B.   TEXT OF THE REGULATION

1.   PURPOSE

The purpose of this regulation is to reduce the risk of serious and fatal injury of vehicle occupants in side impact crashes by limiting the forces, accelerations and deflections measured by anthropomorphic test devices in pole side impact crash tests. This may complement other side impact tests.

A Contracting Party may continue to apply any pre-existing domestic pole side impact requirements[1] using a 5th percentile adult female side impact dummy

2.   APPLICATION / SCOPE

This regulation shall apply to all Category 1-1 vehicles; Category 1-2 vehicles with a Gross Vehicle Mass of up to 4,500 kg; and Category 2 vehicles with a Gross Vehicle Mass of up to 4,500 kg[2].

3.   DEFINITIONS

3.1   "Door Latch System" consists, at a minimum, of a latch and a striker.

3.2   ["Fuel Ballast Leakage" means the fall, flow, or run of fuel ballast from the vehicle but does not include wetness resulting from capillary action].

3.3   "Fully Latched Position" is the coupling condition of the latch that retains the door in a completely closed position.

3.2

3.33.4   "Hinge" is a device used to position the door relative to the body structure and control the path of the door swing for passenger ingress and egress.

3.4   "H point" means the pivot centre of the torso and thigh of the H point machine when installed in a vehicle seat in accordance with Annex 2. Once determined in accordance with the procedure described in Annex 2, the "H" point is considered

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[1] Pre-existing pole side impact requirements are regulations or standards implemented in domestic legislation at the time this Global Technical Regulation is established in the Global Registry.

[2] A Contracting Party may restrict application of the requirements in its domestic legislation if it decides that such restriction is appropriate. [See paragraph X, part A for examples of specific vehicles considered as part of the development of this GTR.]

fixed in relation to the seat cushion structure and is considered to move with it when the seat is adjusted.

3.5   "Impact Reference Line" is the line formed on the impact side of the test vehicle by the intersection of the exterior surface of the vehicle and a vertical plane passing through the centre of gravity of the head of the dummy positioned in accordance with [Annex 2], in the front row outboard designated seating position on the impact side of the vehicle. The vertical plane forms an angle of 75° with the vehicle longitudinal centreline. The angle is measured as indicated in Annex 4, Figure 4-1 (or Figure 4-2) for left (or right) side impact.

3.6   [" Laden Attitude"] means the pitch and roll angle of the test vehicle with all tyres fitted and inflated as recommended by the vehicle manufacturer and loaded to the laden mass. The mass placed in the cargo/luggage carrying area is centred over the longitudinal centreline of the vehicle. The mass of the necessary anthropomorphic test device is placed on the front outboard designated seating position on the impact side of the vehicle. The front row seats are positioned in accordance with [Annex 2].

3.7   [" Laden Mass"] means unladen vehicle mass, plus 136 kg or the rated cargo and luggage mass (whichever is less), plus the mass of the necessary anthropomorphic test device.

3.83.5   "Latch" is a device employed to maintain the door in a closed position relative to the vehicle body with provisions for deliberate release (or operation).

3.9   "Latched" means any coupling condition of the door latch system, where the latch is in a fully latched position, a secondary latched position, or between a fully latched position and a secondary latched position.

3.103.6

3.11   "Pitch Angle" is the angle of a fixed linear reference connecting two reference points on the front left or right door sill (as applicable), relative to a level surface or horizontal reference plane. An example of a suitable fixed linear reference for left side door sill pitch angle measurement is illustrated in Figure 6-1 of Annex 6.

3.12   "Pole" means a fixed rigid vertically oriented metal structure with a continuous outer cross section diameter of 254 mm ± 6 mm, beginning no more than 102 mm above the lowest point of the tyres on the impact side of the vehicle in [the laden attitude], and extending at least above the highest point of the roof of the test vehicle.

3.13   "Rated Cargo and Luggage Mass" (RCLM) means the cargo and luggage carrying capacity of the vehicle, which is the mass obtained by subtracting the unladen vehicle mass and the rated occupant mass from the gross vehicle mass.

3.14   "Rated Occupant Mass" is the mass obtained by multiplying the total number of designated seating positions in the vehicle by 68 kg.

3.15   "Roll Angle" is the angle of a fixed linear reference connecting two reference points either side of the vehicle longitudinal centre plane on the front or rear (as applicable) of the vehicle body, relative to a level surface or horizontal reference plane. An example of a suitable fixed linear reference for rear roll angle measurement is illustrated in Figure 6-2 of Annex 6.

3.16   "Secondary Latched Position" refers to the coupling condition of the latch that retains the door in a partially closed position.

3.7

3.17

3.18 "Striker" is a device with which the latch engages to maintain the door in the fully latched or secondary latched position.

3.19

3.20 "Test Attitude" means the pitch and roll angle of the test vehicle to be impacted with the pole.

3.21 "Three dimensional H-point machine" (SAE H-point machine) means the device used for the determination of "H-points" and actual torso angles. This device is defined in Annex 3.

3.22 "Unladen Attitude" means the pitch and roll angle of the unladen vehicle with all tyres fitted and inflated as recommended by the vehicle manufacturer.

3.23 ["Unladen Mass" is defined in Special Resolution 1].

3.24 "Useable Fuel Tank Capacity" means the fuel tank capacity specified by the vehicle manufacturer.

3.25 "Vehicle Master Control Switch" means the device by which the vehicle's on board electronics system is brought from being switched off, as is the case when the vehicle is parked without the driver present, to the normal operating mode.

3.26 "Vehicle Reference Coordinate System" means an orthogonal coordinate system consisting of three axes, a longitudinal axis (X), a transverse axis (Y), and a vertical axis (Z). X and Y are in the same horizontal plane and Z passes through the intersection of X and Y. The X axis is parallel to the longitudinal centre plane of the vehicle. [The vehicle reference co-ordinate system is established relative to defined vehicle reference points.]

