ANCAP TEST PROTOCOL

AEB Car-to-Car Systems
v4.3.1

2023
2024
2025

ANCAP SAFETY

PREFACE

During test preparation, vehicle manufacturers are encouraged to liaise with ANCAP and to observe the way the vehicle is set up for testing. Where a vehicle manufacturer feels that a particular aspect should be altered, they should raise this with the ANCAP assessor present at the test, or in writing to the ANCAP Chief Executive Officer if no assessor is present. ANCAP will consider the matter and at their sole discretion give direction to the test facility.

Vehicle manufacturers warrant not to, whether directly or indirectly, interfere with testing and are forbidden from making changes to any aspect that may influence the test, including but not limited to dummy positioning, vehicle setting, laboratory environment etc.

Illustrations in this protocol are reproduced from Euro NCAP publications, and therefore show Euro NCAP markings on left-hand-drive vehicles. Where relevant, the layouts depicted should be adapted to right-hand-drive application.

VERSION

VERSION	PUBLISHED	DETAILS
2.0	July 2017	First ANCAP version of protocol
2.0.1	November 2017	Amendments to s6.1.1, 8.1.2, 8.2.4
3.0.1	April 2019	New version of protocol for 2020, introducing junction scenarios and other changes
3.0.2		ECE method added to PBC Definition Corrected references in s8.2.6
3.0.3	July 2020	No equivalent ANCAP version
4.0	February 2022	New protocol version for 2023 implementation. Incorporating C2C Crossing and Head-on
4.1	August 2022	6.1.3 Corrected reference to Assessment Protocol 8.2.2.3 revised final vehicle speed 8.2.5.1 SOV speed specified 8.4.2 New table 8.4.3 Added footnote re VUT/GVT path 8.4.4 OEM provision of mitigation position
4.1.1	January 2023	4.2 Definition of T_0 7.4.1.1 Deactivation of DSM adjustment of AEB/FCW sensitivity 8.2.4.2 Clarification regarding VUT and GVT paths 8.2.5.2 Lane marking definition for CCFho 8.2.5.7 Refined CCFho path definition New figures 8-12 and 8-13 (CCFhol path definition) 8.4.7 ESS evaluation procedure (and previous ANNEX B deleted) ANNEX C Revised T_{Start} definition
4.2		No ANCAP version
4.3		No ANCAP version
4.3.1	April 2024	Update definitions - remove DBS (unused) and clarify Vimpact 3.5 Vehicle profile definition for impact speed determination 6.1.5 Dossier requirements for CCFhol and CCFhos 7.4.4 Update title for clarity Fig 7-3 Update free space definition 8.2.3.5 Add tolerance for timing of turn signal 8.4.2 Table amended for consistency ANNEX C.3 update to clarify requirements

DISCLAIMER

ANCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the current technical decisions taken by the organisation. In the event this protocol contains an error or inaccuracy, ANCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

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AUSTRALASIAN NEW CAR ASSESSMENT PROGRAMME (ANCAP)

TEST PROTOCOL – AEB SYSTEMS

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1 INTRODUCTION

Car-to-car rear impacts are one of the most frequent accidents happening on the roads due to driver distraction or misjudgement. Typical front-to-rear collisions during city driving are normally occurring at relatively low speeds where the impacted car is already at standstill, but with a high risk of a debilitating whiplash injury to the driver of the struck vehicle. While injury severities are usually low, these accidents are very frequent and represent over a quarter of all crashes. Similar accident scenarios occur on the open road, at moderate to higher speeds, where a driver might be distracted and may fail to recognise that the traffic in front of him is stopped, coming to a stop or is driving at a lower speed.

Other common collision types include those with oncoming or crossing vehicles when navigating junctions, and oncoming vehicles in case of leaving the lane. Drivers can be challenged by the more complex nature of the road layout, and the perception, judgement and dynamic manoeuvring required to successfully navigate safely through the other traffic.

To support the driver in avoiding these common collision types, car manufactures offer avoidance technology that warns, supports adequate braking and/or ultimately stops the vehicle by itself. This protocol specifies the AEB Car-to-Car test procedures aimed at addressing these common collision types, which are part of the Safety Assist assessment. To be eligible to score points for AEB Car-to-Car, a good Whiplash score must be achieved for the front seat. The system is tested in the seven scenarios detailed in this protocol.

2 DEFINITIONS

2.1 General

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. Alternatively, 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.

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

Autonomous Emergency Steering (AES) – steering that is applied automatically by the vehicle in response to the detection of a likely collision to steer the vehicle around the vehicle in front to avoid the collision.

Emergency Steering Support (ESS) – a system that supports the driver steering input in response to the detection of a likely collision to alter the vehicle path and potentially avoid a collision.

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

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.

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

Secondary Other Vehicle (SOV) – means the vehicle being overtaken by VUT in CCFhol scenario. This vehicle can either be a GVT or a real vehicle.

Time To Collision (TTC) – means the remaining time before the VUT strikes the GVT, assuming that the VUT and GVT 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

Vimpact – means the speed at which the profiled line around the front end of the VUT coincides with the rectangular shape of the GVT as shown in the right part of Figure 2-1 Front end profile and GVT

Vrel_impact – means the relative speed at which the VUT hits the GVT by subtracting the velocity of the GVT from Vimpact at the time of collision

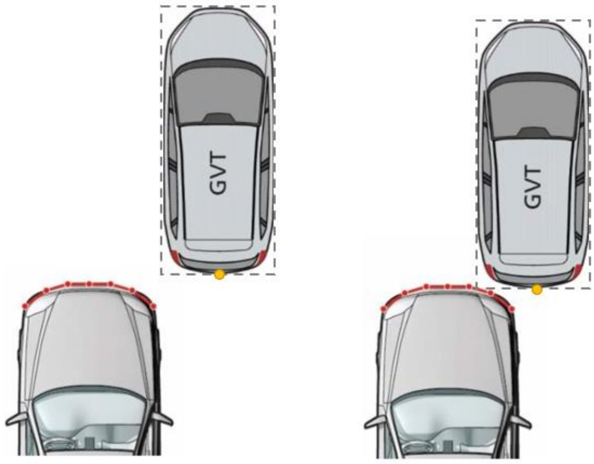


Figure 2-1 Front end profile and GVT

2.2 Test Scenarios

Car-to-Car Rear Stationary (CCRs) – a collision in which a vehicle travels forwards towards another stationary vehicle and the frontal structure of the vehicle strikes the rear structure of the other.

Car-to-Car Rear Moving (CCRm) – a collision in which a vehicle travels forwards towards another vehicle that is travelling at constant speed and the frontal structure of the vehicle strikes the rear structure of the other.

Car-to-Car Rear Braking (CCRb) – a collision in which a vehicle travels forwards towards another vehicle that is travelling at constant speed and then decelerates, and the frontal structure of the vehicle strikes the rear structure of the other.

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-Car Front Head-On Straight (CCFhos) – a collision where a vehicle is travelling along a straight path within its defined lane and strikes another vehicle travelling in the opposite direction, which has drifted into the same lane as the original vehicle. The frontal structure of the vehicle strikes the frontal structure of the other.

Car-to-Car Front Head-On Lane change (CCFhol) – a collision where a vehicle is travelling along a straight path within its defined lane and strikes another vehicle travelling in the opposite direction which has intentionally moved into the lane of the original vehicle to attempt an overtake. The frontal structure of the vehicle strikes the frontal structure of the other.

3 REFERENCE SYSTEM

3.1 Convention

3.1.1 For both VUT and GVT 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 3-1.

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- and right-hand drive vehicles tested.

3.1.4 The nearside is swapped as per LHD and RHD vehicles. Figure 3-1 shows the near and farside of the vehicle for a left hand driven (LHD) vehicle.

