



**EUROPEAN NEW CAR ASSESSMENT PROGRAMME
(Euro NCAP)**



TEST PROTOCOL – AEB VRU systems

Version 2.0
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TEST PROTOCOL – AEB VRU SYSTEMS

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1 INTRODUCTION

Car-to-pedestrian impacts are one of the most frequent accidents happening on the roads due to driver distraction or misjudgement.

Typical accidents between cars and pedestrians occur at city speeds where the pedestrian crosses the path of the vehicle. These types of accidents with vulnerable road users usually coincide with severe injuries and leave the driver with very little reaction time to apply the brakes.

To support the driver in avoiding when possible or mitigating such crashes, car manufactures offer avoidance technology that reacts to the situation by autonomous braking and at higher speeds may issue warnings to alert the driver. Systems that specifically look for and react to vulnerable road users like pedestrians and cyclists are called AEB VRU systems.

This protocol specifies the AEB VRU test procedure for both AEB Pedestrian and AEB Bicyclist, which is part of Pedestrian Protection.

Note:

AEB VRU scoring is conditional to the total points achieved in subsystem tests, i.e. the sum of pedestrian Headform, Upper Legform & Lower Legform scores.

If the subsystem total test score is lower than 22 points, no points are available for AEB VRU, regardless whether the system is fitted and would achieve a good score.

2 DEFINITIONS

Throughout this protocol the following terms are used:

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using the American Society for Testing and Materials (ASTM) E1136-10 (2010) standard reference test tyre, in accordance with ASTM Method E 1337-90 (reapproved 1996), at a speed of 64.4km/h, without water delivery.

Autonomous Emergency Braking (AEB) – braking that is applied automatically by the vehicle in response to the detection of a likely collision to reduce the vehicle speed and potentially avoid the collision.

Forward Collision Warning (FCW) – an audiovisual warning that is provided automatically by the vehicle in response to the detection of a likely collision to alert the driver.

Vehicle width – the widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.

Car-to-Pedestrian Farside Adult 50% (CPFA-50) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path running from the farside and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Nearside Adult 25% (CPNA-25) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 25% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Nearside Adult 75% (CPNA-75) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 75% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Nearside Child 50% (CPNC-50) – a collision in which a vehicle travels forwards towards a child pedestrian crossing its path running from behind and obstruction from the nearside and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Longitudinal Adult 25% (CPLA-25) – a collision in which a vehicle travels forwards towards an adult pedestrian walking in the same direction in front of the vehicle where the vehicle strikes the pedestrian at 25% of the vehicle’s width when no braking action is applied or an evasive steering action is initiated after an FCW.

Car-to-Pedestrian Longitudinal Adult 50% (CPLA-50) – a collision in which a vehicle travels forwards towards an adult pedestrian walking in the same direction in front of the vehicle where the vehicle strikes the pedestrian at 50% of the vehicle’s width when no braking action is applied.

Car-to-Bicyclist Nearside Adult 50% (CBNA-50) – a collision in which a vehicle travels forwards towards a bicyclist crossing its path cycling from the nearside and the frontal structure of the vehicle strikes the bicyclist when no braking action is applied.

Car-to-Bicyclist Longitudinal Adult 25% (CBLA-25) – a collision in which a vehicle travels forwards towards a bicyclist cycling in the same direction in front of the vehicle where the vehicle would strike the cyclist at 25% of the vehicle’s width when no braking action is applied or an evasive steering action is initiated after an FCW.

Car-to-Bicyclist Longitudinal Adult 50% (CBLA-50) – a collision in which a vehicle travels forwards towards a bicyclist cycling in the same direction in front of the vehicle where the vehicle would strike the cyclist at 25% of the vehicle’s width when no braking action is applied.

Vehicle under test (VUT) – means the vehicle tested according to this protocol with a pre-crash collision mitigation or avoidance system on board

Euro NCAP Pedestrian Target (EPTa) – means the adult pedestrian target used in this protocol as specified in the [Articulated Pedestrian Target Specification document version 1.0.](#)

Euro NCAP Child Target (EPTc) – means the child pedestrian target used in this protocol as specified in the [Articulated Pedestrian Target Specification document version 1.0.](#)

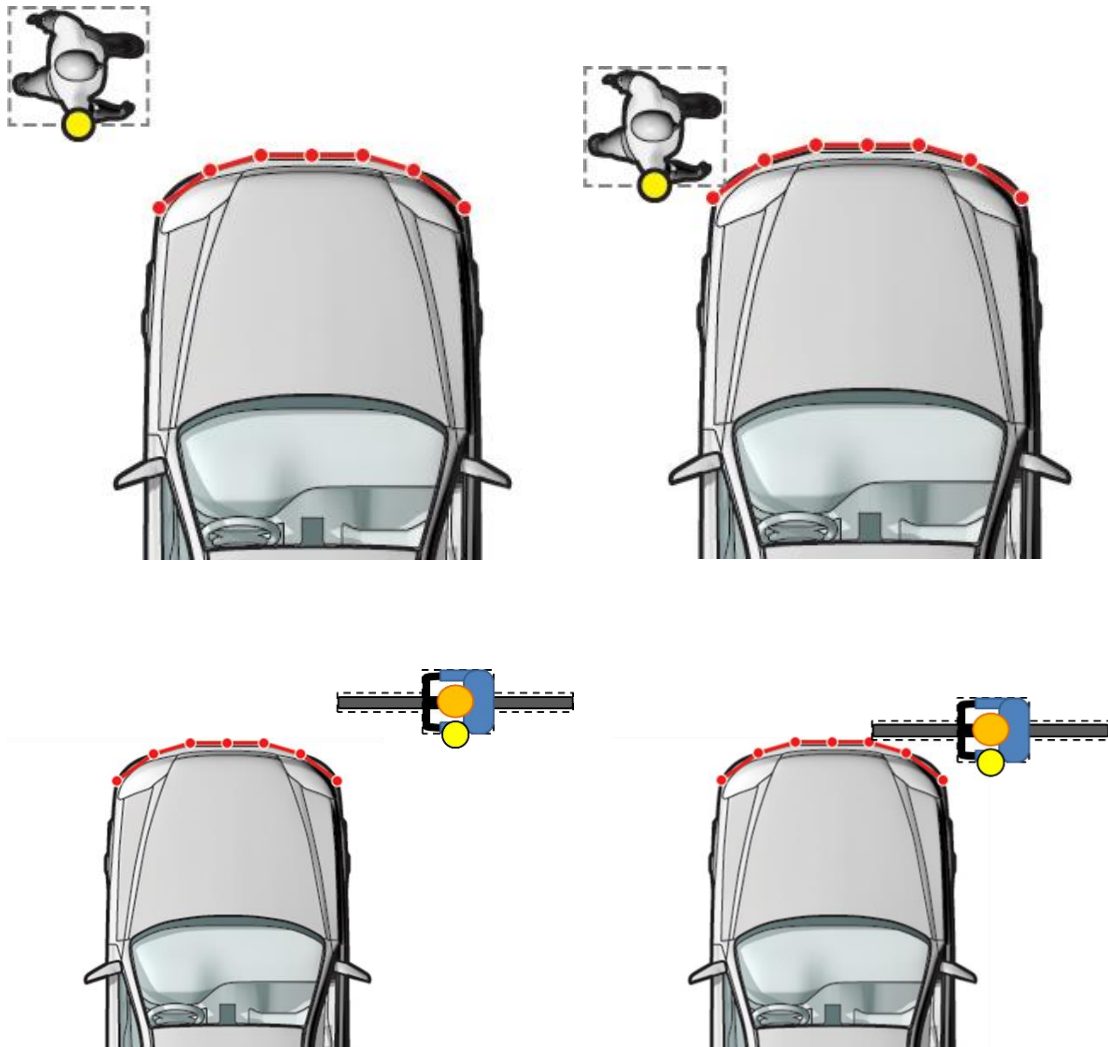
Euro NCAP Bicyclist and bike Target (EBT) – means the bicyclist and bike target used in this protocol as specified in the [Bicyclist Target Specification document version 1.0.](#)

