EUROPEAN NEW CAR ASSESSMENT PROGRAMME
(Euro NCAP)

L7e FULL WIDTH FRONTAL
TESTING PROTOCOL

Version 1.1
June 2014

Preface

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 Euro NCAP. Where a disagreement exists between the laboratory and manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a manufacturer has interfered with any of the set up, the manufacturer's representative 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 representative will be told to leave the test site and the Secretary General should be immediately informed. Any such incident may be reported by the Secretary General to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

Table of Contents

Page No.

1 VEHICLE PREPARATION

1.1 Unladen Kerb Mass

1.1.1 The capacity of the fuel tank will be specified by the manufacturer. This volume will be referred to throughout as the “fuel tank capacity”.

1.1.2 Syphon most of the fuel from the tank and then run the car until it has run out of fuel.

1.1.3 Calculate the mass of the fuel tank capacity using a density for petrol of 0.745g/ml or 0.840g/ml for diesel. Record this figure in the test details.

1.1.4 Put water, or other ballast, to this mass in the fuel tank.

1.1.5 Check the oil level and top up to its maximum level if necessary. Similarly, top up the levels of all other fluids to their maximum levels if necessary.

1.1.6 Ensure that the vehicle has its spare wheel on board along with any tools supplied with the vehicle. Nothing else should be in the car.

1.1.7 Ensure that all tyres are inflated according to the manufacturer’s instructions for half load.

1.1.8 Measure the front and rear axle weights and determine the total weight of the vehicle. The total weight is the ‘unladen kerb mass’ of the vehicle. Record this mass in the test details.

1.1.9 Measure and record the ride heights of the vehicle at all four wheels.

1.2 Reference Loads

1.2.1 Calculate 10 percent of the fuel tank capacity mass as determined in 1.1.3.

1.2.2 Remove this mass of ballast from the fuel tank, leaving 90 percent of the mass in the tank.

1.2.3 Place both front seats in their mid-positions. If there is no notch at this position, set the seat in the nearest notch rearward (this will be done more completely in Section 6).

1.2.4 Place a mass of equivalent to a Hybrid-III 50M dummy (88kg with instrumentation and cables) on the front driver seat.

1.2.5 Place 20kg in the luggage compartment of the vehicle. The normal luggage compartment should be used i.e. rear seats should not be folded to increase the luggage capacity. Spread the weights as evenly as possible over the base of the luggage compartment. If the weights cannot be evenly distributed, concentrate weights towards the centre of the compartment.

1.2.6 Roll the vehicle back and forth to ‘settle’ the tyres and suspension with the extra weight on board. Weigh the front and rear axle weights of the vehicle. These loads are the “axle reference loads” and the total weight is the “reference mass” of the vehicle.

1.2.7 Record the axle reference loads and reference mass in the test details.

1.2.8 Record the ride-heights of the vehicle at the point on the wheel arch in the same transverse plane as the wheel centres. Do this for all four wheels.

1.2.9 Remove the weights from the luggage compartment and the front and rear seat.

1.3 Vehicle Width

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

1.3.2 Record this width in test details.

1.3.3 Determine the centre-line of the vehicle and mark a line on the bonnet and bumper on the centre line of the car.

➔ **Take the pre-impact vehicle intrusion measurements at this point. See Chapter 2 for a full description of how to do this.**

1.4 Vehicle Preparation

Care should be taken during vehicle preparation that the ignition is not switched on with the battery or airbag disconnected. This will result in an airbag warning light coming on and the airbag system will need to be reset. The manufacturer will need to be contacted if this occurs.

1.4.1 Ensure that the vehicle's battery is connected to the vehicle's electrical circuit in its standard position. Check that the dashboard light for the airbag circuit functions as normal.

Alternatively, the vehicle battery acid may be drained or an additional live battery may be placed in the luggage compartment of the vehicle. If the supply from the drained battery is not supported by an additional battery, the test must be conducted within fifteen minutes after draining the battery.

The Euro NCAP Secretariat should be contacted if an additional battery is thought necessary. In the case it is agreed on to use an additional battery, it must be connected directly to the original battery so that the vehicle's original electrical system, cable routing and connections remain unaltered. The power cables connecting both batteries must be positioned on the non-struck side of the car in such a way to minimise the risk of the cable being cut during the impact. The cable used to connect both batteries must have a minimum cross section of $5mm^2$ to ensure a minimum voltage drop. The current supplied to the vehicle must be monitored throughout the impact across the original battery. Where an additional battery is to be used the vehicle manufacturer will be required to indicate the minimum voltage/current needed during the test for all systems to operate as intended. The manufacturer will be asked to confirm that the laboratory modifications are suitable for use in the vehicle being tested and will not influence any of the vehicle systems.

1.4.2 Remove the luggage area carpeting, spare wheel and any tools or jack from the car. The spare wheel should only be removed if it will not affect the crash performance of the vehicle.

1.4.3 An emergency abort braking system may be fitted to the vehicle. This is optional; the test facility may elect to test without an abort system. Where such a system is fitted its inclusion shall not influence the operation or function of any of the foot controls, in particular the brake pedal. The position and the resistance to movement of the pedals shall be the same as prior to fitment of the system. Remove as little as possible of the interior trim; any mass compensation will be made when all equipment has been fitted.

1.4.4 Place weights equivalent to a Hybrid-III 50M dummy (88kg) on the front driver seat (with the seat in the test position).

1.4.5 Weigh the front and rear axle weights of the vehicle. Compare these weights with those determined in Section 1.2.6.

1.4.6 If the axle weights differ from those measured in Section 1.2.6 by more than 5% (of the axle reference loads) or by more than 20kg, remove or add items which do not influence the structural crash performance of the vehicle. Similarly, if the total vehicle mass differs by more than 25kg from the reference mass, non-structural items may be removed or added. Any additional mass that is added to the vehicle should be securely and rigidly attached.

1.4.7 Repeat Sections 1.4.5 and 1.4.6 until the front and rear axle weights and the total vehicle weight are within the limits set in 1.4.6. Record the final axle weights in the test details.

