EURO NCAP

FOR SAFER CARS

Assisted Driving

Highway & Interurban

Assist Systems

Test & Assessment Protocol

Implementation 2024

Version 2.2

Contents

Definitions

Throughout this protocol the following terms are used:

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 in ISO 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 speed to 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 maintaininga 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 the vehicle in response to the detection of a likely collision to reduce the vehicle speed and potentially 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 automatically by 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/activated by the driver and which can perform a single lateral manoeuvre (e.g. lane change) when commanded by the driver.

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 drift beyond a solid lane marking, the edge of the road or into oncoming or overtaking traffic in the adjacent lane.

Lane Keeping Assist (LKA) – heading correction that is applied automatically by the vehicle in 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 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-Motorcyclist Rear Stationary (CMRs) – a collision in which a vehicle travels forwards towards a motorcyclist and the front structure of the vehicle strikes the rear of the motorcycle.

Car-to-Motorcyclist Rear Moving (CMRm) – a collision in which a vehicle travels forwards towardsa motorcyclist that is travelling at constant speed and the frontal structure of the vehiclestrikes the rear of the motorcycle.

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

Car-to-Pedestrian Longitudinal Adult 0% (CPLA-0) – a collision in which a vehicle travels forwards towards an adult pedestrian walking in the same direction in front of the vehicle where the vehicle strikes the pedestrian at 0% of the vehicle's width when no braking action is applied.

Car-to-Bicyclist Longitudinal Adult 0% (CBLA-0) – a collision in which a vehicle travels forwards towards a bicyclist cycling in the same direction in front of the vehicle where the vehicle would strike the cyclist at 0% of the vehicle's width when no braking action is applied.

1 Highway and Interurban Assist systems

Euro NCAP released its first publication on Highway Assist systems in 2018, followed with the incorporation of an additional "Interurban" driving domain in 2024. This protocol is developed to provide consumers with more detailed information on Assisted Driving systems that are typically offered as an option and are as such not considered in the Euro NCAP star rating.

For Highway and Interurban Assist systems, Euro NCAP focusses on two main areas: Assistance Competence,which is the balance between Vehicle Assistance and Driver Engagement, and Safety Backup. The sum of the scores in Assistance Competence and Safety Backup is used in a grading system, similar to the five-star safety rating.

Vehicles used for the assessment shall have all relevant assisted driving options included (even if fitted as a subscription), as assisted driving packages are usually optional.

This protocol describes the details of all scoring elements within Driver Engagement, Vehicle Assistance and Safety Backup.

1.1 Balance principle

The Assistance Competence score is the balance between Vehicle Assistance and Driver Engagement. The higher the level of assistance, the more the driver must be engaged by the system.

In principle, the Assistance Competence score equals the Vehicle Assistance score, but only when the Driver Engagement score (at least) matches Vehicle Assistance. Where Vehicle Assistance outscores Driver Engagement, the Assistance Competence score is limited to the Driver Engagement performance.

ASSISTANCE COMPETENCE	SCORE
Driver Engagement ≥ Vehicle Assistance	Vehicle Assistance
Driver Engagement < Vehicle Assistance	Driver Engagement

1.2 Grading

The sum of Assistance Competence and Safety backup determines the Grading:

GRADING	SCORE REQUIRED
VERY GOOD	≥ 160 points (≥ 80%)
GOOD	≥ 140 points (≥ 70%)
MODERATE	≥ 120 points (≥ 60%)
ENTRY	≥ 100 points (≥ 50%)

2 Assistance Competence – Driver Engagement

The Driver Engagement assessment consists of four elements:

- Consumer Information
- System Status
- Driver Monitoring
- Driving Collaboration

The following sections of the protocol describes the requirements and scoring for each of these elements.

2.1 Consumer Information

Drivers expectations of how much assistance the system provides them may be influenced by information they are supplied prior to them operating the system. It shall be clear to any potential driver that the system is an assistance system only and that driver oversight is always required. This assessment is designed to examine the information supplied to the consumer relating to the assistance system.

2.1.1 System Name

When the Vehicle Manufacturer markets the longitudinal and lateral assistance systems under a single name, this name shall be used. If the Vehicle Manufacturer markets the longitudinal and lateral control systems separately, the name of each shall be assessed and the lowest of the two scores shall be used.

A system name shall contain the word "assistant", "assistance", "assist" or another variation of the term. If this is the case, 10 points are awarded.

The system name shall not contain the word "auto", "automatic", "automated", any other variation of the term or another term which is deemed to imply a level of automation higher than which the system is offering. E.g. "pilot", "self-drive", etc.

Where a system's name neither contains the term "assist" nor a variant of "auto" or "pilot", 5 points are awarded.

2.1.2 Marketing Material

Euro NCAP cannot monitor and assess every piece of marketing material related to the VUT in all countries where the system is sold. However, during the assessment, time will be taken to review publicly available marketing material, relating to the system assessed and published by the Vehicle Manufacturer. This will include, but is not limited to, television and radio advertisements, vehicle brochures and online information, i.e. the Vehicle Manufacturer website (search to include model and feature specific within the website and using the "build your vehicle" service).

Marketing material may not imply that the system offers a higher level of assistance than is provided. Examples of this include descriptions of the system as an automated system, a pilot or self-driving. Images of the driver with hands not touching the steering wheel or performing secondary tasks over and above those permitted during normal driving, whilst the vehicle is in motion, are another example.

Any feature describing higher function but clearly labelled as either "future tech" or "not available in this region" or similar is allowed unless deliberately misleading i.e. use of the function as a header.

In case marketing material correctly describes the system functionality, 5 points are awarded. When one or more violations are found, no points are scored.

2.1.3   Quick start guide

To be considered a "Quick start Guide", information shall be supplied to the consumer on the basic operation of the driving assistance system and system limits. This shall be in a form supplementary to the vehicle handbook. The Quick Start Guide may be accessed on a smartphone and/or tablet and may come in different formats:

- Paper format
- Paperless/digital format
- Tutorial video/animation/interactive experience

The Quick Start Guide shall indicate position and function of controls, usage guidelines and system limitations. Where a "Quick Start Guide" is available that meets the requirements, 3 points are scored.

If the tutorial video/animation/interactive experience containing this information can be broadcasted through the vehicle infotainment system, 2 additional points will be awarded.

If a Vehicle Manufacturer has another means by which to supply the information to the consumer, they shall liaise with the test laboratory and the Euro NCAP secretariat who will assess whether it meets the requirements.

2.1.4   Vehicle Handbook

The vehicle handbook shall make it clear to the consumer that the system is an assistance system, and that driver engagement is always required. The handbook shall detail operationof the system and controls. The handbook shall detail intended use of the system and limitsof the systems operation.

In case the vehicle handbook clearly described the system and its limitations, 5 points are awarded.

2.2 System Status

This assessment is designed to evaluate the information supplied to the driver on a continuous basis, confirming the level of driving assistance being provided by the system. This is anticipated to be visual information only.

This assessment is also designed to evaluate the information supplied to the driver in case the level of assistance by the system changes. This is anticipated to be:

- Visual information only (in case the level of assistance increases).

- Visual information and audible or haptic warnings (in case the level of assistance decreases).

If a manufacturer has a different method of system status indication to the driver, applied either continuously or momentarily at a change of assistance, the manufacturer shall liaise with the test laboratory and the Euro NCAP secretariat who will consider if and how the indicator can be included in the assessment.

2.2.1 Preconditions

To be eligible for assessment, all system status indicators shall be fitted to the vehicle as part of the assistance system.

To be eligible for assessment, it shall not be possible for the assistance system to be used with the primary indicator disabled by the driver. This applies to visual, audible or haptic indicator related to the system

2.2.2 Continuous System Status Indicator Assessment

During this assessment, the vehicle shall be driven in the manner required to achieve the correct level of assistance required for each part of the assessment. This means it shall be driven at least once in:

- Manual mode (stand-by, no assistance)
- Longitudinal control only (e.g. ACC)
- Lateral control only (if available)
- Longitudinal and Lateral Control in combination.

If a system requires certain parameters for a level of assistance, the test laboratory shall, within reason, meet those requirements.

Per system mode available in the vehicle 0.5 points are awarded for configurable status information, when they are always indicated and if the respective indication is distinguishable from other modes. In addition, 1.5 points per system mode are available for additional indicators in a head up display or another additional display in the driver's eye line.

When the status indication corresponds to general human factor guidelines and design principles, 0.416 points (5/12) are scored for each system mode.

The following questions are to be answered:

- Which of the following does the vehicle use to indicate the current level of assistance being provided by the respective system?

	Stand-by for Lat	Long only	Lat only	Long + Lat
Icon for status indication in the instrument cluster (always on)	☐	☐	☐	☐
Configurable status information in the instrument cluster	☐	☐	☐	☐
Other visual indicator (close to driver's expected line of sight in approx. +/- 15° from the driver´s normal forward view to the road scene, e.g. head up display)	☐	☐	☐	☐

- Is the system mode in primary status indicator always indicated (if system is switched on) and are indicators for different modes (e.g. ACC active, lateral control active, L2 active) distinguishable from each other?

	indicated at all times (always on)	Distinguishable from other mode by colour and/or icon form
Stand-by for Lat	☐	☐
Long only	☐	☐
Lat only	☐	☐
Long + Lat	☐	☐
vehicle in lane ahead (when identified)	☐	☐

- Does the primary system status indicator in the instrument-cluster correspond to general human factors guidelines and design principles?

	Stand-by for Lat	Long only	Lat only	Long + Lat
Colour of indicator contrasts adequately from background colour	☐	☐	☐	☐
Colours conform to conventions or stereotypes (green related to "system active"; grey to "stand-by"; red to "warning or danger")	☐	☐	☐	☐
No flashing indicators are used for continuous system status indication (standstill is considered discontinuous)	☐	☐	☐	☐

2.2.3 System Status Change Indicator Assessment

Rewarding specific strategies that prove intuitive (e.g. haptic steering wheel when lateral support is no longer available – when the driver is touching the steering wheel)

Euro NCAP does not specify how each change in system status should be achieved, as the conditions required can vary from vehicle to vehicle. The test laboratory conducting the assessment shall meet the requirements of the system to achieve each change in system status, where possible without conducting manoeuvres largely different from normal driving. It is required that the test driver remains attentive throughout the transition, so changes in assistance given due to driver monitoring are not accepted as they are assessed elsewhere.

For each of the following transitions between levels of assistance being provided to the driver, record through which means the system indicates to the driver that the transition is taking place.

An audible and/or haptic warning to indicate a system change, scores 2 points. An extra 2 points are awarded when additional visual information is shown. In case this information meets the general human factors guidelines, 1 additional point is scored. Finally, 0.2 points per denied requested mode change are available for additional visual information.

The following questions are to be answered:
- Mandatory decreases in level of assistance provided, initiated by the system changes in environmental conditions OR sensor blockage (as per section 4.1.2).

	Change in primary status indicator	Audible tone or noticeable haptic indication	Visual information (additional to primary indication, e.g. icon and/or text)
Long + Lat → Long only	☐	☐	☐

Does the system status change indication correspond to general human factors guidelines and design principles?

	Long + Lat → Long only
Additional visual information is triggered as long as the driver is driving "hands-off"	☐
Additional audible information doesn't startle or annoy the driver (loudness between 50 and 90 dB recommended)	☐

- Mandatory increases in level of assistance provided, initiated by the system due to changes in environmental conditions. The indication of successful increase in level of assistance is given simultaneously to the system initiation:

	Change in primary status indicator
No assistance → Lat only	☐
Long only → Long + Lat	☐

- Driver requested increase in level of assistance provided – request accepted. The indication of successful increase in level of assistance is given simultaneously to the driver input:

	Change in primary status indicator
No assistance → Long only	☐
No assistance → Lat only	☐
No assistance → Long + Lat	☐
Long only → Long + Lat	☐
Lat only → Long + Lat	☐

- Driver requested increase in level of assistance provided – request denied (e.g. sensor is blocked, but driver tries to activate the system). Is the denied request indicated?

	No change primary in status indicator	Additional visual information (icon and/or text)
No assistance → Long only	☐	☐
No assistance → Lat only	☐	☐
No assistance → Long + Lat	☐	☐
Long only → Long + Lat	☐	☐
Lat only → Long + Lat	☐	☐

2.3 Driver Monitoring

The systems being tested are those that can be broadly grouped together as Assisted Driving systems as defined by Euro NCAP, or as SAE Level 2. This means that the driver retains full responsibility and shares control with the vehicle. Both vehicle and driver share OEDR and the driver may not perform any secondary tasks over and above those permitted during normal driving.

2.3.1 Hands-on monitoring

A total of 10 points are available for systems effective at monitoring driver engagement through steering wheel activity:

2.3.1.1 Monitoring

Revision 4 of UN Regulation 79 defines a minimum requirement for interventions by the VUT when steering control is released by the driver with steering assist active, the important points to note are as follows:

- Optical warning no later than 15 seconds after steering control has been released.
- Acoustic warning & red optical warning no later than 30 seconds after steering control has been released.
- System deactivated within 30 seconds of acoustic warning. An additional acoustic warning is required (different from the previous) for at least 5s.

In addition, the Assisted mode shall be locked out for the remainder of the journey after a maximum of 3 accumulated severe hands-off warnings. Severe hands-off shall be considered as reaching the system deactivation phase, or at an earlier timing if the OEM deems it appropriate (e.g., issuing acoustic warning & red optical warning + 5 seconds accounting for response time).

The test laboratory shall run a confirmation test to assess whether the hands-on determination requirements as set out above are met. This test can be completed concurrently with the Unresponsive Driver Intervention assessment.

When the Regulation 79 compliance and misuse provisions are met, 5 points are scored.

2.3.1.2 Sensing

5 points are granted for robust sensing of hands-on steering wheel detection by means of capacitive/direct sensing (i.e., not torque-based only sensing).

2.3.2 Direct Driver Monitoring

Direct DSM systems that monitor driver engagement and/or cognitive workload using cameras and/or other sensors to check that the driver has "eyes-on" and/or "brain-on", are eligible of scoring a maximum of 15 points, provided that the preconditions listed in 2.3.2.1 are met.

