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ASSESSMENT PROTOCOL — ADULT OCCUPANT PROTECTION

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Preface

Where text is contained within square brackets this denotes that the procedure being discussed is currently being trialled in ASEAN NCAP. Its incorporation in the Test Protocol will be reviewed at a later date.

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of ASEAN NCAP. Where a disagreement exists between the laboratory and manufacturer, the ASEAN NCAP secretariat should be informed immediately to pass final judgement. Where the laboratory staff suspect that a manufacturer has interfered with any of the setup, the manufacturer's representatives should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer's representatives will be told to leave the

test site and the Secretariat should be immediately informed. Any such incident may be reported by the Secretariat to the manufacturer and the persons concerned may not be allowed to attend further ASEAN NCAP tests.

DISCLAIMER: ASEAN 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, ASEAN NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

In addition to the settings specified in this protocol, the following information will be required from the manufacturer of the car being tested in order to facilitate the vehicle preparation. A vehicle handbook should be provided to the test laboratory prior to the assessment.

**ASSESSMENT PROTOCOL – ADULT OCCUPANT
PROTECTION**

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**NEW CAR ASSESSMENT PROGRAM FOR
SOUTHEAST ASIAN COUNTRIES
(ASEAN NCAP)**

**ASSESSMENT PROTOCOL – ADULT OCCUPANT
PROTECTION**

1 INTRODUCTION

The ASEAN NCAP programme is designed to provide a fair, meaningful and objective assessment of the impact performance of cars and provide a mechanism to inform consumers. This protocol is based upon those used by the European New Car Assessment Programme for adult occupant protection ratings. Individual documents are released for the four main areas of assessment as follow:

Assessment Protocol – **Adult Occupant Protection**

Assessment Protocol – Child Occupant Protection

Assessment Protocol – Safety Assist

Assessment Protocol – Motorcyclist Safety

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.

2 METHOD OF ASSESSMENT

The starting point for the assessment of adult occupant protection is the dummy response data of the frontal

impact. Initially, each relevant body area is given a score based on the measured dummy parameters. These scores can be adjusted after the test based on supplementary requirements. For example, consideration is given to whether the original score should be adjusted to reflect occupant kinematics or sensitivity to small changes in contact location, which might influence the protection of different sized occupants in different seating positions. The assessment also considers the structural performance of the car by taking account of such aspects as steering wheel displacement, pedal movement, foot well distortion and displacement of the A pillar. The adjustments or modifiers, are based on both inspection and geometrical considerations are applied to the body area assessments to which they are most relevant.

For Adult Occupant Protection, the overall rating is based on the driver data, unless part of the passenger fared less well. It is stated that the judgement relates primarily to the driver. The adjusted rating for the different body regions is presented, in a visual format of coloured segments within a human body outline for the driver and passenger.

2.1 Points Calculation

A sliding scale system of points scoring has been adopted for the biomechanical assessments. This involves two limits for each parameter, a more demanding limit (higher performance), beyond which a maximum score is obtained and a less demanding limit (lower performance), below which no points are scored. For the adult rating, the maximum score for each body region is four points. Where a value falls between the two limits, the score is calculated by linear interpolation.

2.1.1 Capping

For adult occupant protection, capping limits are maintained for criteria related to critical body regions. Exceeding a capping limit generally indicates unacceptable high risk at injury. In all cases, this leads to loss of all points related to the tests. Capping limits can be equal to or higher than the lower performance limit, depending on the test.

3 OFFSET DEFORMABLE BARRIER FRONTAL IMPACT ASSESSMENT

3.1 Criteria and Limit Values

The basic assessment criteria, with the upper and lower performance limits for each parameter, are summarised below. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. The lowest scoring body region of driver or passenger is used to determine the score. For frontal impact, capping is

applied on the critical body regions: head, neck and chest.

3.1.1 Head

3.1.1.1 Drivers with Steering Wheel Airbags and Passengers

If a steering wheel airbag is fitted the following criteria are used to assess the protection of the head for the driver. These criteria are always used for the passenger.

Note: HIC15 levels above 1000 have been recorded with airbags, where there is no hard contact and no established risk of internal head injury. A hard contact is assumed, if the peak resultant head acceleration exceeds 80g, or if there is other evidence of hard contact.

If there is no hard contact, a score of 4 points is awarded. If there is hard contact, the following limits are used:

Higher performance limit

HIC ₁₅	500
Resultant Acc. 3 msec exceedence	72g

Lower performance limit and capping limit

HIC ₁₅	700	(20% risk of injury \geq
AIS3 [1,2])		
Resultant Acc. 3 msec exceedence	80g	

3.1.1.2 Drivers with No Steering Wheel Airbag

If no steering wheel airbag is fitted, and the following requirements are met in the frontal impact test:

HIC₁₅ <700
Resultant Acc. 3 msec exceedence <80g

then 6.8kg spherical headform test specified in ECE Regulation 12 [3] are carried out on the steering wheel. The tester attempts to choose the most aggressive sites to test and it is expected that two tests will be required, one aimed at the hub and spoke junction and one at the rim and spoke junction. The assessment is then based on the following criteria:

Higher performance limit

Resultant peak Acc. 80g
Resultant Acc. 3 msec exceedence 65g

Lower performance limit and capping limit

HIC₁₅ 700
Resultant peak Acc. 120g
Resultant Acc. 3 msec exceedence 80g

From the spherical headform tests, a maximum of 2 points are awarded for performance better than the higher limits. For values worse than the lower performance limit, no points are awarded. For results between the limits, the score is generated by linear interpolation. The results from the worst performing test are used for the assessment. This means that for cars, not equipped with a

steering wheel airbag, the maximum score obtainable for the driver's head is 2 points.

