EURO NCAP

#FORSAFERCARS

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Safe Driving Vehicle Assistance

Protocol

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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 Vehicle Manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Vehicle 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 Vehicle Manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a Vehicle Manufacturer has interfered with any of the set up, the Vehicle 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 Vehicle 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 Vehicle Manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

CONTENTS

DEFINITIONS

Throughout this protocol the following terms are used:

Journey – A journey starts with activation of the master control switch and lasts until the deactivation of the master control switch and the driver's door being opened.

Vehicle master control switch – Means the device by which the vehicle's on-board electronics system is brought from being switched off, as in the case where a vehicle is parked without the driver being present, to a normal operation mode.

Default-ON – A function that is ON by default at the start of every journey. It may be voluntarily switched OFF by the driver, but voluntary function deactivation shall not be possible with a single momentary push of a button.

Speed Assistance

Vindicated – The speed at which the vehicle travels as displayed to the driver by the speedometer as in ECE R39.

Vlimit – Maximum allowed legal speed for the vehicle at the location, time and in the circumstance the vehicle is driving.

Speed Limit Information Function (SLIF) – SLIF means a function with which the vehicle knows and communicates the speed limit.

Speed Limit Warning Function (SLWF) – SLWF means a function that alerts the driver that the Vindicated is exceeding the perceived speed limit

Adjustable speed (Vadj) – Adjustable speed Vadj means the voluntarily set speed for the speed control functions, which is based on **Vindicated** and includes the offset set by the driver.

Speed Limitation Function (SLF) – SLF means a system which allows the driver to set a vehicle speed Vadj, to which he wishes the speed of his car to be limited and above which he wishes to be warned.

Intelligent Speed Limiter (ISL) – ISL is a SLF combined with SLIF, where the Vadj is set by the SLIF with or without driver confirmation.

Intelligent Adaptive Cruise Control (iACC) – iACC is an ACC combined with SLIF, where the speed is set by the SLIF with or without driver confirmation.

Stabilised speed (Vstab) – Stabilised speed Vstab means the mean actual vehicle speed when operating. Vstab is calculated as the average actual vehicle speed over a time interval of 20 seconds beginning 10 seconds after first reaching Vadj – 10 km/h.

Vehicle Assistance

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

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

Secondary Other Vehicle (SOV) – means the “Large Obstruction Vehicle” as defined in the latest AEB VRU test protocol (and not a robot-controlled platform) used in the Cut-out test in this protocol.

Euro NCAP Pedestrian Target (EPTa) – means the articulated adult pedestrian target used in this protocol as specified in the 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 the deliverable D2.1 of the MUSE project (Fritz and Wimmer 2019) which at time of publication is to be replaced with ISO 19206-5.

Real Motorcycle – Means a motorcyclist target that can be used in the Blind-Spot Monitoring Tests of this protocol, as an alternative to the EMT. The Real Motorcycle shall be a type approved two-wheeled motorcycle, with a maximum speed of at least 80km/h by design, without front fairing or windshield. It shall closely resemble the EMT (as specified in section 2.1 of deliverable D2.1 of the MUSE project), thus staying within the mean dimensions of the most registered middleweight naked motorcycles in Europe (i.e. wheelbase >1405mm. and <1445mm.).

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.

Speed Assist System (SAS) –a system that informs or warns the driver and/or controls the vehicle speed

Speed Limit Information Function (SLIF) – a function with which the vehicle knows and communicates the speed limit.

Speed Limitation Function (SCF) – a system which allows the driver to set a vehicle speedto which he wishes the speed of his car to be limited and above which he wishes to be warned.

Adaptive Cruise Control (ACC) – a system that controls the vehicle speed whilst maintainina set distance to vehicles ahead

Intelligent Adaptive Cruise Control (iACC) – iACC is an ACC combined with SLIF, where the speed is set by the SLIF with or without driver confirmation.

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

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 a target in front to avoid the collision.

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

Lane Support System (LSS) – a set of lateral control features that correct the vehicle heading to keep the vehiclewithin its driving lane and/or warns the driver.

Lane Centering (LC) – a function which assists the driver in keeping the vehicle within the chosen lane, by influencing the lateral movement of the vehicle.

Lane Change Assist (LCA) – a function which is initiated by the driver OR proposed by the system and confirmed by the driver, which can perform a single lateral manoeuvre (e.g. lane change).

Emergency Lane Keeping (ELK) – default ON heading correction that is applied automatically by the vehicle in response to the detection of the vehicle that is about to driftbeyond a solid lane marking, the edge of the road or into oncoming or overtaking traffic inthe adjacent lane.

Lane Keeping Assist (LKA) – heading correction that is applied automatically by the vehiclein response to the detection of the vehicle that is about to drift beyond a delineated edge line of the current travel lane.

Lane Departure Warning (LDW) – a warning that is provided automatically by the vehicle in response to the vehicle that is about to drift beyond a delineated edge line of the current travel lane.

Driver State Monitoring (DSM) – Driver State Monitoring system that is able to (in)directly determine the state of the driver

Direct Monitoring – Where driver state determination is supported by sensor(s) directly observing the driver.

Car-to-Car – a collision between a vehicle another car, when no braking and/or steering action is applied.

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.

SCORING

Vehicle Assistance assessment	Total points 40
Speed Assistance	**20**
Speed Limit Information Function	12
Speed Control Function	8
ACC Performance	**15**
Car-to-Car	6
Car-to-PTW	5
Car-to-VRU	2
Road Features	1
Auto-resume	1
Steering Assistance	**5**
Steering Assistance	4
Lane Change Assist	1

1 SPEED ASSISTANCE

Speed Assistance assessment	Total points 20
Speed Limit Information Function	**12**
SLIF Accuracy	4
Advanced Speed Limits	3
Local Hazards	3
System updates	2
Speed Control Function	**8**
ISL not default-ON	5
iACC	8

The Speed Limit Information Function may be a standalone function or an integrated part of a Speed Control Function. Any SLIF using all relevant system inputs, e.g., camera input and electronic map based or a combination of both, is eligible for scoring points for Advanced Functions when meeting the General Requirements.

The Vehicle Manufacturer shall supply Euro NCAP with a dossier containing background information of the SLIF (if applicable to the technology).

1.1 General Requirements

The SLIF, including the Local Hazard warnings*, shall be default ON at the start of a journey and shall be shown at all times (excluding the initialization period and temporary interruption for safety reasons).

The speed limit shall be shown using a traffic sign and shall be clearly seen in the direct field of view of the driver, without the need for the head to be moved from the normal driving position, e.g. instrument cluster or head-up display.

