

Status Report

Ad-Hoc Group 3D H-point machine

May 2023

Background

- See [GRSP-72-33](#) and [GRSP-71-08](#)
- Ad-Hoc group started after GRSP-72 with participation from:
 - * Contracting Parties (Germany, France, Spain, the Netherlands)
 - * NGOs (OICA, CLEPA)

and input from technical experts (Humanetics/Almetec)

- 4 meetings took place (online):
 - * 23 January 2023
 - * 27 February 2023
 - * 13 March 2023
 - * 25 April 2023

Current State of Play

1. Update of R.E.3., referring to:
 - * SAE J826 Nov. 2008 (no reference to ISO 6549 needed)
 - * default setting of lower leg and thigh segments at 50% (i.e. 417 and 432 mm)
 - * other setting allowed, as indicated by manufacturer in the H-point drawings (e.g. 417 and 408 mm)
 - * other setting may be prescribed in certain Regulations like UN R94, R137 for certain applications.
 - * keep spec for muslin cloth

2. Inclusion of calibration procedure.

Calibration procedure

3 common procedures exist:

1. SAE J826 Nov. 2008 with or without calibration of HRMD
2. GLORIA (EuroNCAP)
3. VDA 304 (basically in line with SAE J826, but with tighter tolerances)

Each serving specific needs. For checking compliance with regulatory provisions, SAE J826 Nov. 2008 (or later; current status: 202106) fulfils in our needs without having the need to include the HRMD in the calibration.

