MOTOR VEHICLE DRIVER AND PASSENGER HEAD POSITION—SAE J1052 MAY87

SAE Recommended Practice

Report of the Human Factors Engineering Committee, approved August 1974, revised by the Human Factors Engineering Committee May 1987.

1. Scope—This SAE Recommended Practice describes two-dimensional side and rear view 95th and 99th percentile driver and passenger seated head position contours for fixed and horizontally adjustable seats. New information obtained from the SAE Truck Driver Anthropometric and Workspace Study has resulted in development of new head location procedures for trucks and other vehicles with high H-point heights and large steering wheel diameters. Therefore, this practice has been separated into two parts. Part I describes the head location procedure for 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. Part II describes a separate head locating procedure for vehicles with H-point heights (H30) between 405 and 530 mm and steering wheel diameters (W9) between 450 and 560 mm (Class B Vehicles). This class of vehicles includes heavy trucks and some buses and multipurpose passenger vehicles (See Fig. 2).

2. Definitions

2.1 Head Position Range—A statistical representation of the front, top, sides, and back of heads, when seated in a vehicle. Top and back of head includes hair.

2.2 Head Position Contours—Two-dimensional shapes that describe the seated vehicle occupant head positions in side and rear view. The driver head position contours with seat travel apply to drivers in horizontally adjustable seats. The head position contours without seat travel apply to both drivers and passengers in fixed seats.

2.3 Head Location Clearance Line—The edge view of a plane or boundary on either side of which a specific percentile level of driver head locations is known. A clearance line is drawn tangent to the head position contour in either side or rear view. The selection of the head location clearance lines relative to the head position contours are made by the user depending upon his design problem.

2.4 Eyellipse and Head Locator Line—Adjustable Seats—The side-view head position contour locater for horizontally adjustable seats with back angles between 5 and 40 deg (Table 1). Zero x-z coordinates are at the 25 deg back angle indice and are 25 in (635 mm) above the H-point.

2.5 Head Locater Line—Fixed Seats—The side-view head position contour locator for seats with no adjustment (Table 2). The 25 deg back angle indice is 4.83 in (122.7 mm) aft and 25.65 in (651.5 mm) above the H-point.

2.6 The vehicle interior dimensions used with this recommended practice are defined in SAE J1100[1] and are listed below:

2.6.1 H-point.
2.6.2 Seating reference point.
2.6.3 L17—H-point travel.
2.6.4 L40—Back angle—front.
2.6.5 L53—H-point to accelerator heel point.
2.6.6 H30—H-point to heel point.
2.6.7 H58—H-point rise.
2.6.8 W8—Shoulder room.
2.6.9 W7—Steering wheel center to centerline of car.

[1] Available from SAE as J1100 JUN84.

PART I—HEAD LOCATION PROCEDURE FOR CLASS A VEHICLES

3. Background—The head position contours were developed using data gathered from eye position studies (Refs. 1–4) and anthropometric data of the head (Ref. 5). Mean top of head (including hair) and back of head (including hair) were determined relative to the eye from these studies (Refs. 2 and 3) and averaged. The mean front and side of head was determined relative to the eye from anthropometric data (Refs. 1, 5, and 8). This information was used to develop a mean head profile in side and rear view referenced to the eye.

Fixed-seat head position contours were developed by placing the mean head profile over the side- and rear-view eye ellipses developed in Ref. 7 and tracing the head contours as the eye is spotted around the eye ellipses. Only the upper half of the eye ellipses was used.

The same procedure was used with the side view 5.0 in (127 mm) horizontal seat travel eyellipse (Ref. 6) to develop the adjustable seat head position contours. A rear-view head location contour for the adjustable seat was generated from a rear-view eye ellipse taken from the original driver's eye position study (Ref. 2). (This was a rear-view composite of the data from the Ford, Chevrolet, and Plymouth convertibles.)

The head contour templates are parameters of envelopes formed by an infinite number of planes dividing head positions so that (P) percent of the heads are on one side of the plane and (100-P) percent are on the other. For example, if a plane seen as a straight line in the side view is drawn tangent to the upper edge of the 95th percentile head position contour, then 95% of the heads will be below the line and 5% will be above.

