

AUTOMOTIVE INDUSTRY STANDARD

**Bharat New Car
Assessment Program**

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AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT and HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT and HIGHWAYS)
GOVERNMENT OF INDIA

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Introduction

The Government of India felt the need for a setting up a programme, **Bharat New Car Assessment Programme** (hereinafter referred to as "BHARAT NCAP").

BHARAT NCAP is designed to provide a fair, meaningful and objective assessment of crash safety performance of cars on the basis of standard laboratory tests as per AIS-197.

The program provides guidelines and mechanism to inform consumers about the assessment. BHARAT NCAP shall be a voluntary program monitored by the Ministry of Road Transport and Highways (MoRTH), Government of India.

Accordingly, AISC is publishing the AIS-197: Bharat New Car Assessment Programme. This document contains the overall assessment method, vehicle selection procedure and various tests and their assessment protocols.

The overall assessment is based on the performance of the vehicle model when evaluated under 03 areas of assessment, namely, Adult Occupant Protection (AOP), Child Occupant Protection (COP), and Safety Assist Technologies (SAT).

For each of the assessment areas, there are individual test and assessment- protocols covered in separate annexures of AIS-197.



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1.0 SCOPE

Bharat New Car Assessment Program (BHARAT NCAP) will be applicable to the vehicles of category M1 with GVW less than or equal to 3500 kg.

BHARAT NCAP rating will provide consumers an indication of the level of protection offered to the occupant/s by evaluating the vehicle in the following areas:

- Adult Occupant Protection (AOP)
- Child Occupant Protection (COP)
- Safety Assist Technologies (SAT)

BHARAT NCAP will rate only Right Hand Drive (RHD) vehicle models as RHD configuration is the only prescribed configuration under motor vehicles as per Motor Vehicle Act. (MVA) 1988.

BHARAT NCAP shall be applicable on voluntarily basis to vehicle manufacturers, whereas, MoRTH or Government of India can recommend any vehicle model as detailed in Cl. 4.3

The validity of the rating methodology and test protocols specified in this standard shall be for a period of 4-years.

2.0 REFERENCE:

- 2.1 Global NCAP : Assessment Protocol – Adult Occupant Protection, July 2022-December 2025, Version 1.0, March 2021
- 2.2 Global NCAP : Assessment Protocol – Child Occupant Protection, July 2022-December 2025, Version 1.0, May 2021
- 2.3 Global NCAP : Testing Protocols, Version 1.0.0, June 2022
- 2.4 IS 15139 : Automotive Vehicles – Safety Belt Anchorages
- 2.5 IS 15140 : Automotive Vehicles – Safety Belt Assembly
- 2.6 AIS-017 Procedure for Type Approval and Certification of Vehicles for Compliance to Central Motor Vehicles Rules
- 2.7 AIS-072 : Approval of Restraining Devices for Child Occupants of Power-Driven Vehicles (“Child Restraint System”)
- 2.8 AIS-098 : Requirements for the Protection of the Occupants in the event of an Offset Frontal Collision
- 2.9 AIS-099 : Approval of Vehicles with regards to the Protection of the Occupants in the event of a Lateral Collision
- 2.10 AIS-100 : Requirements for the Protection of Pedestrian and other Vulnerable Road Users in the event of a Collision with a Motor Vehicle
- 2.10 AIS-133 : Electronic Stability Control Systems

- 2.11 AIS-145 : Additional Safety features for Category M & N Vehicles
- 2.12 AIS-182 : Approval of vehicles with regard to ISOFIX anchorage systems ISOFIX top tether anchorages
- 2.13 UN GTR No. 8 : Electronic stability control systems
- 2.14 UN GTR No. 14 Global technical regulation on pole side impact
- 2.15 UNECE Regulation No.16 : Uniform Provisions Concerning The Approval Of: I. Safety-Belts, Restraint Systems, Child Restraint Systems And ISOFIX Child Restraint Systems For Occupants Of Power-Driven Vehicles; II. Vehicles Equipped With Safety-Belts, Restraint Systems, Child Restraint Systems and ISOFIX Child Restraint Systems.
- 2.16 UNECE Regulation No. 44 : Uniform Provisions Concerning The Approval Of Restraining Devices For Child Occupants Of Power-Driven Vehicles (“Child Restraint System”)
- 2.17 UNECE Regulation No. 94 : Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a frontal collision
- 2.18 UNECE Regulation No.95 : Uniform provisions concerning the approval of vehicles with regard to the protection of the occupants in the event of a lateral collision
- 2.19 UN Regulation No. 129 : Uniform provisions concerning the approval of enhanced Child Restraint Systems used on board of motor vehicles (ECR)
- 2.20 UNECE Regulation No. 135 : Uniform provisions concerning the approval of vehicles with regard to their Pole Side Impact performance (PSI)

3.0 DEFINITIONS

- 3.1 **Bharat New Car Assessment Programme (BHARAT NCAP):** For the purpose of this standard BHARAT NCAP is an assessment programme for safety rating of new vehicle models sold or being sold in India.
- 3.2 **Designated Agency under BHARAT NCAP (Designated Agency) :** For the purpose of this standard, Designated Agency means the agency or committee designated by the Central Government, as specified under Central Motor Vehicle Rule 126 E.
- 3.3 **Original Assessment or Originally-Assessed Vehicle :**
An assessment of a vehicle not previously rated by BHARAT NCAP. The model name may be new or an existing model name may also be applied to the new vehicle type.
- 3.4 **Variant :** The variant as defined in AIS-017
- 3.4.1 **Base Variant :** For the purpose of this standard the base test variant means variant which has Basic Level Safety Equipment. The Basic Level equipment will comprise of all those items that are fitted as standard items across the model range.

- 3.5 **Partner:** A partner has the same relationship to the originally-tested vehicle as a variant (same brand) but has a different model name. All important structural elements related to safety performance must be the same as the originally-tested vehicle. Where these differ, additional data is required. Safety equipment and its fitment must be the same as the originally-tested vehicle.
- 3.6 **Corporate Twins:** Corporate Twins differ with regard to make (brand) and model name but are identical to the originally-tested vehicle in all regards, including the fitment of safety equipment and interior parts and trim. Corporate Twins may differ only with regard to minor styling differences such as headlamp and grille shape.
- 3.7 **Assessment Year :** The Assessment Year is defined as the calendar year in which the rating is first published by BHARAT NCAP.
- 3.8 **Testing Agency :** For the purpose of this standard, Testing Agency means the testing agency as approved under CMV Rule 126, duly authorized by the Designated Agency for carrying out testing as per notified BHARAT NCAP test protocols.

4.0 REQUIREMENTS

4.1 Star Rating Methodology

- 4.1.1 BHARAT NCAP shall award separate ratings for the new vehicle on the basis of
- a) Performance in full vehicle crash tests and score achieved in the 02 areas of assessment, namely Adult Occupant Protection (AOP), Child Occupant Protection (COP) and
 - b) Fitment of Safety Assist Technologies
- 4.1.1 BHARAT NCAP specifies following list of crash tests to be performed on the new car for the assessment of star rating. Details of the tests are provided in Table No. 1 below
- a) Offset Deformable Barrier (ODB) Frontal Impact Test
 - b) Mobile Deformable Barrier (MDB) Side Impact Test
 - c) Pole Side Impact Test

Table No. 1 –Tests for BHARAT NCAP						
Sr. No.	Test	Test Dummies		Test Speed	Area of Assessment	Test Protocol
		Adult	Child			
1	ODB Frontal Impact Test	02 No. of - Hybrid-III 50 th percentile dummies at front outboard seating positions	Q-Series Child Dummies 01 No. of 1.5 year old and 01 No. of 3 year old Child dummies at 2 nd row outboard seating positions	64 km/h	Adult and Child Occupant Protection	Annexure I
2	MDB Side Impact Test	01 No. of - EuroSID2 dummy at Front driver seating position	Q-Series Child Dummies 01 No. of 1.5 year old and 01 No. of 3 year old Child dummies at 2 nd row outboard seating positions	50 km/h		Annexure II
3	Pole Side Impact Test	01 No. of - EuroSID2 dummy at Front driver seating position	Not Applicable	29 km/h	Adult Occupant Protection	Annexure III

- 4.1.2.3 Table 2A and 2B below indicates the minimum qualifying percentages required for respective STAR RATING.
- 4.1.2.4 Fitment of Safety Assist Technologies is proposed as qualifier for achieving the specific STAR RATING.
- 4.1.2.4 Table 3 specifies the maximum assessment points available for scoring in Adult Occupant and Child Occupant Assessment Areas.

Table No. 2A MINIMUM QUALIFYING POINTS FOR STAR RATINGS FOR AOP		
STARS	Minimum Score (Frontal impact test + Side impact test)	Safety Assist Technologies
	27	Refer Annexure VI
	22	
	16	
	10	
	4	
Table No. 2B MINIMUM QUALIFYING POINTS FOR STAR RATINGS FOR COP		
STARS	Minimum Score (COP) (Dynamic COP + Reference CRS Installation + Vehicle based Assessment)	
	41	
	35	
	27	
	18	
	9	

Table No. 3 – Distribution of Assessment Points for Tests in BHARAT NCAP					
Sr. No	Group	Description of test / Evaluation	Assessment Points	Assessment Points	Assessment Protocol
A	Adult Occupant Protection	ODB Frontal Impact Test	16	32	Annexure IV
		MDB Side Impact Test	16		
B	Child Occupant Protection	ODB Frontal Impact Test	16	49	Annexure V
		MDB Side Impact Test	8		
		CRS Installation Checks	12		
		Vehicle based Assessments	13		
C	Safety Assist Technologies	Electronic Stability Control	As qualifier with fitment rates		Annexure VI
		Pedestrian Protection			
		Side Head Protection			
		Seat-Belt Reminder			

- 4.1.2.5 Score achieved in Adult Occupant Protection is verified against the MODIFIERS specified in Annexure-VII.
- 4.1.2.6 The brief justification of concepts behind the injury criteria selected for BHARAT NCAP is provided in Annexure IX
- 4.2 ROUNDING :** The following rounding rules will be applied in the calculation of the score for deciding the overall rating
- 4.2.1 The total points scored in a test is the sum of scores in each body region
- 4.2.2 Calculation of points scored (e.g. for individual body regions) in ODB Frontal and MDB Side Impact tests are rounded to 3 decimal points e.g. a head score of 3.1238 in frontal impact would be rounded to 3.124
- 4.2.3 Intermediate calculations (e.g. calculations needed to derive parameters which are then used to calculate scores) are not rounded
- 4.2.4 Total points scored for AOP or COP is the sum of scores in each test where data is entered upto 3 decimal points
- 4.2.5 That integer is then compared with the minimum thresholds specified for respective STAR RATING in Table 2A and 2B.
- 4.2.6 Scoring and Visualization: Scoring and visualization guidelines to be followed for publication of BHARAT NCAP results are specified in Annexure-VIII.

- 4.3 **VEHICLE SELECTION GUIDELINES**
- 4.3.1 A vehicle model or its variant marketed in India can be selected under BHARAT NCAP for star rating by using any one of the following criteria.
- 4.3.1.1 Any vehicle model within the scope of the standard submitted for assessment voluntarily by vehicle manufacturer.
In such case **base variant** of the vehicle model shall be selected for testing and star rating will be awarded to the base variant.
- 4.3.1.2 In addition to the base variant of the vehicle model, vehicle manufacturer may sponsor an additional variant equipped with additional safety features.
Designated Agency shall evaluate and carry-out additional tests as applicable on such additional variant submitted by vehicle manufacturer.
Rating achieved by the additional variant of the vehicle model will be published alongwith official rating achieved by the base variant
- 4.3.1.3 In the interest of public safety, if so desired by the Government of India, it may request the Designated Agency to select a particular variant/s of any vehicle model within the scope of this standard for assessment
- 4.3.2 In any of the above cases, the test vehicles have to be submitted by the OEM along with all the charges applicable for assessment including the cost of test vehicle/s.
- 4.3.3 The base test variant as defined in clause 3.4.1 will have Basic Level Safety Equipment. Only safety equipment which is part of the Basic Level will be eligible for assessment and may contribute towards the scoring of the vehicle.
- 4.3.3.1 The Basic Level will be determined as follows.
- The manufacturer will be asked to complete an Equipment Matrix Template (Sample Matrix is provided in Section 10.0)
 - In the matrix, the manufacturer must identify all items of safety equipment available in the model range and state whether they are standard on all variants or optional on some.
- 4.3.4 Vehicle manufacturers can only sponsor the assessment of vehicles manufactured and marketed by them including partner vehicles or corporate twins. Manufacturer cannot sponsor assessment for vehicles manufactured by other OEM's.
- 4.3.5 In case of vehicle selected by BHARAT NCAP, a manufacturer may advise BHARAT NCAP that a vehicle model which has been chosen is soon to be replaced by a newer version. If so, the manufacturer may request that the updated model be tested.

- 4.3.6 To ensure that the rating always remain credible, it is essential that all vehicles selected for testing are the same as those vehicles offered for sale to consumers. Ideally this means that test vehicles are taken from the production line, which are ready for sale. Many times, however, this is conflicting with the manufactures' time line where ratings must be available at model release date and small adjustments to production are made during ramp up of production. The following provides guidance on these matters.
- 4.3.6.1 The vehicles tested must be of the same production status as for those offered for sale to consumers at or before the time of publication of the new result.
- 4.3.7 The method of selecting test vehicles of the correct specification will be chosen by the Designated Agency. The vehicles selected for testing must be:
- 4.3.7.1 certified as per CMVR 1989; and
- 4.3.7.2 from serial production; and
- 4.3.7.3 lawfully ready for sale to the general public; and
- 4.3.7.4 selected as a random sample from serial production from vehicle manufacturer's premises or from the authorized dealer of the manufacturer / importer.
- 4.4 Once the Vehicle Model is selected for evaluation, for sampling purpose, the *Designated Agency* may appoint representatives to visit the production line of the OEM, who shall identify the test specimen as per above guidelines and shall seal the vehicles proposed for further submission to test agencies.
- 4.5 The *Designated Agency* may opt to select the cars from the dealer / sales representative of the OEM adhering to the requirements specified in Cl. 4.3.6 and 4.3.7 above.
- 4.6 New models are generally produced in small numbers during the early stages of production ("ramp-up"), leading to full-volume production within a few months. Vehicles from such early production phases are acceptable, so long as they comply with the requirements set out above.
- 4.7 Once the test vehicles are identified by the *Designated Agency*, OEM shall make necessary arrangements to dispatch (door deliver with all duties paid, if any) the same to the allocated test agency from the place of selection.

