EURO NCAP

#FORSAFERTRUCKS

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Safe Driving Vision

Test Protocol

Implementation November 2024

PREFACE

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of Euro NCAP. Where a disagreement exists between the laboratory and manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a manufacturer has interfered with any of the set-up, the manufacturer's representative should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer’s representative will be told to leave the test site and the Euro NCAP secretariat should be immediately informed. Any such incident may be reported to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

A-pillar – means any roof support forward of the vertical transverse plane located 68 mm in front of the V Point and includes non-transparent items such as windscreen mouldings and door frames, attached or contiguous to such a support.

Accelerator Heel Point (AHP) – means the lowest point at the intersection of the heel of the foot and the floor of the vehicle, with the shoe positioned on the undepressed accelerator pedal.

Assessment volume – means the volume of space around the forward part of the vehicle where visibility of part of a vulnerable road user will be considered to contribute to the measurement of the vehicle's direct vision performance.

Camera Monitor System (CMS) – means a system comprising of camera(s) and display screen(s) that provide the driver with indirect vision to the front, side(s) and/or rear of the vehicle.

Direct vision – means the field of vision from the driver's eye point that can be seen without the aid of indirect vision devices such as mirrors or cameras.

Direct vision opening line – means the intersection of a surface with a sight line that is positioned at a tangent to the first vision occlusion that would obstruct that sightline (e.g. A-pillar, lower edge of windscreen, steering wheel windscreen wipers, etc.). See the Figure in Annex 7 for an illustration of the process.

Driver's eye point or E-point – means a point representing the midpoint between the centre of the driver's left and right eye.

Frontal plane – means the plane perpendicular to the median longitudinal plane of the vehicle and touching its foremost point, disregarding the projection of devices for indirect vision and any part of the vehicle more than 2.0 m above the ground.

H-point Manikin – means a three-dimensional H-Point Machine as defined in Annex 1 of the Consolidated Resolution on the Construction of Vehicles (R.E.3).

Heel Point Template (HPT) – means the devices used to determine the AHP.

Intended cab mounting angle – means the pitch and roll angle of the cab floor relative to a horizontal plane with the cab in its nominal design condition.

Nearside – means the right side of the vehicle for right-hand traffic or the left side of the vehicle in left-hand traffic.

Nearside Plane – means the plane parallel to the median longitudinal plane of the vehicle and touching its most outboard point in the nearside direction forward of a position 1.0 m behind the driver ocular reference point, disregarding the projection of devices for indirect vision and any part of the subject vehicle higher than 2.0 m above the ground.

Offside – means the left side of the vehicle for right-hand traffic, or the right side of the vehicle for left-hand traffic.

Offside Plane – means the plane parallel to the median longitudinal plane of the vehicle and touching its most outboard point in the offside direction forward of a position 1.0 m behind the

driver ocular reference point, disregarding the projection of devices for indirect vision and any part of the subject vehicle higher than 2.0 m above the ground.

Pedal Reference Point (PRP) – means the mid-point of the accelerator pedal foot plate (excluding the pedal arm), on its lateral midline (which may be a different axis from the vehicle's longitudinal axis, and to the longitudinal axis of the pedal arm).

P-point – means the point about which the driver's head rotates when viewing objects on a horizontal plane at eye level. It is located 98 mm rearward of E2 in the X axis.

R-point – means the seating reference point as defined in Annex 1 of the Consolidated Resolution on the Construction of Vehicles (R.E.3).

Sightline – means a straight line representing the driver's line of sight from an eye point either to a target point or at any particular defined angle within the three-dimensional reference system.

T_{min} – means the minimum steering wheel telescope distance.

T_{max} – means the maximum steering wheel telescope distance.

T_{mid} – means the mean steering wheel telescope distance derived from T_{min} and T_{max}.

θ_{min} – means the minimum steering wheel pitch angle.

θ_{max} – means the maximum steering wheel pitch angle.

θ_{mid} – means the mean steering wheel pitch angle derived from θ_{min} and θ_{max}.

Total Visible Volume (TVV) – means a volume of space, contained entirely within the assessment volume, that is visible via sightlines projected from one of the E-Points through the direct vision opening lines. It is the sum of volumes visible within the assessment zone from the drivers eye point through any window in the vehicle cab.