Figure 1
3-D H Machine elements designation

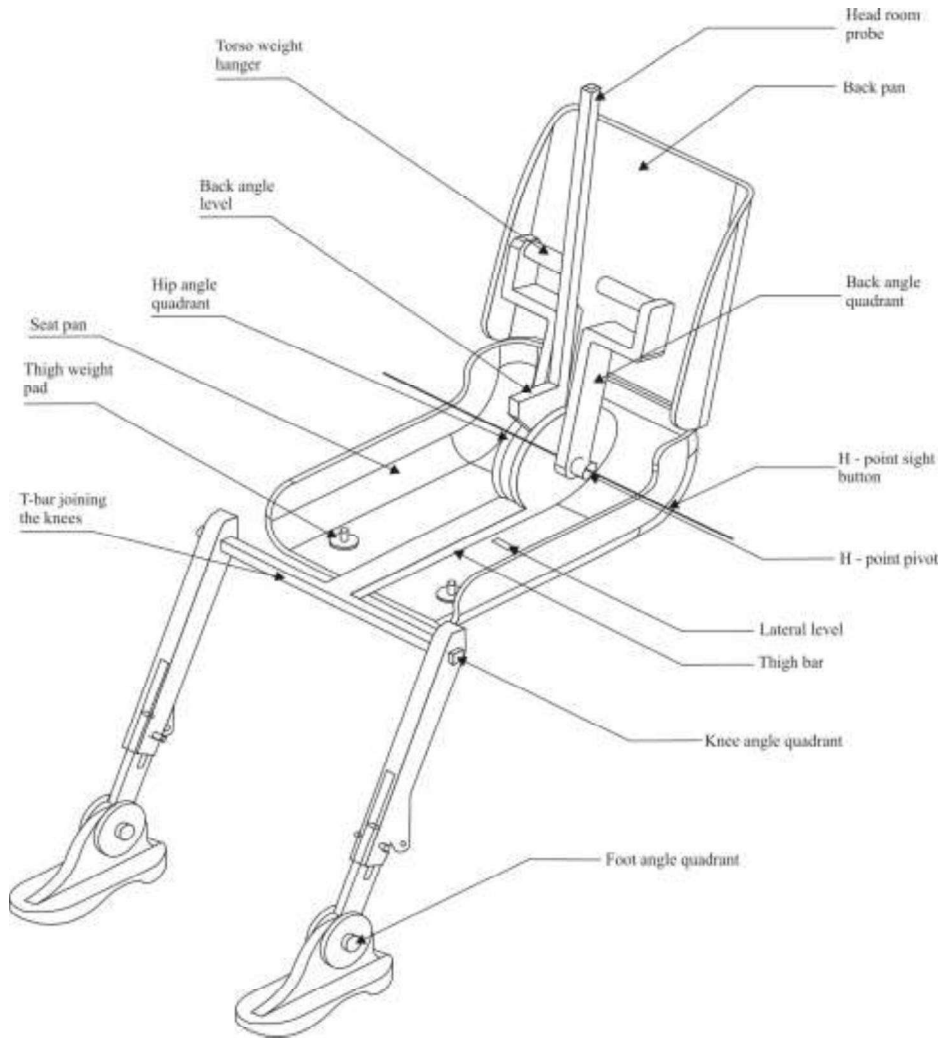
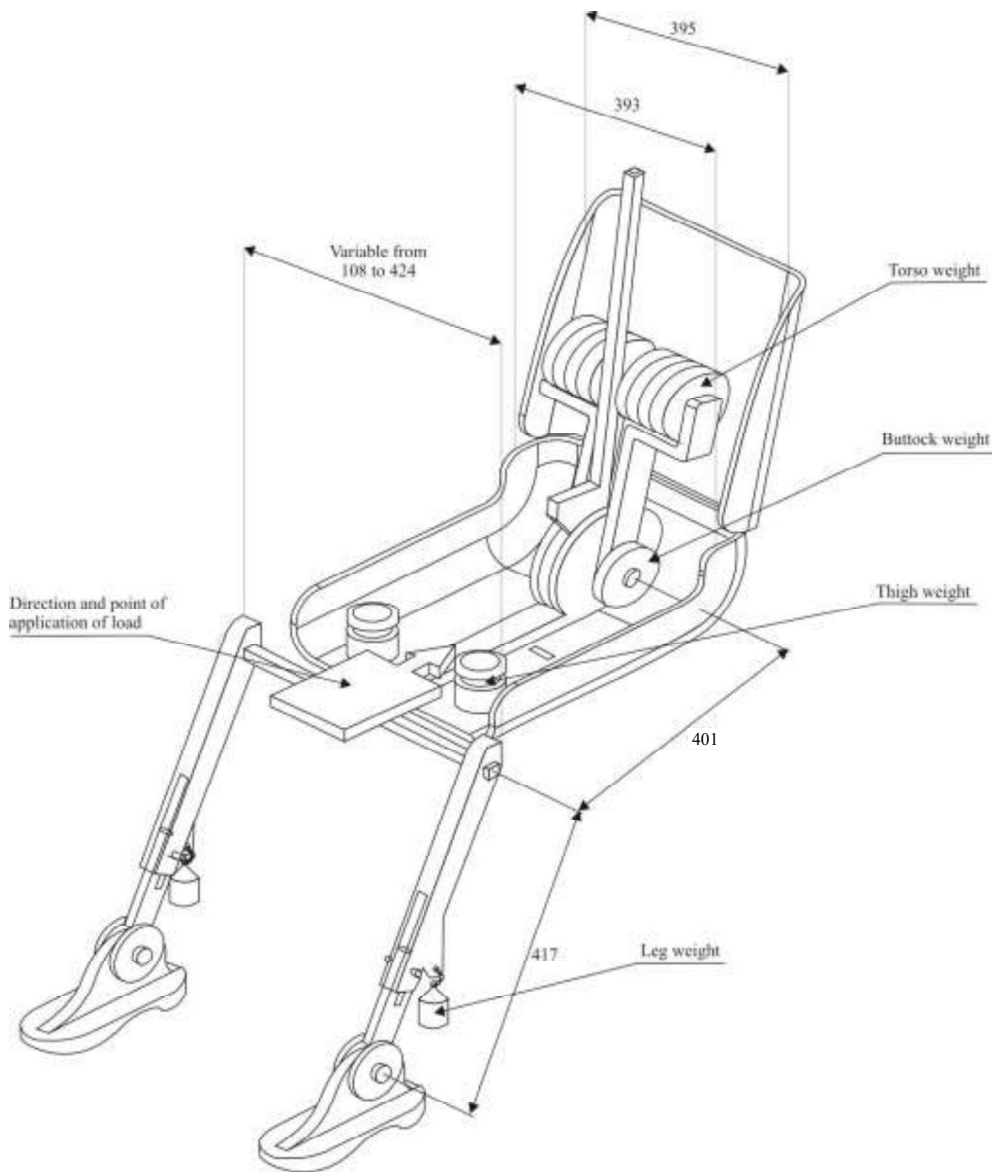


Figure 2
Dimensions of the 3-D H- machine elements and load distribution



Annex 1

Standard annex on the procedure for determining the "H" point and the actual torso angle for seating positions in motor vehicles*

1. Purpose
The procedure described in this annex is used to establish the "H" point location and the actual torso angle for one or several seating positions in a motor vehicle and to verify the relationship of measured data to design specification given by the vehicle manufacturer.¹
2. Definitions
For the purposes of this annex:
 - 2.1. "Reference data" means one or several of the following characteristics of a seating position:
 - 2.1.1. The "H" point and the "R" point and their relationship;
 - 2.1.2. The actual torso angle and the design torso angle and their relationship.
 - 2.2. "Three-dimensional H-point machine" (3-D "H" point machine) means the device used for the determination of "H" points and actual torso angles. This device is described in Appendix 1 to this annex.
 - 2.3. "H" point means the pivot centre of the torso and thigh of the 3-D H machine installed in the vehicle seat in accordance with the procedure described in paragraph 4. below. The "H" point is located in the centre of the centre line of the device which is between the 'H' point sight buttons on either side of the 3-D H machine. The "H" point corresponds theoretically to the "R" point (for tolerances, see paragraph 3.2.2. below). Once determined in accordance with the procedure described in paragraph 4., the "H" point is considered as fixed in relation to the seat-cushion structure and as moving with it when the seat is adjusted.
 - 2.4. "R" point or "seating reference point" means a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system.
 - 2.5. "Torso line" means the centre line of the probe of the 3-D H machine with the probe in the fully rearward position.

