SURFACE VEHICLE RECOMMENDED PRACTICE

J1521™ DEC2024

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Superseding J1521 DEC2014

Truck Driver Shin-Knee Position for Clutch and Accelerator

RATIONALE

SAE J1521 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. Scope—This SAE Recommended Practice describes two-dimensional, 95th percentile truck driver, side view, seated shin-knee contours for both the accelerator operating leg and the clutch operating leg for horizontally adjustable seats (see Figure 1). There is one contour for the clutch shin-knee and one contour for the accelerator shin-knee. There are three locating equations for each curve to accommodate male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5.

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
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

3.1 Drivers Shin-Knee Range (Clutch and Accelerator)—A statistical representation of the drivers' shin-knee location in a heavy-duty truck or bus with horizontally adjustable seats.

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3.2 Drivers Shin-Knee Contour (Clutch)—An arc with a radius of 103.25 mm which defines the drivers shin-knee range (Clutch).

a. (H30) H-point height
b. (CX) Clutch horizontal—horizontal distance from accommodation heel reference point to center of clutch face in mm.
c. (CZ) Clutch height—vertical distance from accommodation heel reference point to center of clutch face in mm.
d. (CHX) Chair horizontal—horizontal distance from accommodation heel reference point to accommodation tool reference point.

3.3 Drivers Shin-Knee Contour (Accelerator)—An arc with a radius of −113.25 mm which defines the drivers shin-knee range (accelerator).

a. (H30) H-point height

3.4 Vehicle Accommodation Tool Reference Line—A two-dimensional side view line which defines a horizontal reference point as a function of H-point height (H30) to which shin-knee contours are referenced in vehicle space. Three different lines are provided to accommodate truck driver populations with male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5. (See SAE J1516.)

3.5 Shin-Knee Position Locator Line—A series of two-dimensional side view lines which define the shin-knee contour x and z locations as a function of seat height (H30). Three sets of locator lines are defined to accommodate truck driver populations with male-to-female ratios of 50:50, 75:25, and 90:10 to 95:5. The three lines are determined using one of two methods.

3.5.1 The x and z values for the shin-knee locator lines for the clutch can be determined by using the following equations:

For 50:50 male-to-female ratio:

$$x = 12049.4057 + (CHX)(-15.7837 - 0.0222(CX) + (CZ)(0.0483 - (6.5 \times 10^{-9})(H30)(CX))) + (H30)(-6.7718 - 0.0105(CX) + 0.0201(CZ)) + (CX)(17.9401 - 0.0001(CX) + 0.0030(CZ)) + (CZ)(-37.9352 + 0.0010(CZ)) \quad \text{(Eq. 1)}$$

$$z = -2210.6823 + (CHX)(3.3278 + 0.0370(CX) + (CZ)(-0.0403 + (2.7 \times 10^{-9})(H30)(CX))) + (H30)(0.4561 + 0.0155(CX) - 0.0167(CZ)) + (CX)(-28.7615 - 0.0009(CX) - 0.0003(CZ)) + (CZ)(32.7120 - 0.0007(CZ)) \quad \text{(Eq. 2)}$$

For 75:25 male-to-female ratio:

$$x = 4229.4784 + (CHX)(-5.8753 + 0.0789(CX) + (CZ)(-0.0473 - (3.9 \times 10^{-9})(H30)(CX))) + (H30)(-2.3832 + 0.0351(CX) - 0.0232(CZ)) + (CX)(-64.3385 - 0.0002(CX) + 0.0024(CZ)) + (CZ)(39.6780 + 0.0007(CZ)) \quad \text{(Eq. 3)}$$

$$z = 12254.3381 + (CHX)(-14.3121 - 0.0450(CX) + (CZ)(0.0692 + (6.6 \times 10^{-9})(H30)(CX))) + (H30)(-7.6863 - 0.0219(CX) + 0.0326(CZ)) + (CX)(37.9286 - 0.0009(CX) - 0.0016(CZ)) + (CZ)(-56.1338 - 0.0006(CZ)) \quad \text{(Eq. 4)}$$

