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

# ASSESSMENT PROTOCOL – SAFETY ASSIST

Version 9.0.4
April 2021

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# 1 INTRODUCTION

The following protocol deals with the assessments made in the area of Safety Assist, in particular for the Occupant Status Monitoring, Speed Assist Systems, Lane Support Systems and Autonomous Emergency Braking Systems.

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

## 2 METHOD OF ASSESSMENT

Unlike the assessment of protection offered in the event of a crash, the assessment of Safety Assist functions does not require destructive testing of the vehicle. Assessment of the Safety Assist functions is based both on performance requirements verified by Euro NCAP. The intention is to promote standard fitment across the car volume sold in the European Community in combination with good functionality for these systems, where this is possible.

It is important to note that Euro NCAP only considers assessment of safety assist systems that meet the fitment requirements for base safety equipment or dual rating (as defined in the Vehicle Specification, Selection, Testing and Re-testing protocol). For the performance assessment of seat belt reminder and speed assistance systems, the car is subjected to a number of trial sequences designed to highlight the effectiveness of the systems. The car performance is scored using the observations made by the inspector during driving. In addition to the basic Euro NCAP assessment, additional information may be recorded that may be added to the Euro NCAP assessment in the future.

# 3 OCCUPANT STATUS MONITORING

## 3.1 Introduction

More than ninety percent of road accidents are caused by “human mistakes”. In general, two kinds of mistakes can be observed: violations, of which speeding and driving under the influence of alcohol or drugs are most common; and human “errors”, in which the driver state - inattentiveness, fatigue, distraction - and inexperience play an important role. In an aging society, sudden medical incapacitation is also a growing cause of road crashes.

Already, driver advisory systems such as Speed Assistance Systems (SAS) and Attention Assist target the human element in crashes by alerting the driver in critical situations and, ultimately, by supporting the driver to improve his behaviour. In addition, adapting intervention criteria to individual drivers and the driver’s state may provide a significant potential for earlier interventions in the future without compromising false-positive levels.

Euro NCAP envisages an incentive for driver monitoring systems1 that effectively detect impaired and distracted driving and give appropriate warning and take effective action e.g. initiating a safe evasive manoeuvre, limp home mode, increased increasing sensitivity of Electronic Stability Control, lane support, speed, etc. Implementation in the overall rating is planned in phases, starting with systems that have already entered the market. The assessment will evolve around how reliably and accurately the status of the driver is detected and what action the vehicle takes based on the information. Other aspects, such as driver position monitoring, could be added in future iterations of the protocol.

## 3.2 Definitions

Throughout this protocol the following terms are used:

**Seat Belt Reminder (SBR)** – Seat Belt Reminder that indicates the status of the seatbelt whether it is in use or not in use

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

**Impaired driving** – A driver who is disconnected from the driving task or not in a physical state that is sufficient for safe driving

- **Fatigue** – State of the driver where he/she is not awake enough to properly perform the driving task
- **Distraction** – Anything (e.g. secondary tasks) that avoid the driver to focus on the primary task of driving/controlling the vehicle
- **DUI** – Driving Under the Influence of alcohol or drugs
- **Sudden sickness** – An instant and unexpected illness wherein the driver is not able to perform his driving task

**Impaired driving warnings and interventions** – Warning and/or adapted vehicle mode after an impaired driving has been detected

- **Impaired driving warning** – Warning issued in case the system determines an impaired driver
- **High sensitivity mode** – A more sensitive and earlier warning and/or intervention of Safety Assist systems to compensate for the driver state
- **Reduced speed mode** – Vehicle state where the speed is limited and high system sensitivity
- **Emergency Stop Manoeuvre** – Emergency manoeuvre where the vehicle will come to a controlled stop

## 3.3 Preconditions

To be eligible for scoring points in DSM, the SBR requirements in section 3.4 must be met:

- Front seats including occupant detection
- If applicable, at least one rear seats with unbuckling and/or occupant detection

Only when the vehicle under assessment is equipped with an AEB, LSS and/or SAS system, points can be scored for DSM.

## 3.4 Seat belt reminder assessment

### 3.4.1 General requirements

All seating positions in the vehicle will be assessed including optional and removable seats.

The seatbelt reminder system should "start" at the commencement of each "journey" that the vehicle makes. Short breaks in the journey are allowed, where the reminder system is not required to start again. Such short breaks, of up to 30 seconds, are to allow for events such as stalling of the engine where passengers may remain in the vehicle.

For the purpose of defining the start of the final audible signal, forward motion at less than 10 km/h, or rearward motion, is not deemed to be motion.

#### 3.4.1.1 Signal

All seatbelt reminder systems shall be audio-visual, where there must be a clear and obvious link between the audible and visual signals. As soon as the audible part of the seatbelt reminder signal starts, the visual signal needs to flash and be synchronised (not necessarily at the same frequency, but an integer multiple of each other, e.g. two flashes with every chime) with the audible part.

Any visual signal must be clearly visible to the driver, without the need for the head to be moved from the normal driving position (e.g. instrument panel, head-up display, rear-view mirror, centre console). Any final audible signal must be "Loud and Clear" for the driver.

#### 3.4.1.2 Airbag deactivation switch

There must be no link between the front seat passenger airbag and the front seat passenger SBR signals. It is NOT acceptable to Euro NCAP for the passenger seat SBR to be disabled via the passenger airbag switch.

