

D. Hammond and R. Roe, "SAE Controls Reach Study." Paper 720199 presented at SAE Automotive Engineering Congress and Exposition, Detroit, January 1972.

D. Hammond, D. Maurer, and L. Razgunas, "Controls Reach—The Hand Reach of Drivers." Paper 750357 presented at SAE Automotive Congress and Exposition, Detroit, February 1975.

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.

SAE J182 Motor Vehicle Fiducial Marks and Three-Dimensional Reference System

SAE J941 Motor Vehicle Drivers' Eye Locations

SAE J1052 Motor Vehicle Driver and Passenger Head Position

3. DEFINITIONS

3.1 SAE J1100 DEFINITIONS

Accelerator Heel Point (AHP)

H-point

Actual H-point

Centerline of Occupant (C/LO, at Y-coordinate of SgRP)

Seating Reference Point (SgRP)

Steering Wheel Center

H17, Accelerator Heel Point (AHP) to Steering Wheel Center

H30-1, Seat Height (SgRP to AHP, z)

L53-1, SgRP to Heel (AHP, x)

Whenever H30 and L53 are used in this document, they apply to the driver seating position. The suffix "-1", which is used in SAE J1100 to designate the front seating row, is herein omitted from the dimension.

3.2 DRIVER HAND REACH CAPABILITY

Maximum reach capability of 95% of drivers in a simulated driving situation with the non-reaching hand on the steering wheel and the right foot on the accelerator pedal.

3.3 BASIC REACH TASK

Hand reach to a forward mounted control with the control held in a three-finger grasp. See Figure 1.

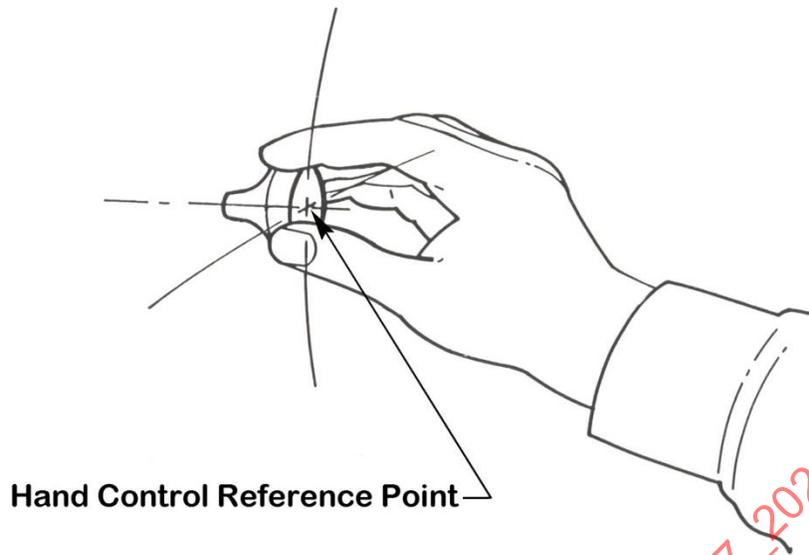


Figure 1 - three-finger grasping reach to a 25 mm diameter control knob; All measurements for the hand reach envelopes are referenced to the center of the control knob face

3.4 HAND REACH ENVELOPE

Geometric description of the hand reach capability for a specified proportion of a driver population and type of torso restraint system. The contour of the hand reach envelope refers to the geometric center of the control knob face. If the control knob face is at, or rearward of, the contour, it is estimated that at least the specified proportion of the indicated driver population can reach and operate the control [Hammond and Roe, 1972].

3.5 HAND REACH REFERENCE PLANE (HR PLANE)

Vertical reference plane extending laterally across the vehicle (an X-plane) used to properly position the hand reach envelopes with respect to the geometry of the vehicle seating configuration. The horizontal location of the HR plane rearward of the Accelerator Heel Point depends on the value of the General Package Factor (G) as shown below:

$$HR = 786 - (99) G, \text{ mm} \quad (\text{Eq. 1})$$

3.6 GENERAL PACKAGE FACTOR (G)

Single index value that characterizes the geometry of the driver seating configuration for a particular vehicle. See Figures 2 and 3.

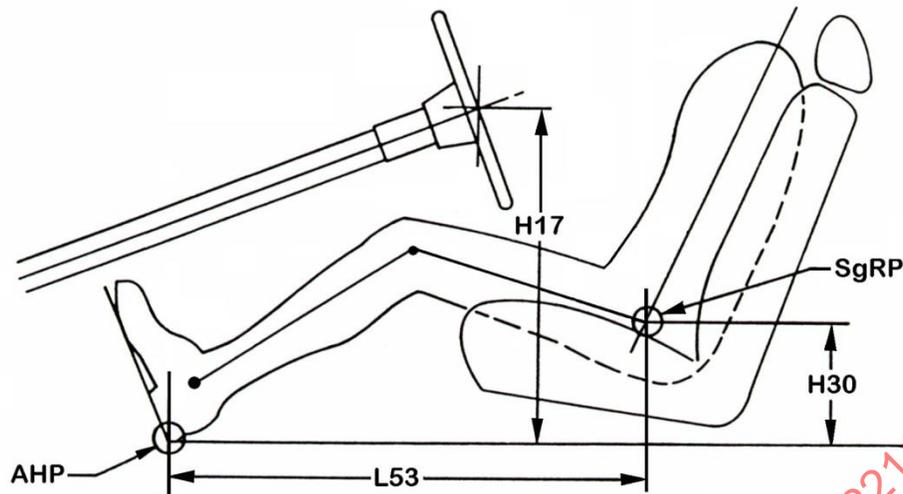


FIGURE 2 - Vehicle interior dimensions used to determine hand reach to a control

The General Package Factor (G) is a synthesized variable that provides a quantitative index of a vehicle's workspace geometry. The G value for a vehicle can be calculated by substituting the principal package dimensions in millimeters into the equation

$$G = 0.00327(H30) + 0.00285(H17) - 3.21$$

Figure 3 - general package factor, G

3.7 TYPE 1 SEAT BELT ASSEMBLY

Lap belt for pelvic restraint.

