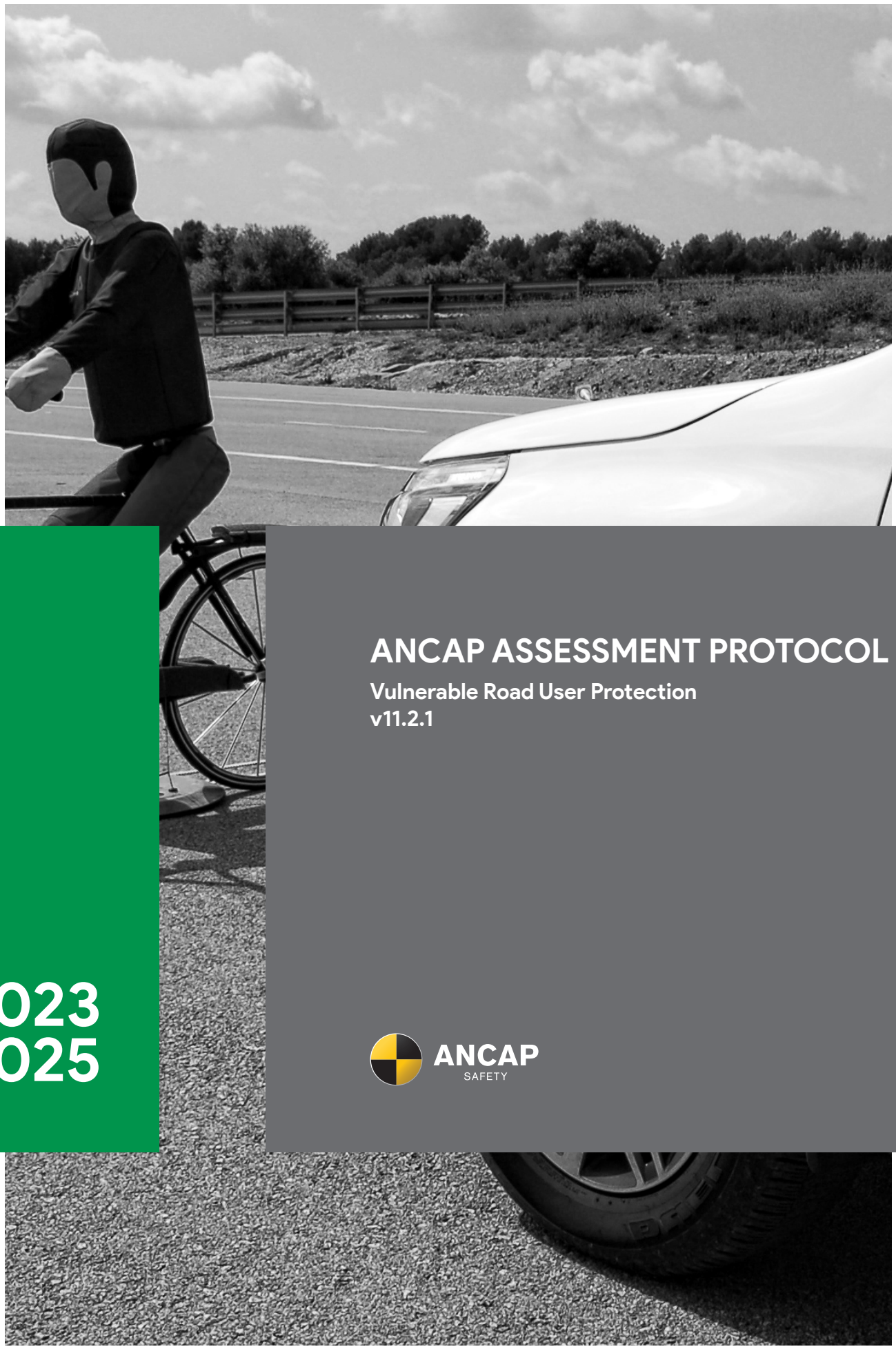

ANCAP ASSESSMENT PROTOCOL

Vulnerable Road User Protection
v11.2.1

2023
2025

ANCAP
SAFETY

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PREFACE

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

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

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

VERSION

VERSION	PUBLISHED	DETAILS
9.0	July 2017	First ANCAP version of protocol
9.0.2	November 2017	Changes to AEB Criteria and Scoring (s1.3) and Visualisation (s1.4.3)
9.0.3	February 2019	Amendment to section 2.1 (application of correction factor)
10.0.1	April 2019	New version of protocol for 2020 application
10.0.2	July 2019	Clarified definition CPRA-s
10.0.3	July 2020	Amendment to s1.4 Part II (AEB-VRU score pre-condition)
11.0	July 2021	New version of protocol for 2023 application Including implementation of aPLI impactor (s1.3.2.4), Cyclist headform testing locations (s1.3.1.1), AEB/LSS for Powered Two Wheelers (s1.3.4) and additional AEB VRU Scenarios (s1.3.2 and 1.3.3)
11.1	March 2022	Ameded definitions (s2.2.1) and added Test Scenario descriptions (s2.2.2) Clarified s2.3 (override action), 2.3.1 (Assessment criteria)
11.2	August 2022	S2.3.1.3 – added pass/fail detail for CBFA scenario. S2.3.1.5 – clarified warning requirement S2.3.1.6 – clarified scoring for CMoncoming and CMovertaking S2.3.3 – Scoring examples for CBDA
11.2.1	January 2023	Clarified assessment criteria (s2.3.1.3) Revised diagrams for CBDA (s2.3.3)

DISCLAIMER

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

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AUSTRALASIAN NEW CAR ASSESSMENT PROGRAM (ANCAP)

ASSESSMENT PROTOCOL – VULNERABLE ROAD USER (VRU) PROTECTION

Table of Contents

INTRODUCTION 1

METHOD OF ASSESSMENT 2

Points Calculation 2

PART I 3

PEDESTRIAN & CYCLIST IMPACT ASSESSMENT 3

1 PEDESTRIAN & CYCLIST IMPACT ASSESSMENT 4

1.1 Criteria and Limit Values 4

1.2 Modifiers 5

1.3 Scoring & Visualisation 5

PART II 11

VULNERABLE ROAD USER (VRU) AEB & LSS ASSESSMENT 11

1 ASSESSMENT OF AEB & LSS VULNERABLE ROAD USER SYSTEMS 12

1.1 Introduction 12

1.2 Definitions 12

1.3 Criteria and Scoring 15

1.4 Visualisation 24

INTRODUCTION

The following protocol deals with the assessments made in the area of vulnerable road user protection (VRU), in particular in the impact zones for the headform, upper legform, aPLI and AEB/LSS VRU.