2.3.2.1 Preconditions

- The DSM shall be offered as an integral part of the Assisted Driving system (i.e., part of the Assisted Driving package),

- It shall not be possible to activate Assisted mode if the DSM is not available due to a complete blockage or system malfunction,

- The Assisted Driving system shall be deactivated no later than 10 seconds from the point the DSM becomes unavailable due to a complete blockage or system malfunction, and it shall not be possible to activate it again until the DSM becomes available,

- The activation of Assisted mode shall force the activation of DSM if the latter was turned OFF whilst in Manual mode,

- After the DSM classifies the driver as unresponsive for a maximum of 3 times, the Assisted mode shall be deactivated no later than 5 seconds after the driver is classified as responsive (or at a timing deemed appropriate by the Vehicle Manufacturer), and it shall not be possible to activate again for the remainder of the journey,

- The DSM during Assisted mode shall be functional in the same Distraction and Fatigue driver states claimed functional in Manual mode.

Furthermore, it is acknowledged that DSM may also provide an opportunity to improve the overall user experience while in Assisted mode by a context-based adjustment of the DSM distraction warning strategy, as long as the safety benefit is kept. Therefore, DSM distraction warning thresholds used in Manual mode may be relaxed during Assisted mode (fatigue warnings/interventions shall not be relaxed in any case), provided that the following conditions are met:

- Long distraction warning timing thresholds shall not be relaxed by more than 150% (e.g., maximum of 4,5s. for a 3s. baseline case),

- The DSM distraction warning strategy shall be ODD-dependent (i.e., context-based: vehicle speed and/or TTC of vehicles around),

- The DSM distraction warning strategy shall be the same as in Manual mode in at least one of the designated ODD(s) where driver engagement is deemed critical (e.g., complex traffic situations).

2.3.2.2 Assessment

The Vehicle Manufacturer shall provide a complete DSM dossier in accordance with the requirements outlined in Euro NCAP Assessment Protocol - SA Safe Driving - v10.2. and TB 036, which in addition shall contain at least:

- Justification of the DSM implementation in the Assisted mode and the added safety benefit,

- Elaboration on the specific DSM strategy/strategies for Assisted mode,

- Evidence on the effectiveness of the DSM system in keeping the driver engaged.

The test laboratory shall carry out a spot check of the DSM claimed performance, following the test execution procedure outlined in TB 039 (where applicable, with specific provisions adapted to the specific DSM system strategy e.g., relaxed warning timing of long off-road glances).

The total of 15 points are distributed amongst the following cases:

Driver State		Distraction Scenario	Movement Type	Warning	Intervention	Sub Total	Total
Distraction	Long Distraction	Away from road / non driving task	Owl	0.225	0.225	0.45	2.25
			Lizard	0.225	0.225	0.45	
			Body Lean	0.225	0.225	0.45	
		Driving task	Owl	0.225	0.225	0.45	
			Lizard	0.225	0.225	0.45	
	Short Distraction (VATS)	Away from road / non driving task	Owl	0.225	0.225	0.45	2.25
			Lizard	0.225	0.225	0.45	
		Driving task	Owl	0.225	0.225	0.45	
			Lizard	0.225	0.225	0.45	
		Away from road (multi-location)	Lizard	0.225	0.225	0.45	
	Phone Use	Phone Use Detection - Basic	Owl + Lizard	0.375	0.75	1.125	2.25
		Phone Use Detection - Advanced	Lizard	0.375	0.75	1.125	
Fatigue	Drowsiness			1.875	0.75	2.625	2.625
	Microsleep			1.5	0.75	2.25	2.25
	Sleep			0.375	1.5	1.875	1.875
Unresponsive Driver					1.5	1.5	1.5
Total							**15**

Where:

- "Intervention" are any specific strategies on the ACC and/or LC and/or LCA function(s) that are dependent on the state of the driver with demonstrated safety benefit.

- For intervention-only strategies, the score for Warning shall be automatically awarded in the corresponding gaze locations as outlined in 3.5.3.1.1. on Euro NCAP Assessment Protocol - SA Safe Driving - v10.2.

- "Drowsiness" cases shall only be awarded when detected via direct DSM.

2.4 Driving Collaboration

This assessment determines how the vehicle responds to a driver steering input, for example to avoid an obstacle within the lane of travel, when the steering assistance system is engaged.

2.4.1 Pothole Test

A direct steering torque measurement system is to be used in these tests, where all torque measurement data shall have a [12-pole phaseless Butterworth filter with a cut off frequencyof 10Hz] filter applied before maximum values are taken.

2.4.1.1 System On

Drive the VUT into a fully marked, 3.5m wide lane at an indicated 45mph (72km/h), using the ACC systemwith the continuous steering assistance system switched ON, and all other lateral support systems turned off where possible. Activate the continuous steering assist system and allow the system to take up a consistent position within the lane.

- Apply a full sine wave of steering angle to the VUT steering wheel, with a frequency of 0.25Hz and a steering amplitude resulting in a DTLE = 15cm.
- Record the maximum/peak steering torque required during the first half of the sine wave.
- Repeat the test three times and record the average maximum steering torque over the three runs.

2.4.1.2 System Off

Drive the VUT down the centre of a fully marked, 3.5m wide lane at an indicated 45mph (72km/h)using the ACC system with the continuous steering assistance system switched OFF, maintaina constant speed and central position within the lane.

- Apply a full sine wave of steering angle to the VUT steering wheel, with a frequency of 0.25Hz and a steering amplitude resulting in a DTLE = 15cm.
- Record the maximum/peak steering torque required during the first half of the sine wave.
- Repeat the test three times and record the average maximum steering torque over the three runs.

Both the increase in steering torque and override response are assessed based on the measurements and behaviour in the pothole test.

The percentage increase in steering torque between system ON and system OFF is compared:

INCREASE IN STEERING TORQUE	Pothole Test			
	0-33%	33-67%	67%-100%	100%+
	5 points	3 points	1 point	0 points

For vehicles where the absolute override torque with system ON <5Nm, 20 points are available for the reaction of the system during the pothole test:

- 20 points are awarded when the system provides continuous steering assistance throughout the manoeuvre and centres the vehicle in the lane afterwards
- 10 points are scored when the system cancels steering assistance during the manoeuvre but automatically reengages once the vehicle is centralised in lane again by the driver
- If a system cancels steering assistance during manoeuvre and requires a reactivation by the driver afterwards, no points are given

2.5 Driver Engagement Assessment

The Driver Engagement score is the sum of the scores of:

- Consumer Information
- System Status
- Driver Monitoring
- Driving Collaboration

For all three elements, the maximum available points for each subsection are detailed below.

2.5.1 Consumer Information

	Score
SYSTEM NAME	**10 points**
System name	10 points
MARKETING MATERIAL	**5 points**
Marketing material	5 points
QUICK START GUIDE	**5 points**
Quick start guide availability	3 points
Integration on infotainment	2 points
VEHICLE HANDBOOK	**5 points**
Clear description of level of Assistance	5 points

2.5.2 System Status

	Score
CONTINUOUS STATUS INDICATOR	**18 points**
Continuous system status indicator	18 points
STATUS CHANGE INDICATOR	**7 points**
System status change indicator	7 points

2.5.3 Driver Monitoring

	Score
Hands-off determination	**10 points**
Monitoring	5 points
Sensing	5 points
DIRECT DRIVER MONITORING	**15 points**
Direct Driver Monitoring	15 points

2.5.4 Driving Collaboration

	Score
OVERRIDE TORQUE	**5 points**
%-age increase in torque	5 points
OVERRIDE RESPONSE	**20 points**
Absolute override torque	10 points
System response	10 points

3 Assistance Competence - Vehicle Assistance

The Vehicle Assistance assessment consists of three elements:

- Speed Assistance
- Adaptive Cruise Control Performance
- Steering Assistance

3.1 Speed Assistance

Using the camera and/or map data, vehicles can adopt the prevailing speed limit into the ACC system and/or display the speed limit for information or adoption by a secondary confirmation by the driver. A system with the capability to self-adjust or offer changes of the set speed can be referred to as iACC (intelligent Adaptive Cruise Control).

The VUT results of the Euro NCAP Speed Assist Systems assessment is used as basis and tests are to be performed as per the Euro NCAP Speed Assist Systems Test Protocol v2.0. Additionally, the VUT is assessed for its ability to recognise a change in speed limit and apply or offer that change in speed to the ACC.

Systems that can advise and make speed adjustments for upcoming road features shall be rewarded, in addition of timely informing and warning the driver of a hazardous event ahead.

3.1.1 Score from Speed Assist Systems assessment

If a vehicle is presented for assisted driving assessment and has not already been through the NCAP rating scheme, it is a requirement to carry out the Speed Assistance System tests as part of this assessment, following Euro NCAP Speed Assist Systems assessment as detailed in the Euro NCAP Assessment Protocol – SA Safe Driving – v10.4., plus specific requirements in the following areas:

- Road Features (see 3.1.3)

- Local Hazards (see 3.1.4)

For the Highway and Interurban Assist assessment, the normal SAS score is tripled (considering the aforementioned specific requirements).

3.1.2 Reaction to speed limit changes

To maintain law abiding driving, vehicles shall have adapted their speed before they reach the sign indicating a change in speed limit, although in some EU countries there is an allowanceof a certain distance before a prosecution can be made.

The Vehicle Manufacturer shall provide the test laboratory and the Euro NCAP secretariat with information showing the vehicle response to speed limit changes for:

- Fixed speed limits
- Variable and temporary speed limits

The Vehicle Manufacturer shall take the following into account when providing the

information:

- Systems that automatically adjust the speed to the desired speed limit shall be deemed to have adopted the speed limit in time if the vehicle speed is reduced to that of a lower speed limit [+2km/h] before the front axle of the vehicle passes the sign.
- Systems which offer adjustment to the new speed limit but require a manual action from the driver shall be deemed to have adopted the speed limit in time if the vehicle speed is reduced to that of a lower speed limit [+2km/h] before the front axle of the vehicle passes the sign when the driver gives the confirmation action 1.5 seconds after the lower limit is offered.
- A system which only provides information about upcoming and current speed limits shall be deemed to have provided the information in time if the lower speed limit information is displayed to the driver at a time which allows the driver to manually set the ACC to the lower speed limit and the vehicle speed is reduced to that of a lower speed limit [+2km/h] before the front axle of the vehicle passes the sign, when the driver starts this process 1.5 seconds after the information is given.

The test laboratory shall perform a short road test on local highways to verify this function and to confirm that the VUT responds as indicated by the Vehicle Manufacturer.

3.1.3 Road Features

In addition to changing the ACC setting relative to the speed limit additional points are available for reducing speed when approaching the following road features:

ROAD FEATURES	Required Action
Curves	Show and start reducing to appropriate speed
Roundabouts	Show and start reducing to appropriate speed
Junctions , without right of way	Show and start reducing to appropriate speed
Traffic Lights	Show and start reducing to appropriate speed
Stop Signs	Show and start reducing to appropriate speed
Yield Signs	Show and start reducing to appropriate speed
Toll Stations	Show and start reducing to appropriate speed

The test laboratory shall perform a short road test on local roads to verify this function and to confirm that the VUT responds as indicated by the Vehicle Manufacturer.

3.1.4 Local Hazards

Additional points are available for timely informing and warning the driver about hazardous events listed in the table below. This shall allow the driver enough time to anticipate the hazardous event, at a TTE (time to event) which shall be specified by the Vehicle Manufacturer. The specified TTE may differ across events and context, and is expected to be within a range from 5 to 20s.

LOCAL HAZARDS	Required Action
Traffic Jams	Inform and Warn, @ specified TTE [s]
Construction Zones	Inform and Warn, @ specified TTE [s]
Accident Ahead	Inform and Warn, @ specified TTE [s]
Wrong Way Driver	Inform and Warn, @ specified TTE [s]
Stopped Vehicle on Hard Shoulder	Inform and Warn, @ specified TTE [s]
Items on road (includes animals, persons, debris, etc)	Inform and Warn, @ specified TTE [s]
Poor Road Conditions (incl. slippery roads)	Inform and Warn, @ specified TTE [s]
Poor Weather Conditions (e.g. fog, heavy rain, etc)	Inform and Warn, @ specified TTE [s]
Emergency Vehicle	Inform and Warn, @ specified TTE [s]

The test laboratory shall perform a short road test on local roads to verify this function and to confirm that the VUT responds as indicated by the Vehicle Manufacturer.

3.1.5 Lane relevancy

Vehicles equipped with a lane-relevant SLIF able to cover all the following speed limit signs are eligible to scoring 4 points:

- Explicit

- Conditional (e.g., Arrows)

- Dynamic / Gantry

3.2 Adaptive Cruise Control Performance

The Adaptive Cruise Control Performance assessment looks at how the longitudinal assist system fitted to the vehicle reacts to other vehicles during operation. For Highway and Interurban Assist systems, car-to-car and car-to-motorcyclist performance is assessed.

The Vehicle Manufacturer is required to provide the Euro NCAP Secretariat with colour data (expected impact speeds are not required) detailing the ACC performance of the vehicle in the CCRs, CCRm, CMRs and CMRm scenarios for all speed combinations. All data shall be supplied by the manufacturer before any testing begins, preferably with delivery of the test vehicle(s).

For CCRs, CCRm, CMRs and CMRm, the assessment is based on a GRID prediction provided by the OEM. The test laboratory will randomly select and test 10 cases for CCRs and CCRm and 10 cases for CMRs and CMRm to verify the prediction, distributed in line with the predicted colour distribution (excluding grey points).

Colour	ACC Scenarios	Expected ACC performance (≥-5 m/s^2)
Green	All	Full avoidance
Orange	Car-to-Car	Impact speed reduction >5 km/h
	Car-to-Motorcyclist	Impact speed reduction >15 km/h
Grey	Car-to-Car	Impact speed reduction ≤5 km/h
	Car-to-Motorcyclist	Impact speed reduction ≤15 km/h

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

Correction factors

The data provided by the manufacturer for CCRs, CCRm, CMRs and CMRm is scaled using a correction factors, which is calculated based on a number of verification tests performed.

The verification points are randomly selected grid points, distributed in line with the predicted colour distribution (excluding grey points).

The actual tested total score of the verification test points is divided by the predicted total score of these verification test points. This is called the correction factor, which can be lower or higher than 1.

$$Correction\ Factor = \frac{Actual\ tested\ score}{Predicted\ score}$$

The correction factor is used to calculate the CCRs, CCRm, CMRs and CMRm scores for the ACC Performance and Collision Avoidance scores. The final scores can never exceed 100%,

regardless of the correction factor.

<u>Impact speed tolerance</u>

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.

3.2.1   ACC Car-to-Car tests

Only the capability of the ACC system is assessed in this section, where braking levels stay below approximately 5 m/s^2 or where it is confirmed that AEB did not intervene.

