



SURFACE VEHICLE STANDARD

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Devices for Use in Defining and Measuring Vehicle Seating Accommodation

RATIONALE

This document has been revised to include:

- A new appendix describing the location and purpose for optional measurement divots located on the HPM head room probe, T-bar, and shoes.
- An improved definition of the muslin cloth used during the physical installation.
- Corrections to the HPM calibration sections regarding the lower leg weight tolerances and the combined HPM-HRMD.

All other content has been reaffirmed to comply with the SAE Five-Year Review policy.

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Documents

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1. SCOPE

The devices of this SAE Standard provide the means by which passenger compartment dimensions can be obtained using a deflected seat rather than a free seat contour as a reference for defining seating space. All definitions and dimensions used in conjunction with this document are described in SAE J1100. These devices are intended only to apply to the driver side or center occupant seating spaces and are not to be construed as instruments which measure or indicate occupant capabilities or comfort. This document covers only one H-point machine installed on a seat during each test. Certified H-point templates and machines can be purchased from:

SAE International
400 Commonwealth Drive
Warrendale, PA 15096-0001

Specific procedures are included in Appendix A for seat measurements in short- and long-coupled vehicles and in Appendix B for measurement of the driver seat cushion angle. Specifications and a calibration inspection procedure for the H-point machine are given in Appendix C. Additional considerations are necessary when a head restraint measuring device (HRMD) is mounted to an H-point machine (Appendix D).

1.1 Purpose

This document specifies a two-dimensional H-point template and a three-dimensional H-point machine (HPM) for use in defining and measuring accommodation in vehicle seats.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

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

SAE J182 Motor Vehicle Fiducial Marks and Three-Dimensional Reference System

SAE J1100 Motor Vehicle Dimensions

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

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

SAE J1516 Accommodation Tool Reference Point for Class B Vehicles

SAE J1517 Driver Selected Seat Position for Class B Vehicles - Seat Track Length and SgRP

SAE J2732 Motor Vehicle Seat Dimensions

SAE J4002 H-Point Machine (HPM-II) Specifications and Procedure for H-Point Determination - Auditing Vehicle Seats

SAE J4003 H-Point Machine (HPM-II) - Procedure for H-Point Determination - Benchmarking Vehicle Seats

SAE J4004 Positioning the H-Point Design Tool - Seating Reference Point and Seat Track Length

Geoffrey, S.P., "A 2-D Manikin - The Inside Story," Paper 267A presented at SAE International Congress, Detroit, January 1961

3. DEFINITIONS

The following terms are defined in SAE J1100. When appropriate, added explanation is provided.

3.1 ACCELERATOR HEEL POINT, AHP

3.2 ANKLE (FOOT) ANGLE, A46

3.3 BALL OF FOOT, BOF

3.4 CUSHION ANGLE, A27

See Appendix B. Cushion angle is measured using the H-point machine with the lower legs removed and the torso weights redistributed about the cushion pan.

3.5 FLOOR REFERENCE POINT, FRP

3.6 H-POINT

The H-point is located on the centerline of the H-point machine midway between the H-point sight buttons on either side of the machine.

3.7 HEEL OF SHOE

3.8 HIP ANGLE, A42

3.9 KNEE ANGLE, A44

3.10 SEATING REFERENCE POINT, SGRP

3.11 SHOE PLANE

3.12 SHOE PLANE ANGLE, SPA

3.13 THIGH ANGLE, A57

3.14 THIGH CENTERLINE

3.15 THIGH LINE

3.16 TORSO (BACK) ANGLE, A40¹

3.17 TORSO LINE

¹ Prior to 2008, SAE Standards generally used the term "back angle" to describe the A40 dimension of SAE J1100. New or revised standards beginning in 2008 will use the term "torso angle" for this dimension.

4. H-POINT TEMPLATE - DESCRIPTION, APPLICATION, AND POSITIONING PROCEDURE

4.1 Description

The H-point template (Figure 1) is constructed to represent in profile an adult male wearing shoes and corresponds to the profile of the deflected seating contour of the H-point machine. Individual torso, thigh, lower leg, and shoe segments are provided with locking pivot joints which can be used to fix the angular relationships of the segments. A torso angle reference bar is included to orient the template's torso in relation to the vertical.