METHOD OF ASSESSMENT

The assessment of VRU protection is combination of impact tests and AEB/LSS tests.

For the impact tests, consisting of headform, upper legform, aPLI impacts, a grid will be marked on the outer surface of the vehicle for all of the impact zones. ANCAP will test a number of grid points and manufacturers may nominate an additional number of tests to be performed, which will also be included in the assessment.

The vehicle manufacturer is required to provide the ANCAP Secretariat with data detailing the protection offered by the vehicle at all grid locations. The data shall be provided to the ANCAP Secretariat before any test preparation begins. The predicted level of protection offered by the vehicle is verified by ANCAP by means of testing of a sample of randomly selected grid-points, the overall prediction is then corrected accordingly.

For AEB/LSS testing, the vehicle manufacturer is also required to provide the ANCAP Secretariat with data detailing the expected performance of the AEB/LSS VRU system for all test scenarios. The expected performance will be used to as a reference to identify discrepancies between the expected results and the test results.

Points Calculation

For the legform impact areas, a sliding scale system of points scoring has been used to calculate points based on each measured criterion. This involves two limits for each parameter, a more demanding limit (higher performance), below which a maximum score is obtained and a less demanding limit (lower performance), beyond which no points are scored. Where a value falls between the two limits, the score is calculated by linear interpolation. No capping is applied to any of the measurements.

For the headform impact area, the protection predicted by the vehicle manufacturer will be compared to the outcome of the randomly selected test locations. The results at those test locations will be used to generate a correction factor, which will then be applied to the predicted score. Only data that results in a correction factor of between 0.850 and 1.150 are accepted. Where this is not the case, the cause will be investigated and the Secretariat will subsequently decide how to proceed. Where the data are accepted, the headform score will be based on the predicted data score with correction applied.

For most AEB scenarios, a stepped sliding scale using colour bands based on the speed reduction is applied. Other AEB and LSS scenarios are assessed as pass/fail only.

PART I

PEDESTRIAN & CYCLIST IMPACT ASSESSMENT

1. PEDESTRIAN & CYCLIST IMPACT ASSESSMENT

1.1 Criteria and Limit Values

The assessment criteria used for the pedestrian and cyclist impact tests are summarised below along with the upper and lower performance limits for each parameter. Where multiple criteria exist for an individual test, the lowest scoring parameter is used to determine the performance of that test, unless indicated otherwise.

1.1.1 **Headform**

The manufacturer must provide predicted data for all grid points. This data shall be expressed as a colour according to the corresponding colour boundaries for the predicted HIC_{15} performance below. Alternatively, HIC_{15} values may be provided.

Green		$HIC_{15} < 650$
Yellow	$650 \leq$	$HIC_{15} < 1000$
Orange	$1000 \leq$	$HIC_{15} < 1350$
Brown	$1350 \leq$	$HIC_{15} < 1700$
Red	$1700 \leq$	HIC_{15}

The manufacturer is allowed to colour a limited number of grid points blue where the performance is unpredictable. These grid points will always be tested. The procedure is detailed in the Pedestrian Protection Test protocol.

1.1.2 **Upper Legform**

Higher performance limit

Sum of forces	5.0kN

Lower performance limit

Sum of forces	6.0kN

1.1.3 **aPLI**

Higher performance limit

Femur Bending Moment	390Nm
Tibia Bending Moment	275Nm
MCL Elongation	27mm

Lower performance limit

Femur Bending Moment	440Nm
Tibia Bending Moment	320Nm
MCL Elongation	32mm

1.2 Modifiers

There are no modifiers applied.

1.3 Scoring & Visualisation

1.3.1 Scoring

A maximum of 18 points are available for the headform test zone (cyclist, adult and child/small adult). The total score for all grid points is calculated as a percentage of the maximum achievable score, which is then multiplied by 18 points. The pelvis and femur will both be awarded a maximum of 4.5 points and the knee/tibia will be awarded a maximum of 9 points. A total of 36 points are available in the passive VRU protection assessment.

1.3.1.1 Headform

Each of the grid points can be awarded up to one point, resulting in a maximum total amount of points equal to the number of grid points. For each predicted colour the following points are awarded to the grid point:

	$HIC_{15} < 650$	*1.00 point*
$650 \leq$	$HIC_{15} < 1000$	*0.75 points*
$1000 \leq$	$HIC_{15} < 1350$	*0.50 points*
$1350 \leq$	$HIC_{15} < 1700$	*0.25 points*
$1700 \leq$	HIC_{15}	*0.00 points*

1.3.2 Headform Correction factor

The data provided by the manufacturer is scaled using a correction factor, which is calculated based on any differences between predicted data and the verification tests performed. The verification points are randomly selected and distributed in line with the predicted colour distribution.

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 multiplied by the predicted score of all the grid points (excluding defaulted and blue points). The final score for the vehicle can never exceed 100% regardless of the correction factor.

1.3.2.1 HIC tolerance

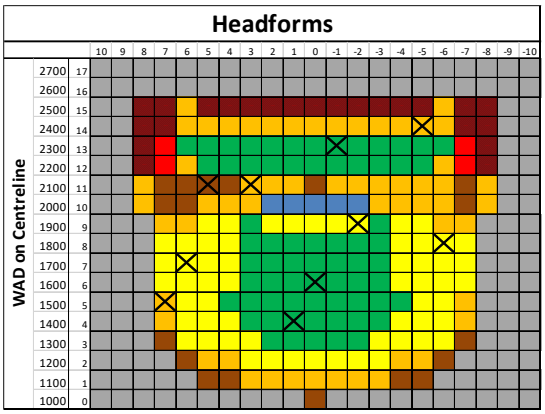
As test results can be variable between labs and in-house tests and/or simulations, a 10% tolerance to the HIC value of the verification test is applied. The tolerance is applied in both directions, meaning that when a tested point scores better than predicted, but within tolerance, the predicted result 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 HIC value with the colour band in section 1.3.1.1 without applying a tolerance to the HIC value.