Transparent area – means that area of a vehicle windscreen or other glazed surface, if fitted, that permits light transmittance measured in a direction perpendicular to the surface of not less than 70 per cent, excluding any dot printed area of opaque obscuration.

Vehicle Under Test (VUT) – means the vehicle tested according to this protocol.

Vision occlusion – means any permanently fitted part of the structure of the vehicle, or of the interior of the driver's cabin, that would obstruct a sightline passing from any of the three defined E-Points to any part of the assessment volume.

1 INTRODUCTION

Collisions between Vulnerable Road Users (VRU) and large commercial vehicles that are undertaking low speed manoeuvres, such as a turn to the nearside or moving off from rest, typically occur at low driving speeds. They usually have serious consequences for VRU.

The cause of this type of collision can be contributed to by many factors. The VRU may have been positioned in a blind spot where they could not be seen directly through the windows or via mirrors. Alternatively, they may have been available to be seen during the build-up to the collision, but the driver may have detected their presence too late to avoid collision or may have failed to detect their presence at all. This late detection, or failure to detect, could be a result of the driver failing to look, looking but failing to see, or seeing but failing to correctly judge the risk.

Aligned with these multi-factor causes, there are also a number of potential solutions to the problem, including the eliminating of blind spots, increasing the areas that can be seen directly through the windows, blind spot information systems, collision warnings and automated intervention to either stop, if moving already, or to prevent movement if stationary and a collision with a vulnerable road user would otherwise be imminent.

In some circumstances, the different solutions will offer synergies. An effective collision warning can alert an attentive driver to the existence of a problem, but that driver is more likely to respond quickly and appropriately if the warning draws their attention to the presence of a VRU that is clearly visible by direct line of sight through a window, rather than to a small, distorted image of the VRU in a blind spot mirror, or where the VRU is not visible at all.

At the other end of the scale, where a moving off from rest collision occurs purely because the VRU was completely invisible to a largely attentive driver who just failed to check the class VI front mirror, then the collision would certainly be avoided by improved direct vision. It would also be certain to be avoided if the vehicle detected the presence of the VRU and prevented motion automatically. The VRU cannot be saved twice and in this circumstance, the benefits are not additive.

Euro NCAP recognises this complexity and has implemented test protocols intended to drive vehicles towards high standards of vision as well as towards high performance collision avoidance systems. These will be applied flexibly in the rating so that manufacturers can choose the most cost-effective way of solving the problems in their specific freight application and vehicle design.

This protocol specifies the HGV direct and indirect vision test procedures, which are used to evaluate vision in a repeatable and reproducible manner for the HGV safety rating scheme.

The Euro NCAP HGV direct vision assessment is based on the numerical test method defined in Annex 7 of UNECE Regulation No. 167 on the Approval of Motor Vehicles with Regard to their Direct Vision (R167). Deviations from the R167 test procedure are:

- The Total Visible Volume (TVV) is the measure of interest, not the sub-volumes (R167 5.2.)
- The VUT is the selected vehicle according to the Euro NCAP HGV selection protocol, not the worst-case vehicle of its type in respect to direct vision (R167 6.2.1)
- The passenger seat (if fitted) is selected according to the Euro NCAP HGV selection protocol, not at the discretion of the vehicle manufacturer (R167 6.2.6.1)
- For Accelerator Heel Point (AHP) height:

    - Where vehicle manufacturer information is available, direct vision is assessed with the AHP positioned at a height from the ground calculated in accordance with the procedure specified in R167 6.2.2. (no deviation)
    - In the absence of vehicle manufacturer information, AHP height from the ground is determined in accordance with the procedure specified in 3.1.1.
- For AHP position, which may be measured:
    - In accordance with Recommended Practice SAE J1100 Rev. 2009 (R167 6.2.2.1.) (no deviation), or
    - In accordance with the procedure specified in 3.1.2.

