U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: FLIGHT ATTENDANT SEAT AND TORSO RESTRAINT SYSTEM INSTALLATIONS

Date: 1/6/94
Initiated by: ANM-110

AC No: 25.785-1A
Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance regarding an acceptable means, but not the only means, of compliance with the portions of §§ 25.785 and 121.311 of the Federal Aviation Regulations (FAR) which deal with flight attendant seats. This material is for guidance purposes; it is not mandatory and does not constitute a regulation. The guidelines incorporated in this AC are intended to address the adequacy of new designs and are not intended to require that in-service airplanes be modified solely for the purpose of meeting them. Voluntary modifications to existing cabins are not required to meet the new criteria but modifiers should incorporate them to the extent practical considering the scope and intent of the voluntary modification.

2. CANCELLATION. Advisory Circular 25.785-1, Flight Attendant Seat Requirements, dated December 4, 1981, is canceled.

3. RELATED FEDERAL AVIATION REGULATIONS AND STANDARDS.

a. Section 25.785 of the FAR, Seats, berths, safety belts, and harnesses.

b. Section 121.311 of the FAR, Seats, safety belts, and shoulder harnesses.

c. Technical Standard Order (TSO)-C39, Aircraft Seats and Berths.

d. Technical Standard Order TSO-C114, Torso Restraint Systems.

4. BACKGROUND.

a. Advisory Circular 25.785-1 was issued on December 4, 1981, in order to clarify changes made to §§ 25.785 and 121.311 by Amendments 25-51 and 121-155, respectively. (With certain specified exceptions, § 121.311(f) incorporates the provisions of § 25.785 by reference.)

b. In September 1985, the Federal Aviation Administration (FAA) held a Public Technical Conference on Emergency Evacuation of Transport Airplanes in Seattle, Washington. As a result of the conference, it was recommended that AC 25.785-1 be revised to provide guidance relative to the close proximity of aft-facing flight attendant seats and forward-facing passenger seats. This AC describes positioning of forward facing passenger seats with respect to aft facing flight attendant seats.

c. Other recommendations pertained to the width of single and double flight attendant seats, and the proper installation of torso restraint systems. This AC also includes guidance relating to these two areas of flight attendant seat installation.

d. Anthropometric dimensions were taken from Humanscale 1a, by Henry Dreyfuss Associates. This document was cited, at a Society of Automotive Engineers (SAE) S-9 Cabin Safety Committee meeting in Seattle, Washington, by industry representatives as the source of anthropometric data used by industry in designing airplane interiors.

5. DEFINITION OF TERMS.

a. Terms Used in §§ 25.785 and 121.311.

(1) Near. As used in § 25.785(h), "near" means sufficiently close to the exit to permit required flight attendants to reach required floor level emergency exits in a timely manner to execute their emergency evacuation duties. A longitudinal distance measured fore or aft from each seat to its associated exit equal to not more than three rows of seats is acceptable. When approved flight attendant seats are installed at more than one location within a three-row longitudinal distance from a required floor level emergency exit, and the operating rules require the location of a flight attendant(s) in the vicinity of that exit, the required flight attendant(s) should be located in the seat(s) closest to that exit, unless the design of the seat(s) further from the exit has increased occupant protection features over the seat(s) closest to the exit.

(2) Extent Possible. As used in § 25.785(h)(1), with respect to "direct view" of the cabin area for which the flight attendant is individually responsible, "extent possible" means to the degree practicable without compromising proximity to required floor level emergency exits. In the current fleet, the intent is not to require changes to existing approved designs to increase direct view only; however, during any cabin alterations to existing airplanes in the current fleet, every practical effort should be made to eliminate obstructions to direct view.