4.2 Application

Aids in displaying the following:

- Passenger compartment space and seating attitude during conception, engineering, and development stages of any new vehicle.
- Passenger compartment space and seating attitude for comparison and reporting purposes.
- Data obtained from checks made with the H-point machine. (See Section 5).

4.3 Positioning Procedure for Physical Template (Figure 1)

4.3.1 Torso Positioning for Any Specified Seating Reference Point and Torso Angle

4.3.1.1 Position the H-point of the H-point template on the seating reference point (SgRP) location on the layout.

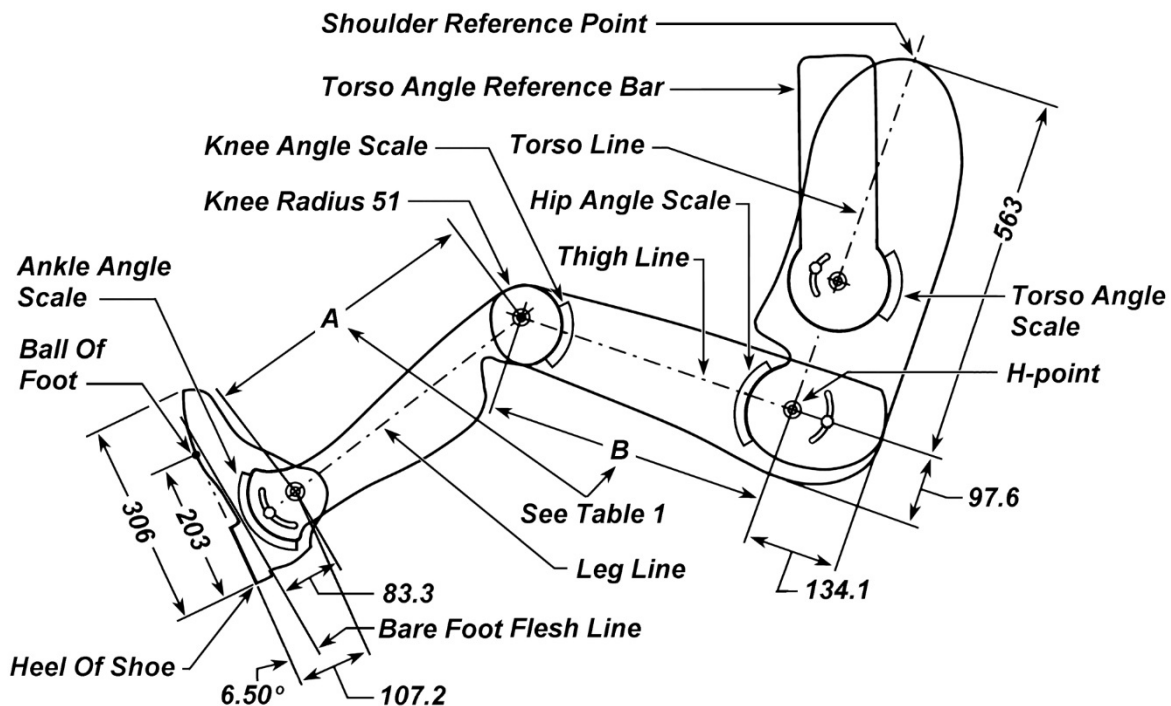


Figure 1 - H-point template

4.3.1.2 Set the torso angle reference bar quadrant scribe line marked on the torso angle quadrant to the specified torso angle. Lock this quadrant in place.

4.3.1.3 Position the vertical reference scribe lines on the torso angle reference bar parallel to the body grid lines on the layout drawing.

4.3.2 Front Seat - Driver Position

Leg and shoe positioning for any specified accelerator heel point location.

