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EUROPEAN NEW CAR ASSESSMENT PROGRAMME
(EuroNCAP)

TESTING PROTOCOL

Version 3
April 2001

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Where text is contained within square brackets this denotes that the procedure being discussed is currently being trialed in EuroNCAP. Its incorporation in the Test Protocol will be reviewed at a later date. These areas are Measurement of Footwell Intrusion, Measurement of Child Dummy Head Excursion and Child Dummy Injury Parameters.

In addition to the settings specified in this protocol, the following information will be required from the manufacturer of the car being tested in order to facilitate the vehicle preparation.

Manufacturer-Specified Settings	
Adjustment	**Section Reference**
Frontal Impact	
Fuel Tank Capacity	Manufacturer's Handbook
Unladen Kerb Weight	Manufacturer's Handbook
Tyre Pressures	Manufacturer's Handbook
Seat Back/Torso Angle	
95th Percentile Male Seating Position	Section 6.1
Seat Base Tilt	Section 6.1
Child Seat Make/Model	
Door Handle Pull Angle	Section 9.4
Seat belt anchorage position	Section 6.0
Seat Lumbar Support Position	
Engine Running	
Driver Airbag Removal Instructions	
Side Impact	
As Front, in addition:	
Height of non-adjustable version of front seat	Section 5.2
R-Point	Section 1.4
Pedestrian Test	
One Lower Legform Point	To be chosen after EuroNCAP points
One Upper Legform Point	To be chosen after EuroNCAP points
Three Child Headform Points	To be chosen after EuroNCAP points
Three Adult Headform Points	To be chosen after EuroNCAP points

Section References

Frontal Impact

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Frontal Impact

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 recommended by the manufacturer, place masses equivalent to a 3 and a 1½ year old child dummy on the rear drivers seat and passenger seat respectively (15kg and 11kg). If the child restraints are not available at this time then default masses of 3kg should be added to the dummy masses.

1.2.7 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.

1.2.8 Record the axle reference loads and reference mass in the test details

1.2.9 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.

1.2.10 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 (Section 1.4.6) 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. 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 a live battery is connected, if possible in its standard position and that the driver airbag is connected. Check that the dashboard light for the airbag circuit functions as normal.

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. If the system is to be fitted, 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 recommended by the manufacturer, place masses equivalent to a 3 and a 1½ year old child dummy on the rear drivers seat and passenger seat respectively (15kg and 11kg). If the child restraints are not available at this time then default masses of 3kg 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 1.2.7.

1.4.10 If the axle weights differ from those measured in Section 1.2.7 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 1.5.9 and 1.5.10 until the front and rear axle weights and the total vehicle weight are within the limits set in 1.5.10. Record the final axle weights in the test details.

1.5 Vehicle Markings

1.5.1 EuroNCAP 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 EuroNCAP 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.

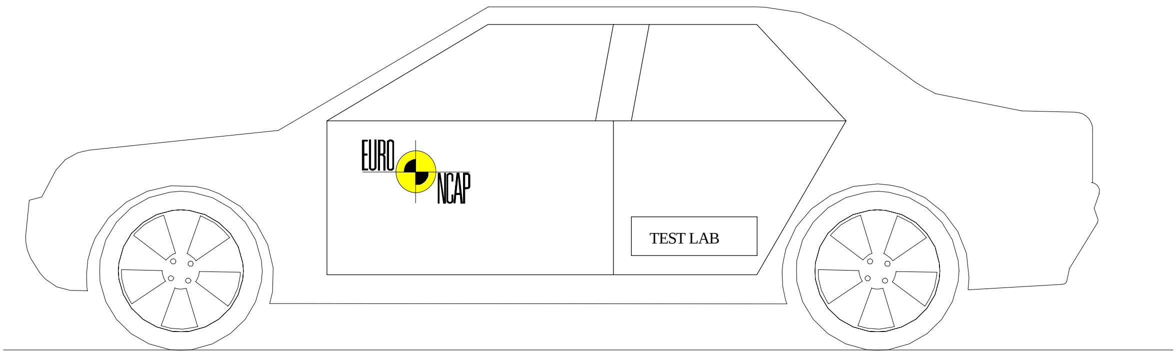


Figure 1.1

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 Section 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 2.1) centrally to the rear of the vehicle.

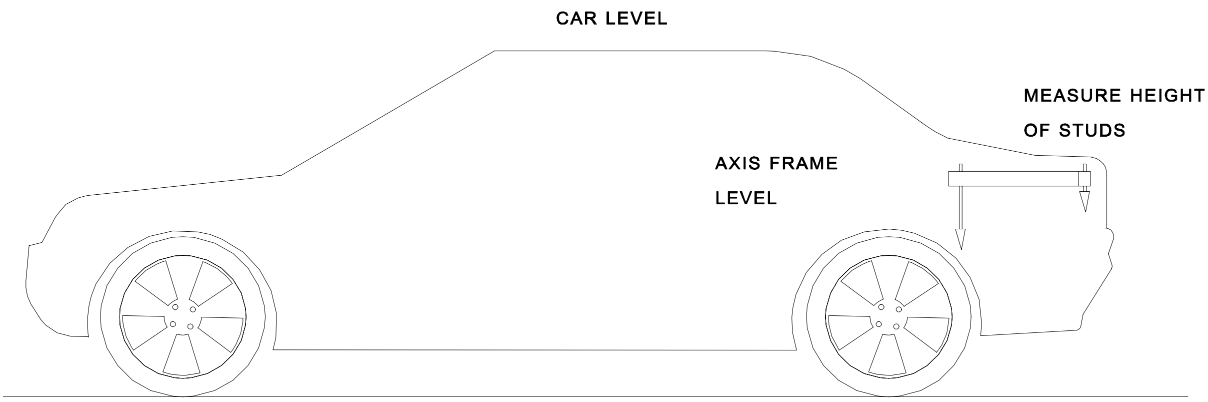


Figure 2.1 Setting up axis reference frame

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: i) at a distance of 100 mm above the sill.
ii) 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: i) at a distance of 100 mm above the sill.
ii) 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 undepressed clutch, brake and accelerator pedals. If the pedal is adjustable, set it to the mid position or a reasonable variation from this in accordance with the manufacturers recommendations for the 50th percentile position.
2.1.17 [From the centre point of the brake pedal move down an imaginary plane at an angle of 56 degrees from the horizontal until the floor-pan is reached. Record this point on the floor-pan through the carpet. (See fig. 2.2 & 2.3). This is the heel point. The line between the centre of the brake pedal and the heel point defines the angle of a plane 400mm wide centred on the brake pedal (See fig. 2.3).]
2.1.18 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.

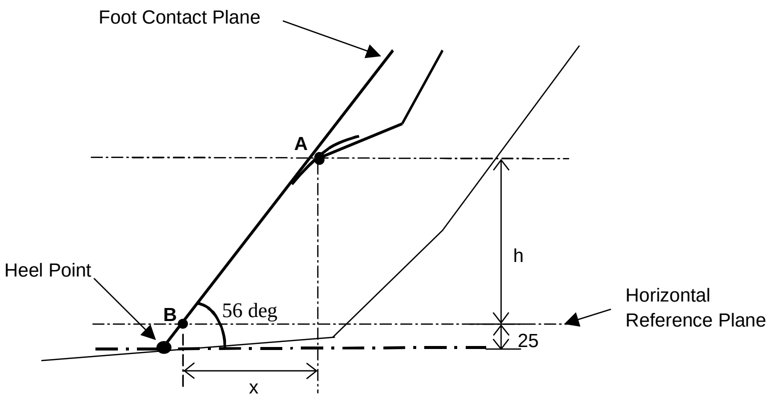


Figure 2.2

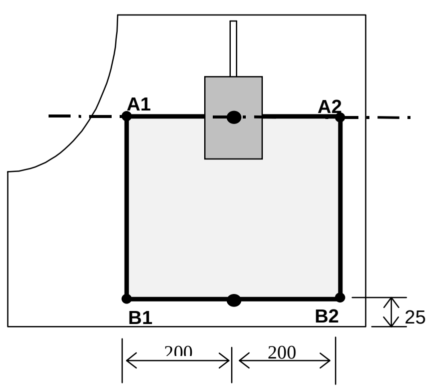


Figure 2.3

It should be noted that the points A1, A2, B1 and B2 are imaginary and are not physical measurement points.

2.1.19 [Mark and record the rearmost point on each of the driver's side seat rails.]

2.2 After Test

2.2.1 After the test remove the dummies according to Section 9.5 and remove the data acquisition and emergency abort equipment (if fitted) from the luggage compartment.

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

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

2.2.4 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 2.1.8. Set the studs of the frame to the same heights as in Section 2.1.11 (Figure 2.4). 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.

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

2.2.6 Compare the vertical co-ordinate of the B-post sill point before (Section 2.1.12) and after (Section 2.2.5) the test.

2.2.7 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).

2.2.8 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, the door aperture points [and the rearmost points on both the driver's side seat rails]. If the steering column has become detached during impact due to the operation of the shear capsules, reposition the column as accurately as possible before measurement. If the brake, clutch or accelerator pedal becomes detached, do not measure this point.

2.2.9 [Record and measure the location of the point of greatest footwell intrusion, perpendicular to the foot contact plane, on the deformed footwell. If it is difficult to determine the point of greatest intrusion then record the location of each possible point for later analysis.]

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.[1]

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

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

ii) the longitudinal and vertical movement of the centre of the clutch, brake and accelerator pedals.

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

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

v) [Determine the perpendicular distance of the point of greatest intrusion, relative to the virtual foot contact plane].

2.2.13 Record these intrusion measurements in the test details.

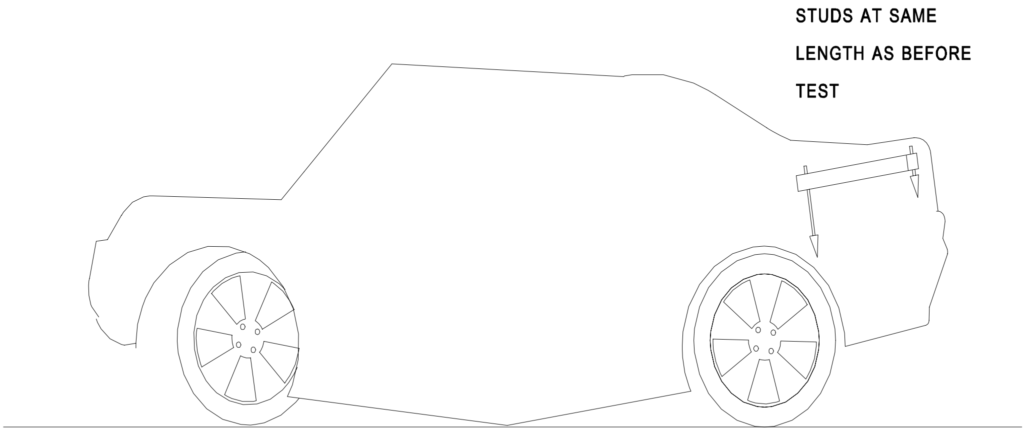


Figure 2.4 Re-setting axis reference frame after test

[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 except for modifications and additions stated later - See Section 3.3.

3.1.2 A TNO/Ogle P1½ child dummy, in a suitable Child Restraint System (CRS) (see Section 7.6), should be used in the rear passenger side seating position (or the rear centre seating position if the vehicle manufacturer prefers). If a dummy is used in the centre seating position then the other dummy must be placed on the impact side seating position.

3.1.3 A TNO P3 child dummy, in a suitable CRS (see Section 7.6), should be used in the rear driver's side seating position (or the rear centre seating position if the vehicle manufacturer prefers).

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). Details of the certification procedure of the TNO P1½ and P3 child dummies are available in the user documentation.

3.2.1 The Hybrid-III dummies should be re-certified after every THREE impact tests.

3.2.2 The TNO P1½ and P3 child dummies shall be re-certified after every SIX impact tests (e.g. 3 frontal and 3 side impacts, or any combination of the two test types).

3.2.3 If an injury criterion reaches or exceeds its normally accepted limit (eg HIC of 1000) then that part of the dummy shall be re-certified.

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

3.2.5 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:

3.3.1.1 Ford 45 degree dorsi-flexion ankles/feet with rubber bump stops and padded heels are fitted.

3.3.1.2 ASTC Research roller ball-bearing knees are fitted.

3.3.2 Extra instrumentation is also fitted such as enhanced instrumented lower legs and a 6-axis neck. See Section 4 for a full instrumentation list.

3.3.3 Foam neck shields such as those supplied by ASTC, must be fitted to the driver and passenger if a frontal protection airbag is present.

3.4 Dummy Clothing and Footwear

3.4.1 Hybrid-III dummies

3.4.1.1 Each dummy will be clothed with formfitting cotton stretch garments with short sleeves and pants which should not cover the dummy's knees.

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

3.4.2 Child Dummies

3.4.2.1 Each child dummy shall be fitted with close-fitting stretch clothing suitable for an infant of an appropriate age.

3.5 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 joint stiffnesses 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-IIIs

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

Child dummies

Top of Head	Blue
Head-band (colours from left to right)	Red, Yellow, Green

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

Paint Area Sizes:

Hybrid-IIIs

Eyebrows	= (25/2) x 50mm
Nose	= 25 x 40mm strip, down nose centre line
Chin	= 25 x 25mm square, centre line of chin
Knees	= 50 x 50mm square, knee centre line with bottom edge level with top of tibia flesh
Tibias	= 25mm x 50mm, 4 adjacent areas down leg centre line with top edge level with top of tibia flesh

Child Dummies

Top of Head	= 50 x 50mm square
Headbands	= 25mm wide, widest circumference remaining at eyebrow level at front, extending to the head C of G at each side.

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 are mounted according to procedures laid out in SAE J211 (1995). The sign convention used for configuring the transducers is stated in SAE J211.

4.1 Dummy Instrumentation

The dummies to be used shall be instrumented to record the channels listed below.

Hybrid-III

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	9kN	2	2
		F_z	14kN	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
Femurs (L & R)	Forces, F_z		20kN	2	2
Knees (L & R)	Displacements, D_{knee}		15mm	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			33	33
	Total Channels			66	

[2] Note that for the passenger dummy it is allowed that the lower tibia force transducers measure Fx and F_y and not F_x and F_z

TNO P3

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations, A_x A_y A_z	150g	3
Chest	Accelerations, A_x A_y A_z	150g	3
	Total Channels per Dummy		6

TNO P1½

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations, A_x A_y A_z	150g	3
Chest	Accelerations, A_x A_y A_z	150g	3
	Total Channels per Dummy		6

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.

VEHICLE

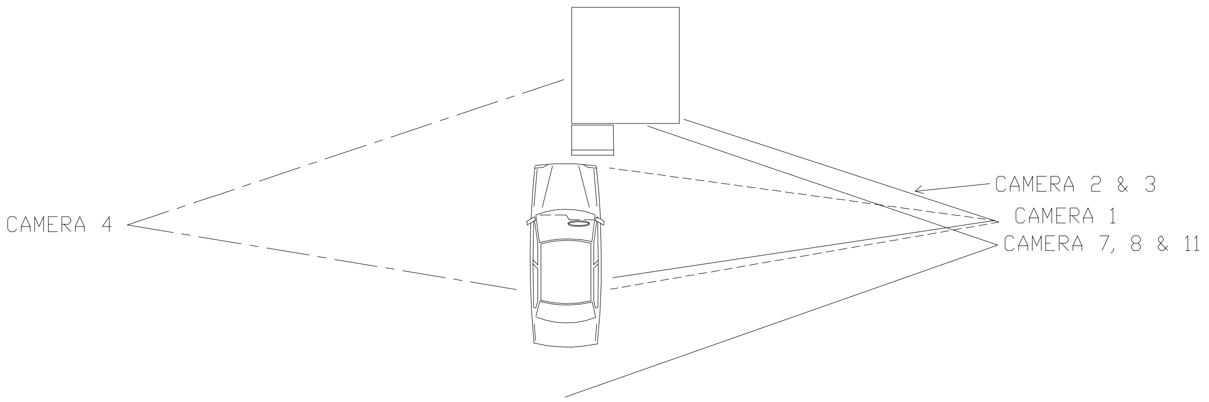
Location	Parameter	Minimum Amplitude	No of channels
B-Post LHS	Accelerations, A_x	150g	1
B-Post RHS	Accelerations, A_x	150g	1
Driver Seatbelt Shoulder Section	Force, $F_{diagonal}$	16kN	1
Passenger Seatbelt Shoulder Section	Force, $F_{diagonal}$	16kN	1
	Total Channels per Vehicle		4

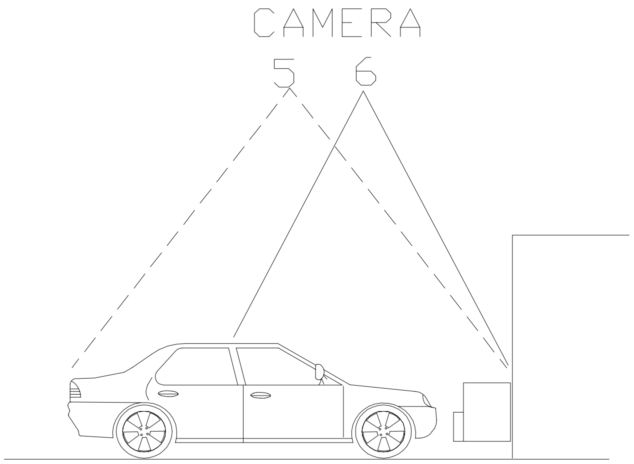
TOTAL CHANNELS

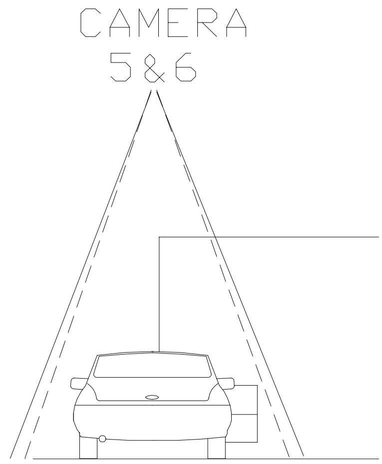
1× Driver Hybrid-III	33
1× Passenger Hybrid-III	33
1× TNO P3	6
1× TNO P1½	6
1× Vehicle	4
Total Channels per Test	82

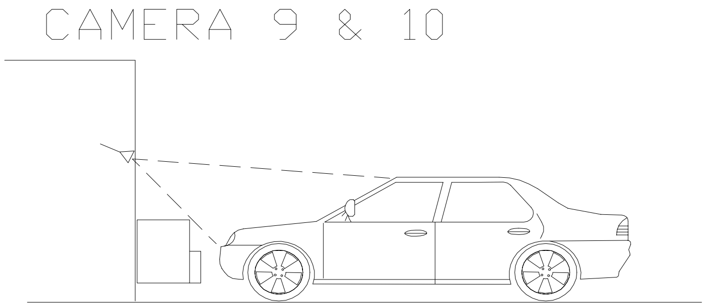
5 CAMERA LOCATIONS

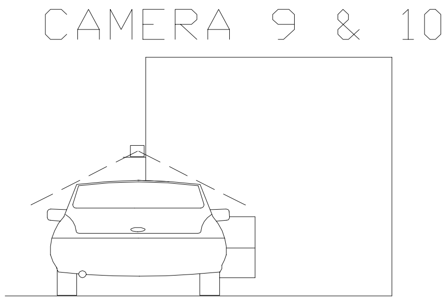
Set up high speed film cameras according to the following diagrams

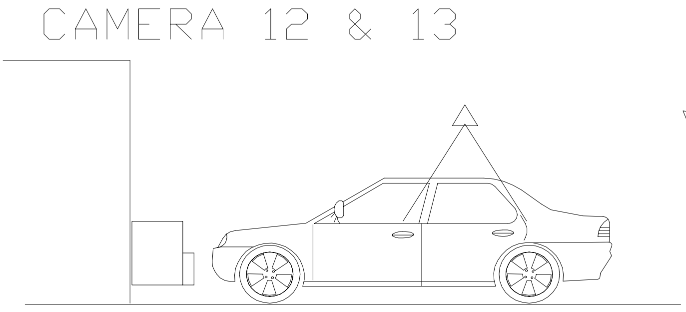


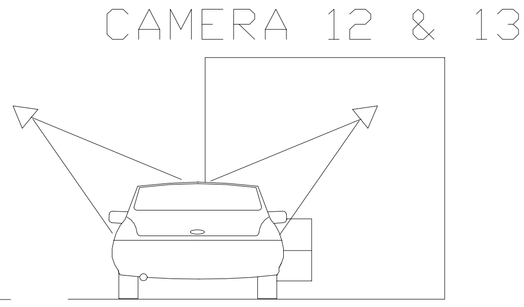












Camera No.	Camera Type	Shot Content
1	>/= 400 fps high speed cine	Driver (tight)
2	>/= 400 fps high speed cine	Driver (wide)
3	>/= 400 fps high speed cine	Backup for 2 (optional)
4	>/= 400 fps high speed cine	Passenger (wide)
5	>/= 400 fps high speed cine	Plan view (wide)
6	>/= 400 fps high speed cine	Plan view (tight)
7	>/= 50 fps stills camera	Driver (wide)
8	>/= 50 fps stills camera	Backup for 7 (optional)
9	>/= 400 fps high speed cine	Front view driver & passenger
10	>/= 400 fps high speed cine	Backup for 9 (optional)
11	>/= 400 fps high speed cine	Driver (wide)
12	>/= 400 fps high speed cine	Child dummy max head excursion
13	>/= 400 fps high speed cine	Child dummy max head excursion

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

6 PASSENGER COMPARTMENT ADJUSTMENTS

Adjustment	Required Setting	Notes	Methods
Seat Fore/Aft	Mid position as defined in Section 6.1	May be set to first notch rearwards of mid position if not lockable at mid position	See Section 6.1
Seat Base Tilt	Manufacturer's design position	Permissible up to Mid Position	See Section 6.1.11
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 7.1.1
Head Restraints	Highest position		
Head Restraint Tilt	Manufacturer's design Position	Otherwise mid position	
Seat Lumbar Support	Manufacturer's design position	Otherwise fully retracted	See Section 6.1.12
Steering wheel - vertical	Mid position		See Section 6.3
Steering wheel - horizontal	Mid position		See Section 6.2
Rear Seat Fore/Aft	Mid position		See Section 6.4.1
Rear Seat Facing	Forwards		See Section 6.4.1
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		
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		
Seat belt anchorage	Manufacturer's 50th percentile design position	If no design position then set to mid-position, or nearest notch upwards	

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

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

6.1.1 The manufacturers seat fore/aft position which corresponds to the 95th percentile male seating position will have been provided.