5.0 APPLICATION TO BHARAT NCAP PROGRAM

5.1 APPLICATION

In case the Designated Agency selects a vehicle model; it shall inform the OEM regarding such a nomination / sponsorship.

- 5.1.1 Upon intimation from the Designated Agency, OEM shall submit additional information about the vehicle model with details as specified in Form 70-A of CMVR.
- 5.1.1.1 Details of the vehicle model recommended
- 5.1.1.2 Details of the variants of the vehicle model alongwith details of the safety equipment fitted in them
- 5.1.1.3 Proposal of the base test variant

- 5.1.1.4 CMVR Type Approval Details
- 5.1.1.5 Details of the production – inception, number of units produced in last calendar year, number of units sold in last calendar year, details of the production plants (including all variants).
- 5.1.2 Upon application, the Designated Agency shall evaluate the application and seek additional details from the OEM regarding the vehicle model
- 5.1.3 The Designated Agency shall further inform the OEM with regard to
 - 5.1.3.1 Payment of BHARAT NCAP Fees
 - 5.1.3.2 Selection of test samples from production line OR dealership. For guidelines clauses 4.3. to 4.7 shall be referred.
- 5.1.4 Upon selection of test samples, the Designated Agency shall notify the identified Test Agency and inform the same to OEM to make further arrangements for submission of the test samples to the allocated Test Agency.
- 5.1.5 Allocated Test Agency shall carry out tests as per BHARAT NCAP protocols (detailed in further sections) and shall submit a consolidated report to the Designated Agency (as per Form No. 70-B)
- 5.1.6 The Designated Agency shall evaluate the test results submitted by the Test Agency, assess the level of rating achieved by the vehicle model and publish the results.

6.0 TESTING, RETESTING AND REASSESSMENT

6.1 Testing

- 6.1.1 All tests shall be carried out by the allocated Testing Agency according to this standard. The Test Agency is responsible for accurate application of the test protocols and keeping test equipment up to date.
- 6.1.2 Before each test, the test agency must check that vehicles and other components scheduled for testing meet the vehicle test specification.
- 6.1.3 The test agency shall inform the *Designated Agency* about the plan / schedule of preparations and actual conduct of test and as far as possible adhere to the same.

6.2 Retest

- 6.2.1 In remote cases, a retest may be requested by the Designated Agency or the manufacturer to the Test Agency. A re-test may be required if
 - 6.2.1.1 Test result presented by the Test Agency is inadequate to assess and compute the final star rating for the submitted model
 - 6.2.1.2 In the instances of missing channel data from the test dummies or any other test parameter, the *Designated Agency* may request the OEM or the Test Agency to submit internal test data if available for the same test configuration on the same vehicle model with a declaration from OEM conforming to the tested vehicle model.

- 6.2.1.3 If such a data is presented by OEM or Test Agency, the *Designatd Agency* will review the submitted results and if found satisfactory, use the results for further computation of star ratings for the vehicle model.
- 6.2.1.4 Incase such a data is not available, or is not submitted by OEM, the *Designated Agency* reserves the right to suitably assess the available data and decide on consideration of values for the missing data.
- 6.2.1.5 In a scenario where the test parameter(s) observed after the tests are out of the defined tolerances in the respective test protocols, the Designated Agency reserves the right to decide on the test validity.
- 6.2.1.6 It is not possible to foresee every circumstance in which the *Designated Agency* may need to repeat test(s) in order to confirm results and vehicle ratings. The final agreement arising in such circumstances shall be at the discretion of the the *Designated Agency*.
- 6.2.1.7 Where a test does not meet requirements of this standard subject to assessment of clause 6.2.1.1 to 6.2.1.5 above, it shall be repeated.
- 6.2.1.8 In case of 6.2.1.7, if the failure is the responsibility of the Test Agency, they shall be responsible for carrying out the retest without charge.
The responsibility for funding the replacement vehicle and components is that of the OEM.
- 6.2.2 Modification and re-testing is allowed if an ***unexpected or undesired vehicle performance problem*** is identified in a BHARAT NCAP test. In such cases, the following condition must be met for a re-test to be allowed:
- 6.2.2.1 The manufacturer has identified deficiencies and can satisfy the Designated Agency.
- 6.2.2.2 The proposed modifications will significantly improve safety.
- 6.2.3 Where there is a failure, or partial failure, of safety related equipment, the *Designated Agency* may withhold publication of the test results, pending investigation of the failure.
- 6.2.4 **Reassessment**
- 6.2.4.1 The *Designated Agency* will reserve all the rights to decide upon the reassessment requests put up, if any, by the OEM.
- 6.2.4.2 If such a request is approved, the entire cost of the reassessment shall be borne by the OEM.
- 6.2.4.3 In case the reassessment leads to change in the results to the previous assessment published, the *Designated Agency* reserves the rights to publish the result on their website

7.0 PUBLICATION OF RESULTS

- 7.1 Under normal circumstances, once the vehicle has been tested and the data is available and verified, the results will be published by the Designated Agency on its website. Manufacturers will not be able to propose further modifications leading to a retest and may not make use of the star rating, or refer to it, until the result has been published by the Designated Agency.
- 7.2 The rating with the details of the test vehicle specification will be published as

part of the normal release schedule as decided by the Designated Agency.

In case of a vehicle model fully certified as per CMVR 1989 and yet to be officially launched or revealed to the public, the date of publication of BHARAT NCAP results shall be mutually agreed between the Vehicle Manufacturer and the Designated Agency.

- 7.3 The Designated Agency will publish the base star rating (and optional rating, if available) and additional information (scores, summary report presented with coloured men etc.) on its website.

In all cases, first right to publish the results of a nominated model will be with the Designated Agency.

- 7.4 (Reserved)

8.0 VALIDITY AND APPLICABILITY OF STAR RATING

- 8.1 **Validity:** Once BHARAT NCAP has published the base star rating and related information on its website, the vehicle is deemed to have obtained a valid rating. By default, the base rating (and optional rating, if applicable) remains valid for a period till such time AIS-197 is revised and notified by MoRTH (basis of the currently published BHARAT NCAP scheme) following the release of the result. The rating should clearly mention the Year of publication and protocol version used for the assessment.

Design modifications in the vehicle having bearing on star rating to vehicle already rated shall render the rating invalid. In some circumstances, the star rating may be carried over from the original test model to a facelifted model, another model variant or twin model based on the declaration and submission of documentary evidences to the Designated Agency by the OEM.

The equipment matrix to be submitted by vehicle manufacturers before tests shall contain a section where all variants, including partner models, must be defined.

The Designated Agency will test a single variant, as identified using the equipment matrix received from OEM. Variants will be considered to share the rating of the tested vehicle if the manufacturer can provide data/information to demonstrate to the satisfaction of the Designated Agency.

The Designated Agency will provide information on its website about the variants to which a model's rating applies.

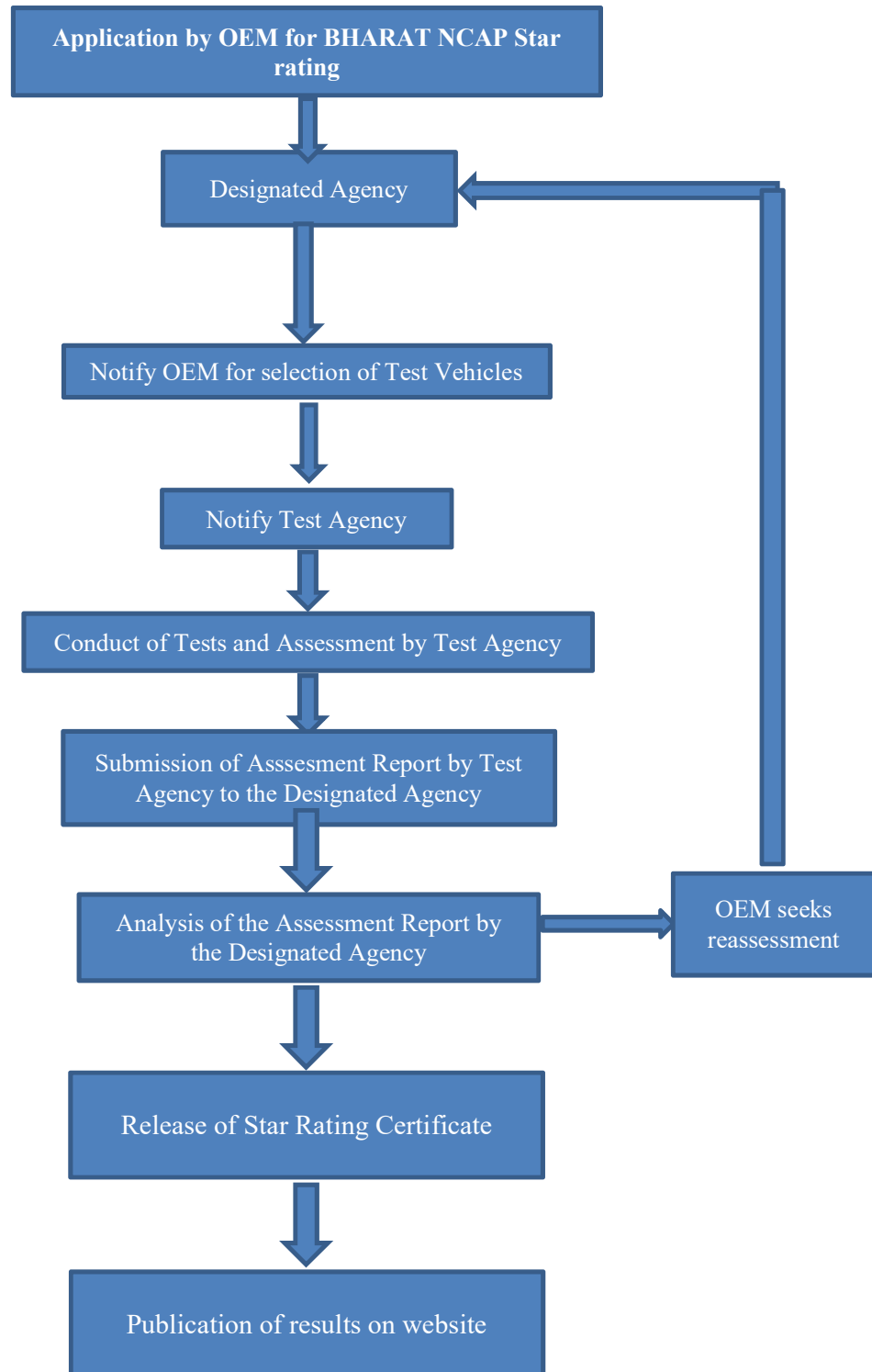
- 8.1.1 Partner Models
- 8.1.1.1 Certain variants may be marketed under a different model name to the originally-tested vehicle.
- 8.1.1.2 The Manufacturer must inform the Designated Agency of its intention to apply for a 'partner' rating at the time of application for assessment of the tested model.
- 8.1.2 Timing
- 8.1.2.1 Vehicle manufacturers may apply for the star rating to be applied to other variants in years later than the one in which the rating was originally published, before the expiry of the original rating.

8.2 **Applicability to Corporate Twins**

8.2.1 A vehicle's star rating can be applied to corporate twins if:

- *The Designated Agency* is satisfied that the twin is, apart from name and branding, identical to the vehicle tested in all ways related to safety.
- The twin has the same base safety specification as the vehicle tested, or better.

8.2.2 An equipment matrix should be completed for all brand models to which the rating will be applied. If the vehicle manufacturer does not submit the Equipment Matrix, the Designated Agency will test the vehicle with the lowest specification.

9. FLOWCHART OF BHARAT NCAP PROCESS

10. SPECIMEN EQUIPMENT TEST MATRIX

10.1 Offset Deformable Barrier Frontal Impact

BHARATNCAP: EQUIPMENT MATRIX TEMPLATE					
Sr. No.	Parameter	Sub Parameter	Data to be filled by OEM	Model Variants	
				Variant X	Variant Y
1	Engine - Fuel Type and capacity				
2	Engine Compartment packaging <i>(Clearance from fr. cross beam to engine and engine to firewall)</i>				
3	Vehicle structure (Front end to B pillar)				
4	Unladen Mass				
5	Tire Size				
6	Ride height				
7	Seat Belt	Driver PT			
		Driver LL			
		Passenger PT			
		Passenger LL			
8	Seat Belt top anchorage position	Driver			
		Passenger			
9	Airbag	Driver			
		Passenger			
10	Seats				
	Driver	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
	Passenger	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
Height Adjuster					
11	Interior fittings				
12	Sun Roof	Front			
		Rear			
13	Fuel tank capacity				
14	Drive train 4x4, 4x2				
15	Propeller shaft components				

10.2 Side Impact / Pole Side Impact

Bharat NCAP : Equipment Matrix for Side Impact / Pole Side Impact					
Sr. No.	Parameter	Sub Parameter	Data to be filled by OEM	Model Variants	
				Variant X	Variant Y
1	Vehicle Type - Hatchback/Notchback				
2	Vehicle structure / BIW				
3	Unladen Mass				
4	Tire Size				
5	Side Sill Height from the ground				
6	Door Trim design and Trim material	RH side			
		LH side			
7	Door Construction	RH side			
		LH side			
8	Seating Position	Driver (RH) side			
		Passenger (LH) side			
9	R point	Driver (RH) side			
		Passenger (LH) side			
10	Airbag - RH side	Roof Airbag			
		Curtain Airbag			
		Seat Airbag			
11	Airbag - LH side	Roof Airbag			
		Curtain Airbag			
		Seat Airbag			
12	Fuel Tank Location				
13	Seats				
	Driver (RH)	Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
	Passenger (LH)	Longitudinal adjustment			
		Angular adjustment			
Height Adjuster					
14	Seat Belt Pretensioner (PT)	Driver			
15	Sun Roof	Front			
		Rear			

ANNEXURE I
OFFSET DEFORMABLE BARRIER FRONTAL IMPACT
TEST PROTOCOL

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1.0 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 theseat 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 driver seat and passenger seats 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 For two seater vehicles only, the mass of child dummies and child seats shall not be included in the reference load. For vehicles with limited rear space, child seats and dummies shall be included in the reference load.