3.1.2 Neck

Higher performance limit

Shear 1.9kN @ 0 msec, 1.2kN @ 25 - 35msec, 1.1kN @ 45msec
Tension 2.7kN @ 0 msec, 2.3kN @ 35msec, 1.1kN @ 60msec
Extension 42Nm

Lower performance limit and capping limit

Shear 3.1kN @ 0msec, 1.5kN @ 25 - 35msec, 1.1kN @ 45msec*
Tension 3.3kN @ 0msec, 2.9kN @ 35msec, 1.1kN @ 60msec*
Extension 57Nm*
(Significant risk of injury (*EEVC Limits))

Note: Neck Shear and Tension are assessed from cumulative exceedence plots, with the limits being functions of time. By interpolation, a plot of points against time is computed. The minimum point on this plot gives the score. Plots of the limits and colour rating boundaries are given in Appendix I.

3.1.3 Chest

Higher performance limit

Compression 22mm (5% risk of injury □ AIS3 [5])
Viscous Criterion 0.5m/sec(5% risk of injury □ AIS4)

Lower performance limit and capping limit

Compression 42mm
Viscous Criterion 1.0m/sec(25% risk of injury □ AIS4)

3.1.4 Knee, Femur and Pelvis

Higher performance limit

Femur compression 3.8kN(5% risk of pelvis injury [6])
Knee slider compressive displacement 6mm

Lower performance limit

Femur Compression 9.07kN @ 0msec,
7.56kN @ □ 10msec* (Femur fracture limit [4])
Knee slider compressive displacement 15mm* (Cruciate
ligament failure limit [4,7])
(*EEVC Limit)

Note: Femur compression is assessed from a cumulative exceedence plot, with the limits being functions of time. By interpolation, a plot of points against time is computed. The minimum point on this plot gives the score. Plots of the limits and colour rating boundaries are given in Appendix I.

3.1.5 Lower Leg

Higher performance limit

Tibia Index 0.4
Tibia Compression 2kN

Lower performance limit

Tibia Index 1.3*
Tibia Compression 8kN* (10% risk of fracture [4,8])

3.1.6 Foot/Ankle

Higher performance limit

Pedal rearward displacement 100mm

Lower performance limit

Pedal rearward displacement 200mm

Notes:

- 1. Pedal displacement is measured for all pedals with no load applied to them.*
- 2. If any of the pedals are designed to completely release from their mountings during the impact, no account is taken of the pedal displacement provided that release occurred in the test and that the pedal retains no significant resistance to movement.*
- 3. If a mechanism is present to move the pedal forwards in an impact, the resulting position of the pedal is used in the assessment.*
- 4. The passenger's foot/ankle protection is not currently assessed.*

3.2 Modifiers

3.2.1 Driver

The score generated from driver dummy data may be modified where the protection for different sized occupants or occupants in different seating positions, or accidents of slightly different severity, can be expected to be worse than that indicated by the dummy readings or deformation data alone. In any single body region, the score may reduce by up to a maximum of two points.

The concepts behind the modifiers are explained in Section 0.

3.2.1.1 Head

Unstable Contact on the Airbag

If during the forward movement of the head its centre of gravity moves further than the outside edge of the airbag, head contact is deemed to be unstable. The score is reduced by one point. If for any other reason head protection by the airbag is compromised, such as by detachment of the steering wheel from the column, or bottoming-out of the airbag by the dummy head, the modifier is also applied.

Note: Head bottoming-out is defined as follows: There is a definite rapid increase in the slope of one or more of the head acceleration traces, at a time when the dummy head is deep within the airbag. The acceleration spike associated with the bottoming out should last for more than 3ms. The acceleration spike associated with the bottoming out should generate a peak value more than 5 g above the likely level to have been reached if the spike had not occurred. This level will be established by smooth extrapolation of the curve between the start and end of the bottoming out spike.

Hazardous Airbag Deployment

If, within the head zone, the airbag unfolds in a manner in which a flap develops, which sweeps across the face of an occupant vertically or horizontally the -1 point modifier for unstable airbag contact will be applied to the

head score. If the airbag material deploys rearward, within the “head zone” at more than 90 m/s, the -1 point modifier will be applied to the head score.

Incorrect Airbag Deployment

Any airbag(s) which does not deploy fully in the designed manner will attract a -1 point modifier applicable to each of the most relevant body part(s) for the affected occupant. For example, where a steering wheel mounted airbag is deemed to have deployed incorrectly, the penalty will be applied to the frontal impact driver’s head (-1). Where, a passenger knee airbag fails to deploy correctly, the penalty will be applied to the frontal impact passenger left and right knee, femur and pelvis (-1).

Where the incorrect deployment affects multiple body parts, the modifier will be applied to each individual body part. For example, where a seat or door mounted side airbag, that is intended to provide protection to the head as well as the thorax, abdomen or pelvis deploys incorrectly, the penalty will be applied to two body regions, -1 to the head and -1 to the chest.