1.4.8 The vehicle manufacturer will be required to inform Euro NCAP and the test laboratory of the presence of any pre-crash systems that must be disabled prior to impact. Disabling information shall be provided to the laboratory prior to impact. It is the responsibility of the vehicle manufacturer to ensure that the disconnection of the system does not influence the performance of any systems that are intended to function during the impact.

1.5 Vehicle Markings

1.5.1 Euro NCAP markings will be attached to the exterior of the vehicle in the following locations; upper half of driver's door, upper half of front passenger's door and on the front half of the roof of the vehicle. Refer to figure 1.1 below.

1.5.2 Test house logos may be added to the vehicle provided that they do not detract attention from the Euro NCAP markings. Suitable locations for such markings would be the lower half of the rear doors and on the bonnet at the base of the windscreen.

Figure 1.1

2 INTRUSION MEASUREMENTS

For vehicle deformation and intrusion measurements a 3D measuring system which is capable of recording 3 dimensional co-ordinates of a point in space can be used. A tolerance of +/- 1mm is applicable to such a system. The system requires an axis system to be set up relative to the object to be measured, typically the transverse, longitudinal and vertical directions of a vehicle. An origin is first needed, followed by a point on the positive x axis and then a point in the positive x-y plane. Since the front of the vehicle is highly deformed after the impact, it is simplest to use some structure at the rear of the vehicle as a reference for measurement; this obviates the need to level the car after testing, the accuracy of which is limited. Most of the procedure which follows relates to the setting up of these axes.

2.1 Before Test

2.1.1 Determine and mark the centre of the clutch, brake and accelerator pedals.

2.1.2 Set the steering wheel to its mid-position, if it is adjustable for either rake or reach (for full description of how to do this, see Chapter 6).

2.1.3 Remove the centre of the steering wheel or, if fitted, the airbag assembly to expose the end of the steering column. When doing this, carefully note the connections to the airbag which will need to be remade on re-assembly. Follow the manufacturer's instructions when removing the airbag and/or steering wheel assemblies.

2.1.4 Determine and mark the centre of the top of the steering-column.

2.1.5 Remove the carpet, trim and spare wheel from the luggage compartment. The plastic trim or rubber seals that might influence the latching mechanism should be re-fitted once the intrusion measurements have been recorded. This is to ensure that any opening of the rear door during the impact is not caused by the omission of some part of the trim around the latching mechanism.

2.1.6 Locate the vehicle axis reference frame (see Figure 1) centrally to the rear of the vehicle.

Figure 1. Setting up axis reference frame.

2.1.7 Level the reference frame.

2.1.8 Measure and record the stud heights of the reference frame. These will be used after the test to help reset the reference frame, if required.

2.1.9 If it is necessary to lean on the vehicle to reach the following points, the vehicle should be supported to maintain the ride heights during measuring.

2.1.10 Set up the vehicle co-ordinate axes in the 3D arm or similar device.

2.1.11 Mark and record the position of at least 5 datum points on the rear of the vehicle. These points should be on structures which are not expected to be deformed in the test and should be positioned such that they have wide spaced locations in three dimensions and can all be reached with the 3D measuring system in one position.

2.1.12 Working on the passenger side of the vehicle determine and mark the positions on the B-post which are:

a) at a distance of 100 mm above the sill.

b) at a distance of 100 mm beneath the lowest level of the side window aperture.

All points should be as close as possible to the rubber sealing strip around the door aperture.

2.1.13 Measure and record the pre-impact positions of the two door aperture points.

2.1.14 Working on the driver's side of the vehicle determine and mark the positions on the A and B posts which are:

a) at a distance of 100 mm above the sill.

b) at a distance of 100 mm beneath the lowest level of the side window aperture.

All points should be as close as possible to the rubber sealing strip around the door aperture.

2.1.15 Use the arm to measure the pre-impact positions of the centre of the top of the steering-column and the four door aperture points.

2.1.16 Record the position of the centre of the un-depressed clutch, brake and accelerator pedals and where applicable foot operated parking brake. If the pedal is adjustable, set it to the mid position or a reasonable variation from this in accordance with the manufacturer's recommendations for the 5th percentile position.

2.1.17 Replace the steering wheel and airbag assembly. Check that all bolts are securely fastened. Ensure that all connections to the airbag are replaced and check the dashboard light to confirm the circuit is functional.

2.2 After Test

2.2.1 Before dummy removal measure the distance between all foot pedals and a fixed point in the footwell, e.g. seat runner, seat mounting bolt. If access cannot be gained remove the dummy, according to Section 8.4, taking care not to disturb any pedals and then record the measurement. This measurement should be re-checked before the pedals are measured with the 3D measuring system. If the pedal has moved re-position the pedal using the measurement taken previously.

2.2.2 Remove the dummy according to Section 8.4 and remove the data acquisition and emergency abort equipment (if fitted) from the luggage compartment.

2.2.3 Remove the centre of the steering wheel or airbag assembly.

2.2.4 Use any 3 of the 5 datum points at the rear of the vehicle, and their pre-impact measurements, to redefine the measurement axes.

2.2.5 If the axes cannot be redefined from any 3 of the datum points relocate the axis reference frame in the same position as in Section 2.1.6. Set the studs of the frame to the same heights as in Section 2.1.8 (Figure 2). The frame should now be in the same position relative to the car as it was before impact. Set up the measurement axes from the frame.

2.2.6 Record the post-impact positions of the B-post points on the passenger's side of the vehicle.

2.2.7 Compare the vertical co-ordinate of the B-post sill point before and after the test.

2.2.8 Find the angle θ that best satisfies the following equation: z = - x′sin θ + z′cos θ for the B-post sill point (where z = pre impact vertical measurement and x′,z′ = post-impact longitudinal and vertical).

