



SURFACE VEHICLE RECOMMENDED PRACTICE

J3099™

MAY2024

Issued

2024-05

Driver Seating Accommodation and Steering Wheel Location Models

RATIONALE

This practice presents methods for establishing the driver workspace. Methods are presented for:

- Establishing accelerator reference points, including the equation for calculating the shoe plane angle.
- Locating the seating reference point (SgRP) as a function of seat height (H30).
- Establishing seat track dimensions using the seating accommodation model.
- Establishing a steering wheel position.

Some of the information in this practice was previously published in SAE J4002, SAE J4003, and SAE J4004.

INTRODUCTION

This document describes recommended methods for laying out important dimensions of the driver workstation. These design tools assume that a design seat height value (H30) is available, along with pedal and floor geometry.

The seating reference point (SgRP) is defined in SAE J1100 as “the rearmost normal design driving or riding position of each designated seating position in a vehicle.” For a driver seating position with an adjustable seat, the SgRP is one H-point location within the H-point travel path. This document describes the industry practice for locating SgRP using the SgRP curve referenced to the Ball of Foot Reference Point (BOFRP) and Accelerator Heel Point (AHP). The SgRP curve is the 95% accommodation curve from SAE J1517, which contained the original SAE seating accommodation model. SAE J1517 is no longer applicable to Class-A vehicles, and the seating accommodation model in SAE J1517 has been completely superseded by the seating accommodation model in the current practice. However, to maintain compatibility with decades of practice, the SgRP equation is retained.

Similarly, an updated version of an equation presented in SAE J1516 has been retained to define the Shoe Plane Angle (SPA) as a function of H30. During the development of SAE J1516 and SAE J1517, an equation for an accelerator “pedal plane angle” (denoted by θ) was derived by moving the H-point of the SAE J826 2D template along the SgRP locator curve while holding the ankle angle at 87 degrees, maintaining the ball of foot at a constant X-location and maintaining the template heel at a constant Z-location. To maintain compatibility with previous practice, the SPA is defined using an updated version of the equation that more accurately replicates the kinematics of the template. Note that SAE J1516 and SAE J1517 are no longer applicable to Class-A vehicles.

After computing SPA, the profile of the shoe of the SAE J826 template is placed at the appropriate angle against the profile of the undepressed accelerator pedal with the heel resting on the floor. When the shoe profile is appropriately positioned, BOFRP and AHP are established.

SAE Executive Standards Committee Rules provide that: “This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user.”

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2024 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, or used for text and data mining, AI training, or similar technologies, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE J3099_202405

For more information on this standard, visit
https://www.sae.org/standards/content/J3099_202405

Documents

Standard, visit Sharing Hub

Prediction of the distribution of driver-selected seat position on the seat adjuster path is important to ensure that a large percentage of drivers can comfortably reach and operate vehicle hand and foot controls. This document provides a method for determining driver seat track length and for positioning the seat track in the vehicle package to achieve the desired level of accommodation. This seating accommodation model (SAM) is based on statistical models developed at the University of Michigan Transportation Research Institute (UMTRI) based on data from hundreds of drivers in dozens of vehicles. This new method completely supersedes the model presented in SAE J1517. The recommended position of the driver seat track in the vehicle is based on H30, L6, and the presence or absence of a clutch pedal. The seat track length is independent of vehicle seat or package variables. Background details of the new method are given in Appendix A. Historical information about the prior procedure is given in Appendix B.

This practice also introduces a recommended procedure for establishing a design steering wheel position. The steering wheel preference model is based on driver preference data gathered and analyzed at UMTRI and confirmed by reference to benchmarking data.