(3) Direct View. As used in § 25.785(h)(1), "direct view" means direct (line of sight) visual contact with cabin area/main aisle(s), which enables the flight attendant to be made aware of passenger needs relative to safety when the flight attendant is seated with torso restraint (safety belt and shoulder harness) fastened. Mirrors or other such devices are not acceptable equivalents to direct view, except in those cases where flight attendant proximity to the floor level emergency exit takes precedence over direct view. Video systems may be an acceptable means of direct view, if the level of conspicuity is equivalent to that provided by line of sight visibility.

(4) Means to Secure. As used in § 25.785(h), this term requires that methods be provided to stow the torso restraint (shoulder harness and safety belt) when not in use. Such methods include an automatic retractor, a pocket near the seat, and a design which permits the straps to be held out of the way by a folding seat. In any case, the torso restraint (safety belt and shoulder

harness), when released quickly, should not impede rapid egress during an emergency.

(5) Required Floor Level Emergency Exits. As used in § 25.785(h)(1), this term refers to the type and location of exits which were used to establish approved seating configurations for type certification of an airplane.

(6) Torso Restraint System. A torso restraint system consists of any strap, webbing, or similar device designed to secure a person in an airplane with the intention of minimizing injury. This includes all buckles or other fasteners, and all integral hardware.

(7) Pelvic Restraint. A pelvic restraint is that portion of a torso restraint system intended to restrain movement of the pelvis. This is commonly referred to as a lap belt, safety belt, or seat belt.

(8) Upper Torso Restraint. An upper torso restraint is that portion of a torso restraint system intended to restrain movement of the chest and shoulder region. This is commonly referred to as a shoulder harness. This should be a double strap design, with one strap over each shoulder.

b. Other Terms.

(1) Passenger Zone. A passenger zone is a portion of the passenger cabin that is separated from the remainder of the cabin by interior features. These features may be class dividers, galleys or other items that interrupt continuous passenger seating, and consequently, line of sight.

(2) Seat Reference Point. As used in this AC, the seat reference point (SRP) is defined as the intersection of the plane of the uncompressed top of the seat cushion with the plane perpendicular to the seat cushion which touches the forward-most surface of the uncompressed center of the seat back.

6. FLIGHT ATTENDANT SEAT GEOMETRY AND TORSO RESTRAINT INSTALLATION.

a. Design changes to interiors of an in-service airplane or newly manufactured airplane of an existing model should not result in flight attendant seats being narrower than the seats presently approved as part of the airplane type design when those seats do not meet the minimum dimensions in this AC. Where design conditions permit, the minimum width of a single occupant flight attendant seat should be increased to provide at least 17.25 inches of shoulder clearance, and the width of a double occupant flight attendant seat should be increased to provide at least 34.5 inches of shoulder clearance. These seat widths apply for both forward and aft-facing seats.

(1) This increase in width is desirable in order to accommodate the larger size of male flight attendants who have been employed since the designs of most flight attendant seats were established. The recommended seat width of 34.5 inches is based on two 50th percentile males (17.7 inches wide at the shoulder, minus .25 inch soft tissue compression on each side equals 17.2 inches times 2 equals 34.4 inches.)

(2) As an illustration, the remaining space on a 34.5 inch wide double seat occupied by a 95th percentile male (19.2 inches shoulder width minus .50 inch soft tissue compression equals 18.7 inches) is 15.8 inches remaining. This 15.8 inches seat width, plus .50 inch soft tissue compression, means that a female that is 16.3 inches wide at the shoulder could occupy the seat together with a 95th percentile male. This shoulder width is slightly larger than a 50th percentile female (16.0 inches).