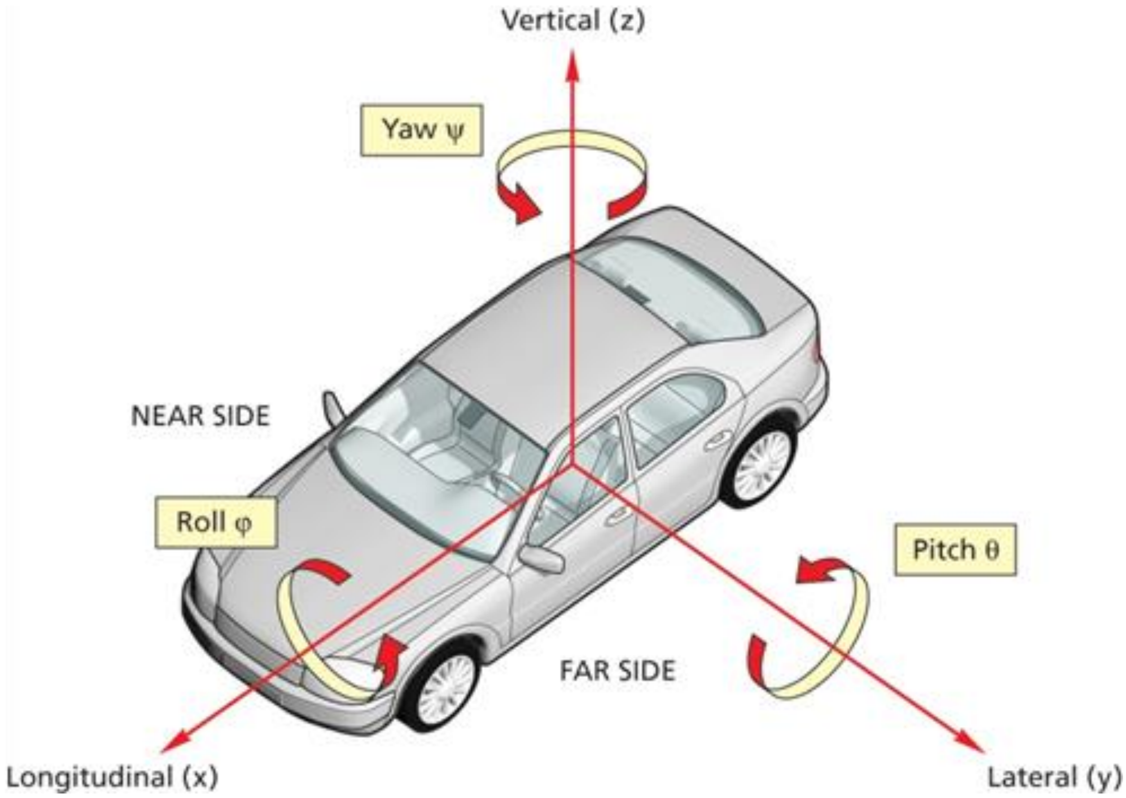


Figure 3-1: Coordinate system and notation

3.2 VUT longitudinal path error

3.2.1 The VUT longitudinal path error is determined as the difference between the desired position and the actual position of the front of the VUT when measured at a single defined “stable” position of the front of the GVT during the test.

$$\text{VUT longitudinal path error} = X_{VUT,\ desired} - X_{VUT,\ actual}\ (@X_{GVT})$$

For CCFtap, when the origin of the reference system is at the intended collision point, the values shown in the table below shall be used to determine the VUT longitudinal path error.

VUT speed	GVT speed	$X_{VUT,\ desired}$	X_{GVT}
10 km/h	30 km/h	- 9.57 m	29.17 m
	45 km/h		43.75 m
	60 km/h		58.33 m
15 km/h	30 km/h	- 14.53 m	29.17 m
	45 km/h		43.75 m
	60 km/h		58.33 m
20 km/h	30 km/h	- 19.47 m	29.17 m
	45 km/h		43.75 m
	60 km/h		58.33 m

3.3 Lateral path error

3.3.1 The lateral path error is determined as the lateral distance between the centre of the front axle of the VUT and the centre of the rear of the GVT when measured in parallel to the intended straight-lined path as shown in the figure below.

$$\text{Lateral path error} = Y_{VUT}\ \text{error} + Y_{GVT}\ \text{error}$$

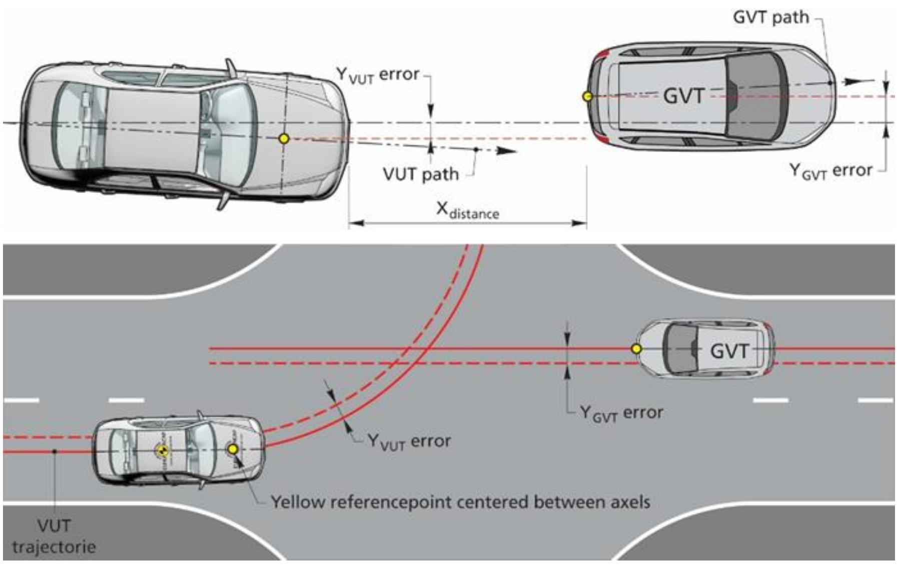


Figure 3-2: Lateral path error

3.4 Lateral overlap

3.4.1 The lateral overlap is defined as a percentage of the width of the VUT overlapping the GVT, where the reference line for the overlap definition is the centreline of the VUT. In case of 100% overlap, the centrelines of the VUT and GVT are aligned.

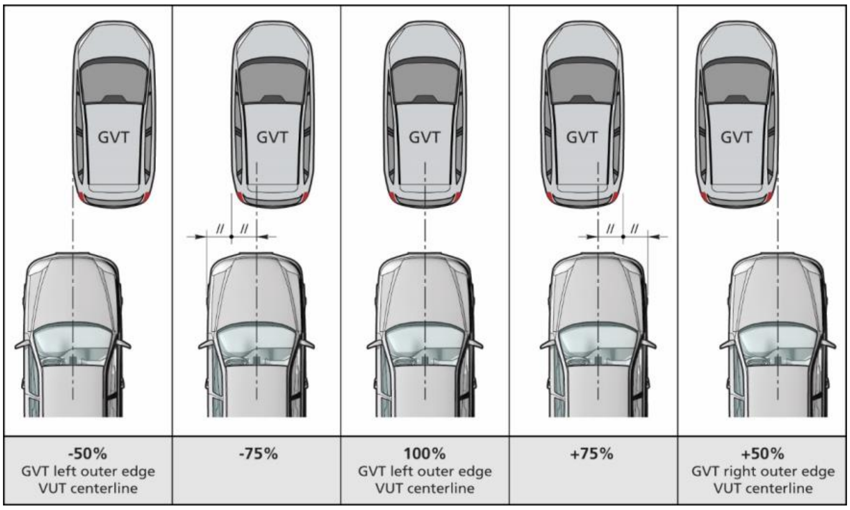


Figure 3-3: Lateral Overlap examples

3.5 Profiles for impact speed determination

3.5.1 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.

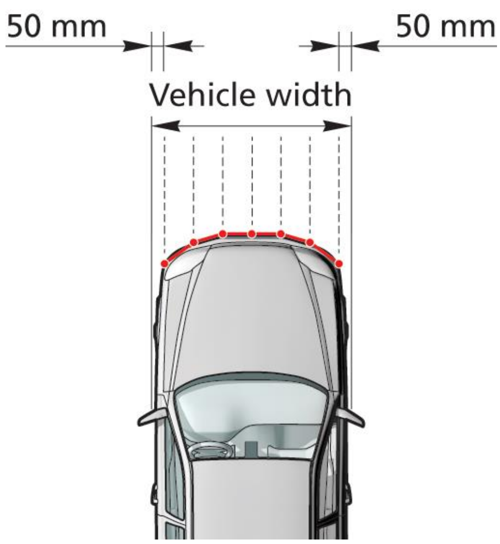


Figure 3-4 VUT Front bumper profile

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 GVT data with that of the VUT.

4.2 Measurements and Variables

4.2.1	Time	**T**
	• $\mathbf{T}_{0}$, time of test start. Unless otherwise stated T_0 = TTC 4s ▪ Scenarios involving steering: T_0 is 1s. before T_{steer}	$\mathbf{T}_{0}$
	• 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_{Start}, time where VUT starts moving (in CCCscp start from stop scenario)	T_{Start}
	• T_{End}, time where VUT has travelled 2.9m. from the start position (in CCCscp start from stop scenario)	T_{End}
	• T_{Avg}, average time value of T_{End} from all the executed trials (in CCCscp start from stop scenario)	T_{Avg}
4.2.2	Position of the VUT during the entire test	$\mathbf{X}_{VUT}$, $\mathbf{Y}_{VUT}$
4.2.3	Position of the GVT during the entire test	$\mathbf{X}_{GVT}$, $\mathbf{Y}_{GVT}$
4.2.4	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	$\mathbf{V}_{rel\_impact}$
4.2.5	Speed of the GVT during the entire test	$\mathbf{V}_{GVT}$
4.2.6	Yaw velocity of the VUT during the entire test	$\dot{\boldsymbol{\Psi}}_{VUT}$
4.2.7	Yaw velocity of the GVT during the entire test	$\dot{\boldsymbol{\Psi}}_{GVT}$
4.2.8	Acceleration of the VUT during the entire test	$\mathbf{A}_{VUT}$
4.2.9	Acceleration of the GVT during the entire test	$\mathbf{A}_{GVT}$
4.2.10	Steering wheel velocity of the VUT during the entire test	$\mathbf{\Omega}_{VUT}$

4.3 Measuring Equipment

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

- VUT and GVT speed to 0.1km/h;
- VUT and GVT lateral and longitudinal position to 0.03m;
- VUT heading angle to 0.1°;

- VUT and GVT yaw rate to 0.1°/s;
- VUT and GVT longitudinal acceleration to 0.1m/s^2;
- 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, steering wheel velocity and force are filtered with a 12-pole phase less Butterworth filter with a cut off frequency of 10Hz.