Time To Collision (TTC) – means the remaining time before the VUT strikes the EPT, assuming that the VUT and EPT would continue to travel with the speed it is travelling.

T_{AEB} – means the time where the AEB system activates. Activation time is determined by identifying the last data point where the filtered acceleration signal is below -1 m/s^2 , and then going back to the point in time where the acceleration first crossed -0.3 m/s^2

T_{FCW} – means the time where the audible warning of the FCW starts. The starting point is determined by audible recognition.

V_{impact} – means the speed at which the profiled line around the front end of the VUT coincides with the square box around the EPTa, EPTc and EBT as shown in the figure below.



3 REFERENCE SYSTEM

3.1 Convention

- 3.1.1 For VUT, EPT and EBT 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 1.
- 3.1.2 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.
- 3.1.3 This reference system should be used for both left (LHD) and right hand drive (RHD) vehicles tested.
- 3.1.4 The nearside is swapped as per LHD and RHD vehicles. Figure 1 shows the near and farside of the vehicle for a left hand driven (LHD) vehicle.

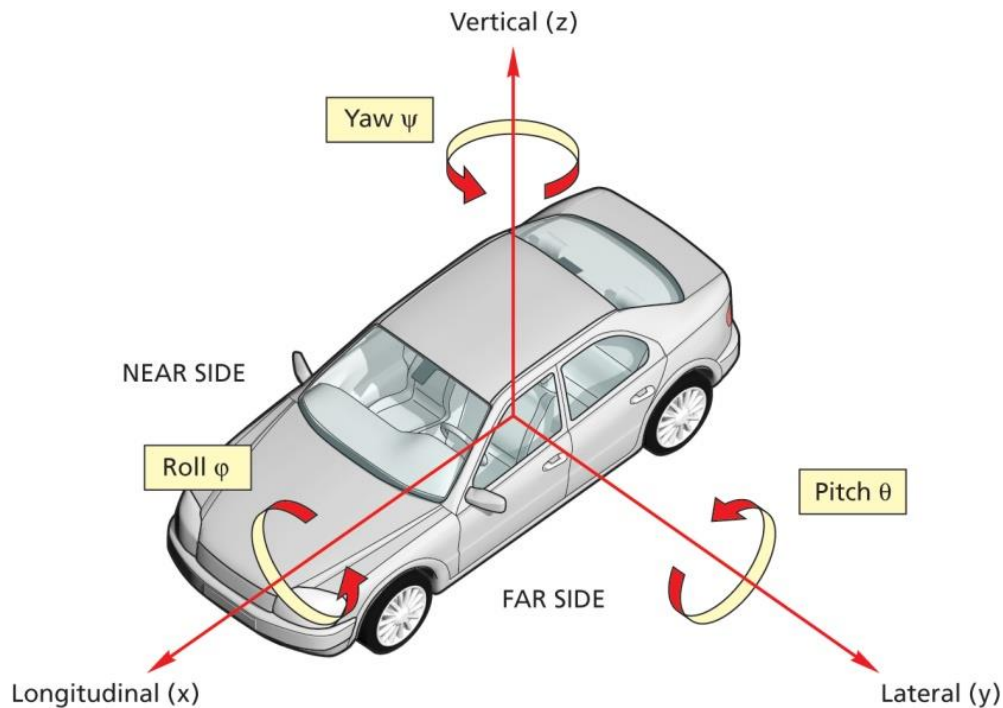


Figure 1: Coordinate system and notation (LHD & RHD) and nearside – farside for LHD vehicle

3.2 Lateral Path Error

3.2.1 The lateral offset is determined as the lateral distance between the centre of the front of the VUT when measured in parallel to the intended straight lined path as shown in the figure below.

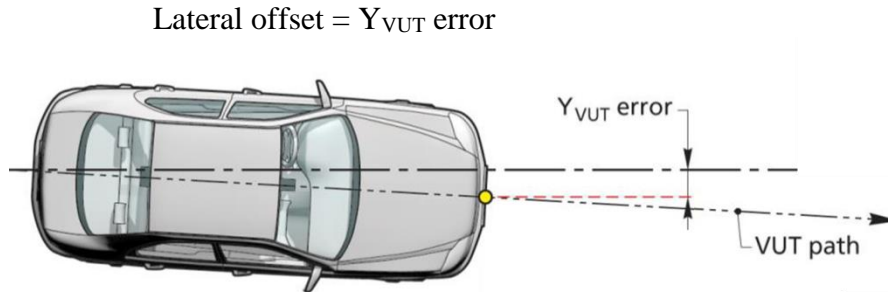


Figure 2: Lateral path error

3.3 Profiles for impact speed determination

3.3.1 A virtual profiled line is defined around the front end of the VUT. This line is defined by straight line segments connecting seven points that are equally distributed over the vehicle width minus 50mm on each side. The theoretical x,y coordinates are provided by the OEMs and verified by the test laboratory.