(3) Additional clearance should be provided to enable rapid donning and adjustment of the restraint system if lateral clearance is limited by sidewalls adjacent to the seat.

b. With regard to aft-facing seat back heights, TSO-C39 specifies that the seat back be sufficient to provide 36.5 inches of support for the occupant, as measured from the point of maximum seat cushion depression to the top of the seat back. Section 25.785(h)(2)(i) requires that forward and aft-facing seats be designed to provide the same occupant support. Thus, all flight attendant seats providing at least 36.5 inches of vertical energy absorbing support for the occupant will meet § 121.311(f). This support need not be continuous and either a single seat back or a segmented seat back plus headrest complies with the requirement. Unpadded bulkheads do not provide adequate energy absorbing support for arms, shoulders, head and spine as required under § 25.785(h)(2)(i).

c. In accordance with § 121.311(f), each seat occupied by a flight attendant required by § 121.391(a) must have torso restraint (a combined pelvic restraint and double strap upper torso restraint with a single point release) that meets the requirements of § 25.785, except that any combined safety belt and shoulder harness approved and installed before March 6, 1980, may continue to be used. A single point release is one that requires only one action to mechanically unlatch the restraint system. This may involve the use of a multi-strap design connected at one point, or a design where the upper torso straps are indirectly released by unlatching the lap belt. Acceptable design and test procedures relating to torso restraint system construction, strength, attachment, performance, and flammability are contained in TSO-C114.

(1) Pelvic Restraint. A pelvic restraint is commonly referred to as a safety belt, a lap belt, or a seat belt. Pelvic restraints perform best when they act at an angle of about 45 degrees to the airplane longitudinal axis; however, a belt angle of between 45 and 55 degrees generally provides sufficient occupant restraint. (See Figure 1.)

(i) Shallow angle. If the pelvic restraint is installed so that it acts along a shallow angle (approaching the horizontal), it is likely to slip off the skeletal pelvis of the occupant, and apply loads to the abdomen, with a likelihood of injury to internal organs.

(ii) Steep angle. If the pelvic restraint is installed at too steep an angle (approaching the vertical), it will be ineffective in resisting movement of the occupant away from the seatback. Since the belt can carry tension loads only, the occupant will move away from the seatback (forward in a forward-facing seat, and aft in an aft-facing seat) until the belt geometry is reoriented to an angle which generates enough tension in the belt to resist further movement.

(iii) Effect of upper torso restraint on pelvic restraint. The dual upper torso restraint configuration allows quick egress from the restraint by releasing only one buckle; however, a system installed with a shallow pelvic restraint angle permits the upper torso restraint to pull the pelvic restraint up off the pelvic area into the abdominal region. In addition to the injury potential discussed in paragraph 6c(1)(i) above, this action also introduces slack in the upper torso restraint which tends to defeat the purpose of the upper torso restraint system installation. Correct installation for the dual belt, single point release system uses pelvic restraint attachment points which provide a pelvic restraint angle sufficient to minimize upward movement of the pelvic restraint (lap belt). As stated above, a 45 to 55 degree pelvic restraint angle relative to the longitudinal axis of the airplane is most appropriate. This angle permits the pelvic restraint to react to the upward pull of the upper torso restraint.

(2) Upper torso restraints.

(a) Certain precautions are warranted in the selection of the upper end attachment point for the upper torso restraint (shoulder harness), to avoid critical problems associated with variations in occupant size. It is possible for the upper torso restraint to bear against the neck or the side of the head of a short occupant. A similar situation can be expected even for an average size occupant, when the upper attachment point is located too near the vertical centerline plane of the seat. This installation geometry is aggravating, and may restrict free movement of the occupant. An excessive elevation angle (more than 30 degrees) on the trailing length of the upper torso restraint straps may have the same effect, or the upper torso restraint straps may tend to fall off the shoulder of a tall occupant when the upper attachment point is too far outboard or too low with respect to the midpoint of the occupant's shoulder. An additional concern is to avoid compression of the spinal column by the upper torso restraint. Spinal compression can generally be avoided if the upper attachment point of the upper torso restraint is selected such that the trailing length of the shoulder straps behind the occupant does not fall below an angle of 5 degrees below the horizontal. A proper range of elevation angles for the trailing length of the upper torso restraint straps would thus be -5 degrees to +30 degrees, measured from the horizontal at the midpoint of the shoulder. (See Figure 2.) The lateral placement of the upper attach point should be approximately 3 to 5 inches from the seat centerline, based on anthropometric data relating to average shoulder and neck width for both male and female occupants.