- 4.3.2.1 Holding the torso portion of the template in position as outlined in 4.3.1.1 to 4.3.1.3, position the heel point of the template at the specified heel point location. This point on the layout is located on top of the heel pad or the depressed floor covering surface at the Y-plane centerline of the accelerator pedal.
- 4.3.2.2 Holding the heel point at the specified location, rotate the shoe forward until the bottom of the shoe contacts the undepressed accelerator pedal without infringing upon the 87 degrees minimum ankle (foot) angle. Normally the pedal contact point is at or below the shoe ball of foot.
- 4.3.2.3 The undepressed accelerator pedal (point of contact with the bottom of shoe or shoe plane) may be determined by locating the heel point as described previously and presetting and locking the ankle angle to 87 degrees.

4.3.3 Front Seat - Driver Position

Leg and shoe positioning for any specified undepressed accelerator pedal location.

- 4.3.3.1 Holding the torso portion of the template in position as outlined in 4.3.1.1 to 4.3.1.3, position the bottom of the shoe on the specified undepressed accelerator pedal and the heel as far forward as allowable. However, the ankle angle is never less than 87 degrees. Lock ankle angle quadrant.

4.3.4 Second Row - Left Side Occupant Position

Leg and shoe positioning with the front seat in its SgRP position.

- 4.3.4.1 Holding the torso portion of the template in position as outlined in 4.3.1.1 to 4.3.1.3, except with the template H-point on the SgRP of the second row seat, place the bottom of the shoe (heel and ball) on the depressed floor covering line. The shoe is to be placed on the Y-plane centerline of the occupant or up to 127 mm (5 inches) on either side of the Y-plane centerline on the floor pan section.

NOTE: Locating the shoe either side of the Y-plane centerline of the occupant position will make the shoe location compatible to the shoe location in the existing H-point machine installation procedure.

- 4.3.4.2 Move the shoe forward along the depressed floor covering line to the nearest interference of the toe, instep, lower leg, or knee with the front seat. The ankle angle is to be restricted to a maximum of 130 degrees.

4.3.5 Third Row - Left Side Occupant Position - Forward Facing

- 4.3.5.1 Follow the procedure as outlined for the second row seat, left side occupant position except that the template is positioned in the third seat compartment.

4.3.6 Third Row - Left Side Occupant Position - Rearward Facing

- 4.3.6.1 Follow the same procedure as outlined for the third row - side occupant position - forward facing, except that the shoe is positioned in the footwell to the interference with the rear end or closure.

4.3.7 H-Point Template Layout Using Data Obtained During H-Point Machine Installation

- 4.3.7.1 Position the H-point pivot of the template at the measured H-point location on a layout drawing or grid system.
- 4.3.7.2 Follow the procedure as outlined in 4.3.1.1 to 4.3.1.3 using the measured torso angle instead of the design torso angle.
- 4.3.7.3 Holding the torso portion of the template in position as outlined previously, move the upper leg segment to the measured hip angle shown on the hip angle quadrant.

- 4.3.7.4 Lock this quadrant in place.
- 4.3.7.5 Position and lock the ankle (foot) angle quadrant to the measured ankle angle.
- 4.3.7.6 Allowing the knee angle to vary as necessary, position the ankle pivot center on an arc from the hip pivot center equal to the measured effective leg room less 254 mm.

4.4 Positioning Procedure for CAD Template (Figure 2)

4.4.1 Use of Optional Shoe Bottom

- 4.4.1.1 The standard H-point template has a shoe with an arched bottom and a defined heel shape. The BOF point on the shoe is 203 mm (8 inches) from the heel of the shoe. SAE manikins defined in SAE J4002 (HPM-II) and SAE J4004 (HPD) have a shoe with a flat shoe bottom from the shoe heel to the BOF. There is no heel pocket. As an option to aid in transitioning to these devices, users are strongly encouraged to flatten the shoe bottom of the CAD template, as shown in Figure 2.

4.4.2 Positioning for Any Specified Seating Reference Point and Torso Angle

- 4.4.2.1 Position the H-point of the CAD template on the SgRP at the specified torso angle. Use values for SgRP and torso angle that are either specified by the manufacturer or can be determined from SAE J4004.
- 4.4.2.2 For the driver position, lock the ankle angle at 87 degrees. The bottom of the shoe should be touching the undepressed accelerator pedal. Alternatively, the heel of shoe may be placed at the manufacturer AHP with the bottom of the shoe touching the pedal.