- 1.2.8 Roll the vehicle back and forth to ‘settle’ the tyres and suspension with the extra weight on board. Weigh the front and rear axle weights of the vehicle. These loads are the “axle reference loads” and the total weight is the “reference mass” of the vehicle.
- 1.2.9 Record the axle reference loads and reference mass in the test details.
- 1.2.10 Record the ride-heights of the vehicle at the point on the wheel arch in the same transverse plane as the wheel centres. Do this for all four wheels.
- 1.2.11 Remove the weights from the luggage compartment and the front and rear seats.
- 1.3 **Vehicle Width and Overlap**
- 1.3.1 Determine the widest point of the vehicle ignoring the rear-view mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mud-guards and the deflected part of the tyre side-walls immediately above the point of contact with the ground.
- 1.3.2 Record this width in test details.
- 1.3.3 Determine the centre-line of the vehicle. Calculate 10% of the vehicle width and mark a line on the bonnet and bumper which is this distance from the centre line on the steering-wheel side of the car. The distance from this line to the widest point on the steering wheel side of the car will be the overlap with the deformable barrier. **Take the pre-impact vehicle intrusion measurements at this point. See Section 2 for a full description of how to do this.**
- 1.4 **Vehicle Preparation**
- Care should be taken during vehicle preparation that the ignition is not switched on with the battery or airbag disconnected. This will result in an airbag warning light coming on and the airbag system will need to be reset. The manufacturer will need to be contacted if this occurs.
- 1.4.1 Ensure that the vehicle’s battery is connected to the vehicle’s electrical circuit in its standard position. Check that the dashboard light for the airbag circuit functions as normal. Alternatively, the vehicle battery acid may be drained or an additional live battery may be placed in the luggage compartment of the vehicle. If the supply from the drained battery is not supported by an additional battery, the test must be conducted within fifteen minutes after draining the battery. Where any additional battery is used it must be connected directly to the original battery so that the vehicle’s original electrical system, cable routing and connections remain unaltered. The power cables connecting both batteries must be positioned on the non-struck side of the car in such a way to minimize the risk of the cable being cut during the impact. The cable used to connect both batteries must have a minimum cross section of 5mm² to ensure a minimum voltage drop. The current supplied to the vehicle must be monitored throughout the impact across the original battery. Where an additional battery is to be used the vehicle manufacturer will be required to indicate the minimum voltage/current needed during the test for all systems to operate as intended. The manufacturer will be asked to confirm that the laboratory modifications are suitable for use in the vehicle being tested and will not influence any of the vehicle systems.

- 1.4.2 In the event that the engine fluids are to be drained then drain the coolant, oil, air- conditioning (air conditioning refrigerant should be drained without venting it to the atmosphere) and Power Assisted Steering (PAS) fluids.
- 1.4.3 If the fluids are drained then measure the weights of each of these fluids, excluding their conditioning fluid, and replace with an equivalent weight of water or other ballast.
- 1.4.4 Remove the luggage area carpeting, spare wheel and any tools or jack from the car. The spare wheel should only be removed if it will not affect the crash performance of the vehicle.
- 1.4.5 An emergency abort braking system may be fitted to the vehicle. This is optional; the test facility may elect to test without an abort system. Where such a system is fitted its inclusion shall not influence the operation or function of any of the foot controls, in particular the brake pedal. The position and the resistance to movement of the pedals shall be the same as prior to fitment of the system. Remove as little as possible of the interior trim; any mass compensation will be made when all equipment has been fitted.
- 1.4.6 Fit the on-board data acquisition equipment in the boot of the car. Also fit any associated cables, cabling boxes and power sources.
- 1.4.7 Place weights equivalent to a Hybrid-III dummy (88kg) in each of the front seats of the car (with the seats in their mid-positions).
- 1.4.8 In the child restraints recommended by the manufacturer, place masses equivalent to a 3 and a 1½ year old child dummy on the rear driver's 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 1.2.9.
- 1.4.10 If the axle weights differ from those measured in Section 1.2.9 by more than 5% (of the axle reference loads) or by more than 20kg, remove or add items which do not influence the structural crash performance of the vehicle. Similarly, if the total vehicle mass differs by more than 25kg from the reference mass, non-structural items may be removed or added. The levels of ballast in the fuel tank (equivalent in mass to 90% capacity of fuel) may also be adjusted to help achieve the desired axle weights. Any additional mass that is added to the vehicle should be securely and rigidly attached.
- 1.4.11 Repeat Sections 1.4.9 and 1.4.10 until the front and rear axle weights and the total vehicle weight are within the limits set in 1.4.10. Record the final axle weights in the test details.
- 1.4.12 The vehicle manufacturer will be required to inform BHARAT NCAP and the test laboratory of the presence of any pre-crash systems that must be disabled prior to impact. Disabling information shall be provided to the laboratory prior to impact. It is the responsibility of the vehicle manufacturer to ensure that the disconnection of the system does not influence the performance of any systems that are intended to function during the impact.

1.5 **Electrical power train adjustments for Electric Vehicles**

1.5.1 Test conditions provide in Annex 1 of AIS-098 shall be followed for testing of high voltage Electric Vehicles and assessment of post-crash electrical safety.

2.0 **INTRUSION MEASUREMENTS**

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

2.1 **Before Test**

- 2.1.1 Determine and mark the centre of the clutch, brake and accelerator pedals.
- 2.1.2 Set the steering wheel to its mid-position, if it is adjustable for either rake or reach (for full description of how to do this, see Section 5).
- 2.1.3 Remove the centre of the steering wheel or, if fitted, the airbag assembly to expose the end of the steering column. When doing this, carefully note the connections to the airbag which will need to be remade on re-assembly. Follow the manufacturer's instructions when removing the airbag and/or steering wheel assemblies.
- 2.1.4 Determine and mark the centre of the top of the steering-column.
- 2.1.5 Remove the carpet, trim and spare wheel from the luggage compartment. The plastic trim or rubber seals that might influence the latching mechanism should be re-fitted once the intrusion measurements have been recorded. This is to ensure that any opening of the rear door during the impact is not caused by the omission of some part of the trim around the latching mechanism.
- 2.1.6 Locate the vehicle axis reference frame (see Figure 1) centrally to the rear of the vehicle.

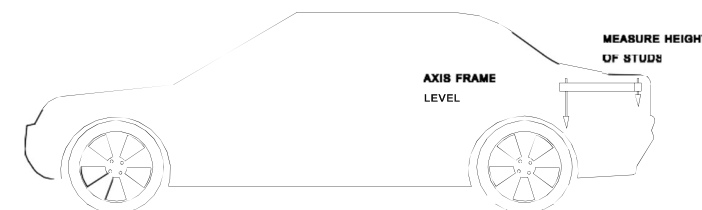


Figure 1.
Setting up axis reference frame.

- 2.1.7 Level the reference frame.

- 2.1.8 Measure and record the stud heights of the reference frame. These will be used after the test to help reset the reference frame, if required.
- 2.1.9 If it is necessary to lean on the vehicle to reach the following points, the vehicle should be supported to maintain the ride heights during measuring.
- 2.1.10 Set up the vehicle co-ordinate axes in the 3D arm or similar device.
- 2.1.11 Mark and record the position of at least 5 datum points on the rear of the vehicle. These points should be on structures which are not expected to be deformed in the test and should be positioned such that they have wide spaced locations in three dimensions and can all be reached with the 3D measuring system in one position.
- 2.1.12 Working on the passenger side of the vehicle determine and mark the positions on the B-post which are:
- a) at a distance of 100 mm above the sill.
 - b) at a distance of 100 mm beneath the lowest level of the side window aperture.
- All points should be as close as possible to the rubber sealing strip around the door aperture.
- 2.1.13 Measure and record the pre-impact positions of the two door aperture points.
- 2.1.14 Working on the driver's side of the vehicle determine and mark the positions on the A and B posts which are:
- a) at a distance of 100 mm above the sill.
 - b) a distance of 100 mm beneath the lowest level of the side window aperture.
- All points should be as close as possible to the rubber sealing strip around the door aperture.
- 2.1.15 Use the arm to measure the pre-impact positions of the centre of the top of the steering-column and the four door aperture points.
- 2.1.16 Record the position of the centre of the un-depressed clutch, brake and accelerator pedals and where applicable foot operated parking brake. If the pedal is adjustable, set it to the mid position or a reasonable variation from this in accordance with the manufacturer's recommendations for the 50th percentile position.
- 2.1.17 Replace the steering wheel and airbag assembly. Check that all bolts are securely fastened. Ensure that all connections to the airbag are replaced and check the dashboard light to confirm the circuit is functional.

- 2.2 **After Test**
- 2.2.1 Before dummy removal measure the distance between all foot pedals and a fixed point in the footwell e.g. seat runner, seat mounting bolt. If access cannot be gained to remove the dummies, according to Section 7.5, taking care not to disturb any pedals and then record the measurement. This measurement should be re-checked before the pedals are measured with the 3D measuring system. If the pedal has moved re-position the pedal using the measurement taken previously.
- 2.2.2 Remove the dummies according to Section 7.5 and remove the data acquisition and emergency abort equipment (if fitted) from the luggage compartment.
- 2.2.3 Remove the centre of the steering wheel or airbag assembly.
- 2.2.4 Use any 3 of the 5 datum points at the rear of the vehicle, and their pre-impact measurements, to redefine the measurement axes.
- 2.2.5 If the axes cannot be redefined from any 3 of the datum points relocate the axis reference frame in the same position as in Section 2.1.6. Set the studs of the frame to the same heights as in Section 2.1.8 (Figure 2.1). The frame should now be in the same position relative to the car as it was before impact. Set up the measurement axes from the frame.
- 2.2.6 Record the post-impact positions of the B-post points on the unstruck passenger's side of the vehicle.
- 2.2.7 Compare the vertical co-ordinate of the B-post sill point before (Section 2.1.12) and after (Section 2.2.6) the test.
- 2.2.8 Find the angle θ that best satisfies the following equation:

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

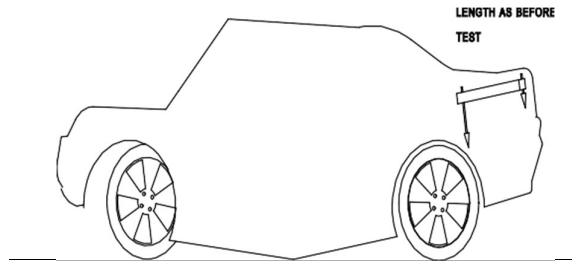


Figure 2.

Re-setting axis reference frame after- test

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

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

Where Θ is the angle determined in Section 2.2.8. X and Z should now be in the same frame of reference as the pre-impact measurements.

- 2.2.11 From the pre-impact and adjusted post-impact data collected, determine
- the longitudinal, lateral and vertical movement of the centre of the top of the steering column.
 - the longitudinal and vertical movement of all of the foot operated pedals
the rearward movement of the A-post at waist level.
 - the reduction in width of the door aperture at waist and sill levels.
- 2.2.12 Record these intrusion measurements in the test details.

3.0 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 AIS098¹ except for modifications and additions stated later - See Section 3.3.
- 3.1.2 A Q-Series child dummy representing 1½ year old child², in a suitable Child Restraint System (CRS) (see Section 6.6), shall be used in the rear passenger side seating position.
- 3.1.3 A Q-Series child dummy representing 3 year old child², in a suitable CRS (see Section 6.6), shall be used in the rear driver's side seating position.

¹ Reference for the description of Hybrid-III dummy and technical drawings as given in Annexure 7 of AIS098

² Description of Q series child dummies representing 1 ½ year old child and 3 year old child is given in Annexure 8 of UNECE R129.

3.2 **Dummy Certification**

Full details of the certification procedure for the Hybrid-III dummy are available elsewhere (see Part 572 Subpart E of US Department of Transportation Code of Federal Regulations), SAE J2856 and Annex 10 of ECE Regulation No. 94). Details of the certification procedure of the Q1½ and Q3 child dummies are available in the user documentation. No manufacturer shall have access to any pre-test information regarding any of the test equipment to be used by BHARAT NCAP, or be permitted to influence its selection in any way.

- 3.2.1 The Hybrid-III dummies shall be re-certified after every THREE impact tests.
- 3.2.2 The chest shall be certified according to the frequency above and should meet both the low speed thorax test as prescribed by SAE J2779, as well as the full certification test detailed in CFR572. Additionally, chest potentiometer calibration and polynomial post processing shall also be performed as detailed in SAE J2517. See Technical Bulletin 005 for more details.
- 3.2.3 The knee slider shall be certified to SAE J2876 after every THREE impact tests and as specified in SAE J2856 after every NINE impact tests. See Technical Bulletin 006 for more details.
- 3.2.4 The Q1½ and Q3 child dummies shall be re-certified after every TEN impact tests (e.g.5 frontal and 5 side impacts, or any combination of the two test types).
- 3.2.5 If an injury criterion reaches or exceeds its normally accepted limit (e.g. HIC of 700) then that part of the dummy shall be re-certified.
- 3.2.6 If any part of a dummy is broken in a test, then the part shall be replaced with a fully certified component.
- 3.2.7 Copies of the dummy certification certificates will be provided as part of the full report for a test.