The modifier(s) will be applied to the scores of the impacts for which the airbag was intended to offer protection, regardless of the impact in which it deployed incorrectly. For example, the penalty will be applied to the side and pole impact scores if a side protection airbag deploys incorrectly during the frontal crash. Or, if a knee airbag deploys incorrectly in the full width impact, the

modifier will be applied to the pelvic region of both the offset and full width tests. Where any frontal protection airbag deploys incorrectly, ASEAN NCAP will not accept knee mapping data for that occupant.

Unstable Contact on a Steering Wheel without an Air Bag

If, during the forward movement of the head, its centre of gravity moves radially outwards further than the outside edge of the steering wheel rim, head contact is deemed to be unstable. The score is reduced by one point. If for any other reason head contact on the steering wheel is unstable, such as detachment of the steering wheel from the column, the modifier is also applied.

Displacement of the Steering Column

The score is reduced for excessive rearward, lateral or upward static displacement of the top end of the steering column. Up to 90 percent of the EEVC limits, there is no penalty. Beyond 110 percent of the EEVC limits, there is a penalty of one point. Between these limits, the penalty is generated by linear interpolation. The EEVC recommended limits are: 100mm rearwards, 80mm upwards and 100mm lateral movement. The modifier used in the assessment is based on the worst of the rearward, lateral and upward penalties.

3.2.1.2 Chest

Displacement of the A Pillar

The score is reduced for excessive rearward displacement of the driver's front door pillar, at a height of 100mm

below the lowest level of the side window aperture. Up to 100mm displacement there is no penalty. Above 200mm there is a penalty of two points. Between these limits, the penalty is generated by linear interpolation.

Integrity of the Passenger Compartment

Where the structural integrity of the passenger compartment is deemed to have been compromised, a penalty of one point is applied. The loss of structural integrity may be indicated by characteristics such as:

- Door latch or hinge failure, unless the door is adequately retained by the door frame.
- Buckling or other failure of the door resulting in severe loss of fore/aft compressive strength.
- Separation or near separation of the cross facia rail to A pillar joint.
- Severe loss of strength of the door aperture.

When this modifier is applied, knee mapping data will not be accepted.

Steering Wheel Contact

Where there is obvious direct loading of the chest from the steering wheel, a one-point penalty is applied.

Shoulder belt load (Driver and Front Passenger)

Where the shoulder belt load measured, exceeds 6kN a two-point penalty is applied.

3.2.1.3 Knee, Femur & Pelvis

Variable Contact

The position of the dummy's knees is specified by the test protocol. Consequently, their point of contact on the facia is pre-determined. This is not the case with human drivers, who may have their knees in a variety of positions prior to impact. Different sized occupant and those seated in different positions may also have different knee contact locations on the facia and their knees may penetrate into the facia to a greater extent. In order to take some account of this, a larger area of potential knee contact is considered. If contact at other points, within this greater area, would be more aggressive penalties are applied.

The area considered extends vertically 50mm above and below the maximum height of the actual knee impact location [8]. Vertically upwards, consideration is given to the region up to 50mm above the maximum height of knee contact in the test. If the steering column has risen during the test it may be repositioned to its lowest setting if possible. Horizontally, for the outboard leg, it extends from the centre of the steering column to the end of the facia. For the inboard leg, it extends from the centre of the steering column the same distance inboard, unless knee contact would be prevented by some structure such as a centre console. Over the whole area, an additional penetration depth of 20mm is considered, beyond that identified as the maximum knee penetration in the test. The region considered for each knee is generated independently. Where, over these areas and this depth,

femur loads greater than 3.8kN and/or knee slider displacements greater than 6mm would be expected, a one point penalty is applied to the relevant leg.

Concentrated Loading

The biomechanical tests, which provided the injury tolerance data, were carried out using a padded impactor which spread the load over the knee. Where there are structures in the knee impact area which could concentrate forces on part of the knee, a one point penalty is applied to the relevant leg.

Where a manufacturer is able to show, by means of acceptable test data, that the Variable Contact and/or Concentrated Loading modifiers should not be applied, the penalties may be removed.

If the Concentrated load modifier is not applied to any of the driver's knees, the left and right knee zones (defined above) will both be split into two further areas, a 'column' area and the rest of the fascia. The column area for each knee will extend 60mm from the centreline of the steering column and the remainder of the fascia will form the other area for each knee. As a result, the one-point penalty for Variable Contact will be divided into two with one half of a point being applied to the column area and one half of a point to the remainder of the fascia for each knee.

3.2.1.4 Lower Leg

Upward Displacement of the Worst Performing Pedal

The score is reduced for excessive upward static displacement of the pedals. Up to 90 percent of the limit considered by EEVC, there is no penalty. Beyond 110 percent of the limit, there is a penalty of one point. Between these limits, the penalty is generated by linear interpolation. The limit agreed by EEVC was 80mm.

3.2.1.5 Foot & Ankle

Footwell Rupture

The score is reduced if there is significant rupture of the footwell area. This is usually due to separation of spot-welded seams. A one-point penalty is applied for footwell rupture. The footwell rupture may either pose a direct threat to the driver's feet, or be sufficiently extensive to threaten the stability of footwell response. When this modifier is applied, knee mapping data will not be accepted.

Pedal Blocking

Where the rearward displacement of a 'blocked' pedal exceeds 175mm relative to the pre-test measurement, a one-point penalty is applied to the driver's foot and ankle assessment. A pedal is blocked when the forward movement of the intruded pedal under a load of 200N is <25mm. Between 50mm and 175mm of rearward displacement the penalty is calculated using a sliding scale between 0 to 1 point.