(b) Upper torso restraint systems should pass through anchorage points fixed to the pelvic restraint anchorages. In practice, these systems should be adjustable to provide consistent, adequate restraint to the occupant, and tend to prevent submarining (sliding down and out from under the pelvic restraint belt). This is a particular problem if the seat bottom deflects due to vertical loading during an emergency landing.

(3) Occupant height. General anthropometric data indicates that adult occupant sitting height to the mid-shoulder can range from about 20 inches for a small female (2.5 percentile) to 25 inches for a large male (97.5 percentile). A mid-shoulder height of 23.3 inches approximates a large female and an average male. Locating the shoulder strap attach point at this height, allowing for seat cushion compression, would accommodate both the large and

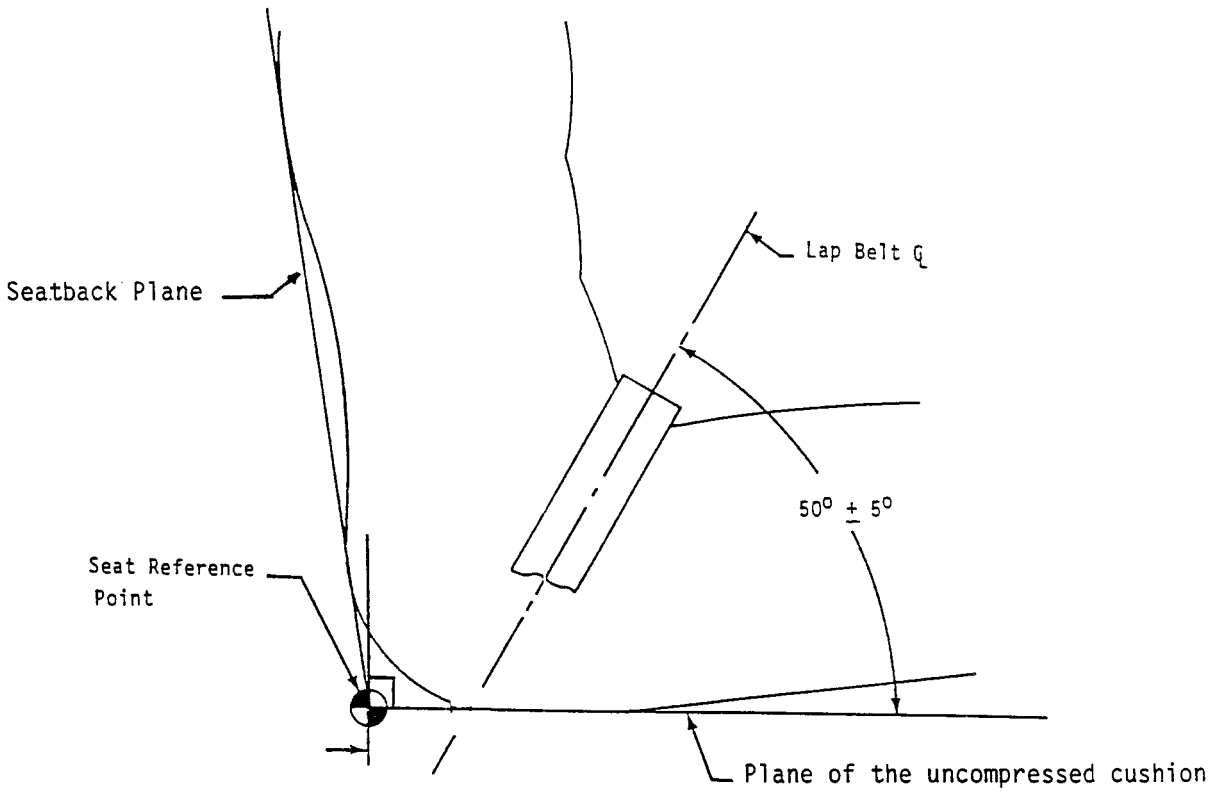
small occupant, and allow the trailing length of upper torso restraint straps to remain close to the +30, -5 degree guidelines. It should be noted that it may be impossible to accommodate extremely large and extremely small people in a given seat location. Installation of upper torso restraint may require certain tradeoffs to assure the best installation, given the limitations of the space available.