3.8 TYPE 2 SEAT BELT ASSEMBLY

Combination of pelvic (lap belt) and upper torso (shoulder belt) restraints.

3.9 TYPE 2A SHOULDER BELT

Separate upper torso restraint (shoulder belt) intended to be used in conjunction with a lap belt to form a Type 2 seat belt assembly.

3.10 UNRESTRAINED REACH

Hand reach with no upper torso restraint, as provided by Type 1 seat belt assembly.

3.11 RESTRAINED REACH

Hand reach with upper torso restraint provided by a Type 2a shoulder belt. Restrained reach data were collected using a non-extending Type 2a shoulder belt under the following conditions [Hammond and Roe, 1972]:

- The subject placed his left fist, thumb inward, between the belt and the sternum, then the investigator would snug the belt
- The subject was instructed to "lean forward firmly into the belt, but do not lunge"

4. FIELD OF APPLICATION

- 4.1 This practice is primarily directed towards the initial design stages of a new vehicle program, once the Seating Reference Point (SgRP) is determined. Its application for checking purposes in actual vehicles and prototype seat models will take into account an allowable tolerance for actual H-point [SAE J826].
- 4.2 The hand reach envelopes are directly applicable to left hand drive vehicles designed for seated operators in full width or single width seats having fore and aft seat adjustment approximately horizontal. Application to right hand drive vehicles is assumed to be symmetrically opposite.
- 4.3 The hand reach envelopes are directly applicable for a three-finger grasping reach to a forward mounted control knob of 25 mm diameter. The hand reach envelopes are also applicable to other types of reach to forward controls by using an appropriate adjustment factor that will account for the mode of operation at the control (see 4.3.1, 4.3.2, and [Roe, 1972]).

4.3.1 Controls Operated by Extended Finger

An adjustment factor of 50 mm is added to the tabled values of the reach envelope in order to describe the center of the finger pad contact surface which will be within the fingertip reach of drivers. This adjustment positions the extended finger reach envelope 50 mm farther from the HR plane (see Figure 4).

4.3.2 Controls Operated by Full Hand Grasp

An adjustment factor of 50 mm is subtracted from the tabled values of the reach envelope in order to describe the center of the face of the control knob which will be within the full hand grasp reach of drivers. This adjustment positions the full hand grasp reach envelope 50 mm closer to the HR plane (see Figure 4).

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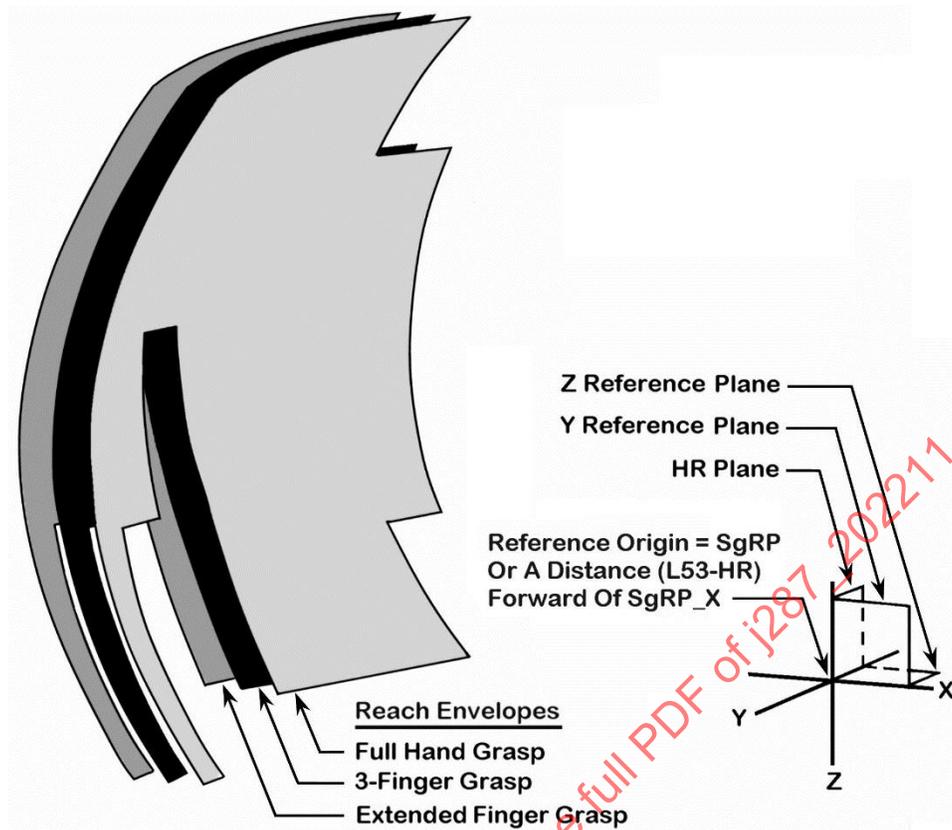


Figure 4 - Hand reach envelopes for 3-finger, extended finger, and full hand grasp of a control

5. REQUIRED CHARACTERISTICS

5.1 The ranges of the interior dimensions for which this recommended practice is applicable are described below:

Range of interior dimensions

DIMENSION	RANGE
H30 Seat Height (SgRP to AHP, z)	127 mm to 405 mm
H17 AHP to Steering Wheel Center, z	530 mm to 838 mm

5.2 The reach envelopes describe the boundaries of control locations that can be reached by at least 95% of certain driver populations that include male-to-female driver population ratios of 50/50, 75/25, and 90/10. The envelopes for each of these categories are specified as an x-distance forward from the HR plane. The envelopes extend from 400 mm outboard to 600 mm inboard of the Centerline of Occupant (C/LO) and from -100 mm below SgRP to 800 mm above SgRP. See Figure 5.