* The text of this "standard annex" appears, with almost the same text, in several (more than three) Regulations and Rules. The aim of its insertion in this document is to permit to replace their reproduction *in extenso* in the Regulations. The original numbering of paragraphs has been kept in order to show their relation with Regulations and Rules in which they appear.

¹ In any seating position other than front seats where the "H" point cannot be determined using the "three-dimensional H-point machine" or other procedures, the "R" point indicated by the vehicle manufacturer may be taken as a reference at the discretion of the Type Approval Authority.

- 2.6. "Actual torso angle" means the angle measured between a vertical line through the "H" point and the torso line using the back angle quadrant on the 3-D H machine. The actual torso angle corresponds theoretically to the design torso angle (for tolerances, see paragraph 3.2.2. below).
- 2.7. "Design torso angle" means the angle measures between a vertical line through the "R" point and the torso line in a position which corresponds to the design position of the seat-back established by the vehicle manufacturer;
- 2.8. "Centre plane of occupant" (C/LO) means the median plane of the 3-D H machine positioned in each designated seating position; it is represented by the co-ordinate of the "H" point on the "Y" axis. For individual seats, the centre plane of the seat coincides with the centre plane of the occupant. For other seats, the centre plane of the occupant is specified by the manufacturer;
- 2.9. "Three-dimensional reference system" means a system as described in Appendix 2 to this annex;
- 2.10. "Fiducial marks" are physical points (holes, surfaces, marks or indentations) on the vehicle body as defined by the manufacturer;
- 2.11. "Vehicle measuring attitude" means the position of the vehicle as defined by the co-ordinates of fiducial marks in the three-dimensional reference system.
3. Requirements
- 3.1. Data presentation
- For each seating position where reference data are required in order to demonstrate compliance with the provisions of the corresponding UN Regulation, all or an appropriate selection of the following data shall be presented in the form indicated in Appendix 3 to this annex:
- 3.1.1. The co-ordinates of the "R" point relative to the three-dimensional reference system;
- 3.1.2. The design torso angle;
- 3.1.3. All indications necessary to adjust the seat (if it is adjustable) to the measuring position set out in paragraph 4.3. below.
- 3.2. Relationship between measured data and design specifications
- 3.2.1. The coordinates of the "H" point and the value of the actual torso angle obtained by the procedure set out in paragraph 4. below shall be compared, respectively, with the coordinates of the "R" point and the value of the design torso angle indicated by the vehicle manufacturer.
- 3.2.2. The relative positions of the "R" point and the "H" point and the relationship between the design torso angle and the actual torso angle shall be considered satisfactory for the seating position in question if the "H" point, as defined by its coordinates, lies within a square of 50 mm side length with horizontal and vertical sides whose diagonals intersect at the "R" point, and if the actual torso angle is within 5° of the design torso angle.
- 3.2.3. If these conditions are met, the "R" point and the design torso angle shall be used to demonstrate compliance with the provisions of the corresponding UN Regulation;