#### 3.4.1.3 Occupant detection

In the case of the driver's seat, occupancy can be assumed so the system does not have to be capable of detecting whether or not the seat is in use. For the front seat passengers, seat use must be detected. Systems that feature rear seat occupant detection are eligible for higher scores. Euro NCAP defines occupancy as use by an occupant larger, taller or heavier than a small female (5th percentile).

#### 3.4.1.4 Secondary buckles

Monitoring of rear seat belt secondary buckles that require a tool to unlock, is not required.

3.4.1.5 Change of Status

During a change of status (from buckled to unbuckled) at speeds over 25 km/h, the system must immediately deploy the audio-visual signal meeting the requirements of section 3.4.2 for the front seats and that of section 3.4.3 for the rear seats.

Where the change of status occurs below 25km/h, and no doors are opened, the signal may be delayed until before at least one of the below requirements (at the choice of the manufacturer) are met:

- The car has reached a forward speed of 25 km/h, or
- The car has been in "Forward Motion" for 500 meters.

Where the change of status occurs below 25km/h, and doors are opened, the system should consider this situation as a “new journey”, and warn accordingly.

Where the system is able to track the number of buckled positions in the rear, no change of status signal (for the rear seats) is required as long as all doors remain closed, and the number of buckled positions remains the same. This is to minimize the number of false positives (ex: children remaining in the vehicle but swapping seats in the rear while at a traffic light).

3.4.1.6 End of signal

Once the audible part of the SBR signal has started, it must only stop under one of the following circumstances.

- The signal has operated for the duration as specified in 3.4.2.3.
- The related seat belts are put into use. Where the system is able to track the number of buckled positions in the rear, the change of status signal (for the rear seats) can be terminated as long as all doors remain closed, and the number of buckled positions remains the same.
- The vehicle speed is below 10 km/h. When no doors have been opened, and the seatbelts remain unbuckled, the signal must resume again when the vehicle speed goes above 25 km/h.

3.4.2 Front seating positions

3.4.2.1 Visual signal

A visual signal must be activated when the ignition switch is engaged (engine running or not) and the seatbelt is not fastened, and in case of a change of status as defined in 3.4.1.5. This signal must remain until the seatbelt is fastened and recommence once a seatbelt is unfastened.

3.4.2.2 Initial Audible Signal

An Initial Audible Signal needs to be deployed before at least one of the following (at the choice of the manufacturer):

- The car has reached a forward speed of 25 km/h, or
- The engine has been running for 60 seconds, or
- The car has been in "Forward Motion" for 500 meters.

The duration of the initial audible signal can have a maximum duration of 30 seconds and must start with a positive audio-visual signal (not a gap). There must be no gaps greater than 10 seconds.

3.4.2.3 Final Audible Signal

A Final Audible Signal (Loud and Clear) is to be deployed before at least one of the following (at the choice of the manufacturer):

- The car has reached a forward speed of 40 km/h, or
- The engine has been running for 90 seconds, or
- The car has been in "Forward Motion" for 90 seconds, or
- The car has been in "Forward Motion" for 1000 meters, or
- The Initial Audible Signal (lasting maximum 30 seconds) is finished.

The duration of the final audible signal must be at least 90 seconds not counting gaps exceeding 3 seconds and must start with a positive audible signal (not a gap). There must be no gaps greater than 10 seconds.

**NOTE:** The manufacturer has the option to utilize the Initial Audible Signal as the Final Audible Signal, as long as it is “Loud and Clear”, and the duration is at least 90 seconds not counting gaps exceeding 3 seconds and must start with a positive audible signal (not a gap). There must be no gaps greater than 10 seconds.

3.4.3 Rear seating positions

3.4.3.1 Visual signal

3.4.3.1.1 A visual signal must be activated when the ignition switch is engaged (engine running or not), and any of the rear seatbelts are not fastened. No signal is required if the system is able to determine that there are no occupants in the rear seating positions. The signal must remain for at least 60 seconds or until the rear belts are buckled for the seats in use.

3.4.3.1.2 The system may allow the driver to acknowledge the signal, switching it off for this unique event (a new trigger of the warning should not be prevented).

3.4.3.1.3 For systems with seat occupant detection on all rear seating positions, the visual signal does not need to indicate the number of seat belts in use or not in use, but the signal must remain as long as the seatbelt remain unfastened on any of the occupied seats in the rear.

3.4.3.1.4 For systems without occupant detection on all rear seating positions, the visual signal must clearly indicate to the driver the seating positions showing the rear seat belts in use and not in use. No signal is required if all of the rear occupants are belted.

3.4.3.2 Audible signal

3.4.3.2.1 In addition to a visual signal, a “Loud and Clear” audible signal is to be deployed for all rear seating positions in case of a change of status (from buckled to unbuckled) as defined in 3.4.1.5.

3.4.3.2.2 Except for change of status events, the system may allow the driver to acknowledge the signal, switching it off for this unique event (a new trigger of the warning should not be prevented).

3.4.3.2.3 For systems with occupant detection on any rear seating positions, a “Loud and Clear” audible signal needs to be deployed before at least one of the following (at the choice of the manufacturer) when any of those seats are occupied and the belt of the occupied seat is unbuckled.