For repeatable application in assessments undertaken by Euro NCAP laboratories, interpretations of the R167 test procedure are applied to the:

- Steering wheel position, which shall be located in the centre of the adjustment range, considering all axes of adjustment, measured in accordance with the procedure specified in 3.1.3, (R167 6.2.4.)
- Passenger seat, if fitted and where foldable, the vehicle shall be assessed with the seat in the position (in-use (deployed) or not-in-use (stowed)) that affords the greatest TVV (R167 6.2.6.3.)
- Arm rests, if fitted and where adjustable, the vehicle shall be assessed with the arm rests in the position (in-use (deployed) or not-in-use (stowed)) that affords the greatest TVV (R167 6.2.6.4.)

The application of any of these interpretations of the R167 test procedure in assessments other than those undertaken by Euro NCAP is at the discretion of the vehicle manufacturer. Where they are not applied, the R167 test procedure shall be followed.

2 REFERENCE SYSTEM

2.1Convention

For the VUT use the convention specified in ISO 8855:1991 in which the x-axis points towards the front of the vehicle, the y-axis towards the left and the z-axis upwards (right hand system), with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 2-1.

Viewed from the origin, roll, pitch and yaw rotate clockwise around the x, y and z axes respectively. Longitudinal refers to the component of the measurement along the x-axis, lateral the component along the y-axis and vertical the component along the z-axis.

This reference system should be used for both left hand drive (LHD) and right-hand drive (RHD) vehicles tested. Figure 2-1 shows the near and far side of the vehicle for a left-hand drive (LHD) vehicle. The far side always corresponds to the hand of drive, and therefore swaps sides accordingly for a right-hand drive (RHD) vehicle.

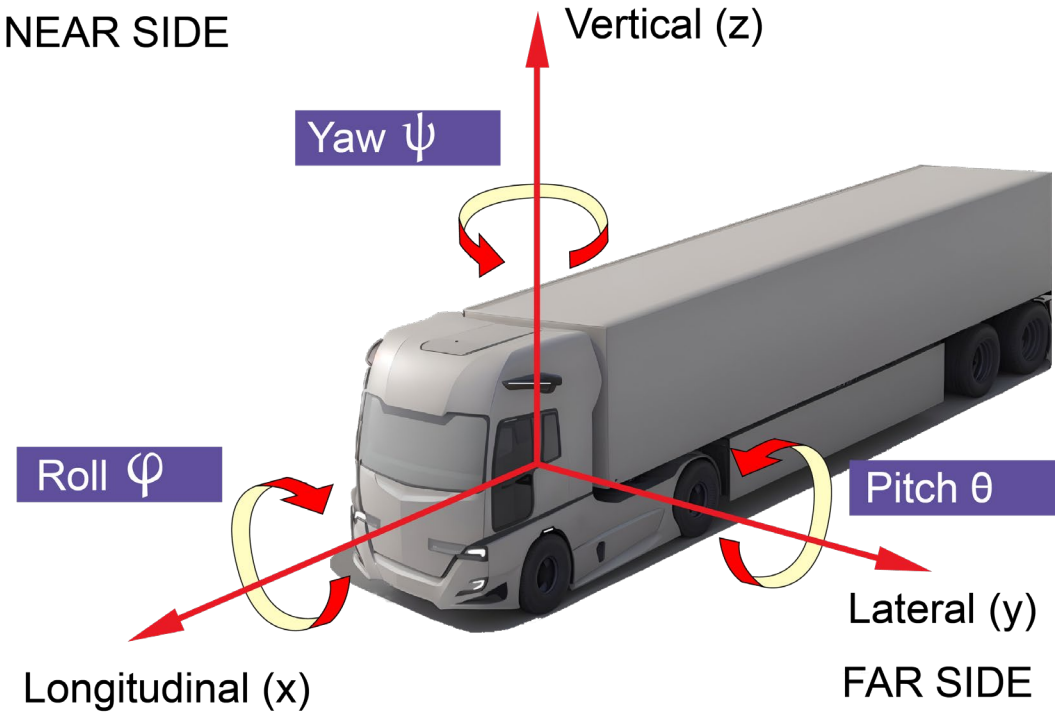

Figure 2-1 Coordinate system and notation (LHD & RHD) and near side – far side for LHD vehicle