In the presence of explicit conditional speed limits the system shall either:

- Identify and show (for example when raining) the applicable speed limit,
  OR
- Indicate the presence of a conditional speed limit which the system is not able to compute, in addition to the non-conditional speed limit.

The SLIF shall incorporate a default ON visual warning informing the driver when Vlimit is exceeded. The visual warning shall be a flashing traffic sign used to communicate the speed limit or an additional visual signal adjacent to the traffic sign.

**User consent may apply.*

1.2 Speed Limit Information Function

Speed Limit Information Function	Total Points 12
SLIF Accuracy	4
Advanced Speed Limits	3
Local Hazards	3
System updates	2

1.2.1 SLIF accuracy

SLIF Accuracy KPI	Requirement	Points
Distance based *($KPI_{Distance}$)*	> 80%*	2
Event based *(KPI_{Event})*	> 80%*	2

* Assuming perfect ground truth.

Both requirements will be determined during an on-road evaluation on public roads of at least 2000 km across different countries in the Euro NCAP Application Area (as defined in TB002), and combining urban, interurban and highway roads in daytime and nighttime conditions. This on-road evaluation will be conducted by the test laboratory.

$$KPI_{Distance} = {}^{D_{correct}}/_{D_{total}}$$

$with$:

$D_{correct}$
$= Total\ distance\ with\ correct\ speed\ limit\ displayed\ (km), applicable\ to\ ALL\ speed\ limit\ elements$

$D_{total} = Total\ distance\ driven\ (km)$

$$KPI_{Event} = {}^{E_{correct}}/_{E_{total}}$$

$with$:

$E_{correct} = Total\ number\ of\ correctly\ identified\ events\ of\ the\ claimed\ speed\ limit\ elements$

$E_{total} = Total\ number\ of\ events\ \ of\ the\ claimed\ speed\ limit\ elements$

1.2.2 Advanced Speed Limits

Advanced Speed Limits	Points
Conditional Speed Limits	2
Implicit Speed Limits	0.5
Dynamic Speed Limits	0.5

To be eligible for points in each advanced speed limit, the Vehicle Manufacturer shall demonstrate by means of a dossier that the system provides the driver with advanced speed limit information during at least 80% of typical driving on the following areas:

- Austria, France, Germany, Italy, Luxemburg, the Netherlands, Spain, Sweden, United Kingdom and Norway.
- In at least half of the countries of the Euro NCAP Application Area (as defined in TB002).

The dossier shall contain evidence of the system performance for each advanced speed limit resulting from on-road evaluation conducted by the Vehicle Manufacturer of approximately 400km of length in above areas, with exceptions allowed for small countries. Alternative validation methods may be used when on-road evaluation is not feasible or sufficient e.g., HiL data, test track data, etc.

1.2.2.1 Conditional speed limits

Conditional Speed Limits	Requirement	Points
Rain/wetness (including implicit)	Show correct speed limit	0.4
Snow/icy	Warning only / ignore if irrelevant	0.4
Time/season	Show correct speed limit	0.4
Distance for/in	Show correct speed limit	0.4
Arrows - Non lane-relevant - Lane-relevant	Show correct speed limit / ignore if irrelevant	 0.1 0.2
Vehicle categories	Show correct speed limit	0.2

Systems that can identify and compute conditions and show the applicable speed limit accordingly are eligible to score the available points. The speed limit under these conditions shall not be shown separately from the speed limit information requested in the general requirements.

1.2.2.2 Implicit speed limits

Implicit Speed Limits	Requirement	Points
Highway / Motorway City Entry / Exit Residential zones	Show correct speed limit*	0.5

** Applicable to ANY implicit speed limits*

1.2.2.3 Dynamic speed limits

Dynamic Speed Limits	Requirement	Points
Dynamic speed signs including roadworks - Non lane-relevant - Lane-relevant	Show correct speed limit	0.25 0.5

1.2.3 Local Hazards

Local Hazards	Direct OR Cloud Communication		Direct AND Cloud Communication	
	Sending	Receiving & informing	Sending	Receiving & informing
Construction zones	0.15	0.15	0.2	0.15
Items on road	0.15	0.15	0.2	0.15
Stopped vehicle*	0.15	0.15	0.2	0.15
Broken down vehicle*	0.15	0.15	0.2	0.15
Post crash*	0.15	0.15	0.2	0.15
Poor weather*	0.15	0.15	0.2	0.15
Poor road*	0.15	0.15	0.2	0.15
Wrong way driver*	0.15	0.15	0.2	0.15
Amber + Blue lights	N/A	0.15	N/A	0.15
Traffic jam	N/A	0.15	N/A	0.15
TOTAL (capped)	**Max 2.5**		**Max 3.0**	

**When sending information, only information about the condition of the ego vehicle, or environmental conditions the ego vehicle is exposed to, is requested*

Vehicles able to send AND receive local hazard information are eligible to score the available points shown in the table above. Points can be scored individually. Local hazards service shall be available in all Euro NCAP Application Area (as defined in TB002).

Vehicles may communicate with a public cloud or via direct communication. Maximum points are achieved when both cloud and direct communication is possible.

“Receiving and informing” is understood as retrieving local hazard data into the vehicle and informing the driver about them in due time before reaching the event location.

“Sending” is understood as sharing local hazard data that is gathered by the vehicle within the DFRS cloud ecosystem or via direct communication.

1.2.3.1 Cloud communication

Cloud communication is foreseen to happen via mobile network. The reference cloud for this communication channel is the Data For Road Safety (DFRS) ecosystem [https://www.dataforroadsafety.eu/].

For each Local Hazard covered by the vehicle, the Vehicle Manufacturer shall demonstrate, by means of fulfilling the self-declaration forms developed by DFRS, that vehicle data is received and/or sent from/to the DFRS ecosystem.

1.2.3.2 Direct Communication

Direct Communication is foreseen to happen via direct short range communication standards (e.g., Wi-Fi ITS-G5 or C-V2X).
The Vehicle Manufacturer shall self-declare fulfilment of the direct short range communication standards and demonstrate interoperability with C-ROADS deployment (where applicable). If a different approach is followed, the Vehicle Manufacturer shall contact the Euro NCAP Secretariat.

1.2.4 System updates

System Updates	Points
Continuous connectivity (Streamed)	2
Temporary connectivity (OTA updates)	1

1.2.4.1 Continuous connectivity

Vehicles that continuously stream speed limit data while driving.

1.2.4.2 Temporary connectivity

Regular updates for speed limit data over the air, at least quarterly.

1.3 Speed Control Function

Speed Control Function	Points
Intelligent Speed Limiter (ISL)	5
Intelligent Adaptive Cruise Control (iACC)	8

The speed control function shall be capable of being activated/de-activated at any time with a simple operation. Functionalities above GSR ISA requirements could be configurable by the driver, without the need of being default ON.