- The car has reached a forward speed of 25 km/h, or
- The car has been in "Forward Motion" for 500 meters.

The duration of the audible signal must be at least 30 seconds not counting gaps exceeding 3 seconds and must start with a positive audible signal (not a gap). There must be no gaps greater than 10 seconds. The system may allow the driver to acknowledge the signal, so switching it off.
Alternatively, the manufacturer may use the same warning strategy (including initial and final warning) as described in Section 3.4.2 in case of occupant detection in all rear seating positions.

## 3.5 Driver Monitoring Systems

For the evaluation of Driver Monitoring Systems, a simplified Euro NCAP Advanced approach will be used for 2020. This means that the manufacturer must provide a dossier containing a detailed technical assessment as per Euro NCAP Advanced protocol.
The dossier should contain:

- Technical detail about the system, to fully understand its functionality, relevant components, and intended availability.
- Test procedures, criteria and limits by which the performance of the system was verified
- If available, the dossier should summarize the findings from real-world or simulated real-world evaluations.

### 3.5.1 General requirements

To be eligible for scoring points in DSM, the system needs to be default ON at the start of every journey and deactivation of the system should not be possible with a momentary single push on a button.

### 3.5.2 Detection of Driver State

This section is foreseen for 2023 implementation and will be developed by the Euro NCAP WG on OSM

### 3.5.3 System Warning and/or Intervention

This section is foreseen for 2023 implementation and will be developed by the Euro NCAP WG on OSM

## 3.6 Scoring & Visualisation

A maximum of 3.0 points can be scored for Occupant Status Monitoring in 2020:

- 1.0 point for DSM
- 2.0 points for SBR on rear seating positions

In 2023 the point distribution between SBR and DSM will change. For 2023, 2.0 points will be awarded for DSM and 1.0 point for SBR (Occupant Detection on Rear seats only).

### 3.6.1 Driver State Monitoring

The Euro NCAP Secretariat will review the DSM dossier as provided by the manufacturer and will decide on the applicability of awarding the point for DSM.

It should be noted that systems using Time-on-Task only will not be awarded.

3.6.2 Seatbelt Reminder

All front row seating positions must meet the assessment criteria of section 3.4.1 and 3.4.2 as a prerequisite of scoring SBR point for the rear seating positions and DSM.

3.6.2.1 Rear seating positions

Rear seating positions (including optional third or more rows of seats) are eligible for scoring 1.0/n points (with n the number of rear seating positions) for seating positions without occupant detection. An additional 1.0/n points is available for rear seating positions with occupant detection systems.

3.6.2.2 SBR Scoring examples

- 5-Seater (2 Front + 3 Rear) with occupant detection on all seats
  - Driver & Passenger — prerequisite
  - Rear Seats — 1.000 Points
  - Rear occupant detection on 3 seats — 1.000 Points
    $(\frac{1.0}{n}) * \#\ of\ seats\ with\ detection = (\frac{1.0}{3}) * 3$
  - Total SBR Score — 2.000 Points

- 5-Seater (2 Front + 3 Rear) with occupant detection on outboard rear seats.
  - Driver & Passenger — prerequisite
  - Rear Seats — 1.000 Points
  - Rear occupant detection on 2 seats — 0.667 Points
    $(\frac{1.0}{n}) * \#\ of\ seats\ with\ detection = (\frac{1.0}{3}) * 2$
  - Total SBR Score — 1.667 Points

- 7-Seater (2 Front + 3 2nd Row + 2 3rd Row) with occupant detection on all seats in the 2nd row.
  - Driver & Passenger — prerequisite
  - Rear Seats — 1.000 Points
  - Rear occupant detection on 3 seats — 0.600 Points
    $(\frac{1.0}{n}) * \#\ of\ seats\ with\ detection = (\frac{1.0}{5}) * 3$
  - Total SBR Score — 1.600 Points

- 7-Seater (2 Front + 3 2nd Row + 2 3rd Row) with occupant detection on outboard seats in the 2nd row.
  - Driver & Passenger — prerequisite
  - Rear Seats — 1.000 Points
  - Rear occupant detection on 2 seats — 0.400 Points
    $(\frac{1.0}{n}) * \#\ of\ seats\ with\ detection = (\frac{1.0}{5}) * 2$
  - Total SBR Score — 1.400 Points

- 7-Seater (2 Front + 3 2nd Row + 2 3rd Row) with occupant detection on outboard seats in the 2nd row, and no SBR in the third row.
    - Driver & Passenger — prerequisite
    - Rear Seats — 0.600 Points
      $(\frac{1.0}{n}) * \#\ of\ seats = (\frac{1.0}{5}) * 3$
    - Rear occupant detection on 2 seats — 0.400 Points
      $(\frac{1.0}{n}) * \#\ of\ seats\ with\ detection = (\frac{1.0}{5}) * 2$
    - Total SBR Score — 1.000 Points

# 4 ASSESSMENT OF SPEED ASSIST SYSTEMS

## 4.1 Introduction

Excessive speed is a factor in the causation and severity of many road accidents. Speed restrictions are intended to promote safe operation of the road network by keeping traffic speeds below the maximum that is appropriate for a given traffic environment, thereby protecting vehicle occupants and other road users, both motorised and non-motorised. These maximum speeds are intended to control energy levels in typical crashes and to allow sufficient time for drivers to react to traffic situations. Properly selected speed limits should facilitate efficient traffic flow, reduce violations and promote safe driving conditions. Greater adherence to speed limits would avert many accidents and mitigate the effects of those that occur.

