



SURFACE VEHICLE RECOMMENDED PRACTICE

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

RATIONALE

This document has been cancelled because it has been superseded by SAE J3099 and SAE J4002.

CANCELLATION NOTICE

This technical report has been declared “CANCELLED” as of August 2024 and has been superseded by SAE J3099 and SAE J4002. By this action, this document will remain listed in the respective index, if applicable. Cancelled technical reports are available from SAE.

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FOREWORD

This document describes how to position and posture the H-point design tool (HPD), and how to establish the seating reference point (SgRP) and other key reference points that are used in the design and specification of both driver and passenger seat positions. Use of the HPD in conjunction with the H-point machine (HPM-II) for benchmarking vehicle occupant packages is described in SAE J4003.

Prediction of where drivers select seat positions on the seat adjuster path is important for many aspects of vehicle design related to comfort and safety. Vehicle designers use driver seat position models to determine the length and location of adjustable seat tracks to insure that drivers of varying size can comfortably reach and operate vehicle hand and foot controls.

This document provides a new method for determining driver seat track length and for positioning the seat track in the vehicle package. It is based on studies and statistical models developed at the University of Michigan Transportation Research Institute. The new method for positioning driver seat tracks in the vehicle is based on H30 and two new variables, L6 and the presence or absence of a clutch pedal. The seat track length is independent of vehicle seat or package variables. It is based on accommodating with high statistical confidence the range of statures represented by an equal number of U.S. male and female drivers. Background details of the new method are given in Appendix A. Historical information about the prior procedure is given in Appendix E.

SAE J4004 will in the future fully replace SAE J1517:1990 for Class A vehicles. Until 2017 the ball-of-foot and accelerator heel point determined according to SAE J1517 may be used in lieu of the BOFRP cited in this document. However, SAE J4004 should be used to determine the seat track length and the accommodation levels for the U.S. driving population.

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1. SCOPE

This SAE Recommended Practice describes how to position and posture the H-point design tool (HPD) described in Appendix B, and how to establish the seating reference point (SgRP), design H-point travel path, and other key reference points that are used in the design and specification of both driver and passenger seat positions.

This practice also provides a method for determining the length of the seat track for a driver seat that adjusts fore/aft. The seat track length is based on a desired level of driver accommodation, assuming a U.S. population containing an equal number of male and female drivers. The procedure can be used to establish driver seat track accommodation for new vehicle designs or to evaluate accommodation in existing vehicles.

A general method for determining driver seat track length for any driver population (male and female stature distribution) at any selected accommodation percentile and gender mix is given in Appendix A.

Application of this document is limited to Class A Vehicles (Passenger Cars, Multipurpose Passenger Vehicles, and Light Trucks) as defined in SAE J1100.

2. REFERENCES

2.1 Applicable Publications

This document contains provisions which reference the following documents. At the time of publication, the indicated editions of these references were valid. Since all publications are subject to revision or deletion, users of this document are encouraged to refer to the most recent published editions of these referenced documents. Information obtained using the following publications is needed for application of the procedures described in this Practice.

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 724-776-4970 (outside USA), www.sae.org.

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

SAE J1100 Motor Vehicle Dimensions

2.2 Related Publications

The following publications were discussed or used to develop the seating accommodation procedures and are not required for application of this document.

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 724-776-4970 (outside USA), www.sae.org.

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

SAE J1516 Accommodation Tool Reference Point

SAE J1517 Driver Selected Seat Position

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

2.2.2 Philippart, N.L., Roe, R.W., Arnold, A.J., and Kuechenmeister, T.J. (1984). *Driver selected seat position model*. SAE Technical Paper 840508. SAE International, Warrendale, PA.

2.2.3 Flannagan, C.C., Schneider, L.W., and Manary, M.A. (1996). *Development of a Seating Accommodation Model*. SAE Technical Paper 960479. SAE International, Warrendale, PA.

2.2.4 Abraham, S., Johnson, C.L., and Najjar, M.F. (1979). Weight and height of adults 18-74 years of age. *Vital and Health Statistics*. Series 11, No. 211.

2.2.5 U. S. National Health and Nutrition Examination Survey (NHANES III): Height for males and females 20 years and older: United States, 1988-1994.