To be awarded full score, speedometer accuracy shall be -3/+0 km/h. When the speedometer accuracy is -5/+0 km/h the SCF points are halved.

1.3.1 Setting the speed

The Speed Control Function (SCF) shall use the speed limit information from the SLIF to set the Vadj, with or without driver confirmation (to the choice of the Vehicle Manufacturer). The system should adopt, or offer the driver to adopt, an adjusted Vadj within 5s after a change in the speed limit.

A negative and/or positive offset with respect to the known speed limit is allowed but may not be larger than 10 km/h (5 mph). This offset is included in Vadj.

1.3.2 Speed Control

The vehicle speed shall be limited or controlled to Vadj, but it shall still be possible to exceed Vadj by applying a positive action – e.g. pressing the accelerator harder/deeper or kickdown.

After exceeding Vadj by applying a positive action, the speed control function shall be reactivated when the vehicle speed drops to a speed less than or equal to Vadj.

If the Vadj is set to a speed lower than the current vehicle speed, the SCF shall start reducing the vehicle speed to the new Vadj, or shall initiate a warning no later than 30s after Vadj has been set.

If the Vadj is set to a speed higher than the current vehicle speed, the SCF shall start increasing the vehicle speed to the new Vadj, when traffic conditions allow (for iACC only, when fitted).

When the speed control function is not able to limit to and/or maintain Vadj and Vadj is exceeded, an acoustic warning shall be issued. No warning needs to be given when Vadj is exceeded as a result of a positive action. For systems where active braking is applied to maintain and/or limit the speed, this warning requirement does not apply.

2 ADAPTIVE CRUISE CONTROL PERFORMANCE

ACC Performance	Total points 15
Car-to-car	**6**
Longitudinal	4
Cut-in / Cut-out	2
Car-to-PTW	**5**
Longitudinal	4
Cut-in / Cut-out	1
Car-to-VRU	**2**
Longitudinal	2
Road Features	**1**
Auto-resume	**1**

Only the capability of the ACC system is assessed, where acceleration ≥-5 m/s^2, or where it is confirmed that AEB did not intervene.

All ACC tests are performed as per Euro NCAP Crash Avoidance protocols however, where the procedure in this protocol deviates from these protocols, this ACC protocol should be followed.

For each test, the vehicle shall be driven in a fully marked lane with the indicated ACC speed set to the required test speed (i.e., not the GPS speed). The ACC shall be initially set to the closest following distance for all tests. Where possible, the Steering Assistance shall be engaged and used to control the VUT's position within the lane. When this system is not available, the vehicle will be driven manually. The ACC shall be active before the lower of 10s TTC or 250m relative longitudinal distance to target.

The Vehicle Manufacturer is required to provide the Euro NCAP Secretariat with colour data (expected impact speeds are not required) detailing the ACC performance in all scenarios included in the assessment, as indicated in the table below:

Colour		Expected ACC performance (≥-5 m/s^2)
Green	Car-to-Car	Full avoidance
	Car-to-PTW	Full avoidance
	Car-to-VRU	Speed reduction > 30 km/h
Orange	Car-to-Car	Speed reduction > 15 km/h
	Car-to-PTW	Speed reduction > 15 km/h
	Car-to-VRU	Speed reduction > 15 km/h
Grey	Car-to-Car	Speed reduction ≤ 15 km/h
	Car-to-PTW	Speed reduction ≤ 15 km/h
	Car-to-VRU	Speed reduction ≤ 15 km/h

Test selection

For CCRs, CCRm, CMRs and CMRm, based on the Vehicle Manufacturer colour prediction, the following test speeds of each scenario will be tested by the test laboratory (excluding tests speeds where the Vehicle Manufacturer predicted Grey in the Safety Backup – Collision Avoidance tests of the Assisted Driving protocol):

- Highest test speed with “Green” prediction
- Highest test speed with “Orange” prediction
- One randomly selected test speed

If the prediction performance is not met in any of these tests, perform a test at the adjacent test speed(s) until the predicted performance is confirmed.

For Cut-in and Cut-out scenarios (both for Car-to-Car and Car-to-PTW), the test laboratory will test all test speeds

In case the Vehicle Manufacturer does not provide performance data, the test laboratory will conduct all test speeds in all scenarios.

Impact speed tolerance

As test results can be variable between labs and in-house tests and/or simulations a 2 km/h tolerance to the impact speeds of the verification test is applied. The tolerance is applied in both directions, meaning that when a tested point scores better than predicted, but within tolerance, the predicted result is applied.

The tolerance only applies to verify whether the predicted colour of the tested verification point is correct. When, including tolerance, the colour is not in line with the prediction, the true colour of the test point will be determined by comparing the actual measured impact speed reduction with the colour band without applying a tolerance to the impact speed reduction.

2.1 Car-to-Car

Car-to-car	Total points 6
Longitudinal	**4**
CCRs straight	1
CCRs curve	1
CCRm	1
CCRb	1
Cut-in / Cut-out	**2**
Cut-in	1
Cut-out	1

ACC Performance Car-to-Car tests consist of the following combination of VUT and target speeds with 10 km/h increments where applicable:

Car-to-car tests	VUT speed	Target speed
CCRs – Stationary Target		
Straight road, 50% impact location	60-130 km/h	0 km/h
Curved road, 50% impact location	60-130 km/h	0 km/h
CCRm – Moving Target		
Straight road, 50% impact location	60-130 km/h	20 km/h
	70-130 km/h	60 km/h
CCRb – Braking Target		
Straight road, 50% impact location	55 km/h	50 km/h & -4m/s^2
Cut-in		
Straight road, 50% impact location		
Cut-in @ TTC = 0.00s	50 km/h	10 km/h
Cut-in @ TTC = 1.50s	120 km/h	70 km/h
Cut-out		
Straight road, 50% impact location		
Cut-out @ TTC = 3.00s	70 km/h	50 km/h
Cut-out @ TTC = 3.00s	90 km/h	70 km/h

For each scenario and test speed, 1 point can be achieved where the ACC fully avoids the collision. Where the ACC intervenes and reduces the impact speed by more than 15 km/h before the AEB intervenes, 0.5 points are scored. Where the ACC does not reduce the impact speed more than 15 km/h, no points are awarded.