5 GLOBAL VEHICLE TARGET

5.1 Specification

5.1.1 Conduct the tests in this protocol using the Global Vehicle Target (GVT) as shown in Figure 5-1 below. The GVT replicates the visual, radar and LIDAR attributes of a typical M_1 passenger vehicle.

Figure 5-1: Global Vehicle Target (GVT)

5.1.2 To ensure repeatable results the combination of the propulsion system and GVT must meet the requirements as detailed in ISO 19206-3:2021.

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

5.1.4 The GVT is designed to work with the following types of sensors:

- Radar (24 and 77 GHz)
- LIDAR
- Camera

When a manufacturer believes that the GVT is not suitable for another type of sensor system used by the VUT but not listed above, the manufacturer is asked to contact the ANCAP Secretariat.

6 MANUFACTURER DATA

6.1 Manufacturer Supplied Data

6.1.1 The vehicle manufacturer is required to provide the ANCAP Secretariat with colour data (expected impact speeds are not required) detailing the performance of the vehicle in the CCRs and CCRm scenarios for all overlap and impact speed combinations. The prediction is to be done for both AEB and FCW system tests where applicable.

6.1.2 All data must be supplied by the manufacturer before any testing begins, preferably with delivery of the test vehicle(s).

6.1.3 Data shall be provided for each grid point for CCRs (10-50km/h for AEB and 55-80km/h for FCW) and CCRm (30-80km/h for AEB) according to the colour scheme detail in the ANCAP Assessment Protocol – Safety Assist: Collision Avoidance Section 3.3.2.

6.1.4 The vehicle manufacturer is required to provide the ANCAP Secretariat with data detailing the performance of the vehicle in the CCCscp scenario for all test speed combinations. The prediction is to be provided for both AEB and FCW system tests where applicable. Where predictions state insufficient performance to score points, the tests will not be performed.

6.1.5 For the Car-to-Car head-on scenarios the vehicle manufacturer must supply a dossier detailing how their vehicle responds in the CCFhol and CCFhos test scenarios. The dossier must, at least, include:

- System performance: The expected performance of the system (TTC of warning – when applicable – , TTC of AEB activation and speed reduction)
- System architecture: Sensor(s) setup used in perception and basic description of sensor fusion and decision-making logic
- System operational conditions/limitations (ODD): system activation speed range, maximum relative speed, overlap range, lighting/environmental conditions, considered vehicle types (passenger car only or motorcycle, truck, etc), required lane width(s), required lane marking, etc.
- System overriding conditions: e.g., accelerator pedal %, brake pedal, steering wheel angle/rate, etc.
- System validation: Evidence of system verification conducted by OEM (physical tests, HiL/SiL/ViL…)
- Real world performance: Evidence from the vehicle manufacturer demonstrating the effectiveness of the head-on function on the field (including false positive likelihood & mitigation strategies)

6.2 Absence of Manufacturer Data

6.2.1 Where predicted data is NOT provided by the vehicle manufacturer, ALL grid points are to be tested by the ANCAP laboratory, taking into account symmetry (except for CCCscp Start From Stop setup, where only farside is tested).

6.2.1.1 For CCR AEB and FCW systems tests, when there is complete avoidance, the subsequent test speed for the next test is incremented with 10km/h. When there is contact, first perform a test at a test speed 5km/h less than the test speed where contact occurred. After this test continue to perform the remainder of the tests with speed increments of 5km/h by repeating section 8.3.1 to8.3.3. Stop testing when the speed reduction seen in the test is less than 5 km/h or the (relative) impact speed is more than 50 km/h.

6.2.1.2 For CCCscp tests should be performed starting with the lowest VUT and GVT speed combination. The next test will use the same VUT test speed and the GVT speed will be incremented by 10km/h. Where the GVT test speed reaches 60km/h, the next test will be the combination of the VUT speed increased to the next increment, and a GVT speed of 10km/h. Continue this method for all VUT test speeds.

7 TEST CONDITIONS

7.1 Test Track

7.1.1 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.

7.1.2 The 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.

7.1.3 The presence of lane markings is allowed for CCR 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.

7.1.4 Junction and Lane Markings

7.1.4.1 The CCFtap and CCCscp tests described in this document requires the use of a junction. The main approach lane where the VUT and GVT paths start, (horizontal lanes in Figure 7-1) will have a width of 3.5m. The side lane (vertical lanes in Figure 7-1) 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

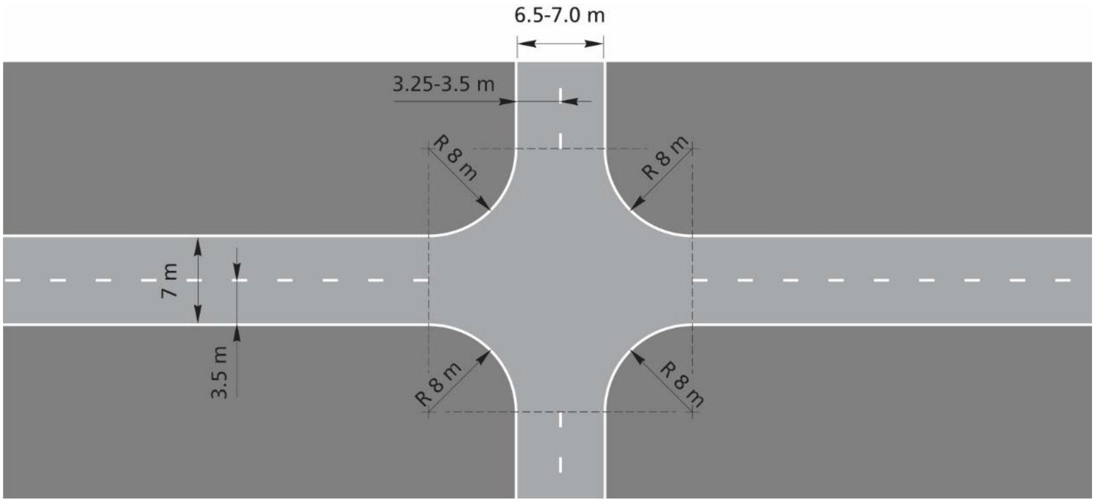


Figure 7-1: Layout of junction and the connecting lanes

7.2 Weather Conditions

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

7.2.2 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 GVT and VUT disturbance.

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

7.2.4 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.

7.3 Surroundings

7.3.1 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 during the full duration of the test starting at T_0 and within a longitudinal distance 20m ahead of the VUT when the test ends, within:

- 5m either side of the VUT test path,
- a circle around the GVT, and
- the visual axis between the geometric centre of the VUT and the circle surrounding the GVT.

For CCCscp only, the above applies from TTC =3.5s (instead of T_0).

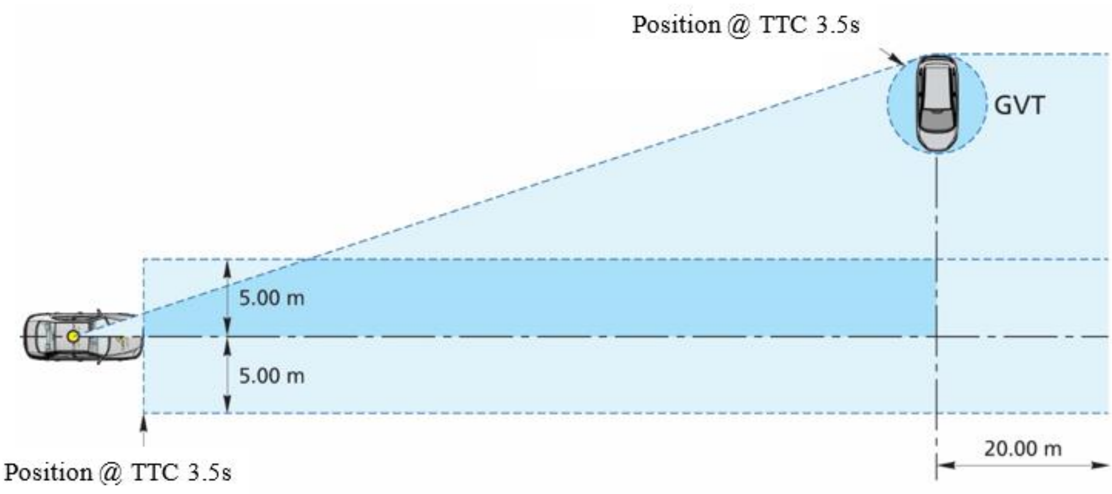


Figure 7-3: Free space requirements – CCC Farside Test

7.3.2 Test areas where the VUT needs to pass under overhead signs, bridges, gantries or other significant structures are not permitted.

7.3.3 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.

7.4 VUT Preparation

7.4.1 AEB and FCW System Settings

7.4.1.1 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 7-2.

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.