6.1.2 Place a mark on the moving part of seat runner close to the unmoving seat guide.

6.1.3 Move the seat to its most forward position of travel.

6.1.4 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most forward position.

6.1.5 Move the seat to the position of its travel provided for the 95th percentile male.

6.1.6 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the 95th percentile male's seating position.

6.1.7 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.

6.1.8 Move the seat so that the mark on the seat runner aligns with the mark on the seat guide.

6.1.9 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.

6.1.10 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.

6.1.11 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. The same seat tilt setting must be used for frontal and side impact.

6.1.12 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.

6.2 Setting the Steering Wheel Horizontal Adjustment

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

6.2.2 Move the steering wheel to the most forward position of its travel

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

6.2.4 Move the steering wheel to the most rearwards position of its travel

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

6.2.6 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.

6.2.7 Move the steering wheel so that the mark on the steering column aligns with the facia.

6.2.8 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.

6.3 Setting the Steering Wheel Vertical Adjustment

A method that is in principle the same as Section 6.2 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.

6.4 Use of The Gabarit and Marking For Child Dummy Head Excursion Measurement

A device known as a Gabarit (as defined in UN ECE Consolidated Resolution RE3) is used to check the compatibility of the vehicle with ECE Regulation 44.03 Universal child restraints. This device is used to check the following;

i) the position of the buckle tongue stop on the adult seat belt to ensure compatibility with all types of child restraint.
ii) the length of the adult seat belt webbing compared to the requirement of Universal restraints for those seats designated as suitable for such restraints.
iii) and the position of the adult seat belt hardware relative to the belt contact zones specified for universal child restraints.

Position the gabarit in the car as specified in R.E.3. Photographs should be taken of the gabarit in position.

This assessment will be done in accordance with UN ECE Consolidated Resolution RE3 Annex 13. The vehicle handbook will be checked for guidance about which seat positions in the vehicle are suitable for use with Universal child restraints and which seat positions are unsuitable for use by children. In addition the Cr point within the vehicle will be defined by use of the Gabarit.

6.4.1 If the vehicle rear seat position is adjustable put it in the mid position of its horizontal adjustment range, unless the manufacturer’s handbook says otherwise when using child seats, and adjust the seat back angle in accordance with the procedure in 7.1. If the direction of facing of the seat is adjustable it should be set to face forward, with its axis parallel to the fore/aft direction of the vehicle.

6.4.2 If the adult seat belt has an adjustable upper anchorage set the anchorage in the lowest position unless permanently attached instructions on the child restraint or vehicle suggest otherwise.

6.4.3 With the Gabarit positioned as specified in R.E.3, 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. The Cr point is needed to give a reference point for head excursion measurement on the dummy.

6.4.4 The vehicle should be clearly marked to define a scale of at least 400-600mm (50mm increments) forward of the Cr point. The intention is that these marks should be clearly visible on the high speed film. The camera views should be set to try to minimise parallax error when viewing the dummy head at full excursion relative to the defined scales. Marking should be applied to the exterior top and waist level of the door as well as inside the car at waist level. Having noted the scale points that are aligned at full excursion from the high speed film, the same points will be identified on the car statically after test. The points will be joined by a straight line and the dummy forward excursion deduced by considering the forward excursion indicated at the mid line of the seating position in question.

7 DUMMY POSITIONING AND MEASUREMENTS

The following chapter deals with all aspects of seating the dummy in the vehicle to be tested. A general timetable of the complete procedure is set out below:-

<u>*Timetable*</u>

	When this is done
1. Determine the H-point of the driver's seat	Before test day
2. Determine the H-point of the passenger's seat	Before test day
3.Dummy installation	Before test day
4. Dummy placement	Test day
5.Dummy positioning	Test day
6. Dummy positioning measurements	Test day - after vehicle has been positioned for test

7.1 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 ± 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 Set the seat back so that the torso of the dummy is as close as possible to the manufacturers reasonable recommendations for normal use. In absence of such recommendations, an angle of 25 degrees towards the rear from vertical will be used.

7.1.2 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.

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

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

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

7.1.6 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.

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

7.1.8 Apply lower leg and thigh weights.

7.1.9 Tilt the back pan forwards to the end stop and draw the machine away from the seatback.

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

7.1.11 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.

7.1.12 Return the machine back to the seat back.

7.1.13 Install the right and left buttock weights.

7.1.14 Apply the torso weights alternately left and right.

7.1.15 Tilt the machine back forwards to the end stop and 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.

7.1.16 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.

7.1.17 Return the machine back to the seat back.

7.1.18 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.

7.1.19 Adjust the seat back angle to the angle determined in 7.1.1, 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.

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

7.2 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.

7.3 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 is not left in overnight or for a similarly lengthy period.

If it is known that the dummy will be in the vehicle for a time longer than 2 hours, then the dummy should be sat on plywood boards placed over the seat. This should eliminate unrealistic compression of the seat.

7.4 Dummy Placement

If the vehicle has only two side doors, it may be necessary to fit the child restraint systems and child dummies (section 7.6) before setting up the Hybrid-III dummies in the front seats.

7.4.1 Ensure that the seat is in the correct position as defined by Section 6.1.

7.4.2 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.

7.4.3 Carefully place the seat belt across the dummy and lock as normal.

7.4.3.1 Apply a small rearwards force to the lower torso and a small forwards force to the upper torso to flex the upper torso forwards from the seat back. Then rock the torso left and right four times, going to between 14 and 16 degrees to the vertical.

7.4.3.2 Maintaining the small rearwards force to the lower torso, apply a small rearwards force to the upper torso to return the upper torso to the seat back. Slowly remove this force.

7.5 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.

7.5.1 *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 7.1. Record the position of the dummy H-point in the test details.

7.5.2 *Pelvic Angle*

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

7.5.3 *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. 7.5.1)
-Adjust the pelvic angle within the limits (par. 7.5.2)
-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.

7.5.4 *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.

7.5.5 *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.

7.5.6 *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.

7.5.7 *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 270mm ± 10mm (except if the left foot is placed on a footrest in par. 7.5.8 below). The legs of the dummies should be in vertical longitudinal planes as far as is possible.

7.5.8 *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 270mm ± 10mm 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.

7.6 Child Restraint System (CRS) Installation and Child Dummy Placement

Two CRS's are to be fitted in the rear seat, one suitable for a 3 year old child, the other for an 18 month old infant. Each will be the system recommended by the manufacturer for that size of child. The type of system to be fitted will be determined from the manufacturer.

7.6.1 Read the relevant sections of the vehicle handbook and the instructions provided with the child restraint. This is to identify any special features of either the vehicle or the child restraint that are intended to improve performance or may influence installation. Instructions on tightening of the adult seat belt around the child restraint should be noted, but the installation itself should follow the procedure below.

7.6.2 Calibrate the seat belt tension load cells to be used in the CRS installation process at the required load reading i.e. 50N for lap and diagonal installations and 75N for lap belt applications directly before beginning the installation procedure.

7.6.3 Ensure that the seat and belt anchorage positions are as defined in section 6.4. In the case of an adult seat belt that is capable of being switched from an emergency locking retractor (ELR) to an automatic locking retractor (ALR) follow clear advice, obvious to the user, about how the ALR feature should be used on any labels associated with the seat belt (information given in the handbook will be ignored as reading of the handbook cannot be assumed for all users).

7.6.4 *For Integral Harness Systems*

7.6.4.1 Install the child restraint and place the dummy within it. Place the 2.5cm thick and 6cm wide flexible spacer between the back of the manikin and the back of the child restraint. The lower end of the spacer should be at the height of the manikin's hip joint. Adjust the harness restraining the child in accordance with the manufacturer's instructions, but to a tension of 250 +/-50N above the frictional adjuster force. The angle of pull on the webbing should be as indicated in the fitting instructions.

7.6.4.2 Release the harness buckle, remove the spacer, refasten the harness and push the dummy towards the seat back. Arrange the slack within the integral harness so that it is evenly distributed. Make sure the dummy head is upright, and the legs are parallel. Raise the dummy feet and allow them to fall lightly into a stable resting position. Place the dummy's hands so that they are resting on the top of the thighs and tape them lightly in position using a weak paper tape.

7.6.4.3 In the case of a rearward facing restraint, use weak paper tape to locate the dummy head relative to the back of the child restraint. The intention is to prevent dummy displacement under acceleration during the vehicle run-up to the barrier. The tape should be weak enough to break on impact of the vehicle with the barrier.

7.6.5 *For Integral Harness Systems Installed With a 3 Point Seat Belt, With No Lock Off or Lock Off Design That Can Be Released To Give No Friction During Installation*

7.6.5.1 Engage the adult seat belt buckle, fit one load cell outboard on the lap section of the adult belt and one on the free webbing of the diagonal section between the child restraint and the pillar loop. Establish a tension of 50N +/-5N in both the lap and diagonal sections of the adult belt webbing. Apply lock-off devices if available. If the design of the CRS is such that tension is maintained within the lap and diagonal sections of webbing, remove the load cell on the free section of diagonal webbing. However, if removal of the diagonal belt load cell changes the installation tension of the belt, leave the load cell in place. Disconnect any electrical leads and stow them ready for impact.

7.6.5.2 Draw all remaining webbing off the inertia reel of the adult seat belt and allow it to retract slowly under the influence of its own retraction mechanism. Where an ALR system is fitted this action may result in it being activated. If it is the intention for the system not to be activated for the test then draw all the webbing from the reel and allow it to fully retract, prior to the installation of the child seats. Do not fully draw the webbing from the reel after this procedure has been completed.

7.6.6 *For Integral Harness Systems Installed With a 3 Point Seat Belt, With a Lock-Off Design That Cannot Be Released To Give No Friction During Installation.*

7.6.6.1 Place the diagonal belt load cell between the lock-off and the buckle tongue slot and leave it in position during the test. All other aspects of the installation are as per 7.6.5.

7.6.7 *For Booster Seats In Which The Adult Belt Restrains The Child And In Which There Is A Fixed Position Lock-Off.*

7.6.7.1 Place the dummy in the seat with the spacer in position. Locate the diagonal load cell between the lock-off and the buckle tongue slot, in a position where it will not interfere with the dummy's arm movement. Locate the lap section load cell on the outboard adult belt webbing. Establish a load of 50N +/-5N in both sections of the webbing. Leave the load cells in position if their removal would alter the set-up tensions. Release the buckle, remove the spacer and refasten the buckle. Set the dummy back in position as described above in section 7.6.4 and check the webbing spooled on the inertia reel of the adult belt as per section 7.6.5.2.

7.6.8 *For Booster Seats In Which The Position Of The Lock-Off/Shoulder Belt Guide Is Adjustable.*

7.6.8.1 Optimise the position of the lock-off/shoulder belt guide before beginning the installation process. For those systems in which the adult belt is used to restrain the child directly, insert the spacer and continue the installation as described in 7.6.7. If the adult belt is used to restrain the child restraint rather than the child itself install the load cells as described above. After installation to the specified tensions operate any device that is specifically designed to increase adult seat belt tension by use of a lever or cam type system or their equivalent. The intention is to correctly credit special design features aimed at achieving improved installation.

7.6.9 *For Child Restraints Using An Impact Shield To Restrain The Child.*

7.6.9.1 Install the dummy with the spacer and position the shield. Put load cells on lap and diagonal sections of the seat belt. Establish correct tensions and, whilst manually clamping the webbing at the belt guides on the impact shield, release the buckle and rotate the shield forward on the buckle side the minimum amount necessary to allow removal of the spacer. Refasten the buckle, check that the shield is positioned centrally, push the dummy back into the seat and continue with remaining aspects of dummy positioning procedure described in sections 7.6.4.2 and 7.6.5.2. It will probably be necessary to rest the dummy arms on the shield rather than the thighs as has been suggested for other restraint types.

7.6.9.2 For seats installed with a static lap belt use one load cell on the non-buckle side of the adult belt and establish a tension of 75N +/-5N equalised throughout the lap belt. Leave the load cell in place if its removal would alter the set-up tension.

7.6.9.3 The time between child seat installation and impact should be subject to the same limits that are applied to adult dummies and should be kept as short as possible.

7.6.9.4 Retro-reflective marking should be applied to the dummy head in positions likely to help assess dummy head movement at full excursion on the high speed films.

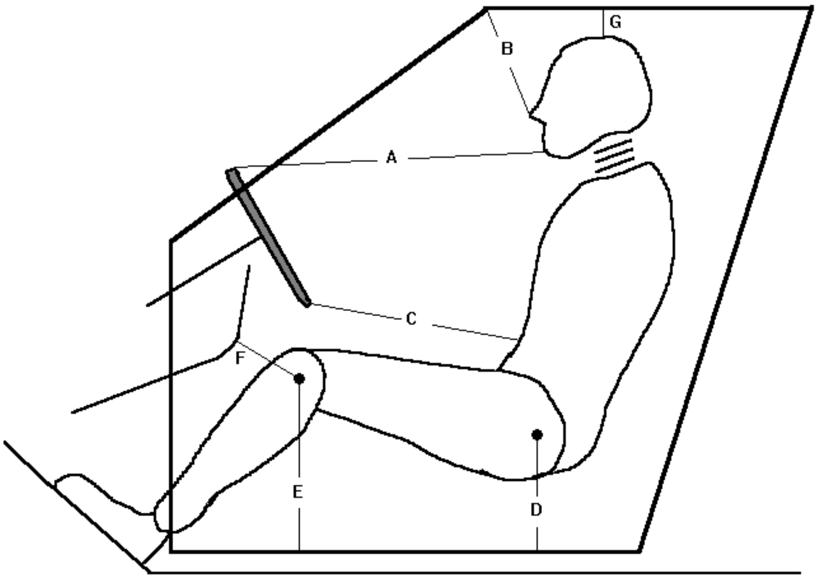
7.6.10 *For "ISOFIX " type seats*

The installation protocol for these seats is under development. If any manufacturers request the use of this type of seat the EuroNCAP Secretariat must be contacted for installation instructions.

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

7.7 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		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
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)

* Shortest distance

8 STILL PHOTOGRAPHY

The following photographs will be taken pre and post-test unless otherwise indicated. Pre-test photographs will be taken with the dummies in their final positions. Examples of the photographs required are given in Annex 1 (EuroNCAP Frontal Impact Photograph Specification Version 1).

No.	**View**
1	Front view of barrier.
2	Side view of barrier.
3	Side view of barrier at 45 degrees to front.
4	Side view of barrier with vehicle.
5	Car RHS, with camera centred on junction of B-post waist, showing full car.
6	Car RHS, with camera centred on B-post waist, showing rear passenger compartment.
7	Car RHS, with camera aimed at waist height, showing driver's compartment.
8	Car RHS at 45 degrees to front.
9	Front view of car.
10	Car LHS at 45 degrees to front.
11	Car LHS, with camera aimed at waist height, showing front passenger's compartment.
12	Car LHS, with camera centred on B-post waist, showing rear passenger compartment.
13	Car LHS, with camera centred on B-post waist, showing full car.
14	Driver and seat to show driver compartment and position of seat relative to the sill.
15	To show area immediately in front of driver.
16	To show driver's footwell area and location of dummy's feet and pedals.
17	Passenger and seat to show compartment and position of seat relative to sill.
18	To show area immediately in front of passenger.
19	To show passenger footwell area and dummy's feet.
20	To show both child dummies and restraints through LHS rear door.
21	To show both child dummies and restraints through RHS rear door.
22*	Overall view of where the car has come to rest after impact (including barrier).
23^	RHS rear seat belt anchorage with child restraint and P3 dummy in place.
24^	LHS rear seat belt anchorage with child restraint and P1 ½ dummy in place.
25*	P3 dummy and restraint through RHS rear door.
26*	P1 ½ dummy and restraint through LHS rear door.

* Post-test only, ^ Pre-test only

After Dummy Removal

No.	**View**
27	Passenger compartment from rear window.
28	LHS interior from RHS of car.
29	RHS interior from LHS of car.
30	LHS front door area.
31	RHS front door area.
32	Facia.
33	Passenger footwell.
34	Driver footwell.
35	Steering wheel taken perpendicular to driver's side.
36	Driver right knee impact point.
37	Driver left knee impact point.
38	Passenger knee impact area.

NB The above photos are for a RHD car, for a LHD car camera locations will switch sides.

9 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.

9.1 Deformable Barrier

Fix a deformable barrier to the concrete block. The height of this barrier should be 200mm from the ground. A full description of the barrier and how it is to be fitted is given in Appendix 1.

9.2 Speed

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

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

TARGET SPEED = 64km/h ± 1km/h

9.3 Overlap

9.3.1 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.

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

9.3.3 After the test, if the mark made by the pin is more than 20mm horizontally away from the original mark, film analysis will be used to try to assess the overlap. (The vertical accuracy should also be noted).

TARGET OVERLAP = 40% ± 20mm

After Test

9.4 Door Opening Force

The opening of vehicle doors post test shall be recorded on video.

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

9.4.2 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.

9.4.3 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.

9.4.4 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.

Note: 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.

9.5 Video of Dummy Position

9.5.1 The post impact positions of the dummies will be recorded on video.

9.6 Dummy Removal

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

9.6.2 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.

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

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

9.6.5 Record the method used to remove the dummies.

9.7 Intrusion Measurements

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

Where a specified requirement has not been met, EuroNCAP reserves the right to decide whether or not the test will be considered as valid.

10 CALCULATION OF INJURY PARAMETERS

The following table lists all of the channels which are to be measured and the Channel Frequency Class at which they are to be filtered. Traces should be plotted of all of these channels. The injury calculation column lists the parameters which will be calculated for each location. If the injury parameter is not a simple peak value and involves some further calculation, details are given subsequently. Peak levels of head or neck parameters occurring from impacts after the dummy head rebounds from an initial contact are not considered when calculating maximum levels of injury parameters.

Location	**Parameter**	**CFC**[3]	Injury Calculation
Head	Accelerations, A_x A_y A_z	1000	Peak Resultant acceleration HIC_{36} Resultant 3msec exceedence
Neck	Forces, F_x F_y F_z	1000	Tension ($+F_z$) continuous exceedence Shear (F_x) continuous exceedence Peak Extension (M_y)I
	Moments, M_x M_y M_z	600	
Chest	Accelerations, A_x A_y A_z	180	Peak resultant acceleration Resultant 3 msec exceedence Peak deflection Viscous Criterion
	Deflection, D	180	
Femurs (L & R)	Forces, F_z	600	Compressive Axial Force ($-F_z$) Continuous exceedence
Knees (L & R)	Displacements, D	180	Peak displacement
Upper Tibia (L & R)	Forces, F_x F_z	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	600	
Lower Tibia (L & R)	Forces, F_x F_z	600	Peak Tibia Compression ($-F_z$) Tibia Index
	Moments, M_x M_y	600	

[3] All CFCs taken from SAE J211

Using the above channels, dummy injury parameters can be calculated according to the following procedures:

10.1 Head

10.1.1 Calculate the resultant head acceleration A_R from the three components A_x, A_y and A_z <u>after</u> they have been filtered and determine the maximum value of A_R

$$A_R = \sqrt{A_X^2 + A_Y^2 + A_Z^2}$$

10.1.2 Determine the highest value of the resultant head acceleration

10.1.3 Calculate the Head Injury Criterion (HIC) according to

$$HIC = (t_2 - t_1)\left[\frac{\int_{t_1}^{t_2} A_R.dt}{(t_2 - t_1)}\right]^{2.5}$$

where A_R is expressed in multiples of g. Maximise HIC for any time 'window' (t_2 - t_1) up to 36 milliseconds.

10.1.4 Determine the acceleration level which A_R exceeds for a cumulative time period of three milliseconds i.e. the head 3msec exceedence.

10.2 Neck

10.2.1 Calculate the neck extension bending moment from

$$(M_y)i = M_y - fx.d$$

Where M_y and Fx are bending moment and shear force respectively measured at the transducer and d is the distance from the transducer to the interface (d=0.01778).

See (SAEJ1733).

10.2.2 Determine the 'continuous exceedence' of both the neck tension (F_z positive) and neck shear (F_x) forces.

10.3 Chest

10.3.1 Determine the greatest value of the chest deflection D_{chest}

10.3.2 Calculate the Viscous Criterion according to the equation

$$\text{Viscous Criterion} = 1.3\ V_{(t)} \times C_{(t)}$$

$D_{(t)}$ is the instantaneous chest deflection at any time t. $C_{(t)}$ is the compression, related to the chest deflection $D_{(t)}$

$$C_{(t)} = \frac{D_{(t)}}{0.229}$$

V is the velocity of deflection and is calculated as the differential of the deflection with respect to time:

$$V_{(t)} = \frac{8*[D_{(t+1)} - D_{(t-1)}] - [D_{(t+2)} - D_{(t-2)}]}{12\delta t}$$

where δt is the time interval between successive digital samples of $D_{(t)}$. Calculate $V_{(t)}*C_{(t)}$ continuously with time and determine its greatest value.

10.4 Femurs

10.4.1 For each of the femurs, calculate the continuous exceedence in compression (F_z negative)

10.5 Knees

10.5.1 For each of the knees, determine the greatest value of the knee displacement D

10.6 Tibia

10.6.1 At the upper and lower of both the left and the right tibias, calculate the resultant bending moment M_R from M_x and M_y after they have been filtered.

$$M_{R(t)} = \sqrt{M_{X(t)}^2 + M_{Y(t)}^2}$$

10.6.2 Calculate the Tibia Index (TI) at the upper and lower tibia of each leg according to the equation

$$TI_{(t)} = \left|\frac{M_{R(t)}}{(M_R)_C}\right| + \left|\frac{F_{Z(t)}}{(F_Z)_C}\right|$$

$TI_{(t)}$ is the instantaneous value of the Tibia Index at time t. $(M_R)_C$ is the critical value of the bending moment = 225Nm and $(F_Z)_C$ is the critical value of the axial force = 35.9kN

The vertical lines indicate that the modulus should be taken.

10.6.3 Determine the highest value of the Tibia Index.

10.6.4 Determine the highest value of the axial compressive force measured at either the upper or lower tibia.

10.7 Child Dummy

10.7.1 For the TNO P3 and P1½ dummies, calculate the peak resultant accelerations of the chest and head.

10.7.2 For both P3 and P1½ dummies determine the levels which chest vertical and chest resultant accelerations exceed for a cumulative time of three milliseconds.