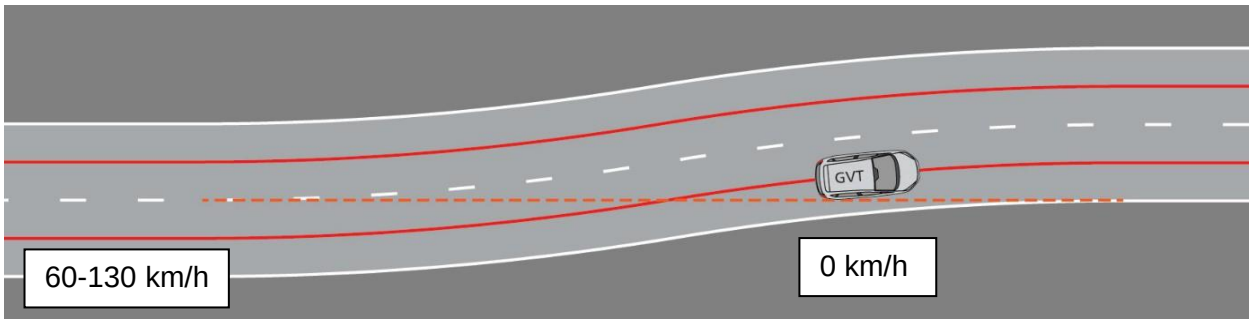
2.1.1 CCRs

CCRs tests are conducted on both straight and curved roads from 60 to 130 km/h in 10 km/h speed increments. Tests on straight roads are conducted with 50% impact location.

For tests on a curved section of road, the first turn of the S-Bend as required for the Steering Assistance assessment is used where the GVT shall be positioned such that it is central in lane around the first bend so that the rear corner is touching the extrapolated line as if the straight were continue (as shown in the picture below).

For vehicles not equipped with Lane Centering or where the VUT cannot follow the S-bend path, conduct the test manually following the S-Bend path and ensuring as much as possible a 50% impact location.

Automatic speed reduction/adaptation prior to entering the S-Bend is allowed if the speed reduction/adaptation strategy is always active.



2.1.2 CCRm

CCRm tests are conducted on straight road with a VUT speed from 60 to 130 km/h in 10 km/h speed increments, and with combinations of target speeds of 20 and 60 km/h. All tests are conducted with 50% impact location.

In the case of CCRm test cases where the GVT travels at 60km/h it is permissible to use a physical Ford Fiesta vehicle fitted with data recording instrumentation.
A physical vehicle shall only be used when full avoidance from the ACC system is predicted, I.e. deceleration levels do not exceed approximately 5m/s^2 and AEB does not intervene. The test shall be aborted safely if the VUT does not initiate ACC braking when TTC = [3.0s], at which point the test is repeated with the Soft Car GVT & platform.

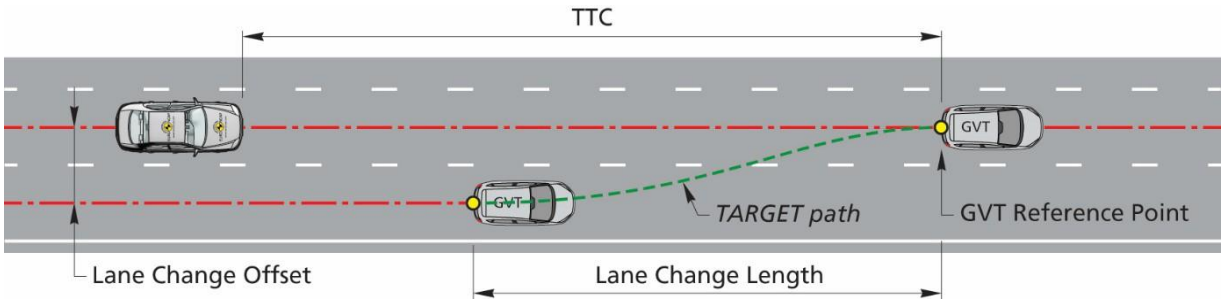
2.1.3 CCRb

CCRb test is conducted with a VUT speed of 55 km/h and target speed of 50 km/h, with ACC set to closest distance, and with 50% impact location. The target shall decelerate at a rate of 4m/s^2

2.1.4 Cut-in

In the Cut-in tests, the GVT on the adjacent lane shall perform a full lane change (3.5m lateral offset) into the lane of the VUT. The indicated TTC is defined as the TTC at the point intime that the GVT has finished the lane change manoeuvre, where the rear centre of the GVT is in the middle of the VUT driving lane.

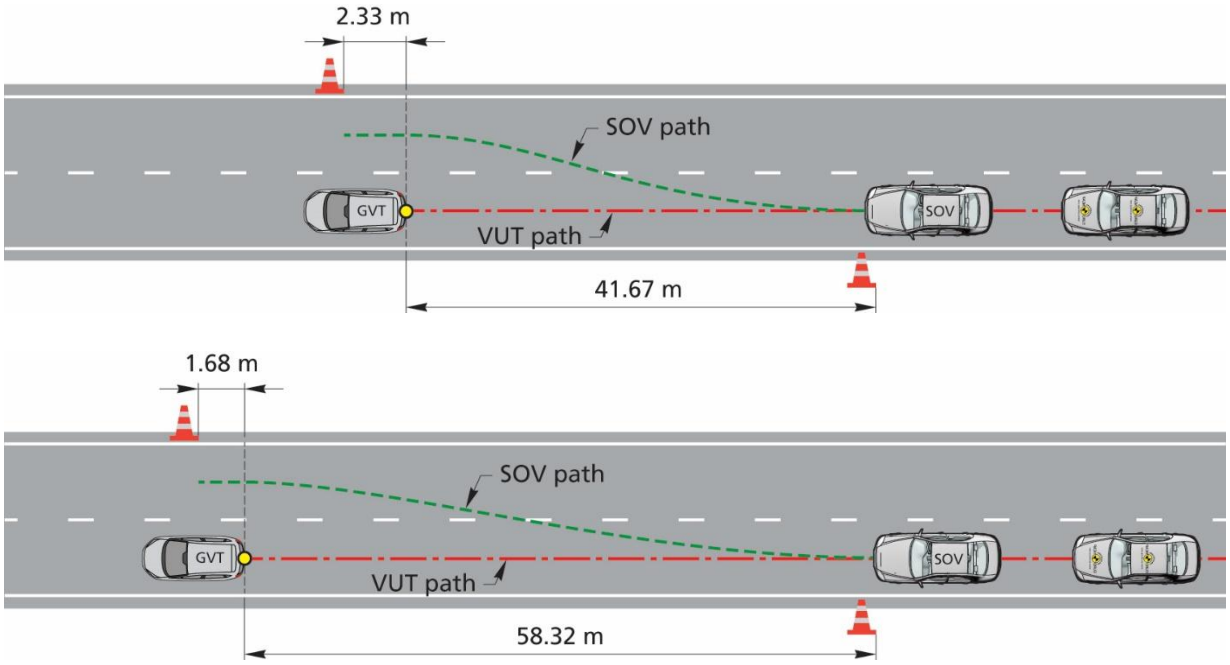
Cut-in	VUT	GVT	Lane Change Manoeuvre GVT		
			Lateral Acceleration	Change Length	Radius of turning segments
Cut-in @ TTC = 0.00 Cut-in @ TTC = 1.50	50 km/h 120 km/h	10 km/h 70 km/h	0.5 m/s^2 1.5 m/s^2	14.5 m 60.0 m	15 m 250 m