Head clearance is established as the distance between the tangent cutoff contour and any protrusion or surface. This distance is measured at the point of tangency normal (90 deg) to the tangent cutoff line. (See Fig. 1.)

These head locations are based on a 50/50 male/female population mix, with heads positioned for straight-ahead viewing without head turning.

Since head location will vary according to seatback angle, locater lines are used (Refs. 1, 4, and 6) to locate the head position contours relative to the seating reference point (SRP). See Tables 1 and 2.

There are two side-view and two rear-view head position contours included in this recommended practice.

4. Application

4.1 The head position contours provide a drafting tool from which driver and passenger head locations can be described in vehicles with horizontally adjustable or fixed seats.

4.2 The head position contours are applicable to motor vehicles designed as passenger cars, multipurpose passenger vehicles, trucks, and

TABLE 1—HORIZONTAL (X) AND VERTICAL (Z) COORDINATES OF EYELLIPSE AND HEAD CONTOUR LOCATER LINE—ADJUSTABLE SEATS
(Relative to a horizontal line 25 in (635 mm) above the seating reference point and a vertical line extending upward from the seating reference point)

Back Angle deg	Horizontal Displacement (X)		Vertical Displacement (Z)	
	mm	in	mm	in
5.0	−186.4	−7.34	27.6	1.09
6.0	−176.5	−6.95	27.3	1.08
7.0	−166.6	−6.56	27.0	1.06
8.0	−156.8	−6.17	26.5	1.04
9.0	−147.1	−5.79	25.9	1.02
10.0	−137.4	−5.41	25.1	0.99
11.0	−127.8	−5.03	24.3	0.96
12.0	−118.3	−4.66	23.3	0.92
13.0	−108.8	−4.28	22.2	0.88
14.0	−99.4	−3.91	21.0	0.83
15.0	−90.0	−3.54	19.7	0.78
16.0	−80.7	−3.18	18.3	0.72
17.0	−71.5	−2.81	16.7	0.66
18.0	−62.3	−2.45	15.0	0.59
19.0	−53.2	−2.10	13.2	0.52
20.0	−44.2	−1.74	11.3	0.45
21.0	−35.2	−1.39	9.3	0.37
22.0	−26.3	−1.04	7.2	0.28
23.0	−17.5	−0.69	4.9	0.19
24.0	−8.7	−0.34	2.5	0.10
25.0	0.0	0.00	−0.0	−0.00
26.0	8.6	0.34	−2.6	−0.10
27.0	17.2	0.68	−5.4	−0.21
28.0	25.8	1.01	−8.2	−0.32
29.0	34.2	1.35	−11.2	−0.44
30.0	42.6	1.68	−14.3	−0.56
31.0	50.9	2.01	−17.5	−0.69
32.0	59.2	2.33	−20.8	−0.82
33.0	67.4	2.65	−24.3	−0.96
34.0	75.6	2.97	−27.9	−1.10
35.0	83.6	3.29	−31.5	−1.24
36.0	91.6	3.61	−35.4	−1.39
37.0	99.6	3.92	−39.3	−1.55
38.0	107.5	4.23	−43.3	−1.71
39.0	115.3	4.54	−47.5	−1.87
40.0	123.0	4.84	−51.8	−2.04

ϕ TABLE 2—HORIZONTAL (X) AND VERTICAL (Z) COORDINATES OF EYELLIPSE AND HEAD CONTOUR LOCATER LINE FOR FIXED SEATS
(Relative to a horizontal line 25 in (635 mm) above the seating reference point and a vertical line extending upward from the seating reference point)