2.2.6 Flannagan, C. C., Schneider, L.W., and Manary, M.A., and Reed, M. P. (1998). *An Improved seating Accommodation Model with Application to Different User Populations*. SAE Technical Paper 980651. SAE International, Warrendale, PA.

3. DEFINITIONS

3.1 SAE J1100 Definitions

Accelerator Heel Point (AHP)

Ball of Foot (BOF)

Ball of Foot Reference Point (BOFRP)

Floor Reference Point (FRP)

Heel of Shoe (HOS)

H-point

H-Point Travel Path

Pedal Contact Point (PCP)

Seating Reference Point (SgRP)

A27 – Cushion Angle

A47 – Shoe Plane Angle (SPA)

H30 – Seat Height

L6 – BOFRP to Steering Wheel Center

PW86 – AHP to BOFRP Lateral Offset

TH21 – Rearmost Lowest to Rearmost Highest H-Point Height – Driver

BOFRP and AHP are reference points in the shoe plane that are coincident with the BOF and HOS points on the HPD shoe, when the HPD shoe is on the accelerator pedal. BOF and BOFRP are not coincident when there is an interference condition (4.2.2.1). When BOF and HOS are on the floor, HOS defines the FRP. The terms “shoe tool” and “shoe” are both used to describe the HPD shoe. (See Figures 1, 5 and 10.)

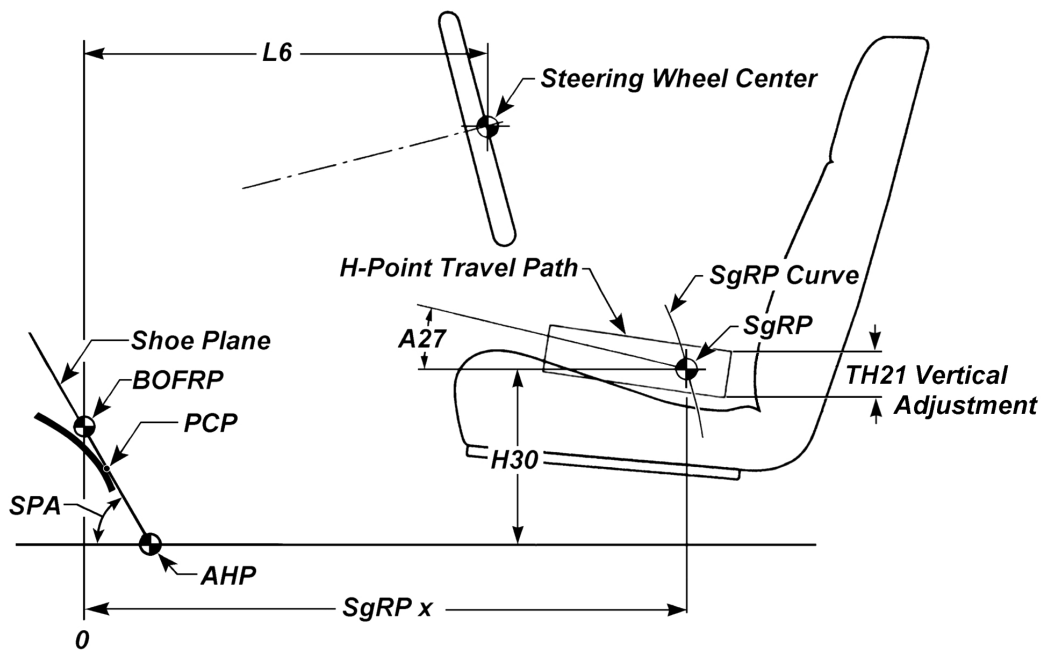


FIGURE 1 - SEATING PACKAGE DESCRIPTION SHOWING PACKAGE FACTORS USED TO CALCULATE DRIVER SEAT POSITIONS

3.2 SAE J4004 Definitions

3.2.1 Driver Seat Position Accommodation

Percent of a 50/50 male/female driver population whose preferred fore/aft seat track position is within the seat track travel path.

3.2.2 Driver Seat Position Accommodation Point

Point on design H-point travel path that provides a specified level of driver seat position accommodation for a given driver population and vehicle package.

