



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



**OFFSET DEFORMABLE BARRIER FRONTAL IMPACT
TESTING PROTOCOL**

Version 7.1.3
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Preface

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

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

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of 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.

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

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1 VEHICLE PREPARATION

1.1 Unladen Kerb Mass

- 1.1.1 The capacity of the fuel tank will be specified in the manufacturer's booklet. 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 dummy (88kg with instrumentation and cables) on each of the front seats.
- 1.2.5 Place 36kg 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 In the child restraints to be used for testing, place masses equivalent to Q6 and Q10 child dummies on the second-row driver's side seat and passenger's side seat respectively (23kg and 36kg). If the child restraints are not available at this time then default masses of 7kg and 2kg should be added to the dummy masses.
- 1.2.7 For two seater vehicles only, the mass of child dummies and child seats shall not be included in the reference load. For vehicles with limited rear space, child seats and dummies shall be included in the reference load.
- 1.2.8 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.
- 1.2.9 Record the axle reference loads and reference mass in the test details.

- 1.2.10 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.
- 1.2.11 Remove the weights from the luggage compartment and the front and rear seats.

1.3 Vehicle Width and Overlap

- 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. Calculate 10% of the vehicle width and mark a line on the bonnet and bumper which is this distance from the centre line on the steering-wheel side of the car. The distance from this line to the widest point on the steering wheel side of the car will be the overlap with the deformable barrier.

➔ Take the pre-impact vehicle intrusion measurements at this point in time. See Section 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. Where any additional battery is used 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 5mm² 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 In the event that the engine fluids are to be drained then drain the coolant, oil, air-conditioning (air conditioning refrigerant should be drained without venting it to the atmosphere) and Power Assisted Steering (PAS) fluids.
- 1.4.3 If the fluids are drained then measure the weights of each of these fluids, excluding the air conditioning fluid, and replace with an equivalent weight of water or other ballast.

- 1.4.4 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.
- 1.4.5 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.
- 1.4.6 Fit the on-board data acquisition equipment in the boot of the car. Also fit any associated cables, cabling boxes and power sources.
- 1.4.7 Place weights equivalent to a Hybrid-III dummy (88kg) in each of the front seats of the car (with the seats in their mid-positions).
- 1.4.8 In the child restraints to be used for testing, place masses equivalent to Q6 and Q10 child dummies on the second-row driver's side seat and passenger's side seat respectively (23kg and 36kg). If the child restraints are not available at this time then default masses of 7kg and 2kg should be added to the dummy masses.
- 1.4.9 Weigh the front and rear axle weights of the vehicle. Compare these weights with those determined in Section 1.2.9.
- 1.4.10 If the axle weights differ from those measured in Section 1.2.9 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. The levels of ballast in the fuel tank (equivalent in mass to 90% capacity of fuel) may also be adjusted to help achieve the desired axle weights. Any additional mass that is added to the vehicle should be securely and rigidly attached.
- 1.4.11 Repeat Sections 1.4.9 and 1.4.10 until the front and rear axle weights and the total vehicle weight are within the limits set in 1.4.10. Record the final axle weights in the test details.
- 1.4.12 For fully electric vehicles, if a total vehicle mass within 25kg of the reference mass cannot be achieved, it is acceptable for the total mass to be within 2% of the reference mass. A heavier test mass may be used with the agreement of the OEM, the test mass must not be below the minimum value of the specified tolerances.
- 1.4.13 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.

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 Section 5).
- 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 latch 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) 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 50th 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 to remove the dummies, according to Section 7.5, 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 dummies according to Section 7.5 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 2.1). 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 unstruck passenger's side of the vehicle.
- 2.2.7 Compare the vertical co-ordinate of the B-post sill point before (Section 2.1.12) and after (Section 2.2.6) the test.
- 2.2.8 Find the angle θ that best satisfies the following equation: $z = -x'\sin\theta + z'\cos\theta$ 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 struck 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.



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

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

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

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 measurements¹.