Back Angle deg	Horizontal Displacement (X)		Vertical Displacement (Z)	
	mm	In	mm	in
5	−114.6	−4.51	47.8	1.88
6	−101.7	−4.00	47.6	1.87
7	−88.9	−3.50	47.2	1.86
8	−76.2	−3.00	46.6	1.84
9	−63.6	−2.50	46.0	1.81
10	−51.1	−2.01	45.2	1.78
11	−38.7	−1.52	44.2	1.74
12	−26.5	−1.04	43.1	1.70
13	−14.3	−0.56	41.9	1.65
14	−02.3	−0.09	40.5	1.60
15	09.6	0.38	39.0	1.54
16	21.5	0.85	37.4	1.47
17	33.2	1.3	35.6	1.40
18	44.7	1.76	33.7	1.33
19	56.2	2.21	31.7	1.25
20	67.6	2.66	29.5	1.16
21	78.8	3.10	27.2	1.07
22	90.0	3.54	24.7	0.97
23	101.0	3.98	22.1	0.87
24	111.9	4.40	19.4	0.76
25	122.7	4.83	16.5	0.65
26	133.4	5.25	13.5	0.53
27	144.0	5.67	10.3	0.41
28	154.5	6.08	07.0	0.28
29	164.8	6.49	03.6	0.14
30	175.1	6.89	00.0	0.00
31	185.2	7.29	−03.7	−0.14
32	195.2	7.69	−07.5	−0.29
33	205.1	8.08	−11.5	−0.45
34	214.9	8.46	−15.6	−0.61
35	224.6	8.84	−19.8	−0.78
36	234.2	9.22	−24.2	−0.95
37	243.7	9.59	−28.7	−1.13
38	253.0	9.96	−33.4	−1.31
39	262.2	10.33	−38.2	−1.50
40	271.4	10.68	−43.1	−1.70
41	280.4	11.04	−48.2	−1.90
42	289.3	11.39	−53.4	−2.10
43	298.1	11.74	−58.8	−2.31
44	306.8	12.08	−64.3	−2.53
45	315.4	12.42	−69.9	−2.75

buses with bench or bucket type seats and within the following range of driver workspace dimensions:

(L40) Back angle	5–40 deg	
(H30) Vertical H-point to heel point	5.0–18.0 in	(127–457 mm)
(H58) Vertical H-point rise	0.0–1.5 in	(0.0–38 mm)
(L17) Horizontal H-point travel	0 or 4.0–6.0 in	(101–165 mm)
(L53 Minus L17) Horizontal H-point to heel point (minimum)	20.0 in	(508 mm)

5. Head Position Contour Location

5.1 The head position contours are located in the vehicle interior by longitudinal (X-X), lateral (Y-Y), and vertical (Z-Z) datum lines which are shown on the contours. These datum lines are not the contour's geometric axes, but are work lines to establish the contour's position in the vehicle with respect to seated drivers.

5.2 Driver Head Position Contour—Side View—Adjusted Seat—Relative to the vehicle[a]:

5.2.1 Select the side-view head position contour appropriate for adjustable seats.

5.2.2 Construct a vertical workline through the seating reference point.

5.2.3 Construct a horizontal workline 25.0 in (635 mm) above the seating reference point.

5.2.4 Position the 25 deg mark of the eyellipse and head contour locater line (Table 1) at the intersection of the lines constructed in paragraphs 5.2.2 and 5.2.3.

5.2.5 Position the side-view driver head position contour on the eyellipse and head contour locater line at the intersection of the contour datum lines X-X and Z-Z at the packaged back angle—front (L40) such that the contour datum lines and the worklines of paragraphs 5.2.2 and 5.2.3 are parallel, and trace the outline on the layout.

5.3 Driver Head Position Contour—Rear View—Adjustable Seat—Relative to the vehicle:

5.3.1 Construct a lateral workline (Y-Y) perpendicular to the vehicle centerline through the line (X-X) projected from the rear view.

5.3.2 Construction of a vertical workline (Z-Z).

5.3.2.1 *Passenger Cars*—Construct a vertical workline (Z-Z) parallel to the vehicle centerline and a distance from the vehicle centerline equal to 0.85 (W7) + 0.075 (W3). The dimensions W7 and W3 are defined in paragraphs 2.6.8 and 2.6.9. (This formula positions the Z-Z workline at a point 15% of the distance from the steering wheel centerline to the inner surface of the driver's door as described in Ref. 6.) This formula is applicable to both passenger car bench and bucket-type seats; however, in the case of bucket-type seats, the contour centerline shall be located no further inboard than the longitudinal centerline of the seat.

5.3.2.2 *Multipurpose Passenger Vehicles, Trucks, and Buses with Individual Driver Seats*—Construct a vertical workline (Z-Z) parallel to the vehicle centerline and position it at a distance from the vehicle centerline such that it will locate the contour centerline at the Y coordinate of the H-point.