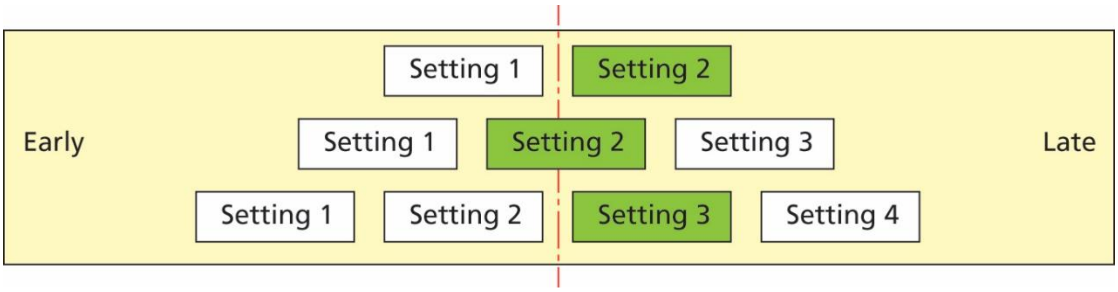


Figure 7-2: AEB and/or FCW system setting for testing

7.4.2 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.

7.4.3 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 8.1.3. After running-in maintain the run-in tyres in the same position on the vehicle for the duration of the testing.

7.4.4 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.

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

7.4.4.2 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.

7.4.4.3 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.

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

7.4.4.5 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.

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

7.4.5 Vehicle Preparation

7.4.5.1 Fit the on-board test equipment and instrumentation in the vehicle. Also fit any associated cables, cabling boxes and power sources.

7.4.5.2 Place weights with a mass of the ballast mass. Any items added should be securely attached to the car.

7.4.5.3 With the driver in the vehicle, weigh the front and rear axle loads of the vehicle.

7.4.5.4 Compare these loads with the "unladen kerb mass"

7.4.5.5 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.

7.4.5.6 Repeat paragraphs 7.4.5.3 and 7.4.5.4 until the front and rear axle loads and the total vehicle mass are within the limits set in paragraph 7.4.5.5. 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.

8 TEST PROCEDURE

8.1 VUT Pre-test Conditioning

8.1.1 General

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

8.1.1.2 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.

8.1.2 Brakes

8.1.2.1 Condition the vehicle’s brakes in the following manner, if it has not been done before or in case the lab has not 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.

8.1.3 Tyres

8.1.3.1 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 not 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.

8.1.3.2 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.

8.1.4 <u>AEB/FCW System Check</u>

8.1.4.1 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.

8.2 Test Scenarios

8.2.1 The performance of the AEB/FCW system is assessed in the CCRs, CCRm, CCRb, CCFtap, CCCscp and CCFhos/CCFhol scenarios as shown in the sections 8.2.3 to 8.2.5.

8.2.1.1 For CCRs AEB, CCRs FCW and CCRm, the assessment is based on a GRID prediction provided by the OEM. The actual scenarios to be tested to verify the prediction will be chosen randomly, distributed in line with the predicted colour distribution (excluding red points).

The vehicle sponsor will fund 15 verification tests, where applicable. For AEB 10 tests (CCRs and CCRm) and 5 tests for FCW (CCRs).

The vehicle manufacturer has the option of sponsoring up to 10 additional verification tests for AEB CCR and 10 for FCW.

8.2.1.2 For CCRb and CCFtap verification tests are conducted at all test points.

8.2.1.3 For CCCscp verification tests are conducted at all test points where sufficient performance to score points is predicted.

8.2.2 For CCR 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.

8.2.2.1 Car-to-Car Rear stationary

The CCRs scenario is a combination of speed and overlap with 5km/h incremental steps in speed and 25% steps in overlap within the ranges as shown in the tables below.

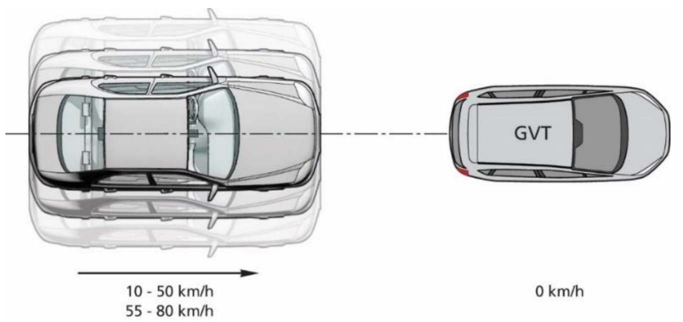


Figure 8-1: CCRs scenario

	AEB + FCW combined		AEB only	FCW only
	AEB	FCW		
AEB CCRs	10-50 km/h -50% to 50%	55-80 km/h -50% to 50%	10-80 km/h -50% to 50%	55-80 km/h -50% to 50%

ESS tests will only be allowed for the -50% overlap situation for left hand drive vehicles (50% for right hand drive).

8.2.2.2 Car-to-Car Rear moving

The CCRm scenario is a combination of speed and overlap with 5km/h incremental steps in speed and 25% steps in overlap within the ranges as shown in the tables below.

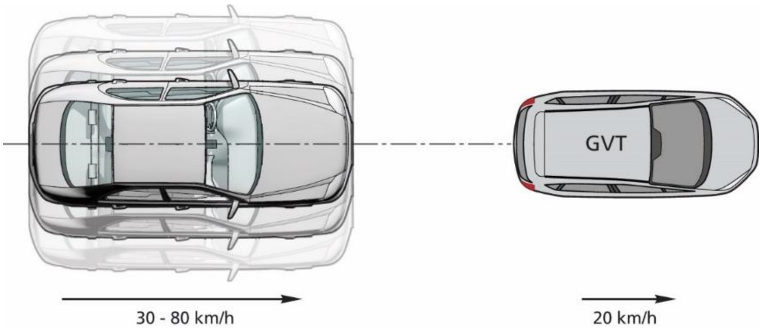


Figure 8-2: CCRm scenario

	AEB + FCW combined & AEB Only
	AEB
AEB CCRm	30-80 km/h -50%-50%

8.2.2.3 Car-to-Car Rear braking

The CCRb tests will be performed at a fixed speed of 50km/h for both VUT and GVT with all combinations of -2 and -6m/s² acceleration and 12 and 40m headway. Different overlap situations may be tested for monitoring purpose at the end of the test program.

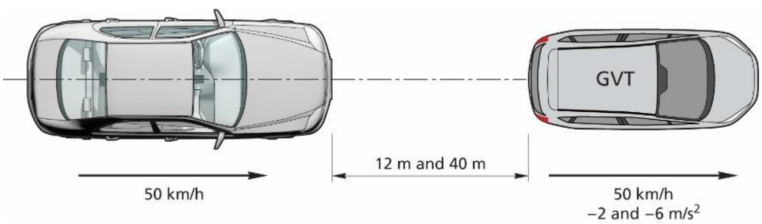


Figure 8-3: CCRb scenario

		AEB+FCW combined & AEB only	
		-2 m/s²	-6 m/s²
AEB CCRb	12m	50 km/h	50 km/h
	40m	50 km/h	50 km/h

For CCRb $T_0 = T_{GVT\_deceleration\_start} - 1s$.

T_0 begins 1 second before GVT starts deceleration, for tolerance monitoring purposes. The desired deceleration of the GVT shall be reached within 1.0 second (T_0 + 2.0s) which after the GVT shall remain within ± 0.5 km/h of the reference speed profile, derived from the desired deceleration, until the vehicle speed equals 2 km/h.

8.2.3 Car-to-Car Front turn-across-path

8.2.3.1 For the CCFtap scenario, for the VUT assume an initial straight-line path followed by a turn (clothoid, fixed radius and clothoid as specified in section 8.2.3.5), followed again by a straight line, hereby known as the test path.

8.2.3.2 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.

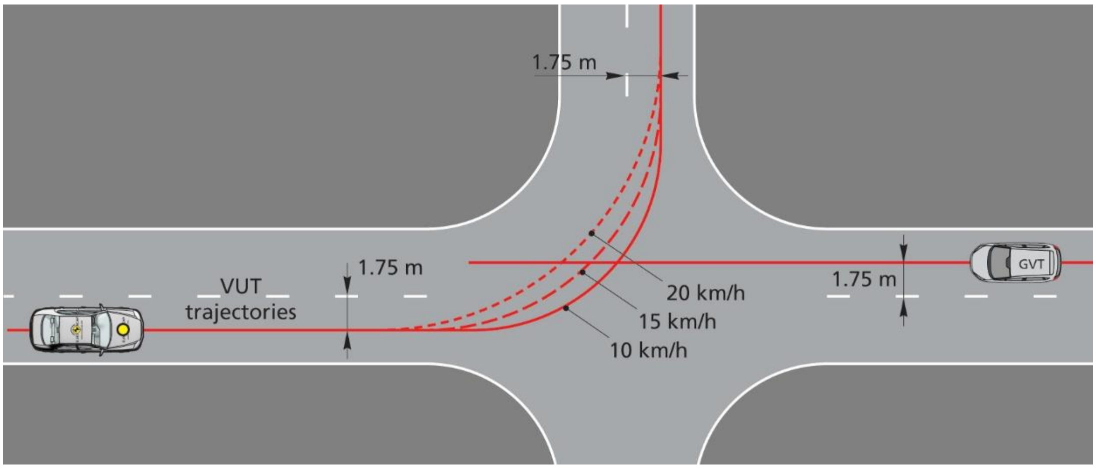


Figure 8-4: CCFtap scenario VUT and GVT paths

8.2.3.3 The paths of the VUT and target vehicle will be synchronised so that the front edges of the vehicle meet with a lateral position that gives a 50% overlap (assuming no system reaction) of the width of the VUT. The VUT longitudinal path error shall be within ± [0.5] m when determined in accordance with section 3.2.1.

