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EUROPEAN NEW CAR ASSESSMENT PROGRAMME (Euro NCAP)

ASSESSMENT PROTOCOL – PEDESTRIAN PROTECTION

Version 6.0
February 2012

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1 INTRODUCTION

Important changes have been made to the Euro NCAP ratings resulting in the introduction of the overall rating scheme. Individual documents are released for the four main areas of assessment:

- Assessment Protocol – Adult Occupant Protection;
- Assessment Protocol – Child Occupant Protection;
- Assessment Protocol – Pedestrian Occupant Protection;
- Assessment Protocol – Safety Assist;

In addition to these four assessment protocols, a separate document is provided describing the method and criteria by which the overall safety rating is calculated on the basis of the car performance in each of the above areas of assessment.

The following protocol deals with the assessments made in the area of Pedestrian Protection, in particular in the adult and child head, the upper leg form and lower leg form impacts.

2 METHOD OF ASSESSMENT

The assessment of pedestrian protection is made with the use of headform, upper legform and legform data. In the legform areas, the bumper and front of the bonnet of the car are divided into zones which are assessed using the two legform impactors. Euro NCAP will select "worst case" test points and manufacturers may nominate additional tests to be performed and the results will be included in the assessment.

In the headform impact area, a grid will be marked on the outer surface of the vehicle. The vehicle manufacturer is required to provide the Euro NCAP Secretariat with data detailing the protection offered by the vehicle at all grid locations. The data shall be provided to the Euro NCAP Secretariat before any test preparation begins. The predicted level of protection offered by the vehicle is verified by Euro NCAP by means of testing of a sample of randomly selected grid-points and the overall prediction is corrected accordingly.

2.1 Points Calculation

For the legform impact areas, a sliding scale system of points scoring has been used to calculate points for 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. The maximum score for each test zone is two points (one point per half for bumper and bonnet leading ledge testing). 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 0.500 and 1.500 are accepted. Where this is not the case, the cause will be investigated and the Secretariat will subsequently take a decision as to how to proceed. Where the data are accepted, the headform score will be based on the predicted data score with correction applied.

3 PEDESTRIAN IMPACT ASSESSMENT

3.1 Criteria and Limit Values

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

3.1.1 Headform

The manufacturer must provide a 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.

3.1.2 Upper Legform

Higher performance limit

Bending Moment	300Nm*	(20% risk of femur/pelvis fracture)
Sum of forces	5.0kN*	(20% risk of femur/pelvis fracture)

*(*EEVC Limits)*

Lower performance limit

Bending Moment	380Nm	
Sum of forces	6.0kN	

3.1.3 Legform

Higher performance limit

Tibia deceleration	150g*	(20% risk of lower leg fracture) [3]
Knee shear displacement	6mm*	(risk for initial knee joint damage) [3]
Knee bending angle	15º *	(risk for initial knee joint damage) [3]
		*(*EEVC Limits)*

Lower performance limit

Tibia deceleration	200g	(40% risk of lower leg fracture) [3]
Knee shear displacement	7mm	
Knee bending angle	20º	

3.2 Modifiers

There are no modifiers applied.

3.3 Scoring & Visualisation

3.3.1 Scoring

A maximum of 24 points is available for the headform test zone. The total score for all grid points is calculated as a percentage of the maximum achievable score, which is then multiplied by 24 points. The bonnet leading edge and bumper test zone will be awarded a maximum of 6 points each. A total of 36 points are available in the pedestrian protection assessment.

3.3.1.1 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:

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

3.3.2 Headform Correction factor

The data provided by the manufacturer is scaled using a correction factor, 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.

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

3.3.2.1 HIC tolerance

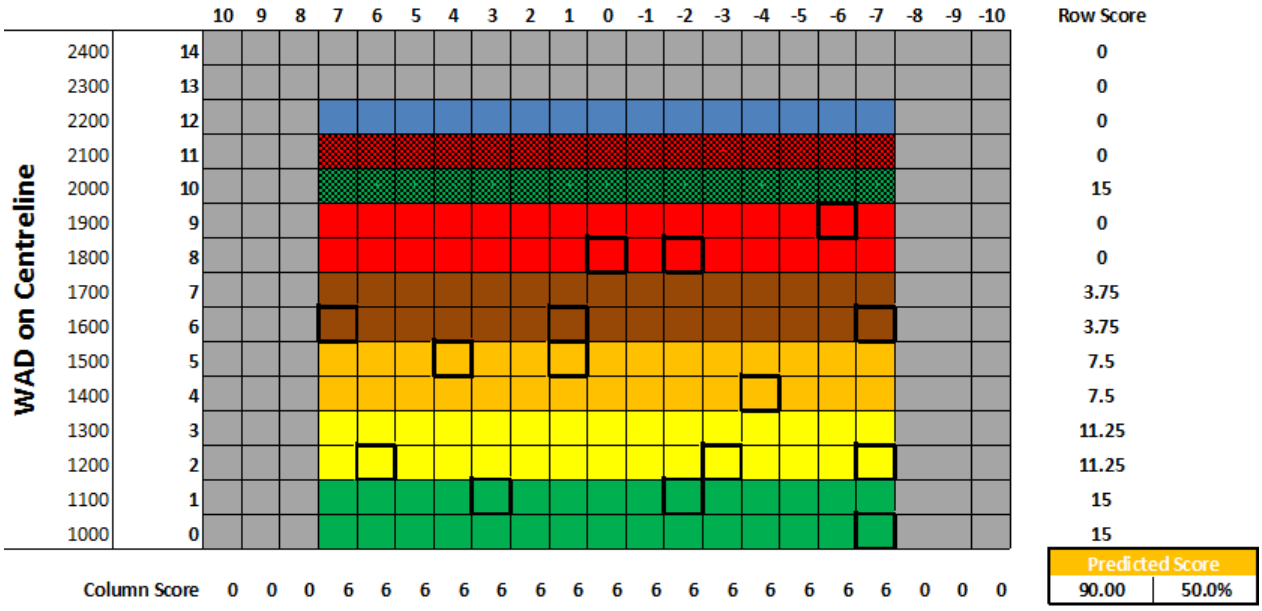
As test results can be variable between labs and in-house tests and/or simulations a 10% tolerance to the HIC value of the verification test is applied. The tolerance is applied in both directions, meaning that when a tested point scores better than predicted, but within tolerance, the predicted result 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 based by comparing the actual measured HIC value with the colour band in section 3.3.1.1 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	$650 \leq HIC_{15} < 1000$	$590.91 \leq HIC_{15} < 1111.11$
Orange	$1000 \leq HIC_{15} < 1350$	$909.09 \leq HIC_{15} < 1500.00$
Brown	$1350 \leq HIC_{15} < 1700$	$1227.27 \leq HIC_{15} < 1888.89$
Red	$1700 \leq HIC_{15}$	$1545.45 \leq HIC_{15}$