10.7.3 For the P1½ dummy calculate peak head vertical acceleration and the level which this acceleration exceeds for a cumulative time of three milliseconds.

Side Impact

Contents

Page No.

Side Impact

1 VEHICLE PREPARATION

1.1 Unladen Kerb Mass

Note: EC directive 96/27/EC defines the Unladen Mass of the vehicle as the mass with 90% fuel but all other fluids at maximum capacity.

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 Refill the tank with fuel, water or other ballast to a weight equivalent to 90% of its fuel tank capacity of fuel.

1.1.4 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.

1.1.5 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.

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

1.1.7 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.

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

1.2 Reference Loads

1.2.1 Place both front seats in their mid-positions, this may not be the same as the final test position. If there is no notch at this position, set the seat in the nearest notch rearward (this will be done more completely in Section 5).

1.2.2 Place weights equivalent to a EuroSID-1 test dummy (80kg) in the front driver's seating position.

1.2.3 Place weights in the luggage compartment of the vehicle until the total vehicle mass (sum of front and rear axle masses) is 100kg more than the unladen kerb mass (from Section 1.1.7). 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.

1.2.4 In the child restraints recommended by the manufacturer, place masses equivalent to a 1½ and a 3 year old child dummy on the rear drivers seat and passenger seat respectively (11kg and 15kg). If the child restraints are not available at this time then default masses of 3kg should be added to the dummy masses.

1.2.5 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.

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

1.2.7 Measure and 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.

1.2.8 Remove the weights from the luggage compartment and from the front and rear seats.

1.3 'R' Point

To measure vehicle dimensions and to apply markers, a pointer used to measure co-ordinates in three dimensions will be used.

1.3.1 The location of the R point relative to some part of the vehicle structure will have been provided by the manufacturer. Determine the position of this point.

1.3.2 Mark a point on the driver's side of the car which has X (longitudinal) co-ordinate not more than 1mm different to the theoretical R point location.

1.3.3 Draw a vertical line through the R-Point and mark it clearly 'R'.

1.3.4 Mark points along the side of the vehicle which have the same X co-ordinates as the 'R' point. Continue these points onto the roof of the vehicle. The points should all lie in the same vertical transverse plane as the 'R' point.

1.3.5 Using a piece of sticky tape in a colour to contrast with the body-colour, join the points with one edge of the tape. Mark clearly on the tape which of its edges aligns with the 'R' point. This edge may be used to assess the alignment of the barrier with the 'R' point.

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.

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

1.4.2 Ensure that a live battery is connected, if possible in its standard position. Check that the dashboard light for the airbag circuit functions as normal.

1.4.3 Fit the on-board data acquisition equipment in the boot of the car. Also fit any associated cables, cabling boxes and power sources.

1.4.4 Place weights equivalent to a EuroSID-1 dummy (80kg) in the front driver's seat of the car (with the front seats in their mid-positions).

1.4.5 In the child restraints recommended by the manufacturer, place masses equivalent to a 1½ and a 3 year old child dummy on the rear drivers seat and passenger seat respectively (11kg and 15kg). If the child restraints are not available at this time then default masses of 3kg should be added to the dummy masses.

1.4.6 Weigh the front and rear axle weights of the vehicle. Compare these weights with those determined in Section 1.2.5

1.4.7 The total vehicle mass shall be within 1% of the reference mass (Section 1.2.5). Each axle load shall be within the smaller of 5% or 20kg of its respective axle reference load (Section 1.2.5). If the vehicle differs from the requirements given in this paragraph, items may be removed or added to the vehicle which have no influence on its structural crash performance. 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 items added to increase the vehicle weight should be securely attached to the car.

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

1.5 Vehicle Markings

1.5.1 EuroNCAP markings will be attached to the exterior of the vehicle in the following locations; centre of the bonnet and on the front half of the roof of the vehicle. Refer to figure 1.1. Areas marked with a dotted box are considered acceptable to place EuroNCAP markings within.

1.5.2 Test house logos may be added to the vehicle provided that they do not detract attention from the EuroNCAP markings. Suitable locations for such markings would be the middle of the roof and on the bonnet at the base of the windscreen.

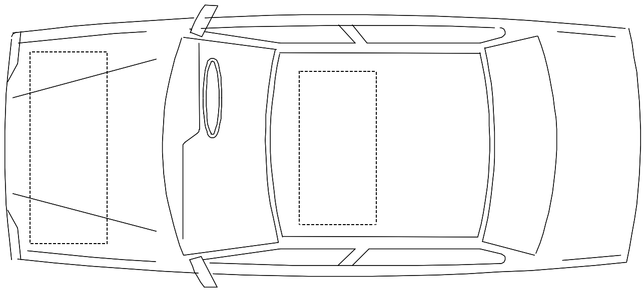


Figure 1.1

2 DUMMY PREPARATION AND CERTIFICATION

2.1 General

2.1.1 A EuroSID-1 test dummy should be used in the front driver's position. It should conform to the requirements given in Appendix 3 of Annex II of EC Directive 96/27/EC.

2.1.2 A TNO/Ogle P1½ child dummy, in a suitable Child Restraint System (CRS) (see Section 6.4), should be used in the rear driver side seating position (or rear centre seating position if the vehicle manufacturer prefers).

2.1.3 A TNO P3 child dummy, in a suitable CRS (see Section 6.4), should be used in the rear passenger side seating position (or rear centre seating position if the vehicle manufacturer prefers).

2.1.4 If either child dummy is placed in the rear centre seating position the other dummy must be placed on the struck side of the vehicle.

2.2 Certification

Full details of the EuroSID-1 certification requirements are available in Appendix 3 of Annex II of EC Directive 96/27/EC and the procedures followed are set out in the TNO EuroSID-1 Training Manual. Details of the certification procedure for P3 and P1½ dummies are available in the user documentation.

2.2.1 The EuroSID dummy should be re-certified after every THREE impact tests.

2.2.2 The TNO P3 and P1½ child dummies shall be re-certified after every SIX impact tests (e.g. 3 frontal and 3 side impacts, or any combination of the two test types).

2.2.3 If an injury criterion reaches or exceeds its normally accepted limit (eg HIC of 1000) then that part should be re-certified.

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

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

2.3 Additions and Modifications to the EuroSID-1 Dummy

2.3.1 The dummy will have a backplate load cell fitted (see section 3.1). [It is also intended to fit a spine load cell]

2.4 Dummy Clothing and Footwear

2.4.1 EuroSID-1

2.4.1.1 The dummy will be clothed in a Eurosid 1 rubber 'wet-suit', covering the shoulders, thorax, upper parts of the arms, abdomen and lumbar spine and the upper part of the pelvis. This rubber suit will act as a nominal 'skin' for the dummy torso.

2.4.1.2 The dummy will be clothed with formfitting, calf-length, cotton stretch pants and shoes.

2.4.2 Child Dummies

2.4.2.1 Each child dummy shall be fitted with close-fitting stretch clothing suitable for an infant of an appropriate age.

2.5 Dummy Test Condition

2.5.1 Dummy Temperature

2.5.1.1 The dummy shall have a stabilised temperature in the range of 18°C to 26°C.
2.5.1.2 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.
2.5.1.3 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.
2.5.1.4 A printout of the temperature readings is to be supplied as part of the standard output of the test.
2.5.2 Dummy Joints
2.5.2.1 Stabilise the dummy temperature by soaking in the required temperature range for at least 5 hours.
2.5.2.2 Set the torque on the shoulder screws to 0.6Nm
2.5.2.3 For adjustable joints in the legs, 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.
2.5.2.4 The dummy joint stiffnesses 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.
2.5.2.5 Maintain the dummy temperature within the range 18° to 26°C between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.

2.5.3 Dummy painting and marking
2.5.3.1 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.

EuroSID

Head (Paint tape outline only)	Red
Shoulder/Arm	Blue
Top Rib	Red
Mid Rib	Yellow
Bottom Rib	Green
Abdomen	Red
Pelvis	Orange

Child dummies

Top of Head	Blue
Head-band thirds (colours from left to right)	Red, Yellow, Green

NOTE: The tape should be completely covered with the coloured paints specified, with the exception of the EuroSID Head which should have only the outer edge of the tape painted. Adhesive target markers should be attached to the top/rear of the child dummy's head in order to aid the assessment of the child head containment.

Tape Sizes:

Eurosid

Head	= 100mm square, centreline of head with lower edge at C of G.
Shoulder/Arm	= 25mm x 150mm, starting at bottom edge of shoulder fixing hole.
Ribs	= 150mm strip, starting at the rearmost accessible point at seat back.
Abdomen	= 50 x 50mm square
Pelvis	= 50mm x 100mm, centred on hip joint point.

Child Dummies

Top of Head	= 50 x 50mm square
Headbands	= 25mm wide, widest circumference remaining at eyebrow level at front, extending to the head C of G at each side.

2.6 Post Test Dummy Inspection

2.6.1 The dummy should be visually inspected immediately after the test. Any lacerations of the skin or breakages of the dummy should be noted in the test details. The dummy may have to be re-certified in this case. Refer to Section 2.2.

3 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 are mounted according to procedures laid out in SAE J211. The sign convention used for configuring the transducers is stated in SAE J211 (1995).

3.1 Dummy Instrumentation

The EuroSID-1 dummy to be used shall be instrumented to record the channels listed below.

EuroSID-1

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations A_x A_y A_z	250g	3
Thorax T1	Accelerations A_x A_y A_z	200g	3
Thorax T12	Accelerations A_y	200g	1
Ribs - Upper, Middle & Lower	Accelerations A_y	700g	3
	Deflection D_{rib}	90mm	3
Abdomen - Front Middle & Rear	Forces F_y	5kN	3
Backplate Load Cell	Forces F_x F_y	5kN	4
	Moments M_y M_z	200Nm	
Lumbar Spine Load Cell	Forces F_x F_y	5kN	4
	Moments M_x M_y	200Nm	

Pelvis	Accelerations A_x A_y A_z	150g	3
Pubic Symphysis	Forces F_y	20kN	1
	Total Channels per Dummy		**28**
	1 × EuroSID-1		**28**

TNO P3

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations A_x A_y A_z	150g	3
Chest	Accelerations A_x A_y A_z	150g	3
	Total Channels per Dummy		**6**
	1 × TNO P3 dummy		**6**

TNO P1½

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations A_x A_y A_z	150g	3
Chest	Accelerations A_x A_y A_z	150g	3
	Total Channels per Dummy		**6**
	1 × TNO P1½ dummy		**6**

3.2 Vehicle Instrumentation

3.2.1 The vehicle is to be fitted with an accelerometer on the unstruck B-post. The accelerometer is to be fitted in the lateral direction (A_y).

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

3.2.3 Securely attach a mounting plate for the accelerometer horizontally on to the sill.

3.2.4 Fix the accelerometer to the mounting plate. Ensure the accelerometer is horizontal to a tolerance of ±5 degree.

VEHICLE

Location	Parameter	Minimum Amplitude	No of channels
B-Post LHS	Accelerations, A_y	150g	1
	Total Channels per Vehicle		1

3.3 Trolley and Barrier Instrumentation

3.3.1 The trolley is to be fitted with an accelerometer at its Centre of Gravity. The accelerometer is to be fitted in the fore/aft direction (A_x). (See Section 7)

TROLLEY

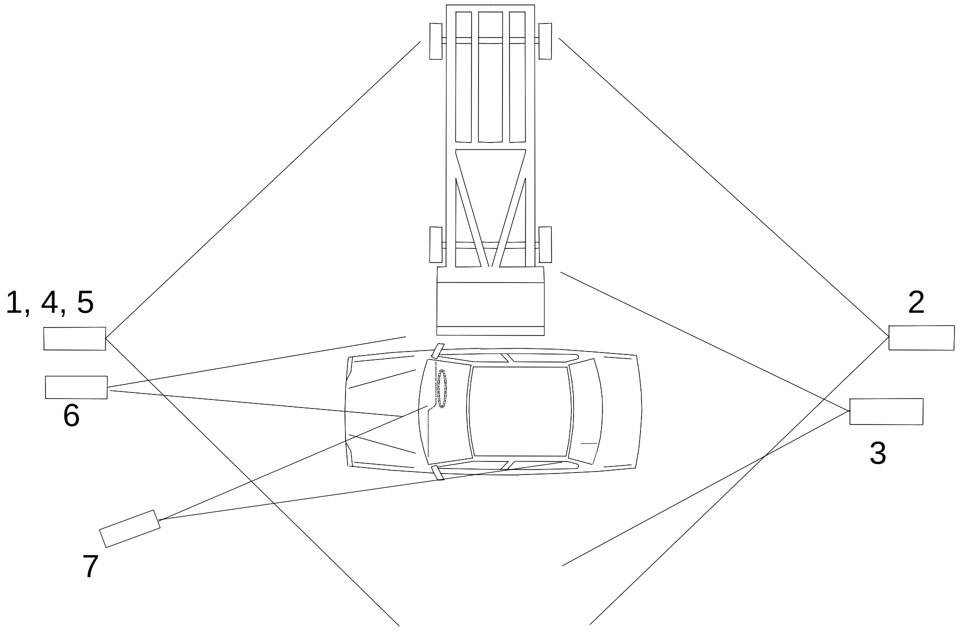
Location	Parameter	Minimum Amplitude	No of channels
Trolley C of G	Accelerations, A_x	150g	1
	Total Channels per Trolley		1

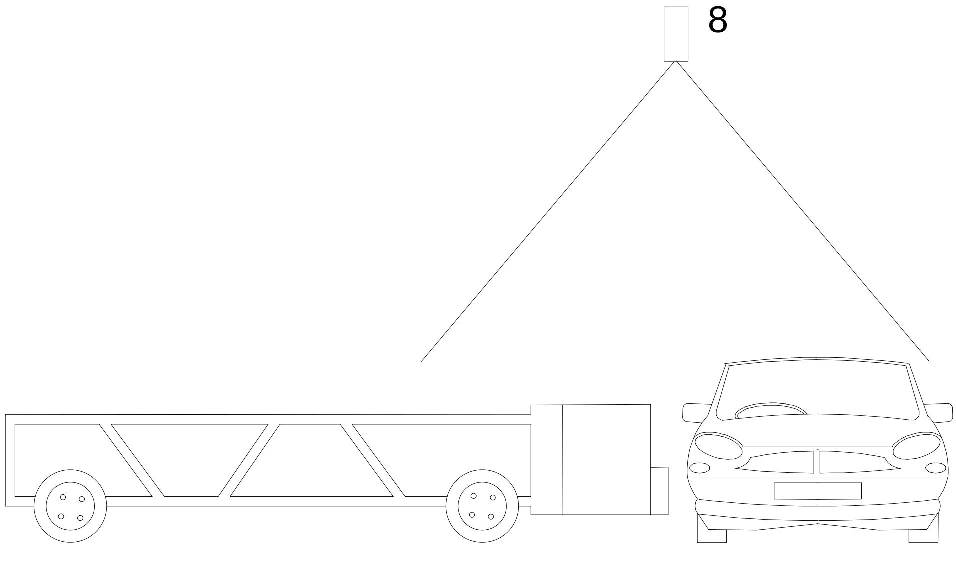
TOTAL CHANNELS

1x Driver EuroSID-1	28
1x TNO P3	6
1x TNO P 1½	6
1x Vehicle	1
1x Trolley	1
TOTAL	42

4 CAMERA LOCATIONS

Set up high speed film cameras according to the following diagrams





Camera No.	Camera Type	Shot Content
1	>/= 400 fps high speed cine	Front view of vehicle and trolley (wide)
2	>/= 400 fps high speed cine	Rear view of vehicle and trolley (wide)
3	>/= 400 fps high speed cine	Rear view of child head containment
4	>/= 50 fps stills camera	Front view of vehicle and trolley (wide)
5	>/= 50 fps stills camera	Backup for 4 (optional)
6	>/= 1000 fps high speed cine	Front view of driver and impact point (tight)
7	>/= 400 fps high speed cine	Front ¾ view of child dummies (tight)
8	>/= 400 fps high speed cine	Plan view of car and trolley (tight)

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. Please note for view number 7 the passenger side headrest should be removed if possible.

5 PASSENGER COMPARTMENT ADJUSTMENTS

Adjustment	Required Setting	Notes	Methods
Seat Fore/Aft	Mid position as defined in 5.1	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	See Section 5.2
Seat Height	Same height as non-adjustable version of front seat	If only adjustable seats available, set to mid-position	
Seat Back Angle (as defined by torso angle)	Manufacturer's design position	Otherwise 25° to Vertical	See Section 6.1
Seat Lumbar Support	Manufacturer's design position	Otherwise fully retracted	
Head Restraints	Top surface level with Centre of Gravity of dummy head	Place at highest setting if unable to align with C of G	
Head Restraint Tilt Angle	Manufacturer's design position	Otherwise mid position	
Steering wheel - vertical	Mid position		See Section 5.4
Steering wheel - horizontal	Mid position		See Section 5.3
Rear Seat Fore/Aft	Mid position	May be set to first notch rearwards of mid position if not lockable at mid position	See Section 5.5.1
Rear Seat Facing	Forwards		See Section 5.5.1
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 - Raised Rear - Raised		
Gear change lever	In the neutral position		
Parking Brake	Disengaged		
Pedals	Normal position of rest		
Doors	Closed, not locked		
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		
Seat belt anchorage	Manufacturer's design position	If no design position then set to mid position, or nearest notch upwards	

Adjustments not listed will be set to mid-positions or nearest positions rearward, lower or outboard. If both an adjustable and non-adjustable seat is fitted, the adjustable seat should be set to the same position as the non-adjustable version.

5.1 Determination of and Setting the Fore/aft Position of the 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.

5.2 Setting the Seat Base Vertical, Tilt and Lumbar Positions

5.2.1 If the seat is adjustable for height, the manufacturer will be asked whether the vehicle is made with non-adjustable seats for driver or passenger. If this is the case, the manufacturer will be asked what the height of the H-point is for the non-adjustable version.

5.2.2 Using the procedure described more fully in Section 6.1, sit the H-point manikin in the seat

5.2.3 Adjust the height of the seat until the H-point of the manikin is at the same height as that given by the manufacturer's information.

5.2.4 If the vehicle is not available with non-adjustable seat height, set the seat to its middle position.

5.2.5 If the seat base is adjustable for tilt it may be set to any angle from the flattest to its mid position according to the manufacturer's preference. The same seat tilt setting must be used for frontal and side impact.

5.2.6 Seat Lumbar Setting. If the seat back is adjustable for lumber support it should be set to the fully retracted position, unless the manufacturer specifies otherwise or the dummy prevents this.

The settings for the passenger seat should be as near as possible to being the same as that of the driver's seat.

5.3 Setting the Steering Wheel Horizontal Adjustment

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

5.3.2 Move the steering wheel to the most forward position of its travel

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

5.3.4 Move the steering wheel to the most rearwards position of its travel

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

5.3.6 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.

5.3.7 Move the steering wheel so that the mark on the steering column aligns with the facia.

5.3.8 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.

5.4 Setting the Steering Wheel Vertical Adjustment

A method that is in principle the same as Section 5.3 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.

5.5 Use of The Gabarit

A device known as a Gabarit (as defined in UN ECE Consolidated Resolution RE3) is used to check the compatibility of the vehicle with ECE Regulation 44.03 Universal child restraints. This device is used to check the following;

i) the position of the buckle tongue stop on the adult seat belt to ensure compatibility with all types of child restraint.

ii) the length of the adult seat belt webbing compared to the requirement of Universal restraints for those seats designated as suitable for such restraints.

iii) and the position of the adult seat belt hardware relative to the belt contact zones specified for universal child restraints.

This assessment will be done in accordance with UN ECE Consolidated Resolution RE3 Annex 13. The vehicle handbook will be checked for guidance about which seat positions in the vehicle are suitable for use with Universal child restraints and which seat positions are unsuitable for use by children.

5.5.1 If the vehicle rear seat position is adjustable put it in the mid position of its horizontal adjustment range, unless the manufacturer’s handbook says otherwise when using child seats, and adjust the seat back angle in accordance with the procedure in 6.1. If the direction of facing of the seat is adjustable it should be set to face forward, with its axis parallel to the fore/aft direction of the vehicle.

5.5.2 If the adult seat belt has an adjustable upper anchorage set the anchorage in the lowest position unless permanently attached instructions on the child restraint or vehicle suggest otherwise.

6 DUMMY POSITIONING AND MEASUREMENTS

The following chapter deals with all aspects of seating the dummy in the vehicle to be tested. A general timetable of the complete procedure is set out below:-

Timetable

	When this is done
1. Determine the H-point of the driver's seat	Before test day
2.Dummy installation (on boards)	Before test day
3. Dummy placement	Test day
4.Dummy positioning	Test day
5. Dummy positioning measurements	Test day - after vehicle has been positioned for test

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 ± 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.

6.1.1 Set the seat back so that the torso of the dummy is as close as possible to the manufacturer's recommendations for normal use. In absence of such recommendations, an angle of 25 degrees towards the rear from vertical will be used.
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 the end stop and 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.
6.1.17 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 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 is not left in overnight or for a similarly lengthy period.

If it is known that the dummy will be in the vehicle for a time longer than 2 hours, then the dummy should be sat on plywood boards placed over the seat. This should eliminate unrealistic compression of the seat.

6.3 Dummy Placement

If the vehicle has only two side doors, it may be necessary to fit the child restraint systems and child dummies (section 6.4) before setting up the EuroSID-1 dummy in the front seat.

6.3.1 *H-point*

Note that the H-point of the EuroSID-1 dummy is situated 21mm forward of and 5mm above that of the H-point determined by the H-point manikin (Section 6.1)

6.3.1.1 Position the dummy in the seat, with its back against the seat and its centreline coinciding with the seat centreline.

6.3.1.2 Carefully place the seat belt across the dummy and lock as normal

6.3.1.3 Manoeuvre the dummy until its Hip-joint point is within 13mm in the vertical dimension and 13mm in the horizontal dimension of a point 21mm fore and 5mm above the H-point as determined in Section 6.1.

6.3.2 *Alignment*

Visually check that the dummy sits square and level in the seat before taking any measurements of the H-point position.

6.3.3 *Legs and Feet*

6.3.3.1 Position the left foot perpendicular to the lower leg with its heel on the floorpan in a transverse line with the heel of the right foot.

6.3.3.2 Carefully position the dummy's right foot on the undepressed accelerator pedal with the heel resting as far forward as possible on the floorpan.

6.3.3.3 Measure the separation of the inside surfaces of the dummy's knees and adjust until they are 150±10mm apart from each other.