3.2.2 Passenger

The score generated from passenger dummy data may be modified where the protection for different sized occupants or occupants in different seating positions, or accidents of slightly different severity, can be expected to be worse than that indicated by the dummy readings alone. In any single body region, the score may reduce by up to a maximum of two points. The concepts behind the modifiers are explained in section 0. The modifiers applicable to the passenger are:

- *Unstable Contact on the airbag*
- *Hazardous airbag deployment*
- *Shoulder load belt*
- *Incorrect airbag deployment*
- *Knee, Femur & Pelvis, Variable Contact*
- *Knee, Femur & Pelvis, Concentrated loading*

The assessments airbag stability, head bottoming-out (where present) and the knee impact areas are the same as for driver. For the outboard knee, the lateral range of the knee impact area extends from the centre line of the passenger seat to the outboard end of the fascia. For the inboard knee, the area extends the same distance inboard of the seat centre line, unless knee contact is prevented by the presence of some structure such as the centre console. The passenger knee zones and penalties will not be divided into two areas even if the concentrated load modifier is not applied.

3.2.3 Door Opening during the Impact

When a door opens in the test, a minus one-point modifier will be applied to the score for that test. The modifier will be applied to the frontal impact assessment for every door (including tailgates and moveable roofs) that opens. The number of door opening modifiers that can be applied to the vehicle score is not limited.

3.2.4 Door Opening Forces after the Impact

The force required to unlatch and open each side door to an angle of 45 degrees is measured after the impact. A record is also made of any doors which unlatch or open in the impact. Currently, this information is not used in the assessment but it may be referred to in the text of the published reports.

Door opening forces are categorised as follows:

Opens normally	Normal hand force is sufficient
Limited force	<input type="checkbox"/> 100N
Moderate force	> 100N to < 500N
Extreme hand force	<input type="checkbox"/> 500N
Tools had to be used	Tools necessary

3.3 Scoring & Visualization

The protection provided for adults for each body region are presented visually, using coloured segments within body outlines. The colour used is based on the points awarded for that body region (rounded to three decimal places), as follows:

Green	4.000	points
Yellow	2.670 - 3.999	points
Orange	1.330 - 2.669	points
Brown	0.001 - 1.329	points
Red	0.000	points

For frontal impact, the body regions are grouped together, with the score for the grouped body region being that of the worst performing region or limb. Results are shown separately for driver and passenger.

The grouped regions are:

- Head and Neck,
- Chest,
- Knee, Femur, Pelvis (i.e. left and right femur and knee slider)
- Leg and Foot (i.e. left and right lower leg and foot and ankle).

This assessment will be applied on the basis of dummy response alone, for any body region where there is **an unacceptably high risk of life-threatening injury** i.e. the dummy response has exceeded the lower performance limit. The body regions which could give rise to a ‘star cap’ are the head, neck and chest.

4 SIDE BARRIER IMPACT ASSESSMENT

4.1 Criteria and Limit Values

The basic assessment criteria used for side barrier impact, with the upper and lower performance limits for each parameter, are summarized below. The assessments are divided into four individual body regions, the head, chest, abdomen and pelvis. A maximum of four points are available for each body region. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. There is no limit to the number of modifiers that can be applied. The concepts behind the modifiers are explained in section 6.

Note: The requirement is for the fitment of a head protection system, meaning that the manufacturer is free to use a solution other than an airbag. However, for technologies other than conventional curtain or head airbags, the manufacturer is requested to provide evidence that the system is effective, at least in principle, before a test can be allowed.

4.1.1 Head

Higher performance limit

HIC 650 (5% risk of injury \geq
36 AIS3 [1,2])

Resultant Acc. 3 msec
exceedence 72g

Lower performance limit

HIC (20% risk of injury \geq
36 1000AIS3 [1,2])

Resultant Acc. 3 msec
exceedence 88g

4.1.2 Chest

The assessment is based on the worst performing individual rib.

Higher performance limit

	22mm	(5% risk of injury \geq AIS3)
	0.32	
Compression		(5% risk of injury \geq AIS3)
Viscous Criterion		

Lower performance limit

	42mm	(30% risk of injury \geq AIS3)
	1.0	
Compression		(50% risk of injury \geq AIS3)
Viscous Criterion		

4.1.3 Abdomen

Higher performance limit

Total Abdominal Force	1.0 kN
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Lower performance limit

Total Abdominal Force	2.5 kN	(* EEVC Limit)
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4.1.4 Pelvis

Higher performance limit

Pubic Symphysis Force 3.0kN

Lower performance limit

Pubic Symphysis Force 6.0kN*

(Pelvic Fracture in
Young Adults)
(*EEVC Limit)

4.2 Modifiers

4.2.1 Incorrect Airbag Deployment

Any airbag(s) which does not deploy fully in the designed manner will attract a -1 point modifier applicable to each of the most relevant body part(s) for the affected occupant. For example, where a head curtain airbag is deemed to have deployed incorrectly, the penalty will be applied to the side impact driver's head (-1). Where the incorrect deployment affects multiple body parts, the modifier will be applied to each individual body part. For example, where a seat or door mounted side airbag fails to deploy correctly that is intended to provide protection to the head as well as the thorax, abdomen and pelvis, the penalty will be applied to two body regions, the head (-1) and the chest (-1). The two penalties would also be applicable to both the side and pole impacts, which are scaled down in the final vehicle rating.