Prediction	***HIC_{15} range***	***Accepted HIC_{15} range***
Green	*HIC_{15} < 650*	*HIC_{15} < 722.22*
Yellow	*650 ≤ HIC_{15} < 1000*	*590.91 ≤ HIC_{15} < 1111.11*
Orange	*1000 ≤ HIC_{15} < 1350*	*909.09 ≤ HIC_{15} < 1500.00*
Brown	*1350 ≤ HIC_{15} < 1700*	*1227.27 ≤ HIC_{15} < 1888.89*
Red	*1700 ≤ HIC_{15}*	*1545.45 ≤ HIC_{15}*

1.3.2.2 Example:

Headform testing:

Manufacturer X has provided the following prediction to ANCAP with a total score of 144 points (excluding blue) out of the possible 232 points:



The prediction consists of the following:

68 Green	*x 1.00 =*	*68.00*
58 Yellow	*x 0.75 =*	*43.50*
56 Orange	*x 0.50 =*	*28.00*
18 Brown	*x 0.25 =*	*4.50*
4 Red	*x 0.00 =*	*0.00*
23 Default Red	*x 0.00 =*	*0.00*
5 Blue		
232 grid points		***144.00 points***

10 verification points were chosen for testing:

VERIFICATION								
Testpoint	Prediction	Value	Points		Testpoint	Prediction	Value	Points
11,+3		1558.20	0.250					
8,-6		705.40	0.750					
7,+6		921.70	0.750					
13,-1		800.50	0.750					
6,0		350.10	1.000					
5,+7		1010.50	0.500					
4,+1		550.80	1.000					
14,-5		958.20	0.500					
9,-2		805.70	0.750					
11,+5		1432.30	0.250					
Total	7.000		6.500		**Total**	0.000		0.000

Correction factor	0.929

$$Correction\ Factor = \frac{Actual\ tested\ score}{Predicted\ score} = \frac{6.50}{7.00} = 0.929$$

3 Blue zones were tested containing 5 blue points:

BLUE POINTS								
Zone	GRID-point	Value	Points		Zone	GRID-point	Value	Points
1	10,2	998.5	0.75		5			
	10,1		0.75					
2	10,0	1650.2	0.25		6			
	10,-1		0.25					
3	10,-2	1399.6	0.25		7			
4					8			
Total blue points							2.250	

The final score will be:

204 Predicted	*144.00 x 0.929 = 133.776*
23 Default Red	*0.000*
5 Blue	*2.250*
232 grid points	***136.026 points***

The score in terms of percentage of the maximum achievable score is 136.026/232 = 58.632%

The final headform score out of a maximum of 18 points is 58.632% x 18 = **10.554 points**

1.3.2.3 **Upper Legform - Pelvis**

Each of the grid points can be awarded up to one point resulting in a maximum total of points equal to the number of grid points. A linear sliding scale is applied between the relevant limits of each parameter. The upper legform performance for each grid point is based upon the worst performing parameter.

The total score for the upper legform area will be calculated out of 4.5 points by scaling the sum of grid points score by the relevant number of grid points.

Example:

For a vehicle that has 9 grid points and tests are performed to points U0, U-2 & U-4 with the following results:

Test result U0	**Score**	**Total**
Femur sum of forces = 5.26kN	0.740	**0.740**
Test result U-2	**Score**	**Total**
Femur sum of forces = 6.80kN	0.000	**0.000**
Test result U-4	**Score**	**Total**
Femur sum of forces = 4.89kN	1.000	**1.000**

Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Given that U-1 and U-3 have not been tested, both will be awarded the result from the adjacent point U-2. Symmetry will also be applied to all grid points on the opposite side of the vehicle (U+1 to U+4).

U+4	U+3	U+2	U+1	U0	U-1	U-2	U-3	U-4
1.000	0.0	0.0	0.0	0.740	0.0	0.0	0.0	1.000

The score for each individual grid point is then summed, this produces a score in terms of the maximum achievable percentage of 2.740/9 = 30.444%

The final upper legform score is 30.444% x 4.5 = **1.370 points**

1.3.2.4 **aPLI**

Each of the grid points can be awarded up to one point resulting in a maximum total of points equal to the number of grid points. A linear sliding scale is applied between the relevant limits of the three parameters. The femur performance for each grid point is based upon the worst performing femur bending moment. The knee and tibia performance is based upon the lowest of the two individual assessment parameters (MCL and maximum tibia bending moment).

The total score for the femur will be calculated out of 4.5 and for the knee/tibia it will be out of 9 points. The sum of grid points scores will then be scaled down by the relevant number of grid points for each of those two regions.

Example:

For a vehicle that has 11 bumper test zone grid points and tests are performed to points L1, L+3 & L+5 with the following results:

Femur

Test result L+1		**Score**	**Total**
Max Femur Bending Moment = 400Nm		0.800	**0.800**
Test result L+3		**Score**	**Total**
Max Femur Bending Moment = 438Nm		0.040	**0.040**
Test result L+5		**Score**	**Total**
Max Femur Bending Moment = 385Nm		1.000	**1.000**
Knee & Tibia			
Test result L+1		**Score**	**Total**
Tibia Bending Moment	= 257Nm	1.000	1.000
MCL Elongation	= 20mm	1.000	
Test result L+3		**Score**	**Total**
Tibia Bending Moment	= 300Nm	0.444	0.444
MCL Elongation	= 29mm	0.600	
Test result L+5		**Score**	**Total**
Tibia Bending Moment	= 225Nm	1.000	
MCL Elongation	= 36mm	0.000	0.000

Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Given that L0, L+2 & L+4 have not been tested, L0 will be awarded the score from L+1, L+2 will be awarded the score from L+3 and L+4 will be awarded the score from L+5. Symmetry will also be applied to the other side of the vehicle.

Femur

L+5	L+4	L+3	L+2	L+1	L0	L-1	L-2	L-3	L-4	L-5
1.000	0.040	0.040	0.040	0.800	0.800	0.800	0.040	0.040	0.040	1.000

The score for each individual grid point is then summed, this produces a score in terms of the maximum achievable percentage of 4.640/11 = 42.182%

The final Femur score is 42.182% x 4.5 = **1.898 points**

Knee/tibia

L+5	L+4	L+3	L+2	L+1	L0	L-1	L-2	L-3	L-4	L-5
0.000	0.000	0.444	0.444	1.000	1.000	1.000	0.444	0.444	0.000	0.000

The score for each individual grid point is then summed, this produces a score in terms of the maximum achievable percentage of 4.776/11 = 43.418%

The final knee/tibia score is 43.418% x 9 = **3.908 points**

1.3.3 Visualisation of results

1.3.3.1 Headform results

The protection provided by each grid location is illustrated by a coloured area, on an outline of the front of the car. Where no grid is used in the assessment and the fallback scenario is adopted, the same 5 colour boundaries and HIC650 – HIC 1700 values will be applied. The headform performance boundaries are detailed below.

