EURO NCAP
#FORSAFERCARS

Version 0.9
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Crash Avoidance
Low Speed Collisions

Protocol

Implementation January 2026

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 Secretary General should be immediately informed. Any such incident may be reported by the Secretary General to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

NOTE: All 2026 protocols with a version number 0.9 are under final review of the Working Group and might undergo minor changes

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

Start from Stop (SfS) – a test condition in which the VUT starts moving off from standstill.

Peak Braking Coefficient (PBC) – the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre, measured using the method as specified in UNECE R13-H.

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.

Door Opening Warning (DOW) – an audio-visual warning that is provided automatically by the vehicle in response to the detection of a likely dooring collision with a passing bicyclist.

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 – a collision between a vehicle and an adult or child pedestrian in its path, when no braking and/or steering action is applied.

Car-to-Bicyclist – a collision between a vehicle and an adult bicyclist in its path, when no braking and/or steering is applied.

Car-to-Motorcyclist – a collision between a vehicle and a Motorcyclist in its path, when no braking and/or steering 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 articulated adult pedestrian target used in this protocol as specified in ISO 19206-2:2018

Euro NCAP Child Target (EPTc) – means the articulated child pedestrian target used in this protocol as specified in ISO 19206-2:2018

Euro NCAP Bicyclist Target (EBTa) – means the adult bicyclist and bike target used in this protocol as specified in ISO 19206-4:2020

Euro NCAP Motorcyclist Target (EMT) – means the Motorcyclist target used in this protocol as specified in ISO 19206-5.

Global Vehicle Target (GVT) – means the vehicle target used in this protocol as defined in ISO 19206-3:2021

Time To Collision (TTC) – means the remaining time before the VUT strikes the test target, assuming that the VUT and test target 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 or rear end of the VUT coincides with the virtual box around the test targets (platform not included in the virtual box) EPTa, EPTc, EBTa and EMT as shown in the right part of the figures below.

V_{rel_test} – means the relative speed between the VUT and the test target (GVT, EPT, EBT or EMT) by subtracting the longitudinal velocity of the test target from that of the VUT at the start of test.

V_{rel_impact} – means the relative speed at which the VUT hits the test target (GVT, EPT, EBT or EMT) by subtracting the longitudinal velocity of the test target from V_{impact} at the time of collision.

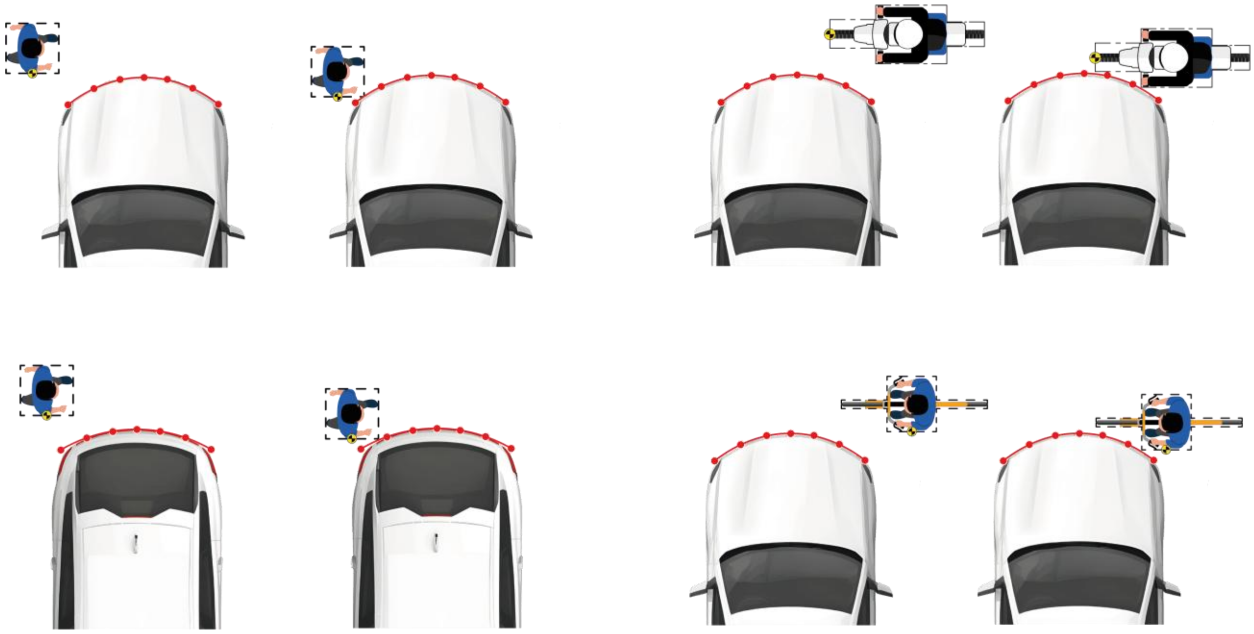


Figure 0-1 Front end profile vs EPT, EMT, and EBT targets, and rear end profile vs EPT target.

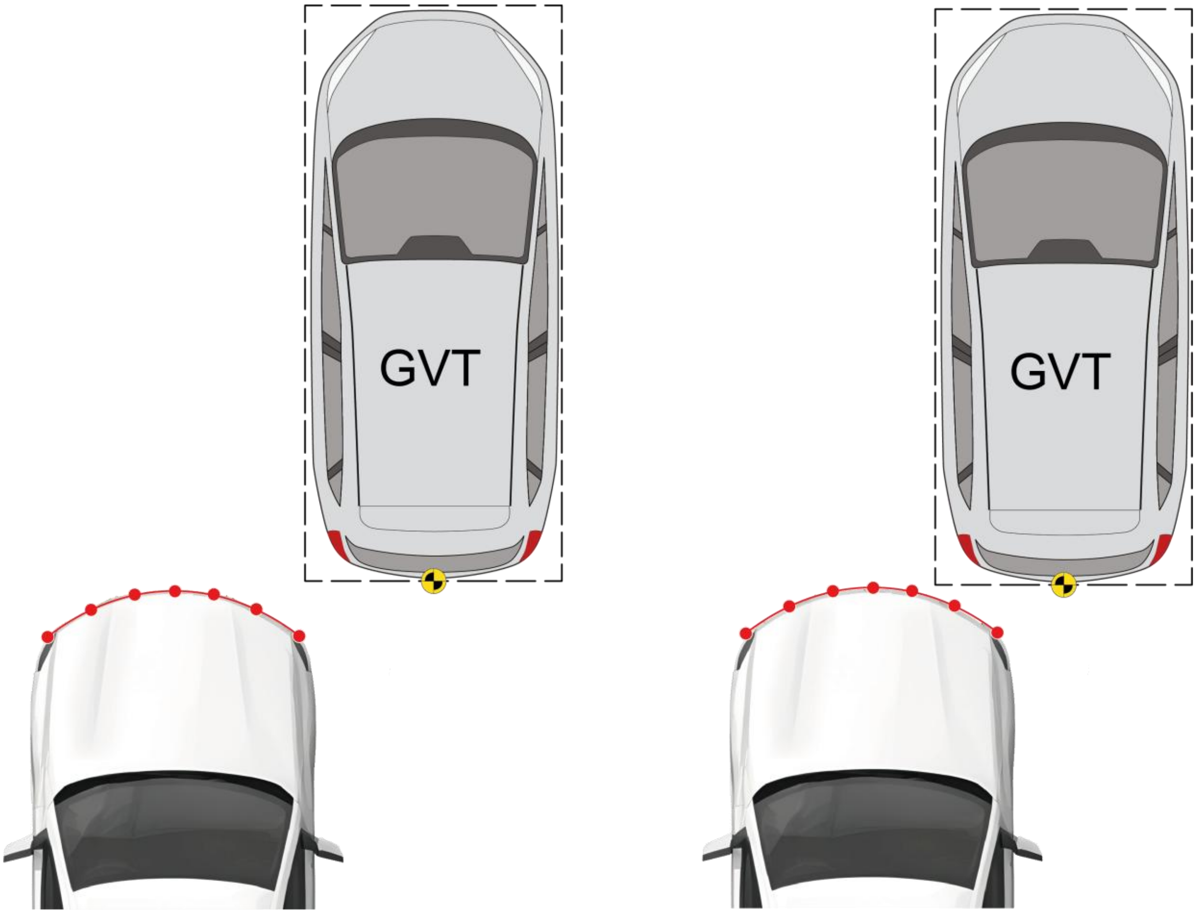


Figure 0-2 Front end profile and GVT

Test Scenarios

Car-to-Bicyclist Dooring Adult (CBDA) – a collision between the vehicle’s door (or an occupant exiting a vehicle equipped with a sliding door) and a bicyclist traveling alongside the parked vehicle.

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

Car-to-Motorcyclist Turn Across Path (CMFtap) – a collision in which a vehicle turns across the path of an oncoming motorcyclist travelling at a constant speed, and the frontal structure of the vehicle strikes the front of the motorcycle.

Car-to-Motorcyclist Crossing Straight Crossing Path (CMCscp) – a collision in which a vehicle travels forwards along a straight path across a junction, towards a motorcyclist crossing the junction on a perpendicular path. The outermost frontal structure of the vehicle under test strikes the front of the motorcycle.

Car-to-Car Front Turn-Across-Path (CCFtap) – a collision in which a vehicle turns across the path of an oncoming vehicle travelling at constant speed, and the frontal structure of the vehicle strikes the front structure of the other.

Car-to-Car Crossing Straight Crossing Path (CCCscp) – a collision in which a vehicle travels forwards along a straight path across a junction, towards a vehicle crossing the junction on a perpendicular path. The frontal structure of the vehicle under test strikes the side of the other vehicle.

Car-to-Pedestrian Manoeuvring Reverse Child moving (CPMRCm) – a collision in which a vehicle travels rearwards towards a child pedestrian crossing its path walking from the nearside. The rear structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Manoeuvring Reverse Child stationary (CPMRCs) – a collision in which a vehicle travels rearwards towards a child pedestrian standing still. The rear structure of the vehicle strikes the pedestrian at 25, 50 or 75% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Manoeuvring Front Child (CPMFC) – a collision in which a vehicle travels forwards towards a child pedestrian standing still. The front structure of the vehicle strikes the pedestrian at 25, 50 or 75% of the vehicle's width when no braking action is applied.