d. As specified in § 121.311(f)(2), the combined safety belt and shoulder harness restraint system with a single point release (torso restraint) may be designed to the inertia loads established by the certification basis of the airplane. This means that for airplanes whose type certification basis includes Civil Air Regulations (CAR) 4b in effect prior to March 5, 1952, a forward load factor as low as 6g may be used. Safety belt and shoulder harness installations on airplanes whose type certification basis includes CAR 04 or Aeronautics Bulletin No. 7A should be designed to a forward load factor of no less than 6g. Load factors in all other directions should be as specified in § 25.561, which contains load factors identical to those of CAR 4b.260.

e. Passenger seats occupied by <u>required</u> flight attendants must fully comply with § 25.785(h), including the combined pelvic restraint and upper torso restraint. Passenger seats occupied by flight attendants in excess of the number required by § 121.391 need not comply with § 25.785(h).

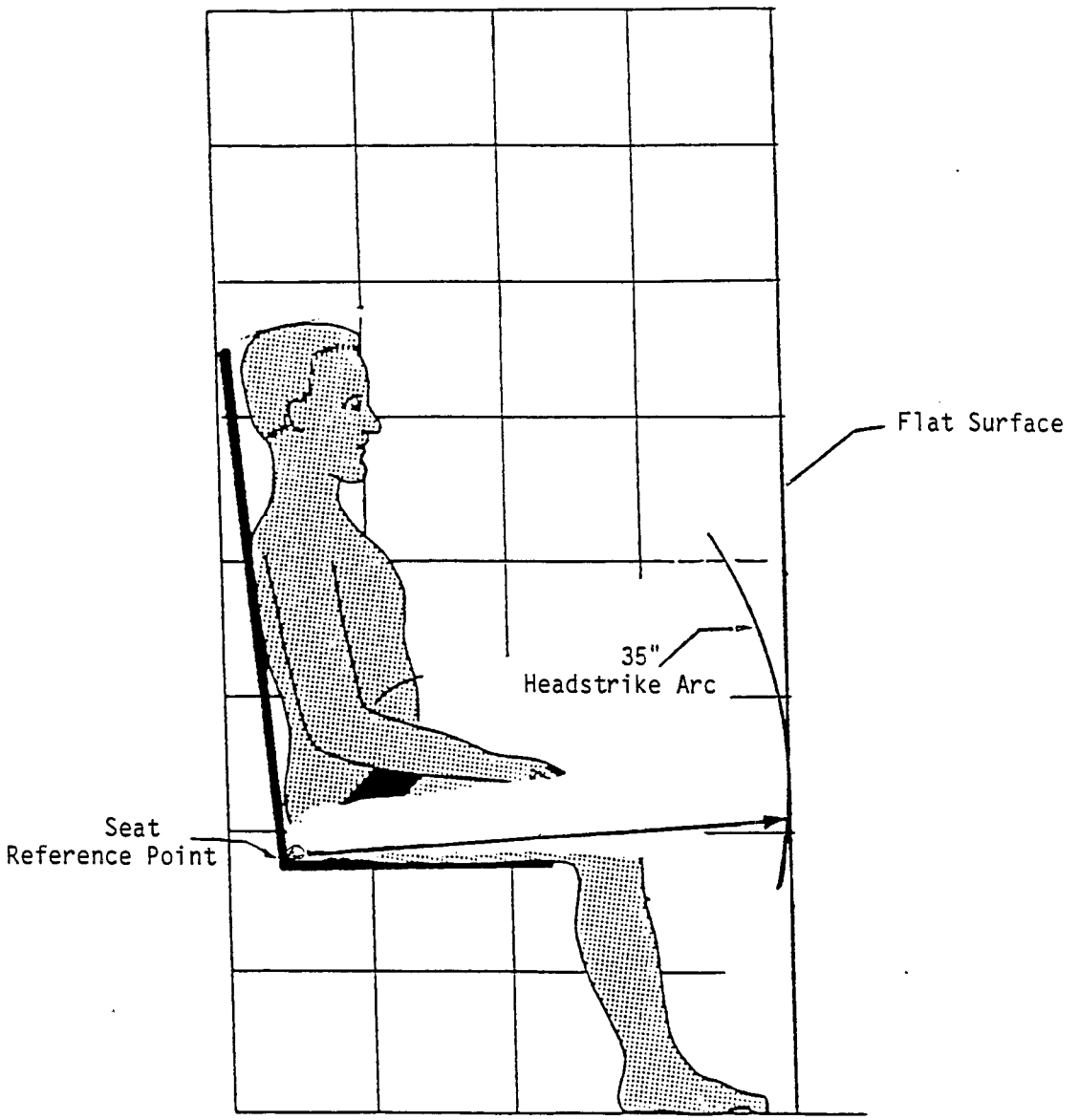
f. If flight attendant seats are located too close to airplane interior structure, the flight attendants may have to sit "twisted" in their seats, because there is insufficient room for their legs in front of the seat. Not only is this uncomfortable, it reduces human tolerance to impact injury because the spinal column is twisted. Anthropometric data indicates that the buttock to knee length for a 95th percentile male is about 25.4 inches. About 4 inches more should be provided for forward clearance so that the knees will not be injured in an emergency landing when the body deforms and the restraint system stretches. Design changes to interiors of an in-service airplane or newly manufactured airplane of existing model should not result in reduction of leg clearance in front of flight attendant seats less than that presently approved for that airplane. Where design conditions permit, however, at least 29.5 inches clearance, measured from the seat back to any obstruction in front of the seat, should be provided for the legs of the flight attendant. This clearance should be provided along the full width of the seat. In addition, projections within striking distance of a seat occupant should be padded in accordance with § 25.785(h)(2)(i).