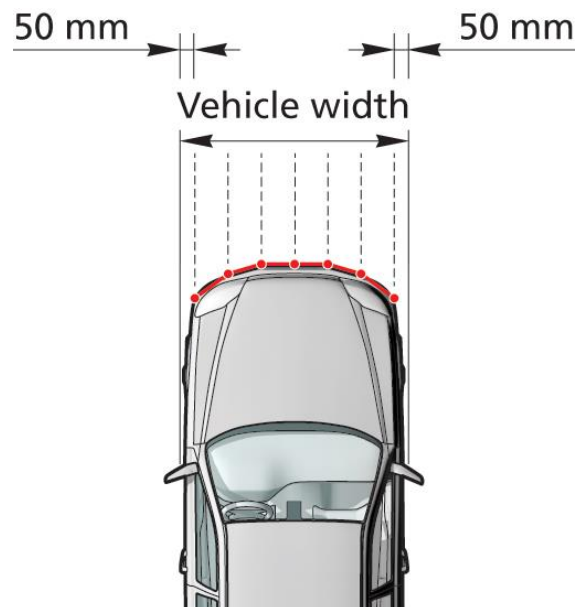


Figure 3: Virtual profiled line around vehicle front end

3.3.2 Around the EPT a virtual box is defined which is used to determine the impact speed. The dimensions of this virtual box are shown in Figure 4 below. For crossing scenarios the reference point of the EPT is the HIP point and for the longitudinal scenario a virtual point where the centreline of the dummy crosses the virtual box.

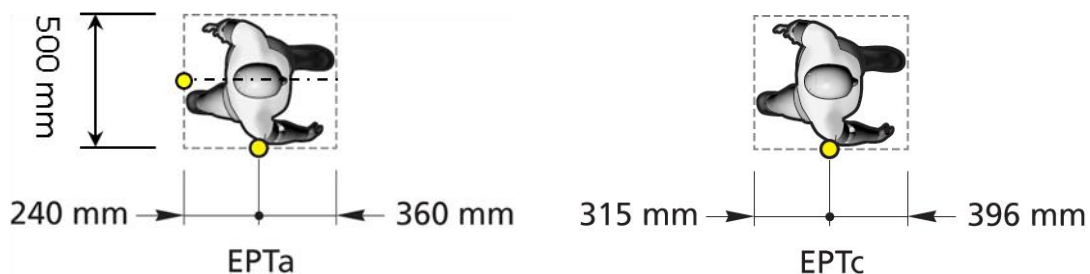


Figure 4: Virtual box dimensions around EPTa and EPTc

3.3.3 Around the EBT a virtual box is defined which is used to determine the impact speed. The dimensions of this virtual box are shown in Figure 5 below. For crossing scenarios the reference point of the EBT is the centre of the bottom bracket (crank shaft) (dashed line in Figure 5) and for the longitudinal scenario the most rearward point on the rear wheel is used.

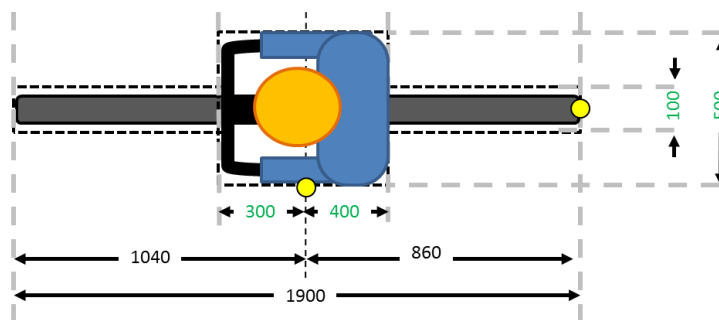


Figure 5: Virtual box dimensions around EBT

4 MEASURING EQUIPMENT

4.1.1 Sample and record all dynamic data at a frequency of at least 100Hz. Synchronise using the DGPS time stamp the EPT and EBT data with that of the VUT.

4.2 Measurements and Variables

| | | |
|-------|---|--|
| 4.2.1 | Time | T |
| | • T_0 equals TTC = 4s | T₀ |
| | • T_{AEB} , time where AEB activates | T_{AEB} |
| | • T_{FCW} , time where FCW activates | T_{FCW} |
| | • T_{impact} , time where VUT impacts EPT or EBT | T_{impact} |
| 4.2.2 | Position of the VUT during the entire test | X_{VUT}, Y_{VUT} |
| 4.2.3 | Position of the EPT or EBT during the entire test | |
| | • for crossing scenarios | Y_{EPT} / Y_{EBT} |
| | • for longitudinal scenarios | X_{EPT} / X_{EBT} |
| 4.2.4 | Speed of the VUT during the entire test | V_{VUT} |
| | • V_{impact} , speed when VUT impacts EPT or EBT | V_{impact} |
| 4.2.5 | Speed of the EPT or EBT during the entire test | V_{EPT} / V_{EBT} |
| 4.2.6 | Yaw velocity of the VUT during the entire test | ψ_{VUT} |
| 4.2.7 | Longitudinal acceleration of the VUT during the entire test | A_{VUT} |
| 4.2.8 | Steering wheel velocity of the VUT during the entire test | Ω_{VUT} |

4.3 Measuring Equipment

4.3.1 Equip the VUT, EPT and EBT with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

- VUT speed to 0.1km/h;
- EPT and EBT speed to 0.01km/h;
- VUT lateral and longitudinal position to 0.03m ;
- EPT and EBT position in the direction of movement to 0.03m;
- VUT yaw rate to 0.1°/s;
- VUT longitudinal acceleration to 0.1m/s²;
- VUT steering wheel velocity to 1.0 °/s.

4.4 Data Filtering

4.4.1 Filter the measured data as follows:

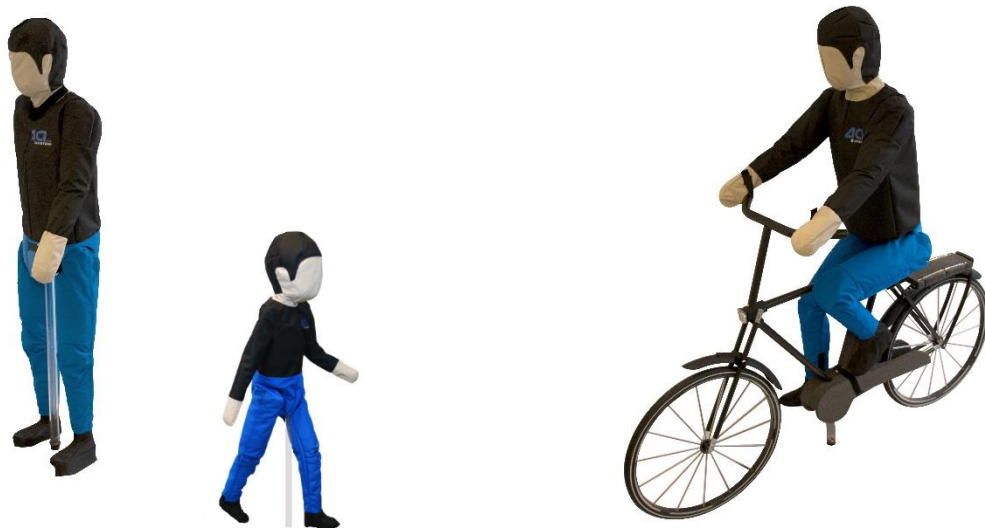
4.4.1.1 Position and speed are not filtered and are used in their raw state.