- 2.2.11 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 the rearward movement of the A-post at waist level.
 - c) the reduction in width of the door aperture at waist and sill levels.
- 2.2.12 Record these intrusion measurements in the test details.

1. This assumes that the point on the un-struck B-post sill is not displaced vertically or laterally during the impact.

3 DUMMY PREPARATION AND CERTIFICATION

3.1 General

- 3.1.1 Hybrid III test dummies should be used for the front seat driver and passenger positions. They 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 - See Section 3.3.
- 3.1.2 Details of the child dummy preparation and certification are contained in the Euro NCAP Child Occupant Protection Testing Protocol.

3.2 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.

- 3.2.1 The Hybrid-III dummies shall be re-certified after every THREE impact tests.
- 3.2.2 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.
- 3.2.3 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.
- 3.2.4 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.
- 3.2.5 If any part of a dummy is broken in a test then the part shall be replaced with a fully certified component.
- 3.2.6 Copies of the dummy certification certificates will be provided as part of the full report for a test.

3.3 Additions and Modifications to the Hybrid III Dummies

- 3.3.1 The additions and modifications which will change the dynamic behaviour of the test dummies from Part 572E specification dummies are:
 - 3.3.2 Roller ball-bearing knees shall be fitted.
 - 3.3.3 Extra instrumentation is also fitted such as enhanced instrumented lower legs and a 6-axis neck. See Section 4 for a full instrumentation list.
 - 3.3.4 Foam neck shields (Part 93051-1-DN or equivalent) must be fitted to the driver and passenger if a frontal protection airbag is present.

3.4 Hybrid III Dummy Clothing and Footwear

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

3.5 Hybrid III Dummy Test Condition

- 3.5.1 Dummy Temperature
 - 3.5.1.1 The dummy shall have a stabilised temperature in the range of 19°C to 22°C.
 - 3.5.1.2 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.
 - 3.5.1.3 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.
 - 3.5.1.4 A printout of the temperature readings is to be supplied as part of the standard output of the test.
- 3.5.2 Dummy Joints

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

 - 3.5.2.1 Stabilise the dummy temperature by soaking in the required temperature range for at least 5hours.
 - 3.5.2.2 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.
 - 3.5.2.3 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.
 - 3.5.2.4 Maintain the dummy temperature within the range 19° to 22°C between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.
- 3.5.3 Dummy face painting
 - 3.5.3.1 With the exception of the Hybrid-III face, the dummies 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.

Hybrid-III

Eyebrows (left and right)	Red
Nose	Green
Chin	Yellow
Left Knee	Red
Right Knee	Green
Left Tibia (top to bottom)	Blue, Green, Red, Yellow
Right Tibia (top to bottom)	Yellow, Red, Green, Blue

NOTE: The tape should be completely covered with the coloured paints specified.

Paint Area Sizes:

Hybrid-IIIs

Eyebrows (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

3.6.1 The dummies 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. Refer to Section 3.2.

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. The transducers mounting and sign convention are according to SAE J211 (1995).

4.1 Dummy Instrumentation

The Hybrid III dummies to be used shall be instrumented to record the channels listed below. Details of the child dummy instrumentation is contained in the Euro NCAP Child Occupant Protection Testing Protocol.

Location	Parameter	Minimum Amplitude	Driver No of channels	Passenger No of channels
Head	Accelerations, A_x A_y A_z	250g	3	3
Neck	Forces	F_x F_y	2	2
		F_z	1	1
	Moments, M_x M_y M_z	290Nm	3	3
Chest	Accelerations, A_x A_y A_z	150g	3	3
	Deflection, D_{chest}	100mm	1	1
Pelvis	Accelerations, A_x A_y A_z	150g	3	3
Lumbar Spine	Forces, F_x F_z		2	2
	Moments, M_y		1	1
Femurs (L & R)	Forces, F_z	20kN	2	2
Knees (L & R)	Displacements, D_{knee}	19mm	2	2
Upper Tibia (L & R)	Forces, F_x F_z	12kN	4	4
	Moments, M_x M_y	400Nm	4	4
Lower Tibia ² (L & R)	Forces, F_x F_z (F_y)	12kN	4	4
	Moments, M_x M_y	400Nm	4	4
Total Channels per Dummy			39	39
Total Channels			78	

2. Note that for both dummies the measurement of F_y is at the laboratory's discretion.

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 (A_x)
- 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 and passenger seatbelts and to the shoulder section of the Q10 and Q6 shoulder seatbelts. The calibration procedure for the loadcells is detailed in Technical Bulletin 16.