2.2.9 Working on the passenger's side of the vehicle, record the post-impact co-ordinates of the centre of the steering column, the centre of the clutch, brake and accelerator pedals, and where applicable a foot operated parking brake, with no load applied to them and in the blocked position (loaded with 200N to produce the maximum moment about the pedal pivot), the door aperture points. Prior to the 'blocked' pedal measurement, i.e. with the 200N applied, the brake fluid shall be removed to avoid the build-up of hydraulic pressure. If the steering column has become detached during impact due to the operation of the shear capsules, the column should be repositioned before measurement in the upward and lateral directions so that it is in contact with whatever structure(s) last constrained it from further movement. If any of the foot pedals become detached do not take a measurement of that pedal.

2.2.10 Transform the post impact longitudinal and vertical measurements (x′,z′) using the following equations.

$$\begin{bmatrix} X' \\ Z' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x' \\ z' \end{bmatrix}$$

2.2.11 Where θ is the angle determined in Section 2.2.8. X and Z should now be in the same frame of reference as the pre-impact measurements, assuming that the point on the passenger's side B-post sill is not displaced vertically or laterally during the impact.

2.2.12 From the pre-impact and adjusted post-impact data collected, determine

a) the longitudinal, lateral and vertical movement of the centre of the top of the steering column.

b) the longitudinal and vertical movement of all of the foot operated pedals.

c) the rearward movement of the A-post at waist level.

d) the reduction in width of the door aperture at waist and sill levels.

2.2.13 Record these intrusion measurements in the test details.

Figure 2. Re-setting axis reference frame after test.

3 DUMMY PREPARATION AND CERTIFICATION

3.1 General

One Hybrid III 50M test dummy should be used for the front driver seat. It should conform to U.S. Department of transportation, Code of Federal Regulations Part 572 Subpart E and ECE Regulation No. 94, except for modifications and additions stated later.

3.2 Additions and Modifications to the Hybrid III Dummy

The additions and modifications which will change the dynamic behaviour of the test dummy from Part 572E specification dummy are:

3.2.1 Roller ball-bearing knees shall be fitted.

3.2.2 Foam neck shields (Part 93051-1-DN or equivalent) must be fitted to the driver and passenger if a frontal protection airbag is present.

3.3 Dummy Certification

Full details of the certification procedure for the Hybrid-III dummy are available elsewhere (see Part 572 Subpart E of US Department of Transportation Code of Federal Regulations), SAE J2856 and Annex 10 of ECE Regulation No. 94). No manufacturer shall have access to any pre-test information regarding any of the test equipment to be used by Euro NCAP, or be permitted to influence its selection in any way.

3.3.1 The Hybrid-III 50M dummy shall be re-certified after every THREE impact tests.

3.3.2 The chest shall be certified according to the frequency above and should meet both the low speed thorax test as prescribed by SAE J2779, as well as the full certification test detailed in CFR572. Additionally, chest potentiometer calibration and polynomial post processing shall also be performed as detailed in SAE J2517. See Technical Bulletin 005 for more details.

3.3.3 The knee slider shall be certified to SAE J2876 after every THREE impact tests and as specified in SAE J2856 after every NINE impact tests. See Technical Bulletin 006 for more details.

3.3.4 If an injury criterion reaches or exceeds its normally accepted limit (eg. HIC of 700) then that part of the dummy shall be re-certified.

3.3.5 If any part of a dummy is broken in a test then the part shall be replaced with a fully certified component.

3.3.6 Copies of the dummy certification certificates will be provided as part of the full report for a test.

3.4 Dummy Clothing and Footwear

3.4.1 The dummy will be clothed with formfitting cotton stretch garments with short sleeves and pants which should not cover the dummy’s knees.

3.4.2 The dummy shall be fitted with shoes equivalent to those specified in MIL-S13192 rev P. (size 11EEE)

3.5 Dummy Test Condition

3.5.1 Dummy Temperature

3.5.2 The dummy shall have a stabilised temperature in the range of 19ºC to 22ºC.

3.5.3 A stabilised temperature shall be obtained by soaking the dummy in temperatures that are within the range specified above for at least 5 hours prior to the test.

3.5.4 Measure the temperature of the dummy using a recording electronic thermometer placed inside the dummy's flesh. The temperature should be recorded at intervals not exceeding 10 minutes.

3.5.5 A printout of the temperature readings is to be supplied as part of the standard output of the test.

3.5.6 Dummy Joints

3.5.7 All constant friction joints should have their 'stiffness' set by the following method:

3.5.8 Stabilise the dummy temperature by soaking in the required temperature range for at least 5 hours.

3.5.9 The tensioning screw or bolt which acts on the constant friction surfaces should be adjusted until the joint can just hold the adjoining limb in the horizontal. When a small downward force is applied and then removed, the limb should continue to fall.

3.5.10 The dummy joints stiffness should be set as close as possible to the time of the test and, in any case, not more than 24 hours before the test.

3.5.11 Maintain the dummy temperature within the range 19°C to 22°C between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.

3.5.12 Dummy face painting

3.5.13 With the exception of the Hybrid-III face, the dummy should have masking tape placed on the areas to be painted using the size table below. The tape should be completely covered with the following coloured paints. The paint should be applied close to the time of the test to ensure that the paint will still be wet on impact.

Eyebrows (left and right)	Red
Top of head (rear passenger only)	Blue
Nose	Green
Chin	Yellow
Left Knee	Red
Right Knee	Green

Paint Area Sizes:

Eyebrow (L/R)	(25/2) x 50mm.
Nose	25 x 40mm strip, down nose centre line.
Chin	25 x 25mm square, centre line of chin.
Knee (L/R)	50 x 50mm square, knee centre line with bottom edge level with top of tibia flesh.
Tibia (L/R)	25mm x 50mm, 4 adjacent areas down leg centre line with top edge level with top of tibia flesh.

3.6 Post Test Dummy Inspection

The dummy should be visually inspected immediately after the test. Any lacerations of the skin or breakages of a dummy should be noted in the test specification. A dummy may have to be re-certified in this case.

