LATIN AMERICAN & CARIBBEAN
NEW CAR ASSESSMENT PROGRAMME
(Latin NCAP)

ASSESSMENT PROTOCOL – ADULT OCCUPANT PROTECTION
2020 - 2024

Version 1.1.2
May 2020

AKNOWLEDGEMENT

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1 INTRODUCTION

The Latin NCAP programme is designed to provide a fair, meaningful and objective assessment of the safety performance of cars and provide a mechanism to inform consumers. This protocol is based upon that used by the European New Car Assessment Programme for the adult occupant protection rating until 2014.

Latin NCAP is introducing relevant changes to this new protocol such as the introduction of the overall rating scheme and together with it the pedestrian, whiplash, and safety assist systems assessment such as AEB. 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 Adult Occupant Protection, in particular in the frontal offset deformable impact test, the side impact barrier test, the pole test, the AEB City system performance and the whiplash tests.

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

2 METHOD OF ASSESSMENT

The starting point for the assessment of adult occupant protection is the dummy response data recorded in four different test configurations: frontal impact in offset overlap, side impact movable deformable barrier, side pole impact and (low speed) rear impact whiplash testing. Latin NCAP can decide which test is to be performed first. 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, displacement of the A pillar and structural symmetry. 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 frontal offset impact, the score for each body area 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. Side impact and pole impact results relate to the struck-side occupant only, while Whiplash results covers only front seats.

No attempt is made to rate the risk of life threatening injury any differently from the risk of disabling injury. Similarly, no attempt is made to rate the risk of the more serious but less frequent injury any differently from the risk of less serious but more frequent injury. Care has been taken to try to avoid encouraging manufacturers to concentrate their attention on areas which would provide little benefit in accidents.

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. This is presented for the driver and front seat passenger in frontal impact, for the struck side occupant in side and pole impact and for front occupants in rear impact. Finally, for the complete area of adult occupant protection assessment, the scores for frontal, side, pole and whiplash are summed along with AEB City score, UN R32 and Rescue Sheet availability. The resulting Adult Occupant Protection Score is expressed as a percentage of the maximum achievable number of points.

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.

For all tests part of the adult occupant protection assessment, capping limits are maintained for criteria related to critical body regions: head, neck and chest for the frontal impact; head, chest, abdomen and pelvis for the side and pole impact. 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

2.2 Rating Calculation

The Adult Occupant Protection Rating is based on the score obtained in the tests by comparing the value with score limits set for each level of stars in this box. Each box has a minimum score required to score certain star level. The lower star rating achieved by any of the 4 boxes will determine the final star rating to be rewarded. The Complete rating scheme can be found on the "Overall Rating" Protocol.

3 ADULT FRONTAL IMPACT OCCUPANT PROTECTION ASSESSMENT

3.1 Criteria and Limit Values

The basic assessment criteria, with the upper and lower performance limits for each parameter, are summarized 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. Capping is applied on the critical body regions: head, neck and chest for the frontal impact and on the head, chest, abdomen and Pelvis for the side movable deformable barrier and pole side impact. When Capping is reached in any of the mentioned body regions by the data recorded in test or due to modifiers in inspection, the test in question will be rated zero points.

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 700 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 and capping limit		
HIC_{15}	700	(20% risk of injury ≥ 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:

HIC_{15}	<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 and capping limit

HIC_{15}	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 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 [4])		

*(*EEVC Limits)*

Note: Neck Shear and Tension are assessed from cumulative exceedance 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 and capping limit		
Compression	42mm*	
Viscous Criterion	1.0m/sec*	(25% risk of injury ≥ AIS4)
		*(*EEVC Limits)*

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 exceedance 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])
		*(*EEVC Limits)*

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. There is no limit to the number of modifiers that can be applied, neither per body region nor in total amount. The concepts behind the modifiers are explained in ***Section 9 – "CONCEPTS BEHIND THE ASSESSMENTS".***

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 or displacement of the steering wheel with or from the column, or bottoming-out of the airbag by the dummy head, the modifier is also applied. In cases where the airbag shows a decrease in internal pressure while the head is still moving forward, increasing the risk of bottoming out, this modifier will be 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. In the case where the modifier is applied due to a low-pressure airbag, there must be clear evidence from the high-speed videos of insufficient airbag pressure during the dummy´s forward movement as well as close proximity to the steering wheel.
Bottoming out of passenger airbag will bring a -1 modifier to passenger head.

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 deploys incorrectly in the frontal impact 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, -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 if a seat mounted side airbag deploys incorrectly in the frontal impact. Where any frontal protection airbag deploys incorrectly, Latin 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.

In the ODB test, in case of asymmetry (reinforcements, layers, and spot welds density) Latin NCAP will apply modifiers for structural instability, footwell area and knees. The manufacturer can always show evidence of a passenger side (not RHD car) ODB test to have the modifiers removed. For the MDB and Pole impact tests, T12 and Backplate load modifiers will be applied under the same concept. No CAD data will be accepted as evidence.

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 for the chest.

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. 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 facia. The column area for each knee will extend 75mm from the centreline of the steering column and the remainder of the facia 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 facia for each knee.

Removal of Knee Modifiers

Latin NCAP allows the vehicle manufacturer to present evidence in the form of knee mapping data in order to remove applied knee modifiers. Tests must be performed according to the Euro NCAP Sled Test Procedure Version 2.7 or later and carried out using original components only. Latin NCAP reserves the right to witness the test. Knee mapping data will be accepted under the conditions below:

- The driver and front passenger's head, neck, chest score are orange, yellow or green.
- Femur loads <3.8kN in the full vehicle test.
- Knee Slider <6mm in the full vehicle test.
- No structural modifiers applied i.e. integrity of the passenger compartment and/or footwell rupture.
- A-pillar displacements must be below 65mm (using the standard Euro NCAP measurement).
- All restraining systems must be final production and exactly as the ones fitted in the tested car, with the same characteristics and performance (volume, firing times, loads etc)

Knee mapping data must be presented for review before the 1-2-1 meeting.