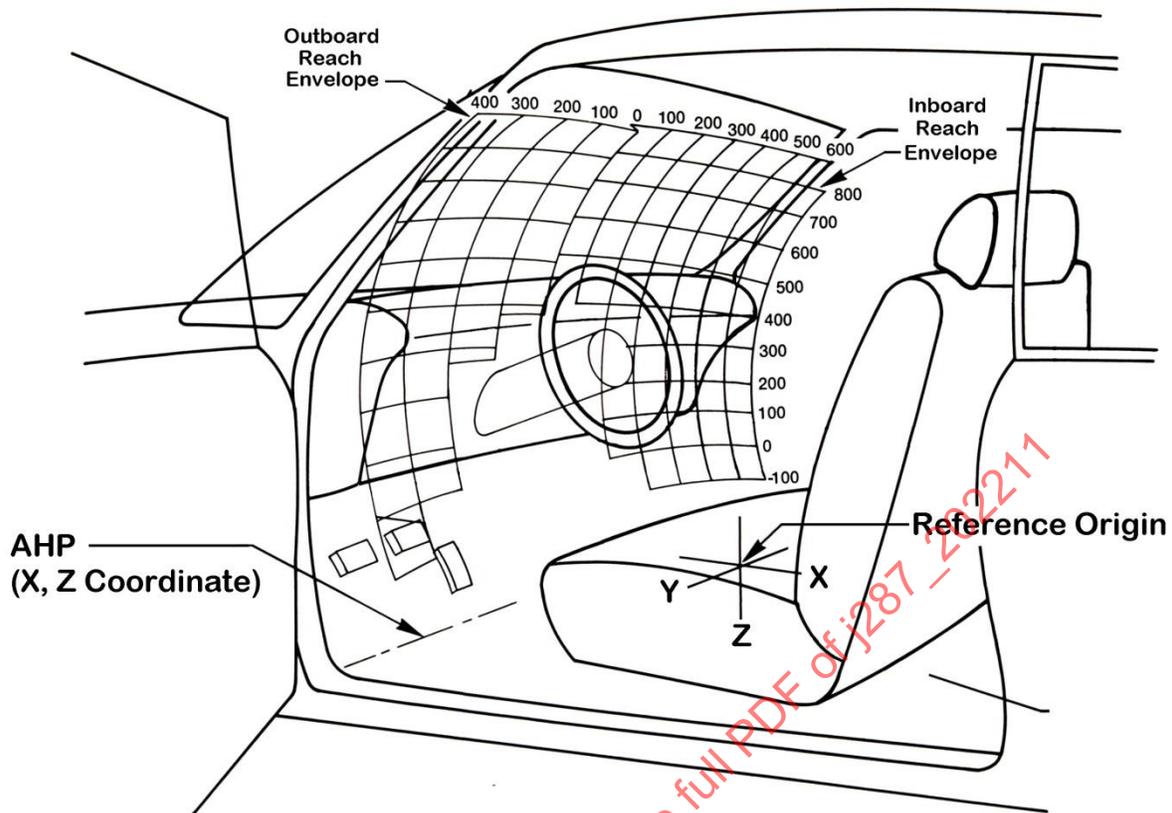


Figure 5 - hand reach envelope and reference planes shown in vehicle workspace

5.3 Hand reach envelopes are provided in the attached tables for seven different seating configurations, three male-to-female driver population ratios, and two types of restraint systems which account for: (i) drivers wearing a lap belt only (Type 1) permitting a free upper torso motion (i.e., unrestrained torso reach); and (ii) drivers wearing both a lap and a shoulder belt (Type 2) permitting only a restrained torso reach. The selection of an envelope for a vehicle is based on the calculated value of the General Package Factor (G), identification of the male-to-female driver population ratio appropriate for the vehicle, and identification of the appropriate restraint system. The General Package Factor (G) is calculated using the dimensions describing the vehicle seating configuration shown in Figures 2 and 3.

5.4 The hand reach envelope is located in the vehicle by employing a relationship that utilizes the value of the General Package Factor (G). The horizontal component of the reach envelopes is measured as a distance forward of the HR plane. The fore and aft location of the HR plane rearward from the AHP is determined from Equation 1.

6. PROCEDURE FOR USING THE HAND REACH ENVELOPES

6.1 Reference Planes for Reach Envelopes: The envelopes are located in the vehicle according to a set of orthogonal reference planes: a Z-plane through SgRP, the HR plane (an X-plane), and a Y-plane through the C/LO. See Figures 4 and 5.

6.2 Establish a reference X-origin.

6.2.1 Specify the dimensions describing the geometry of the vehicle seating configuration and calculate the value of the General Package Factor (G) as described in Figure 3.

6.2.2 Calculate HR from the value of the General Package Factor (G) as shown in Equation 1.

6.2.2.1 If $(HR - L53)$ is less than zero, then the hand reach reference plane is located longitudinally at a distance HR rearward of the AHP.

- 6.2.2.2 If (HR – L53) is greater than zero, the hand reach reference plane is located longitudinally at SgRP.
- 6.3 Identify the appropriate hand reach envelope.
- 6.3.1 Referring to Tables 1-42, identify the hand reach envelope appropriate for the value of the General Package Factor (G) calculated for this vehicle, the specified driver population, and the appropriate type of restraint system.
- 6.3.1.1 If the General Package Factor (G) value, rounded to 2 decimal places, is equal to the limit of a range, use the reach tables associated with that range.
- 6.3.1.2 The reach envelopes of the 50/50 male-to-female driver population ratio are recommended to establish the maximum reach for all Class A vehicles.
- 6.3.1.3 For vehicles with Type 2 seat belt assemblies that allow upper torso movement, use the restrained reach envelopes (Tables 1-21) to establish the maximum reach to controls used by a driver when the vehicle is moving. For controls that are not used while driving, a considerable amount of upper torso lean may be acceptable. The unrestrained hand reach tables may be used to establish maximum reach to these controls.
- 6.4 Determine if the control is within reach.¹
- 6.4.1 Determine the lateral and vertical locations of the controls of interest. Lateral locations are described as lateral distances from the C/LO. Vertical locations are the heights of the control above the SgRP.
- 6.4.2 The limiting value of hand reach should be read from the appropriate table at the designated elevation and horizontal station.
- 6.4.2.1 Interpolation may be required if the necessary control locations are not included in the table. The preferred method is to interpolate laterally then vertically. Curvilinear interpolations, using two locations on either side of the desired control, may also be considered, but minor variations in the resulting reach envelope should be expected.
- 6.4.3 A surface fitted through all the points in each table may also be used to determine if the control is within reach. The fitted surface should not deviate from the table values by more than 1 mm.
- 6.4.4 A control is considered within reach of the specified proportion of the indicated driver population if the geometric center of the control face (in the nominal or resting position) closest to the driver is tangent to or rearward of the reach contour (reach coordinates, interpolated coordinates, or fitted surface).