1 MEASURING EQUIPMENT

1.1 Reference system

1.1.1 Convention

Use the convention specified in ISO 8855:2011, with the origin at the most forward point on the centreline of the VUT for dynamic data measurements as shown in Figure 1-1. This reference system should be used for both left- and right-hand drive vehicles. In Figure 1-1 nearside and far-side are shown for a left-hand drive vehicle. For a right-hand drive vehicle, nearside and far-side are swapped.

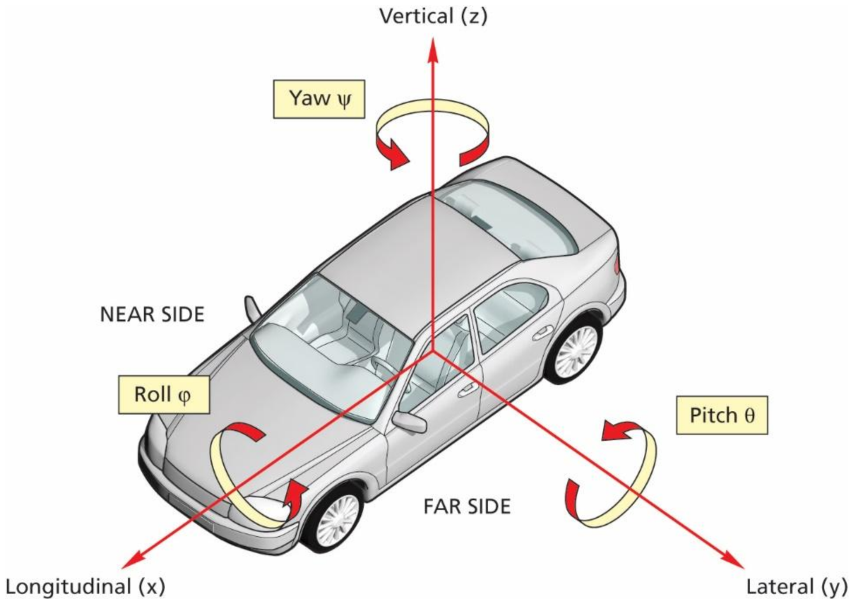


Figure 1-1 Coordinate system and notation

1.2 Targets

Only equipment listed in the current version of TB029 - Suppliers List may be used for testing. The current version can be found on the Euro NCAP website.

1.2.1 Virtual Boxes

For each test target, a virtual box defined will be used to determine the impact speed. The dimensions of these virtual boxes are shown in the figures below, along with impact reference points related to each test target.

Impact location descriptions in Chapter 3.1.2 and scenario descriptions in Chapter 5 illustrate which of the reference points is to be utilised for each specific scenario.

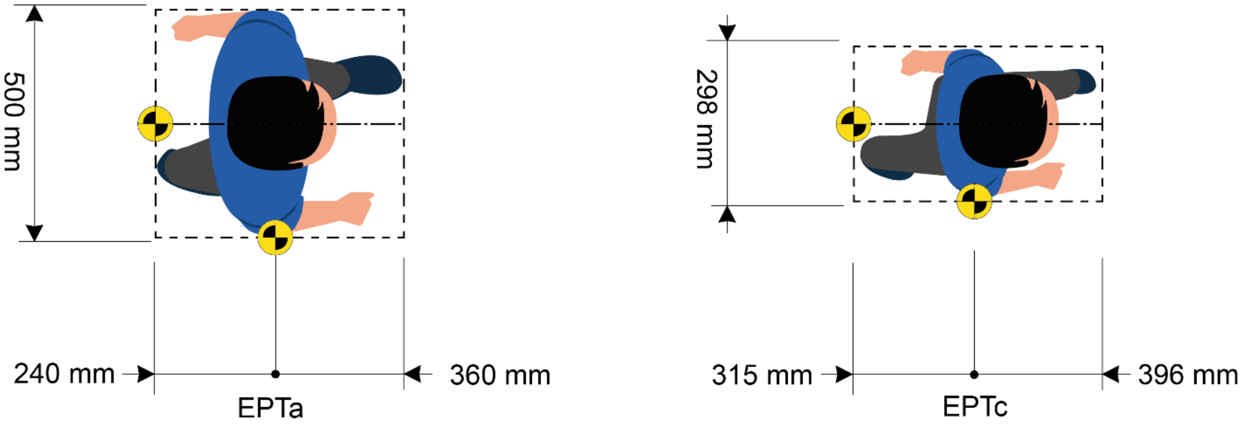


Figure 1.2.1: Virtual box dimensions around EPTa and EPTc

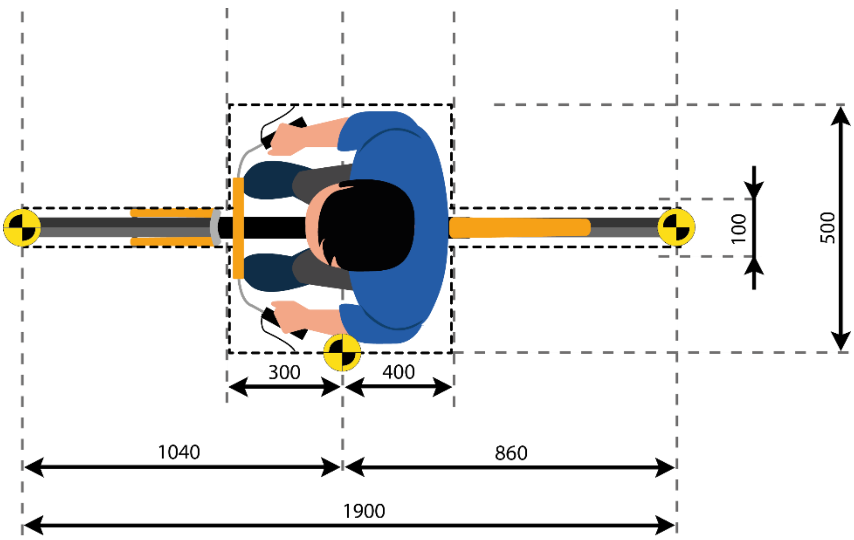


Figure 1.2.2: Virtual box dimensions around EBT

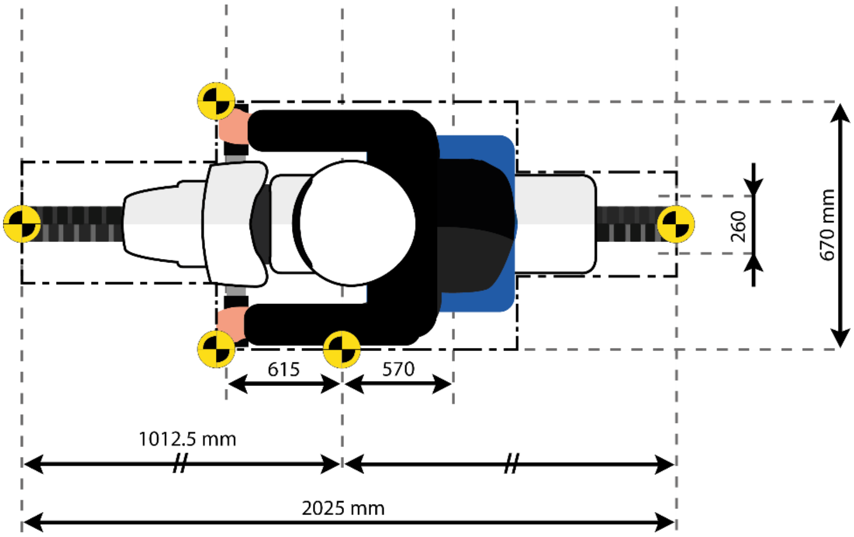


Figure 1.2.3: Virtual box dimensions around EMT

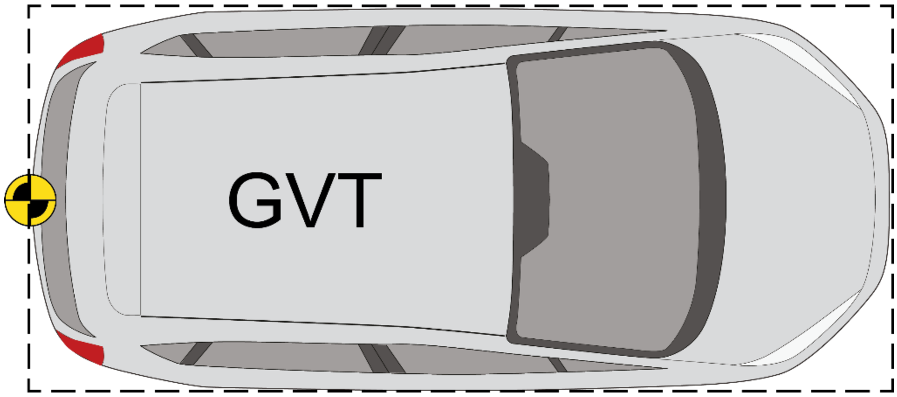


Figure 1.2.4: Virtual box illustration around the GVT, and the rear impact point

1.3 Measurements and variables

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

1.4 Variables

Time	T
T_0, time of test start. Unless otherwise stated T_0 = TTC 4s	T_0
Scenarios involving steering: T_0 is 1s. before T_{steer}	
T_{AEB}, time where AEB activates	$\mathbf{T}_{AEB}$
T_{FCW}, time where FCW activates	$\mathbf{T}_{FCW}$
T_{impact}, time where VUT impacts GVT	$\mathbf{T}_{impact}$
T_{steer}, time where VUT enters in curve segment	$\mathbf{T}_{steer}$
$T_{GVT\_deceleration\_start}$, time where GVT starts decelerating (deceleration to be reached in 1.0 seconds)	$T_{GVT\_deceleration\_start}$
T_{tart}, time where VUT starts moving	T_{Start}
(in CCCscp start from stop scenario)	
T_{End}, time where VUT has travelled 2.9m. from the start position	T_{End}
(in CCCscp start from stop scenario)	
T_{Avg}, average time value of T_{End} from all the executed trials	T_{Avg}
(in CCCscp start from stop scenario)	
Position of the VUT during the entire test	$\mathbf{X}_{VUT}$, $\mathbf{Y}_{VUT}$
Position of the GVT during the entire test	$\mathbf{X}_{GVT}$, $\mathbf{Y}_{GVT}$
Position of the EMT during the entire test	$\mathbf{X}_{EMT}$, $\mathbf{Y}_{EMT}$
Speed of the VUT during the entire test	$\mathbf{V}_{VUT}$
V_{impact}, speed when VUT impacts GVT	$\mathbf{V}_{impact}$
V_{rel_impact}, relative speed when VUT impacts GVT	$\mathbf{V}_{rel\_impact}$
Speed of the target during the entire test	$\mathbf{V}_{target}$
Yaw velocity of the VUT during the entire test	$\dot{\Psi}_{VUT}$
Yaw velocity of the target during the entire test	$\dot{\Psi}_{target}$
Acceleration of the VUT during the entire test	$\mathbf{A}_{VUT}$
Acceleration of the target during the entire test	$\mathbf{A}_{target}$
Steering wheel velocity of the VUT during the entire test	$\mathbf{\Omega}_{VUT}$