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 points.

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. There is no limit to the number of modifiers that can be applied. The concepts behind the modifiers are explained in section 9. The modifiers applicable to the passenger are:

- *Unstable Contact on the airbag*
- *Hazardous airbag deployment*
- *Incorrect airbag deployment*
- *Shoulder belt load*
- *Displacement of the A Pillar*
- *Integrity of the Passenger Compartment*
- *Knee, Femur & Pelvis, Variable Contact*
- *Knee, Femur & Pelvis, Concentrated loading*
- *Footwell rupture*

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 facia. 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.

Passenger head contact with dashboard (no airbag case)
If, during the forward movement of the passenger's head, it contacts the dashboard, the head score is reduced by one point.

The protection offered to the passenger in a frontal passenger-side 40% offset deformable barrier crash test must also be assessed. In order to do this:

1) Check for same layers in A-pillar on driver side and passenger, door waist level reinforcement, footwell area reinforcements inside the compartment and beneath the floor under the car and compare welding spots density for passenger and driver side.
2) In case there are differences between both, or when there other evidence of sub-optimisation for driver side only, modifiers for structure, head bottoming out, knees and footwell area will be included for the adult calculation. These modifiers can subsequently be removed completely or in part by assessing a passenger-side frontal offset test.

3) In case both sides have the same reinforcements, and there is no obvious evidence of sub-optimisation, the manufacturer will provide a comparison of driver and passenger-side frontal offset results for confirmation.

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	≤ 100N
Moderate force	> 100N to < 500N
Extreme hand force	≥ 500N
Tools had to be used	Tools necessary

3.2.5 Fuel Leakage

In the case of fuel leakage after the crash test, -1 point modifier will be included in the ODB full score.

3.3 Scoring & Visualisation

The protection provided for adults for each body region in frontal impact are presented visually, using coloured segments within body outlines. The colour used is based on the points awarded for that body region after application of modifiers but excluding possible capping (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).

The contribution of the frontal impact test to the Adult Occupant Protection Score is calculated by summing the body scores for the relevant body regions, taking the lower of the driver and passenger scores for each region (16 points maximum total).

4 SIDE MOVABLE DEFORMABLE BARRIER TEST AND SIDE POLE IMPACT TEST ASSESSMENT

4.1 Criteria and Limit Values

The basic assessment criteria used for both side movable deformable barrier and side pole impact, with the upper and lower performance limits for each parameter, are summarised below. The assessments are divided into four individual body regions, the head, chest, abdomen and pelvis. The criteria and limits are equal for side movable barrier and pole side test except for the head. 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 9 – "CONCEPTS BEHIND THE ASSESSMENTS"*. To ensure robustness in engineering solutions, Latin NCAP decides if testing will be conducted at the passenger or driver side of the vehicle using the same biomechanical and modifiers criteria. Capping can be reached by direct value reading or when one critical body region scores zero after modifiers are applied.

For both side and pole impacts, capping is applied on the head, chest, abdomen and pelvis. Where no head protection systems are present, the pole test will not be conducted and the points for that test are set to zero. Additionally, a -2 modifier for HPD (Euro NCAP assessment) will be added for the front row and independently a rear row HPD (Euro NCAP assessment) modifier of -2 for 2020 and 2021, and of -4 from 2022 onward (Euro NCAP assessment) will be added for the rear row, both modifiers will affect the total Adult Occupant protection box general score.

4.1.1 Head

4.1.1.1 Side Impact

Side impact		
Higher performance limit		
HIC_{15}	500	
Resultant Acc. 3msec exceedence	72g	
Lower performance and capping limit		
HIC_{15}	700	(20% risk of injury ≥ AIS3 [1,2])
Resultant Acc. 3msec exceedence	88g	

4.1.1.2 Pole Impact

Capping limits	
HIC_{15}	<700

Peak Resultant Acc	<80g
No direct head contact with the pole	

4.1.2 Chest

The assessment is based on the worst performing individual rib.

Higher performance limit		
Compression	22mm	(5% risk of injury≥AIS3 [10])
Viscous Criterion	0.32	(5% risk of injury≥AIS3 [10])
Lower performance and capping limit		
Compression	42mm*	(30% risk of injury≥AIS3 [10])
Viscous Criterion	1.0*	(50% risk of injury≥AIS3 [10])
		*(*EEVC Limits)*

4.1.3 Abdomen

Higher performance limit		
Total Abdominal Force	1.0kN	
Lower and capping performance limit		
Total Abdominal Force	2.5kN*	*(*EEVC Limit)*

4.1.4 Pelvis

Higher performance limit		
Pubic Symphysis Force	3.0kN	
Lower performance and capping limit		
Pubic Symphysis Force	6.0kN*	(Pelvic fracture in young adults)
		*(*EEVC Limit)*

4.2 Modifiers

4.2.1 Side Head Protection Device (HPD)

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 sizes in both the front and the rear on both sides of the

vehicle. Where a vehicle does not offer sufficient protection, a penalty of -4 points, -2 for front and -2 for rear seats (according to Euro NCAP Side Airbag Head Protection Evaluation[1]), shall be applied to the overall Adult Occupant Protection (AOP) score in 2020 and 2021. From the year 2022 onwards, a penalty of -2 shall be applied to the front and -4 to the rear under the same HPD assessment and applied in the same way to the overall AOP score. Any vehicle that does not provide a head protection device covering either the front or rear seat positions on both sides of the vehicle will attract this modifier. The HPD modifier may be applied to the front and rear positions independently.