Green		$HIC_{15} < 650$
Yellow	$650 \leq$	$HIC_{15} < 1000$
Orange	$1000 \leq$	$HIC_{15} < 1350$
Brown	$1350 \leq$	$HIC_{15} < 1700$
Red	$1700 \leq$	HIC_{15}

1.3.3.2 aPLI & upper legform results

The protection provided by each grid location is illustrated by a coloured point on an outline of the front of the car. The colour used is based on the points awarded for that test site (rounded to three decimal places), as follows:

Green	grid point score = 1.000
Yellow	0.750 <= grid point score < 1.000
Orange	0.500 <= grid point score < 0.750
Brown	0.001 <= grid point score < 0.500
Red	0.000 <= grid point score

PART II

VULNERABLE ROAD USER (VRU) AEB & LSS ASSESSMENT

2. ASSESSMENT OF AEB & LSS VULNERABLE ROAD USER SYSTEMS

2.1 Introduction

AEB & LSS Vulnerable Road User (VRU) systems are systems that are designed to brake or steer autonomously for vulnerable road user's like: pedestrians, cyclists and/or powered two wheelers. For the assessment of AEB & LSS VRU systems, three areas of assessment are considered; AEB Pedestrian, AEB Bicyclist and AEB & LSS Powered Two Wheelers, which are assessed in different scenarios.

2.2 Definitions

2.2.1 General

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 to the detection of a likely collision to alert the driver.

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

Vehicle width – the widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.

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

Euro NCAP Pedestrian Target (EPTa) – means the adult pedestrian target used in this protocol as specified in the ISO 19206-2:2018

Euro NCAP Child Target (EPTc) – means the child 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 the 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.

Time To Collision (TTC) – means the remaining time before the VUT strikes the test target, assuming that the VUT and EPT would continue to travel with the speed it is travelling.

T_{AEB} – means the time where the AEB system activates. Activation time is determined

by identifying the last data point where the filtered acceleration signal is below -1 m/s^2, and then going back to the point in time where the acceleration first crossed -0.3 m/s^2

T_{FCW} – means the time where the audible warning of the FCW starts. The starting point is determined by audible recognition.

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 line marking, the edge of the road or into oncoming or overtaking traffic in the adjacent lane.

Vimpact – means the speed at which the profiled line around the front or rear end of the VUT coincides with the virtual box around the EPTa, EPTc, EBTa and EMT.

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

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

2.2.2 Test Scenarios

Car-to-Bicyclist Dooring Adult (CBDA) – a collision between the vehicle's door and a bicyclist traveling alongside the parked vehicle.

Car-to-Pedestrian Farside Adult 50% (CPFA-50) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path running from the farside and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Nearside Adult 25% (CPNA-25) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 25% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Adult 75% (CPNA-75) – a collision in which a vehicle travels forwards towards an adult pedestrian crossing its path walking from the nearside and the frontal structure of the vehicle strikes the pedestrian at 75% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Nearside Child Obstructed 50% (CPNCO-50) – a collision in which a vehicle travels forwards towards a child pedestrian crossing its path running from behind and obstruction from the nearside and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Longitudinal Adult 25% (CPLA-25) – 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 25% of the vehicle's width when no braking action is applied, or an evasive steering action is initiated after an FCW.

Car-to-Pedestrian Longitudinal Adult 50% (CPLA-50) – 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 50% of the vehicle's width when no braking action is applied.

Car-to-Pedestrian Turning Adult 50% (CPTA-50) – a collision in which a vehicle turns towards an adult pedestrian crossing its path, walking across a junction (in either the same and opposite direction as the VUT, before the VUT made the turn) and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

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

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

Car-to-Bicyclist Nearside Adult 50% (CBNA-50) – a collision in which a vehicle travels forwards towards a bicyclist crossing its path cycling from the nearside and the frontal structure of the vehicle strikes the bicyclist when no braking action is applied.

Car-to-Bicyclist Nearside Adult Obstructed 50% (CBNAO-50) – a collision in which a vehicle travels forwards towards a bicyclist crossing its path cycling from the nearside from behind an obstruction and the frontal structure of the vehicle strikes the bicyclist at 50% of the vehicle's width when no braking action is applied.

Car-to-Bicyclist Farside Adult 50% (CBFA-50) – a collision in which a vehicle travels forwards towards a bicyclist crossing its path cycling from the farside and the frontal structure of the vehicle strikes the bicyclist at 50% of the vehicle's width when no braking action is applied.

Car-to-Bicyclist Longitudinal Adult 25% (CBLA-25) – 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 25% of the vehicle's width when no braking action is applied or an evasive steering action is initiated after an FCW.

Car-to-Bicyclist Longitudinal Adult 50% (CBLA-50) – 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 50% of the vehicle's width when no braking action is applied.

Car-to-Bicyclist Turning Adult 50% (CBTA-50) – a collision in which a vehicle turns towards a bicyclist crossing its path, walking across a junction (in either the same and opposite direction as the VUT, before the VUT made the turn) and the frontal structure of the vehicle strikes the pedestrian at 50% of the vehicle's width when no braking action is applied.

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

Car-to-Motorcyclist Oncoming (CMoncoming) – a collision in which a vehicle drifts out of lane and into the path of a motorcyclist travelling in the opposite direction in the adjacent lane.

Car-to-Motorcyclist Overtaking (CMovertaking) – a collision in which a vehicle drifts out of lane and into the path of a motorcyclist travelling in the same direction in the adjacent lane.

2.3 Criteria and Scoring

To be eligible for scoring points in AEB and/or LSS VRU:

- The vehicles must score 18 or more points in the subsystem tests, i.e. the sum of Headform, Upper Legform & Lower Legform scores.

- The system under test must be default ON at the start of every journey. It may not be possible to switch off the system with a momentary single push on a button.