3.3 **Additions and Modifications to the Hybrid III Dummies**

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

- 3.4 **Dummy Clothing and Footwear³**
- 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-S13192rev P. (size 11EEE)
- 3.4.2 Child Dummies
- 3.4.2.1 Each child dummy shall wear their appropriate suits, Q3 part number 020-8000, Q1½part number 048-8000.
- 3.5 **Dummy Test Condition**
- 3.5.1 Dummy Temperature
- 3.5.1.1 The dummy shall have a stabilized temperature in the range of 19°C to 22°C.
- 3.5.1.2 A stabilized 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 Stabilize the dummy temperature by soaking in the required temperature range for at least 5 hours.
- 3.5.2.2 The tensioning screw or bolt which acts on the constant friction surfaces should be adjusted until the joint can just hold the adjoining limb in the horizontal. When a small downward force is applied and then removed, the limb should continue to fall.
- 3.5.2.3 The dummy joints stiffness should be set as close as possible to the time of the test stand, 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 The description and technical drawings of the additional parts specified in clause 3.3 and 3.4 can be referred from Euro NCAP - ODB Frontal Impact Testing Protocol v7.0.1 Apr 2015

3.5.3 Dummy face painting

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

Hybrid-III	
Eyebrows (left and right)	Red
Nose	Green
Chin	Yellow
Left Knee	Red
Right Knee	Green
Left Tibia (top to bottom)	Blue, Green, Red, Yellow
Right Tibia (top to bottom)	Yellow, Red, Green, Blue
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 (L/R)	(25/2) x 50mm
Nose	25 x 40mm strip, down nose centre line.
Chin	25 x 25mm square, centre line of chin.
Knee (L/R)	50 x 50mm square, knee centre line with bottom edge level with top of tibia flesh.
Tibia (L/R)	25mm x 50mm, 4 adjacent areas down leg centre line with top edge level with top of tibia flesh.
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.

4.0 **INSTRUMENTATION**

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

4.1 **Dummy Instrumentation**

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

Hybrid-III Dummy					
Location	Parameter		Minimum Amplitude	No. of Channels	
				Driver	Passenger
Head	Accelerations, Ax Ay Az		250g	3	3
Neck	Forces	Fx Fy	9kN	2	2
		Fz	14kN	1	1
	Moments, Mx My Mz		290Nm	3	3
Chest	Accelerations, Ax Ay Az		150g	3	3
	Deflection, Dchest		100mm	1	1
Pelvis	Accelerations, Ax Ay Az		150g	3	3
Lumbar Spine	Forces, Fx Fz			2	2
	Moments, My			1	1
Femurs (L & R)	Forces, Fz		20kN	2	2
Knees (L & R)	Displacements, Dknee		19mm	2	2
Upper Tibia (L & R)	Forces, Fx Fz		12kN	4	4
	Moments, Mx My		400Nm	4	4
Lower Tibia 2 (L & R) ¹	Forces, Fx Fz (Fy)		12kN	4	4
	Moments, Mx My		400Nm	4	4
Total Channels per Dummy				39	39
Total Channels				78	

- Note that for both dummies the measurement of Fy is at the laboratory's discretion.

Q3 Dummy				
Location	Parameter		Minimum Amplitude	No of Channels
Head	Accelerations, Ax Ay Az		150g	3
Neck	Forces	Fx Fy	3kN	2
		Fz	6kN	1
	Moments, Mx My Mz		290Nm	3
Chest ²	Accelerations, Ax Ay Az		150g	3
	Deflection (frontal)		50mm	1
Total Channels per Dummy				13
Q1½ Dummy				
Location	Parameter		Minimum Amplitude	No of Channels
Head	Accelerations, Ax Ay Az		150g	3
Neck	Forces	Fx Fy	3kN	2
		Fz	6kN	1
	Moments, Mx My Mz		290Nm	3
Chest	Accelerations, Ax Ay Az		150g	3
	Deflection (frontal) ²		50mm	1
Total Channels per Dummy				13

2. Must be measured when dummy is restrained with an impact shield CRS, otherwise optional measurement.

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. The calibration procedure for the loadcells is detailed in Technical Bulletin 16.

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

4.3 Summary of Total Channels	
1X Driver Hybrid-III	39
1X Passenger Hybrid-III	39
1X Q3	13
1X Q1½	13
1X Vehicle	4
Total Channels per Test	
108	

5. PASSENGER COMPARTMENT ADJUSTMENTS			
Adjustment³	Required Setting	Notes	Methods
Seat Fore/Aft	Mid position as defined in Section 5.1	May be set to first notch rearwards of mid position if not lockable at mid position	See Section 5.1
Seat Base Tilt	Manufacturer's design position	Permissible up to Mid Position	See Section 5.1.11
Seat Height	Lowest position		
Seat Back Angle (as defined by torso angle)	Manufacturer's design position	Otherwise 25° to vertical as defined by Torso angle	See Section 6.1.1
Seat Lumbar Support	Manufacturer's design position	Otherwise fully retracted	See Section 5.1.12
Front Head Restraint Height & Tilt	Mid locking position	--	--
Steering wheel - vertical	Mid position		See Section 5.3
Steering wheel - horizontal	Mid position		See Section 5.2
Rear Seat Fore/Aft	Mid position	Vehicle manufacturer to supply details of seat position contained in handbook when no handbook is available at the time of test.	See Section 5.4.5
Rear Seat Back Angle	Manufacturer's design position	Otherwise, 25° to Vertical	See Section 5.1
Rear Seat Facing	Forwards		See Section 5.4.5
Rear Head Restraint Height & Tilt	As recommended in vehicle hand book.	Where no details are provided in the handbook, set to mid or next lowest position for height and mid locking position for tilt. Must not interfere with child/CRS installation.	--

Adjustment³	Required Setting	Notes	Methods
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering	
Arm-rests (Rear seats)	Stowed position		
Glazing	Front - Lowered Rear - Lowered or Removed	This applies to opening windows only	
Gear change lever	In the neutral position		
Pedals	Normal position of rest		
Doors	Closed, not locked		
Roof	Lowered	Where applicable	
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		
Seat belt anchorage (where adjustable)	Initially, manufacturer's 50th percentile design position	If no design position, then set to mid-position, or nearest notch upwards	

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

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

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

5.2 Setting the Steering Wheel Horizontal Adjustment

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

- 5.2.7 Move the steering wheel so that the mark on the steering column aligns with the fascia.
- 5.2.8 Lock the steering column at this position. The steering wheel is now in its mid-position of travel. The vehicle will be tested with the steering wheel in this position.
- 5.3 **Setting the Steering Wheel Vertical Adjustment**
- A method that is in principle the same as Section 5.2 should be used to determine and set the steering wheel vertical adjustment to the mid position. It is unlikely that the same part of the fascia used during the setting procedures for the horizontal adjustments could be used for the vertical adjustment. Care should be taken to avoid unintentional adjustment of the horizontal setting during the vertical adjustment procedure.
- 5.4 **Use of the Gabarit and Marking for Child Dummy Head Excursion**
- 5.4.1 A device known as a Gabarit (as defined in ECE Regulation 16) 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:
- a) the position of the buckle tongue stop on the adult seat belt to ensure compatibility with all types of child restraint.
 - b) the length of the adult seat belt webbing compared to the requirement of Universal restraints for those seats designated as suitable for such restraints.
 - c) and the position of the adult seat belt hardware relative to the belt contact zone specified for universal child restraints.
- 5.4.2 Position the Gabarit in all seating positions within the vehicle, excluding the driver's, as specified in ECE Regulation 16. Photographs of the installation, and in particular, the position of the lap section of the belt (both sides) and buckle tongue slot in relation to the 150mm radius shall be taken. The position of the base of the Gabarit relative to the front of the car seat base cushion should also be photographed for each seating position examined. The photograph should be taken from a point in a horizontal plane passing through the top of the car seat base cushion, to illustrate if there is an air gap between the gabarit base and car seat base cushion and any other indication of insufficient belt webbing.
- 5.4.3 The test laboratory shall specify in the test report whether the three point seat belts fitted to the vehicle are in accordance with ECE Regulation 16, Section 8.2.2.5.
- 5.4.4 This assessment will be done in accordance with ECE Regulation 16 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.
- 5.4.5 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 5.1. 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.

- 5.4.6 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.
- 5.4.7 With the Gabarit positioned as specified in ECE Regulation 16, the positions of the back and bottom planes of the device will be defined using the 3D Measuring arm, targets will be applied to the top and side surfaces of the Gabarit to help in this process. The intersection of these planes will define the Cr point for the seating position in question. The Cr point is needed to give a reference point for head excursion measurement on the dummy.
- 5.4.8 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 minimize 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.
- 5.4.9 The 550mm excursion line shall be clearly distinguished from the other markings in some way, for example using a different colour. This line shall also be marked on the vehicle in locations that are clearly visible to the onboard cameras. Alternatively, it is acceptable for the line across the vehicle to be superimposed during post film processing.

6.0 DUMMY POSITIONING AND MEASUREMENTS

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

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

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

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

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

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

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

6.1.1.3 Where both seats are adjustable, the manufacturer is asked to supply recommended settings. These should not differ from the nominal settings by more than a reasonable amount. In any of the above situations, the manufacturer may provide convincing information that the seat adjustments should be different from that specified here. If so the fully supported request to vary the set up should be made to the Designated Agency.

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

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

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

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

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

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

6.1.8 Apply lower leg and thigh weights.

6.1.9 Tilt the back pan forwards to the end stop and draw the machine away from the seat- back.

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

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

6.1.12 Return the machine back to the seat back.

- 6.1.13 Install the right and left buttock weights.
- 6.1.14 Apply the torso weights alternately left and right.
- 6.1.15 Tilt the machine back forwards to a vertical position and while holding the T-bar rock the pan by 5 degrees either side of the vertical. The feet are NOT to be restrained during the rocking. After rocking the T-bar should be parallel to the ground.
- 6.1.16 Reposition the feet by lifting the leg and then lowering the leg so that the heel contacts the floor and the sole lies on the undepressed accelerator pedal.
- 6.1.17 Holding the T-bar to prevent the H-Point machine from sliding forward on the seat cushion, return the machine back to the seat back.
- 6.1.18 Check the lateral spirit level and if necessary, apply a lateral force to the top of the machine back, sufficient to level the seat pan of the machine.
- 6.1.19 Adjust the seat back angle to the angle determined in 6.1.1, measured using the spirit level and torso angle gauge of the H-point machine. Ensure that the torso always remains in contact with the seat back. Ensure that the machine pan remains level at all times.
- 6.1.20 Measure and record in the test detail the position of the H-point relative to some easily identifiable part of the vehicle structure
- 6.2 **Determine the H-point of the Passenger's Seat**

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

For both right and left feet, place the feet flat on the floor.
- 6.3 **Dummy Installation**

It is the intention that the dummy should not be left to sit directly on the seat for more than 6 hours prior to the test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.
- 6.4 **Dummy Placement**

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

 - 6.4.1 Ensure that the seat is in the correct position as defined by Section 6.1.
 - 6.4.2 Place the dummy in the seat with the torso against the seat back, the upper arms against the seat back and the lower arms and hands against the outside of the upper leg.

6.5 **Dummy Positioning**

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

6.5.1 H-point

The dummy's H-point shall be within 13mm in the vertical dimension and 13mm in the horizontal dimension of a point 6mm below the H-point as determined in Section 6.1. Record the position of the dummy H-point in the test details.

6.5.2 Pelvic Angle

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

6.5.3 Head

The transverse instrumentation platform of the head shall be horizontal to within 2.5° . Levelling of the head shall be carried out in this order:

- Adjust the H-point within the limit (par. 6.5.1)
- Adjust the pelvic angle within the limits (par. 6.5.2)
- Adjust the neck bracket the minimum to ensure that the transverse instrumentation platform is level within limits.

Record the measured angle in the test details.

6.5.4 Arms

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

6.5.5 Hands

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

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

6.5.6 Torso

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

6.5.7 Legs

The upper legs of both dummies shall be in contact with the seat cushion as far as possible. The distance apart of the outside metal surfaces of the knees of each dummy shall be $270\text{mm} \pm 10\text{mm}$. When the left foot is placed on a footrest or the right foot is positioned onto the accelerator pedal as described in 6.5.8 below, the distance between the knees may be altered. The legs of the dummies should be in vertical longitudinal planes as far as is possible.

6.5.8 Feet

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

The passenger dummy's feet shall be placed with the heel as far forwards as possible and the feet as flat as possible. Both feet shall be parallel to the centre line of the vehicle.

6.5.9 Seat belt

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

6.5.9.2 Carefully place the seat belt across the dummy and lock as normal. It will be necessary to re-position the hands as described in Section 6.5.5.

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

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

6.5.9.5 After following the above steps, the seatbelt should lie in a natural position across the dummy sternum assembly and shoulder clavicle. Where this is not the case, for example the belt is close to or in contact with the neck shield or the belt is above the shoulder rotation adjustment screw, and the upper belt anchorage is adjustable the anchorage should be lowered and steps 6.5.9.3 and 6.5.9.4 repeated.

6.5.9.6 The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 6.5.9.3 and 6.5.9.4 repeated. This may require multiple attempts.