The modifier will be applied even if the airbag was not intended to offer protection in that particular impact. For example, the penalty will be applied if a driver's knee airbag deploys incorrectly in a side or pole impact. In this case the modifier will be applied to both frontal impact driver knee, femur and pelvis body parts. Where a frontal protection airbag deploys incorrectly, knee-mapping is not permitted for the occupant whom the airbag was designed to protect.

4.2.2 Backplate Loading

Where the backplate load F_y exceeds 4.0kN, a two-point penalty is applied to the driver's chest assessment. Between 1.0kN and 4.0kN the penalty is calculated using a sliding scale from 0 to 2 points. Only loads applied to the backplate, which might unload the chest by accelerating the spine away from the intruding side are counted.

Higher performance limit

F_y 1.0kN

Lower performance limit

F_y 4.0kN

4.2.3 T12 Modifier

Where the T12 loads F_y and M_x exceed 2.0kN or 200Nm respectively, a two-point penalty is applied to the driver's chest assessment. Between 1.5kN – 2.0kN or 150Nm – 200Nm the penalty is calculated using a sliding scale from 0 to 2 points. The assessment is based upon the

worst performing parameter. Only loads which are transmitted up the spine, which might unload the chest during the loading phase of the impact, will be considered.

Higher performance limit

Fy 1.5kN ; Mx 150Nm

Lower performance limit

Fy 2.0kN ; Mx 200Nm

Using SAE J211 sign convention

Fy > 0 and Mx < 0 for LHD vehicles

Fy < 0 and Mx > 0 for RHD vehicles

4.2.4 Door Opening during the Impact

When a door opens in the test, a minus one-point modifier will be applied to the score for that test. The modifier will be applied to the side impact assessment score for every door (including tailgates and moveable roofs) that opens. The number of door opening modifiers that can be applied to the vehicle score is not limited.

4.2.5 Door Opening Forces after the Impact

A check is made to ensure that the doors on the non-struck side can be opened. The doors on the struck side are not opened.

4.3 Scoring & Visualization

The protection provided for adults for each body region are presented visually, using coloured segments within

body outlines. The colour used is based on the points awarded for that body region (rounded to three decimal places), as follows:

Green	‘Good’	4.000	points
Yellow	‘Adequate’	2.670 - 3.999	points
Orange	‘Marginal’	1.330 - 2.669	points
Brown	‘Weak’	0.001 - 1.329	points
Red	‘Poor’	0.000	points

5 HEAD PROTECTION TECHNOLOGY (HPT) EVALUATION

Vehicles equipped with head protection side airbags, curtain, seat mounted or any other, will have the inflated energy absorbing areas evaluated by means of a geometric assessment. The airbags must provide protection for a range of occupant size seated at the front on both sides of the vehicle. Where a vehicle does offer sufficient protection, maximum 8 point will be awarded based on ASEAN NCAP Fitment Rating System Version 1.1 (FRS).

5.1 Coverage Areas

To ensure adequate head protection is offered, the head protection device coverage is assessed in the geometric area, or the Head Protection Device (HPD) assessment zone, where the occupant head would most likely impact side structures. If the vehicle is equipped with movable rear seats the seat shall be set to the most rearward position. If there is a third row of fixed seats, these will be included in the assessment unless they are per

manufacturers' recommendation as unsuitable for adult occupation (handbook).

5.2 Application

Where the airbags differ between the left- and right-hand sides of the vehicle, the airbags on both sides of the vehicle will be evaluated and the assessment will be based upon worst performing side. All areas of the airbag, both front and rear, will be evaluated and the assessment will be based upon the worst performing part of any of the airbags.

5.3 Exclusion

The head protecting airbags should cover all glazed areas within the defined zone up to the edge of door daylight opening (FMVSS201) where it meets the roofline, B-pillar, C-pillar and door waistline. Seams in the airbag will not be penalised provided that the un-inflated area is no wider than 15mm. Any other areas where the airbag layers are connected will not be penalised provided that the surrounding areas are inflated and any un-inflated areas are no larger than 50mm in diameter or equivalent area or the sum of the major and minor axes of individual areas does not exceed 100mm. In the case that the un-inflated area would be larger than described above, the OEM shall provide data to demonstrate sufficient energy absorption is guaranteed.

Where a vehicle is fitted with a third row of foldable or removable seats, the third row (only) will be excluded from the assessment.

5.4 HPT Assessment

Head Protection Technology (HPT) can be other than an airbag, as long as it protects the head. However, for technologies other than the conventional curtain or head airbags, manufacturer is requested to provide evidence that the system is effective, at least in principle, before an assessment can be carried out.

In order to demonstrate the functionality and performance of the HPT and qualify for further assessment on Fitment Rating System (FRS), ASEAN NCAP will accept any of the following options;

- a. Assessment by ASEAN NCAP. This will be performed after the ASEAN NCAP side barrier impact test. If the vehicle model is not equipped with the HPT (for example, only available in higher variant), the manufacturer is responsible to provide the vehicle model with the HPT to ASEAN NCAP for further assessment without crash testing, OR
- b. Another ASEAN NCAP side barrier impact test is performed with vehicle model with HPT (if the tested model is not equipped with HPT) and assessment by ASEAN NCAP, OR
- c. Assessment by manufacturer and submission of in-house test report.

The deployment situation of the SCA shall be recorded and confirmed as follows. The results of deployment of

the SCA confirmed on the struck side shall be deemed to represent those on the opposite side (if ASEAN NCAP side barrier impact testing is conducted for this model). However, when the struck side is deemed unable to represent the opposite side due to differences in structure, installation location, etc., the method of confirmation shall be determined upon consultation between the ASEAN NCAP and the manufacturer.