3.27 "Vehicle Reference Fuel" means the fuel recommended by the vehicle manufacturer for the normal operation of the vehicle.

3.28 ["Vertical Longitudinal Plane" means a vertical plane parallel to the vehicle longitudinal centreline.]

3.29 ["Vertical Plane" means a vertical plane, not necessarily parallel to the vehicle longitudinal centreline.]

3.4.   REQUIREMENTS

4.1   A vehicle tested in accordance with Annex 1, using a WorldSID 50th percentile adult male dummy[3], must meet the requirements of paragraphs 4.2, 4.4, and 4.5.

4.2   [WorldSID 50th Percentile Adult Male Performance Requirements

4.2.1   The injury criteria response values measured by a WorldSID 50th percentile adult male dummy in the front row outboard seating position on the impact side of a vehicle tested in accordance with Annex 1, must meet the requirements of paragraphs 4.2.2 to 4.2.6.

4.2.2   Head Injury Criteria

4.2.2.1   The HIC36 must not exceed 1000 when calculated in accordance with paragraph -1 of Annex 7.

4.2.3   [Shoulder Performance Criteria]

4.2.4   Thorax Performance Criteria

4.2.4.1   The maximum thorax rib deflection must not exceed [55] mm when calculated in accordance with paragraph 4.1 of Annex 7.

4.2.4.2   [The peak thorax viscous criterion must not exceed [0.82] m/s when calculated in accordance with paragraph 4.2 of Annex 7.]

4.2.5   Abdomen Abdominal Performance Criteria

4.2.5.1   The maximum abdomen abdominal rib deflection must not exceed [58] mm when calculated in accordance with paragraph 5.1 of Annex 7.

4.2.5.2   [The peak abdomen abdominal viscous criterion must not exceed [0.82] m/s when calculated in accordance with paragraph 5.2 of Annex 7].

4.2.5.3   The lower spine acceleration must not exceed 75g (1g = the acceleration due to gravity = 9.81 m/s^2), except for intervals whose cumulative duration is not more than 3ms, when calculated in accordance with paragraph 5.3 of Annex 7.

4.2.6   Pelvis Performance Criteria

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[3] The technical specifications, detailed drawings and adjustment requirements of the WorldSID 50th percentile adult male dummy are specified in [Special Resolution 2], Annex Addendum [X].

5

Comment [tb222]: Text foreshadowing the likely future (i.e. phase 2) inclusion of a BRIC requirement to be included in preamble of GTR. NHTSA will provide some words.

Comment [tb223]: Left open to next meeting – but to be removed if there is no substantive (meaningful and measurable) proposal for criteria. Small working group to consider possible criterion, otherwise can cover with forward looking statements in preamble if removed. Concerns inclusion of a shoulder stop could delay GTR timeline. Not worth delaying head injury reduction benefits due to a shoulder stop design delay.

Comment [tb224]: New 50% AIS 3+ thorax injury risk value based on updated ISO WG6 recommendation (see WS-09-07 Presentation)

Comment [tb225]: ISO group did not consider VC to be most reliable injury risk predictor. Some support for VC to be retained, perhaps with a higher limit value. Available surrogate animal model research data has been provided to ISO WG6. This research data may be able to be used to improve robustness of the VC injury risk curves. To be considered at next meeting.

Comment [tb226]: Lower spine acceleration included as a pass/fail criterion. Can detect loads transferred in a direction not measured by a 1-dimensional deflection criterion (e.g. late thorax airbag deployment to back of thorax). Explanation of reasons for inclusion to be drafted for preamble.

Comment [tb227]: Text foreshadowing the possible future (i.e. phase 2) inclusion of a sacroiliac load limit to be included in preamble of GTR. NHTSA will provide some words.

4.2.6.1   The pubic symphysis force must not exceed 3.36 kN when calculated in accordance with paragraph 6.1 of Annex 7.

4.3   [Reserved].

4.4   <u>Door Opening Requirements</u>

4.4.1   Any side door that is struck by the pole shall not separate totally from the vehicle.

4.4.2   Any door (including a rear hatchback or tailgate) that is not struck by the pole shall meet the following requirements:

4.4.2.1   The door shall remain latched;

4.4.2.2   The latch shall not separate from the striker;

4.4.2.3   The hinge components shall not separate from each other or from their attachment to the vehicle; and

4.4.2.4   Neither the latch nor the hinge systems of the door shall pull out of their anchorages.

4.5   <u>Fuel System Integrity Requirements</u>

4.5.1   In the case of a vehicle propelled by fuel with a boiling point above 0 °C, ~~liquid~~ [fuel ballast] leakage from the fuel system[4] shall not exceed:

4.5.1.1   [~~a total of~~ ~~[860g~~ [142 g] [150 g] [170 g] during the ~~30~~ 5 minute period immediately following first vehicle contact with the pole~~.~~: and

~~4.5.1.1~~4.5.1.2   a total of [140 g] [28 g] during each subsequent [5 minute] [1 minute] period up until 30 minutes after first vehicle contact with the pole].

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[4] To ensure liquid leakage from the fuel system can be easily separated and identified, liquids from other vehicle systems may be replaced by the equivalent ballast mass (as per paragraph ~~3.3~~4.3 of Annex 1).

ANNEX 1

DYNAMIC POLE SIDE IMPACT TEST PROCEDURE

1.   PURPOSE

        Demonstration of compliance with the requirements of paragraph 44 of this regulation.

2.   DEFINITIONS

        For the purposes of this Annex:

2.1   ["Fuel Ballast" means water; or Stoddard Solvent; or any other homogeneous liquid with a specific gravity of [1.0] [+0/-0.25] and a dynamic viscosity of [0.9 ± 0.05] MPa·s at [25°C]].

2.2   ["Gross Vehicle Mass" is defined in Special Resolution 1].