- 6.5.9.7 Once the belt is positioned the location of the belt should be marked across the dummy chest to ensure that no further adjustments are made. Mark also the belt at the level of the D-loop to be sure that the initial tension is maintained during test preparation.
- 6.5.9.8 Measure the vertical distance between the dummy nose and the diagonal webbing.
- 6.5.9.9 Measure the horizontal distance between the diagonal webbing and the door/window.
- 6.5.9.10 Where the fitment of the shoulder belt loadcell (Section 4.2.5) significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non-metallic wire or thread.
- 6.6 **Child Restraint System (CRS) Installation and Child Dummy Placement**
Two CRSs are to be fitted in the rear seat, one suitable for a 3-year-old child, the other for an 18-month-old infant. There must be sufficient space between the vehicle interior and CRS to allow for proper installation of the restraint without the need for excessive force. The restraint must not be prevented from sitting in its 'normal' orientation, for example the vehicle interior trim must not cause any obstruction. The dummies must also be allowed to rest in a 'normal' position.
- 6.6.1 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.
- 6.6.2 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.
- 6.6.3 Ensure that the seat and belt anchorage positions are as defined in section 6.5.9. 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).
- 6.6.4 For Integral Harness Systems
- 6.6.4.1 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.

- 6.6.4.2 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.
- 6.6.4.3 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.
- 6.6.5 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.
- 6.6.5.1 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.
- 6.6.5.2 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.
- 6.6.6 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.
- 6.6.6.1 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 6.6.5.
- 6.6.7 For Booster Seats in which the Adult Belt Restrains the Child and in which there is a Fixed Position Lock-Off.
- 6.6.7.1 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 6.6.4 and check the webbing spooled on the inertia reel of the adult belt as per section 6.6.5.2.

- 6.6.8 For Booster Seats in which the position of The Lock-Off/Shoulder Belt Guide is adjustable.
- 6.6.8.1 Optimize 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 6.6.7. 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.
- 6.6.9 For Child Restraints using an Impact Shield to Restrain the Child.
- 6.6.9.1 Where an impact shield is used, the dummy chest deflection must be measured.
- 6.6.9.2 Install the dummy with the spacer and position the shield. Put load cells on lap and diagonal sections of the seat belt. Establish a load of 50N +/-5N in both sections of the webbing 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 6.6.4.2 and 6.6.5.2. 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.
- 6.6.9.3 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 equalized throughout the lap belt. Leave the load cell in place if its removal would alter the set-up tension.
- 6.6.9.4 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.
- 6.6.9.5 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.
- 6.6.10 For “ISOFIX” type seats
Where a tensioning/ratchet device is provided to secure the child restraint against the rear seats and/or floor etc, a force not exceeding 100N shall be applied in the direction of the tensioning system’s movement. Where a top tether is present it should be attached to the anchorage, a maximum force of 50N ± 5N should be applied to the webbing from a position where the user would be expected to install the tether. The angle of pull on the webbing should be as indicated in the fitting instructions. Note: the 50N load is applied directly to the free end of the tether, and intentionally does not take account of the internal frictional characteristics of the adjuster.

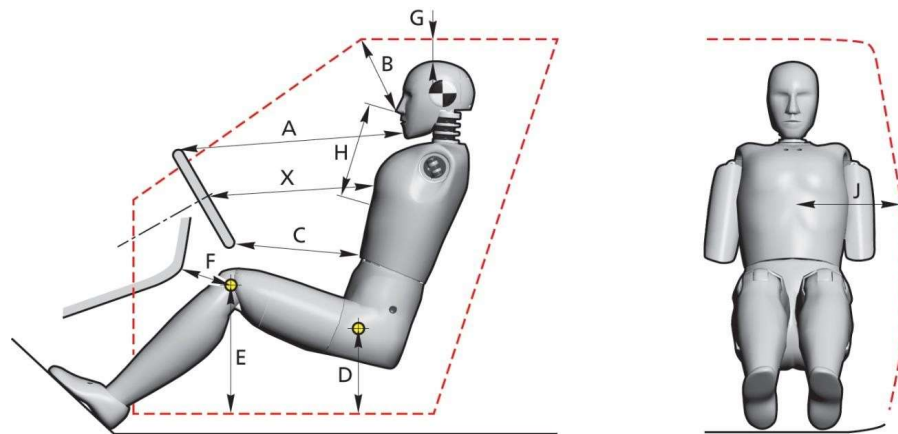
6.6.11 For reclining child restraint systems

To set the seat angle firstly check the seat itself and instruction manual for recommendations accompanying the seat. If no information is provided consult the manufacturer. If the manufacturer makes no recommendation, set to its mid position.

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

6.7 **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
H	Nose to webbing (vertically)	H	Nose to webbing (vertically)

Driver's Side		Passenger's Side	
J	Belt webbing to door (horizontally)	J	Belt webbing to door (horizontally)
θ	Neck Angle	Θ	Neck Angle
	H-Point Co-ordinates (to vehicle)		H-Point Co-ordinates (to vehicle)
α	Seat back angle (as defined by torso angle)	Θ	Seat back angle (as defined by torso angle)

7.0 TEST PARAMETERS

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

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

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

7.1 Deformable Barrier

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

7.2 Speed

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

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

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

7.3 Overlap

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

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

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

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

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

After Test

7.4 Door Opening Force

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

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

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

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

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

7.5 **Dummy Removal**

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

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

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

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

7.5.5 Record the method used to remove the dummies.

7.6 **Intrusion Measurements**

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

7.7 **Liquid Fuel Leakage Measurement**

7.7.1 Immediately after test, measure the leakage of liquid fuel if any at the intervals of 1-minute for atleast 05 minutes

7.7.2 If the liquid from the fuel-feed system mixes with liquids from the other systems and the various liquids cannot easily be separated and identified, all the liquids collected shall be taken into account in evaluating the continuous leakage

7.8 **EV High Voltage Protection Against electrical shock Measurements**

Following the test conducted, the electrical power train operating on high voltage and the high voltage components and systems which are galvanically connected to the high voltage bus of the electrical power train shall be verified for the Protection against electrical shock requirements specified in AIS-098,

**ANNEXURE II
SIDE IMPACT TEST PROTOCOL
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1.0 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 an ES-2 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 driver's 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 For two-seater vehicles only, the mass of child dummies and child seats shall not be included in the reference load. For vehicles with limited rear space, child seats and dummies shall be included in the reference load.
- 1.2.6 Roll the vehicle back and forth to 'settle' the tyres and suspension with the extra weight on board. Weigh the front and rear axle weights of the vehicle. These

loads are the “axle reference loads” and the total weight is the “reference mass” of the vehicle.

- 1.2.7 Record the axle reference loads and reference mass in the test details.
- 1.2.8 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.
- 1.2.9 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 the vehicle’s 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 an ES-2 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 driver’s 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 has 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 BHARAT NCAP 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 shaded box are considered acceptable to place BHARAT NCAP markings within.
- 1.5.2 Test house logos may be added to the vehicle if they do not detract attention from the BHARAT NCAP markings. Suitable locations for such markings would be the middle of the roof and on the bonnet at the base of the windscreen.

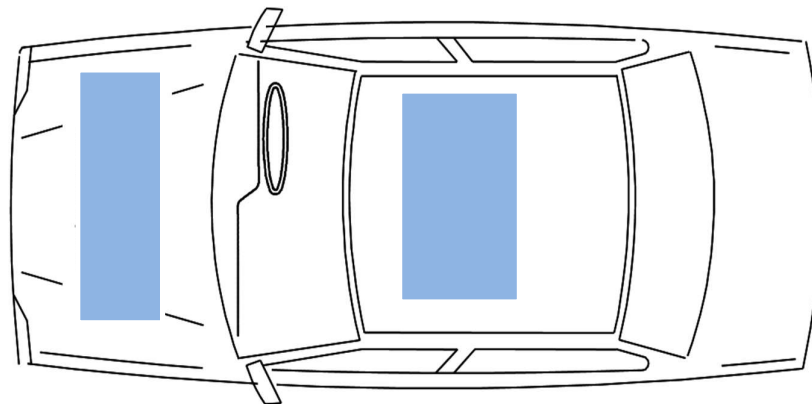


Figure 1.1

- 1.6 **Electrical power train adjustments for Electric Vehicles**
- 1.6.1 Test conditions provided in Annex.1 of AIS-099 shall be followed for testing of high voltage Electric Vehicles and assessment of post-crash electrical safety

2.0 DUMMY PREPARATION AND CERTIFICATION

2.1 General

- 2.1.1 An ES-2 test dummy shall be used in the front driver's position. It shall conform to the requirements given in AIS099 Annexure 3B
- 2.1.2 A Q1½ child dummy, in a suitable Child Restraint System (CRS) (see Section 6.4), shall be used in the rear driver side seating position.
- 2.1.3 A Q3 child dummy, in a suitable CRS (see Section 6.4), shall be used in the rear passenger side seating position.

2.2 Certification

Full details of the ES-2 certification requirements are available in the document mentioned in Section 2.1.1, TRANS-WP29-GRSP-2002-11e, and the procedures followed are set out in the ES2 User Manual. Details of the certification procedure for Q3 and Q1½ dummies are available in the user documentation. No manufacturer shall have access to any pre-test information regarding any of the test equipment to be used by BHARAT NCAP, or be permitted to influence its selection in any way.

- 2.2.1 The ES-2 dummy should be re-certified after every THREE impact tests.
- 2.2.2 The Q3 and Q1½ child dummies shall be re-certified after every TEN impact tests (e.g., 5 frontal and 5 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 ES-2 Dummy

- 2.3.1 The ES-2 dummy neck shall be fitted only with neck buffer 80 shore colour blue, part number: E2.BBC. The assembly must meet the certification procedure detailed below.

2.4 Dummy Clothing and Footwear

2.4.1 ES-2

- 2.4.1.1 The dummy will be clothed in an ES-2 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 wear their appropriate suits, Q3 part number 020-8000, Q1½ part number 048-8000.

- 2.5 **Dummy Test Condition**
- 2.5.1 Dummy Temperature
 - 2.5.1.1 The dummy shall have a stabilized 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 obtain a 1-2g holding force of the arm on its pivot.
 - 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.

ES-2	
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 ES-2 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:	
ES-2	
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.

3.0 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 ES-2 dummy to be used shall be instrumented to record the channels listed below.

ES-2			
Location	Parameter	Minimum Amplitude	No of channels
Head	Accelerations, Ax Ay Az	250g	3
Shoulder	Forces, Fx Fy Fz	8kN	3
Thorax T1	Accelerations, Ax Ay Az	200g	3
Thorax T12	Acceleration, Ay	200g	1
Ribs – Upper, Middle Lower	Acceleration, Ay	700g	3
	Deflection, Drib	90mm	3
Abdomen – Front, Middle Rear	Forces, Fy	5kN	3
Backplate	Forces, Fx Fy	5kN	4
	Moments, My Mz	200Nm	
T12	Forces, Fx Fy	5kN	4
	Moments, Mx My	300Nm	
Pelvis	Accelerations, Ax Ay Az	150g	3
Pubic Symphysis	Force, Fy	20kN	1
Femurs (L & R)	Forces, Fx Fy Fz	22kN	6
	Moments, Mx My Mz	350Nm	6
Total Channels per Dummy			43
1 x ES-2			43

Q3			
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

Q1.5			
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

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 degrees.

VEHICLE

Location	Parameter	Minimum Amplitude	No of channels
B-Post (unstruck)	Acceleration, 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

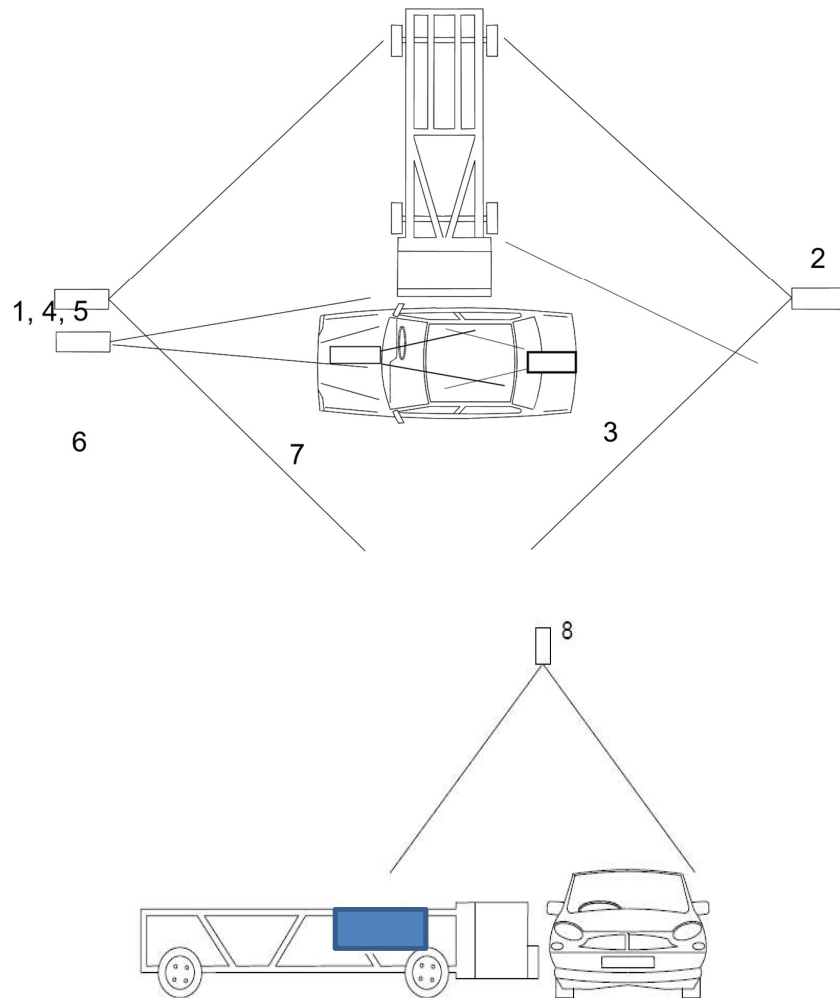
Location	Parameter	Minimum Amplitude	No of channels
Trolley C of G	Acceleration, A_y	150g	1
	Total Channels per Trolley		1

TOTAL CHANNELS

1x Driver ES-2	43
1x Q3	6
1x Q1½	6
1x Vehicle	1
1x Trolley	1
TOTAL	57

4.0 CAMERA LOCATIONS

Set up high speed film cameras according to the following diagrams



Camera No.	Camera Type	Shot Content
1	≥ 500 fps high speed	Front view of vehicle and trolley (wide)
2	≥ 500 fps high speed	Rear view of vehicle and trolley (wide)
3	≥ 500 fps high speed	Child head containment, onboard
4	≥ 500 fps stills camera	Front view of vehicle and trolley (wide)
5	≥ 500 fps stills camera	Backup for 4 (optional)
6	≥ 500 fps high speed	Front view of driver and impact point (tight)
7	≥ 500 fps high speed	Child head containment, onboard
8	≥ 500 fps high speed	Plan view of car and trolley (tight)

- 4.2 Lens sizes should be chosen appropriately in order to achieve the required shot content/intention. In order to prevent view distortion, a minimum lens size of 9mm is applicable. Please note for view number 7 the passenger side headrest should be removed if possible.
- 4.3 For forward facing CRS, cameras 3 and 7 shall face toward the rear of the vehicle to capture head containment. For rearward facing CRS, the camera should face toward the front of the vehicle to capture head containment. The positioning of onboard cameras will be dependent upon the body type and size of test vehicle.
- 4.4 When attaching onboard cameras, the vehicle manufacturer should be consulted to ensure that no damage is caused to the vehicle that would influence the impact performance or interfere with any airbags during deployment. Where additional equipment is added, the mass shall be offset when achieving the final test weight.