2.2Definition of the Direct Vision Assessment Volume

The assessment volume shall be defined as the volume of space between the frontal, nearside and offside plane of the vehicle and the horizontal and vertical boundaries of the assessment zone as defined below and illustrated in Figure 5-1:

- The forward boundary of the assessment zone shall be formed by a plane parallel to the vehicle frontal plane and positioned 2,000 mm forward of the vehicle frontal plane.
- The nearside boundary of the assessment zone shall be formed by a plane parallel to the vehicle nearside plane and positioned 4,500 mm further to its nearside.
- The offside boundary of the assessment zone shall be formed by a plane parallel to the vehicle offside plane and positioned 2,000 mm further to its offside.
- The rearward boundary of the assessment zone shall be formed by a plane parallel to the vehicle frontal plane and positioned 1,000 mm behind the driver's eyepoint (E2).
- The vertical boundaries of the assessment zone shall be formed by the ground plane and a plane parallel to the ground plane but positioned 1,602 mm above the ground.

EU Regulation 2021/535 Section F lists the devices and equipment that are not required to be taken into account for the determination of the outermost dimensions of the vehicle.

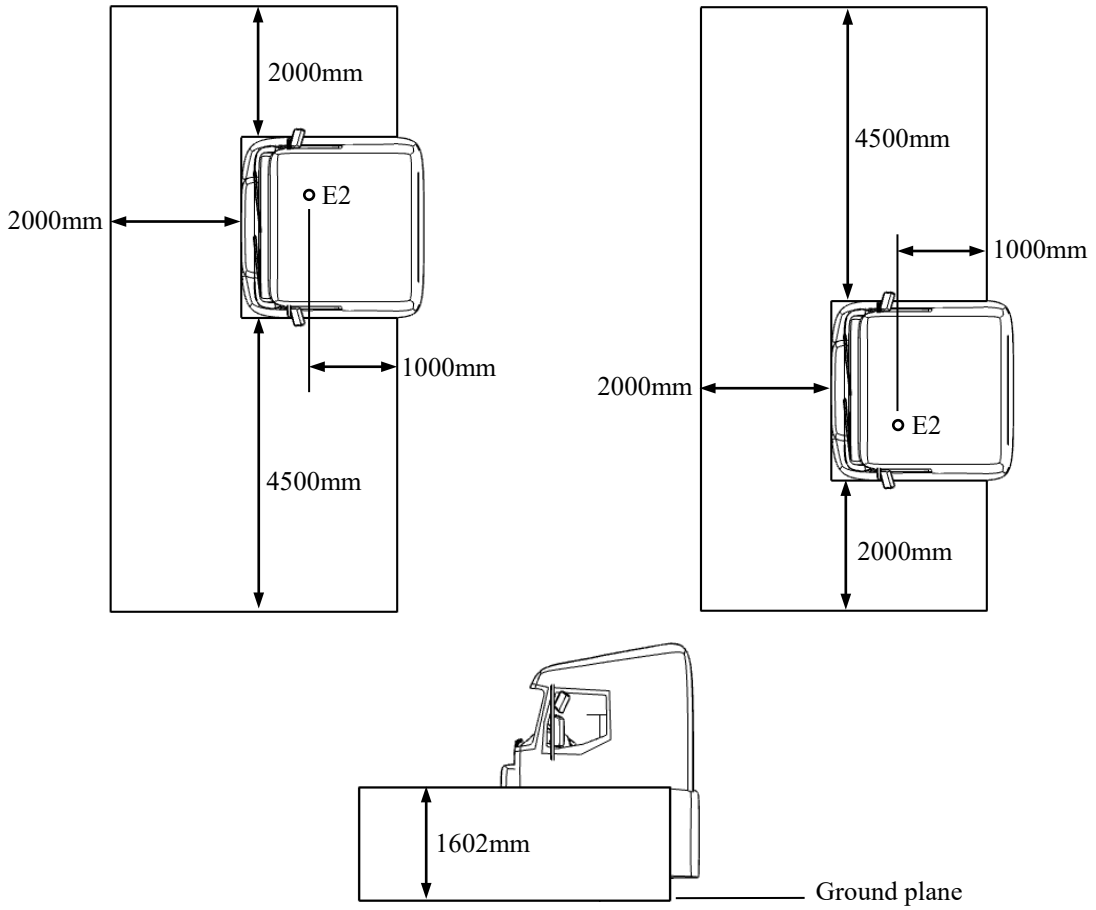

Figure 2-2 Definition of the assessment volume plan view for RHD vehicle (top left), plan view for LHD vehicle (top right), side view (bottom)

2.3Definition of the Driver’s Eye Point

Three separate eye points are defined. E2 is the forward eye point, E1 is the left-side eyepoint and E3 is the right-side eyepoint.