2.3   "Impact Reference Line" is the line formed on the impact side of the test vehicle by the intersection of the exterior surface of the vehicle and a vertical plane passing through the centre of gravity of the head of the dummy positioned in accordance with [Annex 2], in the front row outboard designated seating position on the impact side of the vehicle. The vertical plane forms an angle of 75° with the vehicle longitudinal centreline. The angle is measured as indicated in Annex 4, Figure 4-1 (or Figure 4-2) for left (or right) side impact.

2.4   ["Impact Velocity Vector" means the geometric quantity which describes both the speed and direction of travel of the vehicle at the moment of impact with the pole. The impact velocity vector points in the direction of travel of the vehicle. The origin of the impact velocity vector is the centre of gravity of the vehicle and its magnitude (length) describes the impact speed of the vehicle].

2.5   [" Laden Attitude"] means the pitch and roll angle of the test vehicle with all tyres fitted and inflated as recommended by the vehicle manufacturer and loaded to the laden mass. The mass placed in the cargo/luggage carrying area is centred over the longitudinal centreline of the vehicle. The mass of the necessary anthropomorphic test device is placed on the front outboard designated seating position on the impact side of the vehicle. The front-row seats are positioned in accordance with [Annex 2].

2.6   [" Laden Mass"] means unladen vehicle mass, plus 136 kg or the rated cargo and luggage mass (whichever is less), plus the mass of the necessary anthropomorphic test device.

2.7 "Pitch Angle" is the angle of a fixed linear reference connecting two reference points on the front left or right door sill (as applicable), relative to a level surface or horizontal reference plane. An example of a suitable fixed linear reference for left side door sill pitch angle measurement is illustrated in Figure 6-1 of Annex 6.

2.8 "Pole" means a fixed rigid vertically oriented metal structure with a continuous outer cross section diameter of 254 mm ± 6 mm, beginning no more than 102 mm above the lowest point of the tyres on the impact side of the vehicle in [the laden attitude], and extending at least above the highest point of the roof of the test vehicle.

2.9 "Rated Cargo and Luggage Mass" means the cargo and luggage carrying capacity of the vehicle, which is the mass obtained by subtracting the unladen vehicle mass and the rated occupant mass from the gross vehicle mass.

2.10 "Rated Occupant Mass" is the mass obtained by multiplying the total number of designated seating positions in the vehicle by 68 kg.

2.11 "Roll Angle" is the angle of a fixed linear reference connecting two reference points either side of the vehicle longitudinal centre plane on the front or rear (as applicable) of the vehicle body, relative to level surface or horizontal reference plane. An example of a suitable fixed linear reference for rear roll angle measurement is illustrated in Figure 6-2 of Annex 6.

2.12 ["Specific Gravity" means the density of a reference liquid expressed as a ratio of the density of water (i.e. $\rho_{liquid}/\rho_{water}$) at [25°C] reference temperature and 101.325 kPa reference pressure].

2.13 ["Stoddard Solvent" means a homogeneous, transparent, petroleum distillate mixture of refined [C_7-C_{12}] hydrocarbons; with a flash point of at least [38°C], a specific gravity of [0.78 ± 0.03] and a dynamic viscosity of [0.9 ± 0.05] MPa·s at [25°C]].

2.14 "Test Attitude" means the pitch and roll angle of the test vehicle to be impacted with the pole.

2.15 "Unladen Attitude" means the pitch and roll angle of the unladen vehicle with all tyres fitted and inflated as recommended by the vehicle manufacturer.

2.16 ["Unladen Mass" is defined in Special Resolution 1].

2.17 "Useable Fuel Tank Capacity" means the fuel tank capacity specified by the vehicle manufacturer.

2.18 "Vehicle Master Control Switch" means the device by which the vehicle's on-board electronics system is brought from being switched off, as is the case when the vehicle is parked without the driver present, to the normal operating mode.

2.19 "Vehicle Reference Fuel" means the fuel recommended by the vehicle manufacturer for the normal operation of the vehicle.

2.3. TEST EQUIPMENT

3.1 Test Vehicle Preparation Area

3.1.1 An enclosed temperature controlled area suitable for ensuring stabilization of the test dummy temperature prior to testing.

3.2 Pole

3.2.1 A pole satisfying the definition of paragraph 2.83.11 of this regulationAnnex, and offset from any mounting surface, such as a barrier or other structure, so that the test vehicle will not contact such a mount or support at any time within 100 ms of the initiation of vehicle to pole contact.

3.3 Anthropomorphic Test Devices

3.3.1 A WorldSID 50th percentile adult male dummy in accordance with [Special Resolution 2], Annex Addendum [X] and fitted with (as a minimum) all instrumentation required to obtain the data channels necessary to determine the injury criteria response values listed in paragraph 4.2 of this regulation.

3.4. VEHICLE PREPARATION

4.1 The fuel tank shall be filled with [water] [Stoddard Solvent] [water or Stoddard Solvent][fuel ballast[1]] of mass:

4.1.1 greater than or equal to the mass of the vehicle reference fuel required to fill 90 percent of the useable fuel tank capacity; and

4.1.2 less than or equal to the mass of the vehicle reference fuel required to fill 100 percent of the useable fuel tank capacity.

4.2 Fuel ballast [Water] [Stoddard Solvent] [Water or Stoddard Solvent] shall be used to fill the entire fuel system from the fuel tank through to the engine induction system.

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[1] For safety reasons, flammable liquids with a flash point below 38°C are not recommended for use as fuel ballast.

4.3   The other (non-fuel) liquid containing vehicle systems may be empty, in which case, the mass of the liquids (e.g. brake fluid, coolant, transmission fluid) shall be replaced by the equivalent ballast mass.

4.4   [The vehicle test mass, including the mass of the necessary anthropomorphic test device and any necessary ballast mass, shall be within [+0/-2 percent] of the laden mass defined in paragraph 2.63.7 of this regulationAnnex].