5.0 PASSENGER COMPARTMENT ADJUSTMENTS

Adjustment ¹	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	
Front Head Restraint Height & Tilt	Mid locking 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	Vehicle manufacturer to supply details of seat position contained in handbook when no handbook is available at the time of test	See Section 5.5.1
Rear Seat Back Angle	Manufacturer's design position	Otherwise, 25° to Vertical	See Section 6.1
Rear Seat Facing	Forward		See Section 5.5.1
Rear Head Restraint Height	As recommended in vehicle handbook.	Where no details are provided in the handbook, set to mid or next lowest position.	

		Must not interfere with CRS installation.	
Rear Head Restraint Tilt	Mid locking (where position adjustable)	--	--
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		
Roof	Raised	Where applicable	
Sun Visors	Stowed position		
Rear view mirror	Normal position of use		
Seat belt anchorage (where adjustable)	Initially, 50 th manufacturer's percentile design position	If no design position, then set to mid position, or nearest notch upwards	
¹ 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 manufacturer's 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.

5.4.5 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 lumbar 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**

- 5.4.1 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 **Setting the rear seat (if adjustable).**

- 5.5.1 If the vehicle rear seat position is adjustable put it in the same fore/aft position as that used in the frontal with the same seat back angle.

6.0 **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

		<i>When this is done?</i>
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 $75 \pm 10\text{kg}$ should sit on the seat for 1 minute twice to flex the cushions.
 - The seat shall have been at room temperature and not been loaded for at least 1 hour previous to any installation of the machine.
- 6.1.1 Set the seat back so that the torso of the dummy is as close as possible to the manufacturer's recommendations for normal use. In absence of such recommendations, an angle of 25 degrees towards the rear from vertical will be used.
- 6.1.1.1 The driver and passenger seatback angle and seat base shall be set to the same position.
- 6.1.1.2 Where one seat is height adjustable and the other is fixed, the relative angle between the seat back and the ground should be the same for both seats.
- 6.1.1.3 Where both seats are adjustable, the manufacturer is asked to supply recommended settings. These should not differ from the nominal settings by more than a reasonable amount. In any of the above situations, the manufacturer may provide convincing information that the seat adjustments should be different from that specified here. If so, the fully supported request to vary the set up should be made to the Designated Agency.
- 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 detail 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 ES-2 dummy in the front seat.

6.3.1 H-point

Note that the H-point of the ES-2 dummy is situated 21mm forward of that of the H-point determined by the H-point manikin (Section 6.1). The H-point of the manikin is indicated by 'Hm' on the H-point back plate of the dummy.

- 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 Manoeuvre the dummy until its "Hm" position is in a circle with a radius of 10 mm round the H-point of the H-point Manikin 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 ± 10 mm 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 ES-2 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.
- 6.3.5 Seat belt
 - 6.3.5.1 Where possible, initially position the upper seat belt anchorage in the manufacturer's 50th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the mid-position or nearest notch upward.
 - 6.3.5.2 Carefully place the seat belt across the dummy and lock as normal.
 - 6.3.5.3 Remove the slack from the lap section of the webbing until it is resting gently around the pelvis of the dummy. Only minimal force should be applied to the webbing when removing the slack. The route of the lap belt should be as natural as possible.
 - 6.3.5.4 Place one finger behind the diagonal section of the webbing at the height of the dummy sternum. Pull the webbing away from the chest horizontally forward and allow it to retract in the direction of the D-loop using only the force provided by the retractor mechanism. Repeat this step three times, only.
 - 6.3.5.5 After following the above steps, the seatbelt should lie in a natural position across the dummy sternum and shoulder clavicle. Where this is not the case, for example the belt is close to or in contact with the neck or the belt is above the shoulder rotation adjustment screw, and the upper belt anchorage is adjustable the anchorage should be lowered and steps 6.3.5.3 and 6.3.5.4 repeated.

- 6.3.5.6 The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 6.3.5.3 and 6.3.5.4 repeated. This may require multiple attempts.
- 6.3.5.7 Once the belt is positioned the location of the belt should be marked across the dummy chest to ensure that no further adjustments are made. Mark also the belt at the level of the D-loop to be sure that the initial tension is maintained during test preparation.
- 6.3.5.8 Measure the vertical distance between the dummy nose and the diagonal webbing.
- 6.3.5.9 Measure the horizontal distance between the diagonal webbing and the door/window.

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. There must be sufficient space between the vehicle interior and CRS to allow for proper installation of the restraint without the need for excessive force. The restraint must not be prevented from sitting in its 'normal' orientation, for example the vehicle interior trim must not cause any obstruction. The dummies must also be allowed to rest in a 'normal' position.

- 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 a load of 50N +/-5N in both sections of the webbing 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 equalized 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 BHARAT NCAP Designated Agency must be contacted for installation instructions. Where a tensioning/ratchet device is provided to secure the child restraint against the

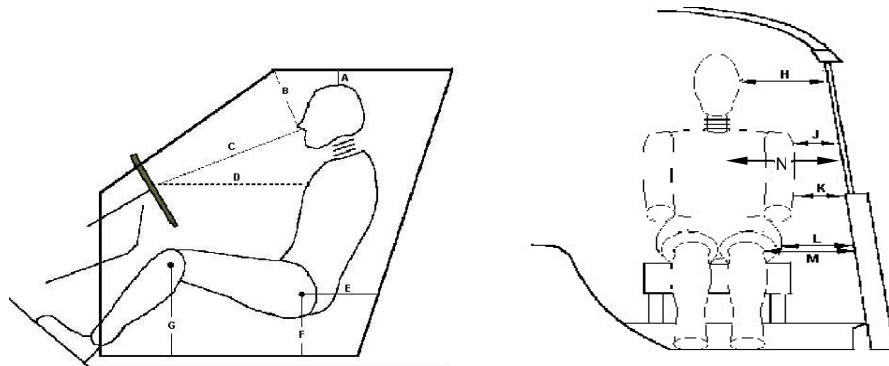
rear seats and/or floor etc, a force not exceeding 100N shall be applied in the direction of the tensioning system's movement. Where a top tether is present it should be attached to the anchorage, a maximum force of $50\text{N} \pm 5\text{N}$ should be applied to the webbing from a position where the user would be expected to install the tether. The angle of pull on the webbing should be as indicated in the fitting instructions. Note: the 50N load is applied directly to the free end of the tether, and intentionally does not take account of the internal frictional characteristics of the adjuster.

6.4.11 For reclining child restraint systems

To set the seat angle firstly check the seat itself and instruction manual for recommendations accompanying the seat. If no information is provided consult the manufacturer. If the manufacturer makes no recommendation set to its mid position.

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 measurements

A	Head/roof panel
B	Nose point/windscreen joint
C	Nose point/centre of the steering
D*	Thorax strap/centre of the steering wheel
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)
J	Shoulder/window pane (or padding)
K	Elbow/door (or padding)
L	Pelvis/door (or padding)
M	Knee/door (or padding)
N	Belt webbing to door (horizontally)
* Horizontal distance from steering wheel centre	

7.0 BARRIER AND TROLLEY

The trolley will be fitted with a deformable barrier face and ventilation frame conforming to the specifications given in Annex 2B of AIS099

7.1 Trolley Preparation

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

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 $300\text{mm} \pm 5\text{mm}$ 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 ± 20 kg.

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

$$x = \frac{W_{\text{rear}} \cdot \text{Wheelbase}}{(W_{\text{rear}} + W_{\text{front}})}$$

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 ± 10 mm 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 BHARAT NCAP 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 BHARAT NCAP markings.

8.0 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.

<u>No.</u>	<u>View</u>
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	*To show position of all door latches and/or open doors.
14	Driver & seat through open driver's door to show driver compartment and position of seat relative to the sill.
15	To show area immediately in front of driver.
16	To show child dummies and restraints through LHS rear door.
17	To show child dummies and restraints through RHS rear door.
18	*Car and barrier at rest at 45 degrees to front of car.
19	*Car and barrier at rest at 45 degrees to rear of car.
* Post-test only.	
After Dummy Removal	
20	*View through LHS front door of driver's door & paint marks from dummy ribs.
Note: The above photos are for a RHD car	

9.0 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 \pm 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 not within the tolerance square detailed below, film analysis will be used to try to assess the alignment. Both the horizontal and vertical alignments shall be noted in the test report.

TARGET ALIGNMENT = CENTRELINE OF BARRIER COINCIDENT WITH 'R'
POINT

LINE OF VEHICLE \pm 25mm

TARGET VERTICAL ALIGNMENT = \pm 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° 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 cannot be removed, try to slide the seat back on its runners.
- 9.5.4 If the dummy still cannot be removed, the seat can be cut out of the car.

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

9.6 Liquid Fuel Leakage Measurement

- 9.6.1 Immediately after test, measure the leakage of liquid fuel if any at the intervals of 1-minute for atleast 05 minutes
- 9.6.2 If the liquid from the fuel-feed system mixes with liquids from the other systems and the various liquids cannot easily be separated and identified, all the liquids collected shall be taken into account in evaluating the continuous leakage

9.7 EV High Voltage Protection Against electrical shock Measurements

Following the test conducted, the electrical power train operating on high voltage and the high voltage components and systems which are galvanically connected to the high voltage bus of the electrical power train shall be verified for the Protection against electrical shock requirements specified in AIS-099

Appendix 1

Impactor Specifications

1.0 IMPACTOR SPECIFICATIONS

Below is excerpt from document TRANS/WP.29/904, which is an amendment to Annex 5 of Regulation ECE R95. For further details refer to R95, note the section headings used are those used in R95.

2.0 CHARACTERISTICS OF THE IMPACTOR

The impactor consists of six single blocks of aluminium honeycomb, which have been processed in order to give a progressively increasing level of force with increasing deflection (see paragraph 2.1.). Front and rear aluminium plates are attached to the aluminium honeycomb blocks.

2.1 Honeycomb blocks

2.1.1 Geometrical characteristics

2.1.1.1 The impactor consists of 6 joined zones whose forms and positioning are shown in figures 1 and 2. The zones are defined as 500 ± 5 mm x 250 ± 3 mm in figures 1 and 2. The 500 mm should be in the W direction and the 250 mm in the L direction of the aluminium honeycomb construction (see figure 3).

2.1.1.2 The impactor is divided into 2 rows. The lower row shall be 250 ± 3 mm high, and 500 ± 2 mm deep after pre-crush (see paragraph 2.1.2.), and deeper than the upper row by 60 ± 2 mm.

2.1.1.3 The blocks must be centred on the six zones defined in figure 1 and each block (including incomplete cells) should cover completely the area defined for each zone).

2.1.2 Pre-crush

2.1.2.1 The pre-crush shall be performed on the surface of the honeycomb to which the front sheets are attached.

2.1.2.2 Blocks 1, 2 and 3 should be crushed by 10 ± 2 mm on the top surface prior to testing to give a depth of 500 ± 2 mm (figure 2).

2.1.2.3 Blocks 4, 5 and 6 should be crushed by 10 ± 2 mm on the top surface prior to testing to give a depth of 440 ± 2 mm.