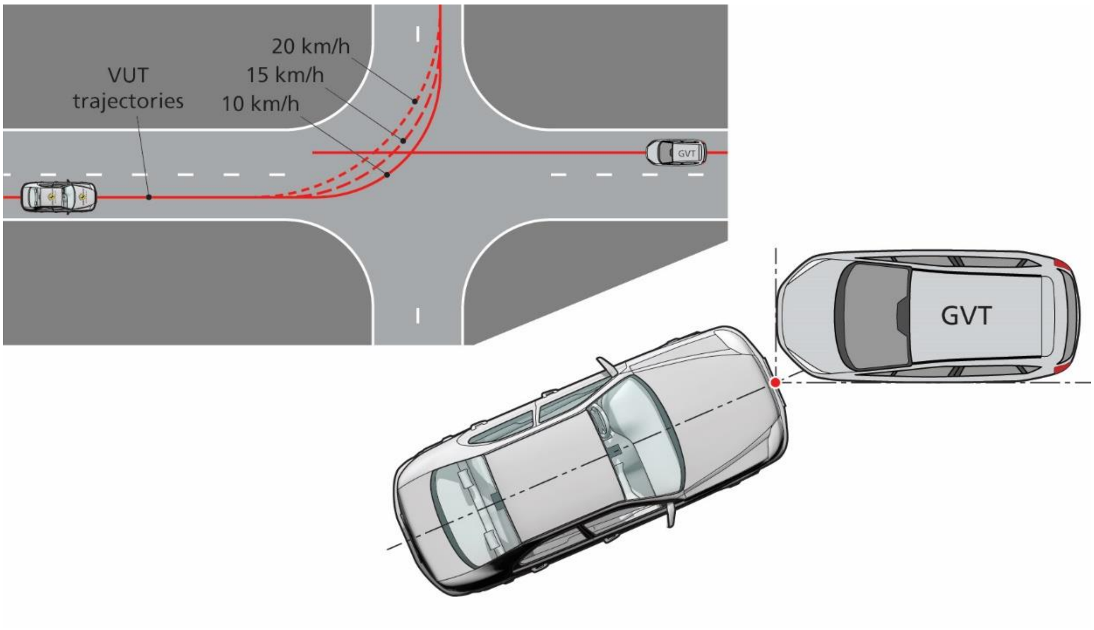
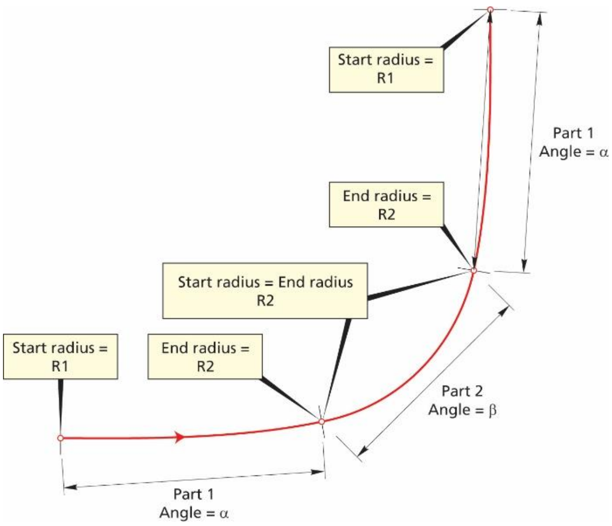


Figure 8-5: CCFtap scenario paths and impact definition

8.2.3.4 The CCFtap scenarios are all combinations of VUT speeds of 10, 15 and 20 km/h combined with GVT speeds of 30, 45 and 60 km/h.

8.2.3.5 The following parameters should be used to create the test paths where the turn signal is applied at 1.0s ±0.5s before T_{steer}:



Test speed	Part 1 (clothoid)			Part 2 (constant radius)			Part 3 (clothoid)		
	Start Radius R1 [m]	End Radius R2 [m]	Angle α [deg]	Start Radius R2 [m]	End Radius R2 [m]	Angle β [deg]	Start Radius R2 [m]	End Radius R1 [m]	Angle α [deg]
10 km/h	1500	9.00	20.62	9.00	9.00	48.76	9.00	1500	20.62
15 km/h	1500	11.75	20.93	11.75	11.75	48.14	11.75	1500	20.93
20 km/h	1500	14.75	21.79	14.75	14.75	46.42	14.75	1500	21.79

Figure 8-6: CCFtap scenario paths definition

8.2.4 Car-to-car Crossing Straight Crossing Path (CCCscp)

8.2.4.1 For the VUT assume a straight-line path equivalent to the centre line of the driving lane, approaching and continuing straight ahead across a junction.

8.2.4.2 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. The scenario is represented in Figure 8-7 and Figure 8-9, where '//-//' indicates a vehicle being centred in the driving lane. For the start from stop tests the GVT travels across the junction from the farside direction. For all other test speed combinations the GVT will travel from either the nearside or farside direction, selected at random by the test laboratory.

8.2.4.3 To achieve the correct GVT speed, the GVT must be accelerated at a rate >1m/s^2 during the acceleration phase. This is followed by a 0.5s stabilization phase, after which steady state conditions must be met as per 8.4.2.

8.2.4.4 The paths will be synchronised to that the centre front of the VUT collides with the side of the GVT, 25% along the length of the GVT (assuming no system reaction).

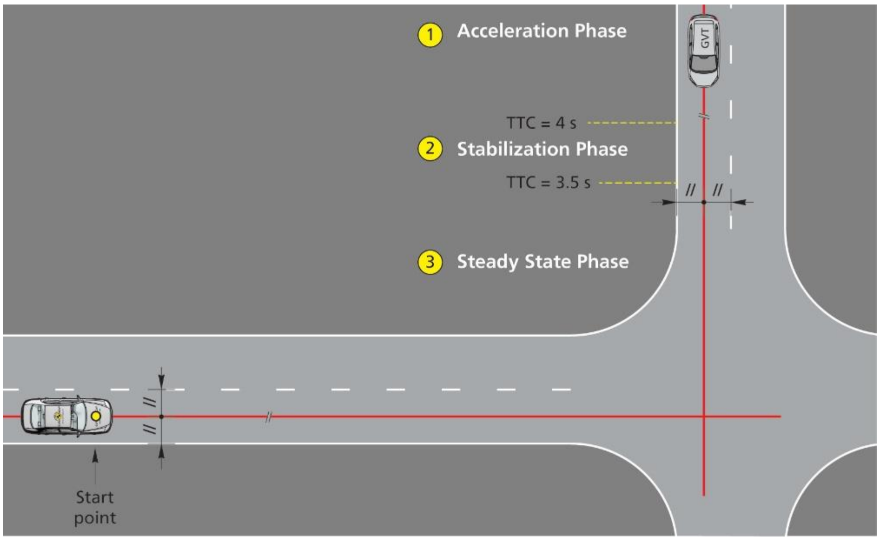


Figure 8-7 Straight Crossing Path VUT and GVT paths

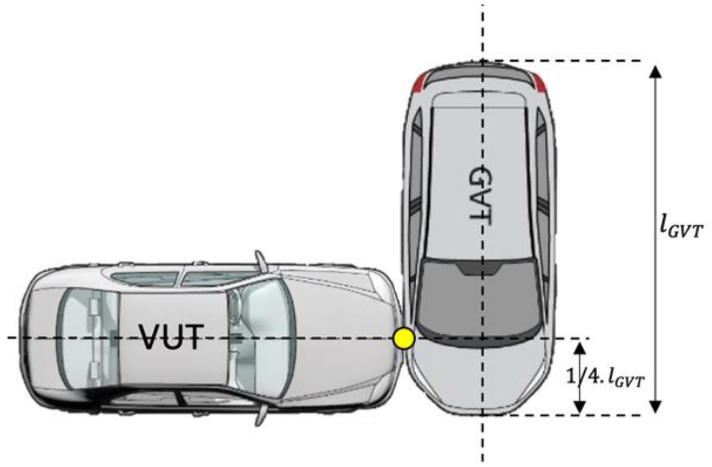


Figure 8-8 SCP Impact point definition

8.2.4.5 For the Start from stop scenario the VUT is at standstill with an initial longitudinal distance to the GVTs side of 2.9 m (Figure 8-9). Apply brake pedal to ensure that VUT is stationary until T_0 condition is reached, and then conduct the Gas-Pedal profile as described in : CCCscp Start from Stop. Determination of T_0 to ensure correct impact location (as in 8.2.4.4.) is also described in : CCCscp Start from Stop. The junction has no further markings (e.g. Stop line).