5.3.2.3 *Multipurpose Passenger Vehicles, Trucks, and Buses with Bench Seats*—Use paragraph 5.3.2.1 as described.

5.3.3 Position the rear view contour on the constructed worklines (Z-Z) and (Y-Y) and trace the outline on the layout.

5.4 Passenger Head Position Contour—Side View—Fixed Seat

5.4.1 Select the fixed seat head position contours and construct a vertical workline 4.83 in (122.7 mm) aft of the H-point.

5.4.2 Construct a horizontal workline 25.6 in (650 mm) above the H-point.

5.4.3 Position the 25 deg indice of the head contour locater line (Table 2) at the intersection of the lines constructed in paragraphs 5.4.1 and 5.4.2.

5.4.4 Position the side-view fixed seat head position contour on the head contour locater line (Table 2) with the intersection of the contour datum lines X-X and Z-Z at the packaged back angle—front (L40) such that the contour datum lines and the worklines of paragraphs 5.4.1 and 5.4.2 are parallel, and trace the outline on the layout.

5.5 Passenger's Head Position Contour—Rear View—Fixed Seat

5.5.1 Construct a lateral workline (Y-Y) perpendicular to the vehicle centerline through the line (X-X) projected from the rear view.

5.5.2 Construct the vertical workline (Z-Z) as follows:

5.5.3 The rear view Z-Z line is positioned such that the contour centerline is at the Y coordinate of the H-point as specified by the manufacturer.

5.5.4 Position the rear-view fixed seat head position contour on the constructed worklines and trace the outline on the layout.

[a] If it is desired to obtain side-view driver's head position relative to the seat, follow procedures described in paragraphs 5.4.1–5.4.4 using the side-view fixed seat head position contour.

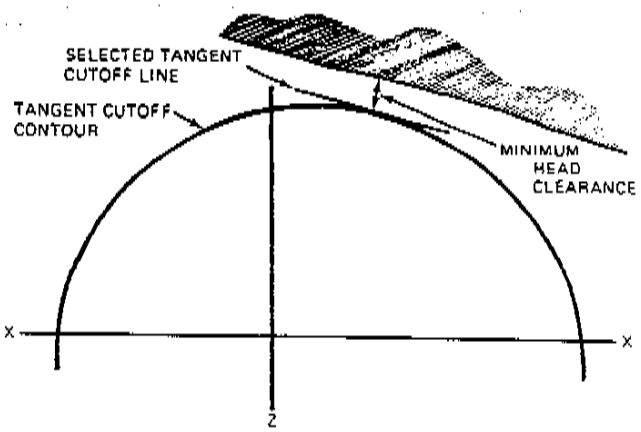

FIG. 1—MINIMUM HEAD CLEARANCE

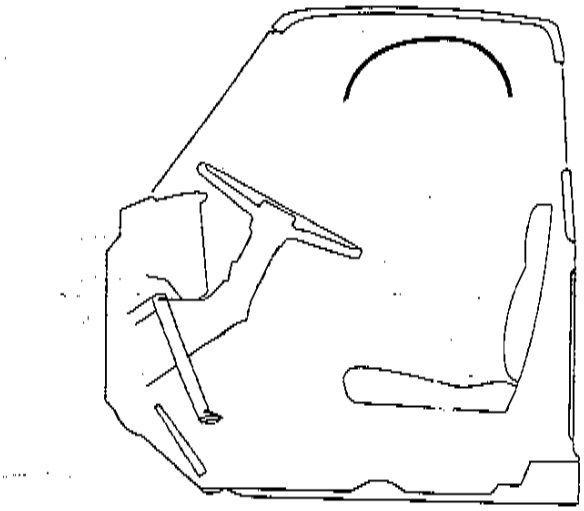

FIG. 2—TRUCK DRIVER'S HEAD LOCATION CONTOUR

6. Head Location Clearance Line Construction—Minimum head clearances are measured from points on the selected contour that are closest to any protrusion or surface. (See Fig. 1.) The distance is measured normal to a line drawn tangent to the contour. The selection of 95th or 99th percentile tangent cutoffs and comfortable clearance distances must be made by the user.