2.1.5 Cut-out

The Cut-out test shall be performed using the SOV. The vehicle cutting out (SOV) shall perform a full lane change (3.5m lateral offset) into the adjacent lane to avoid the stationary GVT. With the measurement behind the stationary GVT indicting that start of the lane change, and the measurement in front of the stationary GVT indicating the end of the lane change. The indicated TTC is defined as the TTC of the lead vehicle to the GVT when the lead vehicle shall start the lane change. Indicators are not to be used by the SOV during the manoeuvre. It is permissible for the test laboratory to place physical markers, that shall not affect vehicle performance, of the different cut-out paths. SOV path deviation = [±0.2m]. An example can be found in the Annex.

Cut-out	VUT	Lead Vehicle	Lane Change Manoeuvre of lead vehicle		
			Lateral Acceleration	Change Length	Radius of turning segments
Cut-out @ TTC = 3.00 Cut-out @ TTC = 3.00	70 km/h 90 km/h	50 km/h 70 km/h	1.5 m/s^2 1.5 m/s^2	44.0 m 60.0 m	130 m 250 m


2.33 m
SOV path
GVT
SOV
VUT path
41.67 m
1.68 m
SOV path
GVT
SOV
VUT path
58.32 m

2.2 Car-to-PTW

Car-to-PTW	Total points 5
Longitudinal	**4**
CMRs straight	1
CMRs curve	1
CMRm	1
CMRb	1
Cut-in / Cut-out	**1**
Cut-in	0.5
Cut-out	0.5

ACC Performance Car-to-PTW tests consist of the following combination of VUT and target speeds with 10 km/h increments where applicable:

Car-to-PTW tests	VUT speed	Target speed
CMRs – Stationary Target		
Straight road, 25% impact location, GVT on side	60-90 km/h	0 km/h
Straight road, 25% impact location, GVT in front	60-90 km/h	0 km/h
Curved road, 50% impact location	60-90 km/h	0 km/h
CMRm – Moving Target		
Straight road, 50% impact location	60-130 km/h	20 km/h
	70-130 km/h	60 km/h
CMRb – Braking Target		
Straight road, 25% impact location	55 km/h	50 km/h & -4m/s^2
Cut-in		
Straight road, 25% impact location		
Cut-in @ TTC = 0.50s	50 km/h	10 km/h
Cut-in @ TTC = 1.50s	120 km/h	70 km/h
Cut-out		
Straight road, 25% impact location		
Cut-out @ TTC = 3.00s	70 km/h	50 km/h
Cut-out @ TTC = 3.00s	90 km/h	70 km/h

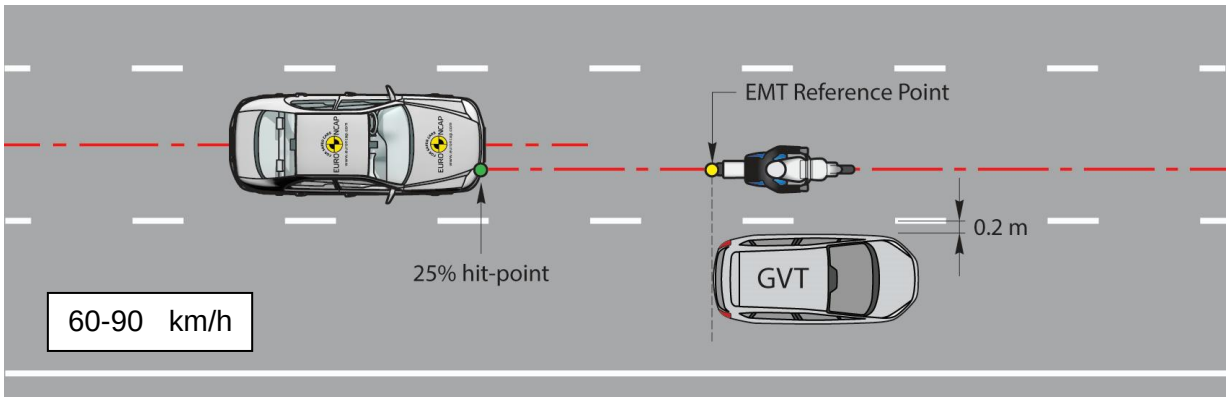
For each scenario and test speed, 1 point can be achieved where the ACC fully avoids the collision. Where the ACC intervenes and reduces the impact speed by more than 15 km/h before the AEB intervenes, 0.5 points are scored. Where the ACC does not reduce the impact speed more than 15 km/h, no points are awarded.

2.2.1 CMRs

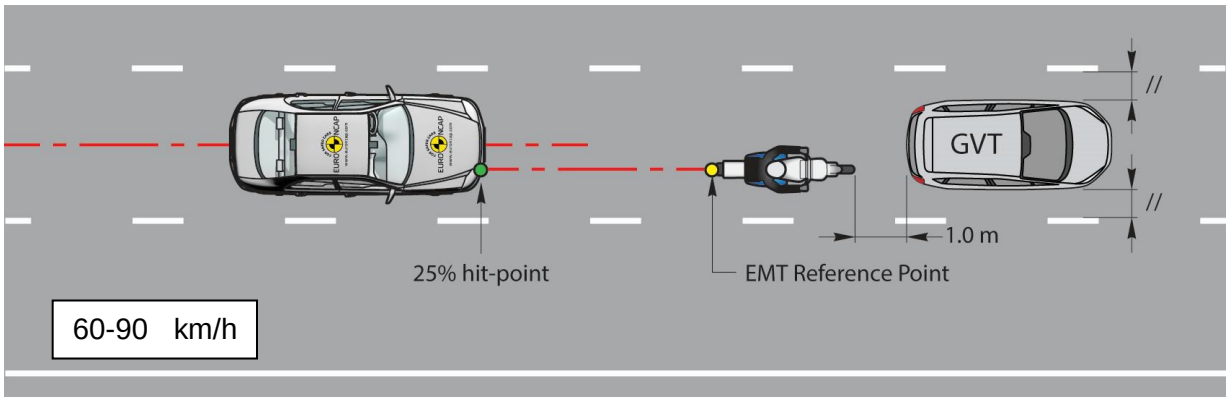
CMRs tests are conducted on both straight and curved roads from 60 to 90 km/h in 10 km/h speed increments.