- 3.2.4. If the "H" point or the actual torso angle does not satisfy the requirements of paragraph 3.2.2. above, the "H" point and the actual torso angle shall be determined twice more (three times in all). If the results of two of these three operations satisfy the requirements, the conditions of paragraph 3.2.3. above shall apply;
- 3.2.5. If the results of at least two of the three operations described in paragraph 3.2.4. above do not satisfy the requirements of paragraph 3.2.2. above, or if the verification cannot take place because the vehicle manufacturer has failed to supply information regarding the position of the "R" point or regarding the design torso angle, the centroid of the three measured points or the average of the three measured angles shall be used and be regarded as applicable in all cases where the "R" point or the design torso angle is referred to in the corresponding UN Regulation.
4. Procedure for "H" point and actual torso angle determination
- 4.1. The vehicle shall be preconditioned, at the manufacturer's discretion, at a temperature of $20\text{ }^{\circ}\text{C} + 10\text{ }^{\circ}\text{C}$ to ensure that the seat material reaches room temperature. If the seat to be checked has never been sat upon, a 70 to 80 kg person or device shall sit on the seat twice for one minute to flex the cushion and back. At the manufacturer's request, all seat assemblies shall remain unloaded for a minimum period of 30 minutes prior to installation of the 3-D H machine.
- 4.2. The vehicle shall be in the measuring attitude defined in paragraph 2.11. above.
- 4.3. The seat, if it is adjustable, shall be adjusted first to the rearmost normal driving or riding position, as indicated by the vehicle manufacturer, taking into consideration only the longitudinal adjustment of the seat, excluding seat travel used for purposes other than normal driving or riding positions. Where other modes of seat adjustment exist (vertical, angular, seat-back, etc.), these will then be adjusted to the position specified by the vehicle manufacturer. For suspension seats, the vertical position shall be rigidly fixed corresponding to a normal driving position as specified by the manufacturer.
- 4.4. The area of the seating position taken up by the 3-D H machine shall be covered by a muslin cotton, of sufficient size and appropriate texture, described as a plain cotton fabric having 18.9 threads per cm^2 and weighing 0.228 kg/m^2 , or knitted or non-woven fabric having equivalent characteristics.
- If the test is performed on a seat outside the vehicle, the floor on which the seat is placed shall have the same essential characteristics² as the floor of the vehicle in which the seat is intended to be used.
- 4.5. Place the seat and back assembly of the 3-D H machine so that the centre plane of the occupant (CPO) coincides with the centre plane of the 3-D H machine. At the manufacturer's request, the 3-D H machine may be moved inboard with respect to the CPO if the 3-D H machine is located so far outboard that the seat edge will not permit levelling of the 3-D H machine.
- 4.6. **Adjust the lower leg and thigh segments to the setting corresponding to 50 percentile, which corresponds to 417 mm for the lower leg segment and 432 mm for the thigh. On request of the manufacturer, the lower leg and**

² Tilt angle, height difference with a seat mounting, surface texture, etc.

thigh setting at which the H-point is measured may deviate from this. This shall be clearly indicated in the H-point drawing(s).

- 4.67. Attach the foot and lower leg assemblies to the seat-pan assembly, either individually or by using the T-bar and lower leg assembly. The line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centre plane of the seat.
- 4.78. Adjust the feet and leg positions of the 3-D H machine as follows:
- 4.78.1. Designated seating position: driver and outside front passenger
- 4.78.1.1. Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located at approximately the same distance to the left of the centre plane of the 3-D H machine as the right foot is to the right. The spirit level verifying the transverse orientation of the 3-D H machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear. The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centre plane of the seat.
- 4.78.1.2. If the left leg cannot be kept parallel to the right leg and the left foot cannot be supported by the structure, move the left foot until it is supported. The alignment of the sight buttons shall be maintained.
- 4.78.2. Designated seating position: outboard rear seat
- For rear seats or auxiliary seats, the legs are located as specified by the manufacturer. If the feet then rest on parts of the floor which are at different levels, the foot which first comes into contact with the front seat shall serve as a reference and the other foot shall be so arranged that the spirit level giving the transverse orientation of the seat of the device indicates the horizontal.
- 4.78.3. Other designated seating positions:
- The general procedure indicated in paragraph 4.7.1. above shall be followed, except that the feet shall be placed as specified by the vehicle manufacturer.
- 4.89. Apply lower leg and thigh weights and level the 3-D H machine.
- 4.910. Tilt the back pan forward against the forward stop and draw the 3-D H machine away from the seat-back using the T-bar. Reposition the 3-D H machine on the seat by one of the following methods:
- 4.910.1. If the 3-D H machine tends to slide rearward, use the following procedure. Allow the 3-D H machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required, i.e. until the seat pan contacts the seat-back. If necessary, reposition the lower leg.
- 4.910.2. If the 3-D H machine does not tend to slide rearward, use the following procedure. Slide the 3-D H machine rearward by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back (see Figure 2 of the Appendix 1 to this annex).
- 4.1011. Apply a 100 ± 10 N load to the back and pan assembly of the 3-D H machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing through the above intersection to a point just above the thigh bar housing (see

Figure 2 of Appendix 1 to this annex). Then carefully return the back pan to the seat-back. Care shall be exercised throughout the remainder of the procedure to prevent the 3-D H machine from sliding forward.

- 4.142. Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the 3-D H machine level.
- 4.123. Tilt the back pan forward to release the tension on the seat-back. Rock the 3-D H machine from side to side through a 10° arc (5° to each side of the vertical centre plane) for three complete cycles to release any accumulated friction between the 3-D H machine and the seat.

During the rocking action, the T-bar of the 3-D H machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar shall therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the 3-D H machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction.

The feet of the 3-D H machine are not to be restrained or held during this step. If the feet change position, they should then be allowed to remain in that attitude for the moment.

Carefully return the back pan to the seat-back and check the two spirit levels for zero position. If any movement of the feet has occurred during the rocking operation of the 3-D H machine, they shall be repositioned as follows:

Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; no forward or lateral loads are to be applied. When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the back pan sufficient to level the 3-D H machine's seat pan on the seat.

