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Truck Driver Shin-Knee Position for Clutch and Accelerator

SAE Recommended Practice
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Submitted for Recognition as
an American National Standard

TRUCK DRIVER SHIN-KNEE POSITION FOR CLUTCH AND ACCELERATOR

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 (Fig. 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/female ratios of 50/50, 75/25 and 90/10 to 95/5.

2. **REFERENCE DOCUMENTS:**

   SAE J1100, Motor Vehicle Dimensions
   SAE J1516 OCT85, Accommodation Tool Reference Point

3. **BACKGROUND:** The shin-knee contours were obtained by developing data gathered during the Truck Driver Anthropometric and Work Space Survey (1,2). This survey utilized a static seating buck in which drivers were photographed in 3 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/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 inch knee curve in several locations about the ellipse. A best fit curve was

3. (Continued):

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/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/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.

4. DEFINITIONS:

4.1 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.

4.2 Drivers Shin-Knee Contour (Clutch): An arc with a radius of 103.25 mm which defines the Drivers Shin-Knee Range (Clutch).

      (H30) H-point Height
      (CX)   Clutch Horizontal - Horizontal
              distance from accommodation heel
              reference point to center
              of clutch face in mm.
      (CZ)   Clutch Height - Vertical distance
              from accommodation heel reference
              point to center of clutch
              face in mm.
      (CHX) Chair Horizontal - Horizontal distance
              from accommodation heel reference
              point to accommodation tool
              reference point.

4.3 Drivers Shin-Knee Contour (Accelerator): An arc with a radius of -113.25 mm which defines the Drivers Shin-Knee Range (Accelerator).

      (H30)   H-point height

4.5 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/female ratios of 50/50, 75/25 and 90/10 to 95/5. (See Accommodation Tool Reference Point, SAE J1516.)

4.6   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/female ratios of 50/50, 75/25 and 90/10 to 95/5.   The three lines are determined using one of two methods.

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/female ratio:

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

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

For 75/25 male/female ratio:

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

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

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

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

$$z = 13495.0413 + (CHX) (-15.2231 - 0.3160 (CX) + (CZ) (0.1508 + (3.4 \times 10^{-8}) (H30) (CX))) + (H30) (-8.8427 - 0.1641 (CX) + 0.0769 (CZ)) + (CX) (27.9531 - 0.0013 (CX) - 0.0085 (CZ)) + (CZ) (-127.735 - 0.0012 (CZ))$$

The Shin-Knee Locator Lines for the accelerator can be determined by using the following equations:

For 50/50 male/female ratio:

$$x = (-991.525 + .8658 (H30)) - 2(((-991.525 + .8658 (H30)) - (-718.243 + .4462 (H30)))$$

$$z = 334.882 - .637 (H30)$$

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4.6 (Continued):

For 75/25 male/female ratio:

$$x = (-1036.737 + .9074 (H30)) -$$
$$2(((-1036.737 + .9074 (H30)) -$$
$$(-741.943 + .4595 (H30)))$$

Ø
$$z = 373.098 - .696 (H30)$$

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

$$x = (-1093.64 + .9932 (H30)) -$$
$$2(((-1093.64 + .9932 (H30)) -$$
$$(-774.852 + .5087 (H30)))$$

$$z = 324.916 - .5832 (H30)$$

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:

- (L40) Back Angle
  - 11.0 to 18 deg
- (H30) H point Height
  - 405 to 530 mm
- (W9) Steering Wheel Diameter
  - 450 to 560 mm
- (L23) Normal Driving Seat Track Travel
  - 100 mm or greater
- (CX) Clutch Horizontal
  - -55 to 160 mm
- (CZ) Clutch Height
  - 130 to 320 mm

5.3 The shin-knee locator lines and contours are applicable to three male/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/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 the Accommodation Tool Reference Point, (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 (paragraph 6.2). Solve the equations in paragraph 4.6 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) Clutch Horizontal
>   -55 to 160 mm
> (CZ) Cluth Height
>   130 to 320 mm

These coordinates will be in mm forward and above, in vehicle space, H30 on the Accommodation Tool Reference Point.