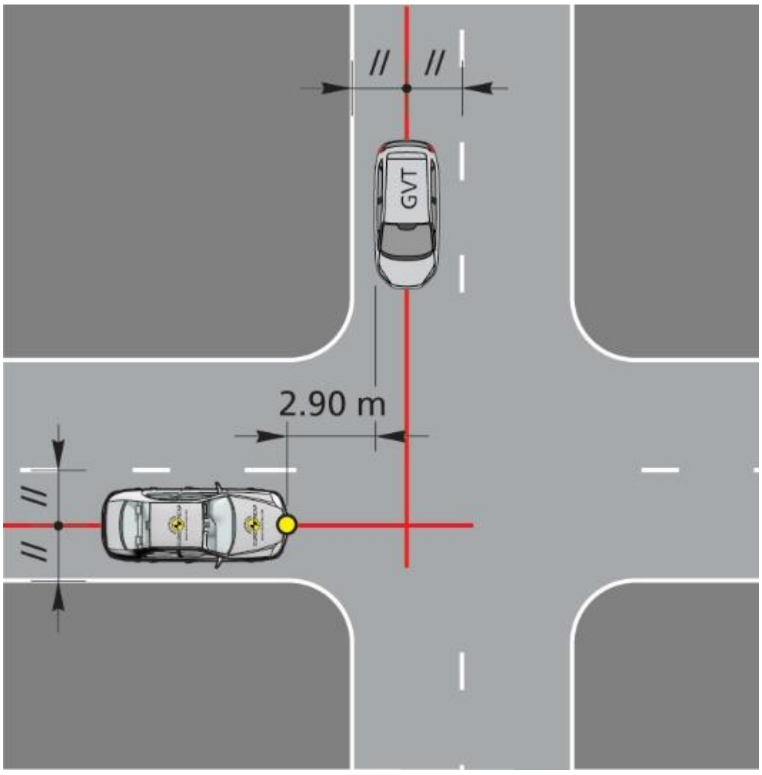


Figure 8-9 SCP start from stop setup

8.2.4.6 In the CCCscp scenario, AEB performance is tested at every combination of VUT and GVT speed shown in the table below (where sufficient performance to score points is predicted). FCW performance is tested at all tests with a VUT speed ≥ 40km/h (where sufficient performance to score points is predicted).

VUT	GVT				
	20 km/h	*30 km/h*	*40 km/h*	*50 km/h*	*60 km/h*
Start from stop	AEB	AEB	AEB	AEB	AEB
20 km/h	AEB	AEB	AEB	AEB	AEB
30 km/h	AEB	AEB	AEB	AEB	AEB
40 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
50 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW
60 km/h	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW	AEB/FCW

8.2.4.7 Where a test scenario is avoided by AEB, do not test the same combination for FCW performance as points are awarded automatically.

8.2.5 Car-to-Car Front Head-On (CCFho)

8.2.5.1 VUT and SOV speeds shall be equal for all CCFho scenarios.

8.2.5.2 The CCFhos and CCFhol tests described in this document require use of two different types of lane markings conforming to one of the lane markings as defined in UN Regulation 130 to mark a lane with a width of 3.5 to 3.7m when measured from the inside edge of the lane marking:

- Dashed line with a width between 0.10 and 0.25m (0.10 and 0.15m for centerlines)
- Solid line with a width between 0.10 and 0.25m

8.2.5.3 For the CCFhos/CCFhol scenarios of the OEM must demonstrate, by means of a dossier, how their system responds in the following scenario. Points will be awarded based on the information provided in the dossier. ANCAP reserve the right to undertake physical testing in the CCFhos/CCFhol scenarios to verify the information in the dossier, using the method detailed below.

8.2.5.4 Both the CCFhos and CCFhol scenario will be assessed at test speed combinations of 50km/h for VUT and 50km/h for GVT and 70km/h for VUT and 70km/h for GVT respectively.

8.2.5.5 For the CCFhos/CCFhol scenarios, for the VUT assume a straight-line path in the middle of the lane at a constant speed.

8.2.5.6 For the CCFhos scenario, the GVT will follow the same path as the VUT, travelling in the opposite direction at a constant speed equal to that of the VUT.

8.2.5.7 For the CCFhol scenario, the GVT will follow an initial straight-line path followed by a lane change manoeuvre at a constant speed equal to that of the VUT. The scenarios are represented in Figure 8-10 and Figure 8-11. Detail on VUT path is given in : Lane Change Path Definition.