7. References

1. D. C. Hammond and R. W. Roe, "Driver Head and Eye Position," SAE Transactions, Vol. 81 (1972), paper 720200.

2. J. F. Meldrum, "Automobile Driver Eye Position," SAE Transactions, Vol. 74 (1966), paper 650464.

3. Letter to SAE Driver Vision Subcommittee, Driver Eye Location Data from SAE Controls Reach Study, Ronald W. Roe, February 12, 1973.

4. Letter to SAE Vision Subcommittee, Definition of a Fixed Seat Eye Ellipse, Ronald W. Roe, May 30, 1973.

5. H. T. E. Hertzberg, G. S. Daniels, and E. Churchill, Anthropometry of Flying Personnel—1950. WADC Technical Report 52-321, Wright-Patterson Air Force Base, Ohio, 1954.

6. Society of Automotive Engineers Recommended Practice, "Motor Vehicle Drivers' Eye Range." SAE J941c, June 1972.

7. Letter to SAE Design Devices Subcommittee, Driver and Passenger Head Location, Ronald W. Roe, June 12, 1973.

8. Letter to SAE Design Devices Subcommittee, Driver Head Position Contours, Lewis J. Tomiko, February 3, 1972.

PART II—HEAD LOCATION PROCEDURE FOR CLASS B VEHICLES

8. Background—Truck driver head location data were collected in the SAE Truck Driver Anthropometric and Workspace Study (Refs. 9,10) in three heavy truck cab configurations with 381 mm of horizontal seat travel. Top of head and rear of head points (including hair) were determined relative to the eye for each driver. These data were used to construct boundaries which contained certain percentages of heads for various truck driver population mixes representing a variety of male to female ratios.

The procedure in Part I for developing head contours from the eyellipse was used to generate contours to compare with the experimentally determined boundaries. The mean head profile developed in Part I was rotated around the upper halves of the experimental eyellipses generated from eye location data collected in the same study. In all cases, contours generated from eyellipses approximated the experimental boundaries with less than 15 mm difference. These head contours were also similar in size and shape to the SAE head contours for adjustable seats described in Part I regardless of proportions of males and females in the truck driver population. However, truck driver head contours were located further forward, lower, and with greater slope than would be predicted using the locating procedure in Part I because of differences in user populations. Therefore, although head contours described in Part I are appropriate for use in Class B vehicles, a new locating procedure and referencing system was developed for vehicles with H-point heights between 405 and 530 mm. Three locator lines are provided to position head contours in Class B workspaces for a range of back angles between 11 and 18 deg; one for each of the populations representing the following ratios of males to females; 50/50, 75/25, and 90/10 to 95/5.

9. Reference Documents

SAE J941 OCT85, Motor Vehicle Driver's Eye Range
SAE J1100 JUN84, Motor Vehicle Dimensions
SAE J1516 OCT85, Accommodation Tool Reference Point

10. Definitions—The following definitions from Part I are also applicable for Part II:

Head Position Range
Head Position Contours
Head Location Clearance Line
Head Locator Line—Fixed Seats
H-Point
Seating Reference Point (SgRP)
SAE J1100 Interior Dimensions

The following definitions are specific to Part II:

ed. **10.1 Class B Vehicles' Accommodation Tool Reference Line**—A two dimensional side view line which defines a horizontal reference point as a function of H-point height to which head contours can be located 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.)

10.2 Head Position Locator Lines—A series of two dimensional side view lines which define head contour x and z location as a function of seat back angle. Three different sets of locator lines are provided to accommodate truck driver populations with male/female ratios of 50/50, 75/25, and 90/10 to 95/5. Further subsets of locater lines are provided to allow for seat track travel ranging from 4.0–6.5 in. The locator lines can be determined from the following equations:

For 50/50 male/female ratio:
Seat track travel

4.0 in $x = -177.76 + 12.68$ (BA deg)
$z = 697.09 - 3.57$ (BA deg)
4.5 in $x = -171.26 + 12.68$ (BA deg)
$z = 698.59 - 3.57$ (BA deg)
5.0 in $x = -165.76 + 12.68$ (BA deg)
$z = 699.59 - 3.57$ (BA deg)
5.5 in $x = -159.26 + 12.68$ (BA deg)
$z = 700.59 - 3.57$ (BA deg)
6.0 in $x = -155.26 + 12.68$ (BA deg)
$z = 701.09 - 3.57$ (BA deg)
6.5 in $x = 152.26 + 12.68$ (BA deg)
$z = 701.59 - 3.57$(BA deg)