1.4.1 Measurements

Equip the VUT and GVT with data measurement and acquisition equipment to sample and record data with an accuracy of at least:

- VUT and target speed to 0.1km/h;
- VUT and target lateral and longitudinal position to 0.03m;
- VUT heading angle to 0.1°;
- VUT and target yaw rate to 0.1°/s;
- VUT and target longitudinal acceleration to 0.1m/s2;
- VUT steering wheel velocity to 1.0 °/s

1.4.2 Filtering

Filter the measured data as follows:

- Position and speed are not filtered and are used in their raw state.
- Acceleration, yaw rate, steering wheel velocity and force are filtered with a 12-pole phase less Butterworth filter with a cut off frequency of 10Hz.

2 TEST CONDITIONS

2.1 Test track

Conduct tests on a dry (no visible moisture on the surface), uniform, solid paved surface with a maximum longitudinal slope of ±1% and a maximum lateral slope of ±3%. The test surface shall have a minimal peak braking coefficient (PBC) of 0.9.

The test track surface must be paved and may not contain 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 5.0m to either side of the test path, and with a longitudinal distance of 20m ahead of the VUT when the test ends.

Unless otherwise specified:

Conduct testing such that, between T_0 and the test end, there are no other vehicles, infrastructure (except lighting columns during the low ambient lighting condition tests), obstructions, other objects or persons which may give rise to abnormal sensor measurements within the visual axis of the VUT and test target, and 20m ahead of the VUT at test end.

The general view ahead and to either side of the test area shall not comprise of any highly reflective surfaces or contain any silhouettes similar in shape to the test target.

2.2 Lane Markings

The presence of lane markings is allowed for AEB tests. 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.

Some scenarios described in this document require the use of a junction, where this is the case the scenario description will illustrate the scenario on a junction as in Figure 4.2. The main approach lane where the VUT path starts, (horizontal lanes in Figure 4.2) will have a width of 3.5m. The side lane (vertical lanes in Figure 4.2) will have a width of 3.25 to 3.5m. The lane markings on these lanes need to conform to one of the lane markings as defined in UNECE Regulation 130:

1. Dashed line starting at the same point where the radius transitions into a straight line with a width between 0.10 and 0.15m
2. Solid line with a width between 0.10 and 0.25m
3. Junction without any central markings

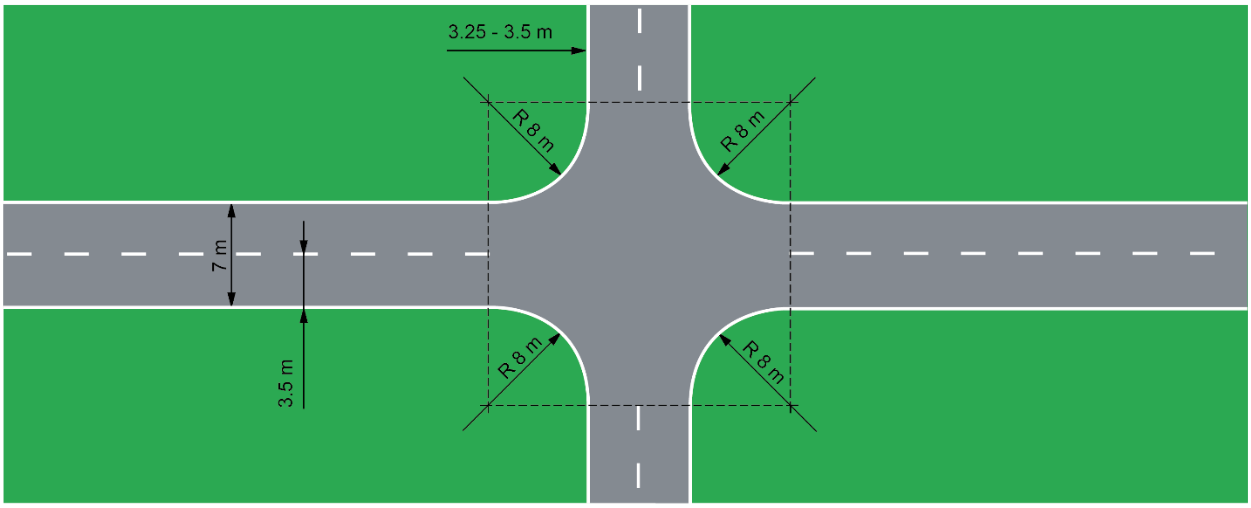


Figure 4.2: Layout of junction and the connecting lanes

(Dimensions reference centre of lane markings)

2.3 Weather Conditions

Unless otherwise specified:

Conduct tests in dry conditions with ambient temperature above 5°C and below 40°C.

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 GVT and VUT disturbance.

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 or GVT. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight.

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.

2.4 VUT Preparation

2.4.1 AEB and FCW System Settings

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 4.4.

When the vehicle is equipped with a Driver State Monitoring (DSM) which alters the AEB and/or FCW sensitivity according to the driver's state (e.g. distracted / attentive), this system shall be deactivated before the testing commences.

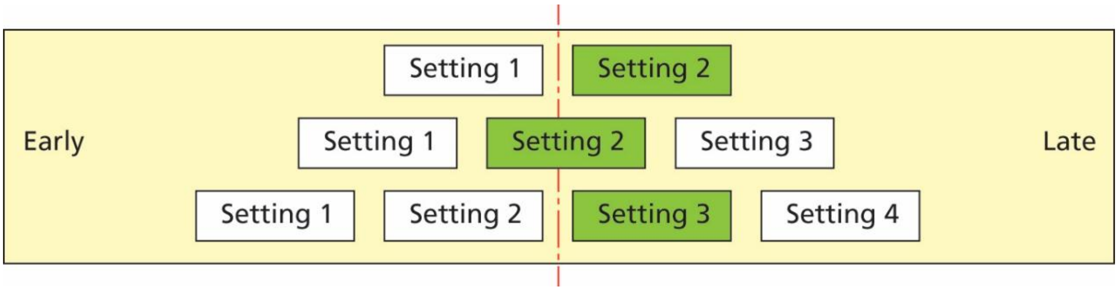


Figure 4.4: AEB and/or FCW system setting for testing

2.4.2 Deployable Pedestrian/VRU Protection Systems

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

2.4.3 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. Inflate the tyres to the vehicle manufacturer's recommended cold tyre inflation pressure(s). Use inflation pressures corresponding to least loading normal condition.

Run-in tyres according to the tyre conditioning procedure specified in **Error! Reference source not found.**. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

2.4.4 Wheel Alignment Measurement and Unladen Kerb Mass

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.

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

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.

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.

Ensure that all tyres are inflated according to the manufacturer's instructions for the appropriate loading condition.

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.

Calculate the required ballast mass, by subtracting the mass of the test driver and test equipment from the required 200 kg interior load.

2.4.5 Vehicle Preparation

Fit the on-board test equipment and instrumentation in the vehicle. Also fit any associated cables, cabling boxes and power sources and place weights with a mass of the ballast mass. Any items added should be securely attached to the car.

With the driver in the vehicle, weigh the front and rear axle loads of the vehicle and compare these loads with the “unladen kerb mass”

The total vehicle mass shall be within ±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.

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.

3 TEST PROCEDURE

For all scenarios, the assessment is based on a GRID prediction provided by the Vehicle Manufacturer. The actual scenarios to be tested to verify the prediction will be chosen randomly (excluding points where performance criteria is not met).

3.1 Car & PTW Scenarios

The test scenarios for Car & PTW are shown below:

3.1.1 Car-to-Car Crossing

CCCscp	**GVT speed**				
	20 km/h	30 km/h	40 km/h	50 km/h	60 km/h
SfS					

The VUT is initially at standstill with an initial longitudinal distance to the impact point side between 2.5 and 2.9m, randomly selected. Assume a straight-line path equivalent to the centre line of the driving lane, approaching and continuing straight ahead across a junction.

For the GVT, assume a straight-line path equivalent to the centre line of the driving lane, perpendicular to that of the VUT, travelling across the junction from the farside direction,

The scenario setup is illustrated in Figure 3-1.