g. The seat design should prevent collapse while occupied when subjected to the transient positive and negative forces associated with turbulence in flight. Specifically, if the seat incorporates features that enable it to retract when not occupied, the seat should not retract when it is occupied. The flight loads pertinent to the airplane as well as the emergency landing loads specified in the regulation should be considered.



Seat Reference Point and
Lap Belt Angle

Figure 1



Headstrike Envelope

Figure 3

7. GALLEY RESTRAINT REQUIREMENTS.

a. Section 25.785(j) requires that each flight attendant seat be located to minimize the probability of its occupant suffering injury by being struck by items dislodged from a galley, stowage compartment, or serving cart. Service experience with galleys, stowage compartments, and serving carts has shown that some of the presently designed latches or locks, of themselves, may not adequately minimize the probability of items being dislodged under operational and emergency load conditions.

b. Flight attendant seats that are located within a longitudinal distance equal to three rows of seats measured fore or aft from the center of a galley or stowage compartment area, with the exception of underseat and overhead stowage bins, are not in compliance with § 25.785(j) unless additional restraint devices (dual latching devices or equivalent) are incorporated to retain all items of mass in the galley or stowage compartment under the inertia loads specified as part of the airplane type certification basis.

c. Doors on galleys, stowage compartments, or serving carts located near flight attendant seats, as defined in paragraph 7b above, should incorporate additional restraint devices that are demonstrated to be reliable and that secure in a positive manner. If the primary latching devices fail, the additional restraint devices should be designed to retain all items of mass under the inertia loads specified as part of the airplane type certification basis. In addition, the relative stiffness of the door structure should be evaluated for possible adverse effects on the latch engagement. Engineering drawings should specify a minimum latch engagement that is compatible with the flexibility of the structure. Items such as coffee pots and brew cups, for which a traditional secondary restraint is not feasible, may be acceptable if the restraint means is of a highly reliable nature. For example, a restraint that captures the brew cup, or locks a plunger into the coffee pot would be a highly reliable restraint, that would not require supplemental straps, or other additional restraint.

d. Nets, straps, bars, thumb latches on individual doors, and doors completely closing off galleys or stowage compartments are examples of acceptable additional restraint devices, provided they are demonstrated to be reliable and are designed for easy verification of engagement. A thumb latch having a colored stripe on a door at the latch locked position is an example of a design which will enable the flight attendant to determine quickly when the door is properly secured. As used herein, a thumb latch is a bar, not completely traversing a door, mounted externally to structure between a galley or stowage compartment door, which can be rotated over the galley or compartment door and locked in place, usually by spring loading the latch, to retain the door or items of mass.

e. Where a serving cart is secured during takeoff and landing outside of a galley or within a compartment in a galley, without additional doors closing off the cart, the criteria in paragraphs 7c and d above, applicable to doors, are also applicable to the serving cart itself, if the location is near a flight attendant seat, as defined in paragraph 7b above.

f. Each air carrier should assure that its FAA-approved maintenance or inspection program includes adequate procedures and standards for maintaining galleys and service units with special emphasis placed on restraint devices.

8. CLOSE PROXIMITY OF FLIGHT ATTENDANT AND PASSENGER SEATS.

a. Published test data on the radius of movement (strike envelopes) of a person's torso, head, hands, and feet during an emergency landing are available from a variety of sources. These previous tests were conducted with various size human subjects and anthropomorphic dummies, seated in standard forward-facing seats, secured by standard pelvic restraints (seat belts). The current criteria for seat placement is to assure that an occupant's head will not swing forward and strike an unpadded bulkhead or other hard surface. Thirty-five inches from the seat reference point has been used for a number of years as a minimum acceptable head strike radius. (See Figure 3.) A larger head strike radius may be appropriate for the specific situation involving the aft-facing flight attendant and the forward-facing passenger seated directly across from each other. A larger distance may be more appropriate in this situation because of conflicting movement of the two occupants due to the "g" forces which may be present during an emergency landing. Data currently available is only sufficient to specify distances at which contact will not occur. Due to the lack of data in this area and the economic significance of the resulting seat spacing, further research needs to be conducted to establish if such increases are warranted and what they should be.

b. The definition of SRP in paragraph 5b(2) allows for seat backs which are not vertical, and which contain a curvature across the seat back ("wings" or a lateral torso support at the vertical edges of the seat back). As stated in paragraph 6(f) the buttock to knee length for a 95th percentile male is about 25 inches. Adding this distance for an aft-facing attendant to the head strike radius for a forward-facing passenger listed above, would result in a minimum distance between seat reference points of approximately 60 inches.

NOTE: The definition of SRP above is for the purposes of establishing a 35-inch arc. Other definitions may exist which pertain to other measurements and should be used where appropriate. (See Figure 1.)