4 INSTRUMENTATION

All instrumentation shall be calibrated before the test programme. The Channel Amplitude Class (CAC) for each transducer shall be chosen to cover the Minimum Amplitude listed in the table. In order to retain sensitivity, CACs which are orders of magnitude greater than the Minimum Amplitude should not be used. A transducer shall be re-calibrated if it reaches its CAC during any test. All instrumentation shall be re-calibrated after one year, regardless of the number of tests for which it has been used. A list of instrumentation along with calibration dates should be supplied as part of the standard results of the test. Transducer mounting and sign convention is in accordance with SAE J211 (1995).

4.1 Dummy Instrumentation

The HIII-50M dummy shall be instrumented to record the channels listed below.

Location	**Parameter**		**Minimum Amplitude**	**Driver No of channels**
Head	Accelerations, A_x A_y A_z		250g	3
Neck	Forces	F_x F_y	9kN	2
		F_z	14kN	1
	Moments, M_x M_y M_z		290Nm	3
Chest	Accelerations, A_x A_y A_z		150g	3
	Deflection, D_{chest}		100mm	1
Pelvis	Accelerations, A_x A_y A_z		150g	3
Femurs (L & R)	Forces, F_z		20kN	2
Knees (L & R)	Displacements, D_{knee}		19mm	2
	Total Channels per Dummy			20
Total Channels				

4.2 Vehicle Instrumentation

4.2.1 The vehicle is to be fitted with an accelerometer on each B-post. The accelerometers are to be fitted in the fore/aft direction (Ax).

4.2.2 Remove carpet and the necessary interior trim to gain access to the sill directly below the B-post.

4.2.3 Securely attach a mounting plate for the accelerometer horizontally on to the sill, without adversely affecting seat belt retractors and/or pretensioners.

4.2.4 Fix the accelerometer to the mounting plate. Ensure the accelerometer is horizontal to a tolerance of ±1 degree and parallel to the X-axis of the vehicle.

4.2.5 Attach lightweight (<100g) seatbelt loadcells to the shoulder section of the driver seatbelts.

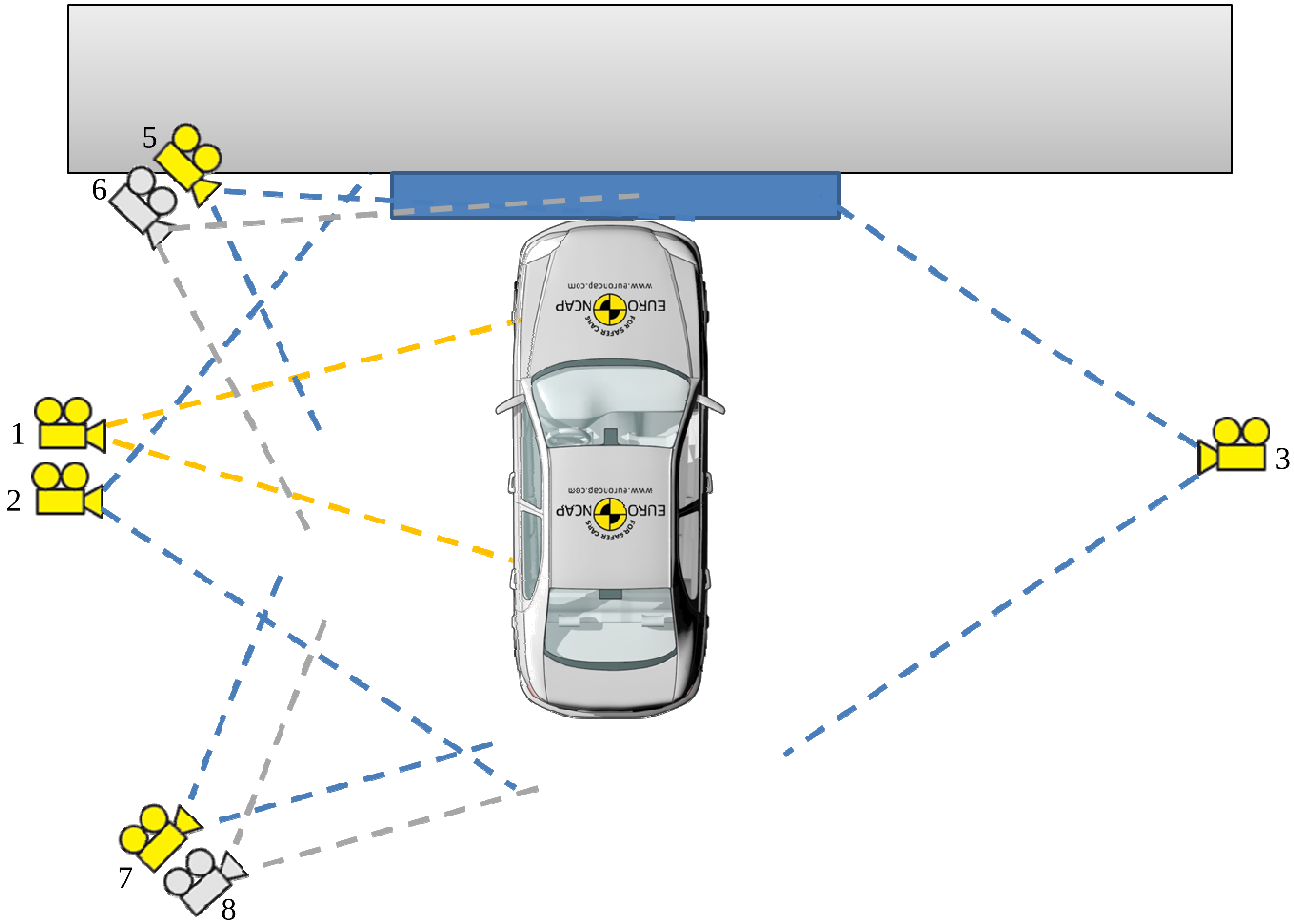
Location	Parameter	Minimum Amplitude	No of channels
B-Post LHS	Accelerations, A_x	150g	1
B-Post RHS	Accelerations, A_x	150g	1
Driver Seatbelt Shoulder Section	Force, $F_{diagonal}$	16kN	1
Total Channels per Vehicle			**3**