4.2.1.1 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 not suitable for adult occupation (handbook).

4.2.1.2 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.

4.2.1.3 Exclusions

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.

4.2.2 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

1 Euro NCAP "OBLIQUE POLE SIDE IMPACT TESTING PROTOCOL", Version 7.0.4, September 2018

impact driver's or passenger'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). In case an MDB or Pole receives modifier(s) for airbag deployment they are carried over from MDB to Pole and vice versa.

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 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.

4.2.3 Backplate Loading

Where the backplate load Fy exceeds 4.0kN, a two point penalty is applied to the driver's or passenger'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: Fy 1.0kN
Lower performance limit: Fy 4.0kN

4.2.4 T12 Modifier

Where the T12 loads Fy and Mx exceed 2.0kN or 200Nm respectively, a two point penalty is applied to the driver's or passenger'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

4.2.5 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 and side pole 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.

4.2.6 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.

4.2.7 Fuel Leakage

In the case of fuel leakage after the crash test, -1 point modifier will be included in the full AOP MDB full scoring.

4.3 Scoring & Visualisation

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 after application of modifiers but excluding possible capping (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 the side barrier and pole impact, all the individual regions are used. Results are shown separately for side barrier and pole impact.

The contribution of the side impact tests to the Adult Occupant Protection Score is calculated by summing the body scores for the relevant body regions. The total score in the side movable deformable barrier and side pole test is limited to 16 points. This is achieved by adding up the individual scores (after modifiers have been applied) for the side impact test (max. 16 points) and the pole test (max. 16 points) and dividing the result by two.

5 WHIPLASH SEAT ASSESSMENT

Whiplash is assessed for front seats. Front seats are tested statically and dynamically according to Euro NCAP Whiplash Testing Protocol. Dynamic test will be assessed using Euro NCAP medium severity pulse and will only be performed when the static assessment score is equal or above 0. The details of the front seat(s) that will be tested by Latin NCAP are contained in Latin NCAP Vehicle Specification, Sponsorship, Testing and Re-testing Protocol. Whiplash points will only be eligible to score when UN R32 point is awarded.

5.1 Front Seat Whiplash Assessment

5.1.1 Criteria and Limit Values

The basic assessment criteria used for front whiplash protection assessment, with the upper and lower performance limits for each parameter, are summarised below.

5.1.1.1 Static Assessments

5.1.1.1.1 Head Restraint Geometry Assessment

The assessment is based on the worst performing parameter from either the height or backset:

Higher performance limit:
Height: 0mm below top height of HPM & HRMD
Backset: 40mm

Lower performance limit:
Height: 80mm below top height of HPM & HRMD
Backset: 100mm

The geometric assessment will be based on the average height and backset taken from at least 9 measurements obtained across all of the seats provided for assessment. A minimum of three drops per seat shall be performed to ensure consistent measurements are obtained on each individual seat. Where obvious outlying HRMD/HPM measurements occur, further installations shall be undertaken on that seat to ascertain whether differences are due to the individual installation or seat to seat variability. Where a seat has a non-reversible head restraint and qualifies for a geometric assessment in the deployed position, additional seats shall be provided by the vehicle manufacturer for measurement.

The geometry assessment has two points allocated to it ranging from plus one to minus one.

5.1.1.1.2 Worst Case Geometry[2]

1/n points (where n = the number of front seats) will be available for each front seat scoring more than 0 points in the worst case geometry assessment. For seats where the occupant must adjust the head restraint, the worst case geometry shall be measured in the lowest and rearmost position regardless of whether or not the seat is equipped with an active head restraint. The assessment will be based on the average height and backset taken from at least 9 measurements in the down and back position obtained across all of the seats provided for assessment. A minimum of 3 drops per seat shall be performed to ensure consistent measurements are obtained on each individual seat. Alternatively, a means of ensuring that the head restraint is correctly positioned for different sized occupants without specific occupant action shall be offered. For these automatically adjusting head restraints, the worst case geometry assessment shall be measured in the position as obtained in Section 6 of the Euro NCAP Whiplash Testing Protocol[3]. This credit will only be available to seats performing well dynamically, with a raw score greater than 4.50 points after capping and all modifiers have been applied.

For the dynamic test of self-adjusting head restraints, the seat should be set in the position as obtained in Section 4.6. of the Euro NCAP Whiplash Testing Protocol[3] and the corresponding head restraint height should be used irrespective of whether this is the mid height position of the head restraint itself.

The individual front seats are scored separately for this feature as cars have been encountered in which different provisions are made for the driver and front passenger seats and the system also allows for cars with three front seats. Where the manufacturer can provide evidence that the front seats are equivalent in terms of the worst case geometry assessment, the seats will be scored equally. Where this is not the case, the manufacturer will be asked to provide an additional seat for assessment.

5.1.1.2 Dynamic Assessments

A sliding scale system of points scoring shall be applied with two limits for each seat design parameter, a more demanding higher performance limit, below which a maximum score is obtained and a less demanding lower performance limit, beyond which no points are scored. Where a value falls between the two limits, the score is calculated by linear interpolation.