4. DETERMINING THE DRIVER SEATING REFERENCE POINT AND POSITIONING THE HPD

This procedure is used to position the H-point design tool (HPD, Figure 2) in the correct location for the driver, and to establish the driver Seating Reference Point (SgRP-Front), Ball of Foot Reference Point (BOFRP), Accelerator Heel Point (AHP) and driver Shoe Plane Angle (SPA). Specifications and tolerances for the HPD are given in Appendix B. Note that shoe plane and SPA replaces pedal plane and pedal plane angle terminology used in SAE J1516.

Design procedures in this document can be used with both the HPM and HPM-II CAD tools. The SAE J826 HPM has a non-articulated torso that does not provide a measure of Lumbar Support Prominence (LSP). The SAE J826 manikin shoe has a standard bottom-of-shoe profile with a heel pocket, and an optional flat shoe bottom without the heel pocket. Procedures in this document use the flat bottom-of-shoe profile.

4.1 Overview of Design Procedures

The HPD is used during design to establish key reference points within the vehicle for each occupant seating position, including the SgRP and heel points (AHP for the driver and FRPs for passengers). These points are then used to configure and measure many aspects of the vehicle interior compartment.

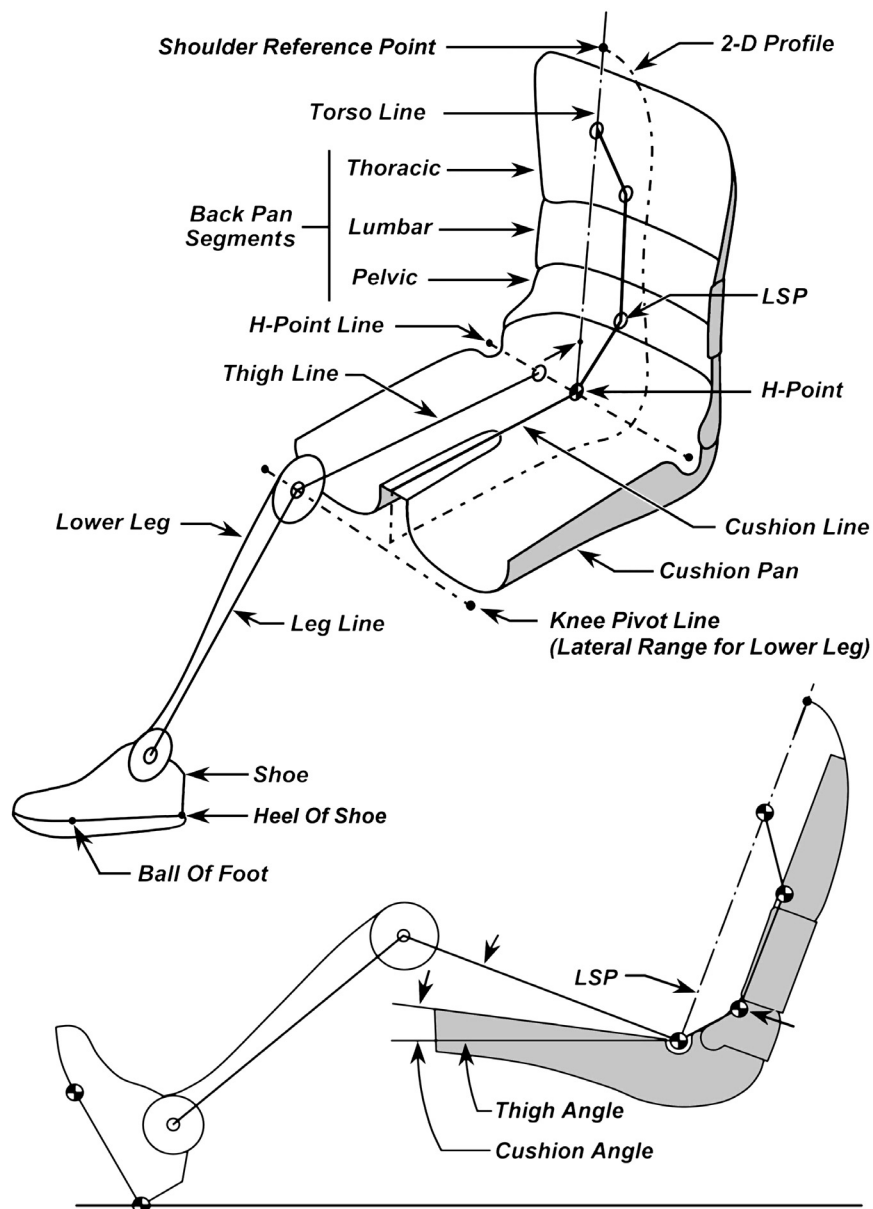


FIGURE 2 - H-POINT DESIGN TOOL (HPD) - ELEMENTS ARE COMMON WITH H-POINT MACHINE (HPM-II) EXCEPT FOR PARTS OF THE 2-D PROFILE

The SgRP is a specific and unique H-point location for each designated seating position. (Although adjustable seats will have many H-point locations within their H-point travel path, only one H-point location is defined as the SgRP for any designated occupant seating position.) The most critical SgRP is the one defined for the driver (SgRP-Front). It is used to position many other design tools (e.g., head clearance contours, eyellipses), to define a number of key vehicle dimensions (e.g., legroom, shoulder room, etc.), and is cited in several national and international regulations and standards.