Each point is defined using the three-dimensional reference system. E2 is defined by an offset from the accelerator heel point of 1,163.25 mm in the Z axis, and 678 mm rearward in the X axis. The position of E2 in the Y axis is on a vertical plane, parallel to the median longitudinal plane and passing through the centre of the driver's seat. Points E1 and E3 are defined by a 60° rotation, to the left and right respectively, about the P-Point.

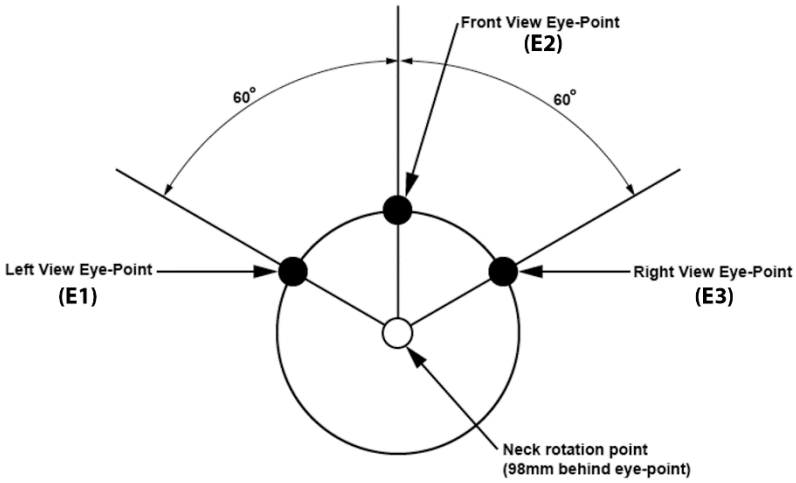

Figure 2-3 Definition of the Driver’s eye points for views to the front, left and right

3 TEST CONDITIONS

3.1 VUT Preparation

3.1.1 Accelerator Heel Point Height

In accordance with R167 6.2.2., where vehicle manufacturer information is available, direct vision is assessed with the AHP positioned at a height from the ground that is no lower than the midpoint between the height that the manufacturer calculates it would be at for an unladen chassis cab (without body) and that which the manufacturer calculates it would be at when the vehicle is loaded to its technically permissible design maximum.

In the absence of vehicle manufacturer information, AHP height from the ground shall be measured:

- In accordance with the procedure specified in 3.1.2,
- With VUT at a height equivalent to half laden in accordance with the procedure specified in Appendix A, and
- With any relevant configurable driving controls (e.g. ride height) set to an automatic setting or, where an automatic setting is not available, the middle setting.

3.1.2 Accelerator Heel Point Position

In accordance with R167 6.2.2.1., the AHP position may be measured in accordance with Recommended Practice SAE J1100 Rev. 2009 using the H-Point Manikin. The foot angle (A46) shall be at a minimum of 87° when the H-Point manikin is positioned at the R-Point. For vehicles with R-Point to heel vertical (H30) greater than 405 mm, the accelerator pedal may be depressed as specified by the manufacturer. If the depressed pedal is used, the foot must be flat on the accelerator pedal.

Alternatively, the AHP may be measured in accordance with the following simplified but consistent method. The method may be applied digitally to the cab model or measured physically in the VUT.

Establish the Pedal Reference Point (PRP), defined as the mid-point of the accelerator pedal foot plate (excluding the pedal arm), on its lateral midline (which may be a different axis from the vehicle’s longitudinal axis, and to the longitudinal axis of the pedal arm).