2.1.3 Material characteristics

2.1.3.1 The cell dimensions shall be 19 mm \pm 10 per cent for each block (see figure 4).

2.1.3.2 The cells must be made of 3003 aluminium for the upper row.

2.1.3.3 The cells must be made of 5052 aluminium for the lower row.

- 2.1.3.4 The aluminium honeycomb blocks should be processed such that the force deflection-curve when statically crushed (according to the procedure defined in paragraph 2.1.4.) is within the corridors defined for each of the six blocks in appendix 1 to this annex. Moreover, the processed honeycomb material used in the honeycomb blocks to be used for constructing the barrier, should be cleaned in order to remove any residue that may have been produced during the processing of the raw honeycomb material.
- 2.1.3.5 The mass of the blocks in each batch shall not differ by more than 5 per cent of the mean block mass for that batch.
- 2.1.4 Static tests
 - 2.1.4.1 A sample taken from each batch of processed honeycomb core shall be tested according to the static test procedure described in paragraph 5.
 - 2.1.4.2 The force-compression for each block tested shall lie within the force deflection corridors defined in appendix 1. Static force deflection corridors are defined for each block of the barrier.
- 2.1.5 Dynamic test
 - 2.1.5.1 The dynamic deformation characteristics, when impacted according to the protocol described in paragraph 6.
 - 2.1.5.2 Deviation from the limits of the force-deflection corridors characterising the rigidity of the impactor - as defined in appendix 2- may be allowed provided that:
 - 2.1.5.2.1 the deviation occurs after the beginning of the impact and before the deformation of the impactor is equal to 150 mm;
 - 2.1.5.2.2 the deviation does not exceed 50 per cent of the nearest instantaneous prescribed limit of the corridor;
 - 2.1.5.2.3 each deflection corresponding to each deviation does not exceed 35 mm of deflection, and the sum of these deflections does not exceed 70 mm (see appendix 2 to this annex);
 - 2.1.5.2.4 the sum of energy derived from deviating outside the corridor does not exceed 5 per cent of the gross energy for that block.
 - 2.1.5.3 Blocks 1 and 3 are identical. Their rigidity is such that their force deflection curves fall between corridors of figure 2a.
 - 2.1.5.4 Blocks 5 and 6 are identical. Their rigidity is such that their force deflection curves fall between corridors of figure 2d.
 - 2.1.5.5 The rigidity of block 2 is such that its force deflection curves fall between corridors of figure 2b.
 - 2.1.5.6 The rigidity of block 4 is such that its force deflection curves fall between corridors of figure 2c.
 - 2.1.5.7 The force-deflection of the impactor shall fall between corridors of figure 2e.

- 2.1.5.8 The force-deflection curves shall be verified by a test detailed in annex 5, paragraph 6., consisting of an impact of the barrier against a dynamometric wall at 35 ± 0.5 km/h.
- 2.1.5.9 The dissipated energy ^{1/} against blocks 1 and 3 during the test shall be equal to 9.5 ± 2 kJ for these blocks.
- 2.1.5.10 The dissipated energy against blocks 5 and 6 during the test shall be equal to 3.5 ± 1 kJ for these blocks.
- 2.1.5.11 The dissipated energy against block 4 shall be equal to 4 ± 1 kJ.
- 2.1.5.12 The dissipated energy against block 2 shall be equal to 15 ± 2 kJ.
- 2.1.5.13 The dissipated total energy during the impact shall be equal to 45 ± 3 kJ.
- 2.1.5.14 The maximum impactor deformation from the point of first contact, calculated from integration of the accelerometers according to paragraph 6.6.3., shall be equal to 330 ± 20 mm.
- 2.1.5.15 The final residual static impactor deformation measured after the dynamic test at level B (figure 2) shall be equal to 310 ± 20 mm.

2.2 Front plates

2.2.1 Geometrical characteristics

- 2.2.1.1 The front plates are 1500 ± 1 mm wide and 250 ± 1 mm high. The thickness is 0.5 ± 0.06 mm.
- 2.2.1.2 When assembled the overall dimensions of the impactor (defined in figure 2) shall be: 1500 ± 2.5 mm wide and 500 ± 2.5 mm high.
- 2.2.1.3 The upper edge of the lower front plate and the lower edge of the upper front plate should be aligned within 4 mm.

2.2.2 Material characteristics

- 2.2.2.1 The front plates are manufactured from aluminium of series AlMg₂ to AlMg₃ with elongation ≥ 12 per cent, and a UTS ≥ 175 N/mm².

2.3 Back plate

2.3.1 Geometric characteristics

- 2.3.1.1 The geometric characteristics shall be according to figures 5 and 6.

2.3.2 Material characteristics

- 2.3.2.1 The back plate shall consist of a 3 mm aluminium sheet. The back plate shall be manufactured from aluminium of series AlMg₂ to AlMg₃ with a hardness between

^{1/} The amounts of energy indicated are the amounts of energy dissipated by the system when the extent to which the impactor is crushed is greatest.

50 and 65 HBS. This plate shall be perforated with holes for ventilation: the location, the diameter and pitch are shown in figures 5 and 7.

2.4 **Location of the honeycomb blocks**

2.4.1 The honeycomb blocks shall be centred on the perforated zone of the back plate (figure 5).

2.5 **Bonding**

2.5.1 For both the front and the back plates, a maximum of 0.5 kg/m² shall be applied evenly directly over the surface of the front plate, giving a maximum film thickness of 0.5 mm. The adhesive to be used throughout should be a two-part polyurethane {such as Ciba Geigy XB5090/1 resin with XB5304 hardener} or equivalent.

2.5.2 For the back plate the minimum bonding strength shall be 0.6 MPa, (87 psi), tested according to paragraph 2.5.3.

2.5.3 Bonding strength tests:

2.5.3.1.1. Flatwise tensile testing is used to measure bond strength of adhesives according to ASTM C297-61.

2.5.3.2. The test piece should be 100 mm x 100 mm, and 15 mm deep, bonded to a sample of the ventilated back plate material. The honeycomb used should be representative of that in the impactor, i.e., chemically etched to an equivalent degree as that near to the back plate in the barrier but without pre-crushing.

2.6 **Traceability**

2.6.1 Impactors shall carry consecutive serial numbers which are stamped, etched, or otherwise permanently attached, from which the batches for the individual blocks and the date of manufacture can be established.

2.7 Impactor attachment

- 2.7.1 The fitting on the trolley must be according to figure 8. The fitting will use six M8 bolts, and nothing shall be larger than the dimensions of the barrier in front of the wheels of the trolley. Appropriate spacers must be used between the lower back plate flange and the trolley face to avoid bowing of the back plate when the attachment bolts are tightened.

3.0 VENTILATION SYSTEM

- 3.1 The interface between the trolley and the ventilation system should be solid, rigid and flat. The ventilation device is part of the trolley and not of the impactor as supplied by the manufacturer. Geometrical characteristics of the ventilation device shall be according to figure 9.
- 3.2 Ventilation device mounting procedure.
- 3.2.1 Mount the ventilation device to the front plate of the trolley;
- 3.2.2 Ensure that a 0.5 mm thick gauge cannot be inserted between the ventilation device and the trolley face at any point. If there is a gap greater than 0.5 mm, the ventilation frame will need to be replaced or adjusted to fit without a gap of > 0.5 mm.
- 3.2.3 Dismount the ventilation device from the front of the trolley;
- 3.2.4 Fix a 1.0 mm thick layer of cork to the front face of the trolley;
- 3.2.5 Re-mount the ventilation device to the front of the trolley and tighten to exclude air gaps.

4.0 CONFORMITY OF PRODUCTION

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2), with the following requirements:

- 4.1 The manufacturer shall be responsible for the conformity of production procedures and for that purpose must in particular:
- 4.1.1 Ensure the existence of effective procedures so that the quality of the products can be inspected,
- 4.1.2 Have access to the testing equipment needed to inspect the conformity of each product,
- 4.1.3 Ensure that the test results are recorded and that the documents remain available for a time period of 10 years after the tests,
- 4.1.4 Demonstrate that the samples tested are a reliable measure of the performance of the batch (examples of sampling methods according to batch production are given below).
- 4.1.5 Analyse results of tests in order to verify and ensure the stability of the barrier characteristics, making allowance for variations of an industrial production, such as temperature, raw materials quality, time of immersion in chemical, chemical concentration, neutralisation etc, and the control of the processed material in order to remove any residue from the processing,

- 4.1.6 Ensure that any set of samples or test pieces giving evidence of non-conformity gives rise to a further sampling and test. All the necessary steps must be taken to restore conformity of the corresponding production.
- 4.2 The manufacturer's level of certification must be at least ISO 9002 standard.
- 4.3 Minimum conditions for the control of production: the holder of an agreement will ensure the control of conformity following the methods hereunder described.
- 4.4 Examples of sampling according to batch
- 4.4.1 If several examples of one block type are constructed from one original block of aluminium honeycomb and are all treated in the same treatment bath (parallel production), one of these examples could be chosen as the sample, provided care is taken to ensure that the treatment is evenly applied to all blocks. If not, it may be necessary to select more than one sample.
- 4.2.2 If a limited number of similar blocks (say three to twenty) are treated in the same bath (serial production), then the first and last block treated in a batch, all of which are constructed from the same original block of aluminium honeycomb, should be taken as representative samples. If the first sample complies with the requirements but the last does not, it may be necessary to take further samples from earlier in the production until a sample that does comply is found. Only the blocks between these samples should be considered to be approved.
- 4.2.3 Once experience is gained with the consistency of production control, it may be possible to combine both sampling approaches, so that more than one groups of parallel production can be considered to be a batch provided samples from the first and last production groups comply.

5.0 STATIC TESTS

- 5.1 One or more samples (according to the batch method) taken from each batch of processed honeycomb core shall be tested, according to the following test procedure:
- 5.2 The sample size of the aluminium honeycomb for static tests shall be the size of a normal block of the impactor, that is to say 250 mm x 500 mm x 440 mm for top row and 250 mm x 500 mm x 500 mm for the bottom row.
- 5.3 The samples should be compressed between two parallel loading plates which are at least 20 mm larger than the block cross section.
- 5.4 The compression speed shall be 100 millimetres per minute, with a tolerance of 5 per cent.
- 5.5 The data acquisition for static compression shall be sampled at a minimum of 5 Hz.
- 5.6 The static test shall be continued until the block compression is at least 300 mm for blocks 4 to 6 and 350 mm for blocks 1 to 3.

6.0 DYNAMIC TESTS

For every 100 barrier faces produced, the manufacturer shall make one dynamic test against a dynamometric wall supported by a fixed rigid barrier, according to the method described below.

6.1 Installation

6.1.1 Testing ground

6.1.1.1 The test area shall be large enough to accommodate the run-up-track of the mobile deformable barrier, the rigid barrier and the technical equipment necessary for the test. The last part of the track, for at least 5 metres before the rigid barrier, shall be horizontal, flat and smooth.

6.1.2 Fixed rigid barrier and dynamometric wall

6.1.2.1 The rigid wall shall consist of a block of reinforced concrete not less than 3 metres wide and not less than 1.5 metres high. The thickness of the rigid wall shall be such that it weighs at least 70 tonnes.

6.1.2.2 The front face shall be vertical, perpendicular to the axis of the run-up-track and equipped with six load cell plates, each capable of measuring the total load on the appropriate block of the mobile deformable barrier impactor at the moment of impact. The load cell impact plate area centres shall align with those of the six impact zones of the mobile deformable barrier face. Their edges shall clear adjacent areas by 20 mm such that, within the tolerance of impact alignment of the MDB, the impact zones will not contact the adjacent impact plate areas. Cell mounting and plate surfaces shall be in accordance with the requirements set out in the annex to standard ISO 6487:1987.

6.1.2.3 Surface protection, comprising a plywood face (thickness: 12 ± 1 mm), is added to each load cell plate such that it shall not degrade the transducer responses.

6.1.2.4 The rigid wall shall be either anchored in the ground or placed on the ground with, if necessary, additional arresting devices to limit its deflection. A rigid wall (to which the load cells are attached) having different characteristics but giving results that are at least equally conclusive may be used.

6.2 Propulsion of the mobile deformable barrier

At the moment of impact the mobile deformable barrier shall no longer be subject to the action of any additional steering or propelling device. It shall reach the obstacle on a course perpendicular to the front surface of the dynamometric wall. Impact alignment shall be accurate to within 10 mm.

6.3 Measuring instruments

6.3.1 Speed

The impact speed shall be 35 ± 0.5 km/h the instrument used to record the speed on impact shall be accurate to within 0.1 percent.

6.3.2 Loads

Measuring instruments shall meet the specifications set forth in ISO 6487:1987	
CFC for all blocks:	60 Hz
CAC for blocks 1 and 3:	200 kN
CAC for blocks 4,5 and 6:	100 kN
CAC for block 2:	200 kN

6.3.3 Acceleration

6.3.3.1 The acceleration in the longitudinal direction shall be measured at three separate positions on the trolley, one centrally and one at each side, at places not subject to bending.

6.3.3.2 The central accelerometer shall be located within 500 mm of the location of the centre of gravity of the MDB and shall lie in a vertical longitudinal plane which is within ± 10 mm of the centre of gravity of the MDB.

6.3.3.3 The side accelerometers shall be at the same height as each other ± 10 mm and at the same distance from the front surface of the MDB ± 20 mm

6.3.3.4 The instrumentation shall comply with ISO 6487:1987 with the following specifications:

CFC 1,000 Hz (before integration)

CAC 50 g

6.4 **General specifications of barrier**

6.4.1 The individual characteristics of each barrier shall comply with paragraph 1. of this annex and shall be recorded.

6.5 **General specifications of the impactor**

6.5.1 The suitability of an impactor as regards the dynamic test requirements shall be confirmed when the outputs from the six load cell plates each produce signals complying with the requirements indicated in this annex.

6.5.2 Impactors shall carry consecutive serial numbers which are stamped, etched or otherwise permanently attached, from which the batches for the individual blocks and the date of manufacture can be established.

6.6 **Data processing procedure**

6.6.1 Raw data: At time $T = T_0$, all offsets should be removed from the data. The method by which offsets are removed shall be recorded in the test report.

6.6.2 Filtering

6.6.2.1 The raw data will be filtered prior to processing/calculations.

6.6.2.2 Accelerometer data for integration will be filtered to CFC 180, ISO 6487:1987.

6.6.2.3 Accelerometer data for impulse calculations will be filtered to CFC 60, ISO 6487:1987.

6.6.2.4 Load cell data will be filtered to CFC 60, ISO 6487:1987.

6.6.3 Calculation of MDB face deflection

6.6.3.1 Accelerometer data from all three accelerometers individually (after filtering at CFC 180), will be integrated twice to obtain deflection of the barrier deformable element.