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 5 km/h before the AEB intervenes, 0.5 points are scored. Where the ACC does not reduce more than 5 km/h, no points are awarded.

The ACC Car-to-Car assessment contains different scenarios when driving at highway and interurban speeds:

ACC CAR-TO-CAR		VUT	GVT/SOV/Real Car
CCRs – Stationary Target (Straight road, 100% overlap)		70 km/h 80 km/h 90 km/h 100 km/h 110 km/h 120 km/h 130 km/h	
CCRs – Stationary Target (Curved road, 100% overlap)		70 km/h 80 km/h 90 km/h 100 km/h 110 km/h 120 km/h 130 km/h	
CCRm – Moving Target (100% overlap)		80 km/h 90 km/h 100 km/h 110 km/h 120 km/h 130 km/h 80 km/h 90 km/h 100 km/h 110 km/h 120 km/h 130 km/h	20 km/h 20 km/h 20 km/h 20 km/h 20 km/h 20 km/h 60 km/h 60 km/h 60 km/h 60 km/h 60 km/h 60 km/h
CCRb – Braking Target **@ -4m/s²** (100% overlap)	ACC-mode closest	55 km/h	50 km/h
Cut-in (100% overlap)	Cut-in @ TTC = 0.00 Cut-in @ TTC = 1.50	50 km/h 120 km/h	10 km/h 70 km/h
Cut-out (100% overlap)	Cut-out @ TTC = 3.00 Cut-out @ TTC = 3.00	70 km/h 90 km/h	50 km/h 70 km/h

3.2.1.1 ACC Car-to-Car tests

All ACC Car-to-Car tests are performed as per Euro NCAP AEB C2C test protocol v4.3 however, where the procedure in this protocol deviates from the AEB Car-to-Car test protocol, the assisted driving 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 (not the GPS speed). The ACC shall be set to the closest following distance for all tests. Lateral assistance shall be engaged and used to control the VUT's position within the lane. Both the ACC and Steering assist shall be active before the lower of 10s TTC or 250m relative longitudinal distance.

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.

For CCRs on a curved road and the Cut-in and Cut-out scenarios, additional details are given in the following paragraphs.

3.2.1.2   CCRs on curved road

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).
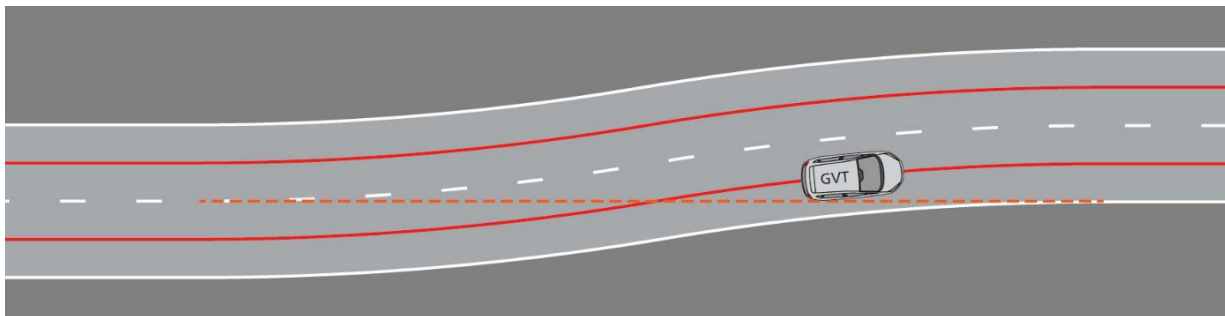
3.2.1.3   Cut-in tests

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.

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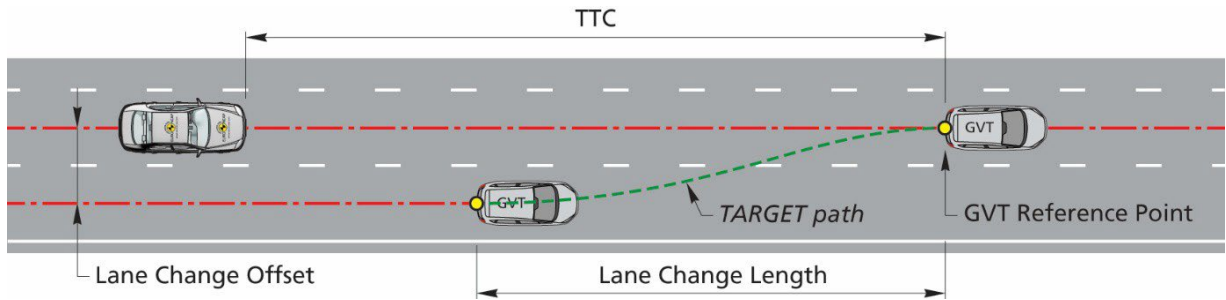
3.2.1.4 Cut-out tests

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.

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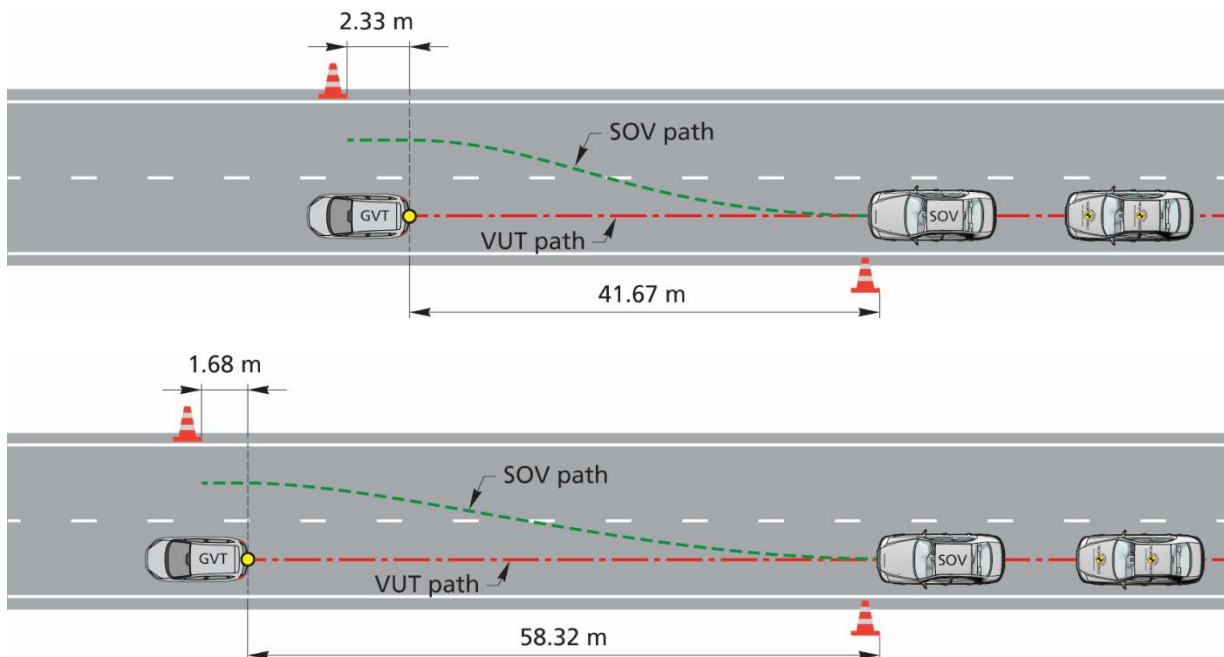
3.2.2 ACC Car-to-Motorcyclist tests

Only the capability of the ACC system is assessed in this section, where braking levels stay below approximately 5 m/s^2 or where it is confirmed that AEB did not intervene.

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 (for relative speeds >15 km/h), 0.5 points are scored. Where the ACC does not reduce more than 15 km/h, no points are awarded.

The ACC Car-to-Motorcyclist assessment contains different scenarios when driving at highway and inter-urban speeds:

ACC CAR-TO-MOTORCYCLIST		VUT	EMT /SOV/ Real Motorcyle
CMRs – Stationary Target (Straight road, 25% hit point, GVT on side)		70 km/h 80 km/h 90 km/h	
CMRs – Stationary Target (Straight road, 25% hit point, GVT in front)		70 km/h 80 km/h 90 km/h	
CMRs – Stationary Target (Curved road)		70 km/h 80 km/h 90 km/h	
CMRm – Moving Target (25% hit point)		100 km/h 110 km/h 120 km/h 130 km/h	20 km/h 20 km/h 20 km/h 20 km/h
		100 km/h 110 km/h 120 km/h 130 km/h	60 km/h 60 km/h 60 km/h 60 km/h
CMRb – Braking Target **@ -4m/s²** (25% hit point)	ACC-mode closest	55 km/h	50 km/h
Cut-in (25% hit point)	Cut-in @ TTC = 0.50 Cut-in @ TTC = 1.50	50 km/h 120 km/h	10 km/h 70 km/h
Cut-out (25% hit point)	Cut-out @ TTC = 3.00 Cut-out @ TTC = 3.00	70 km/h 90 km/h	50 km/h 70 km/h

3.2.2.1 ACC Car-to-Motorcyclist tests

All ACC Car-to-Motorcyclist tests are performed as per Euro NCAP AEB LSS VRU Test Protocol - v4.5 however, where the procedure in this protocol deviates from the AEB LSS VRU Test Protocol, the assisted driving protocol shall 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 (not the GPS speed). The ACC shall be set to the closest following distance for all tests. Lateral assistance shall be engaged and used to control the VUT's position within the lane. Both the ACC and Steering assist shall be active before the lower of 10s TTC or 250m relative longitudinal distance.

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.

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

For CMRs, CMRs on a curved road and the Car-to-motorcyclist Cut-in and Cut-out scenarios, additional details are given in the following paragraphs.

3.2.2.2 CMRs, GVT on side

For CMRs, the stationary EMT shall be positioned in a 25% hit point position. A stationary GVT shall be 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 EMT (as shown in the picture below)
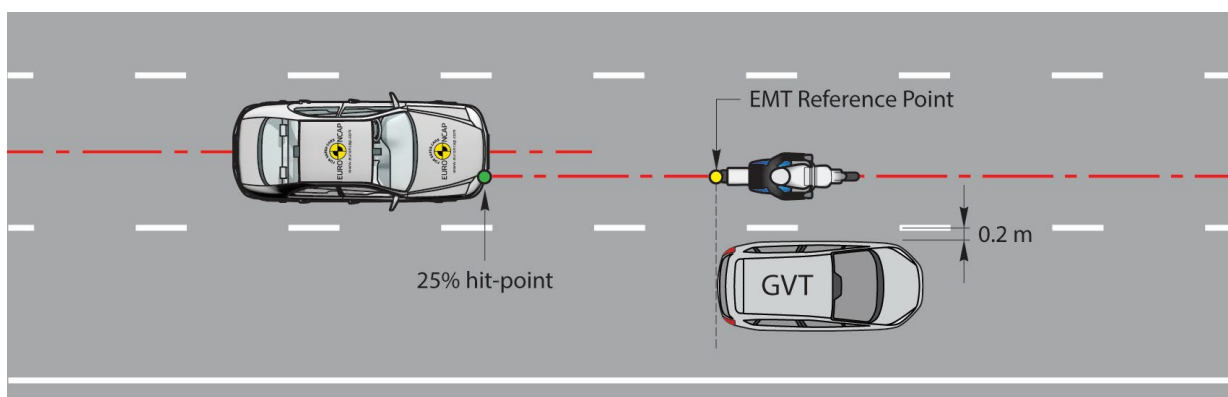
3.2.2.3 CMRs, GVT in front

For CMRs, the stationary EMT shall be positioned in a 25% hit point position. A stationary GVT shall be positioned centred in-lane and 1m in front of the EMT (as shown in the picture below)

25% hit-point   EMT Reference Point
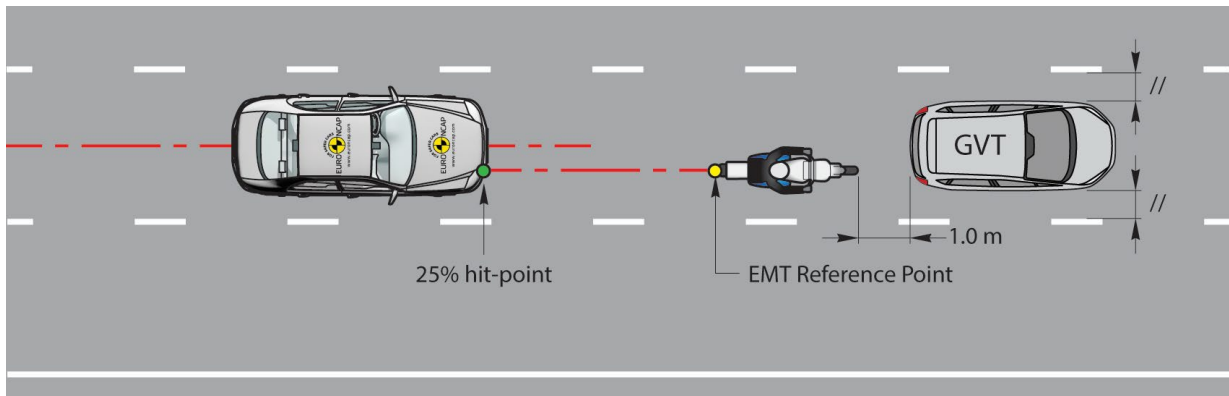
3.2.2.4 CMRs on curved road

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).
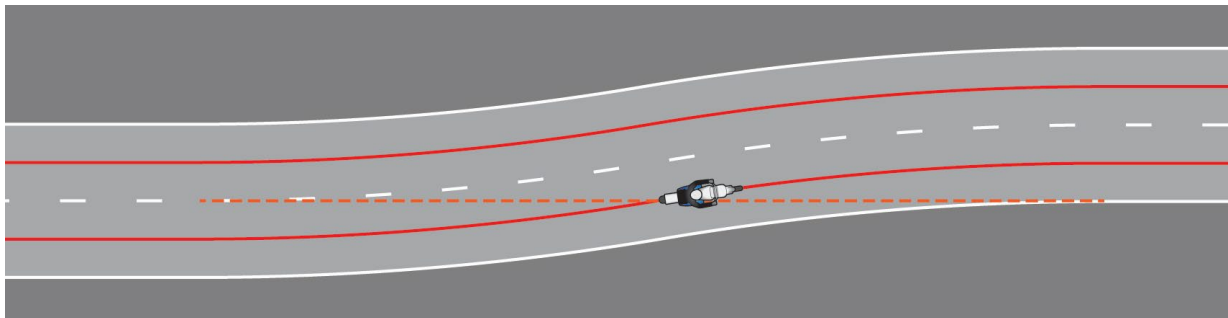
3.2.2.5 Cut-in tests

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% hit-point of the VUT.