¹ The blank areas in the hand reach tables are regions where hand reach was not measured or where design limit values could not be established. The gray shaded areas are regions where the difference between the hand reach model and the observed design limit values exceeded 25 mm. The reach values shown in these areas should be used with caution.

TABLE 1

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
	800	387	438	456	470	490	497	502	493	501	504	495	483	468	426	377
700	463	506	520	531	546	551	556	550	562	566	557	546	532	499	455	
600	519	555	567	576	586	586	584	590	605	611	604	595	584	555	514	449
500	556	586	598	606	609	603	589	614	630	638	637	631	622	595	553	486
450	567	595	607	615	615	604	583	620	636	645	649	644	636	609	565	498
400	574	600	612	621	618	601	571	621	637	648	656	654	646	619	572	506
350	576	601	614	623	616	594	555	619	633	646	660	660	654	625	574	511
300	574	597	612	622	611					639	660	662	658	626	572	510
250	567	590	605	617	602					628	657	662	658	624	564	506
200	557	578	596	608	590					613	649	658	656	618	551	498
100	524	544	566	581							624	639	640	593	510	469
0	474										584	607	610	551	449	423
-100	410										528	561	567	493	367	360

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TABLE 2

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
	800	422	470	488	501	520	526	532	530	539	542	532	520	505	466	419
700	496	536	550	560	574	579	584	582	595	600	590	580	567	534	492	
600	550	584	596	604	612	612	609	619	634	640	634	626	615	586	545	480
500	584	614	625	633	634	625	610	638	654	663	664	658	649	622	580	513
450	594	622	634	641	639	625	602	642	658	668	673	670	662	634	589	523
400	600	626	639	647	640	620	587	642	657	668	679	678	671	642	594	529
350	601	627	640	648	637	611	568	637	651	664	681	682	677	646	594	531
300	598	623	637	646	631					656	680	683	679	646	589	529
250	591	615	630	641	621					643	675	681	678	642	578	523
200	579	603	620	632	607					625	666	675	673	633	563	513
100	544	568	590	604							637	654	654	604	517	480
0	492										593	618	621	558	451	430
-100	426										534	569	575	496	364	363

TABLE 3

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
	800	443	490	507	519	538	544	550	551	561	564	554	542	527	489	443
700	516	555	568	578	591	596	600	601	615	619	610	600	587	555	513	
600	568	601	613	621	628	627	624	635	651	657	652	644	633	605	564	498
500	601	630	641	649	648	639	622	653	669	678	680	674	666	639	595	528
450	611	638	650	657	653	638	612	655	671	681	688	685	677	649	604	537
400	616	642	654	662	653	632	597	654	668	680	693	692	685	656	607	542
350	616	642	655	663	649	621	575	648	661	675	694	695	690	659	605	543
300	613	638	652	661	642					665	691	695	691	657	598	540
250	605	630	645	655	631					651	685	692	689	652	587	533
200	592	618	635	646	617					632	675	685	684	642	570	521
100	556	583	604	617							644	662	662	611	521	486
0	503										598	624	627	562	451	434
-100	436										537	573	579	497	361	365

TABLE 4

Restrained Hand Reach Vehicle Range: (-1.24 < G < -0.75) Population Mix: 50/50 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	391	441	460	474	494	501	507	500	509	512	502	491	475	435	386	
700	466	509	523	535	550	555	560	556	569	573	564	553	540	507	464	
600	521	558	570	579	589	590	589	595	611	617	611	602	591	562	521	456
500	558	589	600	609	613	606	594	618	635	643	644	638	629	602	559	492
450	569	597	609	618	619	608	588	624	640	649	654	650	643	615	571	504
400	576	602	615	623	621	605	577	625	640	651	661	660	653	625	577	512
350	578	602	616	625	620	598	560	622	636	649	665	665	660	630	579	516
300	576	599	613	624	615					641	665	668	663	631	575	515
250	569	591	607	618	606					630	661	667	664	629	567	510
200	559	580	597	610	594					614	653	662	660	622	553	502
100	525	545	566	582							627	643	644	596	511	471
0	476										586	611	614	554	449	425
-100	411										530	564	570	495	367	362

TABLE 5

Restrained Hand Reach Vehicle Range: (-1.24 < G < -0.75) Population Mix: 75/25 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	427	475	493	506	525	532	538	536	546	549	539	527	512	474	426	
700	500	541	555	565	579	584	589	588	602	606	597	587	574	542	499	
600	553	588	600	608	617	617	615	624	640	646	641	633	622	594	553	487
500	587	617	628	636	638	631	616	644	660	669	670	665	657	629	586	519
450	597	625	637	645	643	631	608	647	663	673	680	676	669	641	596	529
400	603	629	641	650	645	626	595	646	661	673	685	684	678	649	600	535
350	604	629	642	651	642	617	576	641	655	668	687	688	683	652	599	537
300	601	625	639	649	636					659	685	689	685	652	593	535
250	593	617	632	643	626					646	680	687	684	647	583	528
200	582	605	622	634	612					628	671	681	679	639	567	518
100	546	569	591	606							641	659	660	609	521	484
0	494										597	623	627	563	454	435
-100	427										538	574	580	500	367	368

TABLE 6

Restrained Hand Reach Vehicle Range: (-1.24 < G < -0.75) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	448	496	513	526	544	551	557	557	567	570	560	549	534	496	450	
700	520	560	573	583	597	602	606	608	621	626	617	607	594	562	520	
600	572	606	617	626	633	633	630	641	657	663	659	651	640	612	571	504
500	605	634	645	653	654	645	630	658	674	683	686	681	673	646	602	535
450	614	642	653	661	658	644	620	661	676	687	694	692	684	656	610	544
400	619	646	658	665	658	639	605	659	673	686	699	698	692	663	613	549
350	620	645	658	666	655	629	585	653	666	680	700	702	697	665	611	550
300	616	641	655	664	648					670	697	702	698	664	604	546
250	608	632	648	658	637					655	691	699	696	658	592	539
200	595	620	637	648	623					636	681	692	690	648	575	527
100	558	584	605	619							650	668	669	616	526	492
0	505										604	630	634	568	456	440
-100	437										543	579	585	503	366	371