For tests on a straight road, the stationary EMT shall be positioned in a 25% impact location position. The test laboratory shall randomly select one of the following scenario layouts.

a) A stationary GVT positioned in the adjacent lane such that the left side is 20 cm. from the centre of the centre dashed lane marking of the VUT lane, and the rear side coincides with the rear wheel of the stationary EMT:



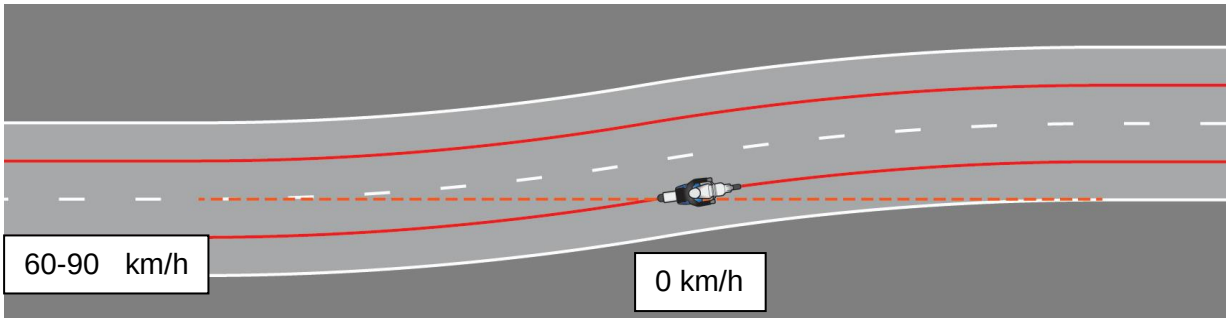
b) A stationary GVT positioned centred in-lane and 1m in front of the EMT:



For tests on a curved section of road, the first turn of the S-Bend as required for the Steering Assistance assessment is used where the EMT shall be positioned such that it is central in lane around the first bend, with the most rear part of the rear wheel is touching the extrapolated line as if the straight were continue (as shown in the picture below).

For vehicles not equipped with Lane Centering or where the VUT cannot follow the S-bend path, conduct the test manually following the S-Bend path and ensuring as much as possible a 50% impact location.

Automatic speed reduction/adaptation prior to entering the S-Bend is allowed if the speed reduction/adaptation strategy is always active.



2.2.2 CMRm

In the case of CMRm test cases where the EMT travels at 60km/h it is permissible to use a real motorcycle with data recording instrumentation.

A real motorcycle shall only be used when full avoidance from the ACC system is predicted, I.e. deceleration levels do not exceed approximately 5m/s^2 and AEB does not intervene. The test shall be aborted safely if the VUT does not initiate ACC braking when TTC = [3.0s], at which point the test is repeated with the EMT.

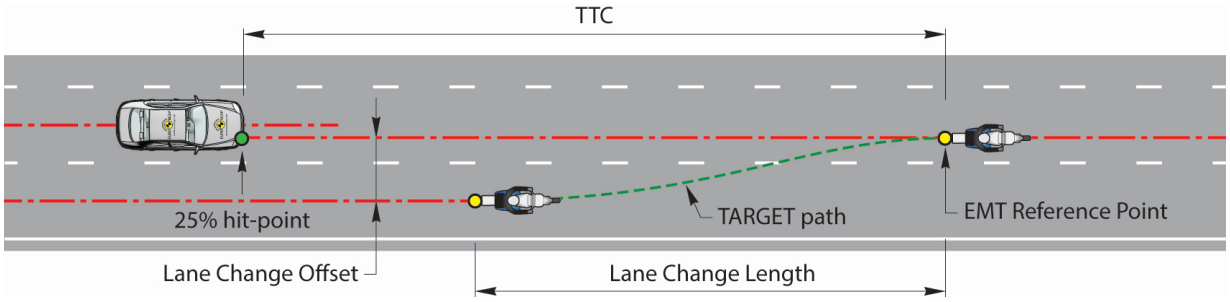
2.2.3 CMRb

For CMRb, the test is conducted in the same way as CCRb, but with an EMT positioned at a 25% impact location.

2.2.4 Cut-in

In the Cut-in tests, the EMT on the adjacent lane shall perform a partial lane change (2.5m lateral offset) into the lane of the VUT. The indicated TTC is defined as the TTC at the point in time that the EMT has finished the lane change manoeuvre, where the rear wheel of the EMT is in the 25% impact location of the VUT.

Cut-in	VUT	EMT	Lane Change Manoeuvre EMT		
			Lateral Acceleration	Change Length	Radius of turning segments
Cut-in @ TTC = 0.50 Cut-in @ TTC = 1.50	50 km/h 120 km/h	10 km/h 70 km/h	0.5 m/s^2 1.5 m/s^2	14.5 m 60.0 m	15 m 250 m



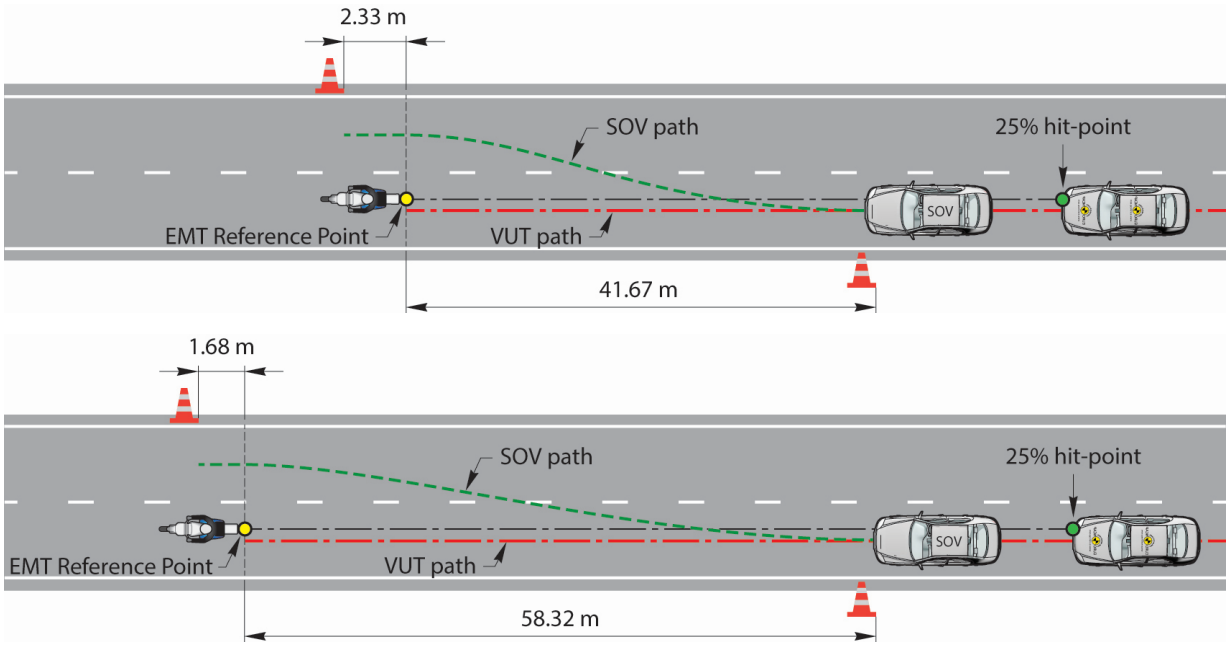
To ensure a realistic trajectory and sufficient repeatability/reproducibility across different EMT platforms, the following EMT boundary conditions shall be met during the Lane Change length:

- Path error/Lateral deviation [m]: +/- 0.15
- Heading/Yaw angle deviation [°]: +/- 2.00
- Speed deviation [km/h]: +/- 0.50

2.2.5 Cut-out

The Cut-out test shall be performed using the SOV. The vehicle cutting out (SOV) shall perform a full lane change (3.5m lateral offset) into the adjacent lane to avoid a stationary EMT positioned at a 25% impact location. With the measurement behind the stationary EMT indicting that start of the lane change, and the measurement in front of the stationary EMT indicating the end of the lane change. The indicated TTC is defined as the TTC of the lead vehicle to the EMT when the lead vehicle shall start the lane change. Indicators are not to be used by the SOV during the manoeuvre. It is permissible for the test laboratory to place physical markers, that shall not affect vehicle performance, of the different cut-out paths. SOV path deviation = [±0.2m].

Cut-out	VUT	Lead Vehicle	Lane Change Manoeuvre of lead vehicle		
			Lateral Acceleration	Change Length	Radius of turning segments
Cut-out @ TTC = 3.00 Cut-out @ TTC = 3.00	70 km/h 90 km/h	50 km/h 70 km/h	1.5 m/s^2 1.5 m/s^2	44.0 m 60.0 m	130 m 250 m



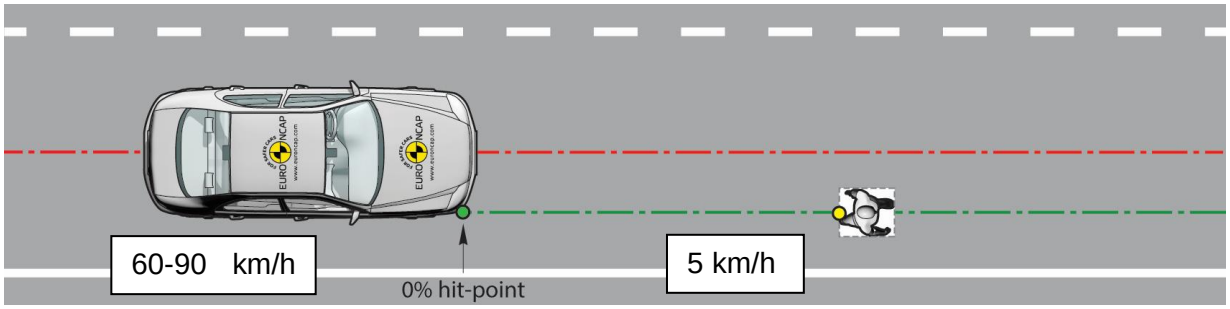
2.3 Car-to-VRU

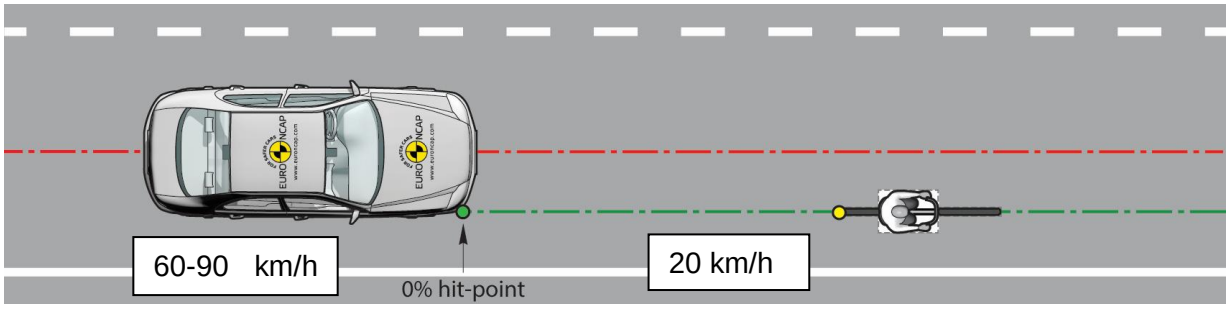
Car-to-VRU	Total points 2
Longitudinal	**2**
CPLA	1
CBLA	1

Car-to-VRU tests evaluate the ACC performance to pedestrians and bicyclists ahead travelling in the same direction, with an impact location of 0%. The CPLA-0 and CBLA-0 consist of the following combination of VUT and target speeds with 10 km/h increments:

Car-to-VRU tests	VUT speed	Target speed
CPLA – Moving Target		
Straight road, 0% impact location	60-90 km/h	5 km/h
CBLA – Moving Target		
Straight road, 0% impact location	60-90 km/h	20 km/h

For each scenario and test speed, 1 point can be achieved where the ACC reduces the impact speed by more than 30 km/h. Where the ACC intervenes and reduces the impact speed by more than 15 km/h before the AEB intervenes, 0.5 points are scored. Where the ACC does not reduce the impact speed more than 15 km/h, no points are awarded.





A valid test run shall be considered when the 0% impact location is achieved with a lateral offset accuracy of + 10cm – 0cm.

The Vehicle Manufacturer may implement an early ACC speed reduction strategy linked to transient and/or non-transient driver states detected by a DSM.

The Vehicle Manufacturer may implement avoidance by steering strategy when preceded by a [15] km/h speed reduction.

2.4 Road Features

Road Features	Required action	Total Points 1
Curves	Show and adjust the vehicle's speed to ensure that lateral acceleration does not exceed 3.5 + 0.5 m/s²	0.2
Roundabouts	Show and start reducing speed so that [25] m before the roundabout, the vehicle's speed is reduced to [50] km/h or lower	0.2
Intersection, no right-of-way	Show and reduce speed to 30 km/h or lower if there is no driver response	0.2
Traffic lights	For red lights, show and reduce speed to 30 km/h or lower if there is no driver response For orange lights, show and reduce speed to 30 km/h or lower if there is no driver response, provided emergency/harsh braking is not required e.g., the maximum deceleration does not exceed 5 m/s².	0.2
Stop signs	Show and reduce speed to 30 km/h or lower if there is no driver response.	0.2

The reaction to road features is not required to be default ON.