The shoulder reference point is unique to the 2-D profile and is located on the torso line. It represents a point below which the shoulder of most vehicle occupants would be found. This point was established by an SAE committee in 1966 to be above the 99th percentile shoulder height of the adult male seated population based on a 1959 Air Force male survey.

Other reference points established by this procedure (AHP and BOFRP), relate directly to the design position of the accelerator pedal. Manufacturers may provide pedal adjustments in a vehicle so that drivers can change the undepressed position of the pedals from their nominal design position. SAE J4004 does not provide methods for designing the travel adjustment path of these adjustable pedals.

4.2 Driver Designated Seating Position Design Procedure

4.2.1 Determine the Initial Target Values

Determine the initial target values for the dimensions listed in Table 1. (See SAE J1100 for definitions.) Some of these values may be modified during the procedure, resulting in different final values.

TABLE 1 - VALUES FOR INITIAL POSITIONING OF THE HPD FOR DRIVER

Dimension	Code	Final Values
Seat Height	H30 _(Target)	The final value of H30 will be defined during this procedure.
Depressed Floor Covering Height		Undepressed floor covering height at AHP minus 5 mm or an amount specified by the manufacturer.
Occupant Centerline	W20 _(Target)	If the seat track has an outboard/inboard angle, then the final value of W20 may be different than the target value (depending on the fore-aft location of SgRP).
Torso Angle	A40	Set at manufacturer design intent. A40 is a seat characteristic. It is neither calculated nor modified by this procedure. Rather, it is used to define the orientation of the back pan assembly.
Lumbar Support Prominence (LSP)	L81	L81 is a seat characteristic. It is neither calculated nor modified by this procedure. Rather, it is used to posture the back pan articulation, specifying the distance (X) of the lumbar-pelvic pivot (L/P pivot) to the torso line, measured normal to the back line. (See Figure 3.) LSP=57-X mm
Ankle Angle	A46-1	87 deg (standardized for this procedure)
Cushion Angle	A27	A27 is a seat characteristic. It is neither calculated nor modified by this procedure. It is used to position the attitude of the cushion pan assembly.