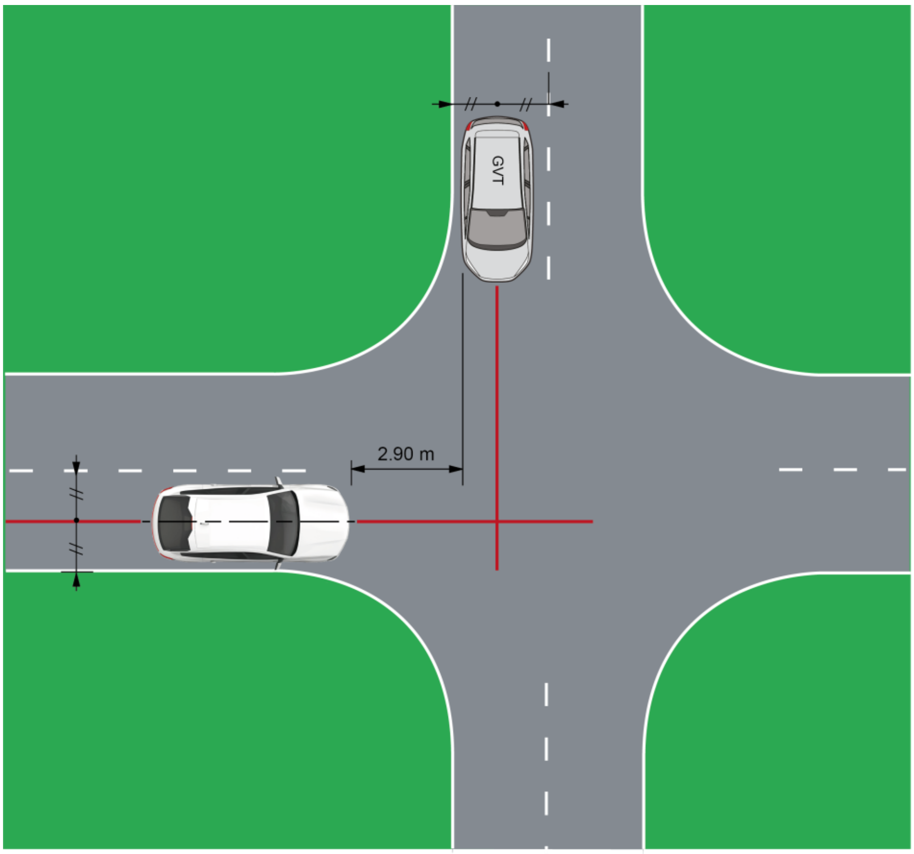


Figure 3-1 CCCscp SfS scenario setup

Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Accelerator Pedal profile as described in APPENDIX A.

The GVT shall be accelerated to the selected speed at a rate >1m/s^2 during the acceleration phase. This is followed by a 0.5 s stabilization phase, after which steady state conditions shall be met.

The paths will be synchronised so that the front of the VUT collides with the reference point of the GVT at an impact location of 50% ±25% (assuming no system reaction).

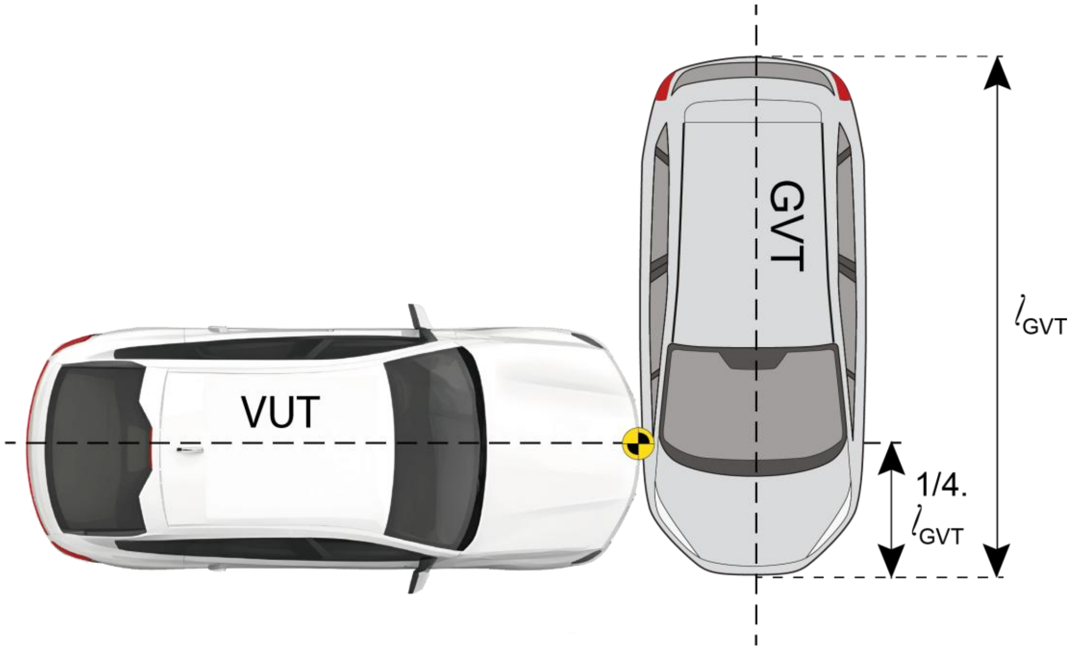


Figure 3-2 CCCscp SfS Impact point definition

3.1.2 Car-to-Motorcyclist Crossing

CMCscp	EMT speed						
	20 km/h	30 km/h	40 km/h	50 km/h	60 km/h	70 km/h	80km/h
SfS							

The VUT is initially at standstill with an randomly selected longitudinal distance to the impact point between 2.5 and 2.9m. Assume a straight-line path equivalent to the centre line of the driving lane, approaching and continuing straight ahead across a junction.

For the EMT, assume a straight-line path equivalent to the centre line of the driving lane, perpendicular to that of the VUT, travelling across the junction from the farside direction.

The scenario setup is illustrated in Figure 3-3.

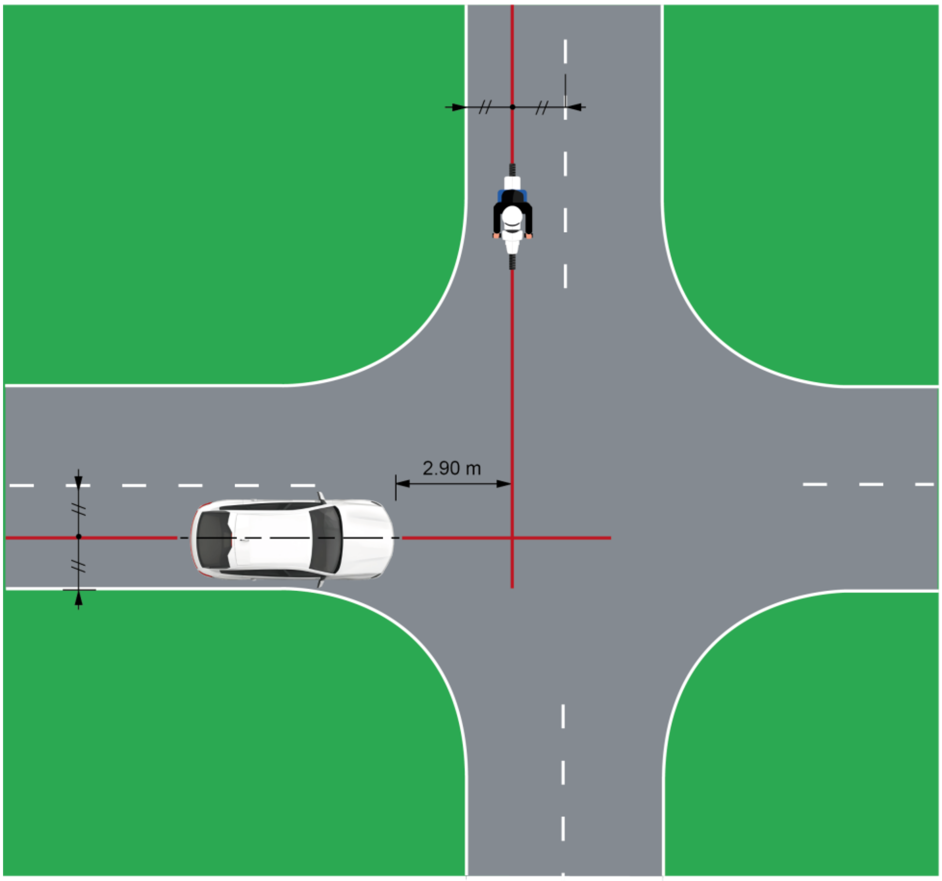


Figure 3-3 CMCscp SfS scenario setup

Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Accelerator Pedal profile as described in APPENDIX A.

The EMT shall be accelerated to the selected speed at a rate >1m/s^2 during the acceleration phase. This is followed by a 0.5 s stabilization phase, after which steady state conditions shall be met.

The paths will be synchronised so that the VUT collides with the reference point of the EMT at an impact location of 100% and with a tolerance of ±10% of the vehicle length (assuming no system reaction), as illustrated in Figure 3-4 100% Impact location on CMCscp SfS (target approching from farside)

Car-to-car Turn Across Path

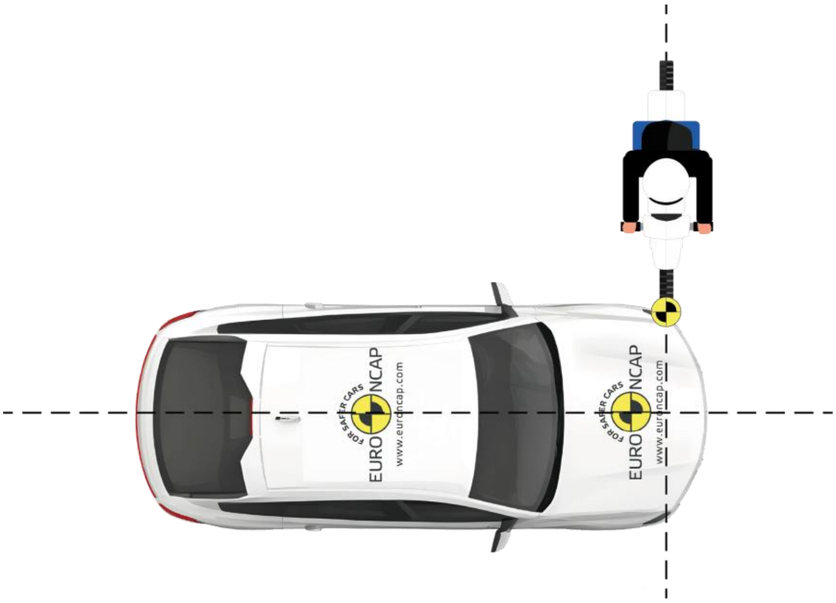


Figure 3-4 100% Impact location on CMCscp SfS (target approching from farside)

3.1.3 Car-to-car Turn Across Path

CCFtap	GVT speed		
	30 km/h	45 km/h	60 km/h
SfS			

The initial position of the VUT shall be defined so that it first follows the 10km/h test case path and then stops when the outermost farside of the VUT coincides with the centre of the (virtual) central lane marking of the intersection.