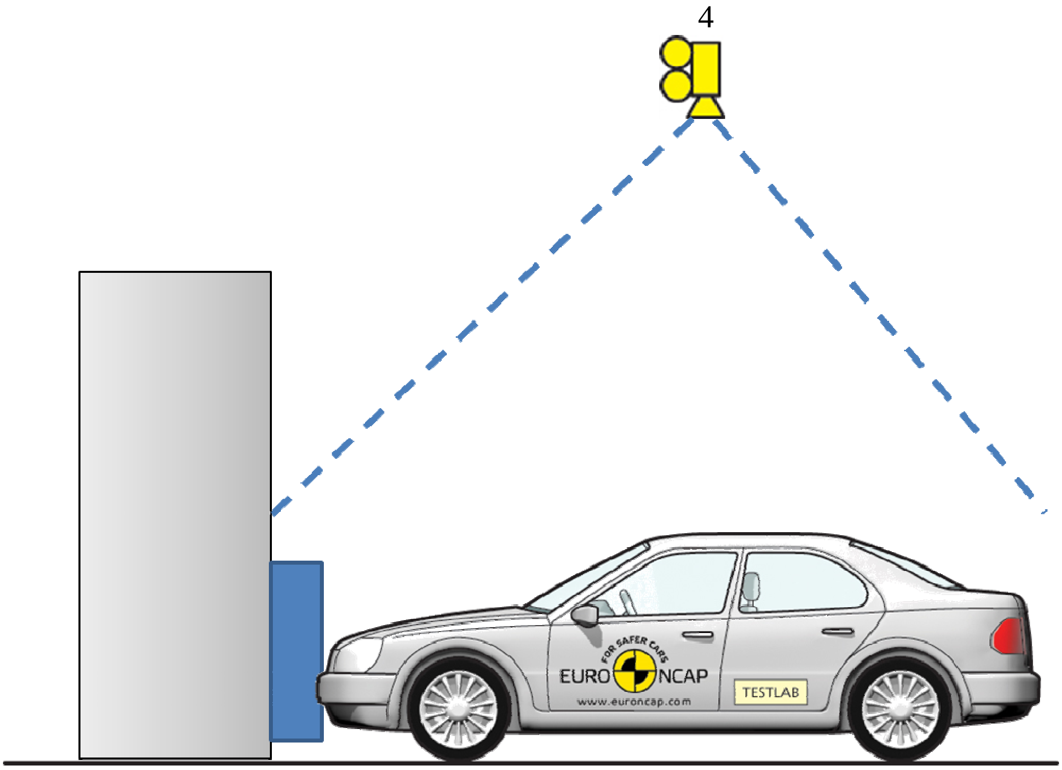
4.3 Summary of Total Channels

1× Driver Hybrid-III	20
1× Vehicle	3
Total Channels per Test	**23**

5 CAMERA LOCATIONS

Set up high speed film cameras according to the following diagrams





Camera No.	Camera Type	Shot Content
1	>/= 500 fps high speed	Driver (tight)
2	>/= 500 fps high speed	Driver (wide)
3	>/= 500 fps high speed	Passenger side (wide)
4	>/= 500 fps high speed	Plan view (wide)
5	>/= 500 fps high speed	Angled front view (wide)
6	>/= 10 fps normal camera	Angled front view (wide)
7	>/= 500 fps high speed	Angled rear view (wide)
8	>/= 10 fps normal camera	Angled rear view (wide)

5.1 The Euro NCAP High Speed Digital Film Specifications are contained in a separate document.

5.2 Lens sizes should be chosen appropriately in order to achieve the required shot content/intention. In order to prevent view distortion, a minimum lens size of 9mm is applicable.

5.3 Cameras 2, 7 and 9 are considered an essential requirement for all tests for media coverage.

6 PASSENGER COMPARTMENT ADJUSTMENTS

6.1 Driver Compartment Adjustments

Adjustment[1]	Required Setting	Notes	Methods
Seat Fore/Aft	Mid position defined as mid between most forward and 95th male position	May be set to first notch rearwards of mid position if not lockable at mid position	
Seat Base Tilt	Manufacturer's design position	Permissible up to Mid Position	
Seat Height	Lowest position		
Seat Back Angle (as defined by torso angle)	Manufacturer's design position	Otherwise 25° to vertical As defined by Torso angle	
Seat Lumbar Support	Manufacturer's design position	Otherwise fully retracted	
Front Head Restraint Height & Tilt	Mid locking position	As whiplash test position	
Steering wheel - vertical	Mid position		
Steering wheel - horizontal	Mid position		
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering	
Seat belt anchorage (where adjustable)	Initially, manufacturer's 50th percentile design position	If no design position then set to mid-position, or nearest notch upwards	

6.2 Other Vehicle Adjustments

Adjustment	Required Setting	Notes	Methods
Glazing	Front – Lowered Rear - Lowered or removed	This applies to opening windows only	
Gear change lever	In the neutral position		
Pedals	50th male position		
Doors	Closed, not locked		
Roof	Lowered	Where applicable	
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		

6.3 Driver Seating Position for Test

6.3.1 Position the test seat's adjustable lumbar supports so that the lumbar supports are in the lowest, retracted or deflated adjustment positions.

6.3.2 Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position.

1. Adjustments not listed will be set to mid-positions or nearest positions rearward, lower or outboard.

6.3.3 Position an adjustable seat cushion length to the retracted position.

6.3.4 Position an adjustable leg support system in its rearmost position.

6.3.5 Place adjustable pedals in the position in the 50th male position.

6.3.6 Identify one seat cushion reference point at the rear side of the seat cushion ($SCRP_{REAR}$).

6.3.7 Locate and mark the longitudinal centreline of the seat cushion.

6.3.8 Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the upper most vertical location.

6.3.9 Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the rear most location.

6.3.10 Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the lowest vertical location.