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

$$x = 14601.7633 + (CHX)(-17.7652 + 0.0081(CX) + (CZ)(0.0506 - (8.6 \times 10^{-9})(H30)(CX))) + (H30)(-8.7461 + 0.0034(CX) + 0.0243(CZ)) + (CX)(-6.6220 + (5.7 \times 10^{-6})(CX) + 0.0035(CZ)) + CZ(-42.6080 + 0.0010(CZ)) \quad \text{(Eq. 5)}$$

$$z = 13495.0413 + (CHX)(-15.2231 - 0.3160(CX) + (CZ)(0.1508 + (3.4 \times 10^{-8})(H30)(CX))) + (H30)(-8.8427 - 0.1641(CX) + 0.0769(CZ)) + (CX)(271.9531 - 0.0013(CX) - 0.0085(CZ)) + (CZ)(-127.735 - 0.0012(CZ)) \quad \text{(Eq. 6)}$$

3.5.2 The shin-knee locator lines for the accelerator can be determined by using the following equations:

For 50:50 male-to-female ratio:

$$x = (-991.525 + 0.8658(H30)) - 2((-991.525 + 0.8658(H30)) - (-718.243 + 0.4462(H30))) \quad \text{(Eq. 7)}$$

$$z = 334.882 - 0.637(H30) \quad \text{(Eq. 8)}$$

For 75:25 male-to-female ratio:

$$x = (-1036.737 + 0.9074(H30)) - 2((-1036.737 + 0.9074(H30)) - (-741.943 + 0.4595(H30))) \quad \text{(Eq. 9)}$$

$$z = 373.098 - 0.696(H30) \quad \text{(Eq. 10)}$$

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

$$x = (-1093.64 + 0.9932(H30)) - 2((-1093.64 + 0.9932(H30)) - (-774.852 + 0.5087(H30))) \quad \text{(Eq. 11)}$$

$$z = 324.916 - 0.5832(H30) \quad \text{(Eq. 12)}$$

4. ***Background—***The shin-knee contours were obtained by developing data gathered during the Truck Driver Anthropometric and Work Space Survey (see M.S. Sanders 1983 and B.E. Shaw and M.S. Sanders 1984). This survey utilized a static seating buck in which drivers were photographed in three seat heights in three different configurations. From the photographs, points on each subject were defined at the forward point of the knee where the knee and shin meet. This was done for the right leg in position for operating the accelerator pedal, and the left leg in position to operate the clutch pedal. The clutch was locked in an undepressed position while the accelerator was allowed to move to the drivers selected operating position. These points were related in true scale and referenced from the seat H-point. At this point, the data was separated into male and female. Utilizing statistical techniques, the male and female data was recombined to form four male-to-female population ratios: 50:50, 75:25, 90:10, and 95:5. Ellipses were generated based on the four population mixes representing 95% accommodation levels, for each population mix, for both the clutch and accelerator shin-knee points. The contours for clutch and accelerator were determined by rotating the SAE manikin leg about the respective heel points with the forward knee point kept on the ellipse itself. This identified the 2 in knee curve in several locations about the ellipse. A best fit curve was drawn to encompass these knee locations which defines the final contour for the clutch and accelerator. Due to curve similarities, the locating equation for the 90:10 and 95:5 male-to-female population ratios were combined.

There is one general contour for both the clutch shin-knee and the accelerator shin-knee which are to be used to accommodate drivers in heavy truck design for three ranges of male-to-female population mixes. These curves or contours are representative of shin-knee locations in a truck environment and are to be used to provide shin-knee definition.

5. Application

5.1 The shin-knee locator lines and contours provide a drafting tool from which truck driver shin-knee locations can be described in vehicles with horizontally adjustable seats.