4.5   The pitch angles measured on the left and right side of the vehicle in the test attitude shall be between the corresponding (left or right as applicable) unladen attitude pitch angle and laden attitude pitch angle, inclusive.

4.6   Each linear reference used to measure the unladen, laden and test attitude pitch angles on the left or right side of the vehicle in paragraph 4.54.53.5 above shall connect the same fixed reference points on the left or right (as applicable) side door sill.

4.7   The roll angles measured at the front and rear of the vehicle in the test attitude shall be between the corresponding (front or rear as applicable) unladen attitude roll angle and laden attitude roll angle, inclusive.

4.8   Each linear reference used to measure the unladen, laden and test attitude roll angles at the front or rear of the vehicle in paragraph 4.74.73.7 above shall connect the same fixed reference points on the front or rear (as applicable) vehicle body.

4.5.   VEHICLE PASSENGER COMPARTMENT ADJUSTMENTS

5.1   Adjustable Front Row Seats
5.1.1   Any seat adjustment, including any seat cushion, seatback, armrest, lumbar support, and head restraint shall be placed in the position of adjustment specified in Annex 2.

5.2   Adjustable Seat Belt Anchorages
5.2.1   Adjustable seat belt anchorages shall be placed in the position of adjustment specified in Annex 2.

5.3   Adjustable Steering Wheels
5.3.1   Adjustable steering wheels shall be placed in the position of adjustment specified in Annex 2.

5.4   Convertible Tops
5.4.1   Convertibles and open-body type vehicles shall have the top, if any, in place in the closed passenger compartment configuration.

5.5   Doors
5.5.1   Doors, including any rear hatchback or tailgate, shall be fully closed and fully latched, but not locked.

5.6   Parking Brake
5.6.1   The parking brake shall be engaged.

5.7   Electrical System
5.7.1   The vehicle master control switch shall be in the "on" position.

5.8   Pedals

5.8.1   Any adjustable pedals shall be placed as specified in Annex 2.

5.9   <u>Transmission</u>

5.9.1   <u>The transmission may be placed in neutral or in gear.</u>

5.9.1   For a vehicle equipped with a manual transmission, the transmission shall be placed in second gear].

5.9.2   For a vehicle equipped with an automatic transmission, the transmission shall be placed in neutral.

5.10   Windows, Vents and Sunroofs

5.10.1 Moveable vehicle windows and vents located on the impact side of the vehicle shall be placed in the fully closed position.

5.10.2 Any sunroof(s) shall be placed in the fully closed position.

5.6.   DUMMY PREPARATION AND POSITIONING

6.1   A WorldSID 50th percentile adult male dummy in accordance with paragraph 3.3.13.3.12.3.1 of this Annex shall be positioned in accordance with Annex 2, in the front outboard seat located on the impact side of the vehicle.

6.2   The test dummy shall be configured and instrumented to be struck on the side closest to the side of the vehicle impacting the pole.

6.3   The stabilised temperature of the test dummy at the time of the test shall be between 20.6 °C and 22.2 °C.

6.4   A stabilised dummy temperature shall be obtained by soaking the dummy at controlled test laboratory environment temperatures within the range specified in paragraph 6.36.35.3 above prior to the test.

6.5   The stabilised temperature of the test dummy shall be recorded by an internal dummy chest cavity temperature sensor.

6.7.   VEHICLE-TO-POLE SIDE IMPACT TEST

7.1   Except as provided in paragraph 7.27.26.2, a test vehicle prepared in accordance with paragraph 43, paragraph 54 and paragraph 65 of this Annex, shall be impacted at any velocity speed up to and including 32 km/h, with a stationary pole[2].

7.2   The maximum test velocity may be reduced to 26 km/h for vehicles with a width of 1.50 m or less. Contracting parties selecting this option shall notify the Secretary General in writing when submitting the notification required by section 7.2 of the Agreement Concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts Which Can Be Fitted.

7.3   The test vehicle shall be propelled so that, when the vehicle-to-pole contact occurs, the direction of vehicle motion forms an angle of 75° ± 3° with the vehicle longitudinal centreline.

7.4   The angle in paragraph 7.37.36.3 above shall be measured between the vehicle longitudinal centreline and a vertical plane parallel to the vehicle impact velocity vector, as indicated in Annex 5, Figure 5-1 (or Figure 5-2) for left (or right) side impact.

Comment [tb248]: Type approval issues associated with this wording will be handled in the preamble so that countries with type approval systems are not obliged to accept vehicles tested at 26 km/h.

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[2] [See paragraph X, part A for a recommendation of how this "any speed up to and including 32 km/h" requirement should be implemented in a UN Regulation (1958 Agreement) or the domestic legislation of a Contracting Party implementing this regulation in a type approval based regulatory system. Based on a determination by each Contracting Party or regional economic integration organisation, "any velocity up to and including 32 km/h" may be limited in domestic legislation to "31.5 ± 0.5 km/h".]

7.5   The impact reference line shall be aligned with the centreline of the rigid pole surface, as viewed in the direction of vehicle motion, so that, when the vehicle-to-pole contact occurs, the centreline of the pole surface contacts the vehicle area bounded by two vertical planes parallel to and [25 mm] forward and aft of the impact reference line.

7.6   During the acceleration phase of the test prior to first contact between the vehicle and the pole, the acceleration of the test vehicle shall not exceed [1.5 m/s^2].

ANNEX 2

WORLDSID 50TH PERCENTILE ADULT MALE SEATING PROCEDURE

[RESERVED]

1.   PURPOSE

[Repeatable and reproducible front row seat installation of the WorldSID 50th percentile adult male dummy in a vehicle seat position and automotive seating posture representative of a typical mid size adult male].

