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## Driver Selected Seat Position

1. **Scope**—A driver selected seat position tool has been developed to describe where certain percentages of drivers position horizontally adjustable seats in various workspace arrangements. The tool consists of series of equations that describe horizontal H-point locations as a function of vehicle H-point height (H30). One series of equations have been established for use in vehicles with H-point heights (H30) and steering wheel diameters (W9) less than 405 mm and 450 mm, respectively (Class A Vehicles). This class of vehicles includes passenger cars, vans, and light trucks. The lines describe the 2.5th, 5th, 10th, 50th, 90th, 95th, and 97.5th percentile accommodation levels expressed as H-point location for a driver population with a male-to-female ratio of 1:1. Separate driver selected seat position equations have been established for use in vehicles with H-point heights (H30) between 405 and 530 mm and steering wheel diameters (W9) between 450 and 560 mm with treadle type pedals (Class B Vehicles). (See Figure 1.) This class of vehicles includes heavy trucks and some buses and multipurpose passenger vehicles. Three series of equations are available for use in Class B vehicles depending on the percentages of males and females in the population the designer wishes to accommodate. Separate equations describe the accommodation level for driver populations with male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5. Different references for locating Class A and Class B driver selected seat position lines in vehicle space have been established based on unique packaging considerations of the two categories of vehicles. For both vehicle classes, the lines can be used as a design tool to estimate the location and length of horizontal seat travel aft of the appropriate reference to provide accommodation of target percentages of drivers. The lines can also be used as a checking tool to estimate the level of accommodation provided by a given horizontally adjustable seat track.

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## 2. References

**2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1100—Motor Vehicle Dimensions

SAE J1516—Accommodation Tool Reference Point

N. L. Philippart, R. W. Roe, A. J. Arnold, T. J. Kuechenmeister (1984), "Driver Selected Seat Position Model," SAE Paper No. 840508, Detroit, MI.

M. S. Sanders (1983), "U. S. Truck Driver Anthropometric and Truck Workspace Data Survey," Final Report Submitted to: Society of Automotive Engineers, Inc., Warrendale, PA.

B. E. Shaw and M. S. Sanders (1984), "Female U. S. Truck Driver Anthropometric and Truck Workspace Data Survey," Final Report Submitted to: Society of Automotive Engineers, Inc., Warrendale, PA.

**3. Definitions**—In addition to the definitions listed as follows, reference is made to the following definitions given in SAE J1100:

- a. H-point
- b. H-point height (H30)
- c. Steering wheel diameter (W9)
- d. Accelerator heel point (AHP)
- e. Seating reference point (SgRP)

**3.1** The following definitions pertain to locating procedures for vehicles defined as belonging to Class A.

3.1.1 CLASS A VEHICLES' DRIVER SELECTED SEAT POSITION LINES—Series of curved two-dimensional side view lines which express driver selected seat position aft of the ball of foot reference for various accommodation levels as a function of vehicle H-point height. The lines can be determined from the following equations:

$$x_{97.5} = 936.6 + 0.613879z - 0.00186247z^2 \quad (\text{Eq. 1})$$

$$x_{95} = 913.7 + 0.672316z - 0.00195530z^2 \quad (\text{Eq. 2})$$

$$x_{90} = 885.0 + 0.735374z - 0.00201650z^2 \quad (\text{Eq. 3})$$

$$x_{50} = 793.7 + 0.903387z - 0.00225518z^2 \quad (\text{Eq. 4})$$

$$x_{10} = 715.9 + 0.968793z - 0.00228674z^2 \quad (\text{Eq. 5})$$

$$x_5 = 692.6 + 0.981427z - 0.00226230z^2 \quad (\text{Eq. 6})$$

$$x_{2.5} = 687.1 + 0.895336z - 0.00210494z^2 \quad (\text{Eq. 7})$$

where:

$x_i$  is the location in millimeters of the  $i$ th percentile H-point aft of the accommodation ball of foot reference point and  $z$  is the height of the H-point above the accommodation heel reference point (H30) in millimeters.

3.1.2 ACCOMMODATION HEEL REFERENCE POINT—A point on the pedal plane that intersects the depressed floor covering below the accelerator pedal. This point defines the horizontal reference plane in side view for locating both the accommodation tool reference line and the driver selected seat position lines for Class A vehicles.