ACC CUT-IN	VUT	EMT	Lane Change Manoeuvre EMT		
			Lateral Acceleration	Change Length	Radius of turning segments
Cut-in					
Cut-in @ TTC = 0.50	50 km/h	10 km/h	0.5 m/s²	14.5 m	15 m
Cut-in @ TTC = 1.50	120 km/h	70 km/h	1.5 m/s²	60.0 m	250 m

To ensuring 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
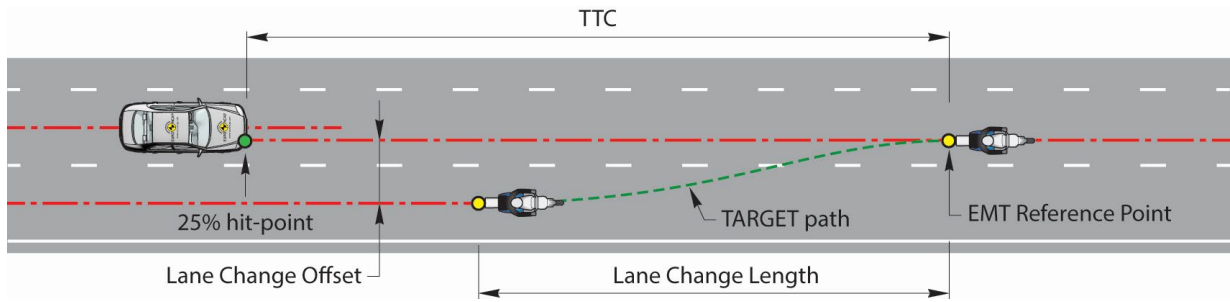
3.2.2.6   Cut-out tests

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% hit-point. 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]. An example can be found in the Annex.

ACC CUT-OUT	VUT	Lead Vehicle	Lane Change Manoeuvre of lead vehicle		
			Lateral Acceleration	Change Length	Radius of turning segments

Cut-Out
  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

3.2.3 Undertake prevention

In most European countries it is only permissible to overtake a slower moving vehicle, in free-flowing traffic, in a lane to one side of the slower moving vehicle. Therefore, an assisted driving system should not overtake a vehicle on the incorrect side in this scenario. For this highway-based assessment, it may be that the system is geofenced and it shall be a requirement for the OEM to inform the test laboratory of the function of the system.

The manufacturers handbook or supplied information shall be used to assess the performance of the system, with its operation confirmed by the test laboratory where possible.

The longitudinal control system shall prevent the VUT from overtaking a slower moving vehicle in an adjacent lane on the incorrect side for that country when travelling in free-flowingtraffic at a minimum speed of 90km/h.

Note: If the vehicle ahead in adjacent lane brakes with a deceleration greater than the maximum design deceleration for the VUT's ACC system then it is acceptable that the VUT would perform the undertake as this is not the intended scenario for this test.

3.2.4 ACC 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	Within 5s	After 5s
10 points	Automatic resume	Driver input
	Eyes-on road	
	Confirm surrounding with external sensors	
7 points	Driver input	
3 points	Automatic resume	

The Euro NCAP test laboratory shall conduct a confirmation test based on the information provided by the Vehicle Manufacturer. If there are any features available on the VUT other than the one detailed below, then the Vehicle Manufacturer shall inform the test laboratory how to test this feature.

3.2.4.1 Coming to a complete stop and resume within the maximum hold time
Drive the vehicle within a fully marked lane, following another vehicle driving at a constant 20km/h. Activate the longitudinal and lateral control system in the VUT with the following distance set to minimum distance and ACC set to a maximum speed of 30km/h or the minimum set speed of the system if this is higher than 30km/h.

After the vehicle has settled in a constant position within the lane and a constant distance behind the lead vehicle, gradually bring the lead vehicle to a halt with a deceleration not more than [-3m/s^2]

Hold the lead vehicle stationary for a time less than the max hold time of the VUT and then resume driving of the lead vehicle. Confirm that the VUT resumes driving as expected.

3.2.4.2   Coming to a complete stop and resume after the maximum hold time
Repeat the test as per 3.2.4.1 then hold the lead vehicle stationary for a time greater than the max hold time of the VUT and then resume driving of the lead vehicle. Confirm that the VUT does not resume driving without driver interaction as expected.

3.2.4.3   Coming to a complete stop and utilising external sensors
If the system utilises advanced sensors (such as ultrasonic parking sensors) to detect obstacles in between the VUT and the lead car to prevent pulling away if, for example, a pedestrian has appeared in the gap then test this using a pedestrian dummy entering the gap between the lead car becoming stationary and the max hold time for this scenario as per the following instructions:

- The lead vehicle and the VUT shall stop equidistant across the path of the pedestrian dummy +/-0.5m. The dummy shall then approach from the nearside at 5km/h as per CPNA AEB tests but with a trigger of when the VUT becomes stationaryand then stop at the midpoint (50%) of the VUT.
- Once the pedestrian dummy is stationary between the vehicles, resume driving the lead vehicle to confirm that the VUT will not resume driving into a pedestrian.
- After a 5s delay remove the pedestrian from the headway of the VUT by continuing across the road at 5km/h.
- Upon the VUT resuming driving once the pedestrian (or obstacle) has passed it shall be confirmed that the driver monitoring escalation strategy remains active during the hold time. For example, if no hands are detected on the steering wheel at the resumption of driving the 1st audible and visual warnings for "hands-off" shall start before the VUT has reached 10km/h, it is not sufficient to assume that the vehicle being in motion will engage the driver.

3.2.4.4   Coming to a complete stop and utilising Driver Monitoring sensors
If the system utilises "eyes-on" monitoring to determine driver gaze during the hold period, then confirm this function by looking elsewhere during the hold period and confirming that the VUT does not pull away to follow the lead vehicle.

5s   1s

Start Test

Driver to look away from road

Lead vehicle to pull away – Driver to maintain glance away from road.
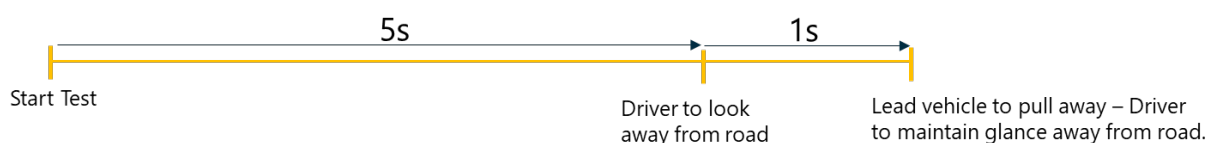
3.3 Steering Assistance

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.

STEERING ASSIST	80 km/h	100 km/h	120 km/h
VUT stays in lane in both turns	10	10	10
VUT stays in lane in the 1st turn and redirects the vehicle in the 2nd turn	7.5	7.5	10
VUT stays in lane in the 1st turn	2.5	5	7.5

STEERING ASSIST	Definition
VUT stays in lane in both turns	VUT does not cross any lane markings to the left and/or right side of the vehicle.
VUT Stays in lane in the 1st turn and redirects the vehicle in the 2nd turn	VUT does not cross any lane markings in the 1st turn. VUT crosses the lane marking in/after the 2nd turn. VUT returns to the lane or put on a trajectory parallel to or heading back towards the original lane. All 4 tyres cannot leave the lane.
VUT stays in lane in the 1st turn	VUT crosses the lane marking after directing the VUT through the 1st turn. VUT continues away from the lane after leaving the lane.

3.3.1 S-Bend dimensions
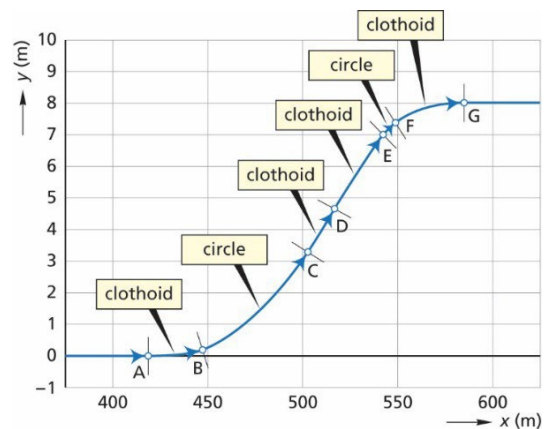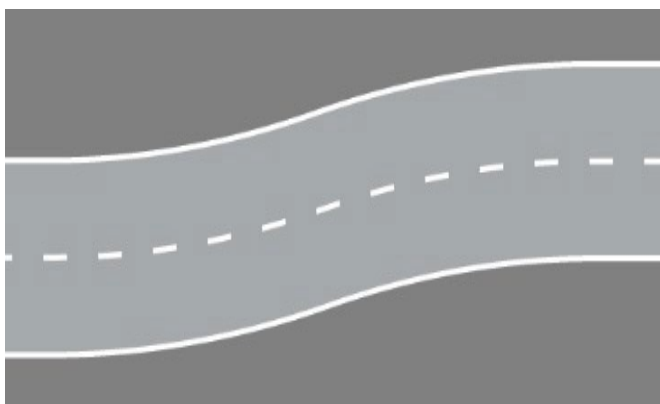
S-Bend parameters are:

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
	-	374m	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.

3.3.2 Test Method

The capability of the steering assist system is tested at ACC indicated vehicle speeds of 80km/h, 100km/h and 120km/h. Where possible, all other lane support systems shall be switched offfor 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 take up 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 vehicle being 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 OEM shall advise the laboratory carrying out the test and confirm a suitable location to prove that the vehicle can slow and remain in lane.

3.4 Vehicle Assistance Assessment

The Vehicle Assistance score is the sum of the scores of:

- Speed Assistance
- Adaptive Cruise Control Performance
- Steering Assistance

For all three elements, the maximum available points for each subsection are detailed below. Where the raw score needs to be scaled, two columns are used. One showing the raw score and the amount of points available per scenario. In the column next to it, the maximum scaled score for each element is shown.

3.4.1 Speed Assistance

	Score
SPEED ASSIST SYSTEM Speed Assist System	**9 points** 9 points

REACTION TO SPEED LIMIT CHANGES
                                        Fixed speed limits
          Variable and temporary speed limits
	12 points
	6 points
	6 points

LANE RELEVANCY Lane-relevant SLIF	**4 points** 4 points

3.4.2 Adaptive Cruise Control Performance

	Raw Score	Score
ACC CAR-TO-CAR	**31.000**	
CCRs – Stationary target	7.000	
CCRs – Stationary target in a curve	7.000	
CCRm – Moving target	12.000	
CCRb – Braking target	1.000	
Cut-in	2.000	
Cut-out	2.000	
ACC CAR-TO-MOTORCYCLIST	**22.000**	**25 points**
CMRs – Stationary target, GVT side	3.000	
CMRs – Stationary target, GVT front	3.000	
CMRs – Stationary target in a curve	3.000	
CMRm – Moving target	8.000	
CMRb – Braking target	1.000	
Cut-in	2.000	
Cut-out	2.000	
UNDERTAKE PREVENTION		**5 points**
Undertake prevention @ speeds > 90 km/h		5 points
ACC AUTO-RESUME		**10 points**
ACC Auto-Resume		10 points

3.4.3 Steering Assistance

	Score
STEERING ASSISTANCE	**30 points**
S-Bend @ 80 km/h	10 points
S-Bend @100km/h	10 points
S-Bend @120km/h	10 points
LANE CHANGE ASSIST	**5 points**
Lane change assist	5 points

4   Safety Backup

The Safety Backup assessment consists of three elements:

- System Failure
- Unresponsive Driver Intervention
- Collision Avoidance

4.1   System Failure

In real world driving, it is anticipated that the sensors involved with the Driver Assistance System (Radar, LiDAR, or camera) may either deteriorate by age or damage or become blocked in adverse environmental conditions. Having a blocked or deteriorated sensor may reduce the competency of the system. It is important that the system does not operate with reduced competency and that the driver is aware of the reason that the system becomes unavailable.

It is believed that all current systems may see some reduction in competency when a sensor fails, but there may be redundancy built into the system or multi-function sensors used to mitigate the effects to the performance of the system if a single sensor fails.

4.1.1   Pre-Test

Due to the complex nature of current systems and sensors the Vehicle Manufacturer shall fill in a questionnaire prior to the test taking place to detail the anticipated effect of blocking the sensors involved in providing the assistance in relation to each system.

4.1.2   Test

The test shall assess all individual sensors systematically in three different scenarios:

- Sensor blocked at vehicle start up.
- Sensor becomes blocked when vehicle is moving but Driver Assistance System not activated.
- Sensor becomes blocked when vehicle is moving with the Driver Assistance System active and engaged.

For each sensor that forms part of the assistance system, the assessment is the same. The total points will then equally distributed amongst the considered sensors. For camera and/or lidar sensor(s) involved in the Driver Assistance System, the assessment shall be repeated with vertical partial coverage, either by blocking half of the effective field of view of the camera/lidar or by fully blocking one of the lenses of a stereo camera (in any case, either left side or right side shall be randomly selected). For sensor location/design for which the field of view cannot easily be determined, the Vehicle Manufacturer may advise the test laboratory on the positioning of the blocking material" (i.e., Vehicle Manufacturer to support with in-house data).

The sensors shall be blocked in accordance with the Technical Bulletin: *"TB 041 - AD Sensor Blocking"*

4.1.2.1 Sensor Blocked at Start-up

With the VUT switched off, cover the sensor under test with a material that shall prevent the sensor receiving a signal (e.g., radar absorbing material is typically used to cover the radar).

Once the material is in place start the car and drive up to the minimum speed to activate the assistance system as detailed in the VUT handbook. If the assistance system can't be engaged after a 2 minute drive, then the VUT scores 8 points and is eligible for a further 2 points if a visual warning is displayed within 5 minutes of driving above the minimum speed following this activation attempt. If the control system can be activated at this time the VUT scores 0 points.

4.1.2.2 Sensor Blocked with VUT in motion, System not active

Drive the VUT with the assistance system not activated at the minimum speed [or 30km/h minimum speed, whichever is lowest] required to activate the system for 1 minute. Then, without slowing below this speed, cover the sensor with the same material that was used in the above test and attempt a system activation after 2 minutes.