The maximum score for each parameter is 1.50 points, with a maximum of 9 points available for the test. For the tests, the score for each of the seven parameters is calculated. The overall score

2 Formerly referred to as “Ease of Adjustment”

3 Euro NCAP “*THE DYNAMIC ASSESSMENT OF CAR SEATS FOR NECK INJURY PROTECTION TESTING PROTOCOL*”, Version 3.3, November 2018

for a single dynamic test is the sum of the scores for NIC, Nkm, Head rebound velocity, neck shear and neck tension, plus the maximum score from either T1 acceleration or head restraint contact time (T-HRC-start). An additional seatback deflection penalty of three points will be applied to seats with a rotation of 32.0° or greater. In the medium term, seat translation may also need to be controlled but, for the interim solution, only rotational control of the seat back is specified. The relevant performance criteria for the medium severity pulse is detailed below.

5.1.1.2.1 Medium Severity Pulse

Criterion*	Higher performance	Lower performance	Capping Limit
NIC	11.00	24.00	27.00
Nkm	0.15	0.55	0.69
Rebound velocity (m/s)	3.2	4.8	5.2
Upper Neck Shear Fx (N)	30	190	290
Upper Neck Tension Fz (N)	360	750	900
T1 acceleration* (g)	9.30	13.10	15.55
T-HRC	57	82	92
Seatback Deflection assessment	32.0°		

* All parameters calculated until THRC-end, except rebound velocity.

5.1.2 Front Whiplash Modifiers

5.1.2.1 Seatback Dynamic Deflection

The medium severity pulse will be subject to an additional seatback deflection assessment where a three point penalty will be applied to the overall score where seats have a rotation of 32.0° or greater.

5.1.2.2 Dummy Artefact Loading

A two point negative modifier would be applied as a means of penalising any seat that, by design, places unfavourable loading on other body areas (e.g. preventing realistic ramping up) or exploits a dummy artefact.

5.2 Scoring

5.2.1 Front Whiplash Score

5.2.1.1 Raw Score

The protocol allows for a maximum score of 11 points as a result of carrying out the whiplash test, assuming no negative modifiers have been applied. This score is known as the raw score and its components are explained below.

The medium severity of whiplash test pulse results in a maximum of 9 points being awarded based on the measured criteria. 1.5 points are awarded for each of NIC, Nkm, Head rebound velocity, F_x and F_z. A further 1.5 points are awarded on the basis of the best score from either T1 acceleration or head restraint contact time (T-HRC).

If any of NIC, Nkm, Head rebound velocity, neck shear or tension exceed the capping limit, no score is given for that pulse. Additionally, if both T1 and head restraint contact time exceed the lower performance limit and either one also exceeds the relevant capping limit, no score is given for the pulse. The sum of the scores from the dynamic tests is then subject to the application of the modifiers.

	Points available
Static assessments	
HR geometry	*-1 to +1 points*
Worst case geometry	*1 point*
Dynamic assessments	
Medium severity pulse	*9 points*
Modifiers	
Seatback deflection	*-3 points*
Dummy artefact loading	*-2 points*
Maximum points	***11 points***

5.2.1.2 Scaled Front Whiplash Score

The raw score is scaled to a maximum of 3 points by multiplication by a factor of 3/11. Scaled scores less than zero are set to zero points.

5.2.2 Front Whiplash Visualisation

For whiplash, the protection provided for the neck of a front seat adult occupant is presented

visually using a colored head and neck graphic. The colour used is based on the scaled points (rounded to three decimal places), as follows:

Green	'Good'	2.250 - 3.000 points
Orange	'Marginal'	1.125 – 2.249 points
Red	'Poor'	0.000 - 0.124 points

6 ASSESSMENT OF AEB CITY SYSTEMS

6.1 Introduction

For the assessment of AEB City systems, two areas of assessment are considered; the Autonomous Emergency Braking function and the Human Machine Interface. The AEB function is assessed in one type of scenario. At this stage the HMI operation is assessed in a general way as scientific evidence regarding quality of warning is lacking.

6.2 Definitions

Throughout this protocol the following terms are used:

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

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

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 Vehicle Target (EVT) – means the vehicle target used in this protocol as specified in Annex A of the AEB test protocol[4].

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

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

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

6.3 Preconditions for scoring AEB city

AEB City points are awarded only when the Whiplash score for the front seat is at least 1.6 points. Additionally, full avoidance needs to be achieved for test speeds up to and including 20 km/h. AEB City points will only be eligible to score when a minimum of 25 points are reached when adding ODB + MDB + Pole side impact assessments score, including the HPD modifiers according to

[4] Euro NCAP TEST PROTOCOL – AEB systems Version 1.1, June 2015

section 4.2.1.

6.4 Criteria and Scoring

6.4.1 Human Machine Interface (HMI)

To be eligible for scoring points for HMI, the AEB system needs to be default ON at the start of every journey.

When the prerequisite mentioned above is met, points can be achieved for the following:

- **Deactivating AEB system not possible with single push of button/switch 2 points**

6.4.2 Autonomous Emergency Braking (AEB)

For the AEB function tests, the assessment criteria used is the relative impact speed Vrel_impact. The available points per test speed are awarded based on the relative speed reduction achieved at every test speed. Where there is no full avoidance a linear interpolation is applied to calculate the score for every single test speed.

$$Score_{\ test\ speed} = ((Vrel_test - Vrel_impact)/Vrel_test) \times points_{test\ speed}$$

The points available for the different test speeds for CCRs are detailed in the table below:

Test speed	**Points$_{\text{test speed}}$**
10 km/h	1.000
15 km/h	2.000
20 km/h	2.000
25 km/h	2.000
30 km/h	2.000
35 km/h	2.000
40 km/h	1.000
45 km/h	1.000
50 km/h	1.000
Total	**14.000**

6.4.3 Total Score

The scoring is based on normalized scores of the AEB function. The test results are used to calculate a normalised AEB score. This results in a single percentage for AEB. The HMI score is the normalised score of the points achieved under section 6.4.1.