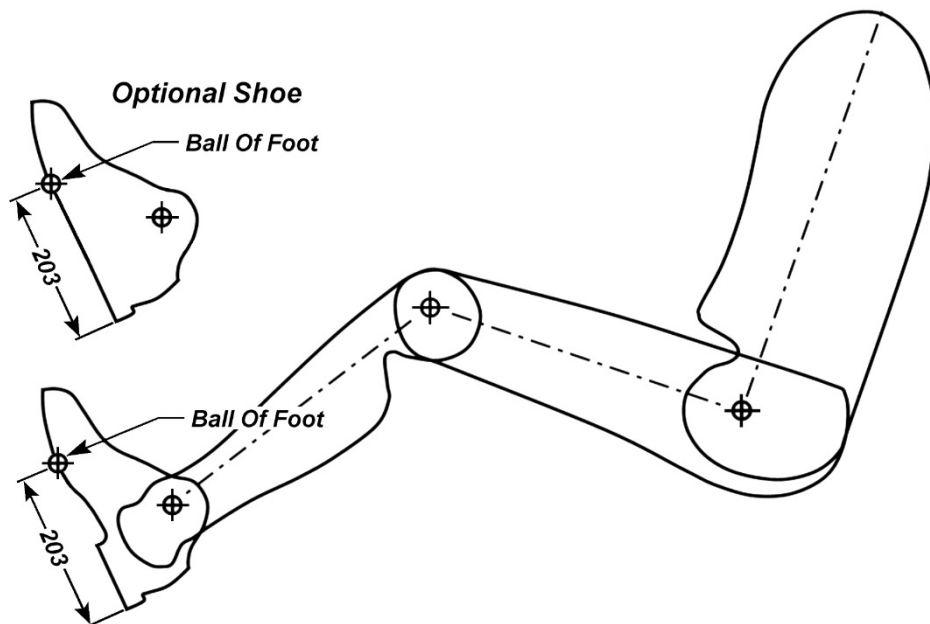


Figure 2 - CAD version of H-point template

- 4.4.2.3 For passenger positions, the shoe should be positioned with the heel of shoe at the floor reference point (FRP) and the bottom of shoe on the floor.
- 4.4.3 Positioning for an Unknown Seating Reference Point and Torso Angle
 - 4.4.3.1 Install the 3-D H-point machine to determine the seat H-point travel path. Refer to SAE J1100 for determining BOF, AHP, shoe plane angle, SgRP, and torso angle.
 - 4.4.3.2 Install the CAD template as described in 4.4.2.

5. H-POINT MACHINE - DESCRIPTION, APPLICATION, AND INSTALLATION PROCEDURE

5.1 Description

The back and cushion pans of the 3-D H-point machine (Figures 3 and 4) are representations of adult male contours. Constructed of reinforced plastic and metal, these separate back and cushion pans simulate the human torso and thigh and are mechanically hinged at the H-point. A graduated sliding probe is hinged from the H-point to measure the head room in the compartment. A quadrant is fastened to the probe to measure the torso angle. An adjustable thigh bar, attached to the cushion pan, establishes the thigh centerline and serves as a baseline for the hip angle quadrant. Lower leg segments, also adjustable in length, are connected to the cushion pan assembly at the knee joining T-bar, which is a lateral extension of the adjustable thigh bar. Quadrants are incorporated in the lower leg segments to measure knee angles. Shoe and ankle assemblies are calibrated to measure the angular relation to the lower leg segment. Positive stops are provided in the thigh and lower leg segments for the 10th, 50th, and 95th percentile of adult male dimensions (Table 1). Two spirit levels orient the device in space. Body segment weights are placed at the center of gravity locations to provide seat penetration equivalent to a 77 kg (169.6 pound) male.