If the system cannot be engaged, then the VUT scores 4 points and is eligible for a further 1 point if a visual warning is displayed within 5 minutes of driving above the minimum speed following this activation attempt. If the assistance system can be activated at this time, the VUT scores 0 points.

4.1.2.3 Sensor Blocked with VUT in motion, System active

Drive the VUT with the assistance system activated at the minimum design speed for the system [or 30km/h minimum speed, whichever is lowest]. Then, without stopping, cover the sensor with the same material that was used in the above test.

If the system cancels within 2 minutes of the material covering the sensor then the VUT scores 8 points and is eligible for a further 2 points if a visual warning is displayed within 5 minutes of driving following the covering of the sensor. Any other time before the system cancels will score 0 points.

If the OEM has declared that the system suffers no loss in performance when a sensor is blocked, then, with that sensor covered, the test laboratory shall confirm this by repeating, either

- the CCRs test from ACC Performance at highest speed that was avoided by the VUT in case the sensor becoming blocked is declared to have no effect on longitudinal control.
- the Steering Assistance test at the highest speed that the VUT remained in lane, in case the blocked sensor is declared to have no detriment to lane guidance. If the vehicle does not remain in lane at any of the test speeds, repeat the 80km/h test and accept a deviation no greater than 0.25m from the original path.

If the OEM declaration is confirmed by this/these test(s), the VUT scores 20 of the available points for this sensor. It shall then provide a visual message to the driver that the sensor has become blocked, this can be at any time but shall be displayed no later than the beginning of the next drive as defined by an ignition cycle, the display of the visual message scores the VUT

an additional 5 points for this sensor and it is added to the total score equation in section 3.

If the VUT fails the confirmation test, then 0 points are scored for that sensor.

4.2 Unresponsive Driver Intervention

This assessment is designed to test the ultimate reaction of the vehicle to a driver who remains unresponsive after the cascade of warnings and attempts re-engage the driver. This test can be run concurrently with the Driver Monitoring assessment.

It is anticipated that many of these systems may be geo-fenced to work only on highways. It is permissible and recommended that the Vehicle Manufacturer has the test labs test track assigned as a highwayon their test vehicle.

This test shall be performed in a minimum two-lane straight road with a length of adequate length not including acceleration and braking zones. The near side most lane shall have a solid white line with enough space for a safe harbour (hard shoulder or none running lane) across from the driving lanes.

Affix onboard cameras to monitor the Instrumentation of the vehicle at the minimum and it is recommended to mount at least one additional camera monitoring the interior / driver cockpit.

4.2.1 80km/h Test

With no other vehicles on the track, and the VUT in the second driving lane, accelerate up to test speed and engage ACC and continuous steering assistance system.

Allow the system to take up a consistent position within the lane and then release the controls "hands off". For ease of video review, use a trigger such as saying the phrase "hands off" at the moment of releasing the steering wheel.

Where direct DSM system is able to classify driver as unresponsive, follow the test execution as outlined in TB 039, (with specific provisions adapted to the specific DSM system strategy).

Observe and if required make verbal comments on the vehicle's response.

The test is considered complete when either:

-   The vehicle comes to a complete stop.
-   The warning escalation ends.
-   Both the longitudinal and steering assistance systems switch off.
-   There is no response from the car and the test driver has to stop at the end of the test track section.

A vehicle that maintains steering control and brings the vehicle to a controlled stop or reduces its speed to crawling speed is awarded 20 points.

An additional 5 points are reserved for a more advanced response in case of an incapacitated driver:

-   Lane change in direction towards slowest lane (1 lane):   +3 points
-   Lane change to the slowest lane (up to 2 lanes) :   +4 Points
-   Lane change to emergency lane (or breakdown spot):   +5 points

4.3 Collision Avoidance

The aim of the Collision Avoidance assessment is to assess only how the longitudinal assist system fitted to the vehicle reacts to other road users during operation, although avoidance by in-lane steering manoeuvre is also permissible in critical situations where avoidance by braking is not possible. The system shall be assessed for performance when driving on typical highway and interurban situations. The "Collision Avoidance" assessment will look at the capability of the vehicle to avoid car-to-car, car-to-motorcyclist, car-to-bicyclist and car-to-pedestrian collisions using both assisted driving systems and emergency systems combined.

The Vehicle Manufacturer is required to provide the Euro NCAP Secretariat with colour data detailing the performance of the vehicle in the CCRs, CCRm, CMRs and CMRm scenarios for all speed combinations. Furthermore, the expected FCW timing in TTC [s] is to be provided. All data shall be supplied by the manufacturer before any testing begins, preferably with delivery of the test vehicle(s).

For CCRs, CCRm, CMRs and CMRm, the assessment is based on a GRID prediction provided by the OEM. For these cases, the actual scenarios to be tested to verify the prediction will be the same scenarios chosen for ACC performance.

Colour	CA Scenarios	Expected CA performance
Green	All	Full avoidance
Orange	Car-to-Car	Impact speed reduction >5 km/h
Orange	Car-to-Motorcyclist	Impact speed reduction >30 km/h
Grey	Car-to-Car	No reaction
Grey	Car-to-Motorcyclist	No reaction

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

4.3.1 Car-to-car

For each scenario and test speed, 1 point can be achieved where the ACC and/or AEB fully avoids the collision. Where the ACC and/or AEB intervenes and reduces the impact speed by more than 5 km/h, 0.5 points are scored. Where the ACC and/or AEB system does not avoid the collision, but an FCW is issued at a TTC >1.5s an additional 0.25 points are awarded for that scenario.

Where the OEM can either demonstrate or show substantial evidence that the ACC and/or AEB intervenes and reduces the impact speed by more than 5 km/h, 0.5 points are scored.

For CCRs, CCRm and CCRb, the same test speeds are used as for the ACC Performance assessment. For Cut-in and Cut-out additional and more critical set-ups are used to verify the Safety Backup.

AEB CAR-TO-CAR	VUT	GVT/SOV
Cut-in		
Cut-in @ TTC = -1.50	50 km/h	10 km/h
Cut-in @ TTC = 0.50	120 km/h	70 km/h
Cut-out		
Cut-out @ TTC = 2.00	70 km/h	50 km/h
Cut-out @ TTC = 2.00	90 km/h	70 km/h

4.1.2.4 Cut-out tests

The additional Cut-out tests for Safety Back-up shall also be performed using a real car but the lead vehicle shall cut-out at a TTC of 2s instead of 3s as in ACC Performance.
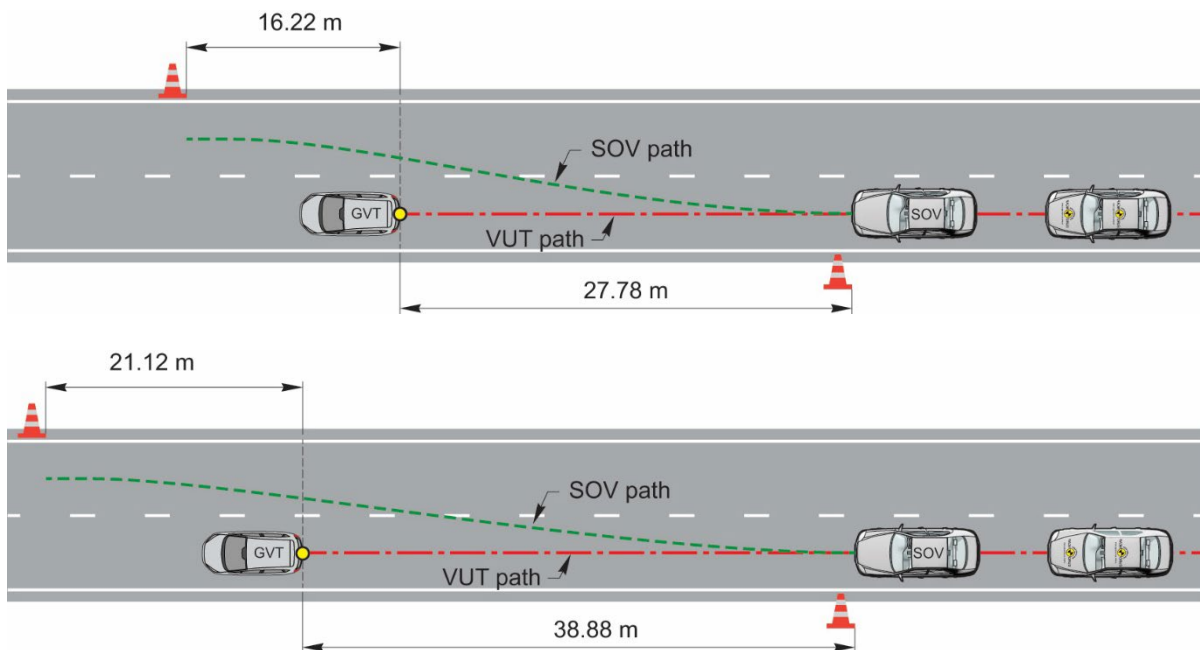
4.2.1 Car-to-Motorcyclist

For each scenario and test speed, 1 point can be achieved where the ACC and/or AEB fully avoids the collision. Where the ACC and/or AEB intervenes and reduces the impact speed by more than 30 km/h (for relative speeds >30 km/h), 0.5 points are scored. Where the ACC and/or AEB system does not avoid the collision, but an FCW is issued at a TTC >1.5s an additional 0.25 points are awarded for that scenario.

Where the OEM can either demonstrate or show substantial evidence that the ACC and/or AEB intervenes and reduces the impact speed by more than 30 km/h (for relative speeds >30 km/h), 0.5 points are scored.

For CMRs, CMRm and CMRb, the same test speeds are used as for the ACC Performance assessment. For Cut-in and Cut-out additional and more critical set-ups are used to verify the

Safety Backup. The EMT boundary conditions defined for Cut-in are the same as in the ACC Performance assessment.

AEB CAR-TO-MOTORCYCLIST	VUT	EMT/SOV
Cut-in		
Cut-in @ TTC = -1.00	50 km/h	10 km/h
Cut-in @ TTC = 0.75	120 km/h	70 km/h
Cut-out		
Cut-out @ TTC = 2.00	70 km/h	50 km/h
Cut-out @ TTC = 2.00	90 km/h	70 km/h

4.1.2.5 Cut-out tests

The additional Cut-out tests for Safety Back-up shall also be performed using a real car but the lead vehicle shall cut-out at a TTC of 2s instead of 3s as in ACC Performance.
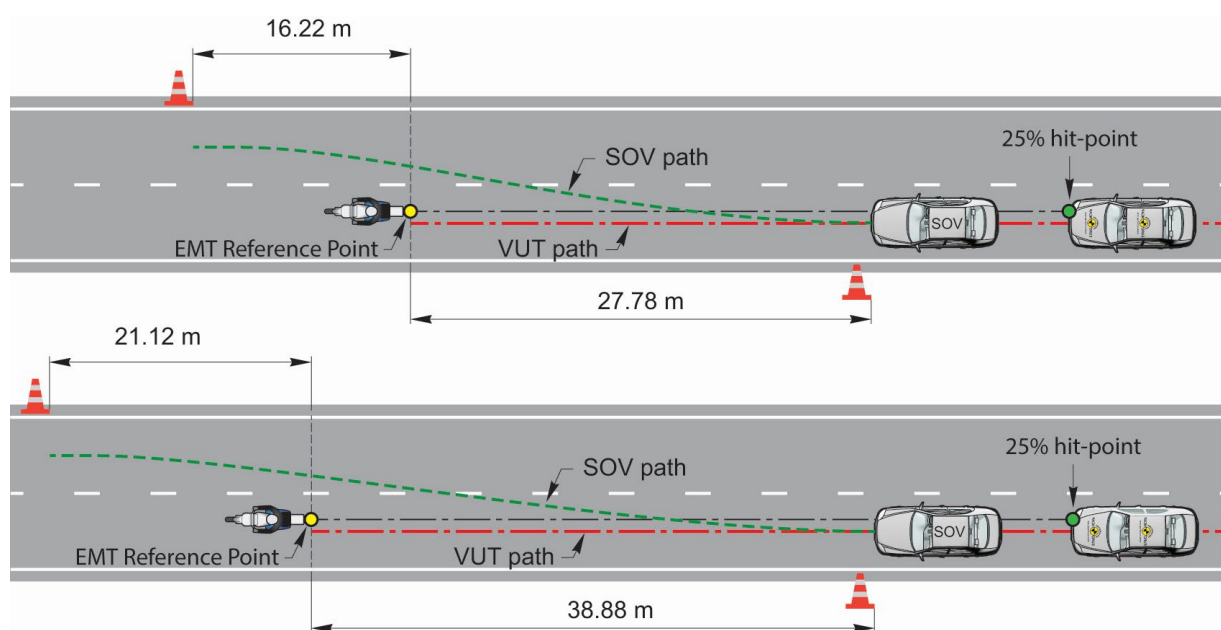
4.2.2 Car-to-Bicyclist

The aim of the Car-to-Bicyclist assessment is to assess how the longitudinal assist system fitted to the vehicle reacts to bicyclists travelling in the same direction and close to the road edge, although avoidance by in-lane steering manoeuvre is also permissible in critical situations where avoidance by braking is not possible. This assessment looks at the capability of the vehicle to avoid a collision, using both assisted driving systems and emergency systems combined. The bicyclist target (EBTa) shall be located at a 0% hit-point position as indicated in the figure below:
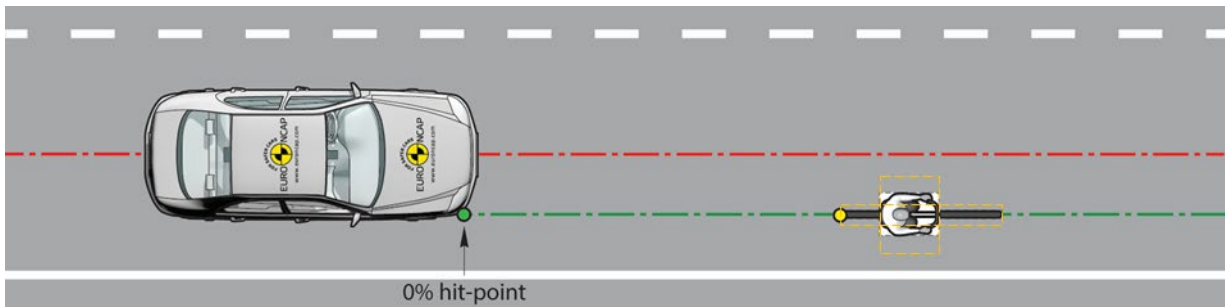
0% hit-point

The virtual box dimensions of the EBTa are increased in [+100%] on the lateral direction (as indicated in orange in the figure above).