TABLE OF CONTENTS

1.	SCOPE.....	3
2.	REFERENCES.....	3
2.1	Applicable Documents	3
2.1.1	SAE Publications.....	3
2.2	Related Publications	3
2.2.1	SAE Publications.....	3
2.2.2	Other Publications.....	4
3.	DEFINITIONS	4
4.	DRIVER LAYOUT REFERENCES	4
4.1	SgRP _x Curve	5
4.2	Driver's SPA Equation.....	5
4.2.1	Driver Shoe Plane Location Derived from Accelerator Pedal Geometry	6
5.	DRIVER SEAT TRACK ACCOMMODATION FOR A U.S. DRIVER POPULATION.....	6
5.1	H-Point Reference X	6
5.2	Seat Track Length.....	7
5.3	Position Fore-Aft H-Point Travel Path in Vehicle	7
5.4	Seat Track Angle.....	7
5.5	Vertical Seat Track Travel.....	8
6.	STEERING WHEEL POSITION.....	8
6.1	L6 _x Equation.....	9
7.	NOTES.....	9
7.1	Revision Indicator.....	9
APPENDIX A	MODEL DESCRIPTION AND APPLICATIONS FOR OTHER DRIVER POPULATIONS.....	10
APPENDIX B	BACKGROUND ON THE SAE J1517 MODEL FOR DRIVER-SELECTED SEAT POSITION	15
APPENDIX C	STEERING WHEEL POSITION.....	17
Figure 1	Driver's SgRP curve and reference point constraints	5
Figure 2	Examples of the HPD-II driver's shoe plane used with different accelerator pedal geometry.....	6
Figure 3	Example of driver seat position accommodation points on the design H-point travel path	8
Figure 4	Definition of H30 and L6.....	9
Table 1	Seat track length (mm).....	7
Table 2	Accommodation points.....	7

1. SCOPE

This practice presents methods for establishing the driver workspace. Methods are presented for:

- Establishing accelerator reference points, including the equation for calculating the shoe plane angle.
- Locating the SgRP as a function of seat height (H30).
- Establishing seat track dimensions using the seating accommodation model.
- Establishing a steering wheel position.

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 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 J826 Devices for Use in Defining and Measuring Vehicle Seating Accommodation

SAE J826/2 2-D CAD Template for SAE J826 H-point Machine

SAE J1100 Motor Vehicle Dimensions

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

Philippart, N., Roe, R., Arnold, A., and Kuechenmeister, T., "Driver Selected Seat Position Model," SAE Technical Paper 840508, 1984, <https://doi.org/10.4271/840508>.

Reed, M., "Driver Preference for Fore-Aft Steering Wheel Location," *SAE Int. J. Passeng. Cars - Mech. Syst.* 6(2):629-635, 2013, <https://doi.org/10.4271/2013-01-0453>.

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.

Flannagan, C., Schneider, L., and Manary, M., "Development of a New Seating Accommodation Model," SAE Technical Paper 960479, 1996, <https://doi.org/10.4271/960479>.

Flannagan, C., Manary, M., Schneider, L., and Reed, M., "An Improved Seating Accommodation Model with Application to Different User Populations," SAE Technical Paper 980651, 1998, <https://doi.org/10.4271/980651>.

2.2.2 Other Publications

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.

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

3. DEFINITIONS

3.1 SAE J1100 Definitions

3.1.1 Accelerator Heel Point (AHP)

3.1.2 Ball of Foot (BOF)

3.1.3 Ball of Foot Reference Point (BOFRP)

3.1.4 Floor Reference Point (FRP)

3.1.5 Heel of Shoe (HOS)

3.1.6 H-point

3.1.7 H-Point Travel Path

3.1.8 Pedal Contact Point (PCP)

3.1.9 Seating Reference Point (SgRP)

3.1.10 A27 - Cushion Angle

3.1.11 A47 - Shoe Plane Angle (SPA)

3.1.12 H30 - Seat Height

3.1.13 L6 - BOFRP to Steering Wheel Center

3.1.14 PW86 - AHP to BOFRP Lateral Offset

3.1.15 H17 - Accelerator Heel Point (AHP) to Steering Wheel Center

4. DRIVER LAYOUT REFERENCES

The SAE Recommended Practice for establishing the driver layout is based on the three key reference points: Seating Reference Point (SgRP), Ball of Foot Reference Point (BOFRP), and the Accelerator Heel Point (AHP). The position of these points relative to one another determines critical measurements defined in J1100 within the Driver's space, specifically:

- Seat Height (H30) - vertical distance from SgRP to AHP
- Shoe plane - plane normal to the Y-axis that passes through the BOFRP and the AHP
- L99 - longitudinal distance from the driver's BOFRP and SgRP

The manufacturer positions any one of these reference points within the Driver's space and uses a defined relationship between the reference points combined with an 87-degree ankle angle requirement to complete the layout of the HPD 2D template. This relationship is set by the SAE SgRP_x Curve and defined below:

4.1 SgRP_x Curve

The SgRP_x curve expresses the driver seat H-point position aft of the ball of foot reference (L99) as a function of Seat Height (H30). See Equation 1.

$$\text{SgRP}_x = 913.7 + 0.672316(H30) - 0.0019553(H30)^2 = \text{Distance (in mm) rearward of BOFRP} \quad (\text{Eq. 1})$$

If HPM-II (SAE J4002) is used, the SgRP_x value needs to be adjusted to account for the difference in length of the AHP to BOFRP between the HPM-I and HPM-II - 203 to 200 mm accordingly. See Equation 2.

$$\text{SgRP}_{x(\text{HPM-II})} = \text{SgRP}_x - 3 \cos(\text{SPA}) \quad (\text{Eq.2})$$

The result of applying this equation to the HPD 2D Template is a bounding box that constraints the position of the remaining key reference points. See Figure 1.

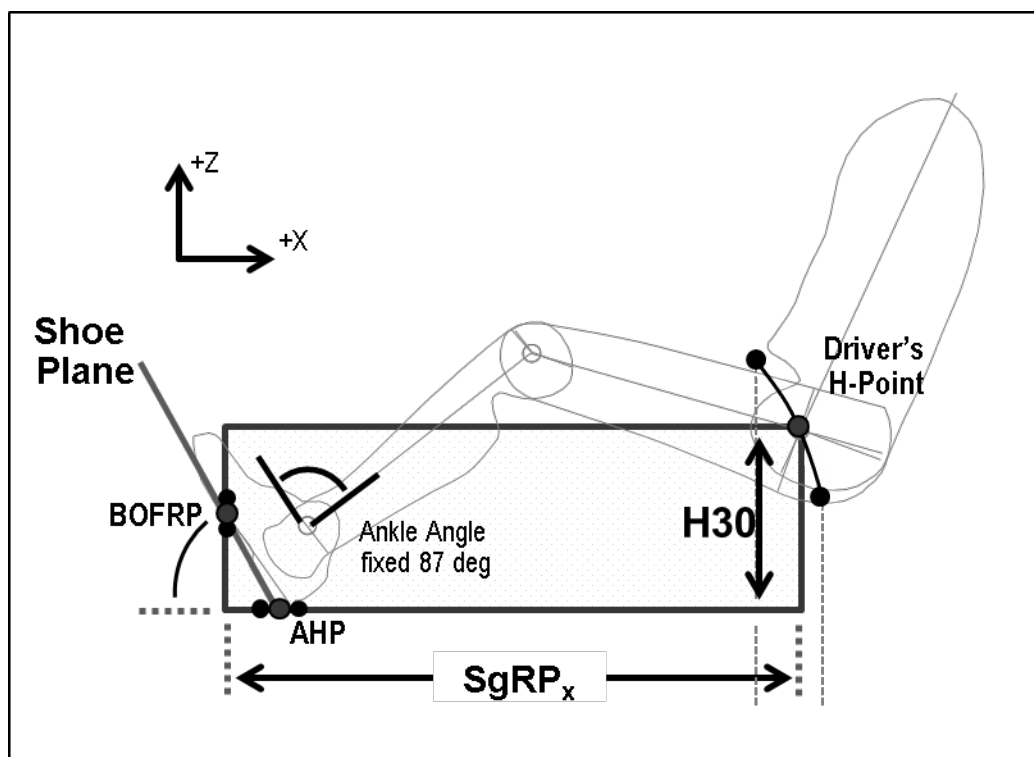


Figure 1 - Driver's SgRP curve and reference point constraints

4.2 Driver's SPA Equation

In some design practices, it is beneficial to only work with the pedal and shoe geometry. The Driver's SPA equation provides a simple method for directly estimating the angle of the Driver's shoe plane as a function of seat height (H30) without the need to determine the complete HPD layout using the SgRP_x equation (see Equation 2).

$$\text{SPA}_{\text{driver}} = 2.522(10^{-7})(H30^3) - 3.961(10^{-4})(H30^2) + 4.644(10^{-2})(H30) + 74.374 \text{ degrees from horizontal} \quad (\text{Eq. 3})$$

The resulting output of the equation is within 0.007 degree of the solution determined by the kinematics of the SAE J826 2D template when applying the SgRP_x methodology for defined Class-A vehicle packages.