Voluntary speed limitation devices are a means to assist drivers to adhere to speed limits. Euro NCAP hopes to encourage manufacturers to promote such speed-limitation devices, to fit them as standard equipment. This, it is hoped, will lead to greater demand by consumers and an increased introduction of speed limitation systems.

The margins for alarm activation set out in this document are based on prevailing speedometer accuracy, which is specified by regulation and typically overstates the vehicle speed by several km/h.

This version of the protocol contains technical requirements for both Speed Limit information functions to continuously inform the driver of the speed limit and Speed Control Functions supporting the driver in his driving task by limiting or maintaining the set speed.

## 4.2 Definitions

Throughout this protocol the following terms are used:

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

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

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

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

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

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

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

The following term is used for the assessment of the Speed Limitation function:

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

## 4.3 Requirements for SLIF and Speed Control Functions

The Speed Assist Systems is developed in such a way that it allows different types of Speed Assist Systems to be assessed in two areas; SLIF and Speed Control functions which may be combined.

### 4.3.1 Speed Limit Information Function

- Basic SLIF meeting the General Requirements
- Advanced Functions
- System Accuracy
- Warning Function

### 4.3.2 Speed Control function

- Speed Limitation function (standalone function or combined with SLIF without coupling)
- Intelligent Speed Assistance (SLIF and Speed Limitation function coupled)
- Intelligent ACC (SLIF and ACC coupled)

## 4.4 Speed Limit Information Function

The Speed Limit Information Function can be a standalone function or an integrated part of a speed control function. Any SLIF, camera or map based or a combination of both, is eligible for scoring points of this section when meeting the General Requirements when the SLIF is default ON at the start of a journey.

The speed limit information could either be provided by vehicle-integrated devices or by mobile devices connected to the vehicle network. A list of compatible devices needs to be mentioned in the vehicle handbook.

### 4.4.1 General Requirements

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

The speed limit information must be shown or accessible at any time with a simple operation and needs to be shown at the start of the next journey (excluding the initialization period).

The indicated speed limit information may indicate the level of reliability of the speed limit.

In the presence of conditional speed limits (see Appendix I) the system needs to either properly identify and show (for example when raining) the applicable speed limit or alternatively, needs to indicate the presence of a conditional speed limit which the system is not able to compute, in addition to the non-conditional speed limit.
Manufacturers need to supply Euro NCAP with background information of the SLIF (if applicable to the technology).

### 4.4.2 Advanced Functions

Systems that are able to properly identify conditions and act accordingly can attract additional points based on the number of advanced functions. These functions are listed in the table below and example traffic signs of a limited number of countries are specified in Appendix I.

| **Advanced Functions** | | **Points** | **Required Action** |
|---|---|---|---|
| Weather | Rain / Wetness | 2 | Show correct speed limit |
| | Snow / Icy | 2 | Warning only and ignore if irrelevant |
| Time | Time | 3 | Show correct speed limit |
| Distance | Distance for / in | 1 | Show correct speed limit |
| Arrows | Arrows | 1 | Show correct speed limit or ignore if irrelevant |
| Vehicle Categories | Other vehicle / weight categories | 1 | Ignore if irrelevant |
| Implicit Speed Limits | Highway / Motorway | 2 | Show correct speed limit |
| | City Entry / Exit | 3 | |
| | Residential zones | 2 | |
| Dynamic Speed Limits | Dynamic speed signs including roadworks | 3 | Show correct speed limit |
| **TOTAL** | | **20** | |

The Advanced Functions score is calculated by multiplying the points achieved by 0.025.

### 4.4.3 System Accuracy

A system that achieves more than 12 out of 20 points from the Advanced Functions will be awarded the score for System Accuracy. If map-based data is required to achieve any of the points up to 12 the speed limits must be updated frequently (at least quarterly) and automatically for the first six years, without user action. (ex. sending DVD/USB to customer allowed).

4.4.4 Warning Function

Speed Limit Information Functions that meet the warning requirements below to indicate the driver that Vlimit is exceeded will score for Warning Function. The warning function may be switched ON/OFF by the driver where the last user mode may be used.

- The warning shall be a flashing traffic sign used to communicate the speed limit or an additional visual signal adjacent to the traffic sign.

- The warning commences when Vindicated is exceeding Vlimit by more than 5km/h (3 mph). A negative and/or positive offset with respect to the known speed limit is allowed but may not be larger than 10 km/h (5 mph).

- The driver continues to be informed for the duration of the time that Vlimit is exceeded by more than 5 km/h, with a total duration of at least 10 seconds. Gaps of less than 1 second, which allow for signals which flash are ignored, but the signal may not start with a gap. If the signal is not continuous for the first 10 seconds, it needs to be repeated every 30 seconds or less, resulting in a minimum total duration of at least 10 seconds.

- The warning sequence does not need to be reinitiated for each exceedance of Vlimit until Vindicated has reduced to more than 5km/h below Vlimit.