The deployment of the SCA shall be confirmed based on the analysis of high-speed videos:

- i. The SCA deployed on the outer side of the dummy's head.
- ii. The SCA smoothly deployed without scratches or breakage during deployment.
- iii. The dummy's head was protected by the energy-absorbing effective area of the SCA.

5.4.1 Front Seat

- a. The front edge of the energy-absorbing area of the SCA projected on the centre plane of the vehicle shall be forward of the base front edge line (hereinafter referred to as the "base front edge"; the concept is shown in Figure X) which is drawn from a point 200 mm horizontally forward from the centre of gravity of the dummy's head projected on the centre plane of the vehicle to a point 160 mm downward or to the bottom line of the windshield.
- b. Provided, however, it is not necessary to meet this requirement if the front edge of the energy-absorbing

area of the SCA is above the upper level of an adjacent window glass. In this case, the front edge of the deployed SCA shall be confirmed as follows. Before conducting the test, the centre of gravity of the dummy's head and the base front edge shall be marked on the test vehicle body in an area which would not be deformed upon collision, then after the test, the SCA shall be filled with a volume of compressed air necessary to deploy it to the size of complete deployment, and it shall be confirmed that the airbag front edge line is forward of the base front edge line. If the right and left SCAs are symmetrical, the opposite side SCA may be used for confirmation.

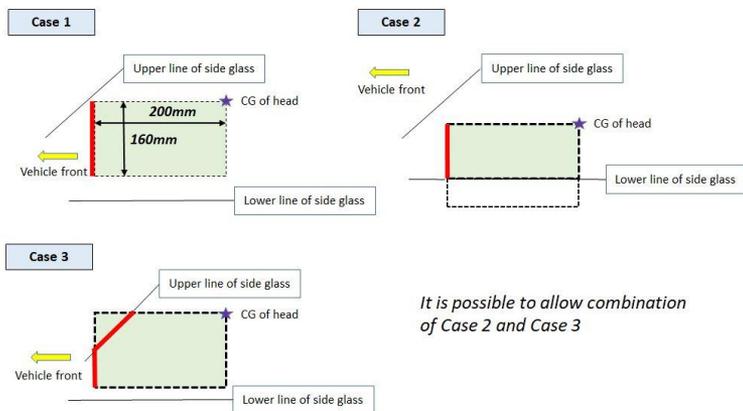


Figure 1: The area considered for SCA evaluation

5.4.2 Rear Seat

a) Using the location of the H-point for the rear seating position as per EURO NCAP Rear Whiplash protocol, calculate and record the corresponding head centre of gravity positions in the most forward and rearward seating positions:

5th female Head CoG in most forward seating position:
 $XCoG_{5th} = H\text{-point}(X) + 126 - \text{seat travel (if applicable)}$
 $ZCoG_{5th} = H\text{-point}(Z) + 594$

95th male Head CoG in most rearward seating position:
 $XCoG_{95th} = H\text{-point}(X) + 147$
 $ZCoG_{95th} = H\text{-point}(Z) + 693$

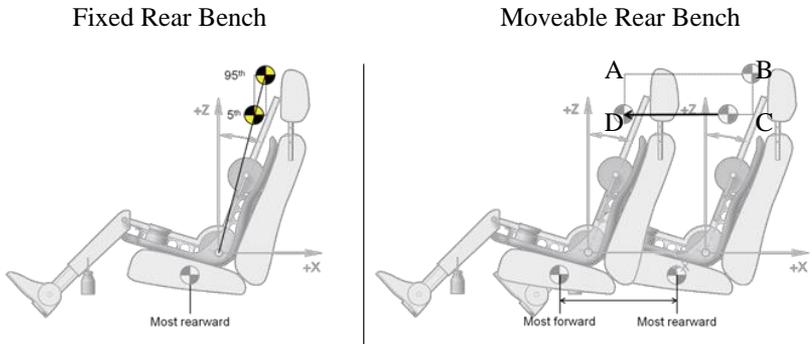
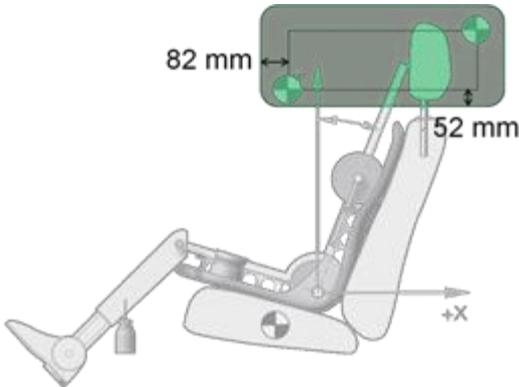


Figure 2: Area considered for SCA evaluation for Rear Seat

The four corners of the Head CoG-box are:

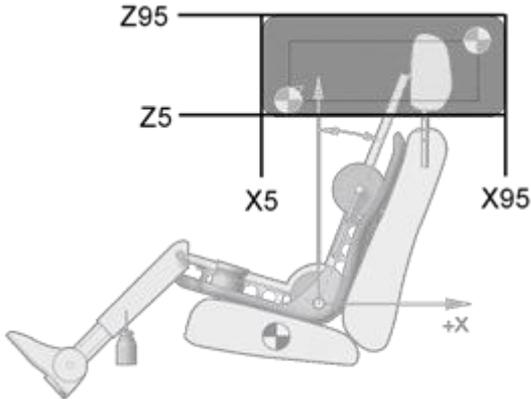
	X-position	Z-position
A	XCoG,5th	ZCoG,95th
B	XCoG,95th	ZCoG,95th
C	XCoG,95th	ZCoG,5th
D	XCoG,5th	ZCoG,5th

b) The head protection device (HPD) evaluation zone is defined as a rounded rectangle around the head CoG box at a distance of 82mm from the upper and fore/aft edges and 52mm below the bottom edge. It is acceptable for the 82mm radius in the lower corners of the airbag to be cut-off at 52mm below the CoG box.



c) The zone shall be constructed parallel and perpendicular to the ground reference level

d) Mark the vertical lines X5 and X95 and the horizontal lines Z95 and Z5 on both the vehicle interior at the struck side and on the vehicle exterior on the non-struck side.



5.5 Prerequisites

Beginning 1 January 2023, UN R135 are required as prerequisites for HPT assessment. In-house results are acceptable.

6 CONCEPTS BEHIND THE ASSESSMENTS

6.1 Frontal Impact

6.1.1 Head

CONCEPT: *The driver's head should be predictably restrained by the airbag, and should remain protected by the airbag during the dummy's forward movement. There should be no bottoming out of the airbag.*

CONCEPT: *Hazardous airbag deployment*
The deployment mode of the airbag should not pose a risk of facial injury to occupants of any size.

CONCEPT: *Incorrect airbag deployment*
All airbags that deploy during an impact should do so fully and in the designed manner so as to provide the maximum amount of protection to occupants available. It is expected that, where required, all airbags should deploy in a robust manner regardless of the impact scenario.

CONCEPT: *Geometric control of steering wheel movement is needed to ensure that the airbag launch platform remains as close as possible to the design position, to protect a full range of occupant sizes.*

6.1.2 Neck

CONCEPT: *Neck injuries are frequent, but relatively little is known about appropriate injury criteria. The neck criteria recommended by EEVC are used to identify poorly designed restraint systems. It is not expected that many cars will fail these requirements.*

In addition to the EEVC recommended limits, additional ones have been added, at the request of the car manufacturers. It is assumed that good restraint systems will have no problems meeting these criteria.

6.1.3 Chest

CONCEPT: *Rib compression is used as the main guide to injury risk. It is expected that the Viscous Criterion will only identify cars with poorly performing restraint systems.*

The injury risk data is relevant for seat belt only loading rather than combined seat belt and airbag loading. No change is made in the event of combined seat belt and airbag restraint. This avoids value judgements about the extent of airbag restraint on the chest and is in line with the EEVC recommendation.

CONCEPT: *There is an interrelationship between chest loading, as measured by the above dummy criteria, and intrusion. To ensure that a good balance is struck, a geometric criterion on waist level intrusion, as measured by door pillar movement at waist level, is used.*

CONCEPT: *When the passenger compartment becomes unstable, any additional load can result in unpredictable excessive further collapse of the passenger compartment. When the passenger compartment becomes unstable the repeatability of the car's response in the test becomes poor and confidence in the car's performance is reduced.*

CONCEPT: *The chest performance criteria are developed for loads applied by a seat belt. The more concentrated loading from a "stiff" steering wheel exposes the chest to direct loading injury.*

6.1.4 Abdomen

Protection of the abdomen is important, but no criteria or assessment techniques are available at present.

6.1.5 Knee, Femur & Pelvis

CONCEPT: *Transmitting loads through the knee joint from the upper part of the tibia to the femur can lead to cruciate ligament failure.*

Zero knee slider displacement is both desirable and possible. The higher performance limit allows for some possible movement due to forces transmitted axially up the tibia.

CONCEPT: *The knee impact area should have uniformly good properties over a wide area of potential impact sites. This is to account for people sitting with*

their knees in different positions and slight variations in impact angle. The characteristics of the area should not change markedly if knee penetration is slightly greater than that observed with the 50th percentile dummy in this test. This takes into account the protection of different sized occupants or occupants in different seating positions.

CONCEPT: *Loading on the knee should be well distributed and avoid concentration that could result in localised damage to the knee.*

The injury tolerance work that supports the legislative femur criterion was conducted with padded impactors that spread the load over the knee.

6.1.6 Lower Leg

CONCEPT: *Loads resulting in fracture of the tibia produce bending moments and forces measurable at the upper and lower ends of the tibia. These measurements on the tibia relate to risk of tibia fracture.*

At the request of the car manufacturers, further limits were added to those proposed for lower leg protection. These limits can be expected to help protect the ankle joint.

CONCEPT: *Pedal blocking*
There should be no blocking of any foot operated pedals which have displaced rearward after the impact; blocked

pedals represent a greater hazard to the lower limbs of the driver than non-blocked pedals.

6.1.7 Foot and Ankle

CONCEPT: *Expert opinion suggests that a Tibia Index of less than 0.2 would be necessary to prevent ankle joint failure. Until a biofidelic ankle and foot become available, the assessment will be based on intrusion. Intrusion is highly correlated with the risk of injury.*

CONCEPT: *Rupture of the footwell exposes the occupant to additional dangers. Objects outside the passenger compartment may enter, parts of the occupant may contact items outside the passenger compartment, there is a risk from exposed edges and the structure may become unstable.*

6.2 Side Impact

CONCEPT: *Incorrect airbag deployment*
All airbags that deploy during an impact should do so fully and in the designed manner so as to provide the maximum amount of protection to occupants available. It is expected that, where required, all airbags should deploy in a robust manner regardless of the impact scenario.