A valid test run shall be considered when the 0% hit-point is achieved with a lateral offset accuracy of + 10cm – 0cm

For each scenario and test speed, 1 point can be achieved where the ACC and/or AEB/AES fully avoids the collision. Where the ACC and/or AEB system does not avoid the collision, but an FCW is issued at a TTC >1.5s an additional 0.25 points are awarded for that scenario.

ACC CAR-TO-BICYCLIST	VUT	EBT
CBLA-0	60 km/h	20 km/h
	70 km/h	20 km/h
	80 km/h	20 km/h
	90 km/h	20 km/h

For the high relative speeds, it is permissible for the Vehicle Manufacturer to implement early ACC speed reduction strategy linked to an inattentive or unresponsive driver (detected by the DSM).

4.2.3   Car-to-Pedestrian

The aim of the Car-to-Pedestrian assessment is to assess how the longitudinal assist system fitted to the vehicle reacts to pedestrians travelling in the same direction and close to the road edge, although avoidance by in-lane steering manoeuvre is also permissible in critical situations where avoidance by braking is not possible. This assessment looks at the capability of the vehicle to avoid a collision, using both assisted driving systems and emergency systems combined. The pedestrian target (EPTa) shall be located at a 0% hit-point position as indicated in the figure below:
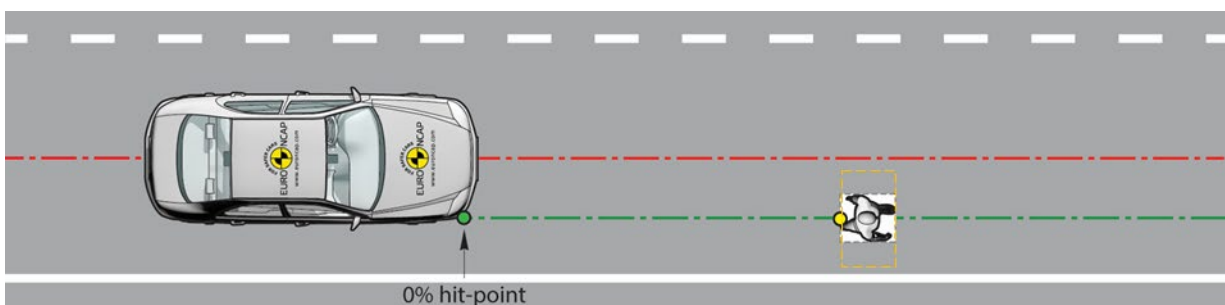
0% hit-point

The virtual box dimensions of the EPTa are increased in [+100%] on the lateral direction (as indicated in orange in the figure above).

A valid test run shall be considered when the 0% hit-point is achieved with a lateral offset accuracy of + 10cm – 0cm

For each scenario and test speed, 1 point can be achieved where the ACC and/or AEB/AES fully avoids the collision. Where the ACC and/or AEB system does not avoid the collision, but an FCW is issued at a TTC >1.5s an additional 0.25 points are awarded for that scenario.

ACC CAR-TO-PEDESTRIAN	VUT	EPT
CPLA-0	60 km/h	5 km/h
	70 km/h	5 km/h
	80 km/h	5 km/h
	90 km/h	5 km/h

For the high relative speeds, it is permissible for the Vehicle Manufacturer to implement early ACC speed reduction strategy linked to an inattentive or unresponsive driver (detected by the DSM).

4.3.2   Lane Support System – S-Bend

The lane support system – S-bend is designed to determine the ability of the vehicle to stay in lane or alert the driver to a lane departure on a curved section of road using both the AD system and the emergency LSS systems such as ELK, LKA and LDW.

This section is based on the same test scenarios and test speeds as the Steering Assistance section. For each test speed at which the vehicle remained in lane during the Steering Assistance assessment, the points for Collision Avoidance are automatically awarded.

For each test speed at which the vehicle did not remain in lane during steering assistance tests, repeat the test, as per Steering Assistance with all additional LSS systems switched on.

Where an LKA intervention prevents the VUT from crossing the lane marking by more than 0.4m, 5 points are awarded. Where there is no intervention by the system, but an audible or haptic LDW is provided before the vehicle has left the lane by more than 0.3m, 2.5 points are scored.

4.3.3   Lane support system - Lane change with overtaking vehicle

The lane change section of the collision avoidance system is to assess the vehicles ability to stop the vehicle changing lane into the path of a vehicle travelling in the adjacent lane. Both ELK systems and Blind Spot Monitoring with active torque systems fitted as part of the driver assistance pack which can change the vehicles heading to prevent a collision are considered beneficial in this scenario.

All the Car-to-Car and Car-to-Motorcyclist Intentional Lane change with overtake tests from the Euro NCAP LSS Test Protocol v4.2 and Euro NCAP AEB LSS VRU Test Protocol - v4.5 are to be performed. If the vehicle has already been assessed by Euro NCAP, these results can

potentially be carried over depending on the fitment of the vehicle tested by Euro NCAP. This may need to be retested with the AD vehicle due to higher fitment resulting is differing performance to the vehicle assessed in the Euro NCAP safety assessment.

A total of 10 points are awarded for intentional lane change tests: 5 Points for Car-to-Car and 5 points for Car-to-Motorcyclist.

4.4 Safety Backup Assessment

The Safety Backup score is the sum of the scores of:

- System Failure
- Unresponsive Driver Intervention
- Collision Avoidance

For all three elements, the maximum available points for each subsection are detailed below. Where the raw score needs to be scaled, two columns are used. One showing the raw score and the amount of points available per scenario. In the column next to it, the maximum scaled score for each element is shown.

4.4.1 System Failure

	Score
SYSTEM FAILURE	**25 points**
Sensor blocked at Start-up	10 points
Sensor blocked with VUT in motion, System inactive	5 points
Sensor blocked with VUT in motion, System active	10 points

4.4.2 Unresponsive Driver Intervention

	Score
UNRESPONSIVE DRIVER INTERVENTION	**25 points**
Controlled stop	20 points
Headroom for more advanced solutions	5 points

4.4.3 Collision Avoidance

	Raw Score	Score
ACC/AEB CAR-TO-CAR	**35.000**	**25 points**
CCRs – Stationary target	7.000	
CCRs – Stationary target in a curve	7.000	
CCRm – Moving target	12.000	
CCRb – Braking target	1.000	
Cut-in	4.000	
Cut-out	4.000	
ACC/AEB CAR-TO-MOTORCYCLIST	**26.000**	
CMRs – Stationary target, GVT side	3.000	
CMRs – Stationary target, GVT front	3.000	
CMRs – Stationary target in a curve	3.000	
CMRm – Moving target	8.000	
CMRb – Braking target	1.000	
Cut-in	4.000	
Cut-out	4.000	
ACC/AEB CAR-TO-BICYCLIST/PEDESTRIAN	**8.000**	
CBLA-0	4.000	
CPLA-0	4.000	
LSS		**25 points**
S-Bend		15 points
Intentional lane change with overtake		10 points
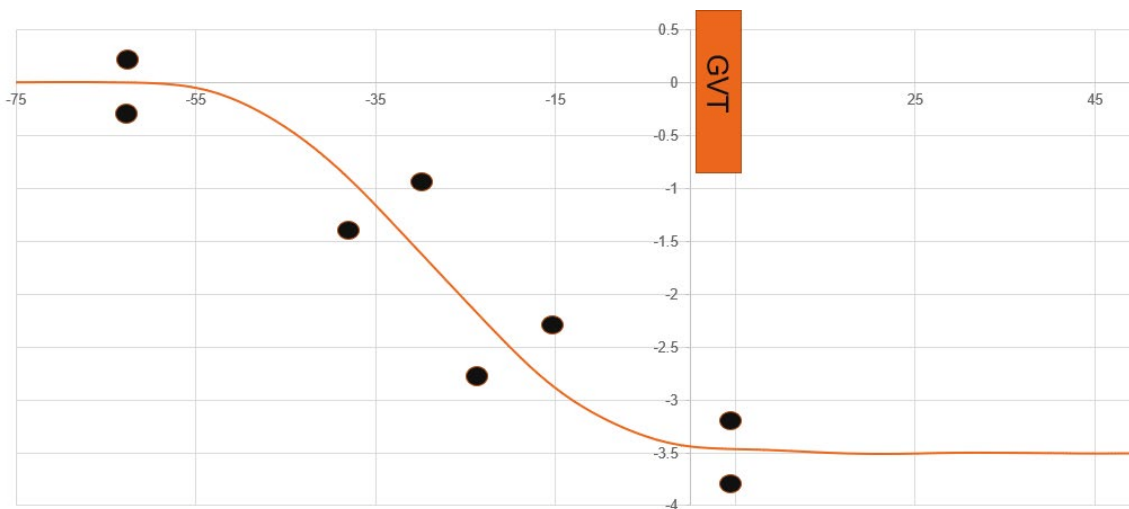
Table 2. Cut out X/Y Co-ordinates

X=0 & Y=0 is defined as the centre rear of the stationary GVT. In the case of the EMT, it shall be located at a lateral offset equal to 25% of the VUT width (25% hit point), but the origin of X and Y coordinates remain the same.

50-70 3s			50-70 2s			70-90 3s			70-90 2s	
X position	Y position		X position	Y position		X position	Y position		X position	Y position
m	m		m	m		m	m		m	m
-42.095	-0.010		-29.943	0.004		-58.292	-0.013		-39.014	-0.005
-41.958	-0.011		-29.799	0.004		-58.101	-0.014		-38.814	-0.007
-41.815	-0.012		-29.662	0.004		-57.910	-0.015		-38.623	-0.008
-41.678	-0.013		-29.525	0.003		-57.710	-0.017		-38.432	-0.010
-41.541	-0.014		-29.382	0.003		-57.501	-0.018		-38.241	-0.011
-41.405	-0.015		-29.245	0.003		-57.320	-0.020		-38.032	-0.013
-41.262	-0.017		-29.102	0.003		-57.127	-0.022		-37.850	-0.014
-41.125	-0.018		-28.965	0.002		-56.927	-0.024		-37.650	-0.017
-40.982	-0.020		-28.821	0.002		-56.736	-0.026		-37.459	-0.018
-40.845	-0.021		-28.684	0.001		-56.536	-0.028		-37.259	-0.020
-40.702	-0.023		-28.547	0.000		-56.347	-0.030		-37.068	-0.023
-40.565	-0.025		-28.404	0.000		-56.153	-0.032		-36.868	-0.025
-40.428	-0.027		-28.267	-0.001		-55.954	-0.035		-36.677	-0.027
-40.285	-0.029		-28.124	-0.002		-55.762	-0.037		-36.477	-0.030
-40.142	-0.032		-27.987	-0.002		-55.562	-0.040		-36.286	-0.032
-40.005	-0.034		-27.844	-0.003		-55.371	-0.043		-36.095	-0.035
-39.868	-0.036		-27.706	-0.004		-55.171	-0.046		-35.895	-0.039
-39.725	-0.039		-27.563	-0.005		-54.980	-0.049		-35.704	-0.042
-39.589	-0.042		-27.426	-0.007		-54.790	-0.053		-35.513	-0.045
-39.446	-0.045		-27.289	-0.008		-54.580	-0.056		-35.322	-0.049
-39.309	-0.048		-27.152	-0.009		-54.400	-0.060		-35.122	-0.052

-39.173	-0.051		-27.009	-0.011		-54.197	-0.064		-34.922	-0.056
-39.035	-0.055		-26.872	-0.013		-54.006	-0.067		-34.731	-0.060
-38.892	-0.058		-26.735	-0.014		-53.815	-0.071		-34.532	-0.064
-38.755	-0.061		-26.591	-0.016		-53.624	-0.076		-34.340	-0.069
-38.613	-0.066		-26.454	-0.019		-53.424	-0.080		-34.149	-0.073
-38.476	-0.069		-26.311	-0.021		-53.224	-0.085		-33.950	-0.078
-38.333	-0.074		-26.174	-0.023		-53.034	-0.090		-33.759	-0.083
-38.196	-0.078		-26.031	-0.026		-52.841	-0.094		-33.559	-0.088
-38.059	-0.082		-25.881	-0.028		-52.642	-0.100		-33.368	-0.093
-37.916	-0.087		-25.752	-0.031		-52.452	-0.105		-33.168	-0.098
-37.779	-0.092		-25.613	-0.034		-52.259	-0.110		-32.977	-0.104
-37.637	-0.097		-25.470	-0.037		-52.068	-0.116		-32.786	-0.109
-37.493	-0.102		-25.333	-0.041		-51.868	-0.122		-32.586	-0.115
-37.363	-0.107		-25.196	-0.044		-51.668	-0.128		-32.395	-0.121
-37.220	-0.113		-25.053	-0.048		-51.469	-0.135		-32.196	-0.128
-37.083	-0.118		-24.910	-0.052		-51.286	-0.141		-32.005	-0.134
-36.940	-0.124		-24.773	-0.056		-51.095	-0.147		-31.814	-0.140
-36.803	-0.130		-24.636	-0.060		-50.895	-0.154		-31.614	-0.147
-36.660	-0.136		-24.492	-0.064		-50.695	-0.161		-31.423	-0.154
-36.524	-0.142		-24.356	-0.069		-50.504	-0.167		-31.232	-0.161
-36.381	-0.148		-24.218	-0.073		-50.304	-0.175		-31.033	-0.168
-36.245	-0.155		-24.075	-0.078		-50.113	-0.182		-30.841	-0.175
-36.101	-0.162		-23.938	-0.083		-49.922	-0.189		-30.642	-0.183
-35.966	-0.168		-23.801	-0.088		-49.722	-0.197		-30.451	-0.190
-35.828	-0.175		-23.652	-0.093		-49.523	-0.205		-30.251	-0.198
-35.685	-0.182		-23.523	-0.099		-49.332	-0.213		-30.061	-0.206
-35.549	-0.189		-23.378	-0.104		-49.142	-0.220		-29.861	-0.213
-35.406	-0.197		-23.241	-0.110		-48.941	-0.229		-29.672	-0.221
-35.269	-0.204		-23.098	-0.116		-48.752	-0.237		-29.479	-0.230
-35.132	-0.212		-22.961	-0.122		-48.559	-0.245		-29.288	-0.237
-34.989	-0.220		-22.818	-0.129		-48.359	-0.254		-29.089	-0.246
-34.854	-0.227		-22.681	-0.135		-48.168	-0.263		-28.890	-0.255
-34.710	-0.236		-22.538	-0.142		-47.968	-0.272		-28.699	-0.264
-34.573	-0.243		-22.403	-0.148		-47.777	-0.281		-28.508	-0.272
-34.431	-0.252		-22.265	-0.155		-47.578	-0.290		-28.308	-0.282
-34.288	-0.261		-22.121	-0.162		-47.389	-0.299		-28.118	-0.291
-34.157	-0.268		-21.985	-0.169		-47.196	-0.308		-27.918	-0.300
-34.015	-0.278		-21.842	-0.177		-46.996	-0.318		-27.728	-0.310
-33.878	-0.286		-21.705	-0.183		-46.807	-0.327		-27.528	-0.319
-33.741	-0.295		-21.562	-0.191		-46.606	-0.337		-27.337	-0.329
-33.599	-0.304		-21.425	-0.199		-46.415	-0.347		-27.147	-0.338
-33.462	-0.313		-21.288	-0.206		-46.215	-0.357		-26.947	-0.348
-33.325	-0.322		-21.145	-0.214		-46.025	-0.367		-26.756	-0.358
-33.176	-0.332		-21.008	-0.222		-45.834	-0.378		-26.557	-0.369