The total score in points is the weighted sum of the AEB score and HMI score as shown below.

$$AEB\ City\ total\ score = (AEB\ score\ x\ 2.5) + (HMI\ score\ x\ 0.5)$$

☞ Scoring Example of AEB City system:

a) AEB test results.

Test speed	**points$_{test\ speed}$**	**Vrel_impact**	**Score$_{test\ speed}$**
10 km/h	1.000	0 km/h	1.000
15 km/h	2.000	0 km/h	2.000
20 km/h	2.000	0 km/h	2.000
25 km/h	2.000	0 km/h	2.000
30 km/h	2.000	10 km/h	1.333
35 km/h	2.000	25 km/h	0.571
40 km/h	1.000	35 km/h	0.125
45 km/h	1.000	-	0.000
50 km/h	1.000	-	0.000
Total	**14.000**		**9.029**
Normalised score		**64.5%**	

b) HMI score. The system is always ON and could not be switched OFF. The HMI score = 100%.

c) AEB City total score. Applying the formula above, the total score equals: 2.5x64.5% + 0.5x100% = 2.113 points.

7 REAR END COLLISION VEHICLE BEHAVIOUR

Meeting the UN R32 structural rear impact test will offer **1 point**. In case no R32 certificate, an audit test will be required.

8 RESCUE SHEET AND POST CRASH

1 point will be awarded to vehicles with a Rescue sheet in accordance with ISO 17840-15 criteria made available on the manufacturer's website in Spanish, Portuguese and English from where it can be linked.

5 *https://www.iso.org/obp/ui/#iso:std:iso:17840:-1:ed-1:v1:en*

9 CONCEPTS BEHIND THE ASSESSMENTS

9.1 Frontal Impact

9.1.1 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 during the official test. Under slightly different test conditions, for example, speed, dummy size and dummy position, the head should also be predictably restrained by 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****.***

9.1.2 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.

9.1.3 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.*

9.1.4 Abdomen

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

9.1.5 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 50 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.

9.1.6 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.

9.1.7 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.*

9.1.8 Door Opening (front, side and pole)

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.

9.2 Side and Pole 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: *Backplate*
Poor dummy biofidelity should not be exploited in such a way that compromises other outputs from the dummy.

CONCEPT: *T12*
Poor dummy biofidelity should not be exploited in such a way that compromises other outputs from the dummy.

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.

9.2.1 Door Opening (Front, Side, Pole Impact)

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.

9.3 Whiplash

9.3.1 Geometry Assessment

CONCEPT: *This is used to encourage front seats to have optimum geometry in terms of both height and backset*

9.3.2 Worst Case Geometry

CONCEPT: *The head restraint should be ideally placed for optimal dynamic performance without occupants of different size taking any action other than simply adjusting the seat to suit their leg length. This implies that the head restraint should either be fixed, automatically adjust to the optimal position or should be an adjustable restraint that provides optimum position even in its fully down (worst case) position.*

9.3.3 Seatback Dynamic Deflection

CONCEPT: *The seat distortion should be controlled so that a front occupant is not liable to ejection from behind the seat belt in a rear impact and the risk of interaction between the front and rear occupants is minimised.*

9.3.4 Dummy Artefact Loading

CONCEPT: *A two point negative modifier will be applied to any seat that, by design, places unfavourable loading on other parts of the body as a result of the head restraint mechanism. This modifier shall also penalise any design feature aimed at exploiting any dummy artefact. This is seen as a clear incentive to avoid such design, and an essential feature to safeguard Euro NCAP's position for future designs.*