6.3.11 Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the rear most location. Record the position XRD.

6.3.12 Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the forward most location. Record the position XFD.

6.3.13 Measure and mark the position at the manufacturer design position X50. If no design position given, X50 is the mid position between most forward and the 95th position.

6.3.14 Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the X50 position marked in 6.3.13.

6.3.15 Determine and record the range of angles of the seat cushion pitch and using only the control(s) that primarily adjust(s) the cushion pitch, set cushion pitch to the manufactures design position. If no design position given, set cushion pitch to mid-angle. Note, for some vehicles this step may change the X50 position as established in 6.3.13, this is acceptable.

6.3.16 Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the lowest vertical location. Record the position Z50D.

6.3.17 Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the highest vertical location. Record the position Z50U.

6.3.18 Measure and mark a position at the manufacturer design position Z50. If no design position given, Z50 is the lowest position of the vertical range.

6.3.19 Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the Z50 position marked in 6.3.18. Note, for some vehicles this final step may change the X50 position established in 6.3.13 and/or the cushion pitch as established in 6.3.15, this is acceptable.

6.3.20 Record test seat base position co-ordinates of the $SCRP_{REAR}$.

6.4 Front Passenger Seating Position for Test

6.4.1 The driver and passenger seatback angle and seat base position shall be set to the same position.

6.4.2 Where one seat is height adjustable and the other is fixed, the relative angle between the seat back and the ground should be the same for both seats.

6.4.3 Repeat the steps in 6.3 to set the front passenger seat to the 50M seating position, identical to the driver.

6.5 Setting the Steering Wheel Horizontal Adjustment

6.5.1 Choose a part of the facia that is adjacent to the steering column and can be used as a reference.

6.5.2 Move the steering wheel to the most forward position of its travel.

6.5.3 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most forward travel of the steering wheel.

6.5.4 Move the steering wheel to the most rearwards position of its travel.

6.5.5 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most rearwards travel of the steering wheel.

6.5.6 Measure the distance between the forwards and rearwards marks on the steering column. Place a third mark on the steering column at the manufacturers design position. If no position is given, place a mark mid-way between the forwards and rearwards marks, which corresponds to the centre of travel of the steering wheel.

6.5.7 Move the steering wheel so that the mark on the steering column as established 6.5.6 aligns with the facia.

6.5.8 Lock the steering column at this position. The vehicle will be tested with the steering wheel in this position.

6.6 Setting the Steering Wheel Vertical Adjustment

The same method as in Section 6.5 should be used to find and set the steering wheel vertical adjustment to the mid position. It is unlikely that the same part of the facia used during the setting procedures for the horizontal adjustments could be used for the vertical adjustment. Care should be taken to avoid unintentional adjustment of the horizontal setting during the vertical adjustment procedure.

7 DUMMY POSITIONING AND MEASUREMENTS

The following chapter deals with all aspects of seating the dummy in the vehicle to be tested.

7.1 Determine the H-point

The device to be used is the H-point machine as described in SAE J826.

If the seat is new and has never been sat upon, a person of mass 75 ± 10kg should sit on the seat for 1 minute twice to flex the cushions. The seat shall have been at room temperature and not been loaded for at least 1 hour previous to any installation of the machine.

7.1.1 Driver seat

7.1.1.1 Set the seat back so that the torso of the dummy is as close as possible to the manufacturer's reasonable recommendations for normal use or to the standard setting as detailed in 6.1

7.1.1.2 Place a piece of muslin cloth on the seat. Tuck the edge of the cloth into the seat pan/back join, but allow plenty of slack.

7.1.1.3 Place the seat and back assembly of the H-point machine on the seat at the centre line of the seat.

7.1.1.3.1 For seats with defined bolsters, or individual auxiliary seats, C/LO is the centreline of the seat.

7.1.1.3.2 For bench seats (or other) seats, C/LO is the middle of the head restraint. If a head restraint is not fitted, find C/LO between the belt anchors.

7.1.1.3.3 If the C/LO cannot be found with the procedures 7.1.1.3.1 through 7.1.1.3.3 the C/LO is located 381mm outboard from the vehicle centreline.

7.1.1.4 Set the thigh and lower leg segment lengths to 401 and 414mm respectively.

7.1.1.5 Attach lower legs to machine, ensuring that the transverse member of the T-bar is parallel to the ground.

7.1.1.6 Place right foot on undepressed accelerator pedal, with the heel as far forwards as allowable. The distance from the centre line of the machine should be noted.

7.1.1.7 Place left foot at equal distance from centre line of machine as the right leg is from centre line. Place foot flat on footwell.

7.1.1.8 Apply lower leg and thigh weights.

7.1.1.9 Tilt the back pan forwards to the end stop and draw the machine away from the seat-back. If required, it is allowed to temporarily adjust the steering wheel postion to allow installation of the H-point machine. If the steering wheel is interfering with the H-point machine, the seat may be positioned more rearward or the steering wheel may be removed to allow installation of the H-point machine.

7.1.1.10 Allow the machine to slide back until it is stopped by contacting the seat back.

7.1.1.11 Apply a 10kg load twice to the back and pan assembly positioned at the intersection of the hip angle intersection to a point just above the thigh bar housing.

7.1.1.12 Return the machine back to the seat back.

7.1.1.13 Install the right and left buttock weights.

7.1.1.14 Apply the torso weights alternately left and right.

7.1.1.15 Tilt the machine back forwards to a vertical position and while holding the T-bar rock the pan by 5 degrees either side of the vertical. After rocking the T-bar should be parallel to the ground.

7.1.1.16 Reposition the feet by lifting the leg and then lowering the leg so that the heel contacts the floor and the sole lies on the undepressed accelerator pedal.

7.1.1.17 Holding the T-bar to prevent the H-Point machine from sliding forward on the seat cushion, return the machine back to the seat back.

7.1.1.18 Check the lateral spirit level and if necessary apply a lateral force to the top of the machine back, sufficient to level the seat pan of the machine.