2   DEFINITIONS

For the purposes of this Annex:

2.1   "H-point" means the pivot centre of the torso and thigh of the H-point machine when installed in a vehicle seat in accordance with Annex 2. Once determined in accordance with the procedure described in Annex 2, the "H" point is considered fixed in relation to the seat-cushion structure and is considered to move with it when the seat is adjusted.

2.2   "Three-dimensional H-point machine" (SAE H-point machine) means the device used for the determination of "H-points" and actual torso angles. This device is defined in Annex 3.

2.3   "Vehicle Reference Coordinate System" means an orthogonal coordinate system consisting of three axes, a longitudinal axis (X), a transverse axis (Y), and a vertical axis (Z). X and Y are in the same horizontal plane and Z passes through the intersection of X and Y. The X-axis is parallel to the longitudinal centre plane of the vehicle. [The vehicle reference co-ordinate system is established relative to defined vehicle reference points.]

2.4   ["Vertical Longitudinal Plane" means a vertical plane parallel to the vehicle longitudinal centreline.]

2.5   ["Vertical Plane" means a vertical plane, not necessarily parallel to the vehicle longitudinal centreline.]

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ANNEX 3

DESCRIPTION OF THE THREE-DIMENSIONAL H-POINT MACHINE [1]/

(3-D H Machine)

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 centreline 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 noticeable friction.

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[1]/ For details of the construction of the 3-D H machine refer to SAE International (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, United States of America (SAE J826 1995 version). The machine corresponds to that described in ISO Standard 6549: 1999.
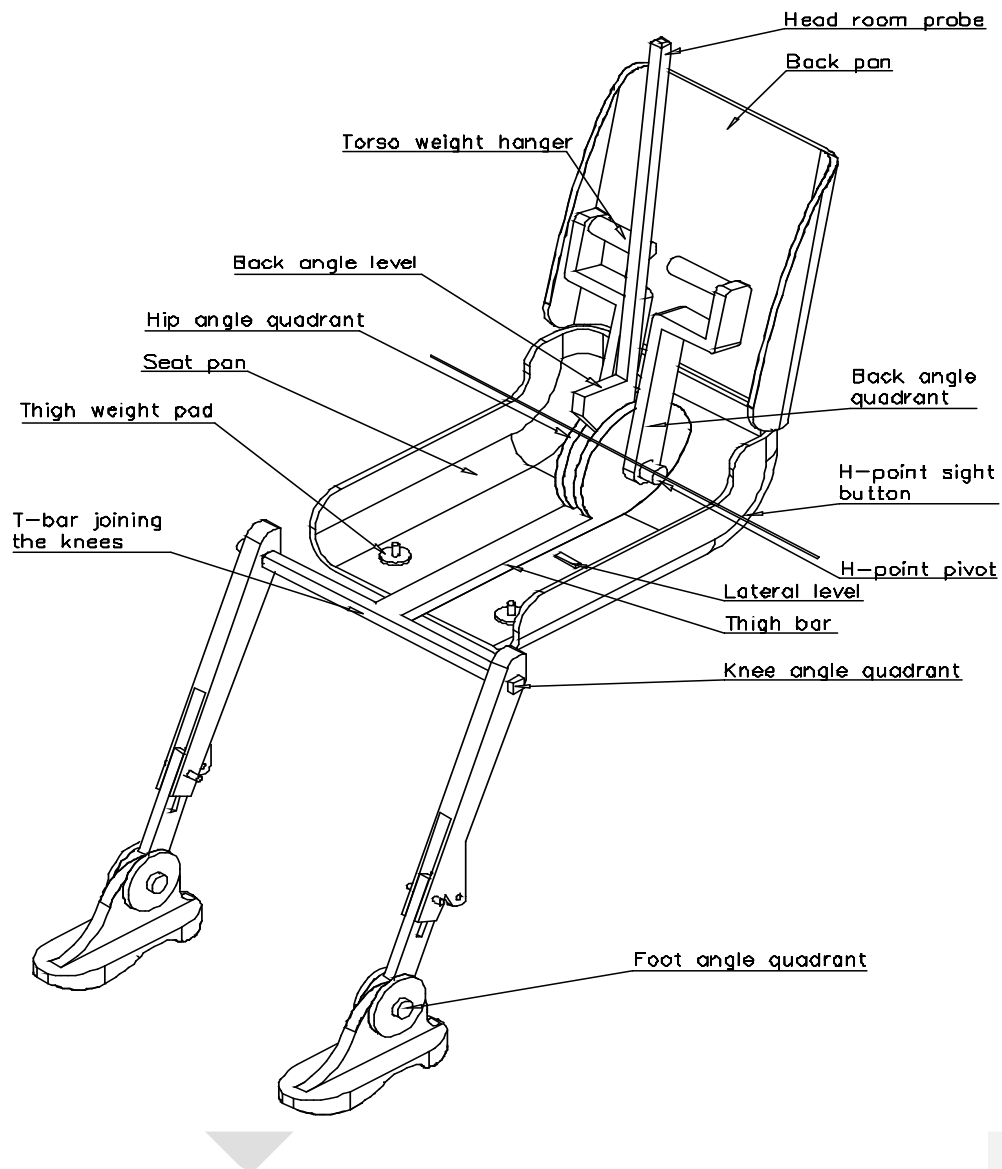
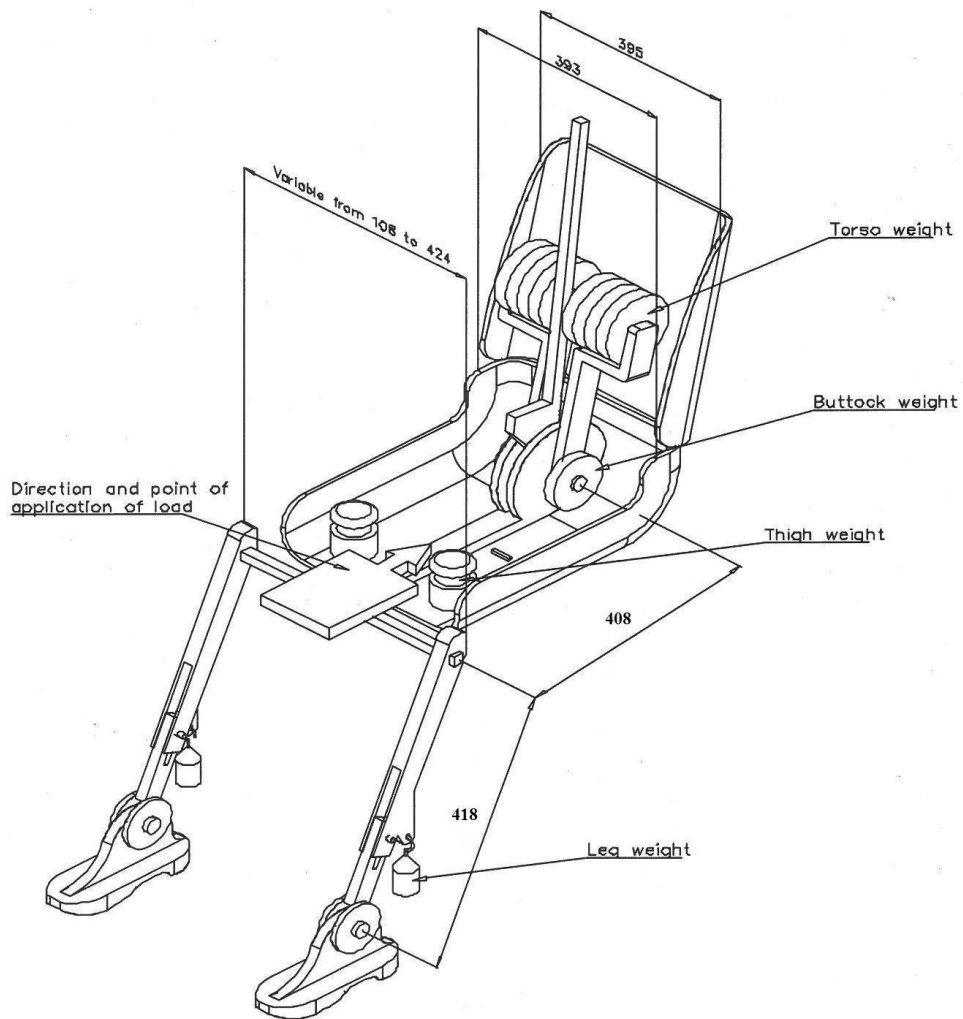Figure 3-1 – 3-D H machine elements designation