4.2.1 Driver Shoe Plane Location Derived from Accelerator Pedal Geometry

If the accelerator pedal has already been designed, driver shoe plane may be located using the existing accelerator pedal geometry per the following:

- Non-pivoting, suspended pedal - Position the driver shoe so that the bottom of the shoe contacts the lateral centerline of the pedal surface with the heel on the depressed floor covering.
- Flat, suspended pedal with a pivoting pedal pad - Position the driver shoe so that the bottom of the shoe contacts the lateral centerline of the pedal pad surface with the heel on the depressed floor covering. The pedal pad should be pivoting within its range of motion as needed to allow the shoe plane to be moved as far forward as possible without depressing the pedal.
- Treadle (pivot at floor) pedal - Position the driver shoe so that the bottom of the shoe contacts the lateral centerline of the pedal pad surface with the heel on the depressed floor covering. Three types of contact can occur with a treadle pedal: at the heel of the shoe with the pedal at a flatter angle than the bottom of the shoe, tangent to the bottom of the shoe, or contact at the upper portion of the shoe with the heel of the shoe rearward of the bottom of the pedal.

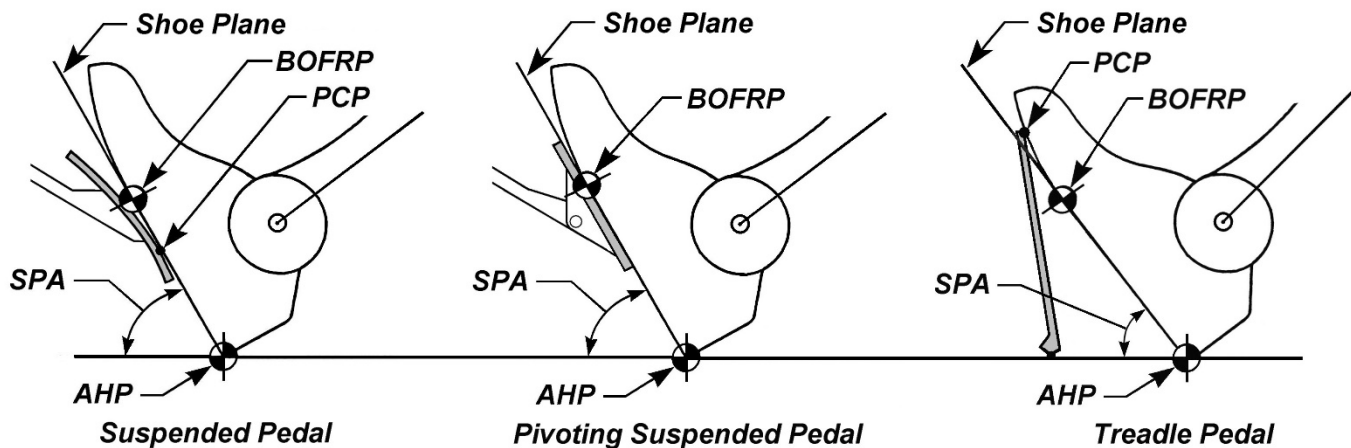


Figure 2 - Examples of the HPD-II driver's shoe plane used with different accelerator pedal geometry

5. DRIVER SEAT TRACK ACCOMMODATION FOR A U.S. DRIVER POPULATION

The Driver Seat Track Accommodation Model provides recommendations for accommodating a preferred fore/aft seat track position of a 50/50 male/female driver population within the seat track travel path.

5.1 H-Point Reference X

The H-point Reference X expresses the position of the Driver Seat Track Accommodation X-reference aft of the BOFRP as a function of seated height (H30), BOFRP to steering wheel center (L6), and transmission type. Determine the X-distance of the H-point reference position aft of the BOFRP based on Equation 4.

$$\text{H-point reference position, } X_{\text{ref}} = 718 - 0.24(H30) + 0.41(L6) - 18.2t \quad (\text{Eq. 4})$$

where:

H30 = vertical distance from the SgRP on the design H-point travel path to the AHP

L6 = horizontal distance from BOFRP-to-steering wheel center (calculation is provided in 6.1)

t = transmission type (1 if clutch pedal and 0 if no clutch pedal)