## 4.5 Speed Control Function

Three speed control functions are considered in this section; Speed Limitation Function (manually set), Intelligent Speed Assist and Intelligent Adaptive Cruise Control which need to meet the following requirements to score points:

| Type Speed Control Function | Sections |
|---|---|
| Speed Limitation Function (SLF) | 4.5.1, 4.5.2.1 & 4.5.3 |
| Intelligent Speed Assist (ISA) | 4.5.1, 4.5.2.2 & 4.5.3 |
| intelligent Adaptive Cruis Control (i-ACC) | |

4.5.1 Activation / de-activation of the function

- The speed control function must be capable of being activated/de-activated at any time with a simple operation.
- At the start of a new journey, the system should be de-activated by default.

### 4.5.2 Setting of Vadj

#### 4.5.2.1 Manually setting the speed

- It shall be possible to set Vadj, by a control device operated directly by the driver, by steps not greater than 10km/h (5mph) between 30km/h (20mph) and 130km/h (80mph).

- It shall be possible to set Vadj independently of the vehicle speed.

- If Vadj is set to a speed lower than the current vehicle speed, the system shall limit the vehicle speed to the new Vadj within 30s or shall initiate a warning (section 0) no later than 30s after Vadj has been set.

- The Vadj value shall be permanently indicated to the driver and visible from the driver's seat. This does not preclude temporary interruption of the indication for safety reasons or driver's demand.

#### 4.5.2.2 Automatic setting the speed

An automatic setting is using the speed limit information from the SLIF to set the Vadj with or without driver confirmation. Both ISA and iACC functions fulfilling the requirements from this section are eligible for scoring points:

- The system should adopt, or offer the driver to adopt, an adjusted Vadj within 5s after a change in the speed limit.

- If Vadj is set to a speed lower than the current vehicle speed, the system starts to limit the vehicle speed to the new Vadj or shall initiate a warning (section 0) no later than 30s after Vadj has been set.

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

- The Vadj in the automatic mode of an ISA system may be retained at the end of a journey.

- Where Vadj is set to the speed limit advised by the SLIF, the indication of Vadj may be suppressed.

4.5.3 Speed Control

- The vehicle speed shall be limited or controlled to Vadj.

- It shall still be possible to exceed Vadj by applying a positive action – e.g. kickdown (SLF/ISA) or depressing the accelerator (iACC).

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

- The speed control function shall permit a normal use of the accelerator control for gear selection.

- The speed control function shall ensure that when stable speed control has been achieved, Vstab shall be within -5/+0 km/h of Vadj (see test protocol)

- When the speed control function is not able to limit to and/or maintain Vadj and Vadj is exceeded by more than 5 km/h an audio-visual warning is issued, with a total duration of at least 10 seconds. No warning needs to be given when Vadj is exceeded as a result of a positive action.

- Gaps of less than 1 second, which allow for signals which flash are ignored, but the signal may not start with a gap. If the signal is not continuous for the first 10 seconds, it needs to be repeated every 30 seconds or less, resulting in a minimum total duration of at least 10 seconds.

- For systems where active braking is applied to maintain and/or limit the speed, this warning requirement does not apply.

**Note:** The warning signal does not preclude temporary interruption of the indication for safety reasons.

## 4.6 Scoring and Visualisation

The following points are awarded for systems that meet the requirements. These points will contribute to the Safety Assist Score.

| **Speed Limit Information Function** | **1.50** |
|---|---|
| Basic SLIF | 0.50 |
| Advanced SLIF | 0.50 |
| System Accuracy | 0.25 |
| Warning Function | 0.25 |
| **Speed Control Function** | **1.50** |
| Speed Limitation Function<br>*For cars without SLIF*<br>*For cars with SLIF* | <br>1.25<br>0.75 |
| ISA and/or intelligent ACC | 1.50 |

# 5 ASSESSMENT OF AEB CAR-TO-CAR SYSTEMS

## 5.1 Introduction

For the assessment of AEB Car-to-Car systems, three areas of assessment are considered: the Autonomous Emergency Braking function, Forward Collision Warning function and the Human Machine Interface (HMI). The AEB and FCW functions are assessed in three different types of scenarios. The FCW function is only considered when the system provides dynamic brake support.

## 5.2 Definitions

Throughout this protocol the following terms are used:

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

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

**Dynamic Brake Support (DBS) –** a system that further amplifies the driver braking demand in response to the detection of a likely collision to achieve a greater deceleration than would otherwise be achieved for the braking demand in normal driving conditions.

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

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

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

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

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

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

**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 TB025 - Global Vehicle Target specification for Euro NCAP v1.0

**Vrel_test –** means the relative speed between the VUT and the EVT by subtracting the velocity of the EVT from that of the VUT at the start of test

**Vimpact –** means the speed at which the VUT hits the EVT

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

## 5.3 Criteria and Scoring

To be eligible for scoring points in AEB Car-to-Car, the AEB and/or FCW system must:

- Be operational up to speeds of at least 130 km/h, excluding stationary targets.
- Needs to be default ON at the start of every journey and deactivation of the system should not be possible with a momentary single push on a button.
- The audible component of the FCW system (if applicable) needs to be loud and clear.

