabric, or if improper adjustment would disconnect the seat back or center console from the seat assembly.

3.15 Legrest and Footbar Retention:

3.15.1 Application:

14 CFR PART 25.789

(a) Means must be provided to prevent each item of mass (that is part of the airplane type design) in a passenger or crew compartment or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of Section 25.561(b).

14 CFR Part 25.813

(c) There must be a passageway leading from the nearest main aisle to each Type A, Type B, Type C, Type I, or Type II emergency exit and between individual passenger areas. Each passageway leading to a Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide. Unless there are two or more main aisles, each Type A or B exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions. If two or more main aisles are provided, there must be unobstructed cross-aisles at least 20 inches wide between main aisles.

(c) The following must be provided for each Type III or Type IV exit -

(1) There must be access from the nearest aisle to each exit. In addition, for each Type III exit in an airplane that has a passenger seating configuration of 60 or more

(i) Except as provided in paragraph (c)(1)(ii), the access must be provided by an unobstructed passageway that is at least 10 inches in width for interior arrangements in which the adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width for interior arrangements in which those rows contain three seats. The width of the passageway must be measured with adjacent seats adjusted to their most adverse position. The centerline of the required passageway width must not be displaced more than 5 inches horizontally from that of the exit.

(ii) In lieu of one 10- or 20-inch passageway, there may be two passageways, between seat rows only, that must be at least 6 inches in width and lead to an unobstructed space adjacent to each exit. (Adjacent exits must not share a common passageway.) The width of the passageways must be measured with adjacent seats adjusted to their most adverse position. The unobstructed space adjacent to the exit must extend vertically from the floor to the ceiling (or bottom of sidewall stowage bins), inboard from the exit for a distance not less than the width of the narrowest passenger seat installed on the airplane, and from the forward edge of the forward passageway to the aft edge of the aft passageway. The exit opening must be totally within the fore and aft bounds of the unobstructed space.

3.15.1 (Continued):

(2) In addition to the access -

(i) For airplanes that have a passenger seating configuration of 20 or more, the projected opening of the exit provided must not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including any seatback in the most adverse position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the airplane.

(ii) For airplanes that have a passenger seating configuration of 19 or fewer, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit.

3.15.2 Definition and Criteria: Legrests and forward mounted footbars in the stowed position should be positively restrained so that they do not deploy or become a tripping hazard when subjected to the normal flight and emergency landing loads.

3.16 Emergency Escape Path (Proximity) Lighting:

3.16.1 Application:

<u>14 CFR Part 25.812</u>

(e) Floor proximity emergency escape path marking must provide emergency evacuation guidance for passengers when all sources of illumination more than 4 feet above the cabin aisle floor are totally obscured. In the dark of the night, the floor proximity emergency escape path marking must enable each passenger to -

(1) After leaving the passenger seat, visually identify the emergency escape path along the cabin aisle floor to the first exits or pair of exits forward and aft of the seat; and

(2) Readily identify each exit from the emergency escape path by reference only to markings and visual features not more than 4 feet above the cabin floor.

<u>AC 25.812</u>

b. Floor proximity marking is intended to allow passengers who have become familiar with the cabin layout during the period of general overhead illumination prior to an accident to find their way to exits unassisted, should the general overhead illumination become obscured by smoke. This objective is stated in the rule as two separate requirements. The first is that the emergency escape path marking will enable each passenger to visually identify the emergency escape path along the cabin aisle floor after leaving the cabin seat, and the second is that the marking will enable each passenger to readily identify each exit from the emergency escape path by reference only to markings and visual features not more than four feet above the cabin floor. In both cases it is assumed that all sources of illumination more than four feet above the cabin aisle floor are totally obscured and that it is dark.'

3.16.2 Definition and Criteria: Seat mounted emergency escape path lights should be located so they indicate the escape path to exits. A generally acceptable location is approximately 38.1 cm (15 inches) maximum above the floor and spaced no more than 102 cm (40 inches) apart. Light spacing greater than 40 inches may be adequate provided that floor path illumination requirements are maintained. Light design and locations must support the intent to indicate the escape path to exits.

The indicated path should be visible from the aisle by both a standing and a crawling occupant. Visibility should be evaluated from a range of 30 cm (12 inches) to 178 cm (70 inches) from the floor in the center of the aisle.

The light assembly should be protected from damage by galley carts, luggage and normal occupant traffic. Because the escape path lighting is required for emergency situations, extra care should be taken to protect the wire routing and connector location from luggage and normal occupant activities.

3.17 Rotating Armrests (above and beyond the requirements for aisle 'handicapped' armrests):

3.17.1 Application:

14 CFR PART 25.785

(d) Each occupant of a seat that makes more than an 18° angle with the vertical plane containing the airplane centerline must be protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head, and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. Each occupant of any other seat must be protected from the head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following:
  (1) A shoulder harness that will prevent the head from contacting any injurious object.
  (2) The elimination of any injurious object within striking radius of the head.

AC 25-17 (14 CFR PART 25.785) guidance (5) Para (c)(2)

(5) Paragraph (c)(2). Some passenger seats are designed with armrests that pivot upward such that the armrest could protrude beyond the seatbacks resulting in a potentially hazardous condition to persons seated behind these seats. Armrests that are adequately delethalized or restricted such that they cannot protrude aft of either seatback in any position are acceptable.

3.17.2 Definition and Criteria: The end of an armrest that pivots upward should not protrude beyond the seat back into a head impact area (as defined by section 3.13 of this document).

