



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



**ASSESSMENT PROTOCOL – PEDESTRIAN PROTECTION**

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### **1 INTRODUCTION**

Euro NCAP's original assessment protocol was developed jointly by TRL and Vehicle Safety Consultants Ltd. under contract to the UK Department of the Environment Transport and the Regions and International Testing, respectively. Subsequent versions of the protocol have been developed and released by the Euro NCAP Secretariat. Beginning Version 5 important changes have been included that have been brought about by 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 based on the dummy response data recorded in three different test configurations: head to bonnet, upper leg to bonnet leading edge and leg to bumper impacts, as specified in EEVC WG17 Report, "Improved Test Methods to Evaluate Pedestrian Protection Afforded by Passenger Cars" of December 1998 [3]. For this purpose, the front and bonnet of the car is divided into zones which are assessed using appropriate bodyform impactors. Besides Euro NCAP selected "worst case" test points (18), manufacturers may nominate additional tests to be performed and the results will be included in the assessment (maximum 18 points).

From the information collected in the three test scenarios, one test score is computed for pedestrian protection. For a given car, the Pedestrian Protection Score is expressed as a percentage of the maximum achievable number of points. The scores for the different test zones on the car front and bonnet is presented, in a visual format of coloured zones within the outlines of a car front-end.

In addition to the basic Euro NCAP assessment, additional information is recorded and may be reported. In future, some of these additional aspects may be added to the Euro NCAP assessment.

## **2.1 Points Calculation**

From Phase 3, 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. For pedestrian, the maximum score for each test zone is two points (a half point per quarter for head form testing and one point per half for bumper and bumper 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.

### 3 PEDESTRIAN IMPACT ASSESSMENT

#### 3.1 Criteria and Limit Values

The basic 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

*Higher performance limit*

|                   |       |   |
|-------------------|-------|---|
| HIC <sub>15</sub> | 1000* | (20% risk of injury $\geq$ AIS3 [1,2])<br>(*EEVC Limit) |
|-------------------|-------|---|

*Lower performance limit*

|                   |      |  |
|-------------------|------|--|
| HIC <sub>15</sub> | 1350 |  |
|-------------------|------|--|

##### 3.1.2 Upper Legform

*Higher performance limit*

|                |        |   |
|----------------|--------|---|
| Bending Moment | 300Nm* | (18% risk of femur/pelvis fracture)                   |
| Sum of forces  | 5.0kN* | (20% risk of femur/pelvis fracture)<br>(*EEVC Limits) |

*Lower performance limit*

|                |       |                                     |
|----------------|-------|-------------------------------------|
| Bending Moment | 380Nm | (33% risk of femur/pelvis fracture) |
| Sum of forces  | 6.0kN | (36% risk of femur/pelvis fracture) |

##### 3.1.3 Legform

*Higher performance limit*

|                         |       |                                      |
|-------------------------|-------|--------------------------------------|
| Tibia deceleration      | 150g* | (27% risk of lower leg fracture) [3] |
| Knee shear displacement | 6mm*  | [3]                                  |
| Knee bending angle      | 15° * | [3]                                  |

(\*EEVC Limits)

*Lower performance limit*

|                         |      |                                  |
|-------------------------|------|----------------------------------|
| Tibia deceleration      | 200g | (46% risk of lower leg fracture) |
| Knee shear displacement | 7mm  |                                  |
| Knee bending angle      | 20°  |                                  |

### 3.2 Modifiers

There are no modifiers applied.

### 3.3 Scoring & Visualisation

#### 3.3.1 Scoring

For pedestrian impact, the front and bonnet of the car is divided into zones which are assessed using appropriate bodyform impactors. Each of the potential 18 test sites can be awarded up to two points, giving a possible overall score of 36 points. However, if the vehicle manufacturer chooses to fund additional tests either in the legform, upper legform or headform test area, the score would be calculated as follows:

Examples:

*Headform testing:*

Euro NCAP test produces a HIC of 1300 = 0.071 points/quarter

The additional test produces a HIC of 1050 = 0.429 points/quarter

| <b>Euro NCAP test Score</b> | <b>Extra Test Score</b> | <b>Number of manufacturer nominated quarters</b> | <b>Area Score</b>                             |
|-----------------------------|-------------------------|--|---|
| 0.071                       |                         | 0  | $(0.071 \times 4) = 0.284$                    |
| 0.071                       | 0.429                   | 1  | $(0.071 \times 3) + (0.429 \times 1) = 0.642$ |
| 0.071                       | 0.429                   | 2  | $(0.071 \times 2) + (0.429 \times 2) = 1.000$ |
| 0.071                       | 0.429                   | 3  | $(0.071 \times 1) + (0.429 \times 3) = 1.358$ |

*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

| <b>Euro NCAP test Score</b> | <b>Extra Test Score</b> | <b>Number of manufacturer nominated halves</b> | <b>Area Score</b>        |
|-----------------------------|-------------------------|--|--------------------------|
| 0.200                       |                         | 0  | $0.200 \times 2 = 0.400$ |
| 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).

### 3.3.2 Visualisation

For pedestrians, the protection provided by each 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**

With the current level of pedestrian protection provided by car fronts, it would be optimistic to expect protection levels to exceed those proposed by the EEVC. 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 experience gained in the early phases of Euro NCAP.



## 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', December 1998.