Additionally, for the AEB CCRs scenario (previously called AEB City) points for this scenario are awarded only when the following preconditions are met:

- Whiplash score for the front seat is at least rated as "Good".
- Full avoidance needs to be achieved for test speeds up to and including 20 km/h for all overlap situations, which is verified by one randomly selected test point.

### 5.3.1 Assessment Criteria

For both AEB and FCW system tests, the assessment criteria used is the relative impact speed Vrel_impact. For CCRb scenarios, the relative test speed is assumed equal to the initial test speed.

Alternatively, for FCW system tests @ -50% overlap (50% for RHD vehicles) where performance does not result in full avoidance, the manufacturer has the option to demonstrate to Euro NCAP at the test laboratory that their (driver initiated) ESS system will function to avoid the collision by steering support.

### 5.3.2 Car-to-Car Rear scoring

A maximum of 3.5 points is available for AEB/AES CCR. The scoring is based on normalized scores of the AEB and FCW/AES functions, assessed in the CCRs, CCRm and CCRb scenarios.

For the CCRs and CCRm scenarios, the total score for all five grid points per test speed is calculated as a percentage of the maximum achievable score per test speed, which is then multiplied by the points available for this test speed. It should be noted that the 100% overlap score is double counted.

For each predicted colour the following scaling is applied to the grid point:

| | |
|---|---|
| *Green* | *1.000* |
| *Yellow* | *0.750* |
| *Orange* | *0.500* |
| *Brown* | *0.250* |
| *Red* | *0.000* |

The points available for the different CCR grid points and/or scenarios are shown in the table below:

| Test speed | AEB | | | FCW | | |
|---|---|---|---|---|---|---|
| | CCRs | CCRm | CCRb | CCRs | CCRm | CCRb |
| 10 km/h | 1.000 | | | | | |
| 15 km/h | 2.000 | | | | | |
| 20 km/h | 2.000 | | | | | |
| 25 km/h | 2.000 | | | | | |
| 30 km/h | 2.000 | 1.000 | | 2.000 | | |
| 35 km/h | 2.000 | 1.000 | | 2.000 | | |
| 40 km/h | 1.000 | 1.000 | | 2.000 | | |
| 45 km/h | 1.000 | 1.000 | | 2.000 | | |
| 50 km/h | 1.000 | 1.000 | 4x 1.000 | 3.000 | 1.000 | 4x 1.000 |
| 55 km/h | | 1.000 | | 2.000 | 1.000 | |
| 60 km/h | | 1.000 | | 1.000 | 1.000 | |
| 65 km/h | | 2.000 | | 1.000 | 2.000 | |
| 70 km/h | | 2.000 | | 1.000 | 2.000 | |
| 75 km/h | | 2.000 | | 1.000 | 2.000 | |
| 80 km/h | | 2.000 | | 1.000 | 2.000 | |
| **TOTAL** | **14.000** | **15.000** | **4.000** | **18.000** | **11.000** | **4.000** |
| **System points** | | **2.000** | | | **1.500** | |

5.3.2.1 Correction factors

The data provided by the manufacturer for CCRs and CCRm is scaled using two correction factors, one for AEB and one for FCW/AES, which are calculated based on a number of verification tests performed. The vehicle sponsor will fund 20 verification tests, 10 for AEB and 10 for FCW/AES where applicable. The vehicle manufacturer has the option of sponsoring up to 10 additional verification tests for AEB and 10 for FCW/AES.

The verification points are randomly selected grid points, distributed in line with the predicted colour distribution (excluding red 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 and CCRm scores for the AEB and FCW/AES function scores. The final CCRs and CCRm scores for AEB and FCW/AES can never exceed 100% (2.0 and 1.5 points respectively) regardless of the correction factor.

5.3.2.2 Impact speed tolerance

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

The tolerance only applies to verify whether the predicted colour of the tested verification point is correct. When, including tolerance, the colour is not in line with the prediction, the true colour of the test point will be determined by comparing the actual measured impact speed with the colour band in section 5.3.2 without applying a tolerance to the impact speed.

As an example, the accepted impact speed ranges for the 50km/h CCRs and CCRb tests are as follows:

| Prediction | Impact speed range [km/h] | Accepted range [km/h] |
|---|---|---|
| Green | $0 \leq v_{impact} < 5$ | $0 \leq v_{impact} < 7$ |
| Yellow | $5 \leq v_{impact} < 15$ | $3 \leq v_{impact} < 17$ |
| Orange | $15 \leq v_{impact} < 30$ | $13 \leq v_{impact} < 32$ |
| Brown | $30 \leq v_{impact} < 40$ | $28 \leq v_{impact} < 42$ |
| Red | $40 \leq v_{impact}$ | excluded |

5.3.3 Car-to-Car Front turn across path

A maximum of 2 points is available for AEB CCFtap. A normalised score is calculated based on the number of scenarios (out of 9) where the vehicle itself avoided the collision. This normalised score is multiplied with the available points for CCFtap.

| Test speed | CCFtap | | |
|---|---|---|---|
| | GVT @ 30 km/h | GVT @ 45 km/h | GVT @ 55 km/h |
| 10 km/h | 1.000 | 1.000 | 1.000 |
| 15 km/h | 1.000 | 1.000 | 1.000 |
| 20 km/h | 1.000 | 1.000 | 1.000 |
| **TOTAL** | **9.000** | | |
| **Scenario points** | **2.000** | | |

5.3.4 Human Machine Interface (HMI)

A maximum of 0.5 points is available for HMI. Points can be achieved for the following:

- Supplementary warning for the FCW system 1 point

In addition to the required audio-visual warning, a more sophisticated warning like head-up display, belt jerk, brake jerk or any other haptic feedback is awarded when it is issued at a TTC > 1.2s. This is only valid for cases where the AEB system is not able to fully avoid the impact at full overlap.
**NOTE:** The supplementary warning point is not applicable to AEB only systems

- Reversible pre-tensioning of the belt in the pre-crash phase 1 point

When the system detects a critical situation that can possibly lead to a crash, the belt can already be pre-tensioned to prepare for the oncoming impact.