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

(Dimensions in millimetres)

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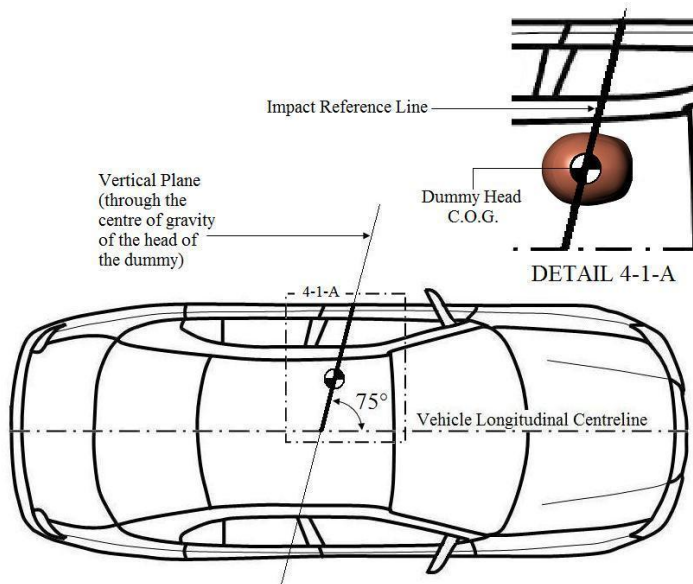
ANNEX 4

IMPACT REFERENCE LINE

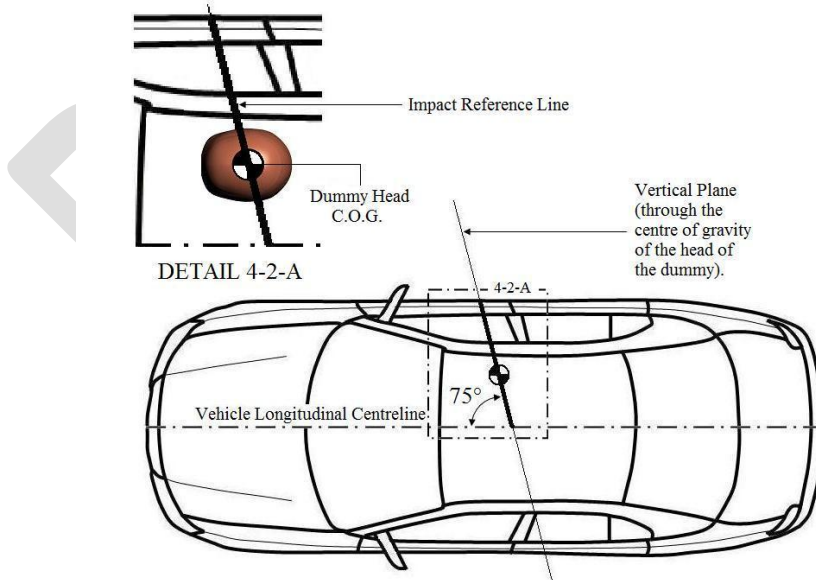Figure 4-1 – vehicle to be impacted on left side (overhead plan view)