7.1.1.19 Adjust the seat back angle to the angle determined in 7.1.1.1, measured using the spirit level and torso angle gauge of the H-point machine. Ensure that the torso remains in contact with the seat back at all times. Ensure that the machine pan remains level at all times.

7.1.1.20 Measure and record in the test details the position of the H-point relative to some easily identifiable part of the vehicle structure

7.1.1.21 Measure and record in the test details the angle of the seat assembly of the H-point machine and the position of the seat cushion front end

7.2 Dummy Placement

7.2.1 Ensure that the seat is in the correct position as defined by Section 7.1.

7.2.2 Place the dummy in the seat with the torso against the seat back, the upper arms against the seat back and the lower arms and hands against the outside of the upper leg.

7.3 Driver Dummy Positioning

Dummy positioning should be carried out immediately before the test and the vehicle should not be moved or shaken thereafter until the test has begun. If a test run is aborted and the vehicle brought to a standstill using an emergency braking method, the dummy placement procedure should be repeated. If the dummy, after three attempts cannot be positioned within the tolerances below then it is to be placed as close to the tolerance limits as possible. Record this in the test details.

7.3.1 H-point

The dummy's H-point shall be within 13mm in the vertical dimension and 13mm in the horizontal dimension of a point 6mm below the H-point as determined in Section 7.1. Record the position of the dummy H-point in the test details.

7.3.2 Pelvic Angle

The pelvic angle measurement gauge should read 22.5° ± 2.5° from the horizontal. Record the measured angle in the test details.

7.3.3 Head

The transverse instrumentation platform of the head shall be horizontal to within 2.5°

Levelling of the head shall be carried out in this order:

- Adjust the H-point within the limit
- Adjust the pelvic angle within the limits
- Adjust the neck bracket the minimum to ensure that the transverse

instrumentation platform is level within limits.

Record the measured angle in the test details.

7.3.4 Arms

The driver's upper arms shall be adjacent to the torso as far as is possible

7.3.5 Hands

The driver dummy's hands shall have their palms placed against the steering wheel at a position of a quarter to three. The thumbs should be lightly taped to the wheel.

7.3.6 Torso

The dummy's backs should be in contact with the seat back and the centre line of the dummy should be lined up with the centre line of their respective seats.

7.3.7 Legs

The upper legs of both dummies shall be in contact with the seat cushion as far as possible. The distance apart of the outside metal surfaces of the knees of each dummy shall be 270mm ± 10mm (except if the left foot is placed on a footrest in par. 6.5.8 below). The legs of the dummies should be in vertical longitudinal planes as far as is possible.

7.3.8 Feet

The driver dummy's right foot shall rest on the undepressed accelerator pedal with the heel on the floor. If the foot cannot be placed on the pedal then it should be placed as far forwards as possible with the foot perpendicular to the lower tibia, in line with the centre line of the pedal. The left foot should be placed as flat as possible on the toe-board parallel to the centre line of the vehicle. If any part of the left foot is in contact with a foot-rest or wheel arch when in this position then place the foot fully on this rest providing a normal seating position can still be achieved. Keep the legs in the same vertical longitudinal plane. The knee gap requirement of 270mm ± 10mm may be ignored in this case. Note the knee gap in the test details.

7.3.9 Seat belt

7.3.9.1 Where possible, initially position the upper seat belt anchorage in the manufacturers 50th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the mid-position or nearest notch upward.

7.3.9.2 Carefully place the seat belt across the dummy and lock as normal. It will be necessary to re-position the hands as described in Section 7.3.5.

7.3.9.3 Remove the slack from the lap section of the webbing until it is resting gently around the pelvis of the dummy. Only minimal force should be applied to the webbing when removing the slack. The route of the lap belt should be as natural as possible.

7.3.9.4 Place one finger behind the diagonal section of the webbing at the height of the dummy sternum. Pull the webbing away from the chest horizontally forward and allow it to retract in the direction of the D-loop using only the force provided by the retractor mechanism. Repeat this step three times, only.

7.3.9.5 After following the above steps, the seatbelt should lie in a natural position across the dummy sternum assembly and shoulder clavicle. Where this is not the case, for example the belt is close to or in contact with the neck shield or the belt is above the shoulder rotation adjustment screw, and the upper belt anchorage is adjustable the anchorage should be lowered and steps 7.3.9.3 and 7.3.9.4 repeated.

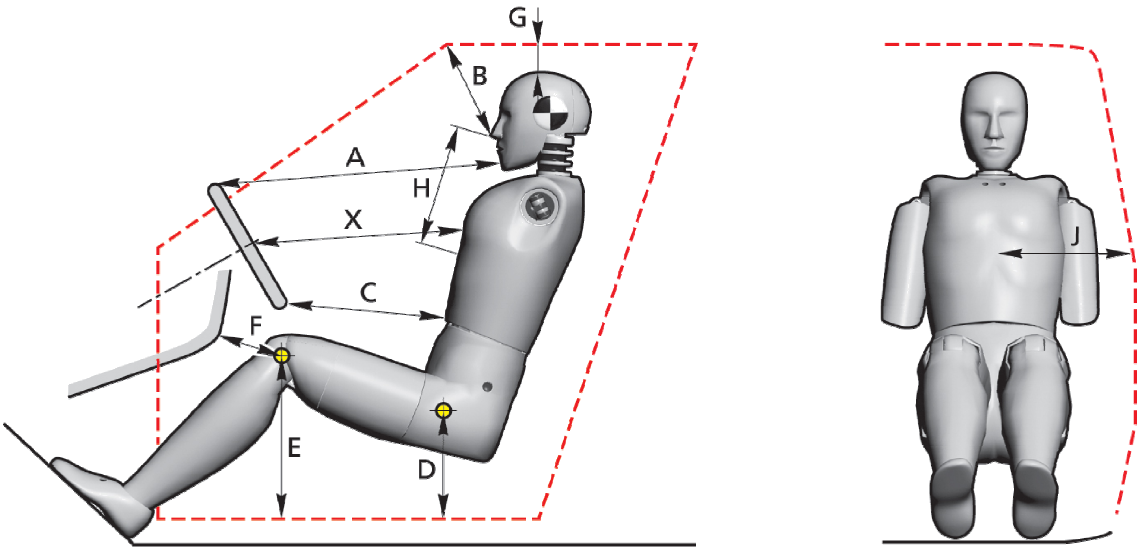
7.3.9.6 The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 7.3.9.3 and 7.3.9.4 repeated. This may require multiple attempts.