6.4.1   Clutch Contour: Using the point obtained in paragraph 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 paragraph 6.4 to a horizontal line drawn through the same point such that the arc is above and forward of the point found in paragraph 6.4. (See Fig. 1.)

6.4.2   Accelerator Contour: Same as paragraph 6.4.1 with a radius of 113.25 mm.

7.   REFERENCES:

(1) 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.

(2) 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.
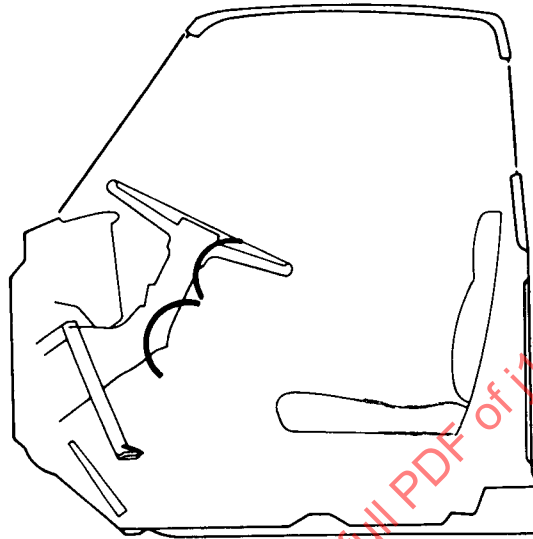
FIG. 1 - Clutch and Accelerator Shin-Knee Position Contours

TABLE 1 - Accelerator Shin-Knee Location
(50/50 Male/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

TABLE 2 - Accelerator Shin-Knee Location
(75/25 Male/Female Ratio)

HP	X	Z
405	-442.451	91.218
410	-442.393	87.736
415	-442.335	84.258
420	-442.277	80.778
425	-442.219	77.298
430	-442.161	73.818
435	-442.103	70.338
440	-442.045	66.858
445	-441.987	63.378
450	-441.929	59.898
455	-441.871	56.418
460	-441.813	52.938
465	-441.755	49.458
470	-441.697	45.978
475	-441.639	42.498
480	-441.581	39.018
485	-441.523	35.538
490	-441.465	32.058
495	-441.407	28.578
500	-441.349	25.098
505	-441.291	21.618
510	-441.233	18.138
515	-441.175	14.658
520	-441.117	11.178
525	-441.059	7.698
530	-441.001	4.218

TABLE 3 - Accelerator Shin-Knee Location
(95/5 and 90/10 Male/Female Ratio)

HP	X	Z
405	-446.263	88.72
410	-446.142	85.804
415	-446.021	82.888
420	-445.9	79.972
425	-445.779	77.056
430	-445.658	74.14
435	-445.537	71.224
440	-445.416	68.308
445	-445.295	65.392
450	-445.174	62.476
455	-445.053	59.56
460	-444.932	56.644
465	-444.811	53.728
470	-444.69	50.812
475	-444.569	47.896
480	-444.448	44.98
485	-444.327	42.064
490	-444.206	39.148
495	-444.085	36.232
500	-443.964	33.316
505	-443.843	30.4
510	-443.722	27.484
515	-443.601	24.568
520	-443.48	21.652
525	-443.359	18.736
530	-443.238	15.82

RATIONALE:

The shin-knee contours were obtained by developing data gathered during the Truck Driver Anthropometric and Work Space Survey. This survey utilized a static seating buck in which drivers were photographed the 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/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 inch 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/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/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.

REFERENCE SECTION:

SAE J1100, Motor Vehicle Dimensions

SAE J1516 OCT85, Accommodation Tool Reference Point

SAE U.S. Truck Driver Anthropometric and Truck Workspace Data Survey

SAE Female U.S. Truck Driver Anthropometric and Truck Workspace Data Survey

APPLICATION:

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. 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/female ratios of 50/50, 75/25 and 90/10 to 95/5.