- For AEB Pedestrian, must operate (i.e. warn or brake) from speeds of 10 km/h in the CPNA-75 scenario in both day and night. In addition, the system must be able to detect pedestrians walking as slow as 3 km/h and reduce speed in the CPNA-75 scenario at 20 km/h, also for both day and night.

- The AEB systems may also not automatically switch off at a speed below 80 km/h.

- Additionally, for CPRA/CPRC the system may not release the brakes after an intervention, unless the threat (EPT) has left the vehicle path or in case of an override action by the driver.

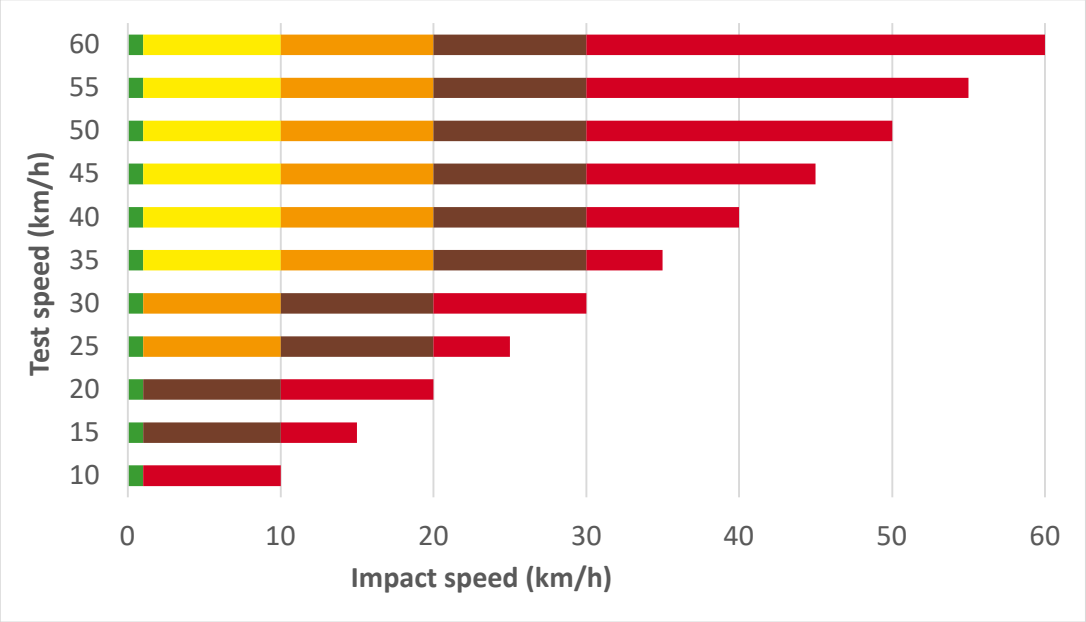
  When the VUT is fitted as standard with a rear-view camera, the brakes may be release after 1.5s or longer after the AEB intervention.

2.3.1 Assessment Criteria

2.3.1.1 For the following test scenarios, the assessment criteria used is V_{impact}.

- CPFA-50, CPNA-25, CPNA-75, CPNCO-50,
- CBNA-50, CBNAO-50, CBFA-50,
- CMRs (AEB and FCW), CMRb (AEB and FCW)

The impact speed is then given a colour based on the test speed as defined in the graph below:



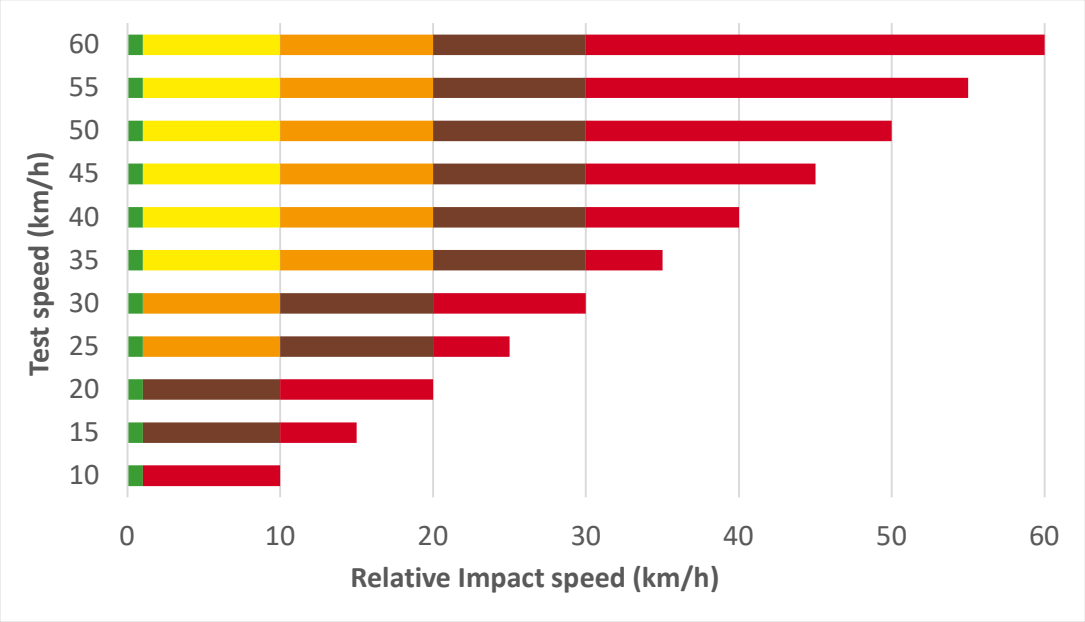
To aid understanding, the following table illustrates the speed range for each colour at a test speed of 60km/h.

Colour	Impact speed range (km/h)
Green	$v_{impact} = 0$
Yellow	$0 < v_{impact} < 10$
Orange	$10 \leq v_{impact} < 20$
Brown	$20 \leq v_{impact} < 30$
Red	$30 \leq v_{impact}$

2.3.1.2 For the following test scenarios, the assessment criteria used is V_{rel_impact}:

- CPLA-50
- CBLA-50

The relative impact speed is then given a colour based on the relative test speed as defined in the graph below:



2.3.1.3 In any scenario the VUT may enter the path of the target after the target has completely passed the path of the VUT.

For CPTA the VUT may enter the path of the EPT, as long as the VUT velocity = 0 before impact with the EPT.