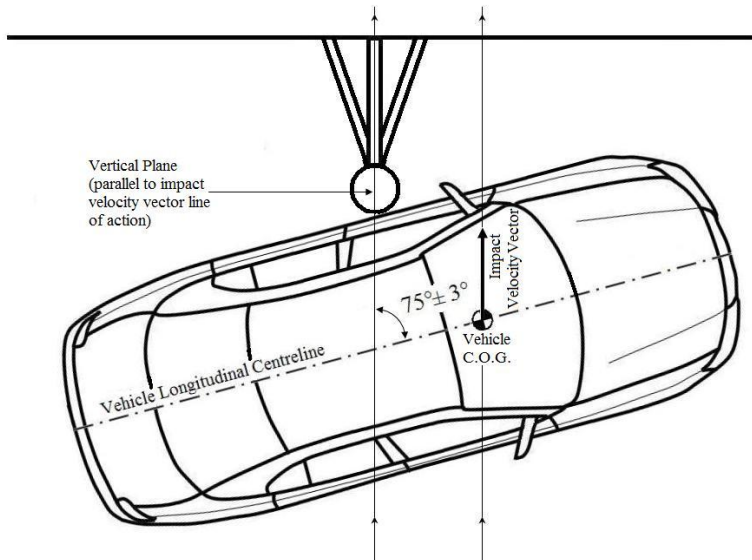Figure 4-2 – vehicle to be impacted on right side (overhead plan view)

ANNEX 5

IMPACT ANGLE
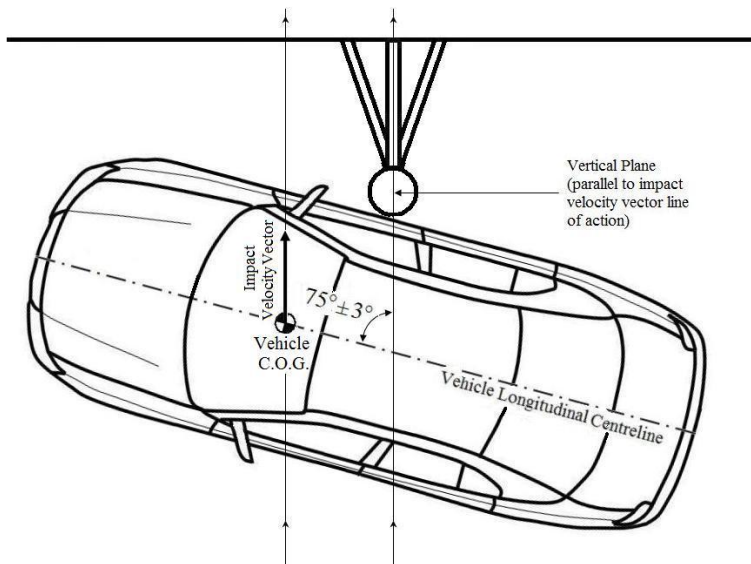

Figure 5-1 – left side impact (overhead plan view)

Figure 5-2 – right side impact (overhead plan view)

PITCH AND ROLL ANGLE REFERENCES

Example linear reference
connecting two reference points
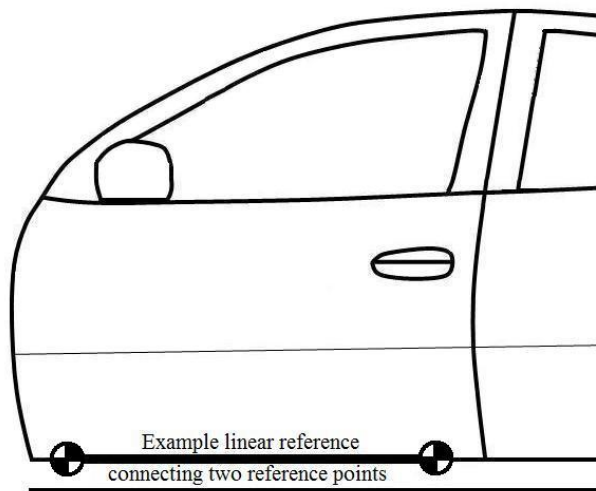
Figure 6-1 – example of a linear reference connecting two reference points on a left door sill

Example linear reference
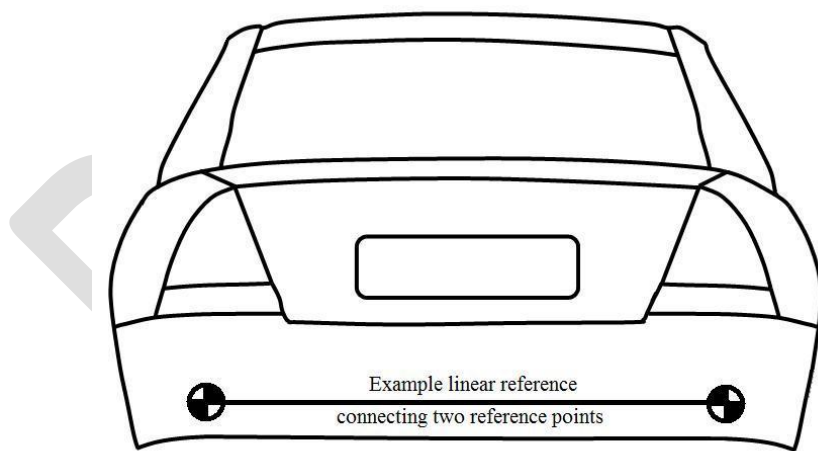connecting two reference points

Figure 6-2 – example of a linear reference connecting two reference points on a rear body

ANNEX 7

DETERMINATION OF WORLDSID ~~50TH~~ 50TH PERCENTILE ADULT MALE
PERFORMANCE CRITERIA

1.   HEAD INJURY CRITERION (HIC36)

1.1   The Head Injury Criterion is the maximum value calculated from the expression:

$$HIC36 = \left[\frac{1}{(t_2-t_1)} \int_{t_1}^{t_2} a_R \, dt\right]^{2.5} (t_2 - t_1)$$

Where:

a_R = the resultant translational acceleration at the centre of gravity of the dummy head recorded versus time in units of gravity, g (1 g = 9.81 m/s^2); and

t_1 and t_2 are any two points in time during the impact which are separated by not more than a 36 millisecond time interval and where t_1 is less than t_2.