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APPENDIX I

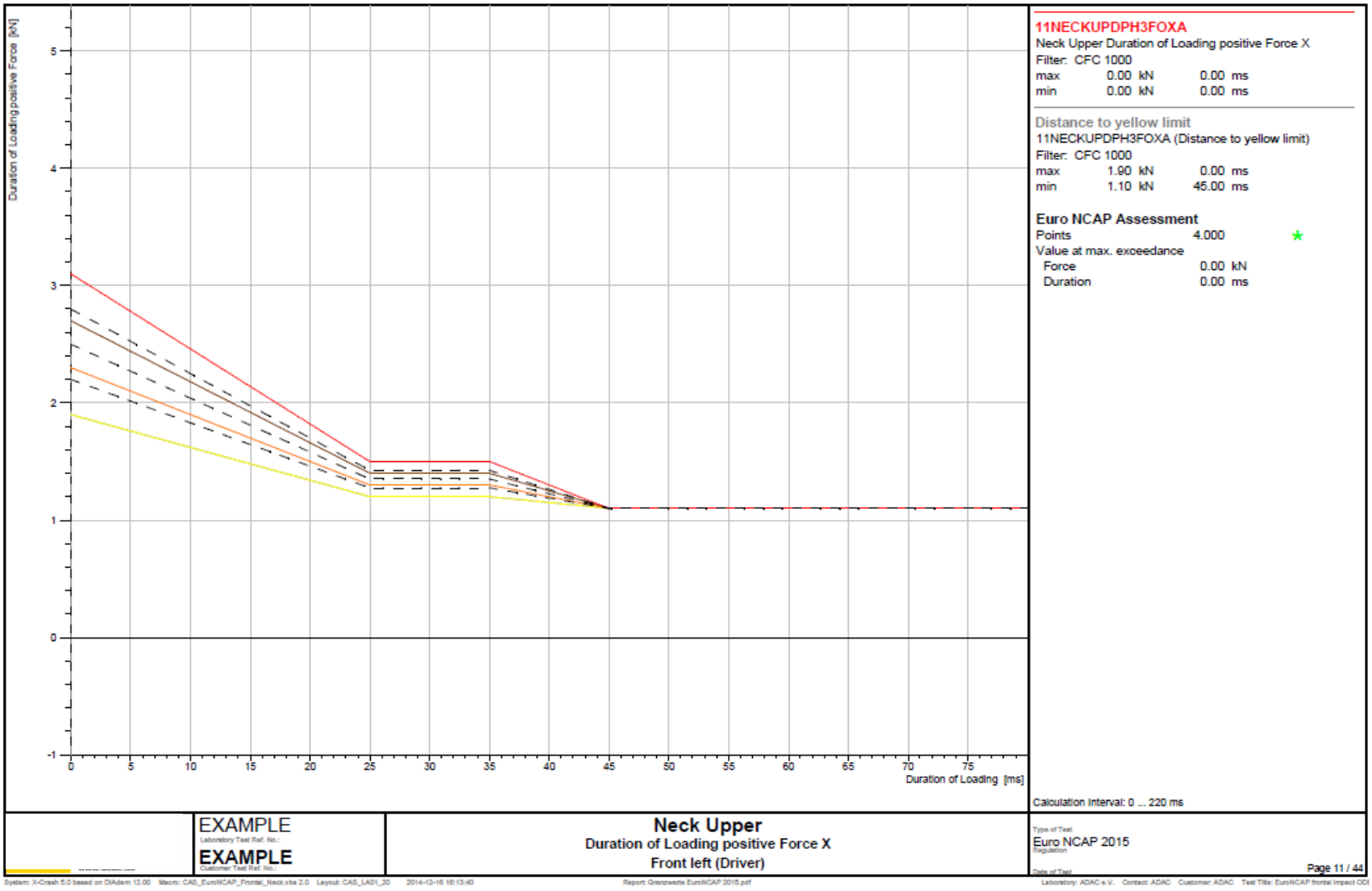
GRAPHICAL LIMITS FOR CUMULATIVE EXCEEDENCE PARAMETERS

1 Upper Neck Shear FX - Positive

2 Upper Neck Shear FX - Negative

3 Upper Neck Tension FZ

4 Femur Compression


Duration of Loading positive Force [kN]
5
4
3
2
1
0
-1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Duration of Loading [ms]
11NECKUPDPH3FOXA
Neck Upper Duration of Loading positive Force X
Filter: CFC 1000
max 0.00 kN 0.00 ms
min 0.00 kN 0.00 ms
Distance to yellow limit
11NECKUPDPH3FOXA (Distance to yellow limit)
Filter: CFC 1000
max 1.90 kN 0.00 ms
min 1.10 kN 45.00 ms
Euro NCAP Assessment
Points 4.000 *
Value at max. exceedance
Force 0.00 kN
Duration 0.00 ms
Calculation Interval: 0 ... 220 ms
EXAMPLE
EXAMPLE
Neck Upper
Duration of Loading positive Force X
Front left (Driver)
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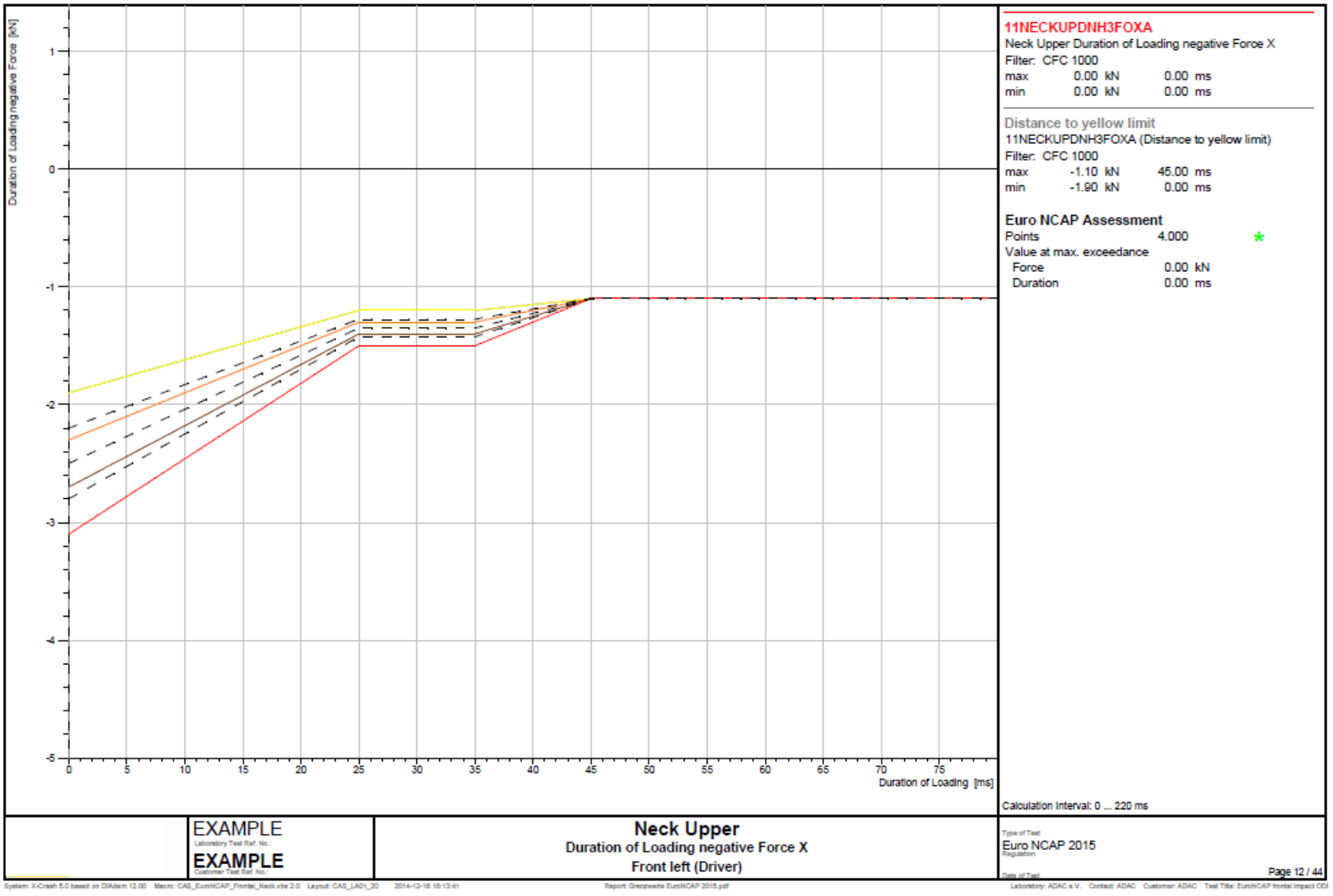
Duration of Loading negative Force [kN]