4.4.1.2 Acceleration, yaw rate and VUT steering wheel velocity with a 12-pole phaseless Butterworth filter with a cut off frequency of 10Hz.

5 EURO NCAP PEDESTRIAN and BICYCLIST TARGET

5.1 Specification

- 5.1.1 Conduct the tests in this protocol using the Euro NCAP Pedestrian Target (EPTa and EPTc) and Euro NCAP Bicyclist and bike Target (EBT) dressed in a black shirt and blue trousers, as shown in Figure 6 below. The EPT and EBT replicate the visual, radar, LIDAR and PMD attributes of a typical pedestrian and bicyclist respectively, and is impactable without causing significant damage to the VUT.



**Figure 6: Euro NCAP Pedestrian and Bicyclist and bike Targets
(EPTa, EPTc and EBT)**

- 5.1.2 To ensure repeatable results the propulsion system, EPT and EBT must meet the requirements as detailed in [Articulated Pedestrian Target Specification document version 1.0](#) and [Bicyclist Target Specification document version 1.0](#).
- 5.1.3 The EPT and EBT are designed to work with the following types of sensors:
- Radar (24 and 77 GHz)
 - LIDAR
 - Camera

When a manufacturer believes that the EPT or EBT is not suitable for another type of sensor system used by the VUT but not listed above, the manufacturer is asked to contact the Euro NCAP Secretariat.

6 TEST CONDITIONS

6.1 Test Track

- 6.1.1 Conduct tests on a dry (no visible moisture on the surface), uniform, solid-paved surface with a consistent slope between level and 1%. The test surface shall have a minimal peak braking coefficient (PBC) of 0.9.
- 6.1.2 The surface must be paved and may not contain any irregularities (e.g. large dips or cracks, manhole covers or reflective studs) that may give rise to abnormal sensor measurements within a lateral distance of 3.0m to either side of the test path and with a longitudinal distance of 30m ahead of the VUT when the test ends.
- 6.1.3 The presence of lane markings is allowed. However, testing may only be conducted in an area where typical road markings depicting a driving lane may not be parallel to the test path within 3.0m either side. Lines or markings may cross the test path, but may not be present in the area where AEB activation and/or braking after FCW is expected.

6.2 Weather Conditions

- 6.2.1 Conduct tests in dry conditions with ambient temperature above 5°C and below 40°C.
- 6.2.2 No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1km. Wind speeds shall be below 10m/s to minimise EPT, EBT and VUT disturbance. In case of wind speeds above 5m/s during test the validity of the tests is decided by lab discretion using the OEM predicted performance.
- 6.2.3 Natural ambient illumination must be homogenous in the test area and in excess of 2000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT, EPT or EBT. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight.
- 6.2.4 Measure and record the following parameters preferably at the commencement of every single test or at least every 30 minutes:
 - a) Ambient temperature in °C;
 - b) Track Temperature in °C;
 - c) Wind speed and direction in m/s;
 - d) Ambient illumination in Lux.

6.3 Surroundings

- 6.3.1 Conduct testing such that there are no other vehicles, highway infrastructure (except lighting columns during the low ambient lighting condition tests), obstructions, other objects or persons protruding above the test surface that may give rise to abnormal sensor measurements within a lateral distance of 6.0m on the driver side and 20.0m on the passenger side of the VUT test path, 1.0m around of the EPT and EBT and within a longitudinal distance of 30m ahead of the VUT when the test ends (Figure 7).

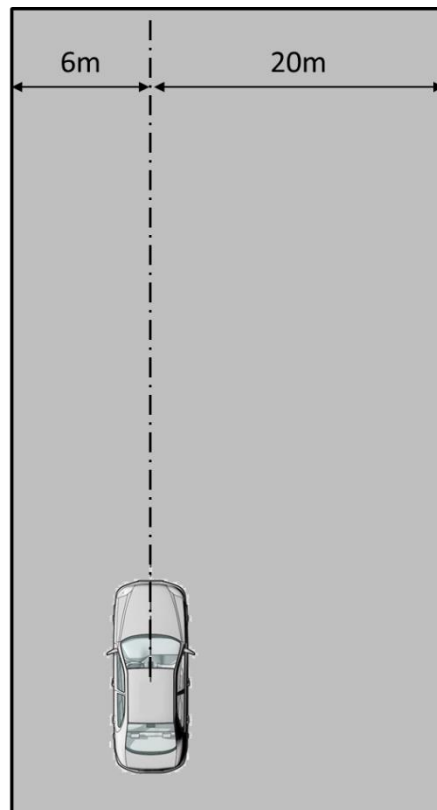


Figure 7: Free surroundings

- 6.3.2 Test areas where the VUT needs to pass under overhead signs, bridges, gantries or other significant structures are not permitted.
- 6.3.3 The general view ahead and to either side of the test area shall comprise of a wholly plain man made or natural environment (e.g. further test surface, plain coloured fencing or hoardings, natural vegetation or sky etc.) and must not comprise any highly reflective surfaces or contain any vehicle-like silhouettes that may give rise to abnormal sensor measurements.

6.4 VUT Preparation

6.4.1 AEB and FCW System Settings

- 6.4.1.1 Set any driver configurable elements of the AEB and/or FCW system (e.g. the timing of the collision warning or the braking application if present) to the middle setting or midpoint and then next latest setting similar to the examples shown in Figure 8.

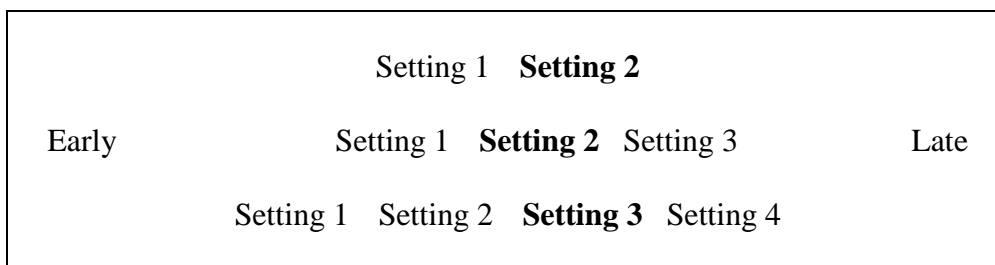


Figure 8: AEB and/or FCW system setting for testing

6.4.2 Deployable Pedestrian/VRU Protection Systems

When the vehicle is equipped with a deployable pedestrian/VRU protection system, this system shall be deactivated before the testing commences.