- 4.134. Holding the T-bar to prevent the 3-D H machine from sliding forward on the seat cushion, proceed as follows:
- (a) Return the back pan to the seat-back,
 - (b) Alternately apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care should be taken to ensure that no exterior downward or lateral loads are applied to the 3-D H machine. If another level adjustment of the 3-D H machine is necessary, rotate the back pan forward, re-level, and repeat the procedure from paragraph 4.12.
- 4.145. Take all measurements:
- 4.145.1. The coordinates of the "H" point are measured with respect to the three-dimensional reference system.
 - 4.145.2. The actual torso angle is read at the back angle quadrant of the 3-D H machine with the probe in its fully rearward position.

- 4.156. If a rerun of the installation of the 3-D H machine is desired, the seat assembly shall remain unloaded for a minimum period of 30 minutes prior to the re-run. The 3-D H machine shall not be left loaded on the seat assembly longer than the time required to perform the test.
- 4.167. If the seats in the same row can be regarded as similar (bench seat, identical seats, etc.) only one "H" point and one actual torso angle shall be determined for each row of seats, the 3-D H machine described in the Appendix 1 to this annex being seated in a place regarded as representative for the row.
- This place shall be:
- 4.167.1. In the case of the front row, the driver's seat.
- 4.167.2. In the case of the rear row or rows, an outer seat.

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Annex 1 - Appendix 1

Description of the three-dimensional "H" point machine (3-D H machine)¹

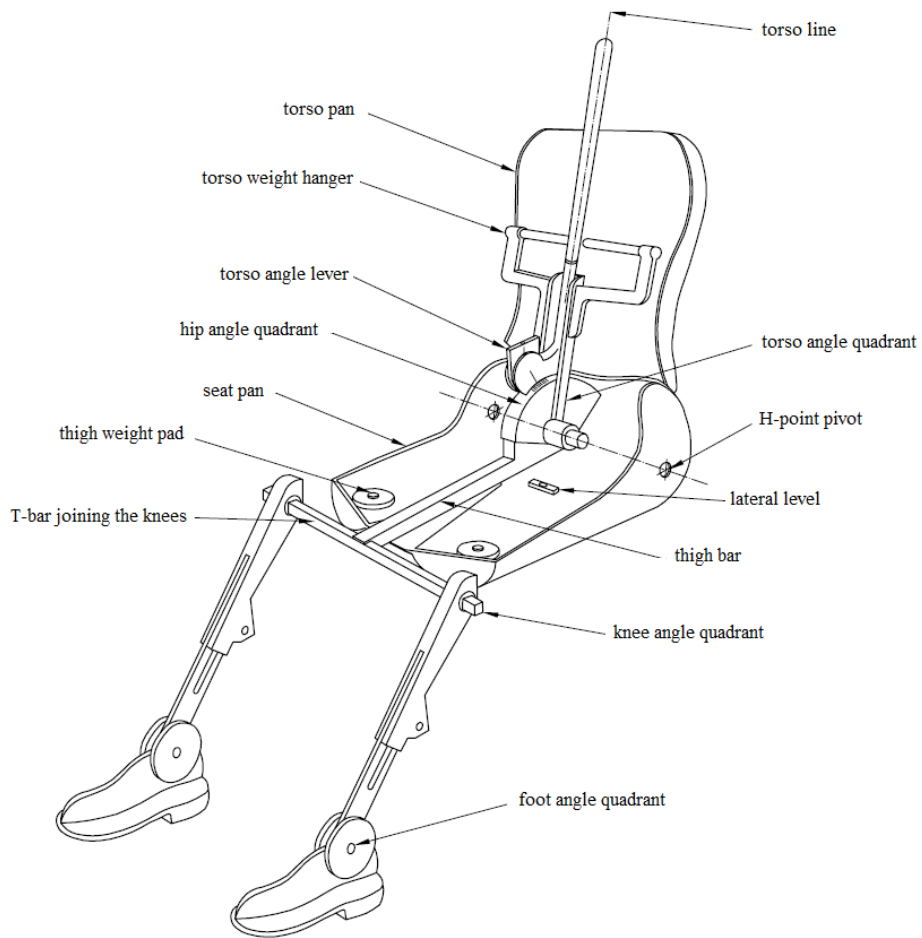
1. Back and seat pans

The back and seat pans are constructed of reinforced plastic and metal; they simulate the human torso and thigh and are mechanically hinged at the "H" point. A quadrant is fastened to the probe hinged at the "H" point to measure the actual torso angle. An adjustable thigh bar, attached to the seat pan, establishes the thigh centre line and serves as a baseline for the hip angle quadrant.
2. Body and leg elements

Lower leg segments are connected to the seat pan assembly at the T-bar joining the knees, which is a lateral extension of the adjustable thigh bar. Quadrants are incorporated in the lower leg segments to measure knee angles. Shoe and foot assemblies are calibrated to measure the foot angle. Two spirit levels orient the device in space. Body element weights are placed at the corresponding-centres of gravity to provide seat penetration equivalent to a 76 kg male. All joints of the 3-D H machine should be checked for free movement without encountering any noticeable friction.