CONCEPT: *Seat position in side impact*
Effective side impact protection needs to consider all sizes of occupants. This concept is included in the EU

Directive. Currently, side impact tests are conducted with the seat in the design position. In future, consideration may be given to the level of protection in other seating positions.

6.3 Door Opening

CONCEPT: *The intention is to ensure that the structural integrity is maintained. The underlying principle is to minimise the risks of occupant ejection occurring.*

The ‘door opening’ modifier will be applied if any of the following have occurred:

the latch has fully released or shows significant partial release, either by release of its components from one another, or effective separation of one part of the latch from its supporting structure

the latch has moved away from the fully latched condition

if any hinge has released either from the door or bodyshell or due to internal hinge failure

if there is a loss of structure between the hinges and latches

if door or hinges fail whilst the door opening tests are being conducted post impact, as loading from an occupant could have a similar effect.

if there was any potential risk of occupant ejection and/or partial ejection/entrapment from openings such as sliding doors or moveable roofs. Dynamic opening during the impact of any apertures, such as roofs, will also be considered even if the openings have closed post test.

if both side doors latch together with no b-pillar or other form of restraint, the modifier may apply to both the front and rear doors.

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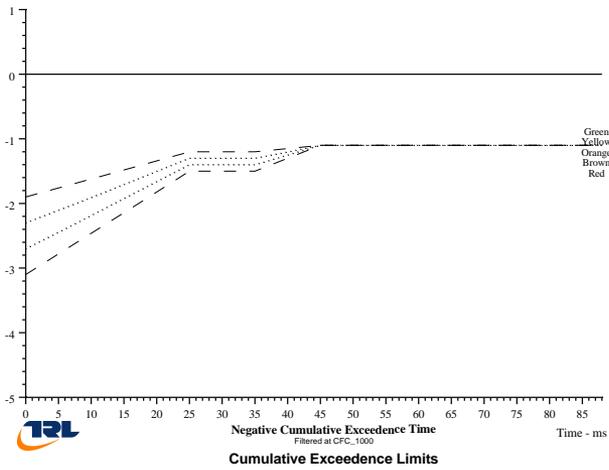
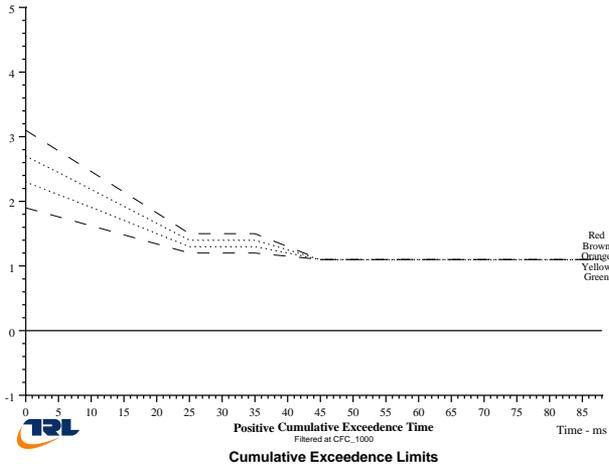
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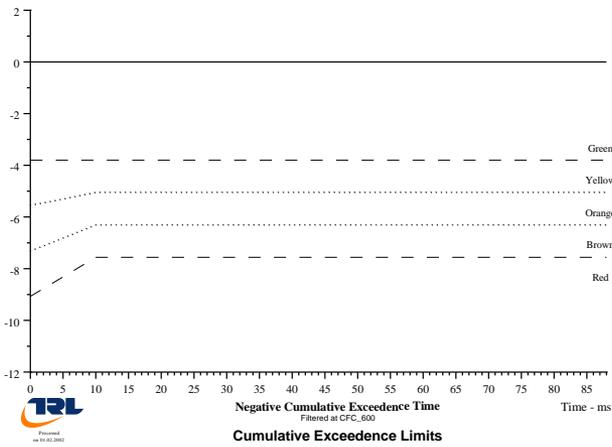
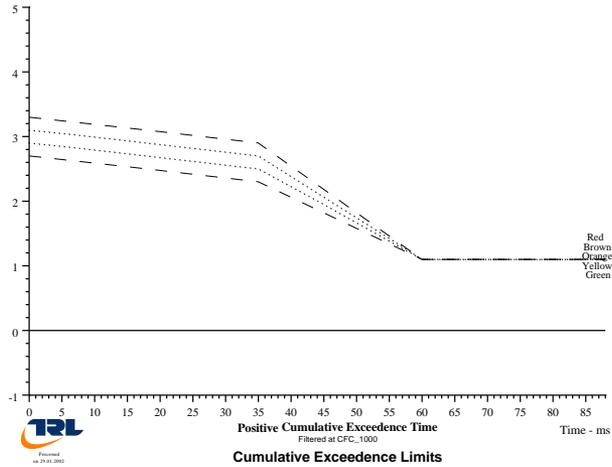
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APPENDIX I

GRAPHICAL LIMITS FOR CUMULATIVE EXCEEDENCE PARAMETERS

- 1 Upper Neck Shear FX - Positive
- 2 Upper Neck Shear FX - Negative
- 3 Upper Neck Tension FZ
- 4 Femur Compression





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