The lower leg and thigh segments are available in 10th, 50th, and 95th percentile lengths. (See Table 1.)

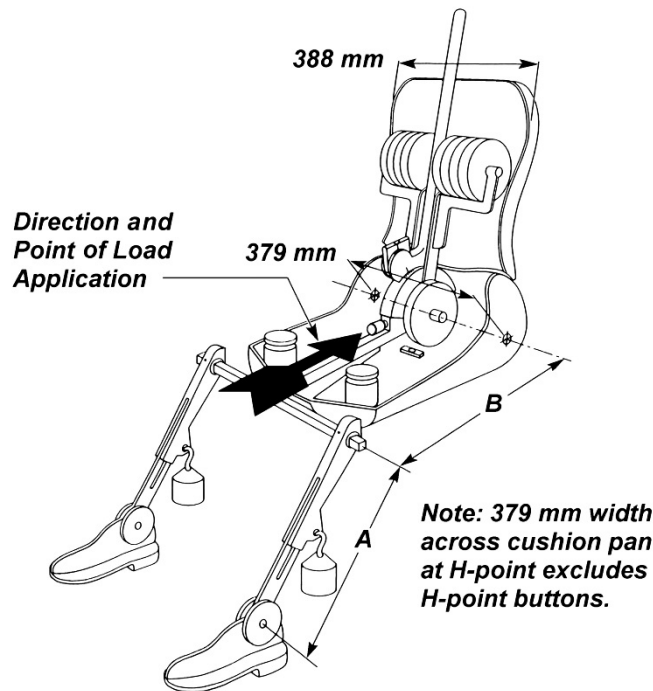


Figure 3 - H-point machine

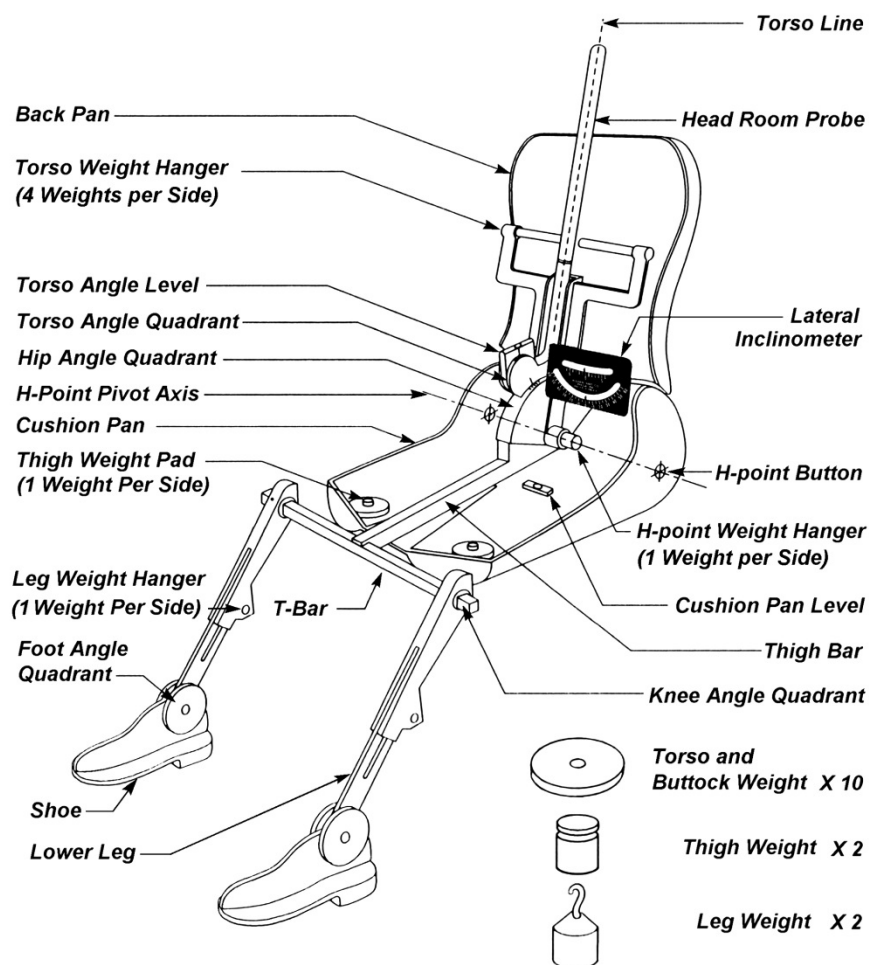


Figure 4 - H-point machine

Table 1 - Leg segment length

	10th Percentile ⁽¹⁾ mm	50th Percentile ⁽¹⁾ mm	HPM 95th Percentile ⁽²⁾ mm
Lower leg segment (A)	392.7	417.1	458.7
Thigh segment (B)	407.7	431.5	455.7

⁽¹⁾ Geoffrey, S.P., "A 2-D Manikin—The Inside Story." Paper 267A presented at SAE International Congress, Detroit, January 1961.

⁽²⁾ Values for the 95th percentile leg lengths were developed on the basis of best judgment of available data by the Design Devices Subcommittee of the SAE Human Factors Engineering Committee at the July 1968 and March 1969 meetings.

5.2 Application

5.2.1 Aid in the design and development of seats and seat materials.

5.2.2 Check vehicle seating compartments for conformance to design specifications (that is, relationship of H-point to body structures, seats, controls, etc).

5.3 Installation Procedure

- 5.3.1 Dimensions are measured relative to the X and Z body zero planes by setting up the vehicle relative to the front and rear fiducial mark (refer to SAE J182) height (H163 and H164). Curb and gross weight rating loads require different fiducial mark heights. (Refer to SAE J1100.) All interior dimensions are measured with the front seat in the SgRP position as specified by the manufacturer. When the seatback has an angular adjustment separate from the seat cushion, the normal driving or riding torso angle is specified by the manufacturer (A40). Use 25 degrees if not specified. The cushion tilt adjustment, if available, should be in the design position.
- 5.3.2 Sufficient time (at least 4 hours) shall be allowed to ensure that the seat material reaches room temperature. Room temperature shall be 19 to 26 °C (66 to 79 °F). Room relative humidity should be within a range of 50% ± 5%. If this relative humidity is not met, record both relative humidity and room temperature. If the seat to be checked has never been sat upon, a 68 to 79 kg (150 to 175 pound) person shall sit on the seat twice for 1 minute to flex the cushion and back. All seat assemblies are to remain unloaded for a minimum period of 1/2 hour (1 hour preferred) prior to the H-point machine installation.