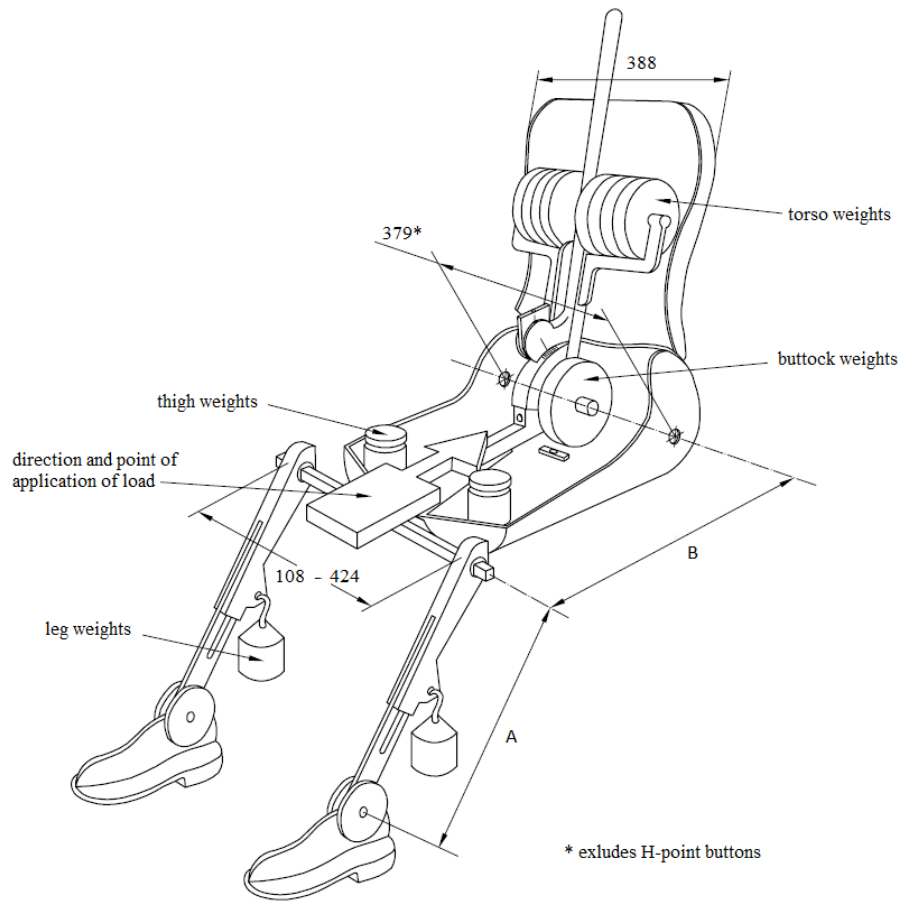
¹ The machine **shall** correspond to that described in **SAE J826-Nov. 2008** from the Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, United States of America.

Figure 1
3-D H Machine elements designation



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Figure 2
Dimensions of the 3-D H- machine elements and load distribution