VEHICLE

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
Passenger Seatbelt Shoulder Section	Force, F_{diagonal}	16kN	1
Q10 Seatbelt shoulder section	Force, F_{diagonal}	16kN	1
Q6 Seatbelt shoulder section	Force, F_{diagonal}	16kN	1
Battery (including any secondary batteries)	Supply voltage, V	15V	1
Total Channels per Vehicle			7

Where loadcells are to be placed on any seatbelts equipped with pretensioners, ensure that the loadcell is placed far enough away from the D-loop to ensure there is no interaction as the pretensioner fires. Where any CRS lock-off does not allow the loadcell to be placed a sufficient distance from the D-loop do not attach the loadcell.

4.3 Summary of Total Channels

1× Driver Hybrid-III	39
1× Passenger Hybrid-III	39
1× Q10	30
1× Q6	13
1× Vehicle	7
Total Channels per Test	128

Adjustment ³	Required Setting	Notes	Methods
Seat fore/aft	Mid position	May be set to first notch rearwards of mid position if not lockable at mid position	See Section 5.1
Seat base tilt	Manufacturer's design position	Permissible up to mid position, otherwise lowest	See Section 5.1.11
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	See Section 6.1.1
Seat lumbar support	Manufacturer's design position	Otherwise fully retracted	See Section 5.1.12
Front head hestraint height & tilt	Mid locking position	As whiplash test position. If there is any interference with the rear of the dummy head, move the HR to the most rearward position.	See Section 6.2 Whiplash testing protocol
Front seat belt anchorage (where adjustable)	Manufacturer's 50th percentile design position	If no design position then set to mid-position, or nearest notch upwards	
Steering wheel - vertical	Mid position		See Section 5.3
Steering wheel - horizontal	Mid position		See Section 5.2
Rear seat fore/aft (where adjustable)	Manufacturer's design position	Where no details are provided in the handbook, set to mid	
Rear seat back angle (where adjustable)	Manufacturer's design position	Otherwise 25° to Vertical	See Section 5.1
Rear seat facing	Forwards		
Rear head restraint height & tilt	As recommended in vehicle handbook	Where no details are provided in the handbook, set to mid or next lowest position for height and mid locking position for tilt. Must not interfere with child/CRS installation.	See Section 6.2 Whiplash testing protocol.
Rear seat belt anchorage (where adjustable)	As recommended in vehicle handbook for CRS installation	If no recommendation then set to mid-position, or nearest notch upwards	
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering	
Arm-rests (Rear seats)	Stowed position		
Glazing	Front - Lowered Rear - Lowered or Removed	This applies to opening windows only	
Gear change lever	In the neutral position		
Pedals	Normal position of rest		
Doors	Closed, not locked		
Roof	Lowered	Where applicable	
Sun visors	Stowed position		
Rear view mirror	Normal position of use		