6.3.3.4 If possible within these constraints, place the thighs of the dummy on the seat cushion.

6.3.3.5 Check again the position of the H-point, the levelness of the pelvis and the squareness of the dummy in the seat. If everything is in position, set the arms.

6.3.4 *Arms*

The arms of the EuroSID-1 dummy have click-stops corresponding to fixed angles between the torso reference line and the arms.

6.3.4.1 Move both arms of the dummy until they have clicked at those positions corresponding to 40° angle between the arms and the torso reference line.

6.4 Child Restraint System (CRS) Installation and Child Dummy Placement

Two CRS's are to be fitted in the rear seat, one suitable for a 3 year old child, the other for an 18 month old infant. Each will be the system recommended by the manufacturer for that size of child. The type of system to be fitted will be determined from the manufacturer.

6.4.1 Read the relevant sections of the vehicle handbook and the instructions provided with the child restraint. This is to identify any special features of either the vehicle or the child restraint that are intended to improve performance or may influence installation. Instructions on tightening of the adult seat belt around the child restraint should be noted, but the installation itself should follow the procedure below.

6.4.2 Calibrate the seat belt tension load cells to be used in the CRS installation process at the required load reading i.e. 50N for lap and diagonal installations and 75N for lap belt applications directly before beginning the installation procedure.

6.4.3 Ensure that the seat and belt anchorage positions are as defined in section 5.5. In the case of an adult seat belt that is capable of being switched from an emergency locking retractor (ELR) to an automatic locking retractor (ALR) follow clear advice, obvious to the user, about how the ALR feature should be used on any labels associated with the seat belt (information given in the handbook will be ignored as reading of the handbook cannot be assumed for all users).

6.4.4 *For Integral Harness Systems*

6.4.4.1 Install the child restraint and place the dummy within it. Place the 2.5cm thick and 6cm wide
flexible spacer between the back of the manikin and the back of the child restraint. The lower end of the spacer should be at the height of the manikin's hip joint. Adjust the harness restraining the child in accordance with the manufacturer's instructions, but to a tension of 250 +/-50N above the frictional adjuster force. The angle of pull on the webbing should be as indicated in the fitting instructions.

6.4.4.2 Release the harness buckle, remove the spacer, refasten the harness and push the dummy towards the seat back. Arrange the slack within the integral harness so that it is evenly distributed. Make sure the dummy head is upright, and the legs are parallel. Raise the dummy feet and allow them to fall lightly into a stable resting position. Place the dummy's hands so that they are resting on the top of the thighs and tape them lightly in position using a weak paper tape.

6.4.4.3 In the case of a rearward facing restraint, use weak paper tape to locate the dummy head relative to the back of the child restraint. The intention is to prevent dummy displacement under acceleration during the vehicle run-up to the barrier. The tape should be weak enough to break on impact of the vehicle with the barrier.

6.4.5 *For Integral Harness Systems Installed With a 3 Point Seat Belt, With No Lock Off or Lock Off Design That Can Be Released To Give No Friction During Installation*

6.4.5.1 Engage the adult seat belt buckle, fit one load cell outboard on the lap section of the adult belt and one on the free webbing of the diagonal section between the child restraint and the pillar loop. Establish a tension of 50N +/-5N in both the lap and diagonal sections of the adult belt webbing. Apply lock-off devices if available. If the design of the CRS is such that tension is maintained within the lap and diagonal sections of webbing, remove the load cell on the free section of diagonal webbing. However, if removal of the diagonal belt load cell changes the installation tension of the belt, leave the load cell in place.

Disconnect any electrical leads and stow them ready for impact.

6.4.5.2 Draw all remaining webbing off the inertia reel of the adult seat belt and allow it to retract slowly under the influence of its own retraction mechanism. If it is the intention for the system not to be activated for the test then draw all the webbing from the reel and allow it to fully retract, prior to the installation of the child seats. Do not fully draw the webbing from the reel after this procedure has been completed.

6.4.6 *For Integral Harness Systems Installed With a 3 Point Seat Belt, With a Lock-Off Design That Cannot Be Released To Give No Friction During Installation.*

6.4.6.1 Place the diagonal belt load cell between the lock-off and the buckle tongue slot and leave it in position during the test. All other aspects of the installation are as per 6.4.5.

6.4.7 *For Booster Seats In Which The Adult Belt Restrains The Child And In Which There Is A Fixed Position Lock-Off.*

6.4.7.1 Place the dummy in the seat with the spacer in position. Locate the diagonal load cell between the lock-off and the buckle tongue slot, in a position where it will not interfere with the dummy's arm movement. Locate the lap section load cell on the outboard adult belt webbing. Establish a load of 50N +/-5N in both sections of the webbing. Leave the load cells in position if their removal would alter the set-up tensions. Release the buckle, remove the spacer and refasten the buckle. Set the dummy back in position as described above in section 6.4.4 and check the webbing spooled on the inertia reel of the adult belt as per section 6.4.5.2.

6.4.8 *For Booster Seats In Which The Position Of The Lock-Off/Shoulder Belt Guide Is Adjustable.*

6.4.8.1 Optimise the position of the lock-off/shoulder belt guide before beginning the installation process. For those systems in which the adult belt is used to restrain the child directly, insert the spacer and continue the installation as described in 6.4.7. If the adult belt is used to restrain the child restraint rather than the child itself install the load cells as described above. After installation to the specified tensions operate any device that is specifically designed to increase adult seat belt tension by use of a lever or cam type system or their equivalent. The intention is to correctly credit special design features aimed at achieving improved installation.

6.4.9 For Child Restraints Using An Impact Shield To Restrain The Child.

6.4.9.1 Install the dummy with the spacer and position the shield. Put load cells on lap and diagonal sections of the seat belt. Establish correct tensions and, whilst manually clamping the webbing at the belt guides on the impact shield, release the buckle and rotate the shield forward on the buckle side the minimum amount necessary to allow removal of the spacer. Refasten the buckle, check that the shield is positioned centrally, push the dummy back into the seat and continue with remaining aspects of dummy positioning procedure described in sections 6.4.4.2 and 6.4.5.2. It will probably be necessary to rest the dummy arms on the shield rather than the thighs as has been suggested for other restraint types.

6.4.9.2 For seats installed with a static lap belt use one load cell on the non-buckle side of the

adult
belt and establish a tension of 75N +/-5N equalised throughout the lap belt. Leave the load cell in place if its removal would alter the set-up tension.

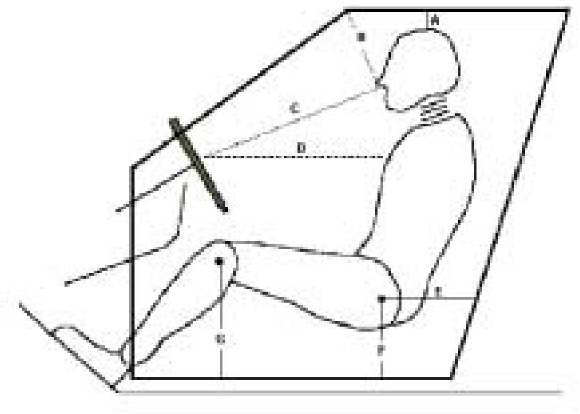
6.4.9.3 The time between child seat installation and impact should be subject to the same limits that
are applied to adult dummies and should be kept as short as possible.

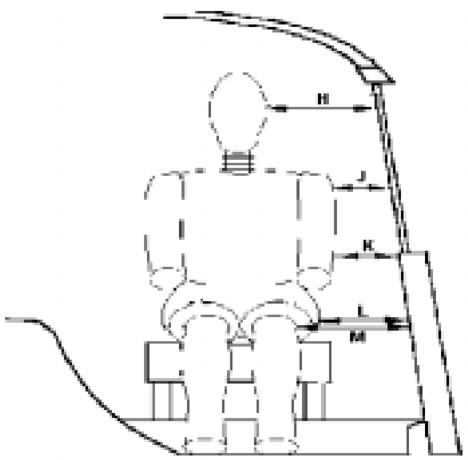
6.4.10 For "ISOFIX " type seats

The installation protocol for these seats is under development. If any manufacturers request the use of this type of seat the EuroNCAP Secretariat must be contacted for installation instructions.

6.5 Dummy Positioning Measurements

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





		Driver, mm or degrees
Head/roof panel	A	
Nose point/windscreen joint	B	
Nose point/centre of the steering	C	
Thorax strap/centre of the steering wheel	D*	
Hip-joint point/inside opening of the door (horizontal)	E	
Hip-joint point/inside opening of the door (vertical)	F	
Knee/floor covering (vertical)	G	
Head/side window pane (or padding)	H	
Shoulder/window pane (or padding)	J	
Elbow/door (or padding)	K	
Pelvis/door (or padding)	L	
Knee/door (or padding)	M	

* Horizontal distance from steering wheel centre

7 BARRIER AND TROLLEY

Currently, EuroNCAP uses the Cellbond Multi-2000 Version 15 mobile deformable barrier face. It should be noted that this barrier does not fully comply with the EEVC specifications. The full EEVC requirements for the performance of the side impact barrier may be found in the reference given at the bottom of the page[1].

7.1 Trolley Preparation

7.1.1 A trolley should be used which has a wheelbase of 3000 ± 10mm and a track at the front and at the rear of 1500 ± 10mm.

7.1.2 The trolley may be fitted with an emergency abort system. This is optional, the test facility may elect to test without an abort system.

7.1.3 Inflate all tyres of the trolley to the same pressure.

7.1.4 Fix the deformable barrier to the front of the trolley such that its bottom edge is at a height of 300mm +/- 5mm from the ground.

7.1.5 Mark a line along the vertical centreline of the barrier which may be used to check the alignment of the barrier with the R point of the test vehicle.

7.1.6 Measure the wheelbase of the trolley, left and right

7.1.7 Determine the average wheelbase from Section 7.1.6 and record in the test details.

7.1.8 Record in the test details the track of the trolley at the front and at the rear.

7.1.9 Measure the weights at all four wheels and record in the test details. The total weight of the trolley should be **950±20kg**.

7.1.10 Calculate the fore/aft position of the centre of gravity from:

$$x = W_{rear}.Wheelbase/(W_{rear} + W_{front})$$

where x is the distance of the centre of gravity from the front axle, W_{rear} and W_{front} are the rear and front axle weights from Section 7.1.9 and Wheelbase is the average determined in Section 7.1.7.

The fore/aft centre of gravity should be 1000 ± 10mm from the centre of the front axle.

7.1.11 Record the position of the centre of gravity in the test details.

7.1.12 Ensure that the weight distribution is as even as possible left to right.

7.1.13 Record in the test details the final weights measured at each of the wheels.

7.2 Trolley Markings

7.2.1 EuroNCAP markings will be stuck to the front of the trolley on both sides.

7.2.2 Test house logos may be added to the trolley provided that they do not detract attention from the EuroNCAP markings.

[1]Refer to EC directive 96/27/EC.

8 STILL PHOTOGRAPHY

The following photographs will be taken pre and post-test unless otherwise indicated. Pre-test photographs will be taken with the dummies in their final positions.

No.	**View**
1	Front view of barrier.
2	Side view of barrier.
3	Side view of barrier at 45 degrees to front.
4	Side view of barrier with vehicle, from front of vehicle.
5	Car RHS, with camera centred on B-post waist, showing full car.
6	Car RHS, with camera centred on B-post waist, showing the rear passenger compartment.
7	Car RHS, with camera aimed at waist height, showing driver's compartment.
8	Car RHS at 45 degrees to rear.
9	Car RHS at 45 degrees to front.
10	Front view of car.
11	Car LHS, with camera centred on B-post waist, showing full car.
12	Car LHS, with camera centred on B-post waist, showing the rear passenger compartment.
13	Driver & seat through open driver’s door to show driver compartment and position of seat relative to the sill.
14	To show area immediately in front of driver.
15	To show child dummies and restraints through LHS rear door.
16	To show child dummies and restraints through RHS rear door.
17*	Car and barrier at rest at 45 degrees to front of car.
18*	Car and barrier at rest at 45 degrees to rear of car.

* Post-test only.

After Dummy Removal

19 View through LHS front door of driver’s door & paint marks from dummy ribs.

NB The above photos are for a RHD car, for a LHD car camera locations will switch sides.

9 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 (1995). **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.

9.1 Speed

9.1.1 Measure the speed of the trolley as near as possible to the point of impact.

9.1.2 Record the actual test speed in the test details.

TARGET SPEED = 50km/h ± 1km/h

9.2 Post-Impact Braking

A method must be employed to eliminate secondary impacts between the barrier and the car. This may be an emergency braking system on the trolley or other method but should be activated only **after the first impact is complete**. Do NOT start the braking *at* the point of initial impact or the trolley will be decelerating during the test.

9.3 Alignment

9.3.1 With the vehicle offered up against the barrier, tape a small rivet at the centreline of the deformable barrier as close as possible to the point of first contact.

9.3.2 This pin should align with the vertical 'R' point line previously marked on the car (Section 1.4)

9.3.3 After the test, if the mark made by the pin is more than 25mm away from the original mark, film analysis will be used to try to assess the alignment.
TARGET ALIGNMENT = CENTRE LINE OF BARRIER COINCIDENT WITH 'R' POINT LINE OF VEHICLE ± 25mm

After Test

9.4 Door Opening Force

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

9.4.2 Try to open each of the doors on the unstruck side (front door followed by rear door) 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.

9.4.3 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.

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.

Note: 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.

9.5 Dummy Removal

9.5.1 Do not move the driver seat. Try to remove the dummy.

9.5.2 If the dummy cannot be removed with the seats in its original position, recline the seat back and try again.

9.5.3 If the dummy still can not be removed, try to slide the seat back on its runners.

9.5.4 If the dummy still can not be removed, the seat can be cut out of the car.

Where a specified requirement has not been met, EuroNCAP reserves the right to decide whether or not the test will be considered as valid.

10 CALCULATION OF INJURY PARAMETERS

The following table lists all of the channels which are to be measured and the Channel Frequency Class at which they are to be filtered. The injury calculation column lists the parameters which will be calculated for each location. If the injury parameter is not a simple peak value and involves some further calculation, details are given subsequently. Head impacts occurring after the dummy head rebounds from an initial contact are not considered when calculating maximum levels of injury parameters.

Location	Parameter	CFC[2]	Injury Calculation
Head	Accelerations A_x A_y A_z	1000	HIC Peak acceleration 3msec exceedence (cumulative)
Thorax T1	Accelerations A_x A_y A_z	180	Peak lateral acceleration on T1 and T12
Thorax T12	Accelerations A_y	180	
Ribs - Upper, Middle & Lower	Accelerations A_y	180	Viscous Criterion Peak rib acceleration Peak rib deflection
	Deflection D_{rib}	180	
Abdomen - Front, Middle & Rear	Forces F_y	600	Peak of sum of 3 abdomen forces
Pelvis	Accelerations A_x A_y A_z	180	Peak lateral acceleration
Pubic Symphysis	Forces F_y	600	Peak Force

[2] All CFCs from the TNO EuroSID-1 Training Manual

Using the above channels, dummy injury parameters can be calculated according to the following procedures:

10.1 Head

10.1.1 Calculate the resultant head acceleration A_R from the three components A_x, A_y and A_z after they have been filtered

$$A_R = \sqrt{A_X^2 + A_Y^2 + A_Z^2}$$

10.1.2 Calculate the Head Injury Criterion (HIC) according to

$$HIC = (t_2 - t_1)\left[\frac{\int_{t_1}^{t_2} A_R .dt}{(t_2 - t_1)}\right]^{2.5}$$

where A_R is expressed in multiples of g. Maximise HIC for any time 'window' (t_2-t_1).

10.1.3 Determine the peak acceleration level of A_R and the level it exceeds for a cumulative time period of three milliseconds i.e. the head 3msec exceedence.

10.2 Ribs

10.2.1 Determine the greatest value of the rib deflection D_{rib} for all three ribs

10.2.2 Calculate the Viscous Criterion according to the equation

Viscous Criterion = V*C

$D_{(t)}$ is the instantaneous rib deflection at any time t. $C_{(t)}$ is the compression, related to the rib deflection $D_{(t)}$

$$C_{(t)} = \frac{D_{(t)}}{0.140}$$

V is the velocity of deflection and is calculated as the differential of the deflection with respect to time:

$$V_{(t)} = \frac{8*[D_{(t+1)} - D_{(t-1)}] - [D_{(t+2)} - D_{(t-2)}]}{12\delta t}$$

where δt is the time interval between successive digital samples of $D_{(t)}$. Calculate V*C continuously with time and determine its greatest value.

10.3 Abdomen

10.3.1 Find the sum of the three abdomen force transducers as a function of time after the individual components have been filtered.

10.3.2 Determine the maximum value of the total abdominal force.

10.4 Pelvis

10.4.1 Determine the peak lateral acceleration of the pelvis

10.5 Pubic Symphysis

10.5.1 Determine the peak value of the lateral force measured on the pubic symphysis.

10.6 Child Dummy

10.6.1 For the TNO P3 and P1½ dummies, calculate the peak resultant accelerations of the chest and head.

10.6.2 For both P3 and P1½ dummies determine the level which head resultant acceleration exceeds for a cumulative time of three milliseconds.

11 SIDE IMPACT - POLE TEST

Where a vehicle is fitted with a head protection device, an optional 'pole test' may be commissioned. This option is only available where the head protection was rated as green in the EuroNCAP side impact test. Full test specification to follow.

Pole Side Impact

Contents

Page No.

Side Impact Pole Test

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

1.1.3 Refill the tank with fuel, water or other ballast to a mass equivalent to 100% of the tank's capacity of fuel.

1.1.4 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.

1.1.5 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.

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

1.1.7 Measure the front and rear axle masses and determine the total mass of the vehicle. The total mass is the 'unladen kerb mass' of the vehicle. Record this mass in the test details.

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

1.2 Rated cargo and luggage mass

1.2.1 Calculate the rated cargo and luggage mass as follows: Subtract the measured unladen kerb mass and the rated occupants mass from the maximum permitted laden mass. The rated occupant mass is equal to rated number of occupants times 68 kg. The maximum permitted laden mass can be found on the Manufacturer's Plate, usually in the engine compartment.

1.3 Reference Loads

1.3.1 Place both front seats in their mid-positions, this may not be the same. If there is no notch at this position, set the seat in the nearest notch rearward.

1.3.2 Place weights equivalent to a EuroSID-1 test dummy (80 kg) in the front driver's seating position.

1.3.3 Place weights with a mass of the rated cargo and luggage mass or 136 kg whichever is less, 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 can not be evenly distributed, concentrate weights towards the centre of the compartment.

1.3.4 Roll the vehicle back and forth to 'settle' the tyres and suspension with the extra weights on board. Determine the front and rear axle loads of the vehicle. These loads are the "axle reference loads" and the total mass is the "reference mass" of the vehicle.

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

1.3.6 Measure and record the ride-heights of the vehicle at a point on the wheel arch in the same transverse plane as the wheel centres. Do this for all four wheels.

1.3.7 Remove the weights from the luggage compartment and the dummy weights from the front seat.

1.4 Impact location

1.4.1 To measure vehicle dimensions and to apply markers, a pointer used to measure co-ordinates in three dimensions will be used.

1.4.2 The impact reference line is a line on the striking side of the vehicle, on the exterior of the vehicle, where a transverse vertical plane passes through the centre of gravity of the head of the dummy seated in accordance with section 6.3.

1.4.3 Mark the impact reference line on the side of the vehicle on the exterior, from roof to sill.

1.4.4 Using a piece of sticky tape in a colour to contrast with the body-colour, join the points with one edge of the tape. Mark clearly on the tape, which of its edges aligns with the impact reference line. This edge may be used to assess the alignment of the vehicle with the pole.

1.4.5 Measure and record the X-distance of the line to the centre of the front wheel axle, or any distinctive reference point.

1.5 Vehicle Preparation

Care should be taken during vehicle preparation that the ignition is not switched on with the battery or any airbag or pretensioner disconnected. This will result in an airbag warning light coming on and the airbag system will need to be reset. Manufacturers will be asked to provide instructions for resetting the airbag so that this may be done 'in-house' in the event that it becomes necessary.

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

1.5.2 Ensure that a live battery is connected, if possible in its standard position. Check that the dashboard light for the airbag circuit functions as normal.

1.5.3 Fit the on-board data acquisition equipment in the boot of the car. Also fit any associated cables, cabling boxes and power sources.

1.5.4 Place weights with a mass of approximately the rated cargo and luggage mass in the luggage area.

1.5.5 Place weights equivalent to a EuroSID-1 dummy (80 kg) in the front driver's seat of the car (with the front seats in their mid-positions).

1.5.6 Weigh the front and rear axle loads of the vehicle. Compare these loads with those determined in Section 1.3.5.

1.5.7 The total vehicle mass shall be within 1% of the reference mass (Section 1.3). Each axle load shall be within the smaller of 5% or 20 kg of its respective axle reference load. If the vehicle differs from the requirements given in this paragraph, items may be removed or added to the vehicle which have no influence on its structural crash performance. The levels of ballast in the fuel tank (equivalent in mass to 100% capacity of fuel) may also be adjusted to help achieve the desired axle loads. Any items added to increase the vehicle mass should be securely attached to the car.

1.5.8 Repeat Sections 1.5.6 and 1.5.7 until the front and rear axle loads and the total vehicle mass are within the limits set in 1.5.7. Record the final axle loads in the test details.

1.6 Vehicle Markings

1.6.1 EuroNCAP markings will be attached to the exterior of the vehicle in the following locations; centre of the bonnet and on the front half of the roof of the vehicle.

1.6.2 Test house logos may be added to the vehicle provided that they do not detract attention from the EuroNCAP markings. Suitable locations for such markings would be the middle of the roof and on the bonnet at the base of the windscreen.

2 DUMMY PREPARATION AND CERTIFICATION

2.1 General

2.1.1 A EuroSID-1 test dummy should be used in the front driver's position. It should conform to the requirements given in Appendix 3 of Annex II of EC Directive 96/27/EC

2.2 Certification

Full details of the EuroSID-1 certification requirements are available in Appendix 3 of Annex II of EC Directive 96/27/EC and the procedures followed are set out in the TNO EuroSID-1 Training Manual.

The EuroSID dummy should be re-certified after every THREE impact tests.

If an injury criterion reaches or exceeds its normally accepted limit (e.g. HIC of 1000) then that part should be re-certified.

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

A copy of the dummy certification certificate will be provided as part of the full report for a test.