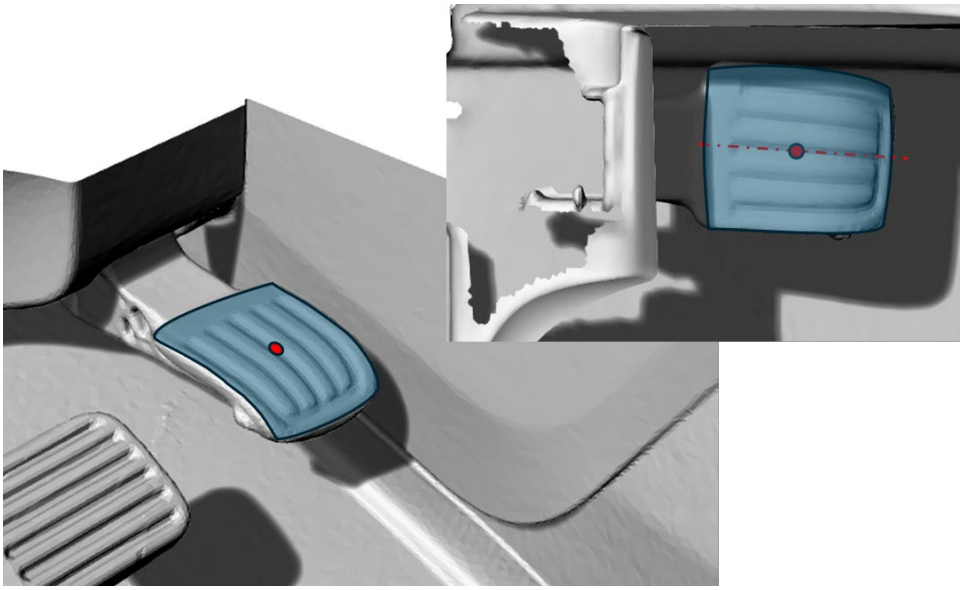

Figure 3-1 Definition of the Pedal Reference Point (PRP)

Define a Heel Point Template (HPT) which is nominally a rectangular object 200 mm in length and 50 mm in height. Points HPT1 and HPT2 are defined as the lower corners of the HPT.

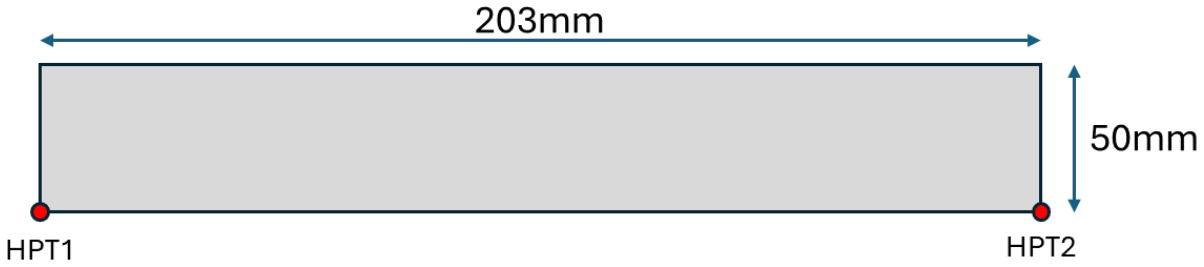

Figure 3-2 Heel Point Template (HPT) geometry

With the HPT oriented in the vertical plane, place HPT1 at the PRP and then roll the HPT along the lateral midline of the accelerator pedal until HPT2 touches the floor of the footwell as shown in Figure 3-3. Measure the XYZ coordinates of HPT2 at this location and use them as the location of the AHP.