6.4.3 Tyres

Perform the testing with new original fitment tyres of the make, model, size, speed and load rating as specified by the vehicle manufacturer. It is permitted to change the tyres which are supplied by the manufacturer or acquired at an official dealer representing the manufacturer if those tyres are identical make, model, size, speed and load rating to the original fitment. Use inflation pressures corresponding to least loading normal condition.

Run-in tyres according to the tyre conditioning procedure specified in 7.1.3. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

6.4.4 Wheel Alignment Measurement

The vehicle should be subject to a vehicle (in-line) geometry check to record the wheel alignment set by the OEM. This should be done with the vehicle in kerb weight.

6.4.5 Unladen Kerb Mass

- 6.4.5.1 Fill up the tank with fuel to at least 90% of the tank's capacity of fuel.

- 6.4.5.2 Check the oil level and top up to its maximum level if necessary. Similarly, top up the levels of all other fluids to their maximum levels if necessary.

- 6.4.5.3 Ensure that the vehicle has its spare wheel on board, if fitted, along with any tools

supplied with the vehicle. Nothing else should be in the car.

- 6.4.5.4 Ensure that all tyres are inflated according to the manufacturer's instructions for the least loading condition.
- 6.4.5.5 Measure the front and rear axle masses and determine the total mass of the vehicle. The total mass is the 'unladen kerb mass' of the vehicle. Record this mass in the test details.
- 6.4.5.6 Calculate the required ballast mass, by subtracting the mass of the test driver and test equipment from the required 200 kg interior load.
- 6.4.6 Vehicle Preparation
- 6.4.6.1 Fit the on-board test equipment and instrumentation in the vehicle. Also fit any associated cables, cabling boxes and power sources.
- 6.4.6.2 Place weights with a mass of the ballast mass. Any items added should be securely attached to the car.
- 6.4.6.3 With the driver in the vehicle, weigh the front and rear axle loads of the vehicle.
- 6.4.6.4 Compare these loads with the "unladen kerb mass"
- 6.4.6.5 The total vehicle mass shall be within $\pm 1\%$ of the sum of the unladen kerb mass, plus 200kg. The front/rear axle load distribution needs to be within 5% of the front/rear axle load distribution of the original unladen kerb mass plus full fuel load. If the vehicle differs from the requirements given in this paragraph, items may be removed or added to the vehicle which has no influence on its performance. Any items added to increase the vehicle mass should be securely attached to the car.
- 6.4.6.6 Repeat paragraphs 6.4.6.3 and 6.4.6.4 until the front and rear axle loads and the total vehicle mass are within the limits set in paragraph 6.4.6.5. Care needs to be taken when adding or removing weight in order to approximate the original vehicle inertial properties as close as possible. Record the final axle loads in the test details. Record the axle weights of the VUT in the 'as tested' condition.
- 6.4.6.7 Verify the x-y coordinates for the virtual front end vehicle contour given by the manufacturer. When the coordinates given are within 10mm of those measured by the test laboratory, the coordinates as provided by the manufacturer will be used. When the coordinates are not within 10mm, the coordinates as measured by the laboratory will be used.

7 TEST PROCEDURE

7.1 VUT Pre-test Conditioning

7.1.1 General

7.1.1.1 A new car is used as delivered to the test laboratory.

7.1.1.2 If requested by the vehicle manufacturer, drive a maximum of 100km on a mixture of urban and rural roads with other traffic and roadside furniture to ‘calibrate’ the sensor system. Avoid harsh acceleration and braking.

7.1.2 Brakes

7.1.2.1 Condition the vehicle’s brakes in the following manner, if it has not been done before or in case the lab has performed a 100km of driving:

- Perform twenty stops from a speed of 56km/h with an average deceleration of approximately 0.5 to 0.6g.
- Immediately following the series of 56km/h stops, perform three additional stops from a speed of 72km/h, each time applying sufficient force to the pedal to operate the vehicle’s antilock braking system (ABS) for the majority of each stop.
- Immediately following the series of 72km/h stops, drive the vehicle at a speed of approximately 72km/h for five minutes to cool the brakes.

7.1.3 Tyres

7.1.3.1 Condition the vehicle’s tyres in the following manner to remove the mould sheen, if this has not been done before for another test or in case the lab has performed a 100km of driving:

- Drive around a circle of 30m in diameter at a speed sufficient to generate a lateral acceleration of approximately 0.5 to 0.6g for three clockwise laps followed by three anticlockwise laps.
- Immediately following the circular driving, drive four passes at 56km/h, performing ten cycles of a sinusoidal steering input in each pass at a frequency of 1Hz and amplitude sufficient to generate a peak lateral acceleration of approximately 0.5 to 0.6g.
- Make the steering wheel amplitude of the final cycle of the final pass double that of the previous inputs.

7.1.3.2 In case of instability in the sinusoidal driving, reduce the amplitude of the steering input to an appropriately safe level and continue the four passes.

7.1.4 AEB/FCW System Check

7.1.4.1 Before any testing begins, perform a maximum of ten runs at the lowest test speed the system is supposed to work, to ensure proper functioning of the system.

7.2 Test Scenarios

7.2.1 The performance of the system is assessed in different scenarios. For AEB Pedestrian the scenarios CPFA-50, CPNA-25, CPNA-75, CPNC-50 and CPLA are considered as shown in Figures 10a, 10b, 10c and 10d respectively.

7.2.2 For AEB Bicyclist the CBNA and CBLA scenarios are considered as shown in Figures 11a and 11b.

7.2.3 For testing purposes, assume a straight line path equivalent to the centreline of the lane in which the collision occurred, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