2.3 Additions and Modifications to the EuroSID-1 Dummy

2.3.1 The dummy will have a backplate load cell and a lumbar spine load cell fitted.

2.4 Dummy Clothing and Footwear

2.4.1 The dummy will be clothed in a rubber 'wet-suit', covering the shoulders, thorax, upper parts of the arms, abdomen and lumbar spine and the upper part of the pelvis. This rubber suit will act as a nominal 'skin' for the dummy torso.

The dummy will be clothed with formfitting, calf-length, cotton stretch pants. Each foot will be equipped with a shoe.

2.5 Dummy Test Condition

2.5.1 Dummy Temperature

2.5.1.1 The dummy shall have a stabilised temperature in the range of 18^{o}C to 26^{o}C.

2.5.1.2 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.

2.5.1.3 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.

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

2.5.2 Dummy Joints

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

2.5.2.2 Set the torque on the shoulder screws to 0.6 Nm

2.5.2.3 For adjustable joints in the legs, 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 downwards force is applied and then removed, the limb should continue to fall.

2.5.2.4 The dummy joint stiffnesses 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.

2.5.2.5 Maintain the dummy temperature within the range 18 to 26 °C between the time of setting the limbs and up to the time of the test.

2.6 Dummy painting

2.6.1 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.

EuroSID		
Head	Red	100mm square, centreline of head with lower edge at C of G. Only paint outer edge of tape.
Shoulder/Arm	Blue	25mm x 150mm, starting at bottom edge of shoulder fixing hole
Top Rib	Red	150mm strip, starting at the rearmost accessible point at seat back
Mid Rib	Yellow	150mm strip, starting at the rearmost accessible point at seat back
Bottom Rib	Green	150mm strip, starting at the rearmost accessible point at seat back
Abdomen	Red	50mm square
Pelvis	Orange	50mm x 100mm, centred on hip joint point.

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

2.7 Post Test Dummy Inspection

2.7.1 The dummy should be visually inspected immediately after the test. Any lacerations of the skin or breakages of the dummy should be noted in the test details. The dummy may have to be re-certified in this case. Refer to Section 0.

3 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, CAC's 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 are mounted according to procedures laid out in SAE J211. The sign convention used for configuring the transducers is stated in SAE J211 (1995).

3.1 Dummy Instrumentation

The EuroSID-1 dummy to be used shall be instrumented to record the channels listed below.

Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations A_x A_y A_z	500 g	3
Thorax T1	Accelerations A_x A_y A_z	200 g	3
Ribs - Upper, Middle & Lower	Accelerations A_y	700 g	3
	Deflections D_{rib}	90 mm	3
Backplate Load Cell	Forces F_x F_y	5 kN	2
	Moments M_y M_z	200 Nm	2
Lumbar Spine Loadcell	Forces F_x F_y	5 kN	2
	Moments M_x M_y	200 Nm	2
Thorax T12	Accelerations A_y	200 g	1
[Lower spine T12	Forces F_x F_y	14 kN	2]
	Moments M_x M_y	1000 Nm	2]
Abdomen - Front Middle & Rear	Forces F_y	5 kN	3
Pelvis	Accelerations A_x A_y A_z	150 g	3
Pubic Symphysis	Forces F_y	20 kN	1
	Total Channels per Dummy		**24** [28]

3.2 Vehicle Instrumentation

3.2.1 The vehicle is to be fitted with an accelerometer on the unstruck B-post. The accelerometer is to be fitted in the lateral direction (A_y).

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

3.2.3 Securely attach a mounting plate for the accelerometer horizontally on to the sill.

3.2.4 Fix the accelerometer to the mounting plate. Ensure the accelerometer is horizontal to a tolerance of ± 5 degree.

Location	Parameter	Minimum Amplitude	No of channels
B-Post non-impact side	Accelerations A_y	350 g	1
	Total Channels per Vehicle		**1**

3.3 Carrier Instrumentation

3.3.1 The carrier is to be fitted with an accelerometer at its structure at the centre line, near the centre of gravity. The accelerometer is to be fitted in the direction of movement(A_X).

Location	Parameter	Minimum Amplitude	No of channels
Carrier c.o.g.	Accelerations A_X	350 g	1
	Total Channels per Carrier		**1**

TOTAL CHANNELS

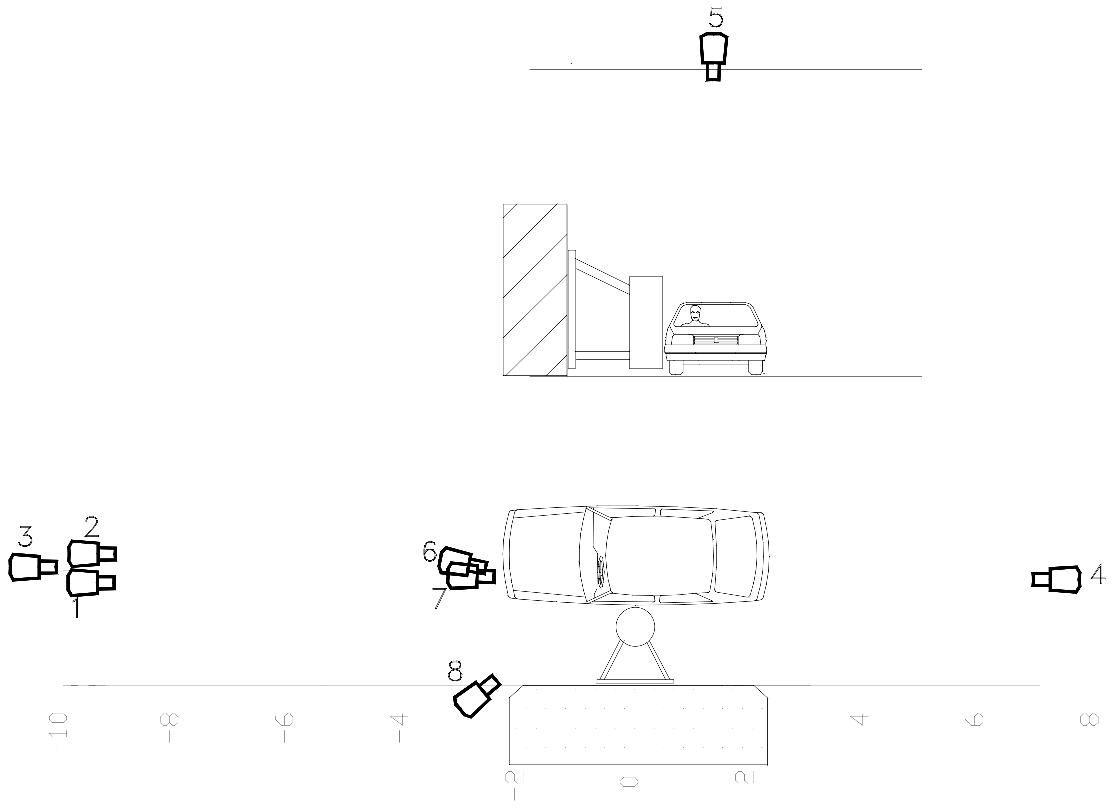
1x Driver EuroSID-1	24
1x Vehicle	1
1x Carrier	1
TOTAL	**26**

4 CAMERA LOCATIONS

Set up high speed film cameras according to the following diagrams.

Camera No.	Camera Type	Shot Content
1	>/= 400 fps high speed cine	Front view of vehicle and carrier (wide)
2	>/= 50 fps stills camera	Front view of vehicle and carrier (wide)
3	>/= 50 fps stills camera	Backup for 2 (optional)
4	>/= 400 fps high speed cine	Rear view of vehicle and carrier (wide)
5	>/= 400 fps high speed cine	Plan view of car and carrier (wide)
6	>/= 1000 fps high speed cine	Front view of driver head (impact area) (tight)
7	>/= 1000 fps high speed cine	Front angled view of driver rib and abdomen area (tight)
8	>/= 400 fps high speed cine	30 ° Side view from front on impact area (wide)

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 9 mm is applicable.



5 PASSENGER COMPARTMENT ADJUSTMENTS

5.1 Overview of settings

Adjustment	Required Setting	Notes	Methods
Seat Fore/Aft	Mid position as defined in section 5.2	Set to first notch rearwards of mid position if not lockable at mid position	See Section 0. See also 0
Seat Base Tilt	Manufacturer's design riding position	Permissible Up to mid position	See Section 0
Seat Height	Lowest position		
Seat Back Angle (as defined by torso angle)	Initially set to manufacturer's design riding position	Otherwise initially 25° to Vertical	See Section 0 See also 0
Seat Lumbar Support	Fully retracted		See section 0
Head Restraints	Highest position		
Head Restraint Tilt Angle	Manufacturer's design riding position	Otherwise mid position	
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering	
Rear Seat Fore/Aft and seat back angle	Manufacturer’s design riding position	Mid or first notch rearwards of mid position if not lockable at mid position	See Section 0
Rear Seat Facing	Forward		See Section 0
Rear seats arm-rests	Stowed position		
Doors	Closed, not locked		
Glazing	Movable windows and vents in fully opened position		
Steering wheel – horizontal	Mid position		See Section 0
Steering wheel – vertical	Mid position		See Section 0
Sunroof	Fully closed		
Gear change lever	In the neutral position		
Parking Brake	Disengaged		
Pedals	Normal position of rest		
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		
Seat belt anchorage	Manufacturer's design riding position	If no design position then set to mid position, or nearest notch upwards	

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

5.2 Determination of and Setting the Fore/aft Position of the Seat.

5.2.1 Place a mark on the moving part of seat runner close to the unmoving seat guide.

5.2.2 Move the seat to its most forward position of travel.
5.2.3 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most forward position.
5.2.4 Move the seat to the most rearward position of its travel.
5.2.5 Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the most rearward seating position.
5.2.6 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.
5.2.7 Move the seat so that the mark on the seat runner aligns with the mark on the seat guide.
5.2.8 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.
5.2.9 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.

5.3 Setting the Seat Base Tilt and Lumber Positions

5.3.1 If the seat base is adjustable for tilt it may be set to any angle from the flattest to its mid position according to the manufacturer's preference. The same seat tilt setting must be used for frontal and Pole Impact.
5.3.2 Seat Lumber Setting. If the seat back is adjustable for lumber support it should be set to the fully retracted position.

The settings for the passenger seat should be as near as possible to being the same as that of the driver's seat.

5.4 Setting the Rear Seats

5.4.1 If the rear seat back or cushion is adjustable, put it in the manufacturer's design riding position. If the direction of the seat is adjustable it should be set to face forward, with its axis parallel to the fore/aft direction of the vehicle.

5.5 Setting the Steering Wheel Horizontal Adjustment

5.5.1 Choose a part of the facia that is adjacent to the steering column and can be used as a reference.
5.5.2 Move the steering wheel to the most forward position of its travel.
5.5.3 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most forward travel of the steering wheel.
5.5.4 Move the steering wheel to the most rearwards position of its travel.
5.4.5 Mark the steering column in line with an unmoving part of the facia. This corresponds to the most rearwards travel of the steering wheel.
5.4.6 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.
5.4.7 Move the steering wheel so that the mark on the steering column aligns with the facia.
5.4.8 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.

5.6 Setting the Steering Wheel Vertical Adjustment

5.6.1 A method that is in principle the same as Section 5.5 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.

6 DUMMY POSITIONING AND MEASUREMENTS

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:July 1995.

If the seat is new and has never been sat upon, a person of mass 75 ± 10 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 recommendations for normal use. In absence of such recommendations, an angle of 25 degrees towards the rear from vertical will be used.

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 414 mm 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 the right foot on the 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 the foot flat on the 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 seatback.

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

6.1.11 Apply a 10 kg 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 the end stop and 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.

6.1.17 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 0, 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 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 is not left in overnight or for a similarly lengthy period.

If it is known that the dummy will be in the vehicle for a time longer than 2 hours, then the dummy should be sat on plywood boards placed over the seat. This should eliminate unrealistic compression of the seat.

6.3 Dummy Placement

6.3.1 H-point

Note that the H-point of the EuroSID-1 dummy is situated 21mm forward of and 5mm above that of the H-point determined by the H-point manikin (Section 0).

6.3.1.1 Position the dummy in the seat, with its back against the seat and its centreline coinciding with the seat centreline.

6.3.1.2 Carefully place the seat belt across the dummy and lock as normal.

6.3.1.3 Visually check that the dummy sits square and level in the seat before taking any measurements of the H-point position.

6.3.1.4 Manoeuvre the dummy until its Hip-joint point is within 13mm in the vertical dimension and 13mm in the horizontal dimension of a point 21mm fore and 5mm above the H-point as determined in Section 0.

6.3.2 Legs and Feet

6.3.2.1 Position the left foot perpendicular to the lower leg with its heel on the floorpan in a transverse line with the heel of the right foot.

6.3.2.2 Carefully position the dummy’s right foot on the undepressed accelerator pedal with the heel resting as far forward as possible on the floorpan.

6.3.2.3 Measure the separation of the inside surfaces of the dummy’s knees and adjust until they are 150 ± 10 mm apart from each other.

6.3.2.4 If possible within these constraints, place the thighs of the dummy on the seat cushion.

6.3.2.5 Check again the position of the H-point, the levelness of the pelvis and the squareness of the dummy in the seat. If everything is in position, set the arms.

6.3.3 Arms

The arms of the EuroSID-1 dummy have click-stops corresponding to fixed angles between the torso reference line and the arms.

6.3.3.1 Move both arms of the dummy until they have clicked at those positions corresponding to 40° angle between the arms and the torso reference line.

6.3.4 Position of the head

6.3.4.1 Locate the horizontal plane passing through the dummy head centre of gravity. Identify the rearmost point on the dummy head in that plane. Construct a line in the plane that contains the rearward point of the front door daylight opening and is perpendicular to the longitudinal vehicle centreline. Measure the longitudinal distance between the rearmost point on the dummy head and this line. Refer to the USA Safety Standard MVSS 201 for the definition of ‘door daylight opening’. The door daylight opening must be measured when the door is closed.

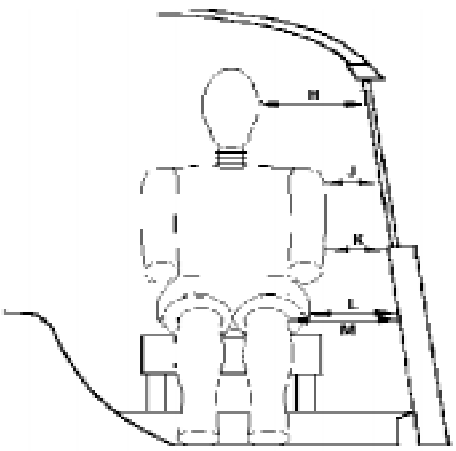
6.3.4.2 If the distance is less than 50 mm or the point is not forward of the line, then the seat and/or dummy position shall be adjusted as follows. First, the seat back angle is adjusted, a maximum of 5 degrees, until a 50 mm distance is achieved. If this is not sufficient to produce the 50 mm distance, the seat is moved forward until the 50 mm distance is achieved or until the knees of the dummy contact the dashboard or kneebolster whichever comes first. If the required distance cannot be achieved through movement of the seat, the seatback angle shall be adjusted even further forward until the 50 mm distance is obtained or until the seat back is in its full upright locking position.

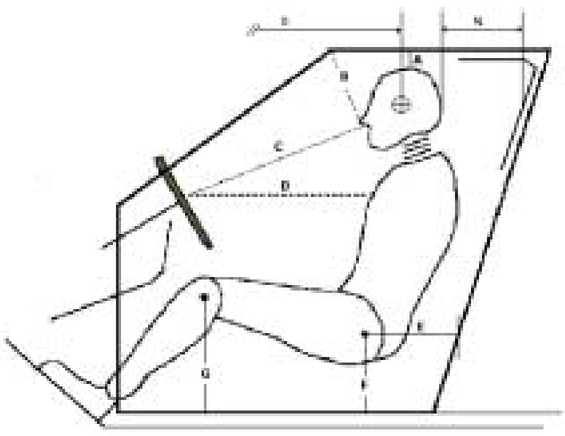
6.3.5 After positioning the dummy measure and record the dummy position according to section 6.4 and determine the impact location as described in section 1.4.

6.4 Dummy Positioning Measurements

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

A	Head/ roof panel vertical	vertical
B	Nose point / windscreen joint	shortest
C	Nose point / centre of steering	shortest
D	Thorax strap / centre of steering wheel	horizontal
E	Hip joint point / inside opening of the door	horizontal
F	Hip joint point / inside opening of the door	vertical
G	Knee / floor covering	vertical
H	Head / side window pane (or padding)	horizontal
J	Shoulder / window pane (or padding)	horizontal
K	Elbow / door (or padding)	horizontal
L	Pelvis / door (or padding)	horizontal
M	Knee / door (or padding)	horizontal
N	Rearmost point head / daylight opening	horizontal
O	C.o.g. head to front axle	horizontal





7 STILL PHOTOGRAPHY

The following photographs will be taken pre and post-test unless otherwise indicated. Pre-test photographs will be taken with the dummies in their final positions. All front, rear and side views to be taken at vehicle waist height.

No.	View
Car on carrier against pole	
1	Top view of full car, carrier and pole
2	Front view of full car, carrier and pole
3	Rear view of full car, carrier and pole
4	Side view of car, carrier and pole at 45 ° to front, impact side
5	Side view of car, carrier and pole at 45 ° to rear, impact side
Car/carrier away from pole	
6	Side view car/carrier impact side, showing full car
7	Side view car/carrier non-impact side, showing full car
8 *	Side view through open driver’s door on driver & seat to show driver compartment and position of seat relative to the sill
9 *	Detail view on driver’s legs and feet through open door
10	Side view through open front passenger door to show driver
11	Side view of car/carrier impact side centred on impact line showing front door and B-post
12 *	Front/side view of pole
Post-test only	
13	Front view of dummy through front windscreen
14	Inside car view on abdomen/pelvis area
After Dummy Removal	
15	Detail view(s) on paint marks on the driver’s door and seat

* = Pre-test only

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 20 kHz (alternatively a sample rate of 10 kHz may be used). The equipment conforms to SAE J211 (1988).

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 suspension system, pedal retraction system or any other system which requires running of the engine just before test execution, the engine should be run for a predetermined time, specified by the manufacturer.

8.1 Carrier

A carrier should be used which has a horizontal flat surface with a sufficiently large area to allow unobstructive longitudinal displacement of the vehicle of about 1000 mm and rotation of the vehicle during the deformation phase of the impact.
To minimise effects of friction between the tires of the test vehicle and the surface of the carrier this friction is reduced to a minimum by placing the vehicle with each tyre on two sheets of PTFE.
To avoid vehicle movement prior to the impact, the vehicle may be fixed to the carrier until 5 m before the point of impact. The impact speed should be reached 10 m before the point of impact.
Crumple tubes or a comparable device will decelerate the carrier not earlier than 12 ms or 100 mm after the moment / point of impact.
The carrier may be fitted with an emergency abort system. This is optional, the test facility may elect to test without an abort system.

8.1.1 Position the vehicle on the carrier to achieve that the impact reference line is aligned with the centre line of the rigid pole.
8.1.2 The horizontal impact accuracy should be ± 38 mm.

8.2 Pole

The rigid pole is a vertical metal structure beginning no more than 102 mm above the lowest point of the tires on the striking side of the test vehicle when the vehicle is loaded as specified in section 0 and extending at least 100 mm above the highest point of the roof of the test vehicle.
The pole is 254 ± 3 mm in diameter and set off from any mounting surface, such as a barrier or other structure, so that the vehicle will not contact such a mount or support at any time within 100 ms of the initiation of the vehicle to pole contact.

8.2.1 Mark a line along the vertical centreline of the pole which may be used to check the alignment of the test vehicle on the carrier.

8.3 Impact Speed

8.3.1 During the acceleration phase of the test, the acceleration of the carrier should not exceed 1.5 m/s^2.

8.3.2 Measure the speed of the vehicle as near as possible to the point of impact. using an infra-red beam intercepting two markers at a measured distance apart.

8.3.3 Record the actual test speed in the test details.

TARGET SPEED = 29 ± 0.5 km/h

8.4 Impact Angle

8.4.1 The impact angle should be 90°± 3°. Align the vehicle on the carrier so that the angle between the vehicle's longitudinal and the direction of movement of the carrier is 90°.

Where a specified requirement has not been met, EuroNCAP reserves the right to decide whether or not the test will be considered as valid.

9 AFTER TEST

9.1 Door Opening Force

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

9.1.3 Try to open each of the doors on the unstruck side (front door followed by rear door) 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 500 N, 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.

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

9.1.5 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.

Note: 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.

9.2 Dummy Removal

9.2.1 Do not move the driver seat. Try to remove the dummy.

9.2.2 If the dummy cannot be removed with the seats in its original position, recline the seat back and try again.

9.2.3 If the dummy still can not be removed, try to slide the seat back on its runners.

9.2.4 If the dummy still can not be removed, the seat can be cut out of the car.

9.3 Calculation of Injury Parameters

The following table lists all of the channels which are to be measured and the Channel Frequency Class (CFC) at which they are to be filtered. The injury calculation column lists the parameters which will be calculated for each location. If the injury parameter is not a simple peak value and involves some further calculation, details are given subsequently. Head impacts occurring after the dummy head rebounds from an initial contact are not considered when calculating maximum levels of injury parameters.

Location	Parameter	CFC[2]	Injury Calculation
Head	Accelerations A_x A_y A_z	1000	HIC Peak acceleration 3msec exceedence (cumulative)

[2] CFC from the TNO EuroSID-1 Training Manual

Using the above channels, dummy injury parameters can be calculated according to the following procedures:

Head

Calculate the resultant head acceleration A_R from the three components A_x, A_y and A_z after they have been filtered.

$$A_R = \sqrt{A_X^2 + A_Y^2 + A_Z^2}$$

Calculate the Head Injury Criterion (HIC) according to:

$$HIC = (t_2 - t_1)\left[\frac{\int_{t_1}^{t_2} A_R . dt}{(t_2 - t_1)}\right]^{2.5}$$

where A_R is expressed in multiples of g. Maximise HIC for any time 'window' (t_2-t_1). Determine the peak acceleration level of A_R and the level it exceeds for a cumulative time period of three milliseconds i.e. the head 3 ms exceedence.

Pedestrian Testing

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Pedestrian Testing

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 Refill the fuel tank with fuel (or an equivalent mass of water or other ballast) to its fuel tank capacity.
1.1.4 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.
1.1.5 Ensure that the vehicle has its spare wheel on board along with any tools supplied with the vehicle. Nothing else should be in the vehicle.
1.1.6 Ensure that all tyres are inflated according to the manufacturer's instructions for half load.
1.1.7 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.