- 5.3.3 Place a piece of muslin cotton cloth over the seat area to be checked. The muslin cloth should be of sufficient size to prevent the machine from contacting the seat. The muslin should be a plain cotton, single weave fabric having a surface area density between 95 to 175 g/m². The muslin should be tucked in a sufficient amount to prevent hammocking of the material. If the test is run in a buck, suitable floor covering sections, or equivalent, are to be placed under the H-point machine's shoes.
- 5.3.4 Place cushion and back assembly of the H-point machine at the centerline of occupant (C/LO). C/LO is also the centerline of H-point machine and is located in vehicle per manufacturer specifications. If specifications are not available, locate C/LO as follows:
- For bucket front seats, seats with defined bolsters, or individual auxiliary seats, C/LO is the centerline of the seat.
 - For bench (or other) seats, C/LO is located at the middle of the head restraint. If a head restraint is not fitted, locate C/LO midway between the lap belt anchors. For the driver, C/LO may be aligned with the steering wheel center.
 - 381 mm outboard from the vehicle centerline (as a last resort).

The C/LO should be moved inboard whenever the H-point machine is sitting far enough outboard that the seat edge will not permit leveling of the H-point machine. It is moved inboard the necessary distance to permit leveling of the H-point machine and the new dimension from centerline of vehicle to C/LO noted in recording measurements.

5.3.5 Use 95th percentile leg and thigh segments specified in Table 1.

5.3.6 Attach shoe and lower leg assemblies to the cushion pan assembly, either individually at the knee joint or by using the T-bar lateral segment and lower leg assembly.