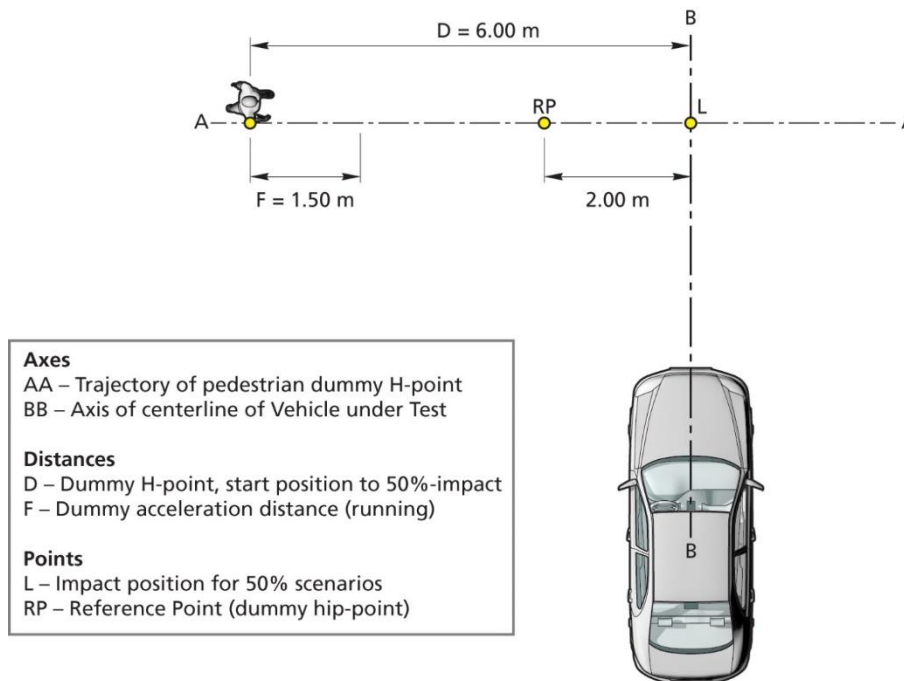


Figure 9a: CPFA-50 scenario, Adult running from Farside

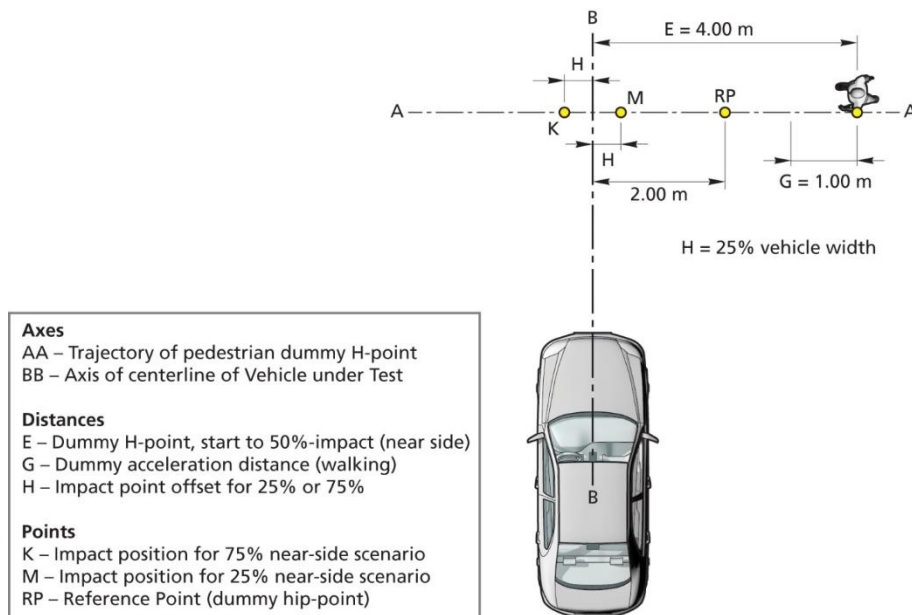


Figure 10b: CPNA-25 & CPNA-75 scenarios, Walking Adult from Nearside

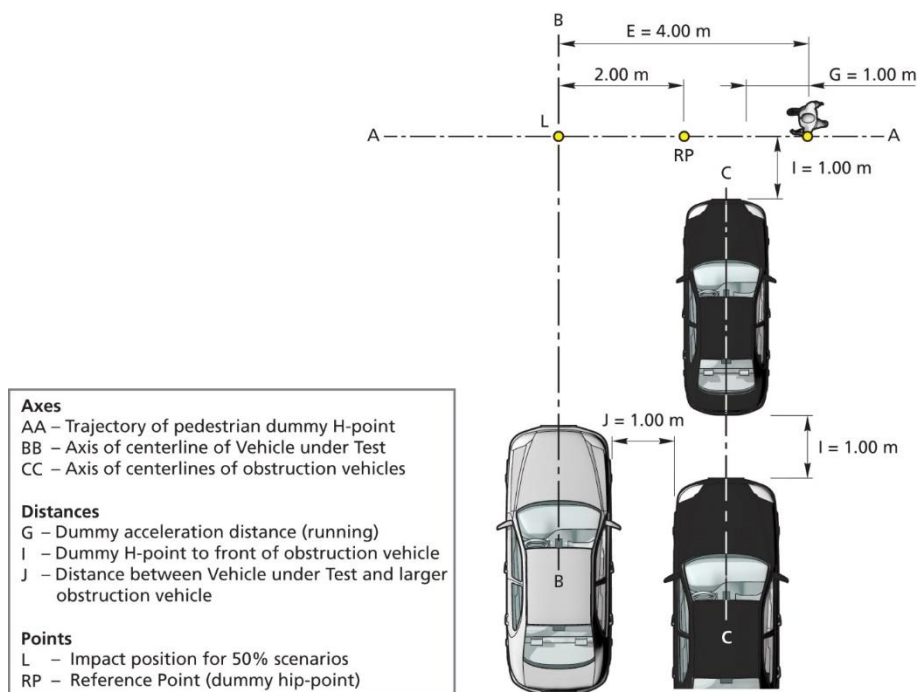


Figure 10c: CPNC-50 scenario, Running Child from Nearside from Obstruction vehicles (see Annex A)