4. NOTES:

4.1 The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document.

PREPARED UNDER THE JURISDICTION OF
SAE AIRCRAFT SEAT

APPENDIX A
TAD-96-002

U.S. Department of Transportation
Federal Aviation Administration

Memorandum

Subject: INFORMATION: Simplified Procedure for Addressing the Head Injury Criteria of § 25.562

Date: February 16, 1996

From: Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100

Reply to Attn. of: Policy Ltr. TAD-96-002

To: SEE DISTRIBUTION

With the adoption of Amendment 25-64 to add § 25.562 of the Federal Aviation Regulations, quantified human tolerance parameters were introduced into the regulations for the first time. One of these human tolerance parameters is the head injury criterion (HIC). The HIC has proven to be one of, if not the most, onerous aspect of the regulation.

The regulations require that the potential for head injury be assessed, if the head can contact airplane interior structure when exposed to the test conditions specified in § 25.562. If head contact occurs, the HIC must be calculated, and must be less than 1000 units. In the case of repetitive rows of seats, determining the critical area for head injury potential on a seat back can be difficult, and can often result in several tests, just to determine a critical case. This procedure is very expensive, and in most cases unnecessary. However, many applicants lack the data to make an analytical assessment to define a minimum set of tests, and are therefore forced to conduct many tests. The procedure defined in this memorandum will help serve to minimize testing.

One of the aspects of compliance that has been somewhat contentious is the consideration of a "range" of occupant heights for HIC. The dynamic test requirements specify the type of test dummy to be used. This dummy represents the approximate stature of a 50th percentile male. This does not mean that only the 50th percentile male is of concern from a head injury standpoint. In fact, § 25.785(b) requires that a "person" be protected from serious injury under the condition specified in § 25.562. The dynamic test provides the means for making the assessment, but does not change the fundamental requirement to protect each occupant. Historically, we have used a range of occupant heights from the 5th percentile female to the 95th percentile male as a reasonable envelope for consideration. Advisory Circular 25.562 -1 alludes to the need to consider other occupants, but does not specify or suggest a means for doing so. This lack of methodology has resulted in poor standardization in application of the requirement.

FIGURE A1

In an effort to reduce the regulatory burden, and simplify/clarify the procedure for demonstrating compliance, we have developed the attached procedure. This procedure should allow demonstration of compliance for HIC with two tests in the majority of cases. The procedure takes into account seat pitch, the relative position of the seat and the row behind it as well as range of occupant sizes. The intent of this procedure is to provide default conditions that can be used in lieu of conducting several tests, or performing lengthy analytical studies. It is recognized that this procedure will not account for every eventuality. The purpose, however, is to provide for reasonable test conditions that meet the intent of the requirements, without causing excessive testing to be performed. This procedure was distributed at the Public Meeting on Dynamic Testing of Seats, in Seattle in October of 1995. Comments received have been considered in the final issuance.

Prepared by: Jeff Gardlin

Concur: Ronald T. Wojnar
Ronald T. Wojnar

Attachment
Seat-to-Seat Installation Tests for Compliance
with the HIC in Transport Airplanes

DISTRIBUTION:

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Manager, Airplane Certification Office, ASW-150
Manager, Special Certification Office, ASW-190
Manager, Aircraft Engineering Division, AIR-100

FIGURE A1 (Continued)

Attachment to
Policy Ltr. TAD-96-002

Seat-to-Seat Installation Tests for Compliance with the HIC in Transport Airplanes

The following is a set of criteria for use in evaluating HIC with "default" parameters. These criteria can be used to standardize the approach to seat-to-seat HIC, and should enable seat-to-seat HIC for the majority of seats to be addressed in only two tests. The general guidelines are based on a typical passenger seat, although the philosophy could be applied to any seat for which it was valid to do so.

Head Strike Envelope:

All dynamic tests and HIC evaluations are to be conducted with a 50th percentile male anthropomorphic test dummy as defined in 25.562. The head strike envelope includes the three dimensional space through which the ATD's head may traverse when tested in accordance with the dynamic conditions defined in 25.562. This three dimensional space includes the ATD's head path which occurs during the vertical test as well as the horizontal-yaw test conditions defined in 25.562 (although the horizontal condition typically produces the critical head path). Since the head of the ATD is a three dimensional object, the head strike envelope encompasses the path of all points defined by the surface of the ATD's head. This includes the back of the head. The head strike envelope for the horizontal-yaw test condition (Test 2) includes the path through which the ATD's head may traverse when tested with a yaw angle of Ø, $-10 < Ø < +10$ degrees.

Structures within the Head Strike Envelope

If the head strike envelope results in head contact with a structure located on or in the vicinity of the seat installation in an aircraft, the HIC requirement in 25.562 must be demonstrated by test(s). There are some seat-to-seat installation practices which are common to contemporary aircraft, and general guidelines on certification test procedures can be defined. The following examples describe how the various factors affecting the seat-to-seat HIC result can be addressed in the test(s) protocol.

Seat-to-seat HIC, Double Row Horizontal-Yaw Tests.

Head Strike Zones. Due to the dynamic deflection of the forward row seat back during the impact test, it is usually difficult to accurately predict exactly where the aft row seated ATD's head will strike the seat back. The typical seat back has three areas that are considered head strike zones within the +/- 10 degree yaw range of impact orientation. These are illustrated in Figure 1. Note the recline mechanism is on the left side of the seat back in this illustration. The recline mechanism can affect the stiffness of the seat back on the side it is located (Zone A.) Thus, head impact must be evaluated on both the left and right (Zone B) sides of the seat back. The third area of potential head impact is the center of the seat back (Zone C), which may include areas on the seat back containing a tray table, telephone handsets, or video displays.

FIGURE A1 (Continued)