2.3.1.4 For the CPLA-25 and CBLA-25 test scenarios, the assessment criteria used is the Time-To-Collision (TTC). The available points per test speed are awarded when the warning is issued at a TTC ≥ 1.70s.

Alternatively, when the FCW issued at a TTC < 1.70s in the CPLA-25 and CBLA-25 scenarios, the manufacturer has the option to demonstrate to ANCAP that their ESS system will provide the appropriate support to avoid the collision by steering to have the available points awarded.

2.3.1.5 For CBDA the assessment criteria used is the Time-to-Collison. The available points per test are awarded when:

- Visual information is provided at a TTC ≥2.3s
- Visual and (audible or haptic) warning is issued at a TTC ≥1.7s
- A door retention system is activated at a TTC of 1.7s ≥ TTC ≥ -0.4s
- If the system issues effective warning (i.e. loud and clear) or retention functionality on all doors on the side where the threat is present

Furthermore, the visual information needs to be provided in the field of view of the front side window.

“All other side doors” points are awarded if the system issues effective warning or retention functionality on all doors on the side where the threat is present. If effectiveness is doubted, tests can be executed for the remaining doors with the performance criteria above applied. Reference point for all tests is the rear of the front door. Visual warning on the rear doors is not required.

An information only system cannot score for functionality on all doors.

It is permitted to combine retention on driver door with warning on all other side doors.
For doors that cannot endanger VRUs passing by the VUT (e.g. sliding doors that open to a small extend), 0.500 will be awarded for a 'Visual warning (e.g. flashing) accompanied with an audible or haptic warning'. This warning can be suppressed 10 seconds after $T_{door\ operation}$.

2.3.1.6 For CMoncoming and CMovertaking, the assessment criteria used is no impact, meaning that the VUT is not allowed to contact the overtaking or oncoming motorcycle target at any time during the test.

The available points per scenario are awarded based on a pass/fail basis.

If LKA dashed line is implemented as an ELK functionality (default-on) and the LKA dashed line tests fulfils all LKA dashed lane criteria, the points for CMoncoming shall be awarded automatically. If LKA dashed line is implemented as an ELK functionality (default-on) and the LKA dashed line tests fulfils all LKA dashed lane criteria, the points for unintentional CMOvertaking shall be awarded automatically for the corresponding speeds.

2.3.1.7 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 without applying a tolerance to the impact speed.

As an example, the accepted impact speed ranges for the 60km/h CMRs test:

Colour	Impact speed range (km/h)	Accepted Range (km/h)
Green	$v_{impact} = 0$	$v_{impact} < 2$
Yellow	$0 < v_{impact} < 10$	$0 < v_{impact} < 12$
Orange	$10 \leq v_{impact} < 20$	$8 \leq v_{impact} < 22$
Brown	$20 \leq v_{impact} < 30$	$18 \leq v_{impact} < 32$
Red	$30 \leq v_{impact}$	$30 \leq v_{impact}$

2.3.2 AEB Pedestrian

A maximum of 9 points is available for AEB Pedestrian, 6 points for daytime performance (all scenarios) and 3 points for performance at night conditions (CPFA, CPNA, CPNCO and CPLA).

For each scenario a normalised score is calculated and multiplied with the available points

for that specific scenario.

For each predicted colour the following scaling is applied to the colourband, which is then multiplied by the points available for the test speed:

Green	1.000
Yellow	0.750
Orange	0.500
Brown	0.250
Red	0.000

The following points are available for the different test speeds in each AEB Pedestrian scenario for both day and night conditions:

Test speed	Daytime												Nighttime					
	CPFA	CPNA		CPNC	CPLA		CPTA				CPRA/CPRC		CPFA	CPNA		CPNC	CPLA	
	50%	25%	75%	50%	50%	25%	Opposite direction		Same direction		Stationary	Moving	50%	25%	75%	50%	50%	25%
							Farside	Nearside	Farside	Nearside								
4 km/h											1.000	1.000						
8 km/h											1.000	1.000						
10 km/h	1.000	1.000	1.000	1.000			1.000	1.000	1.000	1.000			1.000	1.000	1.000	1.000		
15 km/h	1.000	1.000	1.000	1.000			1.000		1.000				1.000	1.000	1.000	1.000		
20 km/h	1.000	1.000	1.000	1.000	1.000		1.000		1.000				1.000	1.000	1.000	1.000	1.000	
25 km/h	1.000	1.000	1.000	1.000	1.000								1.000	1.000	1.000	1.000	1.000	
30 km/h	2.000	2.000	2.000	2.000	1.000								1.000	1.000	1.000	1.000	1.000	
35 km/h	3.000	3.000	3.000	3.000	2.000								2.000	2.000	2.000	2.000	2.000	
40 km/h	3.000	3.000	3.000	3.000	2.000								2.000	2.000	2.000	2.000	2.000	
45 km/h	3.000	3.000	3.000	3.000	3.000								3.000	3.000	3.000	3.000	3.000	
50 km/h	2.000	2.000	2.000	2.000	3.000	3.000							3.000	3.000	3.000	3.000	3.000	3.000
55 km/h	2.000	2.000	2.000	2.000	3.000	3.000							3.000	3.000	3.000	3.000	3.000	3.000
60 km/h	1.000	1.000	1.000	1.000	2.000	2.000							2.000	2.000	2.000	2.000	2.000	2.000
65 km/h						1.000												1.000
70 km/h						1.000												1.000
75 km/h						1.000												1.000
80 km/h						1.000												1.000
TOTAL	**20.000**	**40.000**		**20.000**	**30.000**		**8.000**				**4.000**		**20.000**	**40.000**		**20.000**	**30.000**	
Scenario points	**0.250**	**0.250**		**1.000**	**0.500**		**2.000**				**2.000**		**0.750**	**0.750**		**0.500**	**1.000**	
	6.000												**3.000**					

2.3.2.1 AEB Pedestrian Scoring Example

AEB Pedestrian	Daytime			Nighttime		
	Points	Percentage	Score	Points	Percentage	Score
CPFA	20.000	100.0%	0.250	16.000	80.0%	0.600
CPNA	39.120	97.8%	0.245	26.680	66.7%	0.500
CPNC	8.420	42.1%	0.421	2.500	12.5%	0.063
CPLA	25.824	80.7%	0.404	22.650	75.5%	0.755
CPTA	3.000	75.0%	1.500			
CPRA/CPRC	2.000	50.0%	1.000			
TOTAL	**3.819**			**1.918**		
	5.737					

2.3.3 AEB Bicyclist

A maximum of 9 points is available for AEB Bicyclist. For each scenario a normalised score is calculated and multiplied with the available points for that specific scenario.