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

5.1 Determination of and Setting the Fore/aft, Tilt and Lumbar Settings of Seat

- 5.1.1 The manufacturers' seat fore/aft position which corresponds to the 95th percentile male seating position will have been provided.
- 5.1.2 Place a mark on the moving part of seat runner close to the unmoving seat guide.
- 5.1.3 Move the seat to its most forward position of travel.
- 5.1.4 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most forward position.
- 5.1.5 Move the seat to the position of its travel provided for the 95th percentile male.
- 5.1.6 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the 95th percentile male's seating position.
- 5.1.7 Measure the distance between the forwards and rearwards marks. Place a third mark on the seat guide mid-way between the forwards and rearwards marks.
- 5.1.8 Move the seat so that the mark on the seat runner aligns with the mark on the seat guide.
- 5.1.9 Lock the seat at this position. Ensure that the seat is fully latched in its runners on both sides of the seat. The seat is now defined as being at its 'mid seating position'. The vehicle will be tested with the seat in this position.
- 5.1.10 If the seat will not lock in this position, move the seat to the first locking position that is rear of the mid seating position. The vehicle will be tested with the seat in this position.
- 5.1.11 If the seat base is adjustable for tilt it may be set to any angle from the flattest up to its mid position according to the manufacturer's preference.
- 5.1.12 If the seat back is adjustable for lumbar support it should be set to the fully retracted position, unless the manufacturer specifies otherwise or the dummy prevents this.

5.2 Setting the Steering Wheel Horizontal Adjustment

- 5.2.1 Choose a part of the facia that is adjacent to the steering column and can be used as a reference.
- 5.2.2 Move the steering wheel to the most forward position of its travel
- 5.2.3 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most forward travel of the steering wheel.
- 5.2.4 Move the steering wheel to the most rearwards position of its travel
- 5.2.5 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most rearwards travel of the steering wheel.
- 5.2.6 Measure the distance between the forwards and rearwards marks on the steering column. Place a third mark on the steering column mid-way between the forwards and rearwards marks. This corresponds to the centre of travel of the steering wheel.
- 5.2.7 Move the steering wheel so that the mark on the steering column aligns with the facia.
- 5.2.8 Lock the steering column at this position. The steering wheel is now in its mid-position of travel. The vehicle will be tested with the steering wheel in this position.

5.3 Setting the Steering Wheel Vertical Adjustment

A method that is in principle the same as Section 5.2 should be used to determine 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.

5.4 Marking Q10 & Q6 Child Dummy Head Excursion

5.4.1 If applicable, position the rear seats in accordance with the adjustments detailed in Section 5.

5.4.2 Install the H-point machine in accordance with the procedure detailed in Section 6.1.1 of the Euro NCAP Frontal Full Width Impact Testing Protocol. Mark the H-point location of the 5th female occupant on the vehicle.

5.4.3 The vehicle should be clearly marked on both sides to define a scale of at least 400-600mm (50mm increments) forward of the H-point location of the 5th female occupant. The intention is that these marks should be clearly visible on the high speed film. Markings shall be applied to the exterior top and waist level of the door as well as inside the car at waist level.

5.4.4 The 450mm and 550mm excursion lines shall be clearly distinguished from the other markings in some way, for example using a different colour. These lines shall also be marked on the vehicle in locations that are clearly visible to the onboard cameras. Alternatively, it is acceptable for the lines across the vehicle to be superimposed during post film processing.

5.5 Marking the Cr-Point

5.5.1 Were the Q10 is to be seated on a booster cushion that does not have R44 approval, it will be necessary to mark the C-rpoint on the vehicle.

5.5.2 With the Gabarit positioned as specified in ECE Regulation 16, the positions of the back and bottom planes of the device will be defined using the 3D Measuring arm, targets will be applied to the top and side surfaces of the Gabarit to help in this process. The intersection of these planes will define the Cr point for the seating position in question.

6 DUMMY POSITIONING AND MEASUREMENTS

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

6.1 Determine the H-point of the driver's seat

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 $75 \pm 10\text{kg}$ 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.