The GVT will follow a straight-line path in the lane adjacent to the VUT's initial position, in the opposite direction to the VUT. The straight-line path of the VUT and GVT will be 1.75m from the centre of the centre dashed lane marking of the VUT lane.

The scenario setup is illustrated in Figure 3-5.

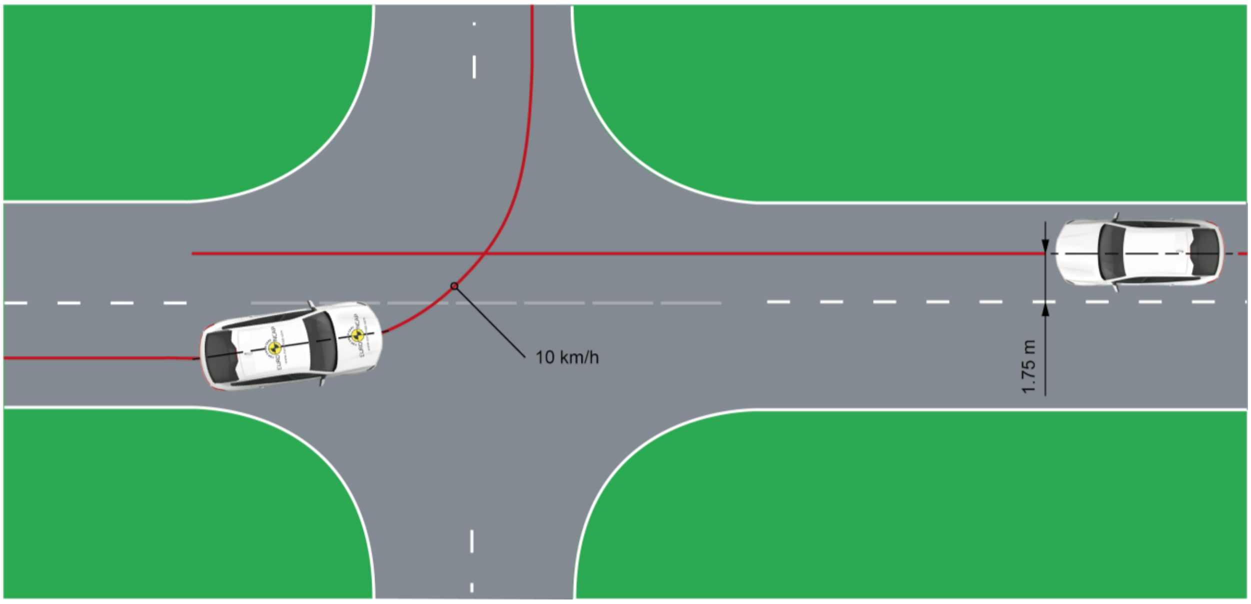


Figure 3-5 CCFtap SfS scenario setup

Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Accelerator Pedal profile as described in APPENDIX A.

The paths of the VUT and GVT will be synchronised so that the VUT coincides with the reference point of the GVT at an impact location of 50% ±25% (assuming no system reaction), as illustrated in Figure 3-6.

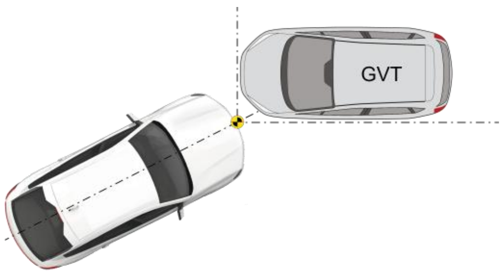


Figure 3-6 CCFtap SfS Impact point definition

3.1.4 Car-to-Motorcyclist Turn Across Path

CMFtap	EMT speed			
	30 km/h	45 km/h	60 km/h	80 km/h
SfS				

The initial position of the VUT shall be defined so that it first follows the path of the 10km/h test case and then stops when the outermost farside of the VUT coincides with the (virtual) central lane marking of the intersection.

The EMT will follow a straight-line path in the lane adjacent to the VUT's initial position, in the opposite direction to the VUT. The straight-line path of the VUT and EMT will be 1.75m from the centre of the centre dashed lane marking of the VUT lane, as illustrated in Figure 3-7.

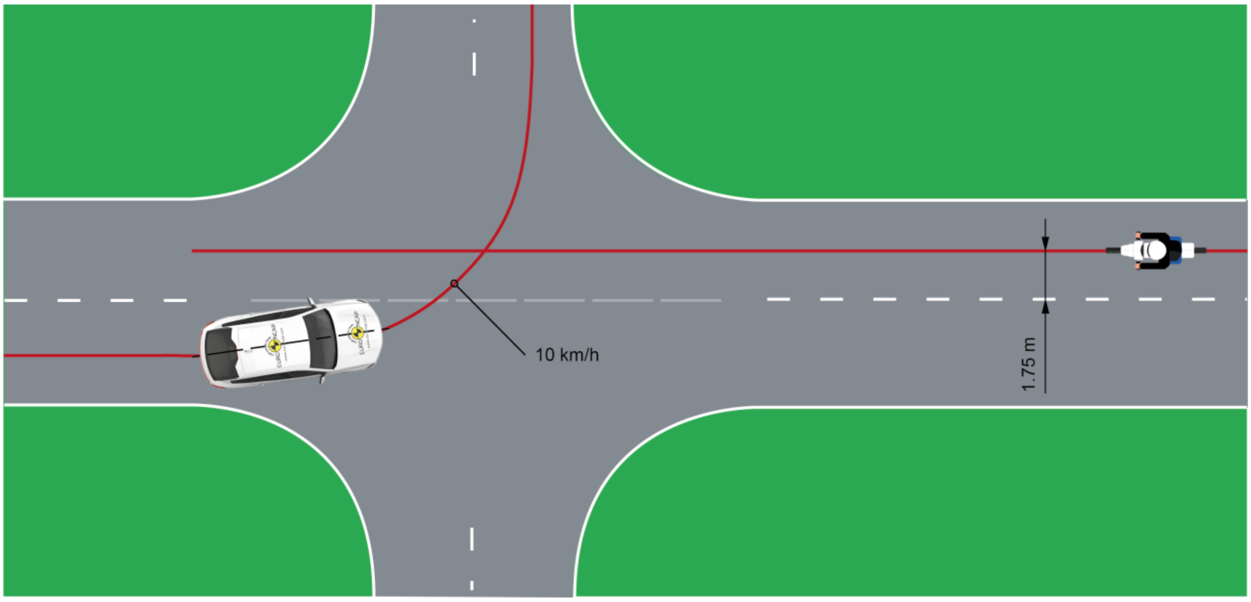


Figure 3-7 CMFtap SfS scenario setup

Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Accelerator Pedal profile as described in APPENDIX A..

The paths of the VUT and EMT will be synchronised so that the VUT coincides with the reference point of the EMT at an impact location of 50% ±25% (assuming no system reaction), as illustrated in Figure 3-8.

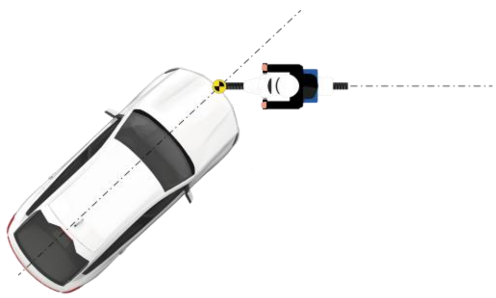


Figure 3-8 CMFtap SfS Impact point definition

3.2 Pedestrian & Cyclist Scenarios

3.2.1 Car-to-Pedestrian Manoeuvring Moving

3.2.1.1 CPMRCm

CPMRCm	EPTc speed	
Rear gap	5 km/h	8 km/h
1.00 m		
1.50 m		
2.00 m		

The VUT is initially positioned at the selected Rear gap, measured as the distance from the rearmost side of the VUT and the reference point of the EPTc. The EPTc is initially positioned 4.00m away from the centre of the VUT trajectory.

The scenario setup is illustrated in Figure 3-9.

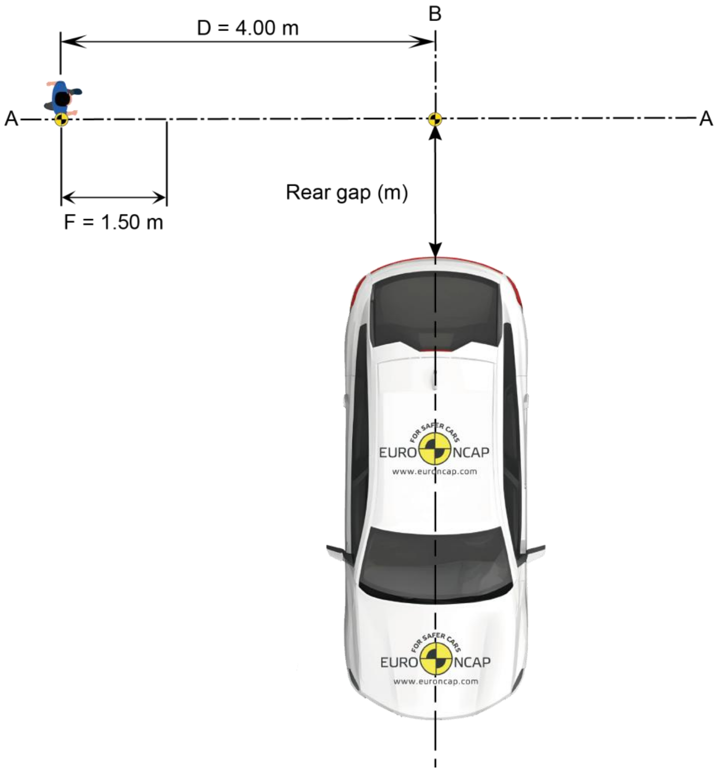


Figure 3-9 CPMRCm scenario setup

The EPTc shall accelerate at the selected speed within 1.50m from its initial position. Conduct a Accelerator Pedal profile to start reversing the VUT so that the impact location occurs at an impact location of 25, 50 and 75%.