For each predicted colour the following scaling is applied to the colourband, which is then

multiplied by the points available for the test speed:

Green	1.000
Yellow	0.750
Orange	0.500
Brown	0.250
Red	0.000

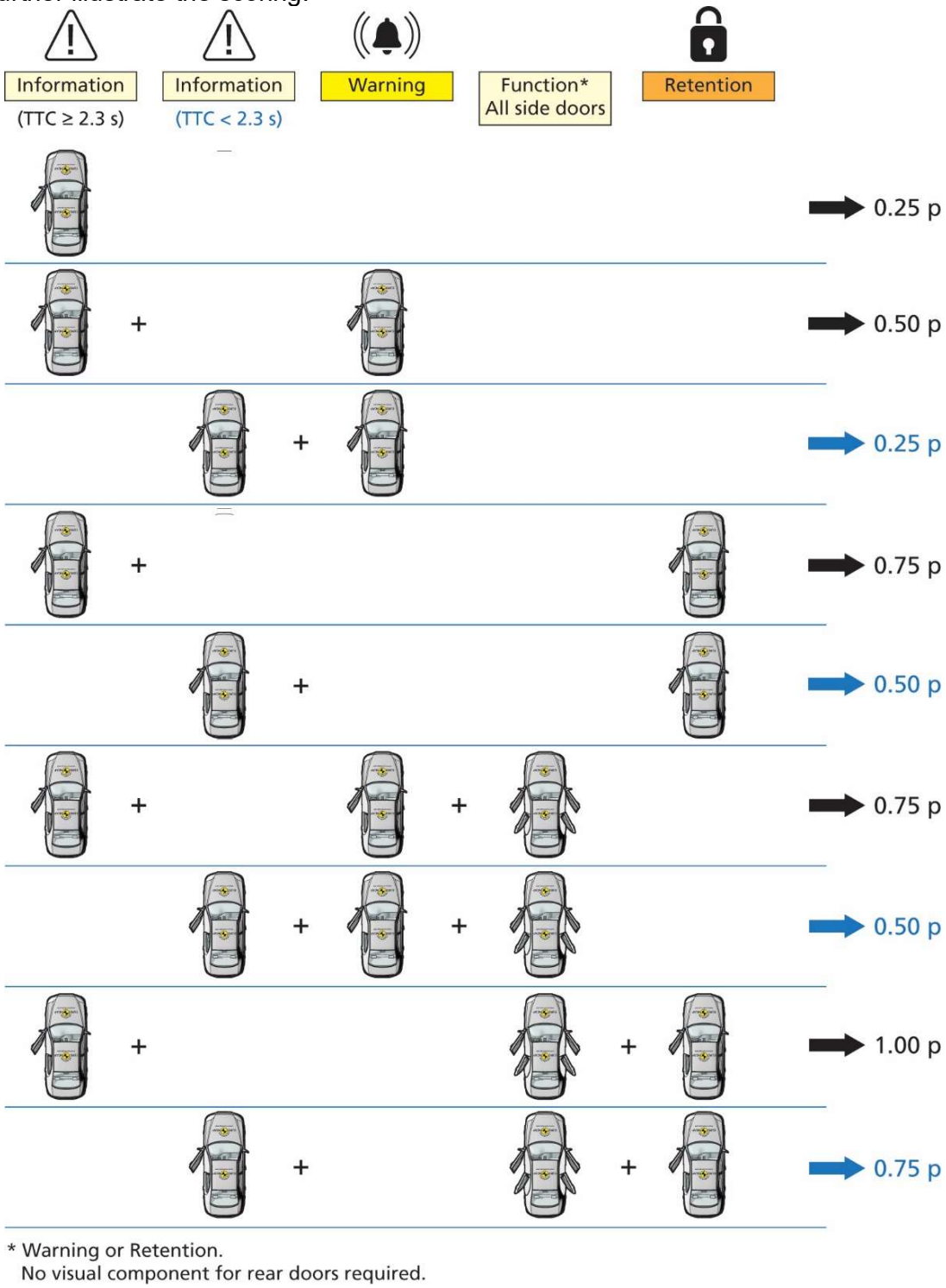
The following points are available for the different test speeds in each AEB Bicyclist scenario:

Test speed	Daytime							
	CBFA	CBNA	CBNAO	CBLA		CBTA		CBDA
	50%	50%	50%	50%	25%	Opposite direction		
						Farside	Nearside	Stationary
0 km/h								1.000
10 km/h	1.000	1.000	1.000			1.000	1.000	
15 km/h	1.000	1.000	1.000			1.000		
20 km/h	1.000	1.000	1.000			1.000		
25 km/h	1.000	1.000	1.000	1.000				
30 km/h	1.000	1.000	1.000	1.000				
35 km/h	1.000	1.000	1.000	2.000				
40 km/h	1.000	1.000	1.000	2.000				
45 km/h	1.000	1.000	1.000	3.000				
50 km/h	1.000	1.000	1.000	3.000	3.000			
55 km/h	1.000	1.000	1.000	3.000	3.000			
60 km/h	1.000	1.000	1.000	1.000	1.000			
65 km/h					1.000			
70 km/h					1.000			
75 km/h					1.000			
80 km/h					1.000			
TOTAL	**11.000**	**11.000**	**11.000**	**27.000**		**4.000**		**1.000**
Scenario points	**2.000**	**1.000**	**1.000**	**2.000**		**2.000**		**1.000**
	9.000							