- 6.1.1 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. In absence of such recommendations, an angle of 25 degrees towards the rear from vertical will be used.
 - 6.1.1.1 The driver and passenger seatback angle and seat base shall be set to the same position.
 - 6.1.1.2 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.
 - 6.1.1.3 Where both seats are adjustable, the manufacturer is asked to supply recommended settings. These should not differ from the nominal settings by more than a reasonable amount. In any of the above situations, the manufacturer may provide convincing information that the seat adjustments should be different from that specified here. If so the fully supported request to vary the set up should be made to the Secretariat.
- 6.1.2 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.
- 6.1.3 Place the seat and back assembly of the H-point machine on the seat at the centre line of the seat.
- 6.1.4 Set the thigh and lower leg segment lengths to 401 and 414mm respectively.
- 6.1.5 Attach lower legs to machine, ensuring that the transverse member of the T-bar is parallel to the ground.
- 6.1.6 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.
- 6.1.7 Place left foot at equal distance from centre line of machine as the right leg is from centre line. Place foot flat on footwell.
- 6.1.8 Apply lower leg and thigh weights.
- 6.1.9 Tilt the back pan forwards to the end stop and draw the machine away from the seat-back.
- 6.1.10 Allow the machine to slide back until it is stopped by contacting the seat back.
- 6.1.11 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.
- 6.1.12 Return the machine back to the seat back.
- 6.1.13 Install the right and left buttock weights.
- 6.1.14 Apply the torso weights alternately left and right.

- 6.1.15 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. The feet are NOT to be restrained during the rocking. After rocking the T-bar should be parallel to the ground.
- 6.1.16 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.
- 6.1.17 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.
- 6.1.18 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.
- 6.1.19 Adjust the seat back angle to the angle determined in 6.1.1, 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.
- 6.1.20 Measure and record in the test details the position of the H-point relative to some easily identifiable part of the vehicle structure

6.2 Determine the H-point of the Passenger's Seat

Follow the procedure for the determination of the driver's H-point ensuring that the distance from the centre line to the legs is the same as that used in the determination of the driver's H-point.

For both right and left feet, place the feet flat on the floor.

6.3 Dummy Installation

It is the intention that the dummy should not be left to sit directly on the seat for more than 2 hours prior to the test. It is acceptable for the dummy to be left in the vehicle for a longer period, provided that the dummy position is checked no more than 1 hour prior to test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.

6.4 Dummy Placement

If the vehicle has only two side doors, it may be necessary to fit the child restraint systems and child dummies (section 6.6) before setting up the Hybrid-III dummies in the front seats.

- 6.4.1 Ensure that the seat is in the correct position as defined by Section 6.1.
- 6.4.2 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.

6.5 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.

6.5.1 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 6.1. Record the position of the dummy H-point in the test details.

6.5.2 Pelvic Angle

The pelvic angle measurement gauge should read $22.5^\circ \pm 2.5^\circ$ from the horizontal. Record the measured angle in the test details.

6.5.3 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 (par. 6.5.1)
- Adjust the pelvic angle within the limits (par. 6.5.2)
- 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.

6.5.4 Arms

The driver's upper arms shall be adjacent to the torso as far as is possible. The passenger's arms shall be adjacent to the torso and in contact with the seat back.

6.5.5 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. The passenger's hands should be placed with the palms in contact with the outside of the legs and the little finger in contact with the seat cushion.

6.5.6 Torso

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

6.5.7 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 $270\text{mm} \pm 10\text{mm}$. When the left foot is placed on a footrest or the right foot is positioned onto the accelerator pedal as described in 6.5.8 below, the distance between the knees may be altered. The legs of the dummies should be in vertical longitudinal planes as far as is possible.

6.5.8 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 $270\text{mm} \pm 10\text{mm}$ may be ignored in this case. Note the knee gap in the test details.

The passenger dummy's feet shall be placed with the heel as far forwards as possible

and the feet as flat as possible. Both feet shall be parallel to the centre line of the vehicle.

6.5.9 Seat belt

- 6.5.9.1 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.
- 6.5.9.2 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 6.5.5.
- 6.5.9.3 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.
- 6.5.9.4 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.
- 6.5.9.5 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 6.5.9.3 and 6.5.9.4 repeated.
- 6.5.9.6 The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of .steps 6.5.9.3 and 6.5.9.4 repeated. This may require multiple attempts.
- 6.5.9.7 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.
- 6.5.9.8 Measure the vertical distance between the dummy nose and the diagonal webbing.
- 6.5.9.9 Measure the horizontal distance between the diagonal webbing and the door/window.
- 6.5.9.10 Where the fitment of the shoulder belt loadcell (Section 4.2.5) 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.