1.2 Additional Weights

1.2.1 Put the fore-aft adjustment of both front seats in their mid-positions. If there is no notch at the mid-position, use the first notch immediately rearward.
1.2.2 Place a 75kg mass on the driver's seat and a 75kg mass on the front passenger's seat.
1.2.3 Ensure that the front wheels are in the straight ahead position.
1.2.4 If the suspension is adjustable in any way, ensure that the vehicle is at the correct attitude for travelling at 40km/h.

1.3 Suspension Settling

1.3.1 Roll the vehicle forwards by a distance of at least 1 metre
1.3.2 Roll the vehicle backwards by a distance of at least 1 metre
1.3.3 Repeat steps 1.3.1 and 1.3.2 for three complete cycles
1.3.4 Measure and 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.

1.4 Normal Ride Attitude

1.4.1 After following the above procedures the vehicle is in its Normal Ride Attitude.
1.4.2 All ride heights measured are the Normal Ride Attitude ride heights

2 VEHICLE MARKING

2.1 General

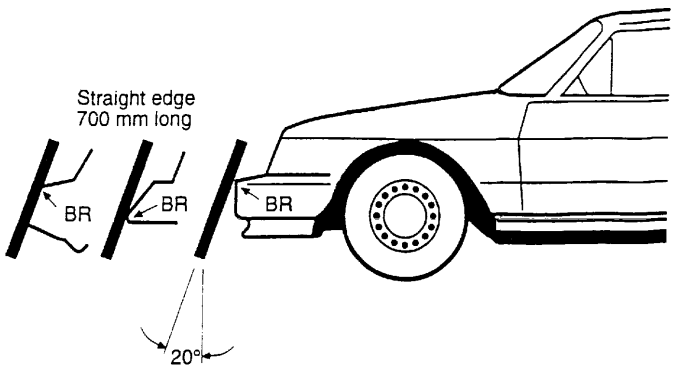
2.1.1 The vehicle shall be marked up as described in the following sections. These marking procedures divide the front and bonnet of the car into zones which are then assessed using appropriate bodyform impactors.

2.1.2 After the vehicle's front has been divided up, specific impact locations shall be chosen according to their likelihood of causing injury. Testing will be carried out at those locations considered the most potentially injurious.

2.1.3 All markings and measurements should be made with the vehicle in its Normal Ride Attitude.

2.2 Bumper Reference Line

The Bumper Reference Line is the geometric trace of the uppermost points of contact between a straight edge 700mm long and the bumper, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 20°, is traversed across the front of the car (Figure 2.1).



2.2.1 With a 700mm straight edge fixed at 20° to the vertical and in a plane parallel to the vertical longitudinal plane of the car, position the straight edge at one end of, and in contact with, the bumper.

2.2.2 Mark the uppermost point of contact of the straight edge and bumper.

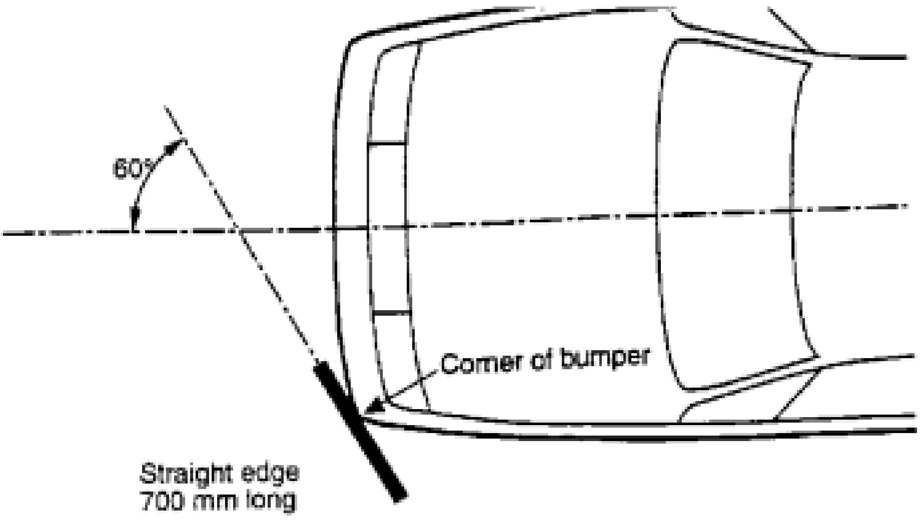
2.2.3 Pull the straight edge away from the bumper, move it towards the other end of the bumper by no more than 100mm and into contact with the bumper.

2.2.4 Mark the uppermost point of contact of the straight edge and bumper.

2.2.5 Repeat Sections 2.2.3 to 2.2.4 along the whole of the length of the bumper.

2.2.6 Using a flexible rule, join the marks on the bumper to form a line. This line may not be continuous but may jump around licence plate etc. This line is the Bumper Reference Line

2.3 Bumper Corners



The Bumper Corner is the point of contact of the vehicle with a horizontal straight edge 700mm long, that falls inside a vertical plane which makes an angle of 60° with the vertical longitudinal plane of the car and is tangential to the outer surface of the bumper (Figure 2.2).

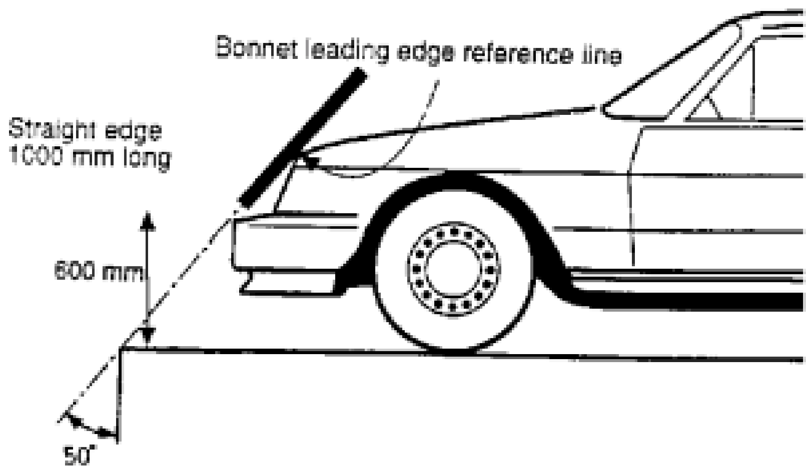
2.3.1 Fix a 700mm straight edge at 60° to the longitudinal direction of the car. With this edge horizontal move it into contact with the edge of the bumper.

2.3.2 Mark the point of contact between the straight edge and the bumper. This is the Bumper Corner.

2.3.3 Repeat for the other side of the vehicle.

2.4 Bonnet Leading Edge Reference Line

The Bonnet Leading Edge Reference Line is defined as the geometric trace of the points of contact between a straight edge 1000mm long and the front surface of the bonnet, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 50° and with the lower end 600mm above the ground, is traversed across and in contact with the bonnet leading edge (Figure 2.3). For vehicles having the bonnet top surface inclined at essentially 50° or less to the vertical, determine the reference line with the straight edge inclined at an angle of 40°.



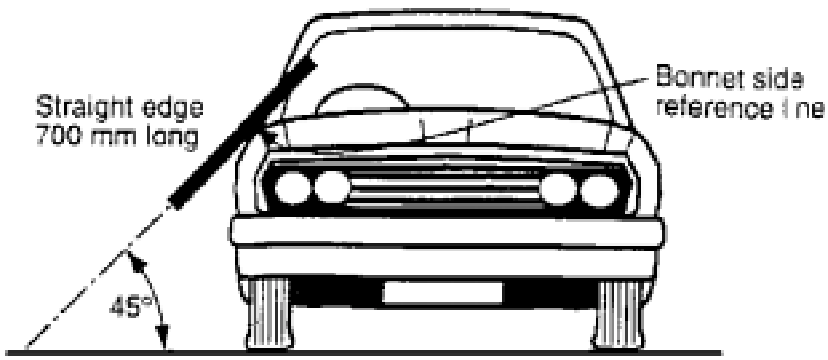
2.4.1 The 'bonnet' shall include not only the engine cover but also the top surface of the wings and the top surface of the slam panel.

2.4.2 Fix a straight edge that is 1000mm long at 50° to the vertical and with its lower end at a height of 600mm. If the top surface of the bonnet is inclined at 50° or less to the vertical then the straight edge should be set to 40^{o} to the vertical. With this edge in a plane parallel to the vertical longitudinal plane of the car, position the straight edge at one end of, and in contact with, the bonnet.

2.4.3 Proceed as per sections 2.2.3 to 2.2.6.

2.5 Bonnet Side Reference Line

The Bonnet Side Reference Line is defined as the geometric trace of the highest points of contact between a straight edge 700mm long and the side of a bonnet (as defined in 2.4.1) and A-Pillar, when the straight edge , held parallel to the lateral vertical plane of the car and inclined inwards by 45° is traversed down the side of the bonnet top and A-Pillar, while remaining in contact with the surface of the body shell (Figure 2.4).

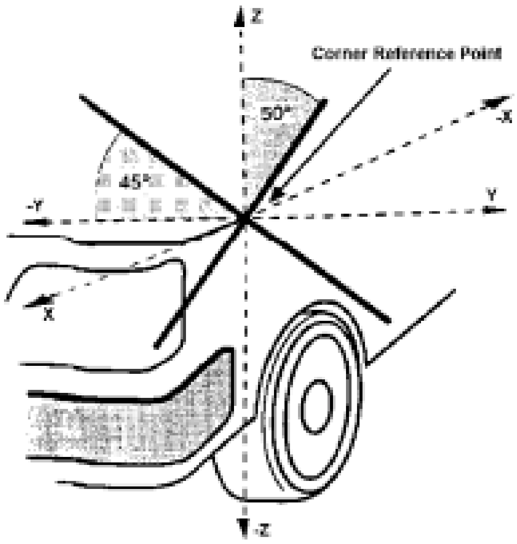


2.5.1 Fix a straight edge that is 700mm long at 45° to the vertical. With this edge in a plane parallel to the lateral vertical plane of the car, position the straight edge at one end of the front wing, and in contact with, the bonnet.

2.5.2 Proceed as per sections 2.2.3 to 2.2.6, but moving the edge along the length of the wing and A-Pillar.

2.5.3 Repeat for the other side of the vehicle.

2.6 Corner Reference Point



2.6.1 This is the intersection of the Bonnet Leading Edge Reference Line (Section 2.4) and the Bonnet Side Reference Line (Section 2.5) (Figure 2.5).

2.7 Bonnet Top

Mark on the bonnet top 1000mm, 1500mm and 2100mm wrap around lines. These are the geometric traces described on the top of the bonnet by the end of flexible tape or wire 1000, 1500 or 2100mm long, when it is held in a vertical fore/aft plane of the car and traversed across the front of the bonnet and bumper. The tape should be held taut throughout the operation with one end held in contact with the ground, vertically below the front face of the bumper and the other end held in contact with the bonnet top (Figure 2.6).

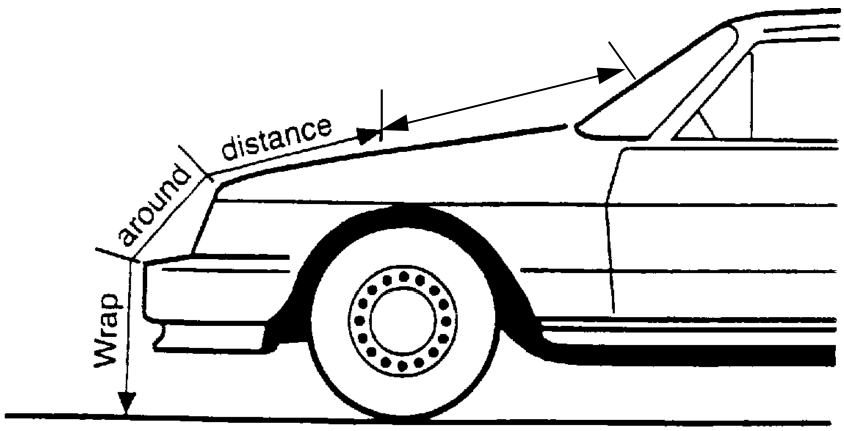


Figure 2.6

2.7.1 Begin at one end of the bumper adjacent to the Bumper Corner

2.7.2 Place the end of a flexible tape measure or graduated wire on the floor vertically below the front edge of the bumper.

2.7.3 Wrap the tape (or wire) over the bumper and bonnet ensuring that it is maintained in a vertical longitudinal plane and that its end is still in contact with the ground (Figure 2.6).

2.7.4 Mark on the bonnet the wrap-around distances of 1000mm, 1500mm and 2100mm. On some cars the 2100mm line may lie on the windscreen.

2.7.5 Reposition the end of the tape on the ground no further than 100mm towards the other side of the bumper.

2.7.6 Repeat steps 2.7.2 to 2.7.6 until the whole of the bonnet has been marked.

2.7.7 Join the points marked on the bonnet to form continuous lines at wrap-around distances of 1000mm, 1500mm and 2100mm. The region between 1000 and 1500mm corresponds to the child headform area. The adult headform testing zone considers two areas. The area between the 1500mm line and the windscreen base and secondly the area between the windscreen base and the 2100mm line. For each of these regions, if either area accounts for more than two-thirds of the total adult head zone, that area shall be used for the adult headform tests. If either area accounts for between one third and two thirds of the total, then three tests should be performed in each area. For each third of the width of the car one test shall be performed on the windscreen/A-pillar and one test on the bonnet.

2.7.8 The windscreen base follows the lower edge of the windscreen glass curvature and extends to the side reference lines on the wings/A pillars. A line following the curvature is extended out to intersect with the side reference lines.

2.8 Dividing the Bonnet Top into Thirds

2.8.1 Begin with the 2100mm bonnet wrap-around line.

2.8.2 Using a flexible tape, measure the distance from one Side Reference Line to the other, along the outer contour of the bonnet (measure directly between the Side Reference Lines and not along the 2100mm bonnet wrap-around line). Record this distance in the test details.

2.8.3 Calculate 1/3 and 2/3 of this distance and mark these points on the 2100mm wrap-around line.

2.8.4 Repeat steps 2.8.2 to 2.8.3 for the 1500mm and 1000mm wrap-around lines

2.8.5 Join up the 1/3 marks at each of the wrap-around distances with straight lines.

2.8.6 Join up the 2/3 marks at each of the wrap-around distances with straight lines.

NOTES: For the adult headform area, impact sites chosen on the glass, with no structure within range behind the glass, shall default to "green" (2 Points) and sites chosen on the A-Pillar default to "red" (0 points) unless the manufacturer provides data which shows otherwise.

Tests on the windscreen or which might damage the windscreen surround should be conducted after the car side impact test has been carried out.

2.9 Dividing the Bonnet Leading Edge Reference Line Into Thirds

2.9.1 Follow the method in Section 2.8 but use the Corner Reference Points (Section 2.6) as the extreme measuring points

2.10 Dividing the Bumper Into Thirds

2.10.1 Follow the method in Section 2.8 but use the Bumper Corners (Section 2.3) as the extreme measuring points. Place the flexible measuring tape along the horizontal contour of the bumper reference line.

2.11 Bumper Lead

2.11.1 This is defined as the horizontal distance between the bonnet leading edge reference line and the bumper reference line. The bumper lead may vary across the front of the car i.e. the bumper lead must be measured separately at all selected impact points.

2.11.2 The bumper lead will be used in Section 7.

2.11.3 Position a vertical straight edge at an arbitrary distance longitudinally in front of the location chosen as the impact point.

2.11.4 Measure the horizontal longitudinal distance from both the bonnet leading edge reference line and the bumper reference line to the vertical edge. The difference between the two measurements is the bumper lead at that point.

2.12 Bonnet Leading Edge Height

2.12.1 This is defined simply as the vertical height above the ground of the bonnet leading edge reference line. This line follows the contours of the bonnet and its height may vary across the front of the car i.e. the bonnet leading edge height must be measured separately at all selected impact points.

2.12.2 The bonnet leading edge height will be used in Section 7.

3 DETERMINATION OF IMPACT POINTS

3.1 Legform to Bumper Test

3.1.1 The impact locations shall be chosen in accordance with the following:

3.1.1.1 There shall be three impact points on the bumper, one in each of the thirds

3.1.1.2 The impact points shall be a minimum of 75mm inside the Bumper Corners.

3.1.1.3 No impact point may be closer than 130mm to any other bumper impact point.

3.1.1.4 Two points should be tested which are judged most likely to cause injury. The vehicle manufacturer shall be invited to choose the third point after the two worst points have been selected. If the manufacturer does not wish to choose a point a third point shall be chosen that is judged to be least injurious.

3.1.1.5 If the most injurious locations in the left and right thirds corresponds to similar structures then test only at that location in *one* of the thirds. In this case assess which of the thirds has the more injurious location excluding the previously mentioned location and select this as the second point.

3.1.2 Often the most injurious locations will be at similar points on all cars and some suggestions are made below. However, the following should be used as a *guide only*. EuroNCAP may choose a test location in any two of the bumper thirds. The Project Manager should be consulted and may decide to test other locations on a car if they appear particularly aggressive, for example:

- I) Towing eye. This is normally mounted on the right or left front longitudinal. If the eye is removable, carry out the test without it, and fit any plastic cover over the hole.
- ii) Centre of the number plate. This will normally be equidistant from the right and left bumper mounts.

3.1.3 Place a mark on the bumper to represent the point of impact of the centre of the legform.

3.2 Upper Legform to Bonnet Leading Edge

3.2.1 The impact locations shall be chosen using a method similar to Section 3.1 but with the following changes:

3.2.1.1 The impact points shall be marked on the Bonnet Leading Edge Reference Line.

3.2.1.2 The selected impact points must be at least 75mm from the Bonnet Corner Reference Points and at least 150mm apart.

3.2.2 Test two points at those locations which are considered to be the most injurious within a zone. The vehicle manufacturer will be invited to choose the third point after the two worst points have been selected. If the manufacturer does not wish to choose a point a third point shall be chosen that is judged to be least injurious. Often, the most injurious locations will be at similar points on all cars and some suggestions are made below. However, the following should be used as a *guide only*, other locations should be chosen if they appear more aggressive:

- I) Over the centre of the headlight
- ii) Over the bonnet catch

3.2.3 After the impact points have been marked, additional marks shall be made on the Bumper Reference Line which are in the same vertical longitudinal plane as the marks on the Bonnet Leading Edge Reference Line. The marks made on the bumper will be used (Section 7.3.1) to determine the Bonnet Leading Edge Height and the Bumper Lead at the impact locations.

3.3 Headform to Bonnet Top - Structure to be tested

3.3.1 To reduce the test programme size there will only be 12 tests to the bonnet top as opposed to the 18 required by the EEVC procedure.

3.3.2 Raise the bonnet and conduct a visual survey of the engine bay and the inner and outer wings to decide which locations are liable to cause injury. Only structures and objects which are relatively close to the bonnet when it is shut are likely to cause injury. Attention should also be paid to the bonnet itself to determine whether the stiffening in the bonnet could cause injury.

3.3.3 The chosen test locations shall accord with the following:

3.3.3.1 The impact points for the child headform shall be in the forward section of the bonnet top i.e. in the section between the 1000mm and 1500mm wrap around lines

3.3.3.2 The impact points for the adult headform shall be in the section between 1500mm and 2100mm wrap around lines, or in the relevant area determined in paragraph 2.7.7. In the situation where the adult headform test zone is above the windscreen base, both A-pillars should be considered as test zones. In the centre section EuroNCAP should chose a site which is considered to be the most injurious, i.e. where a structure is in close proximity behind the glass.

3.3.3.3 There shall be a total of 12 impact points on the bonnet top:

Impactor	Bonnet Top	Third	No of impact points
Child Headform	Forward Part of Bonnet Top	Left third	2
		Centre third	2
		Right third	2
Adult Headform	Rearward Part of Bonnet Top	Left third	2
		Centre third	2
		Right third	2

3.3.3.4 The impact points for the child headform shall be a minimum of 65mm inside the Bonnet Side Reference Lines and a minimum of 130mm apart i.e. no two points either within any third or in adjacent thirds should be less than 130mm apart.

3.3.3.5 The impact points for the adult headform shall be a minimum of 82.5mm inside the Bonnet Side Reference Lines and a minimum of 165mm apart i.e. no two points either within any third or in adjacent thirds should be less than 165mm apart. Where testing on an A-Pillar is involved the minimum distance inside the side reference line for the test location does not apply. The test site in this case may be on the side reference line.

3.3.3.6 Test at one location within each zone which is considered to be potentially injurious. Often, such locations will be at similar points on all cars and some suggestions are made below. However, the following should be used as a *guide only*, other locations should be chosen if they appear more aggressive:

I) Top of suspension strut
ii) Bonnet hinge
iii) Top of rocker cover
iv) Battery terminal
v) Windscreen wiper spindle
vi) Brake master cylinder

3.3.3.7 If the most injurious locations in the left and right thirds corresponds to similar structures then test only at that location in *one* of the thirds. In this case assess which of the thirds has the more injurious location excluding the previously mentioned location. Ensure that the test sites are chosen such that a combination of the most injurious locations are tested excluding similar structure.

3.3.3.8 The manufacturer will then be invited to choose one location within each zone subject to the restrictions in 3.3.3.4 and 3.3.3.5. If the manufacturer does not wish to choose impact locations, points shall be chosen that are judged to be least injurious.

Where there are no adult headform test zones on the bonnet, the windscreen and A pillar will be considered. The aggressive points are assumed to be the A pillars, all the windscreen points would be assumed to be benign. The points chosen by EuroNCAP will be typically the left and right A pillars and one windscreen point or the base of the windscreen if accessible. The manufacturer will be assumed to choose three windscreen points. The A pillar will be assumed to produce a HIC greater than the fixed limit. This would score zero points unless a manufacturer could prove otherwise, in which case the site would be tested. All windscreen points would be assumed to be below the EEVC limit and would score two points each.

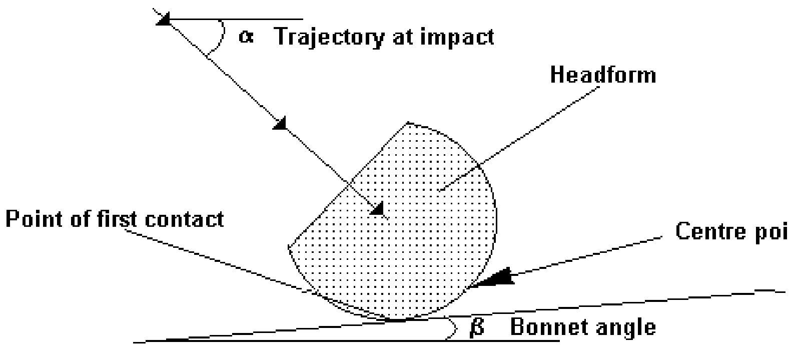
3.4 Headform to Bonnet top - Translation of structural locations to bonnet top.