TABLE 7

Restrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 50/50 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	394	445	464	478	498	505	511	507	516	519	510	498	483	443	395	
700	469	512	527	538	553	559	564	562	576	580	571	561	548	515	472	
600	524	560	573	583	593	594	593	601	617	623	618	610	599	570	529	463
500	560	591	603	612	616	610	598	623	639	648	650	644	636	609	566	498
450	571	600	612	621	622	612	593	628	643	654	660	657	649	622	576	510
400	578	604	617	626	624					655	667	666	659	631	582	517
350	580	604	618	627	623					652	670	671	666	636	583	520
300	578	601	615	626	618					644	669	673	669	636	579	519
250	571	593	608	620	609					632	665	672	669	633	569	514
200	561	581	598	611	597					615	657	667	665	626	555	505
100	527	545	566	583							630	647	648	599	512	474
0	478	494	521	542							588	614	618	556	450	
-100	412	429	461	487							532	567	574	497	368	

TABLE 8

Restrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 75/25 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	431	480	498	512	531	538	544	543	552	556	546	534	519	481	434	
700	504	545	559	570	584	590	594	595	608	613	604	594	581	549	507	
600	556	591	604	613	622	622	620	630	646	653	648	640	629	601	560	493
500	590	620	632	640	643	636	622	649	665	674	677	672	664	636	593	525
450	600	628	640	648	648	636	615	652	667	678	686	683	676	648	602	535
400	606	632	644	653	649					677	691	690	684	655	605	541
350	607	632	645	654	647					673	693	695	690	658	604	543
300	604	627	642	652	640					663	690	695	692	658	598	540
250	596	619	635	646	631					649	685	693	690	653	587	534
200	584	606	624	636	617					631	675	687	685	644	571	523
100	548	570	591	607						646	664	665	665	614	524	489
0	496	518	545	565						601	628	632	632	567	457	
-100	428	451	484	509						543	579	585	585	505	371	

TABLE 9

Restrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	454	501	519	532	551	557	563	564	575	577	567	556	541	503	457	
700	524	565	578	589	603	608	613	614	628	632	624	614	601	570	528	
600	575	610	622	630	639	639	637	647	663	670	666	658	647	619	576	511
500	608	638	649	657	659	651	637	664	680	689	693	688	680	653	609	541
450	617	645	657	665	663	651	628	666	681	692	701	698	691	663	616	550
400	622	649	661	669	664					691	705	705	699	670	619	555
350	623	648	661	670	661					685	706	708	704	672	617	556
300	619	643	657	667	654					674	703	708	705	670	609	552
250	611	634	650	661	643					660	697	705	703	664	597	545
200	598	622	639	651	629					640	686	698	697	654	580	533
100	561	585	606	621						655	674	675	675	622	530	498
0	507	532	559	578						609	637	640	640	574	461	
-100	438	465	498	522						548	586	592	592	509	372	

TABLE 10

Restrained Hand Reach Vehicle Range: (-0.24 < G < 0.24) Population Mix: 50/50 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	397	449	467	482	503	510	516	514	524	527	517	506	491	452	403	
700	472	515	530	542	557	563	568	569	583	588	579	568	555	523	480	
600	526	563	576	586	596	597	596	606	623	629	625	617	606	578	536	470
500	562	593	605	614	619	614	603	627	644	653	656	651	643	616	572	505
450	573	602	614	623	625	616	597	632	647	658	666	663	656	628	582	516
400	580	606	619	628	628					658	672	672	666	637	587	523
350	582	606	620	630	626					654	675	677		641	587	525
300	580	602	617	627	621					646	673	678	675	641	582	524
250	573	594	610	622	613					633	669	677	674	637	572	518
200	563	582	599	613	601					616	660	671	670	629	557	509
100	529	546	567	584						632	651	652	602	513	477	
0	479	494	520	542						590	617	621	558	450		
-100	414	427	460	487						534	570	577	499	368		

TABLE 11

Restrained Hand Reach Vehicle Range: (-0.24 < G < 0.24) Population Mix: 75/25 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	436	485	503	517	537	544	549	549	559	563	553	541	527	489	442	
700	507	549	564	575	589	595	600	601	615	620	611	601	588	557	515	
600	559	595	608	617	626	627	626	636	652	659	655	647	637	609	567	500
500	593	624	635	644	647	641	629	654	670	679	683	679	671	643	599	532
450	603	631	643	652	652	642	622	657	672	683	692	690	683	655	607	542
400	608	635	647	656	654					682	697	697	691	662	611	547
350	610	634	648	657	651					677	698	701	696	665	609	548
300	606	630	644	654	645					667	696	701	698	663	603	546
250	599	621	637	648	635					653	690	698	696	658	591	539
200	587	608	625	638	622					634	680	692	691	649	575	528
100	551	571	592	608						650	669	671	618	527	494	
0	498	518	544	565						606	633	637	572	460		
-100	430	449	483	508						547	584	591	509	374		

TABLE 12

Restrained Hand Reach Vehicle Range: (-0.24 < G < 0.24) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	459	507	524	538	557	564	570	570	581	584	574	562	548	511	464	
700	528	569	584	594	609	614	619	620	634	639	631	621	608	577	535	
600	579	614	626	635	644	645	643	653	669	676	672	665	655	627	585	518
500	611	642	653	661	664	657	644	669	685	695	699	695	687	660	615	548
450	621	649	661	669	669	657	636	671	686	698	707	705	698	670	623	557
400	626	652	664	673	669					696	712	712	706	676	625	562
350	626	651	664	673	666					690	712	715	711	678	622	562
300	622	646	660	670	659					679	709	715	712	676	615	559
250	614	637	653	664	649					664	702	711	709	670	602	551
200	601	624	641	653	634					644	692	704	703	660	585	539
100	564	585	607	623						661	680	682	628	535	504	
0	510	532	559	579						615	643	647	579	466		
-100	439	463	496	521						554	592	598	515	378		