3.2.1.2 CPMRCs

CPMRCs	EPTc position		
	25%	50%	75%
4 km/h			
8 km/h			

The EPTc is initially positioned at the selected impact location, facing a randomly selected direction, and at a distance of 2s TTC from the VUT, measured from T_{steady}.

The scenario setup is illustrated in Figure 3-10.

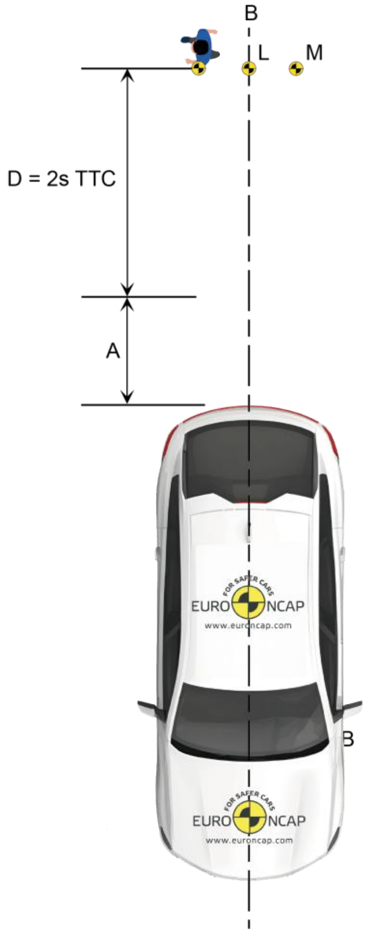


Figure 3-10 CPMRCs scenario setup

The VUT shall accelerate at the selected speed within the minimum distance from its initial position until VUT speed can be reached.

The selected speed shall be kept steady until the end of the test.

3.2.1.3 CPMFC

CPMFC	25%	50%	75%
d_1			
d_2			

The EPTc is initially positioned at the selected impact location, facing a randomly selected direction, and at a distance of 1.5m to the T_{ACC} position.

The scenario setup is illustrated in Figure 3-11.

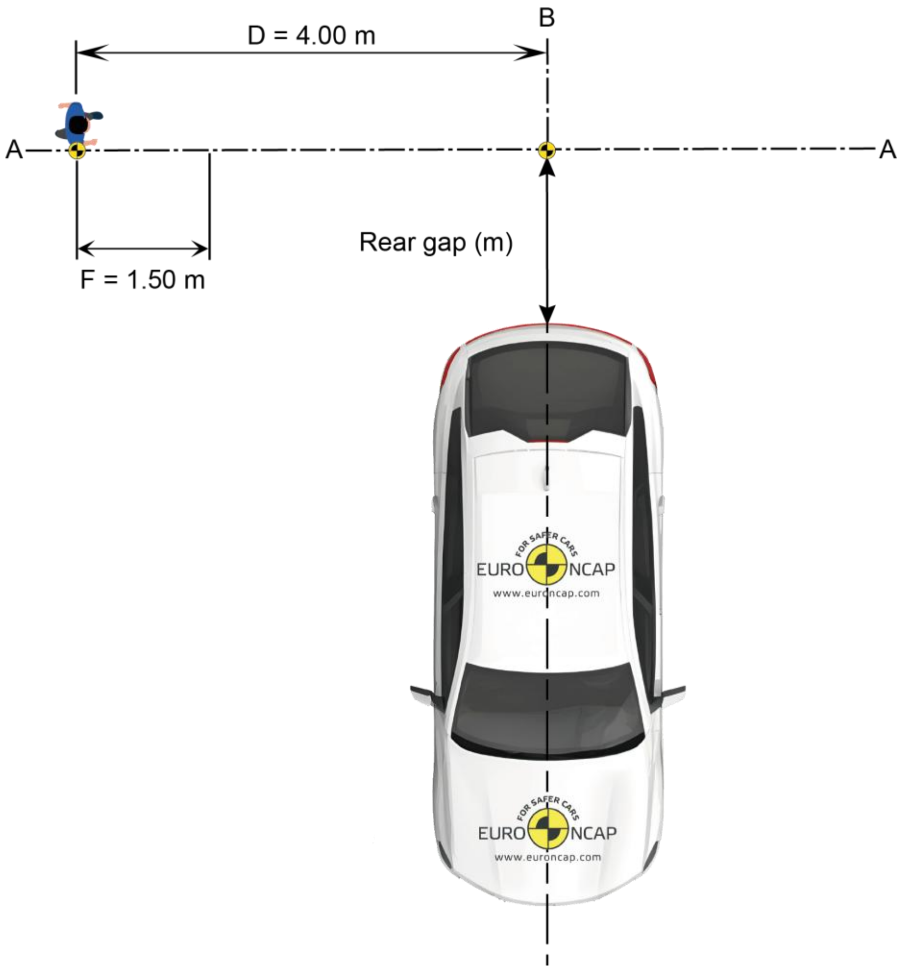


Figure 3-11 CPMFC scenario setup

The VUT will start creeping from standstill (T_0) and travel a distance (randomly select d_1 or d_2) until T_{ACC}.

- d1: stabilized creeping speed until 1s before T_{AEB}
- d2: creeping for [1]s

The following accelerator pedal input profile will be executed at T_{ACC}:

- >90% of absolute position
- >70% of way with ≥400%/s

3.2.2 Car-to-Bicyclist Crossing

3.2.2.1 CBNAO

CBNAO	EBT speed		
	10 km/h	15 km/h	20 km/h
SfS			

The VUT is positioned 1m beside the full obstruction and at a randomly selected range between 2.5 and 1.5m away from the path along the EBT reference point.

The scenario setup is illustrated in Figure 3-12.

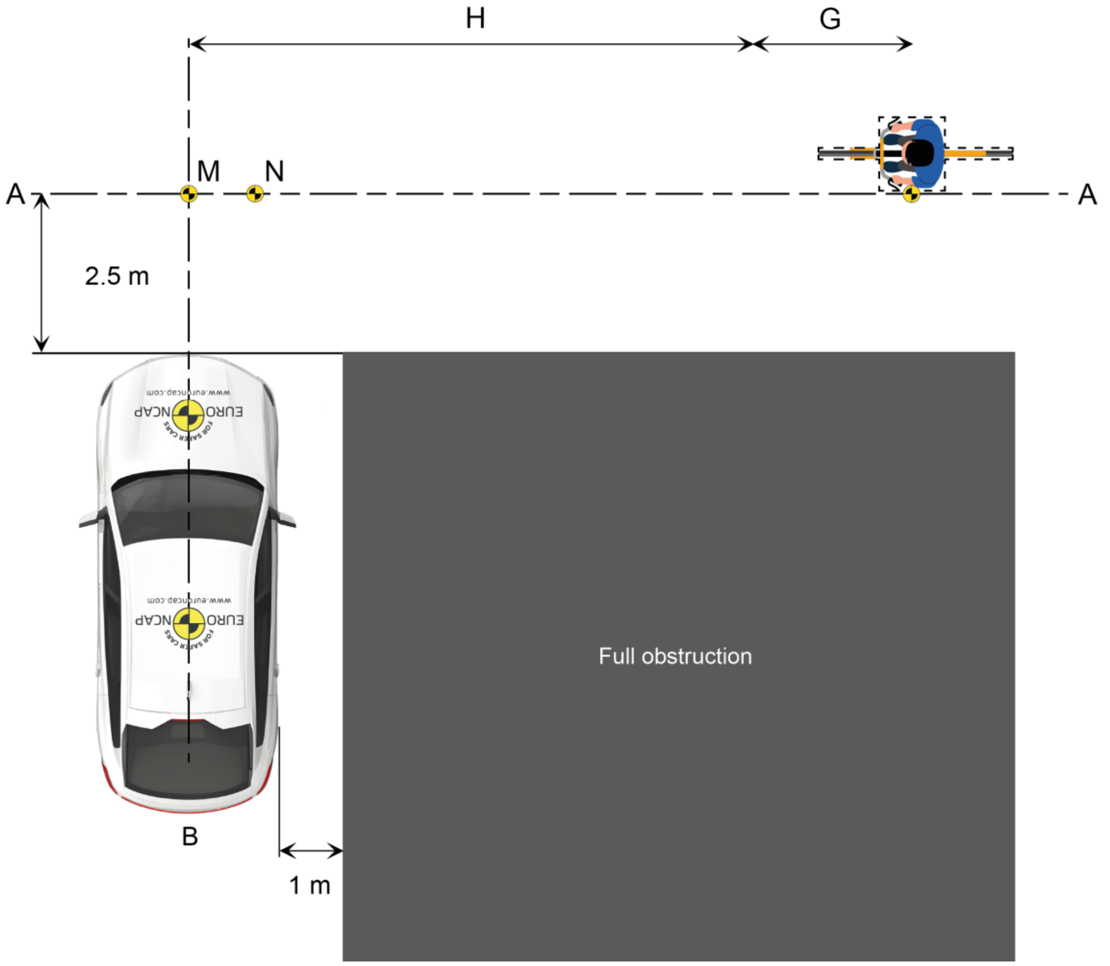


Figure 3-12 CBNAO scenario setup

The EBT shall accelerate at the selected speed within the acceleration distance G.

Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Accelerator Pedal profile as described in APPENDIX A.

The paths of the VUT and the EBT will be synchronized so that the impact location occurs at an impact location of 25 and 50%.

3.2.3 Car-to-Bicyclist Dooring

CBDA	EBT speed		
Rear gap	10 km/h	15 km/h	20 km/h
0.50 m			
1.00 m			
1.50 m			
2.00 m			

For the CBDA scenario a bicycle is traveling in a straight line at 10, 15 and 20 km/h beside the parked vehicle. The Rear gap (distance between VUT and obstruction car) is varied from 0.5 to 2.00m.grid grid cell.