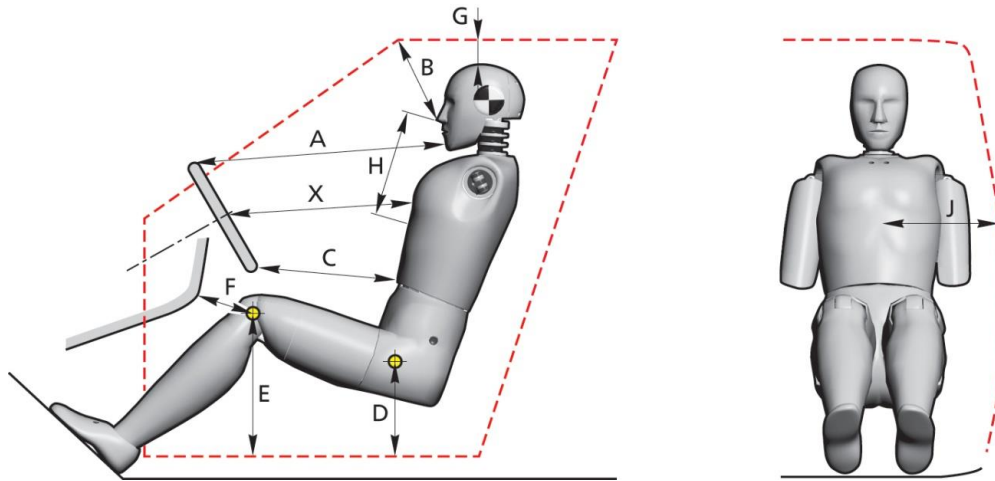
6.6 **Child Restraint System (CRS) Installation and Child Dummy Placement**

The child dummy and CRS installation procedures are detailed in the Euro NCAP Child Occupant Protection Testing Protocol.

➔ PLEASE NOTE: ALL PASSENGER COMPARTMENT SETTINGS MUST BE THE SAME FOR FRONTAL AND SIDE IMPACTS WITH THE EXCEPTION OF SEAT HEIGHT, GLAZING AND HEAD RESTRAINT HEIGHT

6.7 **Hybrid III Dummy Measurements**

The following measurements are to be recorded prior to the test after the dummy settling and positioning procedures have been carried out. Details of the child dummy measurements are contained in the Euro NCAP Child Occupant Protection Testing Protocol.



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

7 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 ran for a predetermined time, specified by the manufacturer.

7.1 Deformable Barrier

Fix a deformable barrier as specified in UNECE Regulation 94 to the concrete block. The height of this barrier should be 200mm \pm 5mm from the ground.

7.2 Speed

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

7.2.2 This speed should be 64km/h (40mph) \pm 1km/h. Record the actual test speed in the test details.

$$\text{TARGET SPEED} = 64\text{km/h} \pm 1\text{km/h}$$

7.3 Overlap

7.3.1 With the vehicle offered up against the barrier, tape a small pin as near as possible to that edge of the deformable barrier which is to be struck.

7.3.2 Mark the point on the bumper of the vehicle where the pin should strike if an exact overlap of 40% was achieved.

7.3.3 After the test, if the mark made by the pin is not within the tolerance rectangle described below, film analysis will be used to try to assess the overlap. Both the horizontal and vertical alignments shall be noted in the test report.

$$\text{TARGET OVERLAP} = 40\% \pm 20\text{mm}$$

$$\text{TARGET VERTICAL ALIGNMENT} = \pm 25\text{mm}$$

After Test

7.4 Door Opening Force

7.4.1 Check that none of the doors have locked during the test.

7.4.2 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 45° in the test details.

7.4.3 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.

7.4.4 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° opening force.

7.5 Dummy Removal

7.5.1 Do not move the driver or passenger seats. Try to remove the dummies.

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

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

7.5.4 If the dummies can still not be moved, the seats can be cut out of the car.

7.5.5 Record the method used to remove the dummies.

7.6 Intrusion Measurements

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