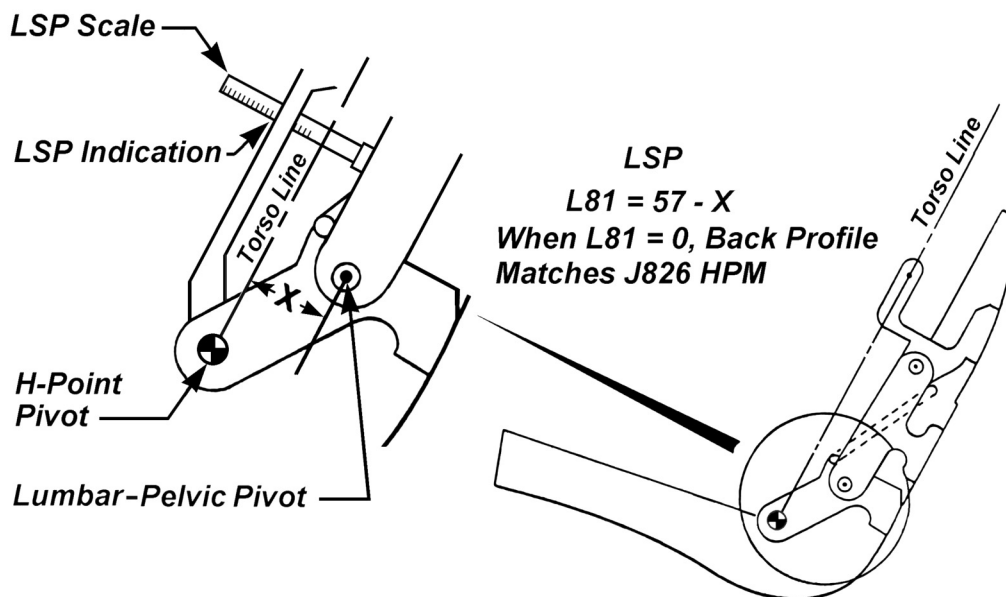


FIGURE 3 - LUMBAR SUPPORT PROMINENCE (LSP)

4.2.2 Define Shoe Tool Location and Attitude

The driver SPA defines the attitude of the shoe tool as a function of the seat height established by the manufacturer. The SPA is calculated by using Equation 1 in 4.2.2.1.1. The location of the shoe tool can be established either before or after a pedal is designed. If the pedal has not yet been designed, refer to Appendix D for information derived from driver studies that can help in designing the side view orientation of the accelerator pedal. The shoe plane along with reference points on the shoe tool are shown in Figure 4. The angle of the shoe plane from horizontal is the SPA.