1
0
-1
-2
-3
-4
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Duration of Loading [ms]
11NECKUPDNH3FOXA
Neck Upper Duration of Loading negative Force X
Filter: CFC 1000
max 0.00 kN 0.00 ms
min 0.00 kN 0.00 ms
Distance to yellow limit
11NECKUPDNH3FOXA (Distance to yellow limit)
Filter: CFC 1000
max -1.10 kN 45.00 ms
min -1.90 kN 0.00 ms
Euro NCAP Assessment
Points 4.000 *
Value at max. exceedance
Force 0.00 kN
Duration 0.00 ms
Calculation Interval: 0 ... 220 ms
EXAMPLE
EXAMPLE
Neck Upper
Duration of Loading negative Force X
Front left (Driver)
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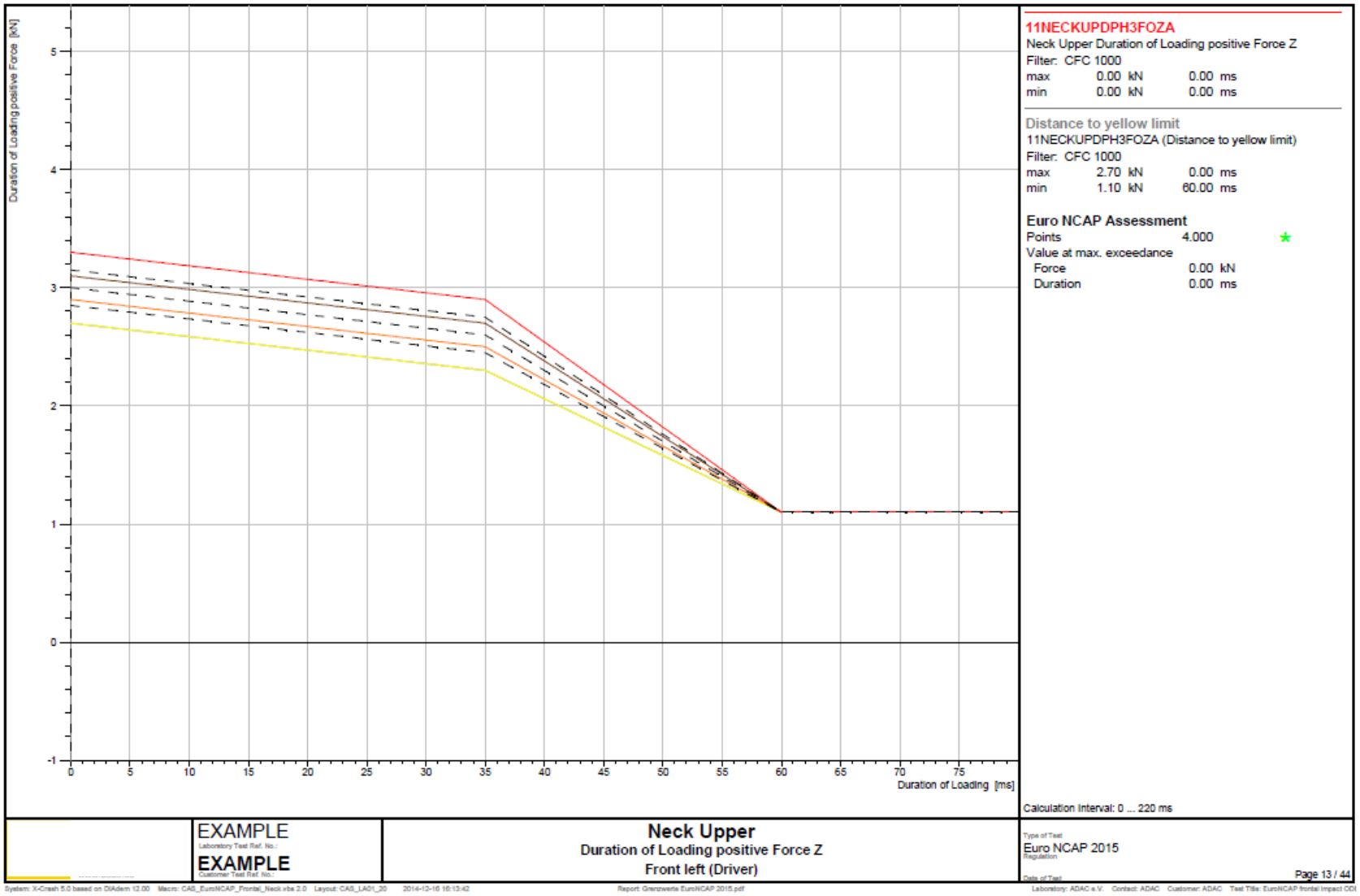
Duration of Loading positive Force [kN]
5
4
3
2
1
0
-1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Duration of Loading [ms]
11NECKUPDPH3FOZA
Neck Upper Duration of Loading positive Force Z
Filter: CFC 1000
max 0.00 kN 0.00 ms
min 0.00 kN 0.00 ms
Distance to yellow limit
11NECKUPDPH3FOZA (Distance to yellow limit)
Filter: CFC 1000