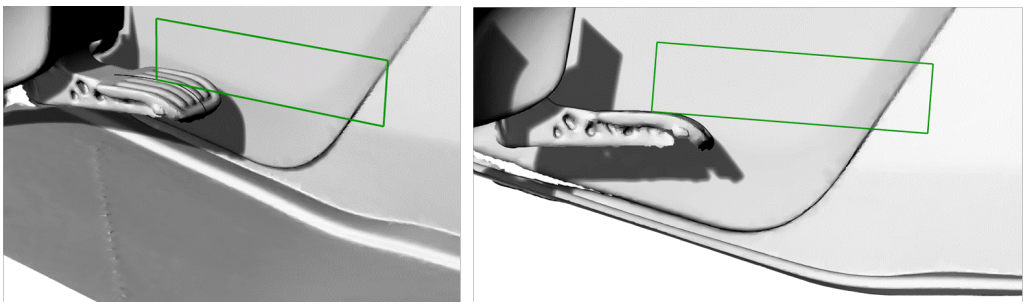

Figure 3-3 Example of HPT rolling along the lateral midline of the accelerator pedal to define the AHP

3.1.3 Steering Wheel Position

R167 6.2.4. states that for vision assessment, the steering wheel shall be located in the centre of the possible range, considering all axes of adjustment. HGVs typically have steering wheel position adjustment that can be defined by rotation angle, pitch angle and telescope distance. For

Euro NCAP direct vision assessment, the steering wheel shall be located in the centre of the adjustment range defined by the steering wheel rotation angle, pitch angle and telescope distance measured in accordance with the following method.

In case of a vehicle manufacturer or test laboratory belief that this configuration is not suitable for direct vision assessment, they are requested to contact the Euro NCAP secretariat.

3.1.3.1 Rotation angle

Adjust the steering wheel rotation angle to the road wheel straight ahead driving position and maintain the steering wheel in this location for direct vision assessment.

3.1.3.2 Pitch angle

Measure and record the minimum and maximum steering wheel pitch angles achievable throughout the full range of steering column adjustment. Calculate the mean of the measured minimum and maximum angles, set the steering wheel at this pitch angle and maintain the steering wheel in this location for direct vision assessment.

3.1.3.3 Telescope position

Measure and record the minimum and maximum steering wheel telescope distance achievable throughout the full range of steering column adjustment. Calculate the mean of the measured minimum and maximum distances, set the steering wheel at this telescope position and maintain the steering wheel in this location for direct vision assessment.

3.1.4 General

Prepare the VUT for direct vision assessment in accordance with the relevant requirements of R167 test procedure:

6.1.1. The test shall be performed on a flat, dry surface of asphalt or concrete construction.

6.1.2. The ambient temperature shall be between 0 °C and 45 °C.

6.2.3. The vehicle cab shall be positioned at the intended mounting angle. It is permitted to drive the vehicle for a short distance in order to settle the cab suspension if requested by the manufacturer.

6.2.5. Devices for indirect vision (where applicable) shall be adjusted to meet the fields of vision required by UN Regulation No. 46 where the eye points are as defined in Figure 2-3.

6.2.6. Passenger seat, if fitted:

6.2.6.1. For vehicles where a range of passenger seat designs may be specified, the seat for evaluation shall be selected according to the Vehicle Selection Protocol.

6.2.6.2. If the position of the seat is adjustable the passenger seat shall be placed at its rearmost lowest position with a backrest angle of 18° from vertical.

6.2.6.3. Where the passenger seat is foldable, the vehicle shall be assessed with the seat in the position (in-use (deployed) or not-in-use (stowed)) that affords the greatest TVV. The single selected seat position shall be applied throughout the whole assessment.

6.2.6.4. Where armrests are adjustable, the vehicle shall be assessed with the arm rests in the position (in-use (deployed) or not-in-use (stowed)) that affords the greatest TVV.

6.2.6.5. Head restraints shall be in the lowest position suitable for normal use in service. They shall not be in a position provided solely for stowage when not in use.

Perform the testing with good condition original fitment tyres of the make, model, size, speed and load rating as specified by the vehicle manufacturer. Use inflation pressures corresponding to the manufacturer’s instructions for the appropriate loading condition.

4 TEST PROCEDURE

4.1Direct Vision

The visible volume shall be quantified according to one of two methods: the Numerical Test Method in accordance with Annex 7 of UNECE Regulation 167 or the Physical Test Method in accordance with Annex 6 of UNECE Regulation 167.

The vehicle manufacturer is requested to provide the Euro NCAP secretariat with supporting evidence illustrating the results of such an assessment, the TVV measurement and the AHP height. Euro NCAP reserve the right to independently spot check any manufacturer supplied result.