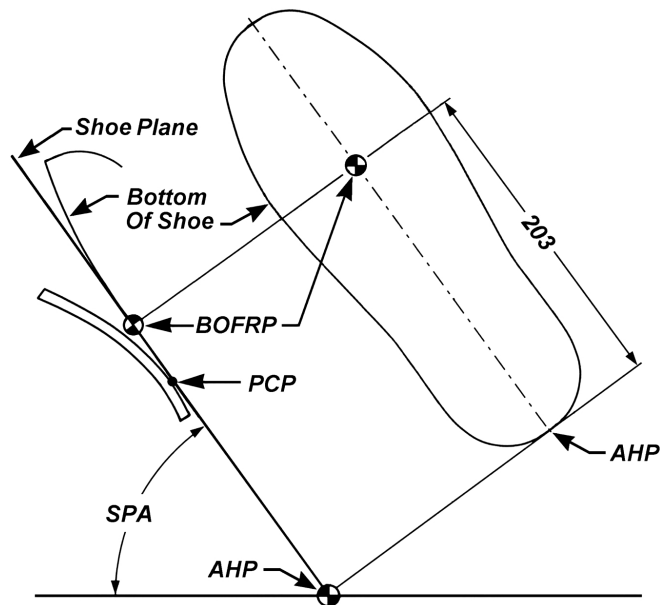


FIGURE 4A - DRIVER SHOE PLANE CAD TOOL

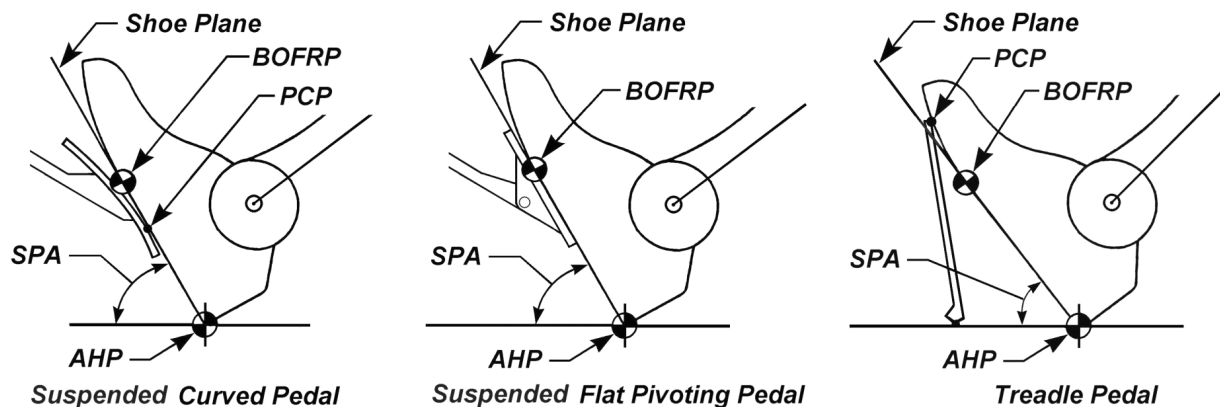


FIGURE 4B - SHOE REFERENCE POINTS SHOWING CURVED, FLAT PIVOTING, AND TREADLE PEDALS RESPECTIVELY

4.2.2.1 Define Driver SPA and Position the Shoe Plane

The shoe plane and SPA are defined at the lateral centerline of the undepressed accelerator pedal. The SPA is measured from horizontal in side view, with the pedal in design position and the shoe in contact with the lateral centerline of the pedal pad. When the shoe contacts the pedal pad at a single point, that point is called the Pedal Contact Point (PCP). Where there is continuous contact, e.g. with a suspended, flat pivoting pedal, there is not a specific PCP. In rear view, the shoe tool will be square to grid (the shoe is not yawed even if the pedal pad has a yaw angle). If the pedal pad has a roll angle, the shoe should not be rolled to align to the pad, so a portion of the pedal pad on either side of the lateral centerline may penetrate the shoe plane.

NOTE: When either the HPM or HPM-II physical measurement tools are used to locate the AHP and BOFRP in an actual vehicle or seating buck the shoe might not contact the accelerator pedal at the pedal centerline due to pedal pad orientation (roll or yaw). This discrepancy will be small and therefore can be ignored. If scan data is obtained on a vehicle it will be possible to adjust the shoe position in CAD to bring it into point contact at the pedal pad centerline.

If the accelerator pedal has already been designed, determine driver shoe plane location by using the existing accelerator pedal geometry per 4.2.2.1.2.

4.2.2.1.1 Driver SPA Equation: Accelerator Pedal Design

The SPA equation defines the side view orientation of the shoe (SPA) as a function of seat height (H30):

$$\text{SPA} = 2.522(10^{-7})(H30^3) - 3.961(10^{-4})(H30^2) + 4.644(10^{-2})(H30) + 73.374 \text{ degrees from horizontal} \quad (\text{Eq. 1})$$

Design the pedal such that once the driver shoe plane location and angle are established, the lateral centerline of the pedal surface contacts but does not protrude through the driver shoe plane and the Heel of Shoe (HOS) contacts the depressed floor covering. If Seat Height (H30) is changed the driver SPA and shoe plane location will change.

NOTE: Equation 1 is the result of a fitting a cubic curve to the data resulting from the geometric relationship between SPA and Seat Height for an 87 deg. ankle angle when the H-point of the 2-D template is moved along the SgRP locator equation. Equation 1 is a replacement for the "theta" equation in SAE J1516. It provides a better fit to the kinematics of the template linkage.

4.2.2.1.2 Driver Shoe Plane Location Derived from Existing Accelerator Pedal Geometry

1. Suspended pedal with a non pivoting curved pad – Position the driver shoe plane CAD tool shown in Figure 4B so that the bottom of the shoe contacts the lateral centerline of the pedal surface with the heel on the depressed floor covering.
2. Suspended pedal with a flat pivoting pedal pad – Position the driver shoe plane CAD tool shown in Figure 4B so that the bottom of the shoe contacts the lateral centerline of the pedal pad surface with the heel on the depressed floor covering, allowing the pedal pad to pivot tangent to the bottom of the shoe.
3. Treadle (pivot at floor) pedal - Position driver shoe plane CAD tool shown in Figure 4B so that the bottom of the shoe contacts the lateral centerline of the pedal pad surface with the heel on the depressed floor covering (same as for # 2. just above) Three types of contact can occur with a treadle pedal: at the heel of shoe with the pedal at a flatter angle than the bottom of shoe, tangent to the bottom of the shoe or contact at the upper portion of the shoe with the heel of shoe rearward of the bottom of the pedal.