max 2.70 kN 0.00 ms
min 1.10 kN 60.00 ms
Euro NCAP Assessment
Points 4.000 *
Value at max. exceedance
Force 0.00 kN
Duration 0.00 ms
Calculation Interval: 0 ... 220 ms
EXAMPLE
EXAMPLE
Neck Upper
Duration of Loading positive Force Z
Front left (Driver)
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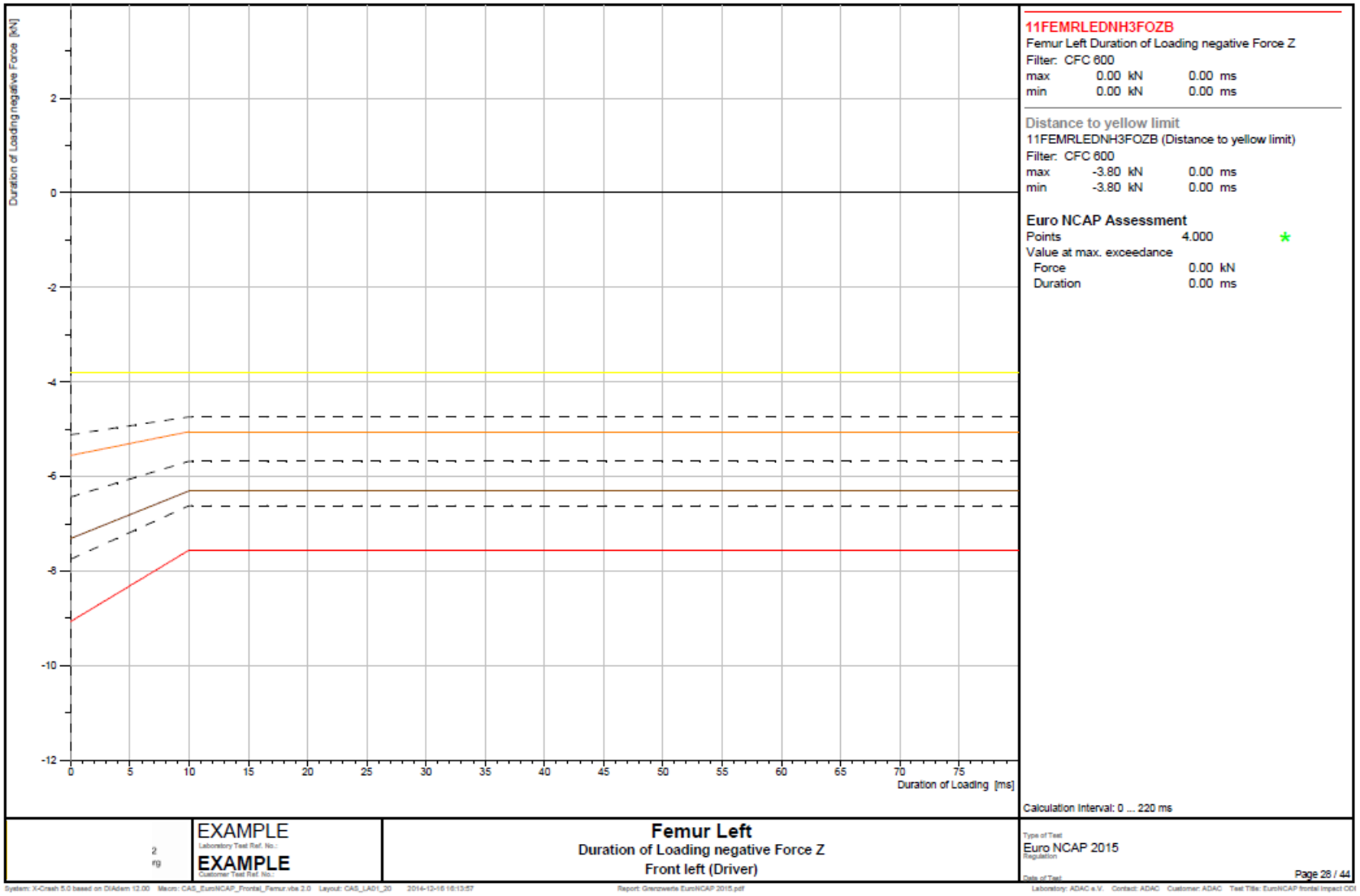
Duration of Loading negative Force [kN]
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Duration of Loading [ms]
11FEMRLEDNH3FOZB
Femur Left Duration of Loading negative Force Z
Filter: CFC 600
max 0.00 kN 0.00 ms
min 0.00 kN 0.00 ms
Distance to yellow limit
11FEMRLEDNH3FOZB (Distance to yellow limit)
Filter: CFC 600
max -3.80 kN 0.00 ms
min -3.80 kN 0.00 ms
Euro NCAP Assessment
Points 4.000 *
Value at max. exceedance
Force 0.00 kN
Duration 0.00 ms
Calculation Interval: 0 ... 220 ms
EXAMPLE
EXAMPLE
Femur Left
Duration of Loading negative Force Z
Front left (Driver)
Euro NCAP 2015
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