7.3.9.7 Once the belt is positioned the location of the belt should be marked across the dummy chest to ensure that no further adjustments are made. Mark also the belt at the level of the D-loop to be sure that the initial tension is maintained during test preparation.

7.3.9.8 Where the fitment of the shoulder belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non metallic wire or thread.

7.4 Dummy Measurements

The following measurements are to be recorded prior to the test after the dummy settling and positioning procedures have been carried out.



Driver's Side	
A	Chin to top of rim
B	Nose to top edge of glass
C	Stomach to rim
D	H-point to top of sill
E	Knee bolt to top edge of sill
F	Knee bolt to top edge of bolster
G	Head to roof surface
H	Nose to webbing (vertically)
J	Belt webbing to door (horizontally)
θ	Neck Angle
	H-Point Co-ordinates (to vehicle)
α	Seat back angle (as defined by torso angle)
X	Chest to centre of steering wheel

8 TEST PARAMETERS

An on-board data acquisition unit will be used. This equipment will be triggered by a contact plate at the point of first contact (t=0) and will record digital information at a sample rate of 20kHz (alternatively a sample rate of 10kHz may be used). The equipment conforms to SAE J211.

BEFORE THE TEST, ENSURE THAT THE LIVE BATTERY IS CONNECTED, A SINGLE KEY IS IN THE IGNITION, THE IGNITION IS ON AND THAT THE AIRBAG LIGHT ON THE DASHBOARD ILLUMINATES AS NORMAL (WHERE FITTED)

If the vehicle is fitted with a brake pedal retraction mechanism which requires a vacuum present in the brake system, the engine may be run for a predetermined time, specified by the manufacturer.

8.1 Deformable Barrier

Fix a Full Width Deformable Barrier (FWDB) to the concrete block. The height of this barrier should be 80mm ±5mm from the ground.

8.2 Speed

8.2.1 Measure the speed of the vehicle as near as possible to the point of impact.

8.2.2 This speed should be 50km/h ± 1km/h. Record the actual test speed in the test details.

TARGET SPEED = 50km/h ± 1km/h

8.3 Door Opening Force

8.3.1 Check that none of the doors have locked during the test

8.3.2 Try to open each of the doors (front doors followed by rear doors) using a spring-pull attached to the external handle. The opening force should be applied perpendicular to the door, in a horizontal plane, unless this is not possible. The manufacturer may specify a reasonable variation in the angle of the applied force. Gradually increase the force on the spring-pull, up to a maximum of 500N, until the door unlatches. If the door does not open record this then try to unlatch the door using the internal handle. Again attempt to open the door using the spring-pull attached to the external handle. Record the forces required to unlatch the door and to open it to 45o in the test details.

8.3.3 If a door does not open with a force of 500N then try the adjacent door on the same side of the vehicle. If this door then opens normally, retry the first door.

8.3.4 If the door still does not open, record in the test details whether the door could be opened using extreme hand force or if tools were needed.

➔ **In the event that sliding doors are fitted, the force required to open the door sufficiently enough for an adult to escape should be recorded in place of the 45^{o} opening force.**

8.4 Dummy Removal

8.4.1 Do not move the seats. Try to remove the dummy.

8.4.2 If the dummy cannot be removed with the seats in their original positions, recline the seat back and try again. Note any entrapment of the dummy.

8.4.3 If the dummy can still not be removed, try to slide the seats back on their runners.

8.4.4 If the dummy can still not be moved, the seats can be cut out of the car.

8.4.5 Record the method used to remove the dummy.

8.5 Intrusion Measurements

Take the vehicle intrusion measurements. See Section 2.2 for a full description of how to do this.

9 ASSESSMENT PARAMETERS

9.1 Head

Drivers with Steering Wheel Airbags

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_{36}	650
Resultant Acc. 3 msec exceedence	72g

Lower performance and capping limit

HIC_{36}	1000
Resultant Acc. 3 msec exceedence	88g

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_{36}	<1000
Resultant Acc. 3 msec exceedence	<88g,

then 6.8 kg 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_{36}	1000
Resultant peak Acc.	120g
Resultant Acc. 3 msec exceedence	80g

From the face form tests, a maximum of 2 points are awarded for performance better than the lower limits. For values worse than the lower performance limit, no points are awarded.

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.

9.2 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)*

9.3 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	50mm	
Viscous Criterion	1.0m/sec	(25% risk of injury ≥ AIS4)

9.4 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)*

For dummy results above or below the lower and higher performance limits, 0 to 4 points is available. For dummy results falling between these two limits a score of 2 points is automatically awarded. (Sliding scales not used for L7e vehicles).

9.5 Modifiers

9.5.1 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.

9.5.1.1 Head

<u>*Unstable Contact on the Airbag*</u>
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.

<u>*Hazardous Airbag Deployment*</u>
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. Further details are contained in Euro NCAP Technical Bulletin TB 001.

<u>*Incorrect Airbag Deployment*</u>
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. Where any frontal protection airbag deploys incorrectly, Euro 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.

9.5.1.2 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.

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

9.5.1.3 Knee, femur and 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 occupants 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. 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 that 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.

Failure of a fundamental restraint component

If a fundamental restraint item fails during the test, such as a belt webbing tear, belt anchorage failure, belt buckle release, etc each body region is automatically downgraded by 1 point to reflect the serious vehicle restraint failure:

Head Assessment	**-1**
Neck Assessment	**-1**
Chest Assessment	**-1**
Knee, femur & Pelvis	**-1**