TABLE 13

Restrained Hand Reach Vehicle Range: (0.25 < G < 0.74) Population Mix: 50/50 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	401	453	471	486	507	514	520	521	531	535	525	513	498	460	412	
700	474	518	534	545	561	567	572	575	590	595	586	576	563	531	489	
600	529	566	579	589	599	601	600	612	628	635	632	624	614	585	544	476
500	564	596	608	617	623	618	607	632	648	658	662	658	650	622	578	511
450	575	604	616	626	629	620	602	635	651	662	671	669	663	634	587	521
400	582	608	621	630	631					662	677	678	672	642	592	528
350	584	608	622	632	629					657	679	682	678	646	591	530
300	582	604	618	629	624					648	678	683	680	646	585	528
250	576	595	611	624	616					635	672	681	679	642	575	522
200	565	583	600	614	604					617	664	676	675	633	559	512
100	531	546	567	585						635	655	657	605	515	480	
0	481	494	520	542						593	621	625	561	451		
-100	415	426	458	486						536	573	581	501	369		

TABLE 14

Restrained Hand Reach Vehicle Range: (0.25 < G < 0.74) Population Mix: 75/25 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	440	490	508	522	542	549	555	555	566	570	560	548	534	496	449	
700	511	553	568	579	594	600	605	607	621	627	618	608	596	565	522	
600	562	599	611	621	631	632	631	641	657	665	662	654	644	616	574	507
500	596	627	639	647	652	646	635	659	675	685	690	686	678	650	605	538
450	606	634	646	655	657	647	625	661	676	688	697	696	690	661	613	548
400	611	638	650	659	658					686	703	703	698	668	616	553
350	612	637	650	660	656					681	704	707	703	671	614	554
300	609	632	646	657	650					670	701	707	704	669	607	551
250	602	623	639	650	640					656	695	704	702	664	595	544
200	590	610	627	640	626					637	685	698	697	654	579	533
100	553	571	593	610						655	675	677	623	531	499	
0	500	517	544	565						610	638	643	576	464		
-100	431	448	481	508						551	589	596	514	378		

TABLE 15

Restrained Hand Reach Vehicle Range: (0.25 < G < 0.74) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	464	513	530	544	564	570	576	576	587	591	581	569	555	518	471	
700	532	574	589	599	614	620	624	626	640	646	638	628	615	584	542	
600	583	618	631	640	649	650	649	659	675	682	679	672	662	634	592	525
500	615	645	657	665	669	663	651	675	691	701	706	702	694	667	622	555
450	624	652	664	673	674	663	644	677	691	703	714	712	706	677	629	563
400	629	655	668	677	674					701	718	719	713	683	631	568
350	629	654	667	677	671					695	718	722	718	685	628	568
300	625	649	663	673	664					684	715	722	718	683	620	565
250	617	639	655	666	654					668	708	718	716	677	608	557
200	605	626	643	656	640					649	698	711	710	666	590	545
100	567	586	608	624						666	687	688	634	540	509	
0	512	531	558	579						620	649	653	585	471		
-100	441	461	494	521						560	598	605	521	383		

TABLE 18

Restrained Hand Reach Vehicle Range: (0.75 < G < 1.24) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	469	518	536	550	570	577	583	582	594	597	587	576	561	525	479	
700	537	579	594	605	620	625	630	632	647	652	644	635	622	592	549	
600	586	622	635	644	655	656	655	665	681	688	686	679	669	641	599	531
500	618	649	661	670	674	669	658	680	696	706	713	709	702	674	628	561
450	627	656	668	677	679	669	651	682	697	708	720	719	713	684	635	570
400	632	658	671	680	679					706	724	725	720	690	637	574
350	632	657	670	680	676					699	724	728	724	691	634	575
300	629	651	666	676						688	721	728	725	689	626	571
250	620	641	657	669						673	714	724	723	683	613	563
200	608	627	645	658						653	703	717	717	672	595	551
100	570	587	609	626							672	693	695	640	545	515
0	515	531	558	580							626	655	660	591	476	464
-100	443	458	492	520							566	605	612	528	389	397

TABLE 19

Restrained Hand Reach Vehicle Range: (G greater than 1.25) Population Mix: 50/50 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	408	460	479	494	515	522	528	534	547	551	541	529	514	477	430	
700	480	525	540	552	568	574	579	587	603	609	601	591	579	548	505	
600	533	571	585	595	606	608	608	622	639	647	645	638	629	601	558	490
500	568	600	613	622	629	625	615	640	656	667	674	671	664	636	590	523
450	579	608	621	630	635	627	611	643	658	670	683	682	676	647	598	533
400	586	612	625	635	637					668	687	689	684	654	601	538
350	588	612	625	636	636					662	689	693	690	657	599	540
300	586	607	622	633						652	686	694	691	655	592	537
250	580	598	614	627						638	680	691	690	650	580	530
200	569	585	603	617						619	671	685	685	641	564	520
100	535	547	568	587							641	663	665	611	517	486
0	485	493	519	542							598	628	633	566	453	438
-100	418	423	455	484							541	580	588	506	371	374

TABLE 20

Restrained Hand Reach Vehicle Range: (G greater than 1.25) Population Mix: 75/25 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	449	500	518	533	553	561	566	568	580	584	574	563	548	512	465	
700	518	562	577	588	604	610	615	619	634	640	633	623	611	580	538	
600	569	606	619	629	640	642	641	652	669	677	675	668	658	631	588	520
500	602	633	645	654	661	656	646	669	684	695	702	699	692	664	618	551
450	611	640	653	662	665	657	641	671	685	697	710	709	703	674	625	560
400	617	643	656	666	667					695	714	716	711	680	627	565
350	618	642	655	666	664					689	715	719	716	682	624	566
300	615	636	651	662						678	712	719	717	680	616	562
250	607	627	643	655						662	705	716	715	674	604	555
200	595	613	630	644						643	695	709	709	664	586	543
100	559	573	594	612						664	685	688	688	633	538	508
0	505	517	543	566						619	649	654	654	586	471	458
-100	435	444	477	506						560	600	607	607	524	386	392