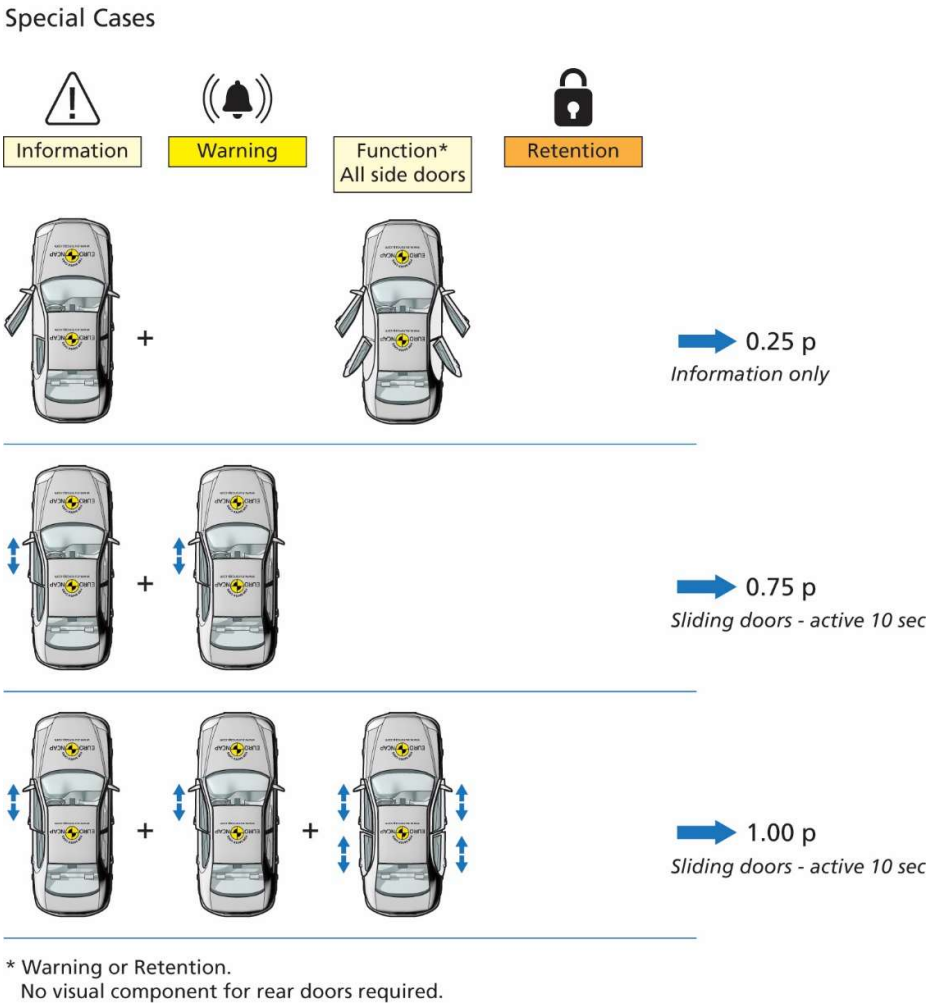
For CBDA, the following scoring is applied:

CBDA	Requirement	Criteria	Points	Score
Driver Door Information	Visual Information	TTC ≥2.3s	0.250	0.250
Driver Door Warning or Retention	Visual warning (e.g. flashing) accompanied by an audible or haptic warning	TTC ≥1.7s	0.250	0.500
	Door Retention	1.7s ≥ TTC ≥ -0.4s	0.500	
All other side doors			0.250	0.250
Total				1.000

To further illustrate the scoring:



* Warning or Retention.
No visual component for rear doors required.



2.3.3.1 AEB Bicyclist Scoring example

AEB Bicyclist	Daytime		
	Points	Percentage	Score
CBFA	6.567	59.7%	1.194
CBNA	11.000	100.0%	1.000
CBNAO	5.775	52.5%	0.525
CBLA	27.000	100.0%	2.000
CBTA	3.000	75.0%	1.500
CBDA	0.500	50.0%	0.500
TOTAL		**6.719**	

2.3.4 AEB/LSS Motorcyclist

A maximum of 9 points is available for AEB/LSS Motorcyclist. For each scenario a normalised score is calculated and multiplied with the available points for that specific scenario.

For each predicted colour the following scaling is applied to the colourband, which is then multiplied by the points available for the test speed:

Green	1.000
Yellow	0.750
Orange	0.500
Brown	0.250
Red	0.000

The following points are available for the different test speeds in each AEB/LSS Motorcyclist scenario:

Test speed	AEB						FCW			LSS				
	CMRs	CMRb		CMFtap			CMRs	CMRb		CMoncoming	CMovertaking			
											Unintentional		Intentional	
	50%	25% & 12m	25% & 40m	30 km/h	45 km/h	60 km/h	50%	25% & 12m	25% & 40m	72 km/h	60 km/h	80km/h	60km/h	80 km/h
10 km/h	1.000			1.000	1.000	1.000								
15 km/h	1.000			1.000	1.000	1.000								
20 km/h	1.000			1.000	1.000	1.000								
25 km/h	1.000													
30 km/h	1.000						1.000							
35 km/h	1.000						1.000							
40 km/h	1.000						1.000							
45 km/h	1.000						1.000							
50 km/h	1.000	1.000	1.000				1.000	1.000	1.000		0.500		0.500	
55 km/h	1.000						1.000							
60 km/h	1.000						1.000							
72 km/h										2.000		0.500		0.500
TOTAL	**11.000**	**2.000**		**9.000**			**7.000**	**2.000**		**2.000**	**2.000**			
Scenario points	**1.000**	**1.000**		**3.000**			**0.500**	**0.500**		**2.000**	**1.000**			
	9.000													

2.3.4.1 AEB/LSS Motorcyclist Scoring example

AEB Motorcyclist	Daytime		
	Points	Percentage	Score
CMRs AEB	8.000	72.7%	0.727
CMRb AEB	1.000	50.0%	0.500
CMFtap	9.000	77.8%	2.333
CMRs FCW	5.000	71.4%	0.357
CMRb FCW	2.000	100.0%	0.500
CMoncoming	2.000	100.0%	2.000
CMovertaking	0.000	0.0%	0.000
TOTAL	**6.417**		

2.4 Visualisation

The AEB/LSS VRU scores are presented separately using a coloured top view of the different scenarios; crossing and longitudinal (where applicable). The colours used are based on the scenario scores respectively, rounded to three decimal places.

Colour	Verdict	Applied to Total Score	Applied to Scenario
Green	*'Good'*	*6.751 -9.000 points*	*75.0% - 100.0%*
Yellow	*'Adequate'*	*4.501 -6.750 points*	*50.0% - 75.0%*
Orange	*'Marginal'*	*2.251 -4.500 points*	*25.0% - 50.0%*
Brown	*'Weak'*	*0.001 -2.250 points*	*00.0% - 25.0%*
Red	*'Poor'*	*0.000 points*	*00.0%*