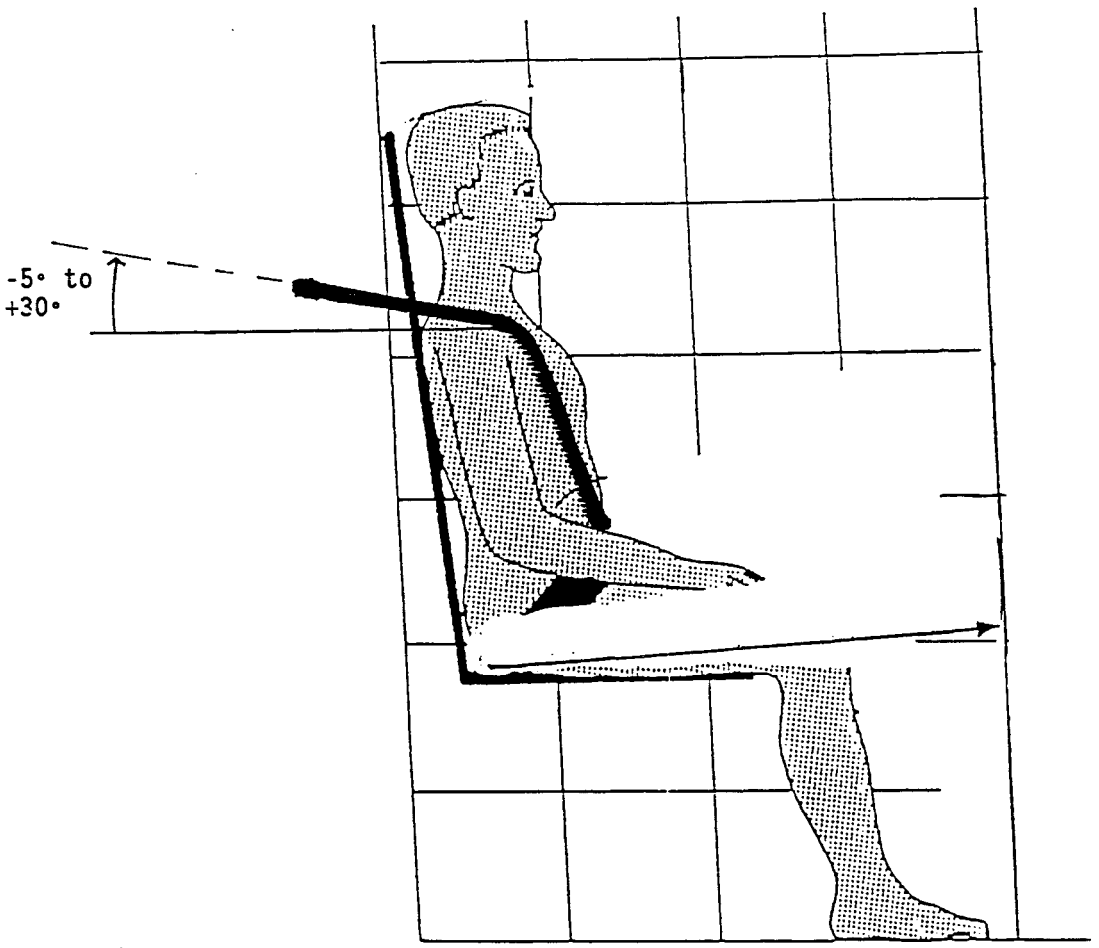
c. Section 25.785(a) requires that a person not suffer serious injury in an emergency landing. The head strike radius noted above will help prevent a passenger's head from striking the seated flight attendant's torso, knees, or legs, and should be considered to be a minimum allowable distance under any circumstances (Ref. § 25.785(c)(2)).

d. There has been no uniform application in the past of the use of a minimum distance to assure that the passenger's hands or feet will also not reach out and strike the seated attendant. Application of these other strike radii would therefore require an analysis of the particular seat installation or interior arrangement under consideration, and a determination if the hands or feet of the forward-facing passenger would, in that situation, pose a hazard to either the aft-facing flight attendant or the passenger.

(1) There is at present no medical data which could be used to determine the degree of injury following a passenger's hands or feet striking a flight attendant's lower legs or knees during an emergency landing. It is

possible that the resulting injury would be serious, however. For this reason, it is recommended that the seats be sufficiently offset to prevent contact between the passenger and the flight attendant wherever possible.

(2) The FAA will conduct further research into the need for specific strike dimensions for hands and feet and if the results indicate a need, rulemaking will be proposed.



Upper Torso Restraint Angle

Figure 2

9. FLIGHT ATTENDANT DIRECT VIEW.

[RESERVED]

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