1.2   The resultant acceleration at the centre of gravity of the dummy head is calculated from the expression:

$$a_R = \sqrt{a_X^2 + a_Y^2 + a_Z^2}$$

Where:

a_X = the longitudinal (x-axis) acceleration at the centre of gravity of the dummy head recorded versus time and filtered at a channel frequency class (CFC)[1] of 1000 Hz;
a_Y = the lateral (y-axis) acceleration at the centre of gravity of the dummy head recorded versus time and filtered at a CFC of 1000 Hz; and
a_Z = the vertical (z-axis) acceleration at the centre of gravity of the dummy head recorded versus time and filtered at a CFC of 1000 Hz.

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[1] For details of each Channel Frequency Class (CFC) refer to SAE Recommended Practice J211/1 (revision December 2003).

2   [Reserved]

3   [SHOULDER PERFORMANCE CRITERIA

3.1   The shoulder rib deflection is determined in accordance with [Special Resolution 2], Annex Addendum [X] from the voltage output measurements recorded by the deflection sensor mounted between the struck side shoulder rib mounting bracket and central spine box ball joint assembly, and filtered at a CFC of 600 Hz.

3.2   The longitudinal (x-axis), lateral (y-axis) and vertical (z-axis) shoulder forces are measured by the load cell mounted between the shoulder clevis assembly and the shoulder rib doubler. The peak resultant shoulder force is calculated from the expression:

$$F_R = \sqrt{F_X^2 + F_Y^2 + F_Z^2}$$

Where:

F_X = the longitudinal (x-axis) shoulder force recorded versus time and filtered at a CFC of 600 Hz;
F_Y = the lateral (y-axis) shoulder force recorded versus time and filtered at a CFC of 600 Hz; and
F_Z = the vertical (z-axis) shoulder force recorded versus time and filtered at a CFC of 600 Hz.]

4   THORAX PERFORMANCE CRITERIA

4.1   The maximum thorax rib deflection is the maximum deflection of any (upper, middle or lower) thorax rib, as determined in accordance with [Special Resolution 2], ~~Annex~~ Addendum [X] from the voltage output measurements recorded by the deflection sensor mounted between the accelerometer mounting bracket and central spine box ~~ball joint assembly~~ mounting bracket inside each struck side thorax rib, and filtered at a CFC of 600 Hz.

4.2   [The peak thorax viscous criterion response is the maximum value of VC on any (upper, middle or lower) thorax rib which is calculated from the instantaneous product of the thorax rib deflection as a proportion of the half thorax width, and the velocity of thorax rib deflection derived by differentiation of the deflection with respect to time:

$$VC = Max\left[\frac{D}{0.17}.\frac{dD}{dt}\right]$$

Where:

D = thorax rib deflection (metres) filtered at a CFC of 600 Hz

$$\frac{dD}{dt} = \frac{8\left[D_{(t+1)}-D_{(t-1)}\right]-\left[D_{(t+2)}-D_{(t-2)}\right]}{12dt}$$

t = time (s)

For the purposes of this calculation the standard width of the half thorax rib cage is 170 mm (0.17 m).]

5   ~~ABDOMEN~~ ABDOMINAL PERFORMANCE CRITERIA

5.1   The maximum ~~abdomen~~ abdominal rib deflection is the maximum deflection of any (upper or lower) ~~abdomen~~ abdominal rib, as determined in accordance with [Special Resolution 2], ~~Annex~~ Addendum [X] from the voltage output measurements recorded by the deflection sensor mounted between the accelerometer mounting bracket and central spine box ~~ball joint assembly~~ mounting bracket inside each struck side ~~abdomen~~ abdominal rib, and filtered at a CFC of 600 -Hz.

5.2   [The peak ~~abdomen~~ abdominal viscous criterion response is the maximum value of VC on any (upper or lower) ~~abdomen~~ abdominal rib which is calculated from the instantaneous product of the abdomen rib deflection as a proportion of the half thorax width, and the velocity of ~~abdomen~~ abdominal rib deflection derived by differentiation of the deflection with respect to time:

$$VC = Max\left[\frac{D}{0.17}.\frac{dD}{dt}\right]$$

Where:

D = ~~abdomen~~ abdominal rib deflection (metres) filtered at a CFC of 600 Hz

$$\frac{dD}{dt} = \frac{8[D_{(t+1)} - D_{(t-1)}] - [D_{(t+2)} - D_{(t-2)}]}{12dt}$$

t = time (s)

For the purposes of this calculation the standard width of the half thorax rib cage is 170 mm (0.17 m).]

5.3   The value of the resultant lower spine (T12) acceleration (a_R) which is exceeded for 3 milliseconds cumulatively (i.e. across one or more peaks) is calculated from the expression:

$$a_R = \sqrt{a_X^2 + a_Y^2 + a_Z^2}$$

Where:

a_X = the longitudinal (x-axis) acceleration of the dummy lower spine recorded versus time and filtered at a CFC of 180 Hz;
a_Y = the lateral (y-axis) acceleration of the dummy lower spine recorded versus time and filtered at a CFC of 180 Hz; and
a_Z = the vertical (z-axis) acceleration of the dummy lower spine recorded versus time and filtered at a CFC of 180 Hz.

6   PELVIS PERFORMANCE CRITERIA

6.1   The peak pubic symphysis ~~peak~~ force ~~(PSPF)~~ is the maximum force measured by the load cell at the pubic symphysis of the pelvis and filtered at a CFC of 600 Hz.