The widest outside structure (without mirrors) of VUT and obstruction car are aligned one meter from the path of the VRU while the central-axis of the cars are in parallel to VUT path. The obstruction vehicle to be used is the smaller obstruction vehicle as defined in APPENDIX B.

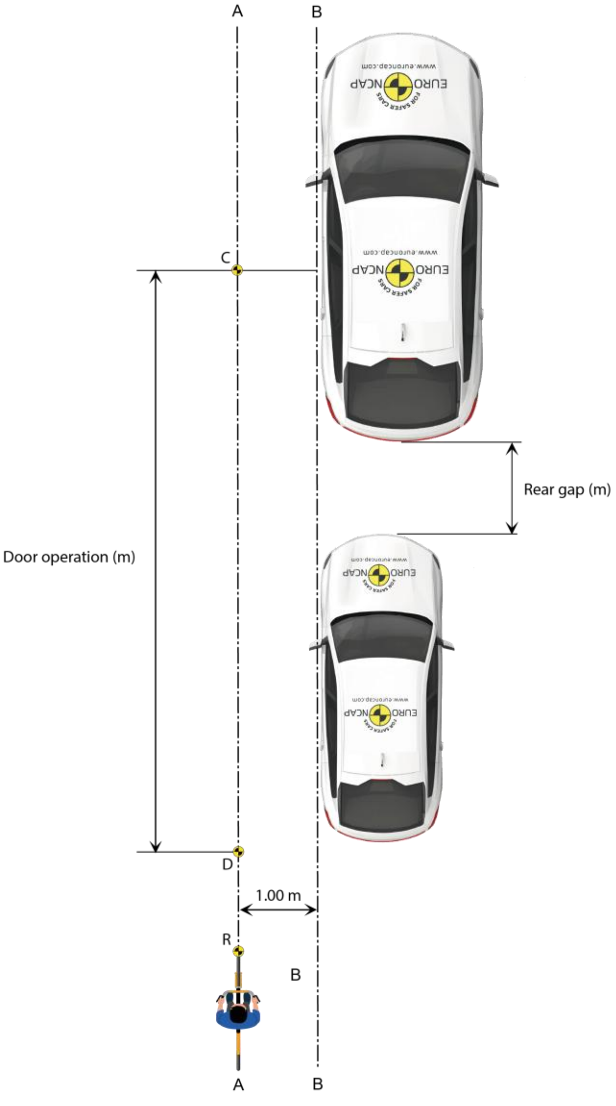


Figure 3-13 CBDA scenario setup

In the first run, the EBT passes the parking car without operation on the door opening interface to assess the information given to the driver, where applicable.

In the second run (applicable for a warning system T_{open} and for a retention system $T_{door\ operation}$), the VUT driver door opening interface shall be operated at a ‘Door operation distance’, defined from the bicyclist front reference point and the most rearward point of the driver door:

EBT Speed (km/h)	Door operation distance (m)
10	5.5 + [0.5]
15	8 + [0,5]
20	11 + [0.5]

Figure 3-14 Reference point and direction relative to the VUT for dooring scenario

Door opening (manually operated):

Pull door handle or activate other door opening interface (e.g. push a button) in a manner that would open the door to exit the car in a normal non-hazard situation, while pushing the door open. Emergency exit functions are permitted where triggered by an additional action (e.g. second pull).

For CBDA, all tests shall be performed with the VUT in parking position within 180 seconds after propulsion system turned off with the driver in unbelted state.

4 TEST EXECUTION

4.1 General Test Conduct

If requested by the Vehicle Manufacturer, 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.

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.

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.

For all AEB and AEB / FCW test scenarios where the assessment is based on a GRID prediction provided by the OEM, the actual grid cells to be tested for verification of the manufacturer prediction will be chosen randomly, distributed in line with the predicted colour distribution.

For Pedestrian and Cyclist FCW systems tests, based on the Vehicle Manufacturer prediction, test the highest test speed of each scenario where the FCW is issued at a TTC ≥ 1.7s, plus one randomly selected test speed per scenario where the FCW is issued at a TTC ≥ 1.7s.

If the FCW is not issued at a TTC ≥ 1.7s in any of these tests, perform tests at all remaining test speeds in the scenario in 5km/h increments.

4.2 Manufacturer Predictions

4.2.1 Manufacturer Supplied Data

The vehicle manufacturer is required to provide the Euro NCAP Secretariat with vehicle performance predictions as colour data (expected impact speeds are not required) applicable to each grid cell.

The information shall be supplied by the manufacturer before any testing begins, preferably with delivery of the test vehicle(s).

4.2.2 Absence of Manufacturer Data

[The method of testing in case of absence of manufacturer data is still to be agreed within the WG]

4.3 Test Execution

Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests within the boundary conditions as specified in 6.2.2.2 for the AEB tests.

4.3.1 AEB tests

Accelerate the VUT and target to the respective test speeds where needed.

The test shall start at T0 and is valid when all boundary conditions are met between T0 and TAEB and/or TFCW:

	VUT	GVT	EPT	EBT	EMT
Speed	+ 1.0 km/h	± 1.0 km/h	± 0.2 km/h	± 0.5 km/h	± 1.0 km/h
Lateral deviation	0 ± 0.05 m (0 ± 0.1 m for CPTA and CBTA)	0 ± 0.10 m	0 ± 0.05 m for crossing scenarios (incl. junction) 0 ± 0.15 m for longitudinal scenarios		0 ± [0.15] m
Lateral velocity			0 ± 0.15 m/s	0 ± 0.15 m/s	
Yaw velocity (upto T_{STEER})	0 ± 1.0 °/s				
Steering wheel velocity (upto T_{STEER})	0 ± 15.0 °/s				

The end of a test, where the AEB function is assessed and for CMRs FCW and CMRb FCW, is considered when one of the following occurs:

- V_{VUT} = 0km/h (crossing) or V_{VUT} = Vtarget (longitudinal)
- Contact between VUT and target
- The target has left the VUT path or VUT has left the target path

To avoid contact in the junction scenarios, the test laboratory may include an automated braking action by the robot in case the AEB system fails to intervene (sufficiently). This braking action is applied automatically when:

- The VUT reaches the latest position at which maximum braking applied to the vehicle will prevent the VUT entering the path of the Motorcyclist and no intervention from the AEB system is detected.
- Lateral separation between the VUT and EMT reaches ≤ 0.3m during / after AEB intervention.

It is at the test laboratory’s discretion to select and use one of the options above to ensure a safe testing environment. If the Vehicle Manufacturer feels the avoidance action is negatively affecting the performance of their vehicle, they should consult with the test laboratory and Euro NCAP secretariat.

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. This does not apply for the CPRA tests.

5 ASSESSMENT CRITERIA & SCORING

5.1 General requirements

To be eligible for scoring points in this assessment, the following requirements shall be met:

- The system shall be default ON at the start of every journey and deactivation of the system should not be possible with a momentary single push on a button.
- For Manoeuvring Reverse, the system may not release the brakes after an intervention, unless the threat (EPT) has left the vehicle path or in case of an override action by the driver. When the VUT is fitted as standard with a rear-view camera, the brakes may be release after 1.5s or longer after the AEB intervention.

5.2 Method of assessment

The Vehicle Manufacturer shall provide the Euro NCAP with data detailing the predicted performance of the system for all test scenarios. The predicted performance will be used as a reference to identify discrepancies between the predicted results and the test results.

Each scenario in this assessment consists of a matrix with combinations of vehicle's initial speed and ranges of impact locations or target longitudinal speeds. Exceptionally for CBDA, the matrix consists of a combination of target speed ranges and rear parking gap ranges. Each combination in a matrix is referred to as grid cell.

For score calculation, first each grid cell is given a score of 1,000 point, which is then scaled as described in 0 according to the Vehicle Manufacturer prediction; and secondly, sub-scores for all grid cells are normalized to the maximum available score (rounded up to the nearest decimal point).

Predictions for each grid cell shall be reported so that there is no loss of performance between that grid cell and all grid cells adjacent to it.

5.2.1 Verification tests

[The exact number of verification tests and overall acceptance criteria for the verification testing are still to be agreed withing the WG]

5.3 Assessment criteria

The assessment criteria is linked to the ability of the system avoid or mitigate the severity of a crash, measured with the following KPIs across scenarios:

Criteria	KPI	Scenarios	
		Car & PTW	Pedestrian & Cyclist
Avoidance	Pass/Fail	All	Rear, Crossing
Mitigation	Pass/Fail	-	Forward
Dooring	TTC	-	Dooring

5.3.1 Avoidance

For all avoidance-only scenarios, the following scaling is applied to each grid cell:

- PASS (Avoidance) = 1,000
- FAIL (Impact) = 0,000

5.3.2 Mitigation

For Car-to-Pedestrian Manoeuvring Forward scenario, the assessment criteria is based on crash mitigation enabled by a suppression of the drivetrain torque upon accelerator pedal input. The following scaling is applied to each grid cell:

- PASS (Drivetrain FULL torque suppression) = 1,000
- FAIL (No drivetrain torque suppression) = 0,000

5.3.3 Dooring

For Car-to-Bicyclist Dooring scenario, the assessment criteria is based on the timely vehicle response upon a door opening attempt while a bicyclist is passing by. The following scaling is applied to each grid cell depending on whether the vehicle response is Information, Warning or Retention:

Vehicle response	Criteria	Doors	Scaling
Information	TTC ≥ 2.3s	Driver's side only	0,125
Warning	TTC ≥ 1.7s	Driver's side only	0,250
		All	0,500
Retention	Start @ TTC ≥ 1.7s, End @TTC≤-0.4s	Driver's side only	0,750
		All	1,000

Where:

- Information shall be visually provided in the field of view of the driver's side window.
- Warning shall have a visual component (e.g., flashing) and an audible or haptic component
- Warning or retention functionality shall be issued on either the driver's door and/or all doors on the side where the threat is present. Reference point for all tests is the rear of the front door. Visual warning on the rear doors is not required.
- Doors that cannot endanger VRUs passing by the VUT (e.g. sliding doors that open to a small extend), Retention may be replaced by Warning and the scaling for Retention shall be used. This warning can be suppressed 10 seconds after $T_{door\ operation}$.