5.2 The shin-knee locator lines and contours are applicable only to motor vehicles, whether trucks, buses, or multipurpose passenger vehicles with bucket or bench seats, that are within the following range of driver workspace dimensions:

a. (L40) Back angle: 11.0 to 18 degrees
b. (H30) H point height: 405 to 530 mm
c. (W9) Steering wheel diameter: 450 to 560 mm
d. (L23) Normal driving seat track travel: 100 mm or greater
e. (CX) Clutch horizontal: −55 to 160 mm
f. (CZ) Clutch height: 130 to 320 mm

5.3 The shin-knee locator lines and contours are applicable to three male-to-female population ratios: 50:50, 75:25, and for the range of 90:10 to 95:5.

6. Shin-Knee Position Contour Location

6.1 Identify which contour is to be used, the clutch or accelerator.

6.2 Identify which of the three male-to-female population ratios that is to be accommodated, 50:50, 75:25, or 90:10 to 95:5.

6.3 Use the method described in SAE J1516 to locate the reference point in vehicle space. Select the point on this line at the workspace H-point height (H30). This point defines the shin-knee contour reference station.

6.4 Use the appropriate shin-knee position locator line for the population mix to be accommodated (see 6.2). Solve the equations in 3.5 or use Tables 1, 2, and 3 (for accelerator shin knee only) to determine the x and z coordinates for the shin-knee contour. Clutch shin-knee contour must use equations:

$$(CX) \quad \text{Clutch horizontal:} \quad -55 \text{ to } 160 \text{ mm} \qquad \text{(Eq. 13)}$$

$$(CZ) \quad \text{Clutch height:} \quad 130 \text{ to } 320 \text{ mm} \qquad \text{(Eq. 14)}$$

These coordinates will be in millimeters forward and above, in vehicle space, H30 on the accommodation tool reference point.

6.4.1 CLUTCH CONTOUR—Using the point obtained in 6.4 as the center, draw an arc on the forward side of this point in vehicle space with a radius of 103.25 mm. This arc should approximate 1/4 of a circle drawn through a vertical line through the point forward in 6.4 to a horizontal line drawn through the same point such that the arc is above and forward of the point found in 6.4. (See Figure 1.)

6.4.2 ACCELERATOR CONTOUR—Same as 6.4.1 with a radius of 113.25 mm.

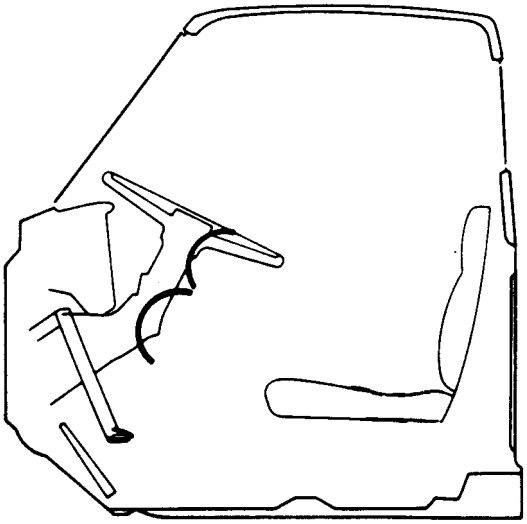

FIGURE 1—CLUTCH AND ACCELERATOR SHIN-KNEE POSITION CONTOURS

TABLE 1—ACCELERATOR SHIN-KNEE LOCATION (50:50 MALE-TO-FEMALE RATIO)

HP	X	Z
405	–434.188	76.897
410	–434.055	73.712
415	–433.922	70.527
420	–433.789	67.342
425	–433.656	64.157
430	–433.523	60.972
435	–433.39	57.787
440	–433.257	54.602
445	–433.124	51.417
450	–432.991	48.232
455	–432.858	45.047
460	–432.725	41.862
465	–432.592	38.677
470	–432.459	35.492
475	–432.326	32.307
480	–432.193	29.122
485	–432.06	25.937
490	–431.927	22.752
495	–431.794	19.567
500	–431.661	16.382
505	–431.528	13.197
510	–431.395	10.012
515	–431.262	6.827
520	–431.129	3.642
525	–430.996	0.456999
530	–430.863	–2.728