-33.046	-0.341		-20.871	-0.230		-45.643	-0.388		-26.366	-0.379
-32.903	-0.351		-20.728	-0.238		-45.435	-0.399		-26.175	-0.389
-32.767	-0.361		-20.592	-0.246		-45.252	-0.409		-25.976	-0.400
-32.624	-0.371		-20.449	-0.255		-45.053	-0.420		-25.785	-0.410
-32.488	-0.380		-20.312	-0.263		-44.862	-0.431		-25.595	-0.421
-32.351	-0.390		-20.169	-0.272		-44.662	-0.442		-25.395	-0.432
-32.209	-0.401		-20.032	-0.280		-44.473	-0.453		-25.205	-0.443
-32.072	-0.411		-19.896	-0.289		-44.272	-0.465		-25.005	-0.454
-31.929	-0.421		-19.759	-0.298		-44.083	-0.476		-24.815	-0.466
-31.793	-0.432		-19.616	-0.307		-43.891	-0.488		-24.615	-0.477
-31.650	-0.442		-19.479	-0.316		-43.691	-0.500		-24.425	-0.489
-31.514	-0.453		-19.330	-0.326		-43.502	-0.511		-24.225	-0.501
-31.377	-0.464		-19.199	-0.334		-43.301	-0.524		-24.035	-0.512
-31.234	-0.475		-19.057	-0.344		-43.112	-0.536		-23.844	-0.524
-31.098	-0.486		-18.920	-0.353		-42.911	-0.548		-23.654	-0.536
-30.962	-0.497		-18.783	-0.363		-42.722	-0.560		-23.454	-0.548
-30.825	-0.508		-18.641	-0.373		-42.530	-0.573		-23.255	-0.561
-30.683	-0.520		-18.504	-0.383		-42.330	-0.586		-23.064	-0.574
-30.547	-0.531		-18.361	-0.393		-42.140	-0.598		-22.874	-0.586
-30.404	-0.543		-18.224	-0.402		-41.941	-0.612		-22.675	-0.599
-30.262	-0.555		-18.088	-0.413		-41.750	-0.625		-22.484	-0.612
-30.125	-0.567		-17.945	-0.423		-41.561	-0.638		-22.285	-0.625
-29.983	-0.579		-17.809	-0.433		-41.360	-0.652		-22.094	-0.638
-29.847	-0.591		-17.666	-0.444		-41.170	-0.665		-21.904	-0.652
-29.710	-0.603		-17.529	-0.455		-40.962	-0.679		-21.705	-0.665
-29.568	-0.616		-17.387	-0.466		-40.782	-0.692		-21.506	-0.680
-29.432	-0.628		-17.250	-0.477		-40.589	-0.706		-21.315	-0.693
-29.289	-0.642		-17.107	-0.488		-40.391	-0.720		-21.125	-0.707
-29.153	-0.654		-16.971	-0.498		-40.202	-0.735		-20.926	-0.721
-29.017	-0.667		-16.834	-0.510		-40.001	-0.749		-20.735	-0.735
-28.875	-0.681		-16.692	-0.522		-39.811	-0.763		-20.545	-0.749
-28.739	-0.694		-16.555	-0.533		-39.620	-0.778		-20.345	-0.765
-28.596	-0.708		-16.412	-0.545		-39.430	-0.792		-20.155	-0.779
-28.461	-0.721		-16.276	-0.557		-39.231	-0.807		-19.965	-0.793
-28.318	-0.736		-16.133	-0.569		-39.032	-0.823		-19.766	-0.809
-28.182	-0.750		-15.998	-0.581		-38.841	-0.837		-19.575	-0.824
-28.046	-0.764		-15.860	-0.594		-38.642	-0.853		-19.376	-0.839
-27.910	-0.777		-15.718	-0.606		-38.452	-0.868		-19.188	-0.855
-27.768	-0.793		-15.582	-0.619		-38.261	-0.883		-18.995	-0.870
-27.632	-0.807		-15.445	-0.632		-38.063	-0.899		-18.797	-0.886
-27.490	-0.822		-15.303	-0.645		-37.874	-0.915		-18.606	-0.902
-27.354	-0.837		-15.166	-0.658		-37.673	-0.931		-18.407	-0.918
-27.212	-0.852		-15.017	-0.672		-37.483	-0.947		-18.217	-0.933
-27.076	-0.867		-14.887	-0.685		-37.293	-0.963		-18.018	-0.950

-26.934	-0.883		-14.751	-0.698		-37.094	-0.979		-17.829	-0.966
-26.798	-0.898		-14.609	-0.712		-36.904	-0.995		-17.637	-0.982
-26.662	-0.913		-14.466	-0.727		-36.713	-1.011		-17.438	-0.999
-26.526	-0.929		-14.330	-0.741		-36.514	-1.028		-17.248	-1.015
-26.384	-0.945		-14.194	-0.755		-36.326	-1.044		-17.049	-1.032
-26.248	-0.960		-14.057	-0.769		-36.125	-1.061		-16.859	-1.048
-26.106	-0.977		-13.915	-0.784		-35.935	-1.078		-16.660	-1.066
-25.970	-0.992		-13.779	-0.798		-35.745	-1.094		-16.470	-1.082
-25.828	-1.009		-13.637	-0.814		-35.546	-1.112		-16.271	-1.099
-25.692	-1.025		-13.500	-0.829		-35.356	-1.128		-16.081	-1.116
-25.550	-1.041		-13.358	-0.844		-35.157	-1.145		-15.890	-1.133
-25.415	-1.057		-13.222	-0.859		-34.958	-1.163		-15.691	-1.150
-25.279	-1.074		-13.086	-0.874		-34.777	-1.179		-15.493	-1.168
-25.137	-1.090		-12.937	-0.891		-34.587	-1.196		-15.311	-1.184
-25.001	-1.107		-12.808	-0.906		-34.388	-1.214		-15.112	-1.202
-24.859	-1.124		-12.672	-0.922		-34.189	-1.232		-14.922	-1.219
-24.723	-1.140		-12.529	-0.938		-33.999	-1.249		-14.723	-1.237
-24.581	-1.157		-12.394	-0.953		-33.800	-1.266		-14.533	-1.254
-24.445	-1.174		-12.252	-0.970		-33.610	-1.284		-14.334	-1.272
-24.304	-1.191		-12.116	-0.986		-33.411	-1.301		-14.144	-1.289
-24.168	-1.208		-11.980	-1.002		-33.221	-1.319		-13.945	-1.307
-24.032	-1.224		-11.832	-1.020		-33.031	-1.336		-13.754	-1.325
-23.890	-1.242		-11.696	-1.036		-32.832	-1.354		-13.564	-1.342
-23.754	-1.258		-11.560	-1.053		-32.633	-1.372		-13.365	-1.360
-23.619	-1.275		-11.424	-1.069		-32.445	-1.389		-13.177	-1.378
-23.477	-1.293		-11.288	-1.085		-32.253	-1.406		-12.985	-1.395
-23.341	-1.309		-11.147	-1.102		-32.054	-1.424		-12.786	-1.413
-23.205	-1.326		-11.005	-1.119		-31.866	-1.441		-12.596	-1.431
-23.070	-1.343		-10.869	-1.136		-31.665	-1.459		-12.397	-1.449
-22.922	-1.361		-10.733	-1.152		-31.477	-1.476		-12.198	-1.468
-22.786	-1.378		-10.597	-1.169		-31.285	-1.494		-12.008	-1.485
-22.650	-1.395		-10.455	-1.186		-31.095	-1.511		-11.818	-1.502
-22.509	-1.412		-10.313	-1.204		-30.896	-1.529		-11.627	-1.520
-22.373	-1.429		-10.178	-1.220		-30.706	-1.546		-11.428	-1.538
-22.231	-1.447		-10.036	-1.238		-30.499	-1.565		-11.238	-1.556
-22.095	-1.463		-9.901	-1.254		-30.319	-1.581		-11.031	-1.575
-21.953	-1.481		-9.764	-1.272		-30.118	-1.600		-10.849	-1.592
-21.818	-1.498		-9.622	-1.289		-29.930	-1.616		-10.659	-1.609
-21.682	-1.514		-9.486	-1.306		-29.729	-1.635		-10.460	-1.628
-21.540	-1.531		-9.345	-1.324		-29.541	-1.652		-10.270	-1.645
-21.398	-1.549		-9.209	-1.340		-29.349	-1.669		-10.080	-1.662
-21.269	-1.565		-9.067	-1.358		-29.150	-1.687		-9.881	-1.681
-21.127	-1.582		-8.931	-1.375		-28.962	-1.704		-9.691	-1.698
-20.991	-1.599		-8.795	-1.392		-28.770	-1.722		-9.483	-1.717

-20.849	-1.616		-8.653	-1.409		-28.571	-1.740	-9.302	-1.734
-20.714	-1.633		-8.517	-1.426		-28.372	-1.758	-9.103	-1.752
-20.572	-1.650		-8.382	-1.443		-28.182	-1.775	-8.913	-1.770
-20.436	-1.667		-8.240	-1.460		-27.993	-1.792	-8.714	-1.789
-20.294	-1.684		-8.104	-1.477		-27.793	-1.810	-8.524	-1.806
-20.158	-1.701		-7.962	-1.495		-27.602	-1.827	-8.333	-1.823
-20.017	-1.718		-7.826	-1.511		-27.404	-1.845	-8.135	-1.842
-19.881	-1.735		-7.684	-1.529		-27.213	-1.863	-7.944	-1.859
-19.745	-1.752		-7.542	-1.547		-27.015	-1.880	-7.746	-1.877
-19.609	-1.768		-7.407	-1.563		-26.826	-1.898	-7.555	-1.895
-19.467	-1.786		-7.271	-1.580		-26.634	-1.915	-7.357	-1.913
-19.331	-1.802		-7.135	-1.597		-26.435	-1.933	-7.166	-1.931
-19.190	-1.820		-6.993	-1.614		-26.245	-1.950	-6.976	-1.948
-19.054	-1.837		-6.857	-1.631		-26.046	-1.968	-6.777	-1.966
-18.912	-1.854		-6.715	-1.649		-25.858	-1.985	-6.587	-1.984
-18.776	-1.870		-6.580	-1.665		-25.666	-2.002	-6.388	-2.002
-18.634	-1.888		-6.444	-1.682		-25.467	-2.020	-6.198	-2.020
-18.498	-1.905		-6.308	-1.699		-25.277	-2.037	-6.008	-2.037
-18.363	-1.921		-6.166	-1.716		-25.078	-2.055	-5.809	-2.055
-18.221	-1.939		-6.024	-1.734		-24.888	-2.072	-5.619	-2.073
-18.085	-1.956		-5.888	-1.751		-24.698	-2.089	-5.429	-2.090
-17.943	-1.973		-5.753	-1.767		-24.490	-2.108	-5.230	-2.108
-17.808	-1.990		-5.617	-1.784		-24.310	-2.124	-5.022	-2.127
-17.672	-2.007		-5.475	-1.801		-24.118	-2.141	-4.841	-2.144
-17.530	-2.024		-5.333	-1.819		-23.919	-2.159	-4.650	-2.161
-17.394	-2.041		-5.197	-1.835		-23.729	-2.177	-4.452	-2.179
-17.252	-2.059		-5.061	-1.852		-23.530	-2.194	-4.263	-2.196
-17.117	-2.075		-4.920	-1.869		-23.340	-2.211	-4.063	-2.215
-16.981	-2.092		-4.784	-1.886		-23.150	-2.229	-3.872	-2.232
-16.845	-2.109		-4.642	-1.904		-22.960	-2.245	-3.682	-2.249
-16.709	-2.125		-4.506	-1.920		-22.761	-2.263	-3.483	-2.267
-16.561	-2.144		-4.364	-1.938		-22.561	-2.281	-3.293	-2.284
-16.425	-2.161		-4.228	-1.954		-22.371	-2.298	-3.094	-2.302
-16.290	-2.177		-4.093	-1.971		-22.172	-2.315	-2.904	-2.319
-16.154	-2.194		-3.951	-1.989		-21.982	-2.332	-2.714	-2.336
-16.012	-2.212		-3.815	-2.005		-21.783	-2.350	-2.515	-2.354
-15.871	-2.229		-3.673	-2.023		-21.593	-2.366	-2.325	-2.371
-15.735	-2.246		-3.537	-2.040		-21.405	-2.383	-2.134	-2.387
-15.600	-2.263		-3.395	-2.057		-21.204	-2.400	-1.936	-2.405
-15.457	-2.280		-3.260	-2.074		-21.013	-2.417	-1.745	-2.421
-15.322	-2.297		-3.126	-2.091		-20.814	-2.435	-1.546	-2.438
-15.180	-2.314		-2.988	-2.107		-20.624	-2.451	-1.356	-2.455
-15.044	-2.331		-2.847	-2.125		-20.425	-2.468	-1.166	-2.471
-14.908	-2.347		-2.705	-2.142		-20.237	-2.484	-0.967	-2.488