TABLE 21

Restrained Hand Reach Vehicle Range: (G greater than 1.25) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 2a restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	474	524	542	556	576	583	589	588	600	604	594	583	568	532	486	
700	541	584	598	610	625	631	636	638	653	659	651	642	630	599	557	
600	590	627	639	649	660	662	661	670	687	695	693	686	676	649	606	538
500	621	653	665	674	679	675	665	686	701	712	719	716	709	681	635	568
450	630	659	671	681	684	675	658	687	702	714	727	726	720	691	641	576
400	635	662	674	684	684					711	730	732	727	696	643	581
350	636	660	673	683	681					704	731	735	731	698	639	581
300	632	654	668	679						693	727	735	732	695	631	577
250	624	644	660	672						677	720	731	729	689	618	569
200	611	629	647	661						657	709	723	723	678	600	557
100	573	588	610	628						677	699	701	701	646	550	521
0	517	531	558	580						631	662	667	667	597	482	470
-100	445	456	490	519						572	611	619	619	534	395	403

TABLE 22

Unrestrained Hand Reach	Vehicle Range: (G less than -1.25)								Population Mix: 50/50 Males to Females							
	(mm)															
	Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 1 lap belt restraint.															
Elevation above SgRP (mm)	Stations outboard of C/LO (mm)								Stations inboard of C/LO (mm)							
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	532	563	573	580	579	570	556	568	575	580	581	575	566	532	477	398
700	605	628	635	638	633	622	606	619	629	637	642	640	633	605	556	482
600	662	679	684	686	677	665	648	659	672	681	691	690	685	662	617	548
500	703	717	720	721	710	698	681	689	703	713	726	727	723	703	661	595
450	717	730	733	733	723	711	695	700	714	725	738	739	737	717	677	612
400	727	739	742	743	733	722	706	708	722	733	747	749	746	727	688	624
350	732	745	748	749	740					739	753	754	752	734	694	631
300	734	746	750	751	744					741	755	756	754	736	697	633
250	730	744	748	750	744					740	753	755	752	734	694	631
200	722	737	742	745							748	749	747	727	688	624
100	692	711	718	724							727	727	724	702	660	595
0	642	667	678	687							692	690	685	660	615	546
-100	573	605	620	634							642	638	630	601	551	478

TABLE 23

Unrestrained Hand Reach	Vehicle Range: (G less than -1.25)								Population Mix: 75/25 Males to Females							
	(mm)															
	Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 1 lap belt restraint.															
Elevation above SgRP (mm)	Stations outboard of C/LO (mm)								Stations inboard of C/LO (mm)							
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	573	602	612	617	616	609	598	599	607	613	615	611	602	571	520	447
700	642	665	671	674	668	659	645	645	656	664	671	668	662	637	591	524
600	695	714	718	719	709	698	684	681	694	704	714	713	709	688	646	584
500	732	748	751	750	739	728	713	708	722	732	745	746	743	724	686	626
450	745	760	762	761	750	739	724	718	731	742	755	757	754	736	699	640
400	753	767	770	769	757	746	732	725	739	750	763	764	762	745	708	651
350	757	771	774	773	762					754	767	769	766	749	713	656
300	757	772	774	774	764					755	768	770	767	750	714	657
250	753	768	771	771	762					754	766	767	764	747	711	654
200	744	760	764	765							760	761	758	740	703	646
100	712	732	728	741							739	738	734	713	675	615
0	663	687	695	701							703	701	695	670	628	566
-100	594	625	637	646							654	649	640	611	564	498

TABLE 24

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
	800	614	639	646	650	647	640	628	629	636	641	643	640	632	605	560
700	677	698	703	705	697	688	674	671	681	688	694	693	687	665	624	563
600	725	743	747	747	736	725	710	705	716	725	734	734	730	711	673	616
500	758	774	777	776	763	751	735	729	741	750	761	762	759	742	707	652
450	769	784	786	785	772	760	744	737	749	759	771	772	769	753	719	664
400	776	790	792	791	778	766	749	743	755	765	777	778	776	760	726	672
350	778	793	795	794	781					768	780	781	779	763	729	676
300	777	792	794	793	780					768	780	781	779	763	729	675
250	771	787	789	789	777					765	776	777	775	758	724	670
200	761	778	781	781							770	771	768	750	716	661
100	729	748	753	754							747	747	743	723	686	630
0	680	703	709	713							711	709	703	680	640	581
-100	612	641	650	656							662	657	649	622	577	514

TABLE 25

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
	800	545	583	594	601	601	595	586	589	602	611	615	609	596	552	479
700	619	641	658	662	654	645	631	633	649	662	672	670	663	629	567	485
600	676	703	708	709	696	683	666	666	684	698	715	716	711	686	634	552
500	717	740	744	742	725	710	690	679	708	723	743	746	744	724	680	607
450	734	753	756	754	735	719	699	697	716	731	752	756	755	737	696	626
400	741	762	765	762	742	726	705	703	721	737	758	762	762	746	707	641
350	747	768	770	767	747					740	761	765	765	751	713	650
300	748	770	772	769	748					741	761	765	765	751	716	654
250	746	768	770	767	747					739	758	762	762	749	714	654
200	740	763	765	763							753	756	756	742	707	649
100	715	741	745	744							735	737	735	719	683	625
0	675	705	711	712							708	707	702	682	644	585
-100	618	655	664	668							674	668	660	634	591	528

TABLE 26

Unrestrained Hand Reach Vehicle Range: (-1.24 < G < -0.75) Population Mix: 75/25 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	587	621	631	636	636	630	622	620	633	642	646	640	630	591	528	438
700	657	684	691	693	686	677	665	661	676	688	698	696	689	659	605	525
600	710	733	737	737	724	713	698	691	708	722	736	737	733	710	664	593
500	747	767	769	767	751	737	720	711	729	744	762	765	763	744	704	640
450	759	778	780	778	760	746	728	718	736	751	770	774	772	756	718	657
400	768	786	788	785	766	751	733	723	741	756	775	779	779	763	728	669
350	772	791	792	789	770					759	778	782	781	767	733	676
300	773	791	793	790	770					759	777	781	781	767	734	679
250	770	789	790	787	768					756	774	778	778	764	732	678
200	762	782	784	782							769	772	771	757	725	672
100	737	759	763	762							750	751	749	734	700	648
0	696	723	729	729							721	720	716	697	661	607
-100	640	673	682	685							684	680	673	648	608	551