5.4 Scoring

5.4.1 Car & PTW

The point distribution for Car & PTW scenarios is summarized in the table below:

Car & PTW	Maximum Points
	TOTAL 10
Turning	**4**
Car-to-Car Turn Across Path	1
Car-to-Motorcycle Turn Across Path	3
Crossing	**6**
Car-to-Car Crossing	3
Car-to-Motorcycle Crossing	3

5.4.2 Pedestrian & Cyclist

The point distribution for Pedestrian & Cyclist scenarios is summarized in the table below:

Pedestrian & Cyclist	Maximum Points
	TOTAL 10
Crossing	**3**
Car-to-Bicyclist Crossing	3
Manoeuvring	**5**
Car-to-Pedestrian Manoeuvring Reverse	3
Car-to-Pedestrian Manoeuvring Forward	2
Dooring	**2**
Car-to-Bicyclist Dooring	2

APPENDIX A ACCELERATOR PEDAL CHARACTERIZATION PROCEDURE

The accelerator pedal characterization test determines the accelerator pedal displacement and accelerator pedal application velocity necessary to achieve a typical vehicle drive-away acceleration in junction, turning and manoeuvring situations. In addition, the corresponding synchronization timing between VUT and GVT is determined with the obtained speed profile.

A.1 Definitions

- $T_{Start,}$ Time when VUT filtered acceleration reaches [0.1] m/s^2 T_{Start}
- $T_{End,}$ time where VUT meets the impact point location T_{End}
- $T_{Avg,}$ average time value of T_{End} from all the executed trials T_{Avg}

A.2 Measurements

Measurements and filters to be applied as described in section **Error! Reference source not found.** of this protocol.

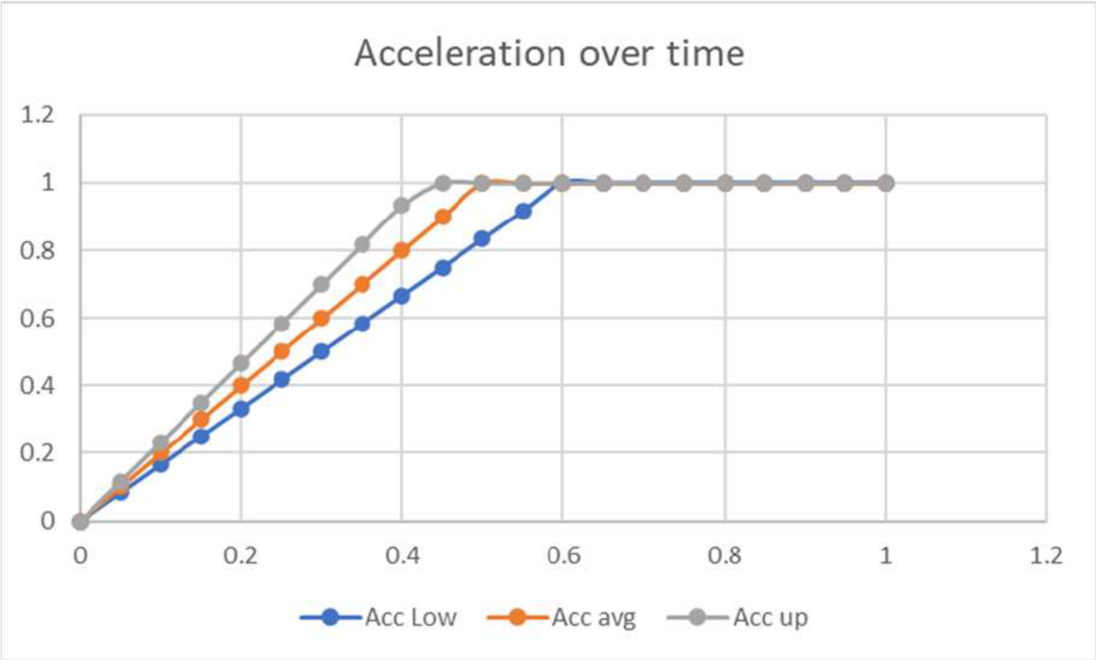
A.3 Procedure for Crossing and Turn across path

Via an iterative approach the accelerator pedal position has to be examined to achieve the following:

- The longitudinal acceleration shall not exceed 1 m/s² before T_{Start} + 0.5 seconds.
- The longitudinal acceleration shall not exceed 1.75 m/s² at any point and shall exceed 1m/s² from T_{Start} + 1.25 until T_{End}.

Execute the start action as trial (without the GVT) at least three times. T_{End} of all runs should be inside of an Interval of [0.1 s]. The results from the trials are used to determine the accelerator pedal position and T_{Avg} which constitute the parameters for the test.

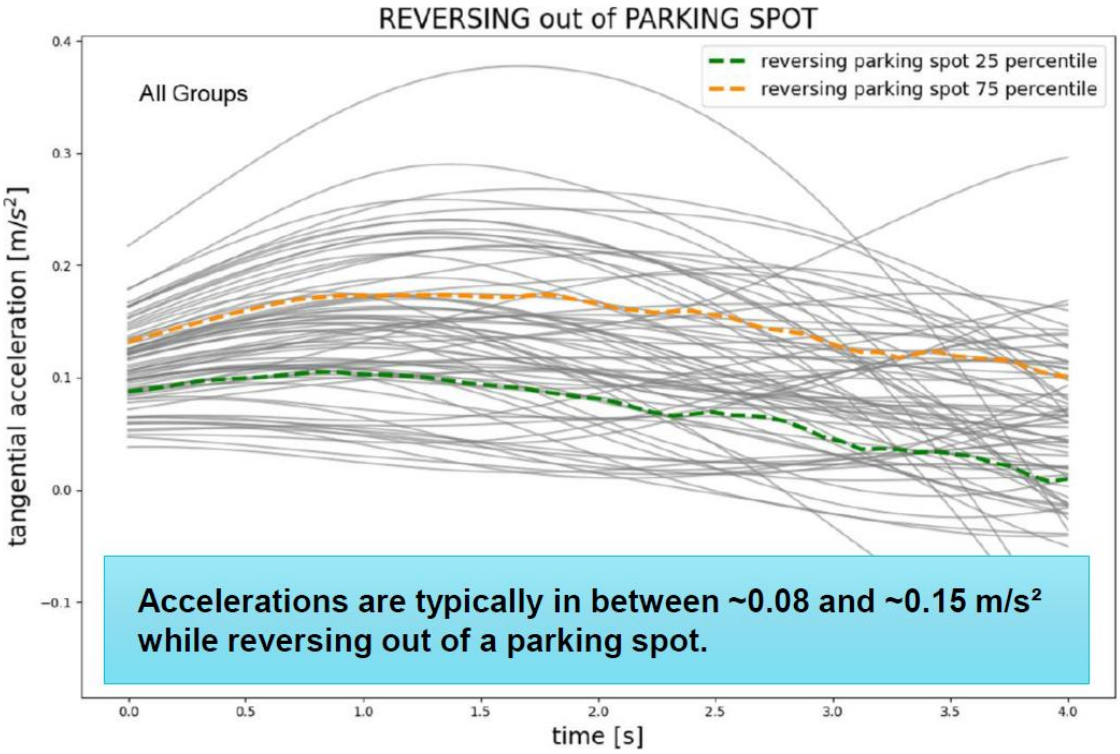
Thereby, T_{Avg} is used to trigger the start action of the VUT to ensure correct synchronization to the target. With the known time that the VUT needs to reach the impact location, it can be triggered by the approaching target and its known time to reach the impact point location.

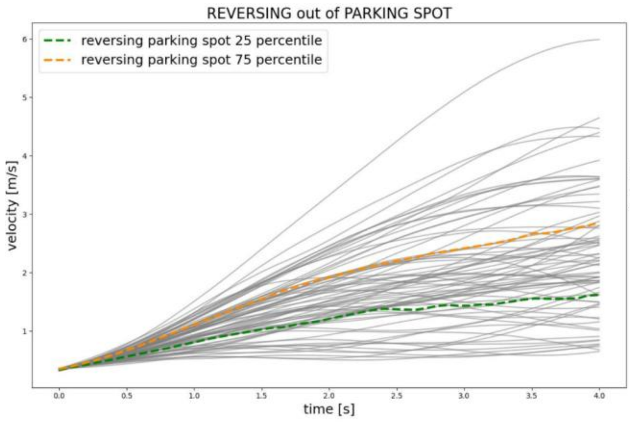


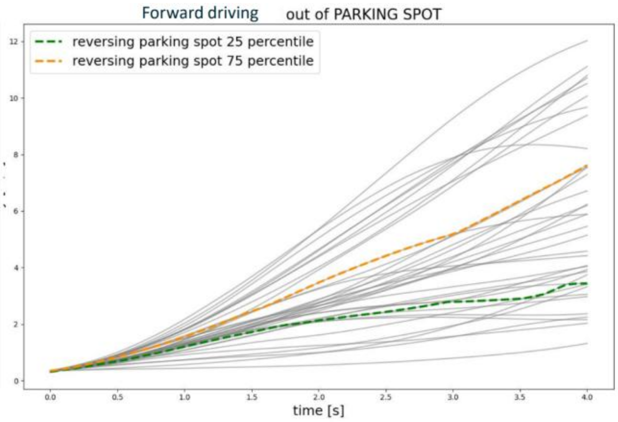
In the event that the above method does not satisfy the test requirements, or that the intended vehicle to be tested (i.e. vehicle with base safety pack) is only offered with a manual transmission and has Start-from-Stop capabilities, the OEM shall contact Euro NCAP to discuss an alternative approach.

A.4 Procedure for Manoeuvring

Develop procedure for forward and rearward manoeuvring based on naturalistic data below:




REVERSING out of PARKING SPOT
reversing parking spot 25 percentile
reversing parking spot 75 percentile
velocity [m/s]
time [s]


Forward driving out of PARKING SPOT
reversing parking spot 25 percentile
reversing parking spot 75 percentile
time [s]

APPENDIX B OBSTRUCTION DIMENTIONS

B.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**

B.2 Larger obstruction vehicle

The larger obstruction vehicle should be of the category Small Off-road 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