-14.773	-2.364		-2.569	-2.159		-20.045	-2.501		-0.777	-2.504
-14.631	-2.381		-2.427	-2.177		-19.854	-2.517		-0.578	-2.521
-14.489	-2.398		-2.291	-2.194		-19.655	-2.534		-0.387	-2.537
-14.353	-2.415		-2.155	-2.210		-19.456	-2.550		-0.189	-2.554
-14.212	-2.432		-2.020	-2.227		-19.266	-2.566		0.002	-2.569
-14.076	-2.448		-1.878	-2.245		-19.075	-2.582		0.192	-2.585
-13.934	-2.465		-1.736	-2.262		-18.877	-2.598		0.391	-2.601
-13.799	-2.481		-1.600	-2.279		-18.686	-2.614		0.581	-2.616
-13.663	-2.497		-1.464	-2.296		-18.496	-2.629		0.780	-2.632
-13.521	-2.514		-1.322	-2.313		-18.305	-2.644		0.979	-2.648
-13.385	-2.530		-1.181	-2.330		-18.098	-2.661		1.161	-2.663
-13.243	-2.546		-1.045	-2.347		-17.907	-2.676		1.360	-2.678
-13.107	-2.562		-0.909	-2.364		-17.717	-2.691		1.559	-2.693
-12.972	-2.577		-0.773	-2.380		-17.518	-2.706		1.749	-2.708
-12.823	-2.594		-0.631	-2.397		-17.327	-2.721		1.940	-2.722
-12.694	-2.609		-0.496	-2.413		-17.128	-2.736		2.139	-2.737
-12.552	-2.624		-0.354	-2.430		-16.938	-2.750		2.329	-2.751
-12.416	-2.639		-0.218	-2.447		-16.747	-2.764		2.528	-2.766
-12.280	-2.654		-0.082	-2.463		-16.557	-2.778		2.719	-2.780
-12.138	-2.669		0.054	-2.479		-16.358	-2.792		2.909	-2.793
-12.002	-2.684		0.196	-2.496		-16.167	-2.806		3.108	-2.807
-11.860	-2.699		0.338	-2.512		-15.968	-2.820		3.299	-2.820
-11.724	-2.713		0.473	-2.528		-15.778	-2.833		3.498	-2.834
-11.588	-2.727		0.615	-2.544		-15.578	-2.847		3.689	-2.847
-11.446	-2.742		0.751	-2.560		-15.390	-2.859		3.888	-2.860
-11.310	-2.755		0.893	-2.577		-15.197	-2.872		4.078	-2.873
-11.168	-2.770		1.028	-2.592		-14.998	-2.886		4.269	-2.885
-11.032	-2.783		1.163	-2.607		-14.807	-2.898		4.468	-2.898
-10.890	-2.797		1.301	-2.622		-14.608	-2.910		4.658	-2.911
-10.754	-2.810		1.443	-2.638		-14.419	-2.923		4.858	-2.923
-10.618	-2.823		1.579	-2.653		-14.218	-2.935		5.048	-2.935
-10.476	-2.837		1.721	-2.669		-14.028	-2.946		5.239	-2.947
-10.339	-2.849		1.857	-2.683		-13.828	-2.959		5.438	-2.959
-10.203	-2.862		1.993	-2.698		-13.638	-2.970		5.629	-2.970
-10.061	-2.875		2.135	-2.713		-13.447	-2.981		5.828	-2.982
-9.925	-2.887		2.271	-2.726		-13.248	-2.992		6.018	-2.993
-9.783	-2.900		2.413	-2.741		-13.059	-3.003		6.209	-3.004
-9.641	-2.911		2.549	-2.755		-12.858	-3.014		6.408	-3.015
-9.510	-2.922		2.691	-2.769		-12.667	-3.025		6.599	-3.026
-9.368	-2.935		2.827	-2.783		-12.477	-3.035		6.798	-3.037
-9.232	-2.946		2.969	-2.797		-12.286	-3.045		6.997	-3.048
-9.090	-2.957		3.106	-2.810		-12.086	-3.056		7.188	-3.058
-8.953	-2.969		3.241	-2.823		-11.887	-3.066		7.379	-3.068
-8.811	-2.980		3.384	-2.836		-11.696	-3.075		7.570	-3.078

-8.674	-2.990		3.520	-2.849		-11.497	-3.085		7.760	-3.088
-8.538	-3.001		3.656	-2.862		-11.308	-3.095		7.960	-3.098
-8.396	-3.012		3.799	-2.875		-11.115	-3.104		8.159	-3.108
-8.259	-3.022		3.935	-2.886		-10.916	-3.114		8.350	-3.117
-8.117	-3.033		4.077	-2.899		-10.725	-3.122		8.549	-3.127
-7.981	-3.043		4.226	-2.913		-10.526	-3.132		8.740	-3.137
-7.838	-3.053		4.356	-2.923		-10.335	-3.141		8.930	-3.146
-7.702	-3.063		4.492	-2.935		-10.144	-3.149		9.130	-3.155
-7.559	-3.073		4.628	-2.947		-9.945	-3.158		9.320	-3.164
-7.423	-3.082		4.771	-2.958		-9.754	-3.167		9.511	-3.173
-7.286	-3.092		4.907	-2.970		-9.563	-3.175		9.710	-3.182
-7.144	-3.101		5.049	-2.981		-9.363	-3.183		9.901	-3.190
-7.009	-3.110		5.186	-2.992		-9.164	-3.192		10.092	-3.199
-6.865	-3.120		5.328	-3.003		-8.973	-3.200		10.291	-3.207
-6.728	-3.128		5.465	-3.014		-8.782	-3.207		10.482	-3.215
-6.592	-3.137		5.601	-3.024		-8.583	-3.216		10.682	-3.223
-6.449	-3.146		5.744	-3.035		-8.392	-3.223		10.873	-3.232
-6.313	-3.154		5.880	-3.045		-8.201	-3.230		11.072	-3.240
-6.170	-3.163		6.023	-3.055		-7.993	-3.239		11.263	-3.247
-6.033	-3.172		6.159	-3.065		-7.813	-3.245		11.471	-3.256
-5.891	-3.180		6.308	-3.076		-7.620	-3.253		11.653	-3.263
-5.754	-3.188		6.438	-3.084		-7.420	-3.260		11.853	-3.270
-5.617	-3.197		6.575	-3.094		-7.230	-3.267		12.044	-3.277
-5.475	-3.205		6.711	-3.104		-7.030	-3.274		12.235	-3.284
-5.332	-3.213		6.854	-3.113		-6.839	-3.281		12.434	-3.291
-5.195	-3.221		6.990	-3.122		-6.639	-3.288		12.625	-3.298
-5.059	-3.228		7.133	-3.132		-6.442	-3.294		12.825	-3.305
-4.916	-3.236		7.269	-3.141		-6.258	-3.300		13.024	-3.311
-4.780	-3.244		7.412	-3.150		-6.058	-3.307		13.207	-3.318
-4.643	-3.251		7.549	-3.158		-5.859	-3.313		13.406	-3.324
-4.506	-3.258		7.685	-3.167		-5.667	-3.319		13.597	-3.330
-4.364	-3.266		7.828	-3.176		-5.478	-3.325		13.797	-3.336
-4.221	-3.273		7.964	-3.184		-5.285	-3.330		13.988	-3.342
-4.084	-3.280		8.107	-3.193		-5.095	-3.336		14.179	-3.348
-3.947	-3.287		8.244	-3.201		-4.886	-3.342		14.379	-3.353
-3.805	-3.294		8.380	-3.209		-4.696	-3.348		14.570	-3.359
-3.668	-3.300		8.529	-3.218		-4.504	-3.353		14.769	-3.364
-3.531	-3.307		8.658	-3.225		-4.305	-3.358		14.960	-3.369
-3.389	-3.313		8.802	-3.234		-4.114	-3.363		15.151	-3.374
-3.246	-3.319		8.945	-3.241		-3.914	-3.368		15.351	-3.379
-3.109	-3.326		9.082	-3.249		-3.723	-3.373		15.542	-3.384
-2.972	-3.331		9.218	-3.256		-3.524	-3.378		15.742	-3.388
-2.836	-3.337		9.355	-3.264		-3.335	-3.382		15.933	-3.392
-2.699	-3.343		9.498	-3.271		-3.145	-3.386		16.132	-3.397

-2.556	-3.348		9.634	-3.278		-2.942	-3.390		16.323	-3.401
-2.413	-3.354		9.777	-3.286		-2.753	-3.395		16.514	-3.405
-2.277	-3.359		9.914	-3.293		-2.552	-3.399		16.714	-3.409
-2.134	-3.364		10.056	-3.300		-2.361	-3.402		16.905	-3.413
-1.997	-3.369		10.193	-3.306		-2.171	-3.406		17.096	-3.416
-1.860	-3.374		10.330	-3.313		-1.970	-3.409		17.296	-3.420
-1.718	-3.379		10.472	-3.320		-1.781	-3.412		17.504	-3.423
-1.581	-3.383		10.615	-3.326		-1.580	-3.416		17.687	-3.426
-1.438	-3.388		10.752	-3.332		-1.389	-3.419		17.878	-3.429
-1.301	-3.392		10.889	-3.338		-1.198	-3.421		18.078	-3.432
-1.158	-3.396		11.025	-3.344		-0.998	-3.425		18.269	-3.435
-1.015	-3.401		11.168	-3.350		-0.807	-3.427		18.469	-3.438
-0.885	-3.404		11.305	-3.356		-0.616	-3.429		18.660	-3.440
-0.742	-3.407		11.448	-3.361		-0.408	-3.432		18.851	-3.442
-0.605	-3.411		11.584	-3.367		-0.226	-3.434		19.059	-3.445
-0.462	-3.414		11.733	-3.372		-0.026	-3.436		19.242	-3.447
-0.325	-3.417		11.864	-3.377		0.165	-3.438		19.433	-3.448
-0.188	-3.421		12.001	-3.382		0.365	-3.440		19.633	-3.450
-0.045	-3.423		12.143	-3.387		0.556	-3.441		19.825	-3.452
0.091	-3.426		12.280	-3.391		0.755	-3.443		20.024	-3.453
0.234	-3.429		12.417	-3.396		0.944	-3.445		20.216	-3.455
0.371	-3.431		12.560	-3.400		1.134	-3.446		20.407	-3.456
0.514	-3.433		12.697	-3.404		1.337	-3.447		20.607	-3.458
0.651	-3.435		12.840	-3.408		1.528	-3.448		20.807	-3.459
0.794	-3.437		12.970	-3.412		1.719	-3.450		20.998	-3.460
0.931	-3.438		13.119	-3.416		1.919	-3.451		21.190	-3.461
1.068	-3.440		13.256	-3.419		2.118	-3.451		21.381	-3.462
1.211	-3.442		13.399	-3.423		2.309	-3.452		21.581	-3.463
1.348	-3.443		13.536	-3.426		2.500	-3.453		21.781	-3.463
1.484	-3.444		13.679	-3.429		2.691	-3.454		21.972	-3.464
1.627	-3.446		13.815	-3.432		2.882	-3.455		22.164	-3.465
1.764	-3.447		13.952	-3.434		3.091	-3.456		22.364	-3.465
1.908	-3.448		14.095	-3.437		3.282	-3.456		22.555	-3.466
2.044	-3.449		14.232	-3.440		3.473	-3.457		22.755	-3.466
2.187	-3.450		14.369	-3.442		3.664	-3.458		22.946	-3.467
2.324	-3.450		14.512	-3.444		3.855	-3.458		23.138	-3.467
2.468	-3.451		14.649	-3.446		4.072	-3.459		23.338	-3.467
2.603	-3.452		14.786	-3.447		4.252	-3.459		23.538	-3.468
2.741	-3.452		14.929	-3.449		4.442	-3.460		23.729	-3.468
2.885	-3.453		15.065	-3.451		4.636	-3.460		23.921	-3.469
3.022	-3.453		15.208	-3.452		4.836	-3.461			
3.165	-3.454		15.345	-3.454		5.036	-3.461			
3.302	-3.454		15.482	-3.455		5.227	-3.461			
3.439	-3.455		15.625	-3.456		5.418	-3.462			

3.582	-3.455			15.762	-3.458		5.609	-3.462		
3.719	-3.455			15.906	-3.459		5.809	-3.463		
3.862	-3.456			16.049	-3.459		6.008	-3.463		
3.999	-3.456			16.179	-3.460		6.199	-3.463		
4.136	-3.457			16.323	-3.461		6.399	-3.464		
4.279	-3.457			16.459	-3.462		6.590	-3.464		
4.416	-3.457			16.603	-3.463		6.790	-3.465		
4.553	-3.457			16.740	-3.464		6.972	-3.465		
4.697	-3.458			16.883	-3.464		7.172	-3.465		
4.840	-3.459			17.020	-3.465		7.371	-3.466		
4.977	-3.459			17.163	-3.465		7.563	-3.466		
5.114	-3.459			17.299	-3.466		7.762	-3.467		
5.257	-3.460			17.443	-3.466		7.953	-3.467		
5.394	-3.460			17.580	-3.467		8.143	-3.468		
5.531	-3.461			17.717	-3.467		8.344	-3.468		
5.675	-3.461			17.854	-3.468		8.535	-3.469		
5.812	-3.461			17.997	-3.468		8.724	-3.469		
5.955	-3.462			18.141	-3.469		8.926	-3.470		
6.092	-3.463			18.278	-3.469		9.117	-3.471		
6.229	-3.463			18.415	-3.470		9.317	-3.472		
6.373	-3.464			18.558	-3.470		9.508	-3.472		
6.516	-3.465			18.695	-3.471		9.708	-3.473		
6.653	-3.465			18.838	-3.471		9.897	-3.474		
6.790	-3.466			18.975	-3.472		10.090	-3.475		
6.934	-3.467			19.112	-3.472					
7.071	-3.468			19.255	-3.473					
7.208	-3.469			19.392	-3.474					
7.351	-3.470			19.536	-3.474					
7.488	-3.470			19.673	-3.475					
7.632	-3.472			19.810	-3.475					
7.769	-3.473			19.953	-3.476					
7.912	-3.473			20.090	-3.477					
8.049	-3.474			20.233	-3.478					
8.186	-3.476			20.377	-3.479					
8.330	-3.476			20.508	-3.479					
8.467	-3.477			20.645	-3.480					
8.604	-3.478			20.788	-3.481					
8.747	-3.479			20.931	-3.482					
8.884	-3.480			21.075	-3.483					
9.028	-3.481			21.212	-3.484					
9.165	-3.482			21.349	-3.485					
9.308	-3.483			21.486	-3.486					
9.445	-3.484			21.629	-3.486					
9.582	-3.485			21.766	-3.487					

9.726	-3.486			21.910	-3.488				
9.863	-3.487			22.047	-3.489				
10.006	-3.488			22.184	-3.490				