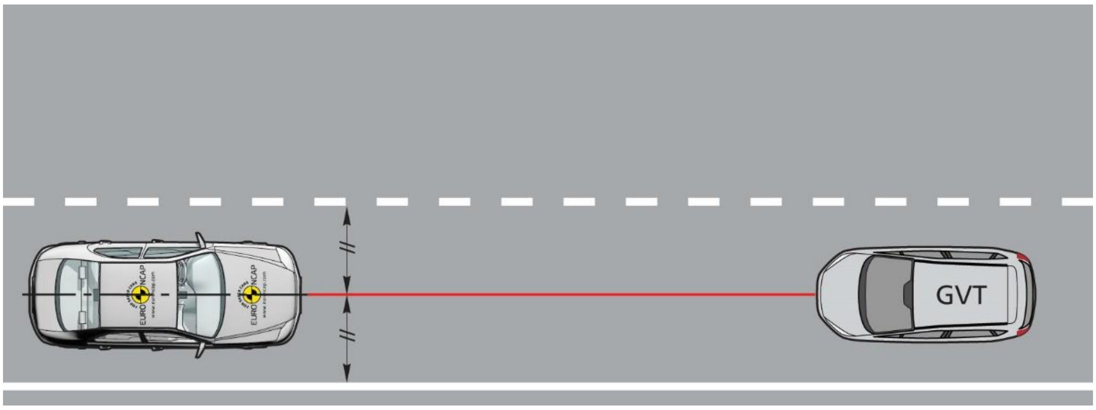


Figure 8-10: CCFhos

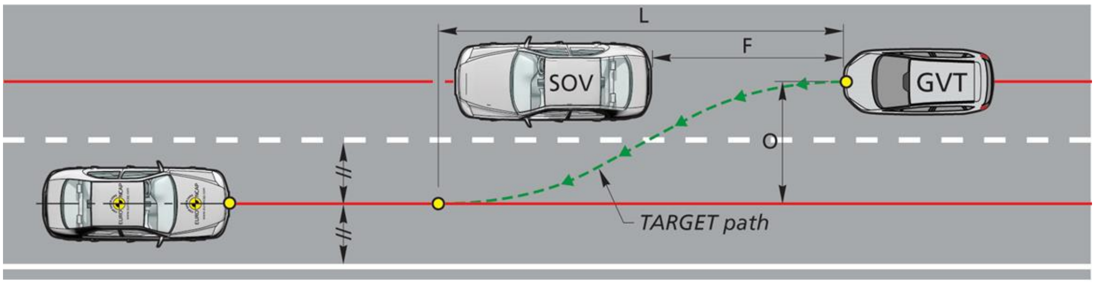


Figure 8-11: CCFhol

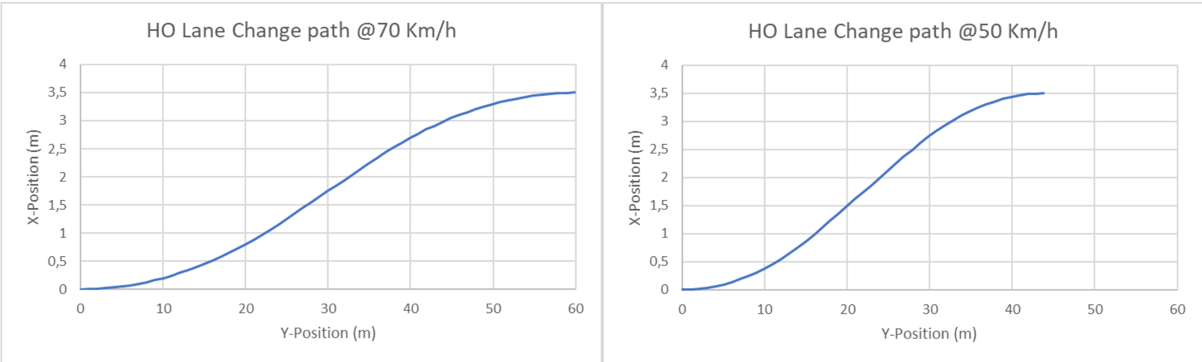


Figure 8-12 CCFhol path at 70 and 50 km/h

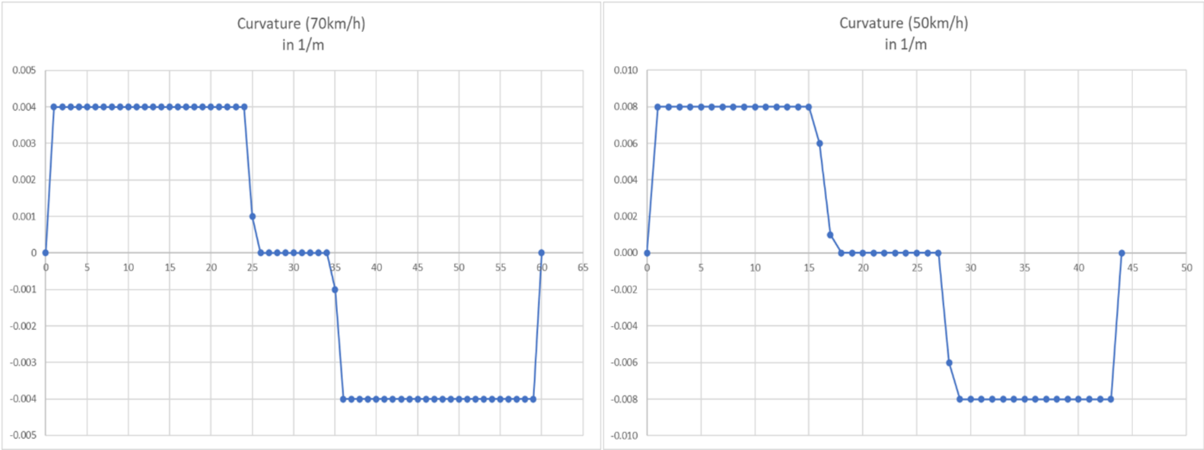


Figure 8-13 CCFhol curvature values at 70 and 50 km/h

GVT Speed	VUT Speed	Lane change offset (O)	Lane change length (L)	Following Distance (F)	TTC at end of lane change	Max Lateral acceleration
50km/h	50km/h	3.5m	44m	[13.9]m	[1.5] s	1.50 m/s²
70km/h	70km/h	3.5m	60m	[19.4]m	[1.5] s	1.50 m/s²

8.3 Test Conduct

8.3.1 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 a simple 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.

8.3.2 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. If fitted, a speed limiting device or cruise control may be used to maintain the VUT speed (not ACC), unless the vehicle manufacturer shows that there are interferences of these devices with the AEB system in the VUT. Apply only minor steering inputs as necessary to maintain the VUT tracking along the test path.

8.3.3 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.

8.4 Test Execution

8.4.1 Accelerate the VUT and GVT (if applicable) to the respective test speeds.

8.4.2 The test shall start at T_0 and is valid when all boundary conditions are met between T_0 and T_{AEB} and/or T_{FCW}, or any other system intervention:

	Remark	VUT	GVT
Speed [km/h]	Constant state	+ 1.0	± 1.0
	Deceleration state		± 0.5
Lateral Deviation [m]	CCR, CCCscp, CCFhos, CCFhol	0 ± 0.05	0 ± 0.10
	CCFtap(initial straight-line path)	0 ± 0.05	
	CCFtap(turn)	0 ± 0.10	
Relative distance VUT and GVT [m]	CCRb only	12 or 40 ± 0.5	
Yaw velocity	CCFtap (until T_{steer})[°/s]	0 ± 1.0	
Steering wheel velocity	CCFtap (until T_{steer}))[°/s]	0 ± 15.0	

8.4.3 The end of a test is considered when one of the following occurs:

- V_{VUT} = 0km/h
- $V_{VUT} < V_{GVT}$ for CCR
- Contact between VUT and GVT
- The GVT has left the path of the VUT (CCFtap and CCCscp)

	CCRs/m/b	CCFtap	CCCscp	CCFhos/hol
V_{VUT} = 0km/h	✓	✓*	✓	✓
$V_{VUT} < V_{GVT}$ for CCR	✓			
Contact between VUT and GVT	✓	✓	✓	✓
The GVT has left the path of the VUT		✓	✓	

** The VUT must not enter the path of the GVT to achieve the pass.*

8.4.4 To ensure a safe testing environment in the CCFtap and CCCscp scenario, the test laboratory may include an avoidance action by the robot in case the AEB/FCW system fails to intervene (sufficiently). This action can be applied automatically when:

- The VUT reaches the latest position at which AEB intervention could be activated to result in avoidance or significant mitigation (as applicable) and no intervention from the AEB system is detected. OEMs can provide the latest position described above, in this case, the labs may consider using them as reference to perform the avoidance action.

- Lateral separation between the VUT and GVT reaches ≤ 0m 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 OEM feels the avoidance action is negatively affecting the performance of their vehicle, they should consult with the test laboratory and ANCAP secretariat.

8.4.5 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.

8.4.6 The CCRs and CCCscp FCW system tests should be performed using a braking robot reacting to the warning with a delay time of 1.2 seconds as per A.4 to account for driver reaction time.

8.4.6.1 Braking will be applied that results in a maximum brake level of -4 m/s^2 – 0.50 m/s^2 when applied in a non-threat situation. The particular brake profile to be applied (pedal application rate applied in 200ms (max. 400mm/s) and pedal force) shall be specified by the manufacturer. When the brake profile provided by the manufacturer results in a higher brake level than allowed, the iteration steps as described in ANNEX A will be applied to scale the brake level to -4 m/s^2 – 0.50 m/s^2.

8.4.6.2 When no brake profile is provided, the default brake profile as described in ANNEX A will be applied.

8.4.7 The ESS is evaluated at the ANCAP lab with input from the OEM to ensure proper triggering of the system. The recommended testing procedure can be found in Euro NCAP Technical Bulletin TB037.

ANNEX A: BRAKE APPLICATION PROCEDURE

The braking input characterisation test determines the brake pedal displacement and force necessary to achieve a vehicle deceleration typical of that produced by a typical real-world driver in emergency situations.

A.1 Definitions

T_{BRAKE} – The point in time where the brake pedal displacement exceeds 5mm.

T_{-6m/s^2} – The point in time is defined as the first data point where filtered, zeroed and corrected longitudinal acceleration data is less than $-6m/s^2$.

T_{-2m/s^2}, T_{-4m/s^2} - similar to T_{-6m/s^2}.

A.2 Measurements

Measurements and filters to be applied as described in Chapter 4 of this protocol.

A.3 Brake Characterization Procedure

First perform the brake and tyre conditioning tests as described in 8.1.2 and 8.1.3. The brake input characterisation tests shall be undertaken within 10 minutes after conditioning the brakes and tyres.

A.3.1 Brake Displacement Characterisation Tests

- Push the brake pedal through the full extent of travel and release.
- Accelerate the VUT to a speed in excess of 85km/h. Vehicles with an automatic transmission will be driven in D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1500 at the 85km/h.
- Release the accelerator and allow the vehicle to coast. At a speed of 80 ± 1.0km/h initiate a ramp braking input with a pedal application rate of 20±5mm/s and apply the brake until a longitudinal acceleration of $-7m/s^2$ is achieved. For manual transmission vehicles, press the clutch as soon as the RPM drops below 1500. The test ends when a longitudinal acceleration of $-7m/s^2$ is achieved.
- Measure the pedal displacement and applied force normal to the direction of travel of the initial stroke of the brake pedal, or as close as possible to normal as can be repeatedly achieved.

A.3.1.1 Perform three consecutive test runs. A minimum time of 90 seconds and a maximum time of 10 minutes shall be allowed between consecutive tests. If the maximum time of 10 minutes is exceeded, perform three brake stops from 72 km/h at approximately 0.3g.

- Using second order curve fit and the least squares method between T_{-2m/s^2}, T_{-6m/s^2}, calculate the pedal travel value corresponding to a longitudinal acceleration of -4 m/s² (=D4, unit is m). Use data of at least three valid test runs for the curve fitting.
- This brake pedal displacement is referred to as D4 in the next chapters.
- Using second order curve fit and the least squares method between T_{-2m/s^2}, T_{-6m/s^2}, calculate the pedal force value corresponding to a longitudinal acceleration of -4 m/s² (=F4, unit is N). Use data of at least three valid test runs for the curve fitting.
- This brake pedal force is referred to as F4 in the next chapters.

A.3.2 Brake Force Confirmation and Iteration Procedure

- Accelerate the VUT to a speed of 80+1km/h. Vehicles with an automatic transmission will be driven in D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1500 at the 80km/h.
- Apply the brake force profile as specified in B.4, triggering the input manually rather than in response to the FCW. Determine the mean acceleration achieved during the window from T_{BRAKE} +1s T_{BRAKE} +3s. If a mean acceleration outside the range of -4-0.5m/s2 results, apply the following method to ratio the pedal force applied.

  F4new = F4original * (-4/mean acceleration), i.e. if F4original results in a mean acceleration of -5m/s2, F4new = F4original * -4 / -5
- Repeat the brake force profile with this newly calculated F4, determine the mean acceleration achieved and repeat the method as necessary until a mean acceleration within the range of -4-0.5m/s2 is achieved.

A.3.2.1 Three valid pedal force characteristic tests (with the acceleration level being in the range as specified) are required. A minimum time of 90 seconds and a maximum time of 10 minutes shall be allowed between consecutive tests. If the maximum time of 10 minutes is exceeded, perform three brake stops from 72 km/h at approximately 0.3g.

- before restarting the brake pedal force characterisation tests. This brake pedal force is referred as F4 in the next chapters.

A.4 Brake Application Profile

- Detect TFCW during the experiment in real-time.
- Release the accelerator at T_{FCW} + 1 s.
- Perform displacement control for the brake pedal, starting at T_{FCW} + 1.2 s with

a gradient of the lesser of 5 x D4 or 400mm/s (meaning the gradient to reach pedal position D4 within 200ms, but capped to a maximum application rate of 400mm/s).