TABLE 27

Unrestrained Hand Reach Vehicle Range: (-1.24 < G < -0.75) Population Mix: 90/10 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	628	655	663	667	665	659	649	649	661	668	672	667	657	624	570	493
700	692	714	720	721	713	703	691	687	701	711	720	718	712	685	638	569
600	740	759	762	762	749	737	721	714	730	742	756	756	752	731	690	628
500	773	790	792	790	773	760	742	732	749	763	779	781	779	762	726	668
450	784	800	801	799	781	767	749	738	755	769	786	789	788	772	738	682
400	791	806	808	805	786	771	753	741	759	773	791	794	793	779	745	692
350	791	809	811	808	789					774	792	796	795	782	749	697
300	793	809	811	807	789					773	791	795	794	781	750	698
250	789	806	807	804	785					770	787	791	791	777	746	696
200	781	799	801	798							781	784	784	770	739	689
100	754	775	778	777							761	763	761	746	714	663
0	713	738	743	744							731	731	728	710	676	623
-100	658	689	696	699							691	689	684	662	623	567

TABLE 28

Unrestrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 50/50 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	556	600	613	619	621	617	612	610	626	637	642	635	620	569	485	362
700	632	670	679	682	675	666	656	650	669	684	697	695	687	649	579	474
600	689	723	729	729	714	701	686	679	699	716	735	737	733	706	649	559
500	729	759	763	760	739	723	704	697	718	735	758	763	762	743	696	618
450	742	772	774	771	747	729	709	702	723	741	765	770	771	754	712	639
400	752	780	782	778	752	733	711	706	727	744	768	774	775	761	723	655
350	757	785	787	782	754					745	769	775	777	765	729	665
300	759	787	788	782	753					744	767	773	775	764	731	671
250	757	785	786	780	749					742	763	769	771	761	729	672
200	752	780	781	775							758	763	764	754	723	668
100	731	762	763	756							741	744	744	731	701	649
0	698	732	734	728							721	720	716	700	667	615
-100	654	692	696	691							697	692	684	661	624	569

TABLE 29

Unrestrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 75/25 Males to Females
(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 75% male and 25% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	598	637	647	653	654	650	644	641	656	666	670	664	651	607	536	435
700	669	702	709	711	704	696	686	679	696	709	721	719	711	678	618	530
600	723	750	755	754	740	729	715	705	724	739	757	758	754	729	679	603
500	759	783	786	783	764	749	733	721	741	758	778	782	781	762	720	653
450	771	794	796	792	771	756	737	725	746	763	785	789	789	773	734	671
400	779	802	803	799	776	759	740	728	749	766	788	793	793	779	744	684
350	784	806	807	802	778					766	789	794	795	782	749	692
300	785	807	807	802	777					765	787	792	793	782	750	696
250	782	804	805	800	774					762	783	788	789	778	748	696
200	776	799	800	794							777	781	782	772	742	692
100	754	780	781	776							759	762	762	750	721	672
0	721	749	753	749							735	736	734	718	687	638
-100	676	710	715	714							708	705	699	679	644	592

TABLE 30

Unrestrained Hand Reach Vehicle Range: (-0.74 < G < -0.25) Population Mix: 90/10 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 90% male and 10% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	638	669	678	682	681	677	670	669	682	691	694	689	678	640	579	494
700	704	729	735	736	728	720	709	704	720	732	742	740	733	703	652	577
600	752	774	777	776	763	751	737	728	746	760	775	776	772	750	706	639
500	785	804	806	803	785	771	754	742	761	777	796	799	797	780	742	682
450	795	814	815	811	792	777	758	746	765	781	802	805	805	789	754	697
400	802	820	821	817	796	780	761	747	767	783	804	809	809	795	762	707
350	806	824	824	820	798					783	805	810	810	798	766	714
300	806	824	824	819	797					781	803	808	808	797	767	716
250	802	821	821	817	794					777	798	803	804	793	764	715
200	796	815	816	811							792	796	797	786	758	710
100	773	795	797	793							773	776	777	765	736	689
0	739	765	768	766							747	749	748	734	704	655
-100	694	725	731	731							716	715	712	694	661	610

TABLE 31

Unrestrained Hand Reach Vehicle Range: (-0.24 < G < 0.24) Population Mix: 50/50 Males to Females

(mm)

Horizontal reach forward of the HR reference plane at stations located laterally from the centerline of operator (C/LO) and at elevations above the Seating Reference Point (SgRP). The envelope describes a 95% level of performance of a driver population composed of 50% male and 50% female drivers wearing a Type 1 lap belt restraint.

Elevation above SgRP (mm)	Stations outboard of C/LO (mm)							Stations inboard of C/LO (mm)								
	400	300	250	200	100	50	0	0	50	100	200	250	300	400	500	600
800	564	615	628	635	638	636	635	629	645	656	661	653	638	584	493	362
700	642	687	697	700	693	687	680	670	689	703	717	714	705	665	592	480
600	700	740	747	746	731	720	709	696	717	733	753	755	751	722	663	568
500	738	774	779	775	754	738	722	711	732	749	773	777	777	757	710	629
450	750	786	789	784	759	742	724	716	736	753	777	783	784	768	725	651
400	759	793	795	790	762	743	723	718	738	755	779	785	787	774	735	666
350	764	797	798	792	761					754	778	785	787	776	741	677
300	765	798	798	791	758					752	775	781	784	774	742	683
250	763	795	796	787	752					748	770	776	778	770	740	684
200	759	790	790	781							763	769	771	762	734	681
100	741	773	772	763							747	750	750	741	714	664
0	714	747	747	737							729	729	726	713	684	636
-100	680	716	715	706							713	708	701	681	648	599