For 75/25 male/female ratio:
Seat track travel

4.0 in $x = -203.55 + 13.65$ (BA deg)
$z = 705.66 - 3.82$ (BA deg)
4.5 in $x = -197.05 + 13.65$ (BA deg)
$z = 707.16 - 3.82$ (BA deg)
5.0 in $x = -191.55 + 13.65$ (BA deg)
$z = 708.16 - 3.82$ (BA deg)
5.5 in $x = -185.05 + 13.65$ (BA deg)
$z = 709.16 - 3.82$ (BA deg)
6.0 in $x = -181.05 + 13.65$ (BA deg)
$z = 709.66 - 3.82$ (BA deg)
6.5 in $x = -178.05 + 13.65$ (BA deg)
$z = 710.16 - 3.82$ (BA deg)

For 90/10 to 95/5 male/female ratio:
Seat track travel

4.0 in $x = -186.94 + 12.23$ (BA deg)
$z = 713.52 - 4.17$ (BA deg)
4.5 in $x = -180.44 + 12.23$ (BA deg)
$z = 715.02 - 4.17$ (BA deg)
5.0 in $x = -174.94 + 12.23$ (BA deg)
$z = 716.02 - 4.17$ (BA deg)
5.5 in $x = -168.44 + 12.23$ (BA deg)
$z = 717.02 - 4.17$ (BA deg)
6.0 in $x = -164.44 + 12.23$ (BA deg)
$z = 717.52 - 4.17$ (BA deg)
6.5 in $x = -161.44 + 12.23$ (BA deg)
$z = 718.02 - 4.17$ (BA deg)

where x is the horizontal head contour location in mm forward (a negative x value being forward in cab space, and a positive x value being rearward) of the Accommodation Tool Reference Line at height H30, z is the vertical head contour location in mm above the Accommodation Tool Reference Line at height H30, and BA deg is the seat back angle in degrees.

11. Application

11.1 The head position contours have the same function for describing driver head location in Class B workspaces as described in Part I. See paragraph 4.1.

11.2 The head contours shown in Part I are applicable to Class B workspaces regardless of the male to female population mix one wishes to accommodate. However, Class B locating procedures are applicable only to motor vehicles, whether trucks, buses, or multi-purpose passenger vehicles with bucket or bench seats, that are within the following range of driver workspace dimensions:

(L40) Back Angle
11.0–18 deg
(H30) H-Point Height
405–530 mm
(W9) Wheel Diameter
450–560 mm
(L23) Seat Travel
greater than 100 mm

12. Head Contour Location Procedure

12.1 The SAE head contours are appropriate for use in Class B vehicle workspaces.

12.2 Driver Head Contour Locating Procedure—Side View—Adjustable Seat

12.2.1 Select the side view head position contour appropriate for adjustable seats. The same head contour is appropriate regardless of proportions of males and females in the population.

12.2.2 Locate eyellipse per SAE J941 OCT85, paragraph 10.2.

12.2.3 Align XX and ZZ datum lines of head contour template with XX and ZZ datum lines of eyellipse template.

12.3 Driver Head Contour Locating Procedure—Rear View—Adjustable Seat—Use procedures developed in Part I, paragraph 5.3.2.2 or 5.3.2.3.

12.4 Passenger Head Contour Locating Procedure—Side View—Fixed Seat—Use procedure developed in Part I, paragraph 5.4.

12.5 Passenger Head Contour Locating Procedure—Rear View—Fixed Seat—Use procedure developed in Part I, paragraph 5.5.

13. Head Location Clearance Line Construction—Use procedure described in Part I, Section 6.

14. References

9. M. S. Sanders (1988), "U.S. Truck Driver Anthropometric and Truck Workspace Data Survey," Final Report Submitted to: Society of Automotive Engineers, Inc., Warrendale, PA.

10. 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.