The normalised HMI score is calculated by dividing the points achieved by 2.

5.3.5 Total AEB Car-to-Car Score

The total score in points is the weighted sum of the CCR scores for AEB and FCW, the CCFtap score and the HMI score as shown below.

$$
\begin{aligned}
&(CCR\ AEB\ score\ x\ CCR\ AEB\ Correction\ factor\ x\ 2.0)\\
+&(CCR\ FCW\ score\ x\ CCR\ FCW\ Correction\ factor\ x\ 1.5)\\
+&(CCFtap\ score\ x\ 2.0)\\
+&(HMI\ score\ x\ 0.5)\\
\hline
&\boldsymbol{AEB\ CartoCar\ total\ score}
\end{aligned}
$$

5.3.5.1 Scoring Example

| AEB Car-to-Car | Points | Correction factor | Percentage | Score |
|---|---|---|---|---|
| **CCR AEB** | | | **91.0%** | **1.820** |
| CCRs | 13.750 | 1.026 | 100% | |
| CCRm | 14.334 | 1.026 | 98.0% | |
| CCRb | 3.000 | - | 75.0% | |
| **CCR FCW** | | | **84.9%** | **1.274** |
| CCRs | 11.950 | 1.016 | 82.8% | |
| CCRm | 10.500 | 1.016 | 97.0% | |
| CCRb | 3.000 | - | 75.0% | |
| **CCFtap** | **5.000** | | **55.6%** | **1.112** |
| **HMI** | **1.000** | | **50%** | **0.250** |
| **TOTAL** | **4.456** | | | |

## 5.4 Visualisation

The AEB Car-to-Car scores are presented separately using a coloured top view of the scenario for the different overlap situations (where applicable); left overlap, full overlap and right overlap. The colours used are based on the overlap scores respectively, rounded to three decimal places.

| **Colour** | **Verdict** | **Applied to Total Score** | **For sub Scores** |
|---|---|---|---|
| Green | 'Good' | 4.501 - 6.000 points | 75.0% - 100.0% |
| Yellow | 'Adequate' | 3.001 - 4.500 points | 50.0% - 75.0% |
| Orange | 'Marginal' | 1.501 - 3.000 points | 25.0% - 50.0% |
| Brown | 'Weak' | 0.001 - 1.500 points | 00.0% - 25.0% |
| Red | 'Poor' | 0.000 points | 00.0 |

# 6 ASSESSMENT OF LANE SUPPORT SYSTEMS

## 6.1 Introduction

Lane support systems are becoming increasingly widespread and Euro NCAP has acknowledged their safety potential via the Euro NCAP Advanced award process. From 2014, these systems are included in the Safety Assist score.
Euro NCAP has developed tests which complement any legislative requirements, to be able to rate lane support systems in more detail.

## 6.2 Definitions

**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 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.

**Vehicle under test (VUT)** – means the vehicle tested according to this protocol with a Lane Keep Assist and/or Lane Departure Warning system.

**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.

**Lane Edge** – means the inner side of the lane marking or the road edge

**Distance To Lane Edge (DTLE) –** means the remaining lateral distance (perpendicular to the Lane Edge) between the Lane Edge and most outer edge of the tyre, before the VUT crosses Lane Edge, assuming that the VUT would continue to travel with the same lateral velocity towards it.

## 6.3 Criteria and Scoring

To be eligible for scoring points in Lane Support Systems, the vehicle must be equipped with an ESC system that complies with UNECE Regulation 13H.

For any system, the driver must be able to override the intervention by the system.

### 6.3.1 Human Machine Interface (HMI)

A maximum of 0.50 HMI points can be achieved for one of the following:

**Lane Departure Warning** 0.50 points
Any LDW system that issues a haptic warning before a DTLE of -0.2m is awarded when active at lateral velocities of at least 0.7m/s

**Blind Spot Monitoring** 0.50 points
The vehicle is additionally equipped with a Blind Spot Monitoring system on both sides of the vehicle to warn the driver of other vehicles present in the blind spot

### 6.3.2 Lane Keep Assist (LKA)

For LKA system tests, the assessment criteria used is the Distance to Lane Edge (DTLE).

The limit value for DTLE for LKA tests is set to -0.3m for testing against lines, meaning that the LKA system must not permit the VUT to cross the inner edge of the lane marking by a distance greater than 0.3m.