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- 3.1.3 ACCOMMODATION BALL OF FOOT REFERENCE POINT—A point on the pedal plane 203 mm from the accommodation heel reference point. This point defines the vertical reference plane in side view for locating both the accommodation tool reference line and the driver selected seat position lines for Class A vehicles.
- 3.1.4 PEDAL PLANE—A plane viewed as a line in side view which is tangent to the accelerator pedal and represents the bottom of the two-dimensional manikin's shoe.
- 3.1.5 CLASS A VEHICLES' ACCOMMODATION TOOL REFERENCE LINE—Curved two-dimensional side view line which defines a horizontal reference point as a function of H-point height to which driver workspace accommodation tools can be located in vehicle space. This line is appropriate to reference workspace tools to accommodate a driver population with a male-to-female ratio of 1:1.

**3.2** The following definitions pertain to locating procedures for vehicles defined as belonging to Class B.

- 3.2.1 CLASS B VEHICLES' DRIVER SELECTED SEAT POSITION LINES—Series of two-dimensional side view lines which express driver selected seat position aft of a heel point reference for various accommodation levels as a function of vehicle H-point height. Three sets of lines are provided to accommodate truck driver populations with male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5. The lines can be determined from the following equations:

For 50:50 male-to-female ratios:

$$\begin{aligned}
 x_{97.5} &= 916.50 - 0.471z && \text{(Eq. 8)} \\
 x_{95} &= 900.23 - 0.471z \\
 x_{90} &= 888.44 - 0.487z \\
 x_{50} &= 798.74 - 0.446z \\
 x_{10} &= 668.97 - 0.340z \\
 x_5 &= 637.76 - 0.317z \\
 x_{2.5} &= 625.21 - 0.327z
 \end{aligned}$$

For 75:25 male-to-female ratios:

$$\begin{aligned}
 x_{97.5} &= 941.88 - 0.514z && \text{(Eq. 9)} \\
 x_{95} &= 928.86 - 0.519z \\
 x_{90} &= 909.79 - 0.512z \\
 x_{50} &= 822.44 - 0.460z \\
 x_{10} &= 699.71 - 0.354z \\
 x_5 &= 668.86 - 0.339z \\
 x_{2.5} &= 641.35 - 0.329z
 \end{aligned}$$

For 90:10 to 95:5 male-to-female ratios:

$$\begin{aligned}
 x_{97.5} &= 929.13 - 0.480z && \text{(Eq. 10)} \\
 x_{95} &= 922.49 - 0.494z \\
 x_{90} &= 903.03 - 0.485z \\
 x_{50} &= 855.31 - 0.509z \\
 x_{10} &= 785.36 - 0.492z \\
 x_5 &= 762.17 - 0.485z \\
 x_{2.5} &= 732.62 - 0.460z
 \end{aligned}$$

where:

$x_i$  is the location in millimeters of the  $i$ th percentile H-point aft of the accommodation heel reference point and  $z$  is the height of the H-point above the accommodation heel reference point (H30) in millimeters.

- 3.2.2 ACCOMMODATION HEEL REFERENCE POINT—A point on the pedal plane that intersects the depressed floor covering below the accelerator pedal. This point defines both the horizontal and vertical reference planes in side view for locating both the accommodation tool reference line and the driver selected seat position lines for Class B vehicles.
- 3.2.3 PEDAL PLANE—A plane viewed as a line in side view that is parallel to the treadle pedal surface and represents the bottom of the two-dimensional manikin's shoe.
- 3.2.4 CLASS B VEHICLES' ACCOMMODATION TOOL REFERENCE LINE—Two-dimensional side view line which defines a horizontal reference point as a function of H-point height to which driver workspace accommodation tools can be located in vehicle space. Three different lines are provided to reference workspace tools to accommodate truck driver populations with male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5.
4. **Background**—Seat position data used to develop the driver selected seat position lines for Class A vehicles were collected in fourteen different driver workspaces (see Reference SAE Paper No. 840508, 1984). The workspaces included a range of vehicles from sports cars with 145 to 180 mm H-point heights through vans and multipurpose vehicles with 300 to 405 mm H-point heights. Steering wheel diameters were between 330 and 442 mm. Driver selected seat positions of subjects stratified by stature and sex to represent the general driving population (assuming a 1:1 male-to-female ratio) were collected in these workspaces. Data were converted to H-point locations relative to a manikin ball of foot for each package.