3.3.2.2 Example:

Headform testing:

Manufacturer X has provided the following prediction to Euro NCAP with a total score of 90 points (excluding blue) out of the possible 195:



The prediction consists of the following:

15 Default Green	*x 1.00 =*	*15.00*
30 Green	*x 1.00 =*	*30.00*
30 Yellow	*x 0.75 =*	*22.50*
30 Orange	*x 0.50 =*	*15.00*
30 Brown	*x 0.25 =*	*7.50*
30 Red	*x 0.00 =*	*0.00*
15 Default Red	*x 0.00 =*	*0.00*
15 Blue		
195 grid points		***90.00 points***

15 verification points were chosen for testing:

Verification											Score
1-10	GRID-point	R2|C-7	R2|C-3	R1|C-2	R4|C-4	R5|C1	R5|C4	R8|C-2	R6|C-7	R2|C6	R1|C3	
	Prediction											6
	Test result (HIC)	750	600	500	1200	1492	850	2000	1400	1112	660	
	Test result (pts)	0.75	0.75	1	0.5	0.5	0.75	0	0.25	0.5	1	6
11-20	GRID-point	R8|C0	R6|C7	R0|C-7	R9|C-6	R6|C1						
	Prediction											1.50
	Test result (HIC)	2000	1822	700	1544	1450						
	Test result (pts)	0	0.25	1	0.25	0.25						1.75
										Correction factor		1.033

$$Correction\ Factor = \frac{Actual\ tested\ score}{Predicted\ score} = \frac{4.25 + 3.5}{4.25 + 3.25} = 1.033$$

8 Blue zones were tested containing 15 blue points:

Blue points										Score
Blue	Blue Zone	1	2	3	4	5	6	7	8	
	GRID-point	12,7 / 12,6	12,5 / 12,4	12,3 / 12,2	12,1 / 12,0	12,-1 / 12,-2	12,-3 / 12,-4	12,-5 / 12,-6	12,-7	
	Test result (HIC)	1000	650	1700	1500	1700	1699	1350	1349	
	Test result (pts)	0.5	0.75	0	0.25	0	0.25	0.25	0.5	**4.5**

The final score will be:

150 Non-defaulted or Blue	*75.00 x 1.033 =*	*77.475*
15 Default Green		*15.000*
15 Default Red		*0.000*
15 Blue		*4.500*
195 grid points		***96.975 points***

The score in terms of percentage of the maximum achievable score is 96.975/195 = 55.099%
The final headform score is 55.099% x 24 = **13.224 points**

3.3.2.3 Upper Legform & Legform

Legform/upper legform testing (based upon the worst result of any parameter):
Euro NCAP test produces a knee bending angle of 19° = 0.200 points/half
Additional test produces a tibia acceleration of 175g = 0.500 points/half

Euro NCAP test Score	**Extra Test Score**	**Number of manufacturer nominated halves**	**Area Score**
0.200		0	0.200 x 2 = 0.400
0.200	0.500	1	0.200 + 0.500 = 0.700

Scores achieved in tests performed at locations outside the bumper corners will be applied to the adjacent legform sixth (L1A or L3B).

3.3.3 Visualisation of results

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

3.3.3.2 Legform & upper legform results

The protection provided by each legform test site is illustrated by a coloured area, 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	2.000	points
Orange	0.001 – 1.999	points
Red	0.000	points

4 CONCEPTS BEHIND THE ASSESSMENTS

4.1 Tolerance Limits

Where possible, Euro NCAP uses EEVC biomechanical limits as the higher and lower performance criteria. In order to discriminate between cars which more nearly meet the EEVC requirements from those which greatly exceed them, a lower limit has been set. This has been derived from the lower performance limit used in the European Regulation (EC) No 78/2009 in case of the headform tests and mainly from experience gained in the early phases of Euro NCAP in case of the legform and upper legform tests.

5 REFERENCES

1 Prasad, P. and H. Mertz. *The position of the US delegation to the ISO Working Group 6 on the use of HIC in the automotive environment.* SAE Paper 851246. 1985

2 Mertz, H., P. Prasad and G. Nusholtz. *Head Injury Risk Assessment for forehead impacts*. SAE paper 960099 (also ISO WG6 document N447)

3 EEVC WG17 Report, 'Improved Test Methods to Evaluate Pedestrian Protection Afforded by Passenger Cars', September 2002.