4.2.2.1.3 Carryover Pedal Design

A third method is provided to give manufacturers the option of retaining the SPA, AHP, and BOF from the carryover design. In this case the 2-D H-point template should be used in lieu of the HPD as the design tool (see SAE J826 and SAE J1517). Users can either keep the shoe of the 2-D template that has a heel pocket or use the flat shoe from the HPD (See SAE J826 and Appendix C.). This is the least preferred method and will be eliminated in 2017. For most of these carryover designs the SPA was determined by the theta equation given in SAE J1516.

Manufacturers may retain driver shoe plane (pedal plane) and SgRP locations in carryover designs for vehicles entering production before 2011.

For this method the BOF shall also be the BOFRP.

4.2.2.2 Determine Coordinates for Shoe Reference Points

The X and Z location of the BOFRP are the same as for the BOF.

4.2.2.2.1 BOFRP and AHP Lateral Location

The Y coordinate location for the BOFRP is determined by aligning the BOF of the shoe with the lateral centerline of the pedal. With a curved pedal pad the BOFRP may not be on the surface of the pedal pad.

The AHP Y coordinate will be the same as the BOFRP unless there is interference from a center console, the contour of the tunnel, etc., that prevents the heel of shoe from assuming that position. When there is interference, translate the AHP to the left until the shoe clears the interference (Figure 5). The lateral offset between AHP and BOFRP should be recorded. (PW86). The lateral offset does not influence the positioning of the H-point. It is measured for tracking purposes only.

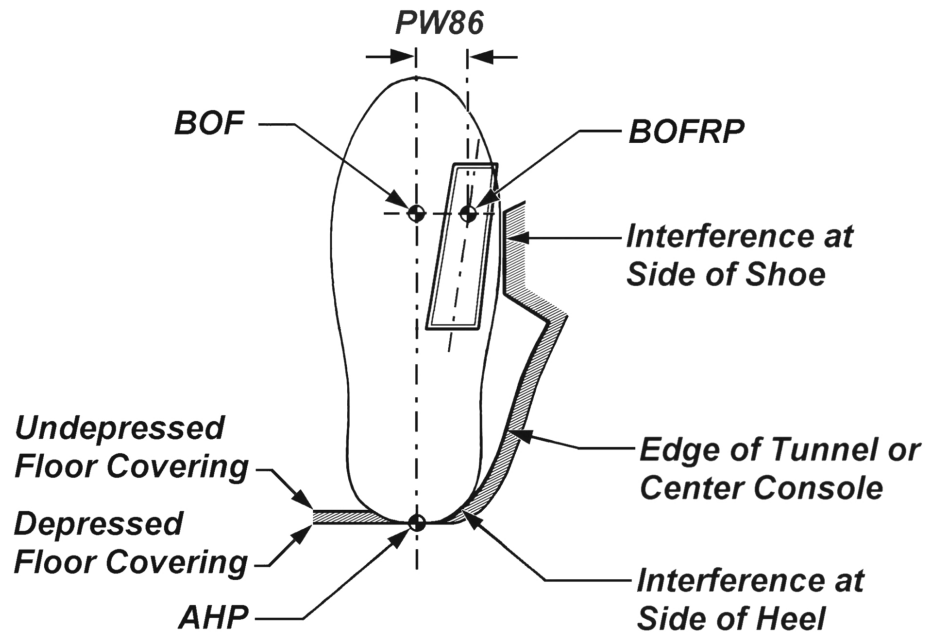


FIGURE 5 - LATERAL OFFSET OF SHOE ON PEDAL IN SHOE PLANE (PW86)

After the shoe plane, the SPA, and the shoe tool are properly positioned, the dimensions listed in Table 2 can be determined.

TABLE 2 - BALL OF FOOT AND PEDAL REFERENCE POINTS AND DIMENSIONS
(SEE SAE J1100 FOR DEFINITIONS)

Code	Name	Comment
A47	Shoe Plane Angle	
L1	BOFRP X Coordinate	Used for positioning SgRP curve
W1	BOFRP Y Coordinate	
H1	BOFRP Z Coordinate	
L8	AHP X Coordinate	
W8	AHP Y Coordinate	W8=W1 unless there is an interference condition
H8	AHP Z Coordinate	Used to measure H30 (vertical distance between AHP and SgRP)
PW86	AHP to BOFRP Lateral Offset	