Where the vehicle manufacturer information and TVV measurement are not available, the test laboratory will undertake direct vision assessment in accordance with one of the two methods.

Considering direct vision opening lines, for the purposes of assessment, any parts of glazing covered with dot-printed areas shall be considered as non-transparent. Only vehicle manufacturer original equipment shall contribute to vision occlusion. Discount the effect on TVV of any other equipment causing vision occlusion during the assessment.

4.2Indirect vision

Indirect vision systems, such as Camera Monitor Systems (CMS) and other novel indirect vision technologies, that cover the Class II, IV V and VI fields of view as defined by UNECE Regulation No. 46 and other areas, will be assessed on a feature basis:

- CMS covering the class II view equipped with adjustable markings illustrating the rearmost point of the of the vehicle and safe distances behind the vehicle
- CMS covering the class IV view
- CMS covering the class V view
- CMS view covering the class VI view
- Novel CMS feature(s) promoting improved real world safety and/or driver acceptance

Record the presence of a CMS and/or a conventional reflective mirror covering each of the class fields of view. Investigate and record the presence and functionality of novel CMS features.

APPENDIX A VEHICLE LOADING FOR DIRECT VISION EVALUATION

Where manufacturer information is not available on direct vision, or where independent measurement is required for validation purposes, the following requirements and process may be used to establish a 'half laden' weight.

The procedure to prepare the VUT load requirement for testing is:

- If applicable, fill up the tank with fuel to at least 90 % of the tank's capacity of fuel, or in case of large tank capacity, partially fill the tank with adequate fuel to perform the testing, noting the fuel level and the vehicle manufacturer specified tank capacity
- Check that the levels of all fluids are within operating limits and top up where necessary
- Ensure that the VUT has all its bodywork and spare wheel on board, if fitted, along with any equipment or tools supplied. Nothing else should be in the VUT
- Ensure that all tyres are inflated according to the manufacturer's instructions for the appropriate loading condition
- Measure the VUT axle masses (without trailer for a drawing vehicle – unladen test trailer mass to be determined separately) to determine the 'measured kerb mass'
- If applicable, calculate the total mass including full fuel tanks (accounting for absent fuel as necessary) and for drawing vehicles, adding a 'nominal trailer mass' of 6,700 kg
- The total mass is the 'unladen kerb mass' of the VUT. Record calculation details and this mass in the test details

Determine the 'maximum permitted mass' for the VUT as the lesser of:

- The vehicle manufacturers maximum design mass, or
- The maximum permitted mass of the relevant vehicle or vehicle combination that is legally complaint for international transport under the terms of Annex 1 of Directive 96/53/EC

Note, the 'maximum permitted mass' must include any applicable allowance to compensate for the mass of equipment associated with alternative fuel or zero emission technologies, clearly identified from a section on the vehicle plate titled 96/53/EC article 10b compliant.

Calculate the 'nominal as tested mass' as follows:

- Nominal as tested mass = (unladen kerb mass + maximum permitted mass) / 2

Calculate the 'load mass' required to achieve the ''nominal as tested mass'', accounting for absent fuel. For drawing vehicles, also account for any difference between the 'nominal trailer mass' and 'actual test trailer mass'.

- Load mass = nominal as tested mass - measured kerb mass - actual test trailer mass

Apply the 'load mass' to the vehicle comprising of the occupant(s), test equipment (i.e. on-board test equipment and instrumentation, associated cables, cabling boxes and power sources) and ballast, density of no less than 1,000 kg/m^3, placed directly on the load bed.

Locate the centre of mass of the ballast centrally within the cargo space (longitudinally and laterally) as far as is as practically possible. Ballast must be securely attached to the VUT and regularly checked during testing to confirm security. If water is used as ballast, it should be used in full containers to prevent the movement under acceleration.

Measure the VUT axle masses with the occupant(s), test equipment and ballast on board and determine the ‘as tested mass’, confirming that individual axle weights do not exceed their permitted maximums.

The difference between the ‘actual as tested mass’ and the ‘nominal as tested mass’ shall be no more than the lesser of ± 2.5 % of the VUT maximum permitted mass or ± 500 kg.