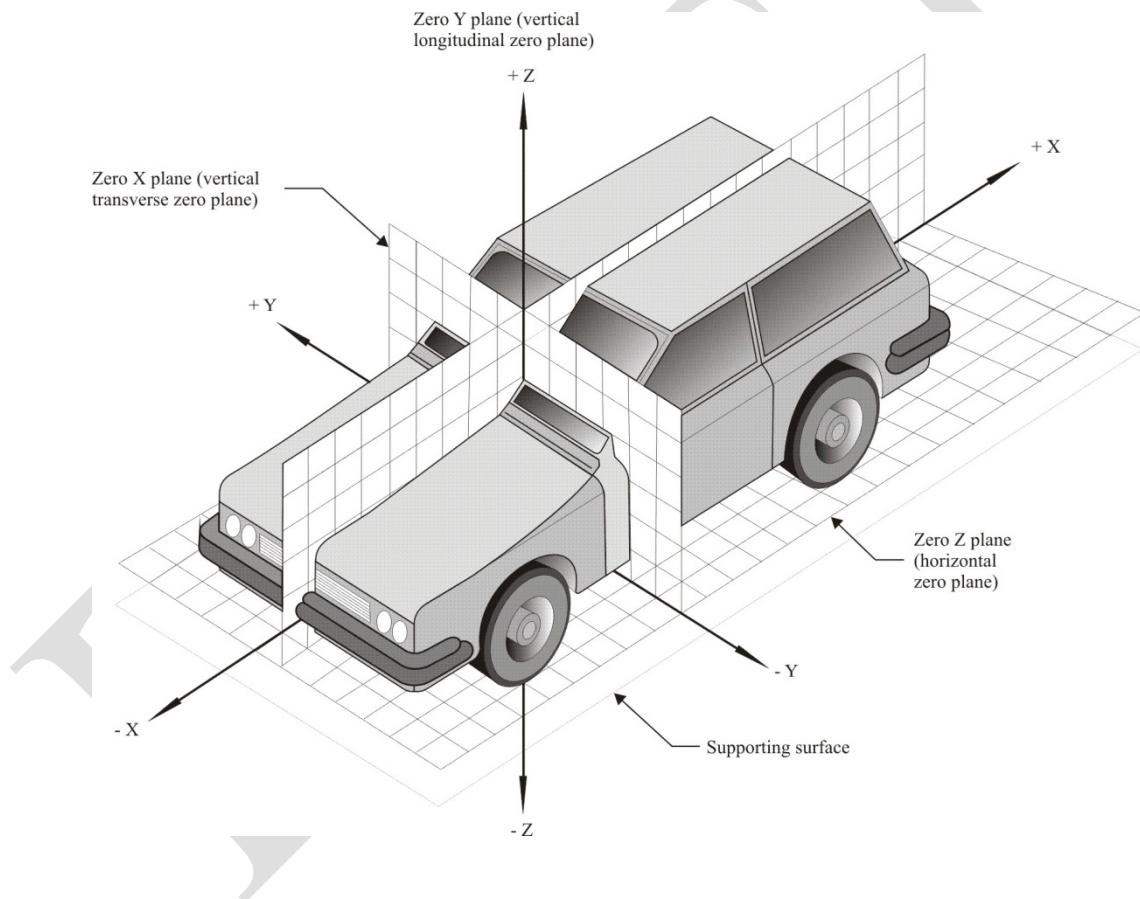


	10th Percentile (mm)	50th Percentile (mm)	95th Percentile (mm)
Lower leg segment (A)	392.7	417.1	458.7
Thigh segment (B)	407.7	431.5	455.7

Annex 1 - Appendix 2

Three-dimensional reference system

1. The three-dimensional reference system is defined by three orthogonal planes established by the vehicle manufacturer (see Figure).¹
2. The vehicle measuring attitude is determined by positioning the vehicle on a supporting surface such that the co-ordinates of the fiducial marks correspond to the values indicated by the manufacturer.
3. The coordinates of the "R" point and the "H" point are established in relation to the fiducial marks defined by the vehicle manufacturer.



¹ The reference system corresponds to ISO Standard 4130:1978

Annex 1 - Appendix 3

Reference data concerning seating positions

1. Coding of reference data

Reference data are listed consecutively for each seating position. Seating positions are identified by a two-digit code. The first character is an Arabic numeral and designates the row of seats, counting from the front to the rear of the vehicle. The second digit is a capital letter which designates the location of the seating position in a row, as viewed in the direction of forward motion of the vehicle; the following letters shall be used:

L = left,

C = centre,

R = right.

2. Description of vehicle measuring attitude

2.1. Coordinates of fiducial marks

X

Y

Z

3. List of reference data

3.1. Seating position:

3.1.1. Coordinates of the "R" point:

X

Y

Z

3.1.2. Design torso angle:

3.1.3. Specifications for seat adjustment:⁵

Horizontal:

Vertical:

Angular:

Torso angle:

4. **Setting of the lower legs and thighs 3D H-point machine:**

Lower leg:

Thigh:

Note: List reference data for further seating positions under paragraphs 3.2., 3.3., etc.

⁵ Strike out what does not apply.