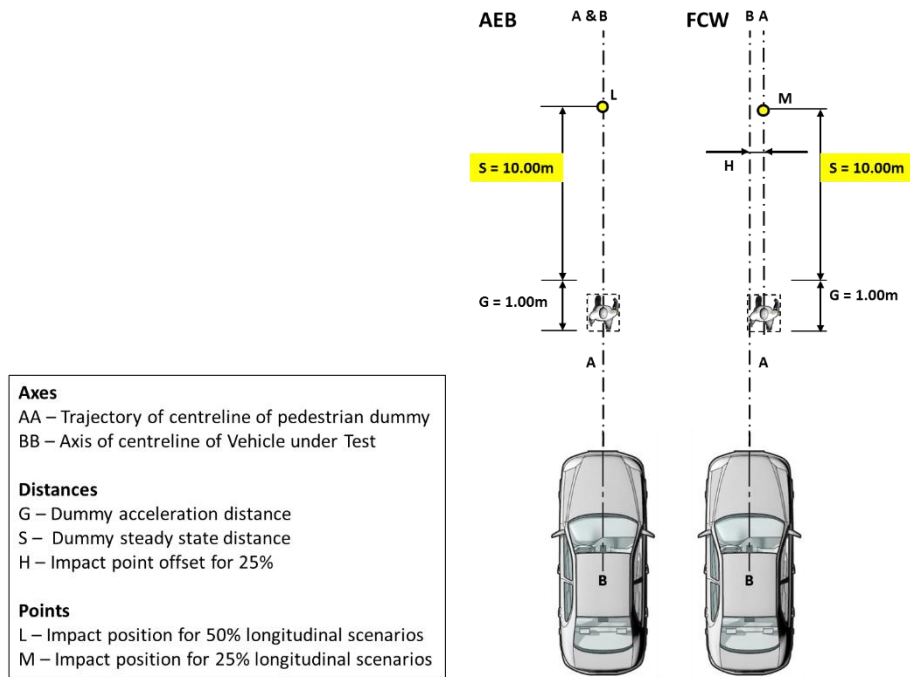


Figure 10d: CPLA scenario, Longitudinal walking Adult

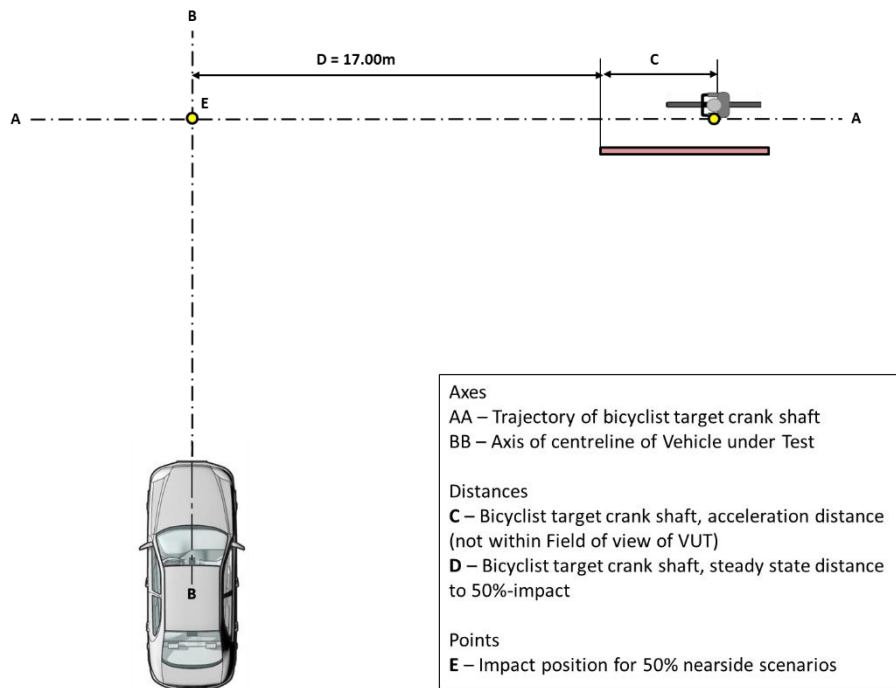


Figure 10a: CBNA scenario, Bicyclist from Nearside

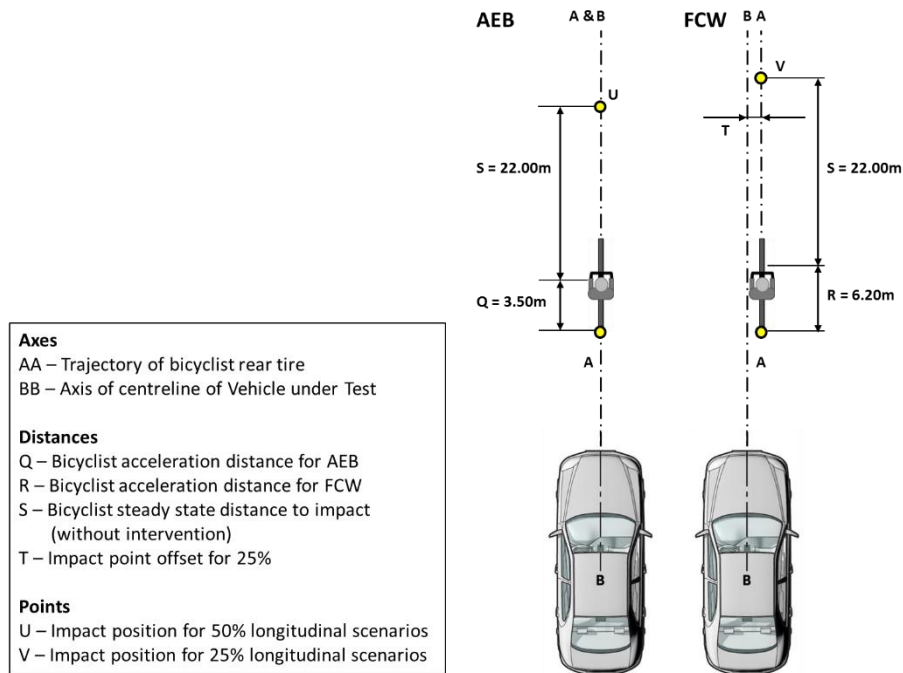


Figure 11b: CBLA scenarios, Longitudinal Bicyclist (AEB left & FCW right)

7.2.4 All tests will be performed with 5 km/h incremental steps within the speed ranges as summarised in the tables below:

| | AEB Pedestrian | | | | | |
|------------------------|-----------------------|---------|---------|---------|---------|------------|
| | CPFA-50 | CPNA-25 | CPNA-75 | CPNC-50 | CPLA-50 | CPLA-25 |
| Type of test | AEB | | | | | FCW |
| VUT speed | 20-60 km/h | | | | | 50-80 km/h |
| Target speed | 8 km/h | 5 km/h | | | | |
| Impact location | 50% | 25% | 75% | 50% | 50% | 25% |

| | AEB Bicyclist | | |
|------------------------|----------------------|------------|------------|
| | CBNA-50 | CBLA-50 | CBLA-25 |
| | AEB | | FCW |
| VUT speed | 20-60 km/h | 25-60 km/h | 50-80 km/h |
| Target speed | 15 km/h | | 20 km/h |
| Impact location | 50% | | 25% |

7.2.5 For the CPNA-75 scenario the following additional tests are performed as part of the prerequisite verification:

- Test speed of 20km/h with an EPTa speed of 3 km/h
- Test speed of 10km/h with an EPTa speed of 5 km/h

7.3 Test Conduct

7.3.1 Before every test run, drive the VUT around a circle of maximum diameter 30m at a speed less than 10km/h for one clockwise lap followed by one anticlockwise lap, and then manoeuvre the VUT into position on the test path. If requested by the OEM an initialisation run may be included before every test run. Bring the VUT to a halt and push the brake pedal through the full extent of travel and release.

7.3.2 For vehicles with an automatic transmission select D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1500 at the test speed.

7.3.3 Perform the first test a minimum of 90s and a maximum of 10 minutes after completing the tyre conditioning (if applicable), and subsequent tests after the same time period. If the time between consecutive tests exceeds 10 minutes perform three brake stops from 72 km/h at approximately 0.3g.

Between tests, manoeuvre the VUT at a maximum speed of 50km/h and avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.