The T-bar lateral segment should be parallel to the ground and perpendicular to the Y-plane of the vehicle unless otherwise specified by the manufacturer.

5.3.7 The shoe and leg positions of the H-point machine for the various individual seat positions to be checked are as follows:

5.3.7.1 Front Seat - Driver Position

The right shoe and leg assembly is placed on the undepressed (blocked or mechanically restrained) accelerator pedal with the sole of the shoe on the pedal and the heel as far forward as allowable. The right leg is adjusted inboard on the T-bar toward the centerline of the vehicle until just contacting the tunnel (or other components) or until the ball of foot on the shoe is aligned with the center of the accelerator pedal pad unless specified otherwise by the manufacturer. Tunnel contact at the heel is defined where the Heel Point on the shoe is at the beginning transition of horizontal to upturned compressed carpet surface. The heel may not be placed on the toe board. However, the ankle angle is never less than 87 degrees. The 87 degree limit can be fixed by inserting the pin into the shoe assembly.

The left shoe is positioned on the floor or toe pan and located approximately the same distance to the left of the H-point machine centerline as the right shoe is to the right. The T-bar should be maintained parallel to the ground.

5.3.7.2 Front Seat - Occupant in Vehicle Centerline Position

The H-point machine is installed in the front seat vehicle centerline position with both legs extended at the specified percentile, one on either side of the tunnel. The left shoe is placed on the undepressed accelerator pedal and the right shoe is located to the right of the tunnel, approximately opposite and symmetrical in a manner that levels the knee joint T-bar. A T-bar extension may be required to straddle the knee segments on either side of the tunnel. In vehicles having no tunnel, the shoes are set approximately 254 mm (10 inches) apart. The leg comfort angles are determined from the H-point machine's left leg.

5.3.7.3 Second and Successive Seats - Side Occupant Position

The H-point machine is installed in the second seat outboard occupant position at the C/LO as described in 5.3.4. (Check applicable seating arrangement drawing for specified location.) The two shoes are placed together, or up to 127 mm (5 inches) to either side of C/LO, and positioned to the nearest interference of the toe, instep, or lower leg with the front seat, unless otherwise specified by the manufacturer. In instances where one shoe reaches interference before the other, the one with the farthest interference will be used for dimensioning purposes. For additional H-point machine leg location conditions and restrictions, see Appendix A. For a description of short- and long-coupled seating conditions, see Sections 6 and 7.

5.3.7.4 Second and Successive Seats - Occupant in Vehicle Centerline Position

The H-point machine is installed in the second seat-vehicle centerline position with both the shoe and lower leg assemblies on the normal floor, and placed astride the tunnel, if present. Both leg assemblies are extended to the nearest interference of the toe, instep, or lower leg with the front seat.

If necessary, in order to clear lateral obstructions, such as seat belt anchors, tunnel width, etc., the T-bar may be extended. In vehicles with no tunnel, set the H-point machine's shoes approximately 254 mm (10 inches) apart.

5.3.8 Apply lower leg and thigh weights and level the H-point machine.

5.3.9 Tilt the back pan forward against the forward stop and draw the H-point machine away from the seatback using the T-bar. Reposition the H-point machine on the seat by one of the following methods:

5.3.9.1 If the H-point machine tends to slide rearward, use the following procedure: allow the H-point machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required due to the cushion pan contacting the seatback.

5.3.9.2 If the H-point machine does not tend to slide rearward, use the following procedure: slide the H-point machine rearward by a horizontal rearward load applied at the T-bar until the cushion pan contacts the seatback.

5.3.10 Apply a 10 kg (22 pound) load twice to the back and pan assembly positioned at the intersection of the hip angle quadrant and the T-bar housing (Figure 3). The direction of load application should be maintained along a line from the above intersection to a point just above the thigh bar housing. Then carefully return the back pan to the seatback. Care must be exercised through the remainder of the procedure to prevent the H-point machine from sliding forward.

5.3.11 Install the right and left buttock weights and then alternately the eight torso weights. Maintain H-point machine level.