The available points per test are awarded based on a pass/fail basis where all tests within the scenario and road marking combination need to be a pass. The points available for the different LKA scenario and road marking combinations are detailed in the table below:

| LKA Scenario | Road Marking | Points |
|---|---|---|
| Dashed Line | Single lane marking | 0.25 |
| Solid Line | Single lane marking | 0.25 |
| **TOTAL** | | **0.50** |

### 6.3.3 Emergency Lane Keeping (ELK)

From 2020 onwards, to be eligible for scoring points in ELK, the ELK part of the LSS system needs to be default ON at the start of every journey and deactivation of the system should not be possible with a momentary single push on a button.

For ELK Road Edge and Solid line tests, the assessment criteria used is the Distance to Lane Edge (DTLE).

The limit value for DTLE for ELK Road Edge tests is set to -0.1m, meaning that the vehicle is only allowed to have a part of the front wheel outside of the road edge.

The limit value for DTLE for ELK Solid line tests is set to -0.3m for testing against lines, meaning that the ELK system must not permit the VUT to cross the inner edge of the lane marking by a distance greater than 0.3m.

For ELK tests with oncoming and overtaking vehicles, the assessment criteria used is no impact, meaning that the VUT is not allowed to contact the overtaking or oncoming vehicle target at any time during the test.

The available points per test are awarded based on a pass/fail basis where all tests within the scenario and road marking combination need to be a pass. The points available for the different ELK scenario and road marking combinations are detailed in the table below:

| ELK Scenario | Road Marking | Points |
|---|---|---|
| Road Edge | Road Edge only | 0.25 |
| | Dashed centreline & no line next to Road Edge | 0.25 |
| | Dashed centreline & dashed line next to Road Edge | 0.25 |
| | Dashed centreline & solid line next to Road Edge | 0.25 |
| Solid Line | Single lane marking | 0.50 |
| Oncoming Vehicle | Fully marked lanes | 1.00 |
| Overtaking Vehicle | Fully marked lanes | 0.50 |
| **TOTAL** | | **3.00** |

### 6.3.4 Total LSS Score

The total score in points is the sum of the HMI score, LKA score and ELK score.

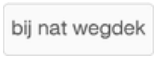
| LSS Function | | Points |
|---|---|---|
| HMI | Section 6.3.1 | 0.50 |
| LKA | Section 6.3.2 | 0.50 |
| ELK | Section 6.3.3 | 3.00 |
| **TOTAL** | | **4.00** |

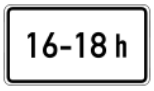
## 6.4 Visualisation

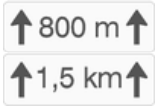
The LSS scores are presented separately using a colour for the different LSS functions; HMI, LKA and ELK. The colours used are based on the function scores respectively, rounded to three decimal places.

| Colour | Verdict | Applied to Total Score | For sub Scores |
|---|---|---|---|
| Green | 'Good' | 3.001 - 4.000 points | 75.0% - 100.0% |
| Yellow | 'Adequate' | 2.001 - 3.000 points | 50.0% - 75.0% |
| Orange | 'Marginal' | 1.001 - 2.000 points | 25.0% - 50.0% |
| Brown | 'Weak' | 0.001 - 1.000 points | 00.0% - 25.0% |
| Red | 'Poor' | 0.000 points | 00.0% |

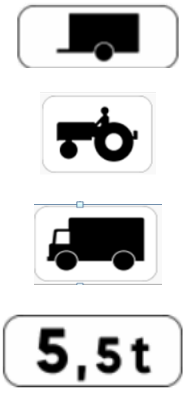
**APPENDIX I SPEED ASSIST SYSTEMS: CONDITIONAL AND IMPLICIT SPEED LIMIT SIGNS**

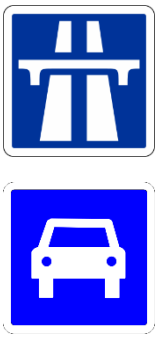
| Weather Condition | | | | | |
|---|---|---|---|---|---|
| | **France** | **Germany** | **Netherlands** | **Sweden** | **United Kingdom** |
| **RAIN AND/OR WETNESS** | |  |  | | |
| **SNOW AND/OR ICE** | |  | | | |

| Time Condition | | | | | |
|---|---|---|---|---|---|
| | **France** | **Germany** | **Netherlands** | **Sweden** | **United Kingdom** |
| **TIME** | |  |  | | |

| Distance Conditions | | | | | |
|---|---|---|---|---|---|
| | **France** | **Germany** | **Netherlands** | **Sweden** | **United Kingdom** |
| **DISTANCE FOR** | |  |  | | |
| **DISTANCE IN** | | |  |  | |

| Arrows | | | | | |
|---|---|---|---|---|---|
| | **France** | **Germany** | **Netherlands** | **Sweden** | **United Kingdom** |
| **ARROWS** | | | | | |

| Other vehicle/weight categories | | | | | |
|---|---|---|---|---|---|
| | France | Germany | Netherlands | Sweden | United Kingdom |
| VEHICLE AND/OR WEIGHT |  |  |  |  | |

| Implicit Speedlimits | | | | | |
|---|---|---|---|---|---|
| | France | Germany | Netherlands | Sweden | United Kingdom |
| HIGHWAY AND/OR MOTORWAY |  |  |  |  |  |
| CITY ENTRY AND/OR CITY EXIT |  |  |  |  | |
| RESIDENTIAL ZONES |  |  |  |  |  |