7.4 Test Execution

7.4.1 Accelerate the VUT and EPT or EBT to the respective test speeds.

7.4.2 The test shall start at T_0 (4s TTC) and is valid when all boundary conditions are met between T_0 (for CPLA & CBLA-AEB T_0 -1s) and T_{AEB} and/or T_{FCW} :

- Speed of VUT (GPS-speed) Test speed + 0.5 km/h
- Lateral deviation from VUT test path 0 ± 0.05 m
- Lateral deviation from EPT and EBT test path
 - crossing scenarios 0 ± 0.05 m
 - longitudinal scenarios 0 ± 0.15 m
 - lateral velocity 0 ± 0.15 m/s

- Yaw velocity 0 ± 1.0 °/s
- Steering wheel velocity 0 ± 15.0 °/s

- Speed of EPT or EBT during steady state ± 0.2 km/h

- Start of steady state
 - EPT Nearside 3.0 m from vehicle centreline
 - EPT Farside 4.5 m from vehicle centreline
 - EBT Nearside 17m from vehicle centreline
 - EPT and EBT Longitudinal 22m from vehicle front impact point

7.4.3 The end of a test, where the AEB function is assessed, is considered when one of the following occurs:

- $V_{VUT} = 0\text{km/h}$ (crossing) or $V_{VUT} = V_{EPT/EBT}$ (longitudinal)
- Contact between VUT and EPT or EBT
- EPT or EBT has left the VUT path or VUT has left the EPT or EBT path

For tests where the FCW function is assessed, the end of a test is considered when one of the following occurs:

- $V_{VUT} = 0\text{km/h}$ (crossing) or $V_{VUT} = V_{EPT/EBT}$ (longitudinal)
- $T_{FCW} < 1.5\text{s TTC}$, after which an evasive action can be started

7.4.4 For manual or automatic accelerator control, it needs to be assured that during automatic brake the accelerator pedal does not result in an override of the system. The accelerator pedal needs to be released when the initial test speed is reduced by 5 km/h. There shall be no operation of other driving controls during the test, e.g clutch or brake pedal.

7.4.5 The subsequent test speed for the next test is incremented with 5km/h. Stop testing when the actual speed reduction seen in the tests above 40 km/h is less than 20 km/h or when the manufacturer predicts no performance.

7.4.6 When the impact speed recorded in the test differs from the manufacturer predicted performance by more than 5 km/h, the test shall be repeated a further two times for monitoring purposes. These results will be discussed between Euro NCAP and manufacturer to determine which results are to be used for the assessment (most representative) for the vehicle under test.

ANNEX A OBSTRUCTION DIMENSIONS

A.1 Smaller obstruction vehicle

The smaller obstruction vehicle should be of the category Small Family Car and is positioned closest to the pedestrian path. The smaller obstruction vehicle should be within the following geometrical dimensions and needs to be in a dark colour.

| | Vehicle Length | Vehicle width (without mirrors) | Vehicle Height | Bonnet length (till A pillar) | BLE height |
|---------|-----------------------|--|-----------------------|--------------------------------------|-------------------|
| Minimum | 4100 mm | 1700 mm | 1300 mm | 1100 mm | 650 mm |
| Maximum | 4400 mm | 1900 mm | 1500 mm | 1500 mm | 800 mm |

A.2 Larger obstruction vehicle

The larger obstruction vehicle should be of the category Small Offroad 4x4 and is positioned behind the smaller obstruction vehicle. The larger obstruction vehicle should be within the following geometrical dimensions and needs to be in a dark colour.

| | Vehicle Length | Vehicle width (without mirrors) | Vehicle Height |
|---------|-----------------------|--|-----------------------|
| Minimum | 4300 mm | 1750 mm | 1500 mm |
| Maximum | 4700 mm | 1900 mm | 1800 mm |

A.3 Obstruction for bicycle acceleration phase

The obstruction represents a permanent full view blocking obstruction from the ground up (brick building or wall) between vehicle and bicyclist running parallel with the bicyclist path.

A.3.1 Obstruction dimensions

The obstruction should have flat uniform surfaces from the ground up visible from the VUT.

- Height of the obstruction $\geq 2.00\text{m}$
- Width of the obstruction ≥ 0.05 and $\leq 0.50\text{m}$
- Length of the obstruction $\geq 8.50\text{m}$

A.3.2 Visible properties

The obstruction sides visible from the VUT should have a uniform light colour.

A.3.3 Radar properties

The radar cross section (RCS) properties of the obstructions long side, visible from the VUT, should be similar to brick wall with similar RCS observed as depicted in Figure A.1. It is noted that the RCS verification scenario is not a 2018 test scenario.

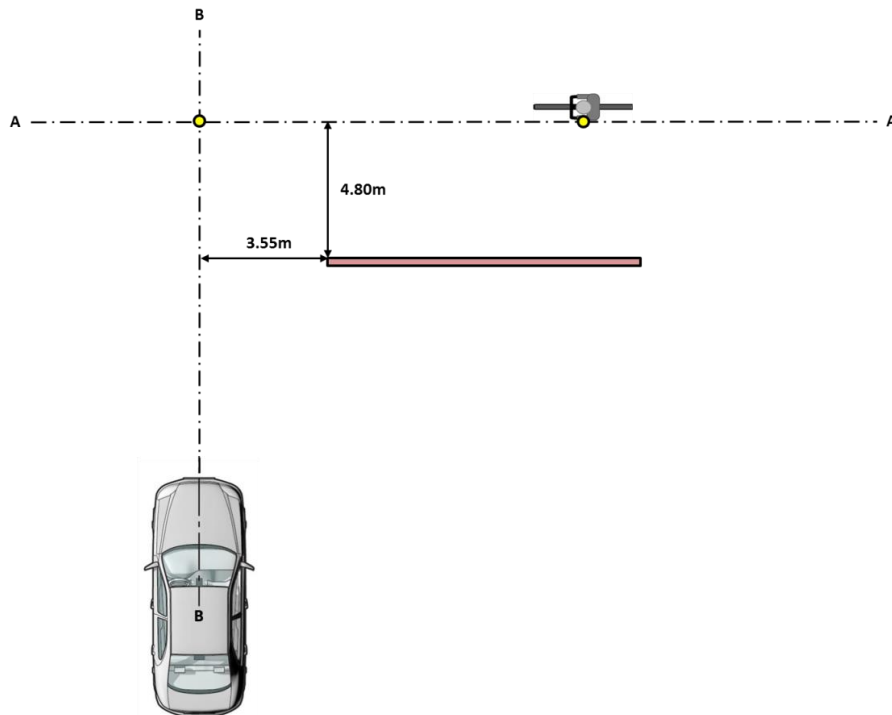


Figure A.1 Obstruction measurement set-up