3.4.1 Using the 3D Measurement Arm, or a device with similar accuracy and reliability, the impact points on the chosen structures beneath the bonnet will be transferred to the bonnet top. This is done simply by changing the vertical component of the point's location so that it lies on the bonnet top. Impact points will be marked with target stickers.

3.4.2 There are two effects which would determine the impact position on the bonnet top relative to the positions marked. These effects are;

3.4.2.2 *Gravity*
Under the influence of gravity the headform will deviate from the trajectory it has initially when leaving the propulsion system

3.4.2.3 *Point of contact not at centre line of headform*
As the headform does not necessarily impact normal to the bonnet top, the point of first contact on the headform will not be the centre point of the headform in the direction of travel. See Figure 3.1



3.4.3 Effects described in section 3.4.2.2 and 3.4.2.3 must be taken into account in determining the Aiming Point for the impact test gun.

3.4.3.1 The determination of this point will require the following information

- Headform Diameter
- Distance that the headform must travel between velocity measurement and leaving propulsion system
- Distance that the headform must travel after leaving the propulsion system
- Required angle of impact to horizontal
- Angle of the bonnet top at the point of impact
- Required impact velocity

3.4.3.2 Using the above information calculate the distance up the bonnet that the propulsion system should be aimed to ensure that the required point of first contact is hit. The angle to which the propulsion system should be set and the velocity that the propulsion system must give to achieve the required velocity of impact and the required angle of incidence must also be calculated.

3.4.3.3 Measure up the bonnet from the point of impact the distance calculated in 3.4.3.2 and mark a point. This should be marked as the Aiming Point.

3.4.4 This procedure should be used to mark up all of the structures to be tested at the bonnet.

4 RECORDING THE IMPACT LOCATIONS

4.1 General

4.1.1 A three dimensional measuring arm shall be used to record the impact locations in 3D-space. The following is only an example of EuroNCAP procedure and as such a device of similar accuracy and reliability may be used in place of the 3D arm (tolerance of +/-0.5mm).

4.1.2 Care should be taken at all times not to move the vehicle while the impact locations are being recorded or transferred.

4.2 Brief Description of the 3D Measuring Arm

4.2.1 For vehicle deformation and intrusion measurements and for marking vehicles, a FARO 3D measuring arm consisting of a series of accurate rotational transducers which can calculate the 3 dimensional position of a pointer at its end at any time will be used. This information is fed in to a computer and can be stored as a series of 3 dimensional co-ordinates. The arm 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.

4.3 Setting Up 3D Measuring Arm Axes

4.3.1 Place the test vehicle on an area of flat level floor

4.3.2 Ensure that the steering wheel is in the ‘neutral’ position with the wheels pointing directly forward.

4.3.3 Mark a point on the floor which is 200mm laterally from the centre of one of the front wheels.

4.3.4 From this mark, draw a straight line 1500mm long parallel to the centerline of the car.

4.3.5 Repeat steps 4.3.3 and 4.3.4 for the other front wheel.

4.3.6 Measure the distance between the two lines.

4.3.7 Join the two lines with a perpendicular line. This line should be perpendicular to the centerline of the car and will be used as the datum for measurements. See Figure 4.1

4.3.8 Mark on the datum line the intersection with the vehicle centerline. Digitise this point in the 3D arm as the axis origin

4.3.9 From the origin, extend a line that is perpendicular to the datum further out in front of the vehicle. The line should extend at least 500mm. Digitise a point on this line. This defines the positive x-axis of the vehicle.

4.3.10 Digitise a point in the horizontal plane in front of the datum line and to the *right* of the centerline of the vehicle. This defines the positive x-y plane.

4.3.11 The arm will now be set up with positive x forwards, positive y right and positive z up, in accordance with SAE J211 practices.

4.4 Digitising Impact Points

4.4.1 Ensure that the vehicle is at its test weight and fully test prepared as defined in Section 1.

4.4.2 Measure the ride heights at all four wheels using the marks defined in Section 1.3.4. Record the ride heights in the test details.

4.4.3 During digitising, care should be taken not to move the vehicle by, for example, leaning on it.

4.4.4 The co-ordinates of all impact locations defined in Section 3 should be digitised with the 3D arm. For each of the bonnet leading edge locations, record both the co-ordinates of the location and that point on the bumper reference line in the same longitudinal vertical plane as it.

4.4.5 With the bonnet open, use the arm to determine the 3 dimensional co-ordinates of the locations chosen for testing (Section 3)

4.4.6 Close the bonnet and use the arm to locate and mark those points on the bonnet which have the same X and Y (longitudinal and lateral) co-ordinates as the locations in the engine bay. The points marked on the bonnet will be vertically above the locations chosen in the engine bay.

4.4.7 A hard copy of the impact points' co-ordinates should be obtained for reference.

4.4.8 After digitisation, the bonnet top featuring all the impact point marks shall be removed and a replacement bonnet fitted (see Section 5.3 for fitting procedures).

4.4.9 The original bonnet shall be kept for reference.

4.5 Transferring Impact Points to Replacement Vehicle Parts

Many replacement parts will need to be fitted to the vehicle for this series of tests. It is not practical to have to mark out each of the parts completely for a single test. Therefore, the original marked-out bonnet will be retained as a reference and individual impact locations transferred to replacement components.

4.5.1 With the new component fitted, measure the ride heights at all four wheels

4.5.2 These ride heights must be altered until they match the original recorded ride heights (Section 1.3). If the ride heights are too high then they can be reduced by adding weights. If the ride heights are too low then they can be increased by inserting blocks under the body of the vehicle. These blocks shall be removed before testing.

4.5.3 Set up the 3D measuring arm and its axes as described in Section 4.3.

4.5.4 Using the co-ordinates recorded in Section 4.4 for the original impact locations, use the 3D measurement arm to locate and mark the desired impact position on the new component.

5 PERFORMING OF PEDESTRIAN IMPACT TESTS

5.1 General

5.1.1 Safety to personnel shall be a priority at all times

5.1.2 Ensure that all equipment used is in full working order, has been checked for safety and is in calibration where appropriate

5.2 Propulsion System

5.2.1 An air, spring or hydraulic gun will be used to propel the various body form impactors.

5.2.2 For the legform and the headform tests the impactors are required to be in free flight at the time of impact.

5.3 Fitting Replacement Parts to Vehicles

5.3.1 Careful note shall be taken before any testing is performed as to how any parts liable to need replacement are fitted to the vehicle structure.

5.3.2 Fitting of parts shall not increase or decrease the strength of the structure of the vehicle.

5.3.3 If significant repair work is required, this will be done at a manufacturer-approved dealer.

5.4 Photographic Record

5.4.1 A photographic record shall be kept of each test.

5.4.2 Before any testing has been conducted but after the vehicle is fully test prepared including all markings, the vehicle shall be photographed according to the following schedule. Note that these shall be the only pre-test photographs taken.

5.4.3 List of still photographs

Amount of vehicle visible	View Point
Full vehicle	Left side
Full vehicle	Right side
Front third vehicle	Left side
Front third vehicle	Right side
Full vehicle	Front
Left half vehicle	Front
Right half vehicle	Front
Front third of vehicle	Top
Front third, right half of vehicle	Top
front third, left half of vehicle	Top

5.4.4 Post-test photographs are detailed for each test type in the individual test procedures.

6 LEGFORM TESTS

6.1 Description of Legform and its Instrumentation

6.1.1 The legform used shall conform to that specified in EEVC WG10 Report, 'Proposals for methods to evaluate pedestrian protection for passenger cars', November 1994

6.1.2 Instrumentation

Location	Measurement	CFC (Hz)	CAC	No of channels
Bottom of Femur	Angle (gives shear displacement)	180	20^{o}	1
Top of Tibia	Knee Bend Angle	180	20^{o}	1
Tibia, non-impacted side	Acceleration	180	500g	1

6.2 Certification

6.2.1 The certification procedures are detailed in EEVC Working Group 10, 'Proposal for methods to evaluate pedestrian protection for passenger cars', Annex III

6.2.2 The legform shall be certified before the test programme.

6.2.3 The foam sheet[2] from which the pieces of foam shall be taken shall be certified before the test programme

6.2.4 The legform shall be re-certified after a maximum of 20 impacts and the foam rubber replaced.

6.2.5 The legform shall be re-certified at least once every 12 months regardless of the number of impacts it has undergone.

6.2.6 If the legform exceeds any of its CACs then it shall be re-certified

6.3 Test Procedure - Pre Test

6.3.1 Ensure that the vehicle is fully test prepared as described in Section 1.

6.3.2 Ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle.

6.3.3 Ensure that the legform, the vehicle, the propulsion system and the data acquisition equipment has soaked in a temperature in the range of 16°C to 24°C for at least 2 hours prior to testing.

6.3.4 Fit a new piece of foam and fit the neoprene skin over the foam.

6.3.5 Align the vehicle so that the propulsion system can aim at the impact position and the propulsion system can fire the legform in a direction that is parallel to the vehicle centerline.

6.3.6 Roll the vehicle forwards to give the desired free flight distance.

The foam shall be 25mm thick Confor™ foam type CF-45

6.3.7 Insert blocks under the wheels of the vehicle such that the ride heights are raised by 150mm. Alternatively ensure that the vehicle is positioned above a trench in the floor such that there will be 150mm height difference between the bottom of the trench and the surface on which the vehicle's wheels rest.

6.3.8 Set the propulsion system so that the bottom of the legform will be at the same height as the bottom of the vehicle's tyres (±10mm) and its axis vertical at the point of first impact.

6.3.9 To ensure that the legform impacts with its bottom at the correct height above the ground a correction to take into account the action of gravity when the legform is in free flight is required. This additional height is calculated as follows.

6.3.10 Measure the distance d (in mm) between the point of first contact and the point from where the legform will leave the propulsion system and begin free flight.

$$\text{Fall due to Gravity} = \frac{g\,d^2}{2\,v^2}$$

6.3.11 The distance that the legform will fall due to gravity can be calculated from the formula Assuming values for g, acceleration due to gravity = $9.81 ms^{-2}$
and v, exit velocity of the legform from the propulsion system = $11.1 ms^{-1}$
gives:

$$\text{Fall due to Gravity} = 0.03981\,d^2$$

6.3.12 Raise the propulsion system by this calculated amount

6.3.13 Set the speed control on the propulsion system to give 11.1m/s ± 0.5m/s at the point of first contact.

6.3.14 Fire the propulsion system.

6.4 Test Procedure - Post Test

6.4.1 Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.

6.4.2 Additional photographs may be required for an individual test at the Project Managers discretion.

6.4.3 Check that no CAC has been exceeded before conducting the next test.

6.4.4 Replace the foam with a new piece

6.4.5 Replace any damaged part of the vehicle that will affect the results of the next test with new parts according to Section 5.3.

6.4.6 Repeat procedure for the next impact location.

7 UPPER LEGFORM TESTS

7.1 Description of Upper Legform and its Instrumentation

7.1.1 The upper legform used shall conform to that specified in EEVC WG10 Report, ‘Proposals for methods to evaluate pedestrian protection for passenger cars’, November 1994

7.1.2 Instrumentation

Location	Measurement	CFC (Hz)	CAC	No of channels
Upper femur	lateral load[3]	180	10kN	1
Lower femur	lateral load[2]	180	10kN	1
Centre of femur	bending moment	180	1000Nm	1
50mm above centre of femur	bending moment	180	1000Nm	1
50mm below centre of femur	bending moment	180	1000Nm	1

7.2 Certification

7.2.1 The certification procedures are detailed in EEVC Working Group 10, ‘Proposal for methods to evaluate pedestrian protection for passenger cars’, Annex III

7.2.2 The upper legform shall be certified before the test programme.

7.2.3 The foam rubber sheet[4] from which the pieces of foam shall be taken shall be certified before the test programme

7.2.4 The upper legform shall be re-certified after a maximum of 20 impacts.

7.2.5 The upper legform shall be re-certified at least once every 12 months regardless of the number of impacts it has undergone.

7.2.5 If the upper legform exceeds any of its CACs then it shall be re-certified

[3]With respect to the pedestrian

[4] The foam shall be 25mm thick Confor™ foam type CF-45

7.3 Determination of Impact Velocity, Impact Angle and Impact Energy

The shape of the front of the car determines the velocity, angle of incidence and kinetic energy of the impactor. Full details are given in EEVC WG10 Report, 'Proposals for methods to evaluate pedestrian protection for passenger cars', November 1994. The velocity, angle of impact and total kinetic energy of the impactor will be calculated from the bonnet leading edge height and bumper lead.

7.3.1 Determine the Bonnet Leading Edge Height (Section 2.12) and the Bumper Lead (Section 2.11) at each impact point. These can be simply calculated using the previously digitised co-ordinates of the bonnet leading edge location and its 'equivalent' point on the bumper reference line (Section 4.4).

7.3.2 Calculate the required velocity V, kinetic energy E and the impactor mass M needed to give kinetic energy E at the required impact velocity V

$$M = \frac{2E}{V^2}$$

The influence of gravity on the velocity of the impactor must also be accounted for. Determine also the required angle of impact.

7.4 Test procedure - Pre-test

7.4.1 Ensure that the vehicle is fully test prepared as described in Section 1.

7.4.2 Ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle.

7.4.3 Ensure that the upper legform, the vehicle, the propulsion system and the data acquisition equipment has soaked in a temperature in the range of 16^{o}C to 24^{o}C for at least 2 hours prior to testing.

7.4.4 Apply weights to the back of the upper legform impactor to bring the total mass up to that calculated in Section 7.3.2. Larger weights should first be applied and various smaller weights should then be added to achieve the correct weight. *The tolerance in mass is ± 1% of the mass calculated in Section 7.3.2* .

7.4.5 Fit new pieces of foam to the upper legform.

7.4.6 Align the vehicle so that the propulsion system can aim at the impact position and the propulsion system can fire the legform in a direction that is parallel to the vehicle centerline.

7.4.7 Roll the vehicle forwards to give the desired free flight distance.

7.4.8 Adjust the propulsion system to give the correct velocity and angle of incidence at the point of impact.

7.4.9 Fire the propulsion system.

7.5 Test Procedure - Post Test

7.5.1 Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.

7.5.2 Additional photographs may be required for an individual test at the Project Managers discretion.

7.5.3 Check that no CAC has been exceeded before conducting the next test.

7.5.4 Replace the foam with new pieces

7.5.5 Replace any damaged part of the vehicle which would affect the results of the next test with new parts according to Section 5.3.

7.5.6 Repeat procedure for the next impact location.

8 HEADFORM TESTING

8.1 Description of Headforms and Their Instrumentation

8.1.1 The headforms used shall conform to those specified in EEVC WG10 Report, ‘Proposals for methods to evaluate pedestrian protection for passenger cars’, November 1994

8.1.2 Instrumentation

Location	Measurement	CFC	CAC	No of channels
Centre of gravity of headform	Fore/Aft acceleration[5]	1000	500g	1
Centre of gravity of headform	Vertical acceleration	1000	500g	1
Centre of gravity of headform	Lateral acceleration	1000	500g	1

8.2 Certification

8.2.1 The certification procedures are detailed in EEVC Working Group 10, ‘Proposal for methods to evaluate pedestrian protection for passenger cars’, Annex III

8.2.2 The headforms shall be certified before the test programme.

8.2.3 The headforms shall be certified after a maximum of 20 impacts.

8.2.4 The headforms shall be certified at least once every 12 months regardless of the number of impacts they have undergone.

8.2.5 If the headforms exceed any of their CACs then they shall be re-certified.

8.3 Test Procedure - Pre Test

8.3.1 Ensure that the vehicle is fully test prepared as described in Section 1.

8.3.2 Ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle.

8.3.3 Ensure that the headforms, the vehicle, the propulsion system and the data acquisition equipment have soaked in a temperature in the range of 16°C to 24°C for at least 2 hours prior to testing.

8.3.4 Align the vehicle so that the propulsion system can aim at the impact position and the propulsion system can fire the headform in a direction that is parallel to the vehicle centerline.

8.3.5 Fit the required headform to the propulsion system. If testing the front section of the bonnet then the Child headform shall be used. If testing the rear part of the bonnet then the Adult headform shall be used

8.3.6 Roll the vehicle forwards to give the desired free flight distance.

8.3.7 Calculate the Point of Contact

[5] Relative to the direction of motion of the headform

8.3.8 Adjust the propulsion system so that it can fire the headform at the target with the correct angle of incidence and is aimed at the *Aiming Point*

8.3.9 Set the speed control on the propulsion system to give a velocity of 11.1±0.5m/s at the point of first contact.

8.3.10 Fire the propulsion system.

8.4 Test Procedure - Post Test

8.4.1 Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.

8.4.2 Additional photographs may be required for an individual test at the Project Manager's discretion.

8.4.3 Check that no CAC has been exceeded before conducting the next test.

8.4.4 Replace any damaged part of the vehicle which would affect the results of the next test with new parts according to Section 5.3

8.4.5 Repeat procedure for the next impact location.

Where a specified requirement has not been met, EuroNCAP reserves the right to decide whether or not the test will be considered as valid.

9 INJURY PARAMETERS

9.1 General

9.1.1 Any breakages or other damage of the body form impactors caused by the severity of the impact shall be recorded.

9.1.2 All data channels shall be filtered at their specified Channel Frequency Class

9.2 Limits

9.2.1 The table below lists the various injury criteria used in the pedestrian tests

Body form Impactor	Injury criterion	Limit	Method of calculation
Legform	Knee bending angle	15^o	see 9.2.2
	Knee shear displacement	6mm	see 9.2.3
	Upper tibia acceleration	150g	Maximum Value
Upper legform	Sum of Impact forces	4kN[6]	See 9.2.4
	Bending moment	220Nm[1]	Maximum Value
Child Headform	Head Injury Criterion	1000	See 9.2.5
Adult Headform	Head Injury Criterion	1000	See 9.2.5

9.2.2 *Calculation of Knee Bending Angle*

9.2.2.1 Channel required: rotational transducer in the tibia

$$\text{Instantaneous Bending Angle} = \theta(t) + \text{Sin}^{-1}(1.3678 * \text{Sin}\,\theta(t))$$

9.2.2.2 The units of radians shall be used in the following formula:
where $\theta(t)$ is the angle that the transducer measures.

Note: The value of 1.3678 in the above equation is the ratio of lengths in the knee. These lengths shall be checked before testing begins

9.2.3 *Calculation of Knee Shear distance*

9.2.3.1 Channel required: rotational transducer in the femur

[6]Subject to confirmation by EEVC WG10

$$\text{Instantaneous Shear Displacement} = \sin\phi(t) \times 27.5$$

9.2.3.2 Units of degrees and millimetres are used in the following formula:
where $\phi(t)$ is the angle that the transducer measures

Note: The value of 27.5 in the above formula is a measured length and shall be checked before any testing begins

9.2.4 *Calculation of Sum of Impact forces*
9.2.4.1 Channels required: Load transducer at the top of the femur
Load transducer at the bottom of the femur

$$\text{Instantaneous sum of impact forces } F(t) = F_t(t) + F_b(t)$$

9.2.4.2 Units of kN are used in the following formula:
where $F_t(t)$ is the instantaneous value of the top load transducer
$F_b(t)$is the instantaneous value of the bottom load transducer

9.2.5 *Calculation of the Head Injury Criterion*
9.2.5.1 Channels required: Fore/aft acceleration
Vertical acceleration
Lateral acceleration
9.2.5.2 Units of g are used in both of the following formulae

$$\text{Resultant Acceleration } A_R = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

9.2.5.3 Calculate the resultant head acceleration according to:
Where A_x is the instantaneous acceleration in the Fore/Aft direction
A_y is the instantaneous acceleration in the Vertical direction
A_z is the instantaneous acceleration in the Lateral direction

9.2.5.4 Calculate the Head Injury Criterion (HIC) according to:

$$HIC = (t_2 - t_1)\left[\frac{\int_{t_1}^{t_2} A_R\,.dt}{(t_2 - t_1)}\right]^{2.5}$$

9.2.5.5 Find the maximum of the HIC for any time ‘window’ $(t_2\text{-}t_1)$.

Appendix I
Frontal Impact
Barrier Specification

BARRIER SPECIFICATION

The frontal impact barrier for testing and its mounting to the block shall conform to the following specification:

1 Component and Material Specifications

The dimensions of the barrier are illustrated in Figure 1. The dimensions of the individual components of the barrier are listed separately below.

<u>Main Honeycomb Block</u>

Dimensions

Height:	650mm [in direction of honeycomb ribbon (foil) axis]
Width:	1000mm
Depth:	450mm [in direction of honeycomb cell axes]
	All above dimensions ± 2.5mm
Material:	Aluminium 3003 (BS 1470)
Foil Thickness:	0.076mm ± 15%
Cell Size:	19.1mm ± 20%
Density:	28.6kg/m^3 ± 20%
Crush Strength:	0.342MPa +0% -10%

[in accordance with test method described in Section 2]

<u>Bumper Element</u>

Dimensions

Height:	330mm [in direction of honeycomb ribbon axis]
Width:	1000mm
Depth:	90mm [in direction of honeycomb cell axes]
	All above dimensions ± 2.5mm
Material:	Aluminium 3003 (BS 1470)
Foil Thickness:	0.076mm ± 15%
Cell Size:	6.4mm ± 20%
Density:	82.6kg/m^3 ± 20%
Crush Strength:	1.711MPa +0% -10%

[in accordance with test method described in Section 2]

<u>Backing Sheet</u>

Dimensions

Height:	800mm
Width:	1000mm
	All above dimensions ± 2.5mm
Thickness:	2.0 ± 0.1mm
Material:	Aluminium 5251/5052 (BS 1470)

Cladding Sheet
Dimensions

Height:	1700mm
Width:	1000mm
	All above dimensions ± 2.5mm
Thickness:	0.81 ± 0.07mm
Material:	Aluminium 5251/5052 (BS 1470)

Bumper Facing Sheet
Dimensions

Height:	330mm
Width:	1000mm
	All above dimensions ± 2.5mm
Thickness:	0.81 ± 0.07mm
Material:	Aluminium 5251/5052 (BS 1470)

Adhesive
The adhesive to be used throughout shall be a two-part polyurethane (such as Ciba-Geigy XB5090/1 resin with XB5304 hardener, or equivalent).