Annex 1 - Appendix 4

H-point machine dimensions and tolerances

H-Point Machine		Date	
Item	Description	Specification	Measurement
Back Pan and Cushion Pan			
1	H-point joint torque	3.4 ± 0.45 Nm	
2a	H1L divot rearward to vertical angle block surface	134.9 ± 2 mm	
2b	H1R divot rearward to vertical angle block surface	134.9 ± 2 mm	
2c	Mean H-point (center) rearward to vertical angle block surface	134.9 ± 2 mm	
3a	H1L divot height from level surface	97.6 ± 2 mm	
3b	H1R divot height from level surface Shim under cushion pan until 3a=3b	97.6 ± 2 mm	
3c	H1 divot height from level surface (mean of 3a and 3b)	97.6 ± 2 mm	
3d	Cushion pan bubble level	bubble reads level	
4a (b)	Left (Right) knee pivot to H1L (H1R), x – horizontal distance for 95% leg length	455.7 ± 2 mm	Left Right
4c (d)	Left (Right) knee pivot height from level surface, z – 95% leg	97.6 ± 2 mm	
4e (f)	Left (Right) knee pivot to H1L (H1R), x - 50% leg	431.5 ± 2 mm	
4g (h)	Left (Right) knee pivot to H1L (H1R), x - 10% leg	407.7 ± 2 mm	
4i	Knee pivot x-distance from H-point (mean of 4a and 4b)	455.7 ± 2 mm	
4j	Knee pivot height from level surface (mean of 4c and 4d)	97.6 ± 2 mm	
4k	Difference in height between mean H1 and knee pivot (4j-3c)	0 ± 1 mm	
4m	x-axis side view angle [$\arctan(4k/4i)$]	$0 \pm 0.2^\circ$	
5a	Back pan to cushion pan offset (value is positive if back pan is forward of cushion pan); measure to middle bolts of lower back at C/L	$0 +4/-0$ mm	Initial Final
5b	Flat surface on lower mid-back; measure offset difference between upper and lower bolts at lower back C/L	< 1.1 mm $(90 \pm 0.5^\circ)$	
<i>Note: After adjusting cushion pan bubble level or back pan offset/verticality, re-establish the measurement coordinate system. Retake measurements 2-5.</i>			
6a	Thigh angle land (inclinometer on T-bar housing)	$0 \pm 0.1^\circ$	
6b	Thigh angle (from CMM points on land)	$0 \pm 0.2^\circ$	
7a	Torso angle land (inclinometer on head room probe scale)	$90 \pm 0.1^\circ$	
7b	Torso angle (from CMM points on land)	$90 \pm 0.2^\circ$	

7c	Hip angle (from CMM points on torso and thigh angle lands) Hip angle = torso angle – thigh angle	$90 \pm 0.25^\circ$			
7d	Hip angle scale reading	$90 \pm 1^\circ$			
7e	Torso angle bubble level on hip quadrant	bubble reads level			
7f	Torso (back) angle scale reading (forward is a negative angle)	$0 \pm 1^\circ$			
7g	Torso angle (inclinometer on land--left side torso weight yoke)	$90 \pm 0.5^\circ$			
7h	Torso angle (from CMM points on land--left torso weight yoke)	$90 \pm 0.5^\circ$			
8a ¹	Mean H-pt to left inboard center of torso weight bar, Z Note: Measurements 8a-d are made at 25 mm from inboard end of torso weight bar. Use CMM circle method to find center.	356.4 ± 1 mm			
8b ¹	Mean H-pt to left inboard center of torso weight bar, X	0 ± 1 mm			
8c ¹	Mean H-pt to right inboard center of torso weight bar, Z	356.4 ± 1 mm			
8d ¹	Mean H-pt to right inboard center of torso weight bar, X	0 ± 1 mm			
9	Lateral bubble level inclinometer reading	$0 \pm 1^\circ$			
10a ²	Cushion pan width at H-point (3.8 mm button depth not included)	379 ± 2 mm			
10b ²	Back pan width, maximum	388 ± 2 mm			
Head Room					
11a	Head room probe height at 39 inch setting above surface plate at H-point (subtract 97.6 if measured from H-point)	986.2 ± 2 mm (888.6 mm from H-point)			
11b	Tip of head room probe fore aft of H-point	± 5 mm			
11c	Tip of head room probe each side of H-point	± 5 mm			
Lower Legs					
12a (c)	Left (Right) knee angle scale – inboard (I) and outboard (O) sides (back of leg set at 90 degrees and T-bar horizontal)	$90 \pm 1^\circ$	I		
			O		
12b (d)	Ankle (foot) angle scale	$96.5 \pm 1^\circ$	I		
			O		
13a (e)	Left (Right) ankle pivot to level surface	107.2 ± 2 mm			
13b (f)	Left (Right) knee pivot to ankle pivot (95%)	458.7 ± 2 mm			
13c (g)	Left (Right) knee pivot to ankle pivot (50%)	417.1 ± 2 mm			
13d (h)	Left (Right) knee pivot to ankle pivot (10%)	392.7 ± 2 mm			
14a	Left (Right) ankle pivot rotates freely	Yes If No, repair.			
14b	Left (Right) knee pivot rotates freely	Yes If No, repair.			

Machine Weights			
15a	Cushion and Back Pans (includes inclinometer but no weights)	19.7 ± 1.2 kg	
15b	Lower leg and shoe * 2	8.8 ± 0.2 kg	
15c	Torso and buttock weight * 10, Thigh weight * 2, Leg weight * 2	48.5 ± 0.3 kg	
15d	Total weight	77.0 ± 1.5 kg	

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Timeline

Update of R.E.3.:

- GRSG-126 (October 2023)

Update of UN Regulations:

- Informal documents at GRSG-126 (October 2023) and GRSP-74 (December 2023)
- Working documents at GRSG-127 (March 2024) and GRSP-75 (May 2024)

Update of GTRs

- Guidance needed from GRSP

Thank you for your attention !