- Monitor brake force during displacement control and use second-order filtering with a cut-off frequency between 20 and 100 Hz (online) as appropriate.
- Switch to force control, maintaining the force level, with a desired value of F4 when

   i. the value D4 as defined in B.3 is exceeded for the first time,

   ii. the force F4 as defined in B.3 is exceeded for the first time,

   whichever is reached first.

- The point in time where position control is switched to force control is noted as T_{switch}.
- Maintain the force within boundaries of F4 ± 25% F4. A stable force level should be achieved within a period of 200ms maximum after the start of force control. Additional disturbances of the force over ± 25% F4 due to further AEB interventions are allowed, as long as they have a duration of less than 200ms.
- The average value of the force between T_{FCW} + 1.4s and the end of the test should be in the range of F4 ± 10 N.

ANNEX B: Lane Change Path Definition

70km/h Lane Change Co-ordinates

Distance (m)	Time (s)	X-Position (m)	Y-Position (m)	Curvature (1/m)
0	0	0	0	0
1	0,051	1	0,002	0,004
2	0,103	2	0,008	0,004
3	0,154	3	0,018	0,004
4	0,206	4	0,032	0,004
5	0,257	5	0,05	0,004
6	0,309	5,999	0,072	0,004
7	0,36	6,999	0,098	0,004
8	0,411	7,999	0,128	0,004
9	0,463	8,998	0,162	0,004
10	0,514	9,997	0,2	0,004
11	0,566	10,996	0,242	0,004
12	0,617	11,995	0,288	0,004
13	0,669	12,994	0,338	0,004
14	0,72	13,993	0,392	0,004
15	0,771	14,991	0,45	0,004
16	0,823	15,989	0,512	0,004
17	0,874	16,987	0,578	0,004
18	0,926	17,984	0,648	0,004
19	0,977	18,982	0,722	0,004
20	1,029	19,979	0,8	0,004
21	1,08	20,975	0,881	0,004
22	1,131	21,972	0,967	0,004
23	1,183	22,968	1,057	0,004
24	1,234	23,963	1,151	0,004
25	1,286	24,958	1,249	0,001
26	1,337	25,953	1,348	0
27	1,389	26,949	1,447	0
28	1,44	27,944	1,546	0
29	1,491	28,939	1,645	0
30	1,543	29,934	1,743	0
31	1,594	30,929	1,842	0
32	1,646	31,924	1,941	0
33	1,697	32,919	2,04	0
34	1,749	33,914	2,139	0
35	1,8	34,909	2,238	-0,001
36	1,851	35,904	2,336	-0,004
37	1,903	36,9	2,43	-0,004
38	1,954	37,896	2,521	-0,004
39	2,006	38,892	2,607	-0,004
40	2,057	39,889	2,69	-0,004

41	2,109	40,886	2,768	-0,004
42	2,16	41,883	2,843	-0,004
43	2,211	42,88	2,913	-0,004
44	2,263	43,878	2,98	-0,004
45	2,314	44,876	3,042	-0,004
46	2,366	45,875	3,101	-0,004
47	2,417	46,873	3,155	-0,004
48	2,469	47,872	3,206	-0,004
49	2,52	48,871	3,252	-0,004
50	2,571	49,87	3,295	-0,004
51	2,623	50,869	3,333	-0,004
52	2,674	51,868	3,368	-0,004
53	2,726	52,868	3,398	-0,004
54	2,777	53,868	3,425	-0,004
55	2,829	54,867	3,447	-0,004
56	2,88	55,867	3,466	-0,004
57	2,931	56,867	3,48	-0,004
58	2,983	57,867	3,491	-0,004
59	3,034	58,867	3,497	-0,004
60	3,086	59,867	3,5	0

50km/h Lane Change Co-ordinates

Distance (m)	Time (s)	X-Position (m)	Y-Position (m)	Curvature (1/m)
0	0	0	0	0
1	0,072	1	0,004	0,008
2	0,144	2	0,015	0,008
3	0,216	3	0,035	0,008
4	0,288	3,999	0,062	0,008
5	0,36	4,999	0,096	0,008
6	0,432	5,998	0,138	0,008
7	0,504	6,997	0,188	0,008
8	0,576	7,995	0,246	0,008
9	0,648	8,993	0,311	0,008
10	0,72	9,99	0,384	0,008
11	0,792	10,987	0,465	0,008
12	0,864	11,983	0,553	0,008
13	0,936	12,978	0,649	0,008
14	1,008	13,973	0,753	0,008
15	1,08	14,967	0,864	0,008
16	1,152	15,96	0,983	0,006
17	1,224	16,952	1,109	0,001
18	1,296	17,944	1,235	0
19	1,368	18,936	1,361	0

20	1,44	19,928	1,487	0
21	1,512	20,92	1,613	0
22	1,584	21,912	1,739	0
23	1,656	22,904	1,865	0
24	1,728	23,896	1,991	0
25	1,8	24,888	2,117	0
26	1,872	25,88	2,243	0
27	1,944	26,872	2,369	0
28	2,016	27,864	2,495	-0,006
29	2,088	28,857	2,615	-0,008
30	2,16	29,85	2,728	-0,008
31	2,232	30,845	2,833	-0,008
32	2,304	31,84	2,93	-0,008
33	2,376	32,836	3,02	-0,008
34	2,448	33,833	3,102	-0,008
35	2,52	34,83	3,176	-0,008
36	2,592	35,828	3,243	-0,008
37	2,664	36,826	3,302	-0,008
38	2,736	37,825	3,353	-0,008
39	2,808	38,824	3,397	-0,008
40	2,88	39,823	3,433	-0,008
41	2,952	40,823	3,461	-0,008
42	3,024	41,822	3,482	-0,008
43	3,096	42,822	3,495	-0,008
44	3,168	43,822	3,5	0

ANNEX C: CCCscp Start from Stop

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

C.1 Definitions

- $T_{Start,}$ time where VUT filtered acceleration reaches [0.1] m/s^2 (in CCCscp start from stop scenario) — T_{Start}
- $T_{End,}$ time where VUT has travelled 2.9m. from the start position (in CCCscp start from stop scenario) — T_{End}
- $T_{Avg,}$ average time value of T_{End} from all the executed trials (in CCCscp start from stop scenario) — T_{Avg}

C.2 Measurements

Measurements and filters to be applied as described in section 4 of this protocol.

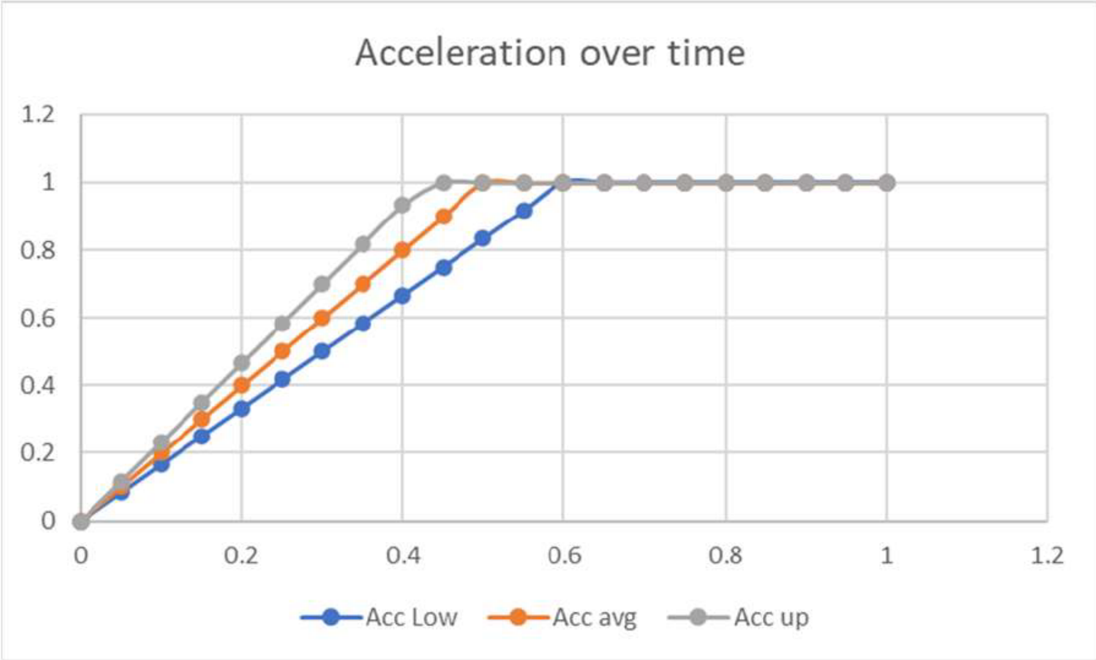
C.3 Gas-Pedal characterization procedure

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

- The longitudinal acceleration shall not exceed 1 m/s^2 before TStart + 0.5 seconds.
- The longitudinal acceleration shall not exceed 1.75 m/s^2 at any point and must exceed 1m/s^2 from TStart + 1.25 until TEnd.

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 gas 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 GVT. With the known time that the car needs to reach the impact location, it can be triggered by the approaching GVT 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 CCCscp Start-from-Stop capabilities, the OEM shall contact ANCAP to discuss an alternative approach.