To avoid overreliance, Euro NCAP recommends that ACC speed adaptation to road features Curves, Roundabouts and Intersections may only be available for roads where the posted speed limit is 60 km/h or higher. It is assumed that traffic lights and stop signs are never placed at locations where the posted speed is more than 80 km/h.

The road features functions shall be verified in the default ACC mode with activated road feature reaction during on-road driving to confirm that the VUT responds as indicated by the Vehicle Manufacturer.

2.5 Auto-Resume

This assessment looks at the strategy to resume the ACC after the vehicle has come to a full stop. To be eligible for assessment, the VUT shall be capable of coming to a complete stop under ACC control when the traffic in front stops whilst also maintaining steering assistance.

ACC Auto-Resume	Requirements	Total Points 1
Automatic resume	All below requirements should be met: - Confirm surrounding with external sensors - Eyes on-road	1
Driver input	Resume only after driver confirmation	0.5

With ACC active and following the GVT or other surrogate vehicle, decelerate the leading vehicle to a complete stop avoiding harsh decelerations.

2.5.1.1 Confirm surrounding with external sensors

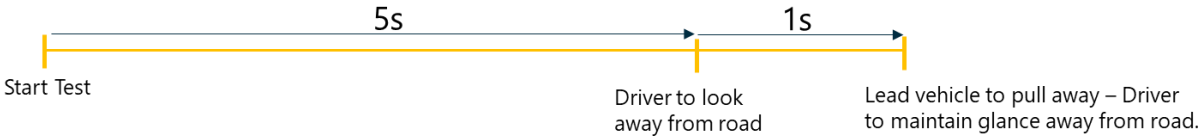
After 5 seconds hold time, position a pedestrian dummy between the VUT and lead vehicle which after the lead vehicle shall drive off to confirm the VUT remains stopped.

When confirmed, the pedestrian dummy should be removed and the VUT may resume driving.

2.5.1.2 Eyes on-road

After 5 seconds hold time, the driver shall look away from the forward road to after which the lead vehicle shall drive off to confirm the VUT remains stopped.

When confirmed, the VUT may only resume driving within 0.5s of the driver looking back towards the forward road view.



3 STEERING ASSISTANCE

Steering Assistance Performance	Total points 5
Steering Assistance	**4**
Lane Change Assist	**1**

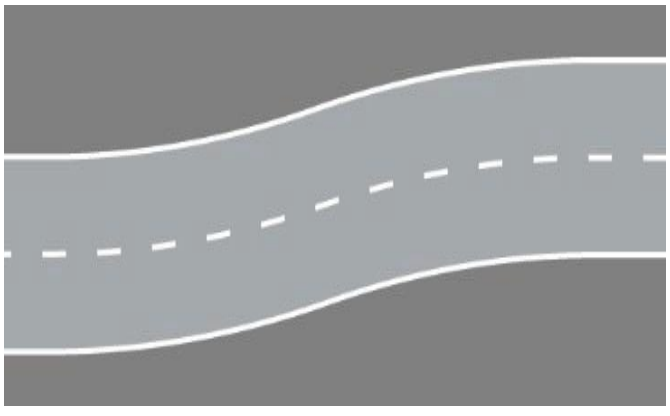
3.1 Steering Assistance

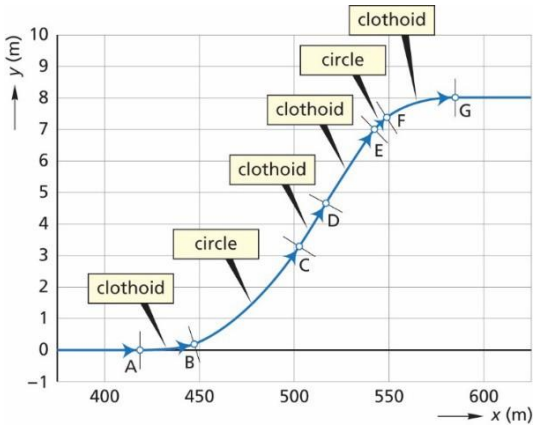
Steering Assistance				
S-bend	60 km/h	80 km/h	100 km/h	130 km/h
VUT stays in lane in both turns	1	1	1	1
VUT stays in lane in 1st turn and redirects in 2nd turn	0.5	0.5	0.5	0.5

A steering assistance function should support the driver to keep the vehicle in lane, not only on straight roads. If a car departs from its lane there is an increased risk of collision. Euro NCAP does not expect vehicles to stay in the centre of the lane in all corners, but expects the vehicle to always support the driver by directing the vehicle to the correct heading. Euro NCAP tests the steering assistance in a so called S-Bend.

All tests shall be performed with longitudinal and lateral assistance activated. For test vehicles without longitudinal assistance available, the vehicle shall be controlled with driver input or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.

3.1.1 S-Bend dimensions





S-Bend	Clothoid parameter	Radius	Length
1st turn	153.7		30.0
		787 m	57.1
	105.0		14.0
2nd turn	98.6		26.0
		374 m	5.1
	120.8		39.0

It is permissible for an S-Bend to be used with the turn directions mirrored as long as the same geometry is maintained.

3.1.2 Test Method

The capability of the steering assist system is tested at ACC indicated vehicle speeds of 60, 80km/h, 100km/h and 130km/h. Where possible, all other lane support systems shall be switched off for the duration of the test.

The vehicle shall be driven along the straight section of the fully marked lane at a constant speed with the steering assist system on for enough time for the steering assist system to takeup a constant position within the lane, prior to the start of the S-Bend.

The driver shall make every effort not to add any input into the steering system which can affect the path of the vehicle once it has entered the S-Bend section. It is permissible for the test driver to remove their hands from the steering wheel. However, the driver may need to keep their hands on the wheel or provide a different input to prevent the actions of the vehiclebeing dictated by the systems recognition of an inattentive driver.

The driver shall allow the vehicle to maintain a continuous maximum ACC speed as set throughout each test run. It is permissible for the vehicle system to reduce the driven speed in response to the road geometry, and this reduction in speed shall not be overridden by the test driver. It may also be the case that the curvature tested would cause the vehicle to slow sufficiently to remain within lane if it were on a mapped location (real world driving); if this is predicted to be the case the Vehicle Manufacturer shall advise the laboratory carrying out the test and confirm a suitable location to prove that the vehicle can slow and remain in lane.