The 2.5th, 5th, 10th, 50th, 90th, 95th, and 97.5th percentile H-point locations were determined for each package and plotted as a function of the package H-point height (H30). A second-degree polynomial was fit to the data for each percentile level. Curved lines were fit to the data for each percentile level. These lines give a horizontal H-point location aft of the ball of foot as a function of vehicle H-point height for a 50% male, 50% female driver population for Class A vehicles.

Seat position data used to develop the driver selected seat position lines for Class B vehicles were collected from a heavy truck workspace study (see Reference M. S. Sanders, 1983 and B. E. Shaw and M. S. Sanders, 1984). The workspace simulated three truck cab configurations with H-point heights of 405, 468, and 530 mm and steering wheel diameters of 457, 508, and 560 mm. All configurations had a treadle accelerator pedal and suspended clutch. Driver selected seat position of male and female heavy truck drivers were collected in the workspace. Data were converted to H-point locations relative to a manikin heel point reference for each package.

Pedal configuration determined the reference points chosen for both classes of vehicles. Most Class A vehicles have suspended accelerator pedals. With a suspended pedal, the manikin's ball of foot reference is less likely to change due to the amount of seat travel provided in a workspace. The heel point location, however, changes with the amount of available travel. Most Class B vehicles have treadle pedals. With this pedal configuration, the manikin's heel point usually has a physical stop to rest against making it less likely to change as a function of pedal depression angle.

A statistical technique was used to generate four populations from the original truck workspace data with the following male-to-female ratios 50:50, 75:25, 90:10, and 95:5. The 2.5th, 5th, 10th, 50th, 90th, 95th, and 97.5th percentile H-point locations were determined for the H-point height configurations by population mix and plotted as a function of H-point height (H30). Straight lines were fit to each of the four mixes of data for each percentile level. (Second-degree expressions were not used due to paucity of data.) Separate sets of equations define horizontal H-point locations as a function of H-point height for truck driver populations with 50:50 and 75:25 male-to-female ratios. The sets of linear expressions for populations with 90:10 and 95:5 male-to-female ratios were very similar. Therefore, one equation, appropriate for both mixes, was developed to define horizontal H-point location as a function of H-point height. These three sets of lines define horizontal H-point location as a function of H-point height for three separate truck driver populations for Class B vehicles.

- 5. Description**—Equations are given that define driver selected seat position as a function of H-point height. One set of second-degree equations define horizontal H-point location for Class A vehicles at the 2.5th, 5th, 10th, 50th, 90th, 95th, and 97.5th percentile accommodation levels for a single driver population. Three sets of first degree equations define horizontal H-point location for Class B vehicles at the 2.5th, 5th, 10th, 50th, 90th, 95th, and 97.5th percentile accommodation levels for three driver populations. Locating procedures for both classes of vehicles requires familiarization with SAE J1516.
- 6. Locating Procedures**—Different procedures are used to locate driver selected seat position lines in Class A and Class B vehicles. Both procedures are based on a given H-point height and given accelerator pedal hardware.
- 6.1** Use the following procedures for Class A vehicles.
- 6.1.1 Refer to SAE J1516 for the procedure used to define the accommodation heel and ball of foot reference points for Class A vehicles. Locate Class A Vehicles' accommodation tool reference point.
- 6.1.2 Locate the driver selected seat position lines to the same reference as used to locate the accommodation tool reference point; the intersection of the lines through the accommodation ball of foot and heel reference points. The 50th percentile selected seat position curve will coincide with the accommodation tool reference point.
- 6.1.3 With the selected seat position lines in place:
- To design a vehicle, determine the H-point travel to meet the desired accommodation level. For example, to provide accommodation for 95% of drivers, locate H-point travel at the given height between the 2.5th and 97.5th percentile seat position lines.
  - To check a vehicle, determine the accommodation provided by the given H-point travel.

**NOTE**—The lines for Class A vehicles are referenced to a ball of foot defined from the SAE two-dimensional manikin geometry with the H-point at 95% accommodation. For checking purposes, the input H-point height is as measured and may not be at 95% accommodation. If the seat track travel is inclined, one or two iterations of the procedure may be required to properly locate the 95% H-point on the H-point travel path. A similar situation exists in the design process if the SgRP is to be set at an accommodation level greater or less than 95% and the seat tracks are inclined. The resulting H-point height will be slightly less or greater than the given value used to set the lines in place.

- 6.2** Use the following procedures for Class B vehicles:
- 6.2.1 Refer to SAE J1516 for the procedure used to define the accommodation heel reference point for Class B vehicles. Locate Class B Vehicles' accommodation tool reference point for the appropriate population mix.