2 Aluminium Honeycomb Certification

A complete testing procedure for certification of aluminium honeycomb is given in NHTSA TP-214D-02. The following is a summary of the procedure as it should be applied to 0.342MPa and 1.711MPa material for the frontal impact barrier.

2.1 Sample Locations

To ensure uniformity of crush strength across the whole of the barrier face, 8 samples shall be taken from 4 locations evenly spaced across the honeycomb block. For a block to pass certification, 7 of these 8 samples must meet the crush strength requirements of the following sections.

The location of the samples depends on the size of the honeycomb block. First, four samples, each measuring 300mm×300mm×50mm thick shall be cut from the block of barrier face material. Please refer to Figure 2 for an illustration of how to locate these sections within the honeycomb block. Each of these larger samples shall be cut into samples for certification testing (150mm×150mm×50mm). Certification shall be based on the testing of two samples from each of these four locations. The other two should be made available to the customer, upon request.

2.2 Sample Size

Samples of the following size shall be used for testing:

Length = 150mm ± 6mm
Width = 150mm ± 6mm
Thickness = 50mm ± 2mm

The walls of incomplete cells around the edge of the sample shall be trimmed as follows:
In the 'W' direction, the fringes shall be no greater than 1.8mm (see Figure 3)
In the 'L' direction, half the length of one bonded cell wall (in the ribbon direction) shall be left at either end of the specimen (see Figure 3).

2.3 Area Measurement

The length of the sample shall be measured in three locations, 12.7mm from each end and in the middle, and recorded as L1, L2 and L3 (Figure 3). In the same manner, the width shall be measured and recorded as W1, W2 and W3 (Figure 3). These measurements shall be taken on the centreline of the thickness. The crush area shall then be calculated as:

$$A = \frac{(L1 + L2 + L3)}{3} x \frac{(W1 + W2 + W3)}{3}$$

2.4 Crush Rate and Distance

The sample shall be crushed at a rate of not less than 5.1mm/min and not more than 7.6mm/min. The minimum crush distance shall be 16.5mm.

2.5 Data Collection

Force versus deflection data are to be collected in either analog or digital form for each sample tested. If analog data are collected then a means of converting this to digital must be available. All digital data must be collected at a rate of no less than 5Hz (5 points per second).

2.6 Crush Strength Determination

Ignore all data prior to 6.4mm of crush and after 16.5mm of crush. Divide the remaining data into three sections or displacement intervals (n=1,2,3) (see Figure 4), where:

n=1 - 6.4mm - 9.7mm inclusive
n=2 - 9.7mm - 13.2mm exclusive
n=3 - 13.2mm - 16.5mm inclusive

For each of these three displacement intervals, calculate the average crush force F(n) using *all* of the points measured within that interval. Thus,

$$F(n) = \frac{[F(n)_1 + F(n)_2 + ... + F(n)_m]}{m} ; n = 1,2,3$$

where m is the number of data points in each of the displacement intervals.
Using the area A, measured as described in Section 2.3, calculate the crush strength of each displacement interval as follows:

$$S(n) = \frac{F(n)}{A} ; n = 1,2,3$$

Thus, for each sample tested, there should be three values of crush strength, each covering one of the displacement intervals detailed above.

2.7 Sample Crush Strength Specification

For a honeycomb sample to pass this certification, the average crush strength of each of the three displacement intervals must meet the following condition:

$0.308MPa \leq S(n) \leq 0.342MPa$ for 0.342MPa material
$1.540MPa \leq S(n) \leq 1.711MPa$ for 1.711MPa material

n=1,2,3

Note: It is not satisfactory to calculate the crush strength averaged over the entire crush distance (6.4mm - 16.5mm). A sample may give an overall average that satisfies the requirement, while individual displacement intervals may not. The procedure of Section 2.6 must therefore be followed.

2.8 Block Crush Strength Specification

Eight samples are to be tested from four locations, evenly spaced across the block. For a block to pass certification, 7 of the 8 samples must meet the crush strength specification of the previous section.

3 Adhesive Bonding Procedure

Immediately before bonding, Aluminium sheet surfaces to be bonded shall be thoroughly cleaned using a suitable solvent, such as 1,1,1 Trichloroethane. This is to be carried out at least twice or as required to eliminate grease or dirt deposits. The cleaned surfaces shall then be abraded using 120 grit abrasive paper. Metallic/Silicon Carbide abrasive paper is not to be used. The surfaces must be thoroughly abraded and the abrasive paper changed regularly during the process to avoid clogging, which may lead to a polishing effect. Following abrading, the surfaces shall be thoroughly cleaned again, as above. In total, the surfaces shall be solvent cleaned at least four times. All dust and deposits left as a result of the abrading process must be removed, as these will adversely affect bonding.

The adhesive shall be applied to one surface only, using a ribbed rubber roller. In cases where honeycomb is to be bonded to Aluminium sheet, the adhesive should be applied to the Aluminium sheet only. A maximum of $0.5kg/m^2$ shall be applied evenly over the surface, giving a maximum film thickness of 0.5mm.

4 Construction

The main honeycomb block shall be adhesively bonded to the backing sheet such that the cell axes are perpendicular to the sheet. The cladding sheet shall be bonded to the front surface of the honeycomb block. The top and bottom surfaces of the cladding sheet shall NOT be bonded to the main honeycomb block but should be positioned closely to it. The cladding sheet shall be adhesively bonded to the backing sheet at the mounting flanges.

The bumper element shall be adhesively bonded to the front of the cladding sheet such that the cell axes are perpendicular to the sheet. The bottom of the bumper element shall be flush with the bottom surface of the cladding sheet. The bumper facing sheet shall be adhesively bonded to the front of the bumper element.
The bumper element shall then be divided into three equal sections by means of two horizontal slots. These slots shall be cut through the entire depth of the bumper section and extend the whole width of the bumper. The slots shall be cut using a saw; their width shall be the width of the blade used and shall not exceed 4.0mm.

Clearance holes for mounting the barrier are to be drilled in the mounting flanges (shown in Figure 5). The holes shall be of 9.5mm diameter. Five holes shall be drilled in the top flange at a distance of 40mm from the top edge of the flange and five in the bottom flange, 40mm from the bottom edge of that flange. The holes shall be at 100mm, 300mm, 500mm, 700mm, 900mm from either edge of the barrier. All holes shall be drilled to ±1mm of the nominal distances. These hole locations are a recommendation only. Alternative positions may be used which offer at least the mounting strength and security as that provided by the above mounting specifications.

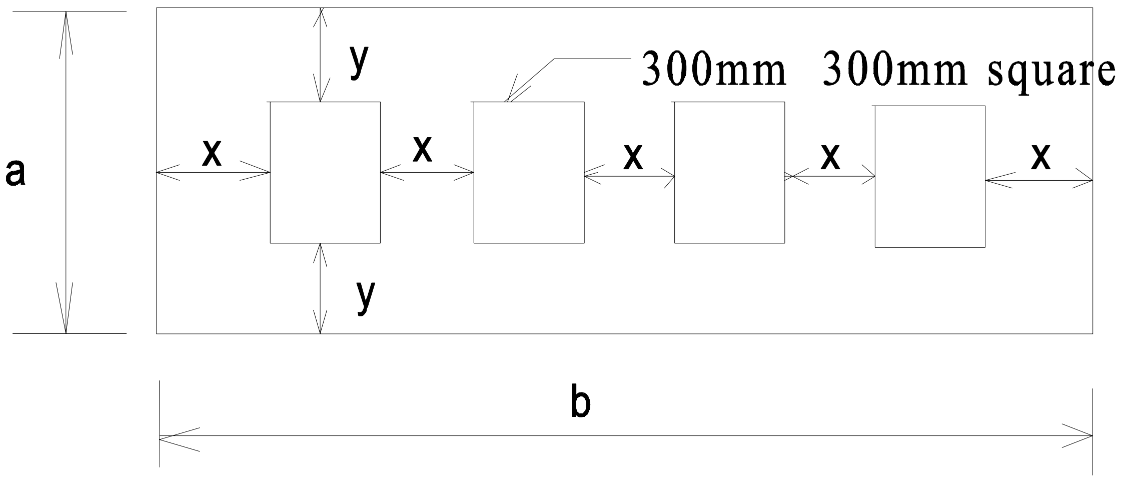
5 Mounting

The deformable barrier shall be rigidly fixed to the edge of a block of reinforced concrete weighing at least 70 tonnes or to some structure attached thereto. The attachment of the barrier face shall be such that the vehicle shall not come into contact with any structure at any height above 75mm from the top surface of the barrier (excluding the upper flange) during any stage of the impact. The front face of the surface to which the deformable face is attached shall be flat and continuous over the height and width of the face and shall be vertical and perpendicular to the axis of the run-up track. The attachment surface shall not be displaced by more than 10mm during any stage of the test. If necessary, additional anchorage or arresting devices shall be used to prevent displacement of the concrete block. The edge of the deformable barrier shall be aligned with the edge of the attachment surface appropriate for the side of the vehicle to be tested.

The deformable barrier shall be attached by means of ten bolts, five in the top mounting flange and five in the bottom. These bolts shall be of at least 8mm diameter. Steel clamping strips shall be used for both the top and bottom mounting flanges (see Figure 2). These strips shall be 60mm high and 1000mm wide and have a thickness of at least 3mm. The edges of the clamping strips should be rounded off to prevent tearing of the barrier against the strip during impact. The edge of the strip should be located no more than 5mm above the base of the upper barrier mounting flange, or 5mm below the top of the lower barrier mounting flange. Five clearance holes of 9.5mm diameter shall be drilled in both strips to correspond with those in the mounting flange on the barrier (see Section 4). The mounting strip and barrier flange holes may be widened from 9.5mm up to a maximum of 25mm in order to accommodate differences in back-plate arrangements and/or load cell wall hole configurations. None of the fixtures shall fail in the impact test.

In the case where the deformable barrier is mounted on a load cell wall (LCW) it should be noted that the above dimensional requirements for mountings are intended as a minimum. Where a LCW is present, the mounting strips may be extended to accommodate higher mounting holes for the bolts. If the strips are required to be extended, then thicker gauge steel should be used accordingly, such that the barrier does not pull away from the wall, bend or tear during the impact. If an alternative method of mounting the barrier is used, it should be at least as secure as that specified in the above paragraphs.

If a<900mm: x=1/5(b-1200) and y=1/2(a-300) [for ab]



If a900mm: x=1/3(b-600) and y=1/3(a-600) [for ab]

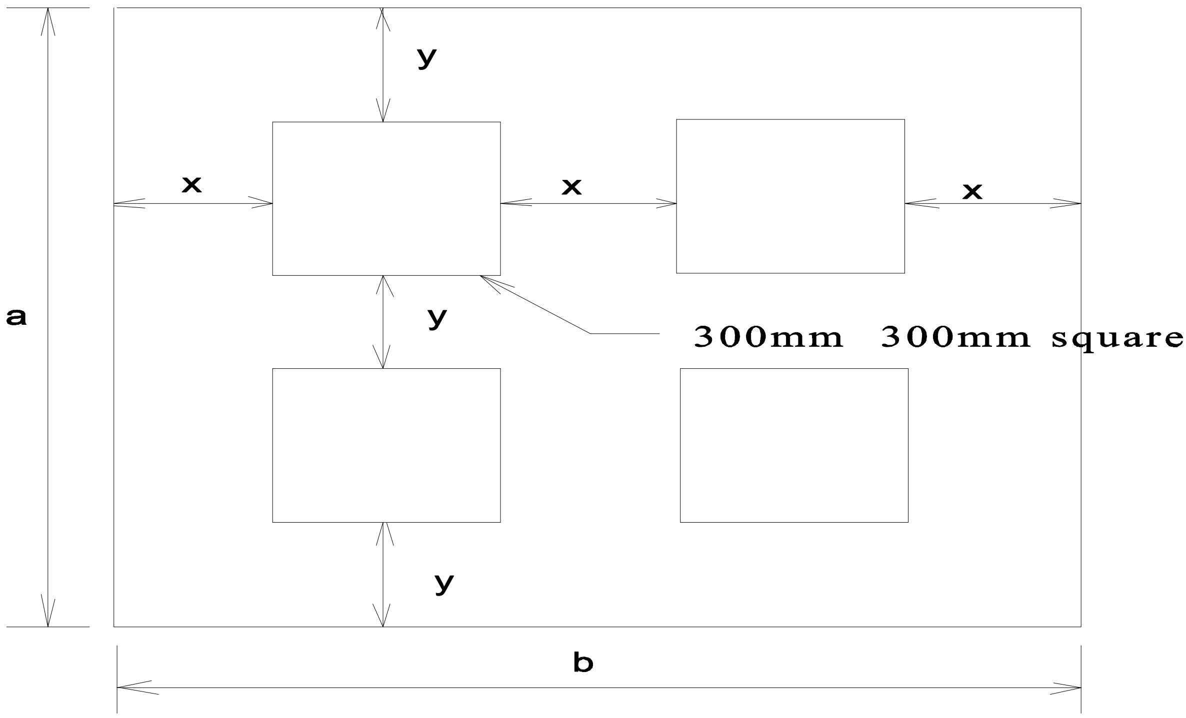


Figure 2 Locations of Samples for Certification

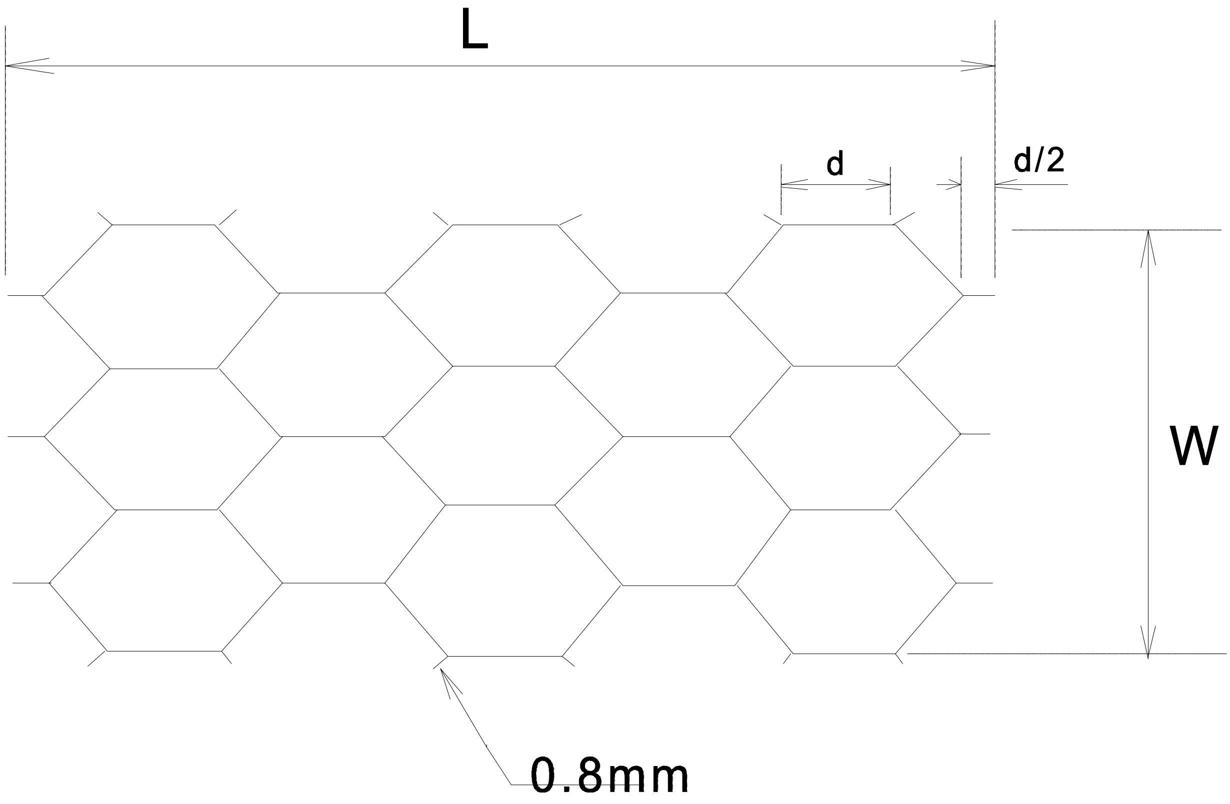
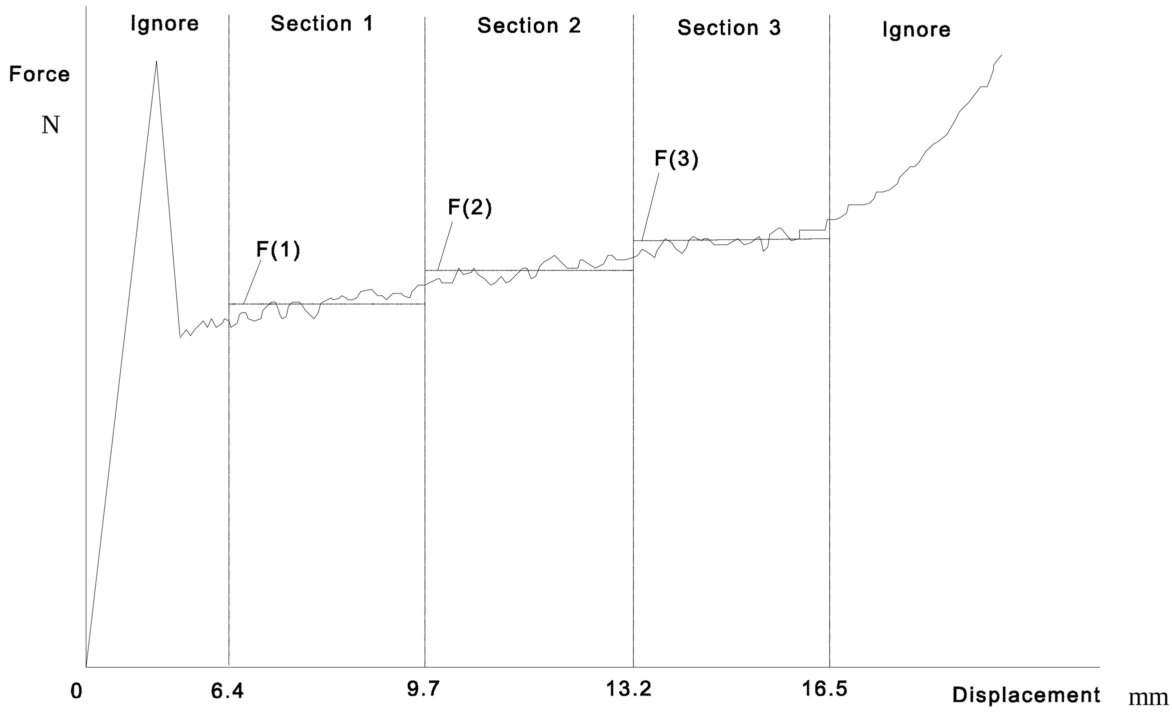


Figure 3 Honeycomb Axes and Measured Dimensions



$$\textit{Crush Strength}\ \ S(n) = \frac{F(n)}{A};\ n = 1,2,3$$

Figure 4 Schematic Load-Displacement Trace for Honeycomb Certification

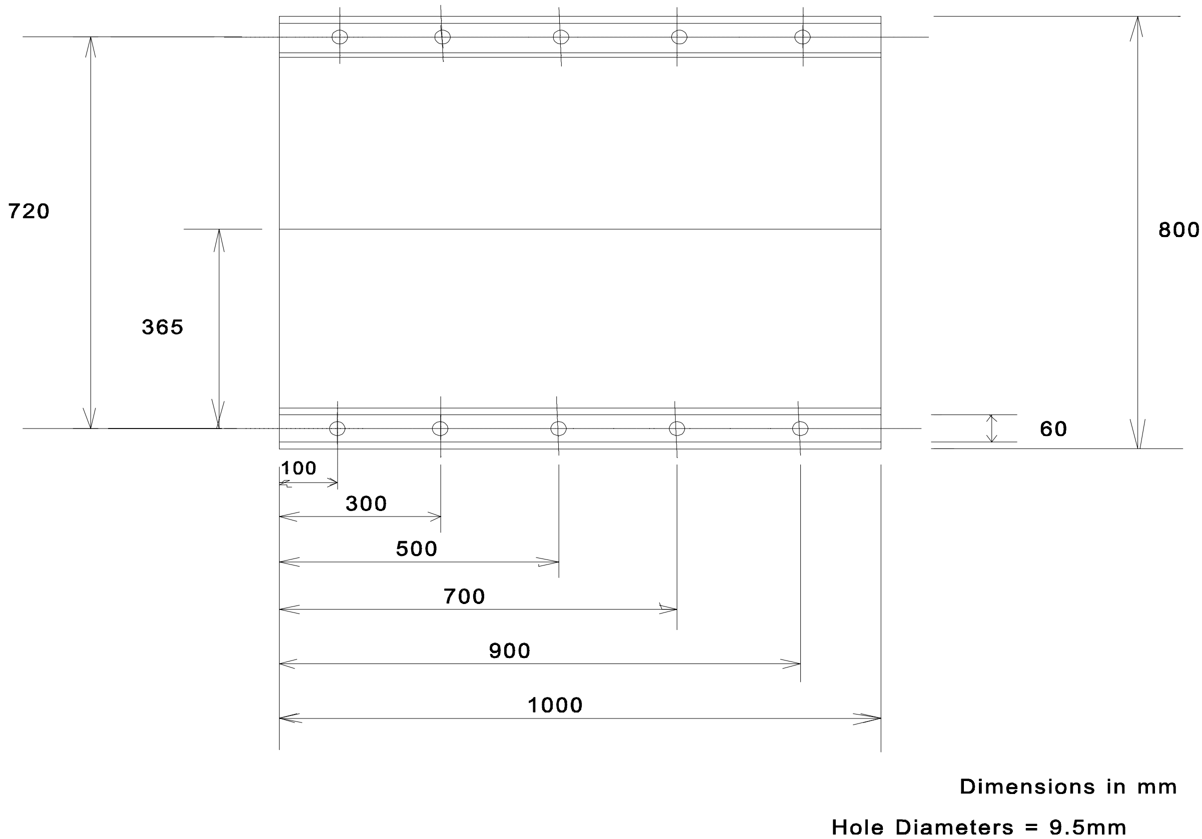


Figure 5 Recommended Positions of Holes for Barrier Mounting