6.6.3.2 The initial conditions for deflection are:

6.6.3.2.1 velocity = impact velocity (from speed measuring device).

6.6.3.2.2 deflection = 0

- 6.6.3.3 The deflection at the left hand side, mid-line and right hand side of the mobile deformable barrier will be plotted with respect to time.
- 6.6.3.4 The maximum deflection calculated from each of the three accelerometers should be within 10 mm. If it is not the case, then the outlier should be removed and difference between the deflection calculated from the remaining two accelerometers checked to ensure that it is within 10 mm.
- 6.6.3.5 If the deflections as measured by the left hand side, right hand side and mid-line accelerometers are within 10 mm, then the mean acceleration of the three accelerometers should be used to calculate the deflection of the barrier face.
- 6.6.3.6 If the deflection from only two accelerometers meets the 10 mm requirement, then the mean acceleration from these two accelerometers should be used to calculate the deflection for the barrier face.
- 6.6.3.7 If the deflections calculated from all three accelerometers (left hand side, right hand side and mid-line) are NOT within the 10 mm requirement, then the raw data should be reviewed to determine the causes of such large variation. In this case the individual test house will determine which accelerometer data should be used to determine mobile deformable barrier deflection or whether none of the accelerometer readings can be used, in which case, the certification test must be repeated. A full explanation should be given in the test report.
- 6.6.3.8 The mean deflection-time data will be combined with the load cell wall force-time data to generate the force-deflection result for each block.

6.6.4 Calculation of energy

The absorbed energy for each block and for the whole MDB face should be calculated up to the point of peak deflection of the barrier.

$$E_n = \int_{t_0}^{t_1} F_n \cdot ds_{mean}$$

Where

t ₀	is the time of first contact
t ₁	is the time where the trolley comes to rest, i.e., where u = 0.
s	is the deflection of the trolley deformable element calculated according to paragraph 6.6.3

- 6.6.5 Verification of dynamic force data
 - 6.6.5.1 Compare the total impulse, I, calculated from the integration of the total force over the period of contact, with the momentum change over that period (M)*V).
 - 6.6.5.2 Compare the total energy change to the change in kinetic energy of the MDB, given by:

$$E_K = \frac{1}{2} MV_i^2$$

where V_i is the impact velocity and M the whole mass of the MDB
 If the momentum change (M*)V) is not equal to the total (impulse (I) ± 5 percent, or if the total energy absorbed (E_n) is not equal to the kinetic energy, E_K ± 5 per cent, then the test data must be examined to determine the cause of this error.

DESIGN OF IMPACTOR 2

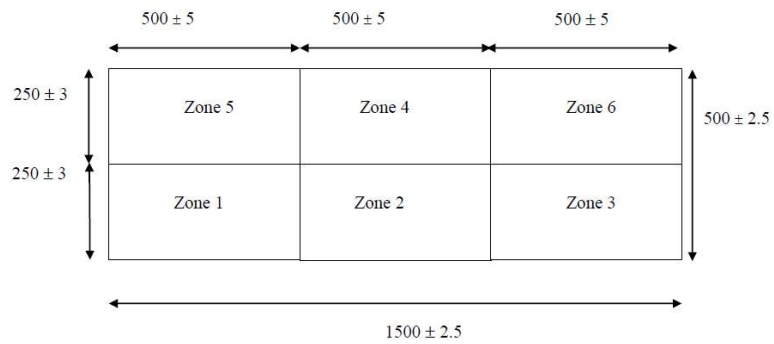


Figure 1

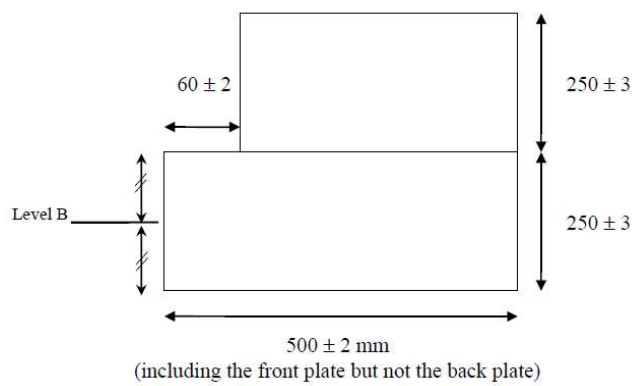
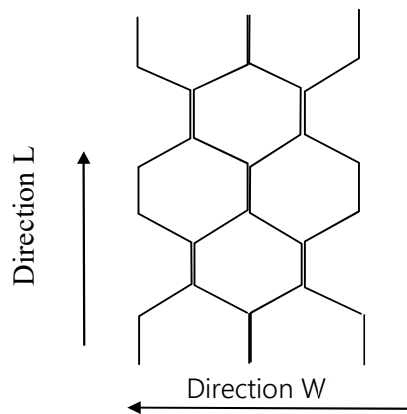


Figure 2

⚠ All dimensions are in mm. The tolerances on the dimensions of the blocks allow for the difficulties of measuring cut aluminium honeycomb. The tolerance on the overall dimension of the impactor is less than that for the individual blocks since the honeycomb blocks can be adjusted, with overlap if necessary, to maintain a more closely defined impact face dimension.

Impactor Top



Expansion direction of the Aluminium honeycomb

Figure 3

Aluminium Honeycomb Orientation

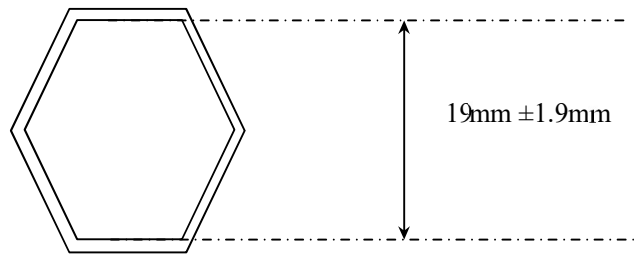


Figure 4
Dimension of Aluminium Honeycomb Cells

DESIGN OF THE BACK PLATE

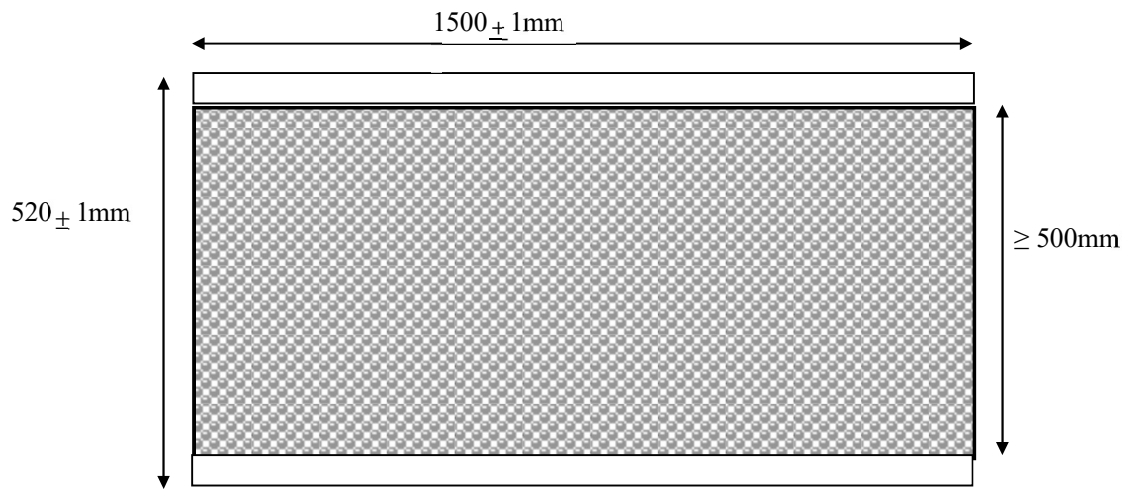


Figure 5
Front View

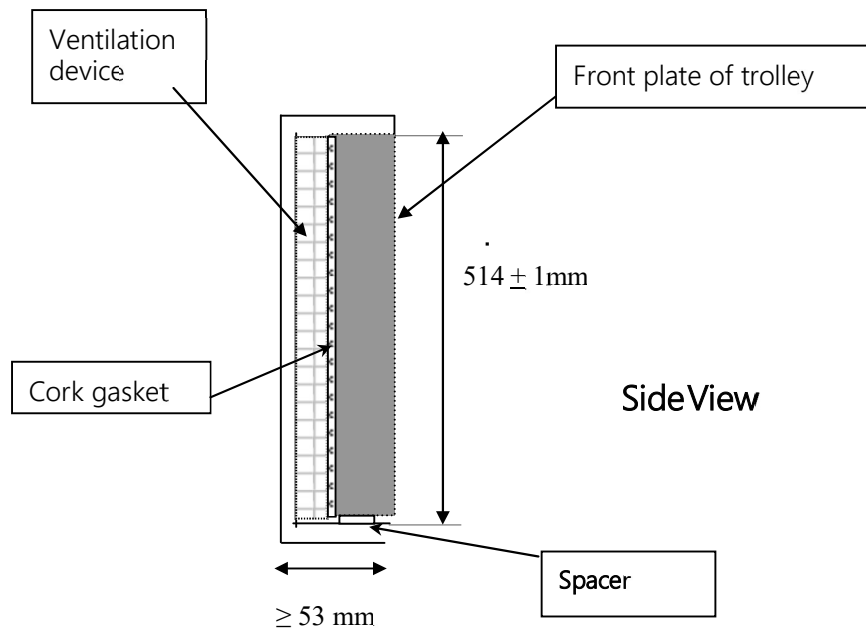


Figure 6
Attachment of backplate to ventilation device and trolley face plate

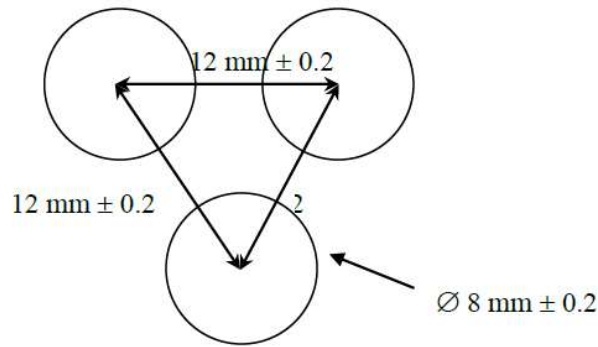
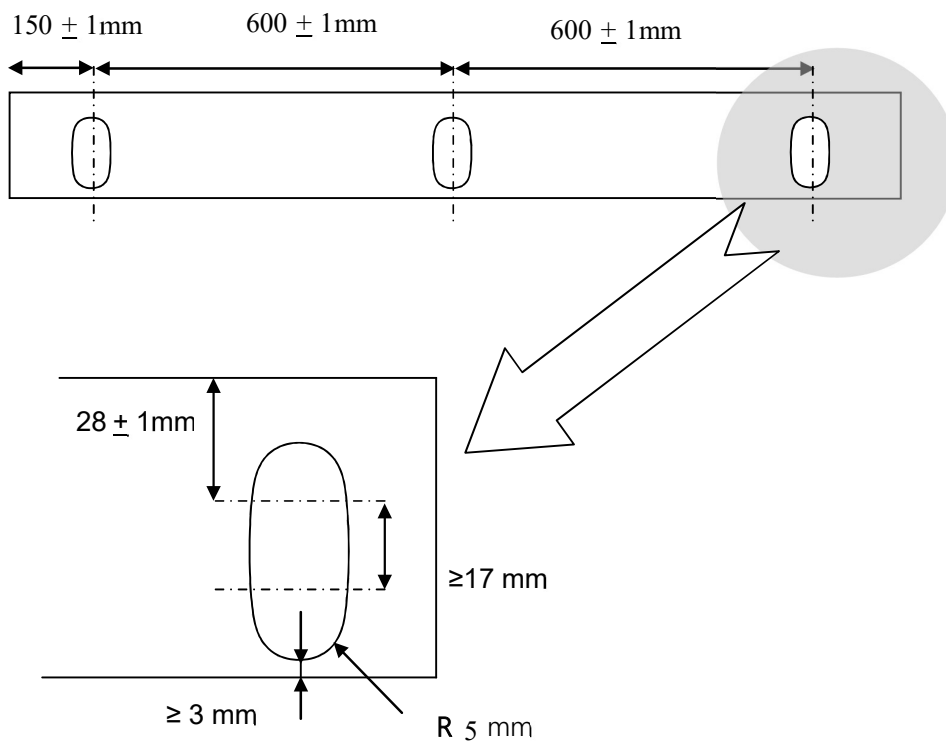


Figure 7

Staggered pitch for the back plate ventilation holes



Top and bottom back plate flanges

Note: The attachment holes in the bottom flange may be opened to slots, as shown below, for ease of attachment provided sufficient grip can be developed to avoid detachment during the whole impact test.

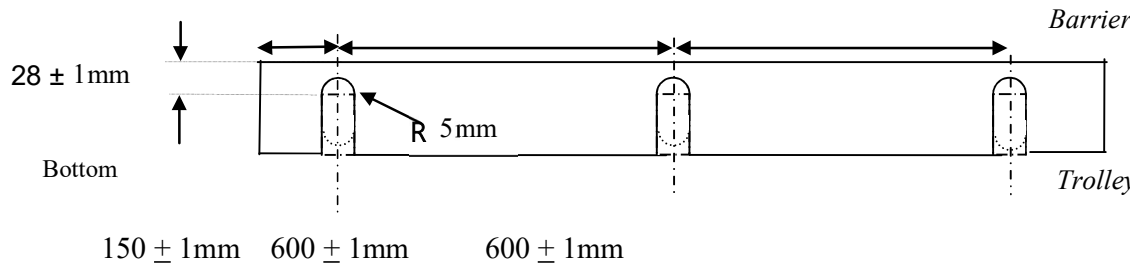
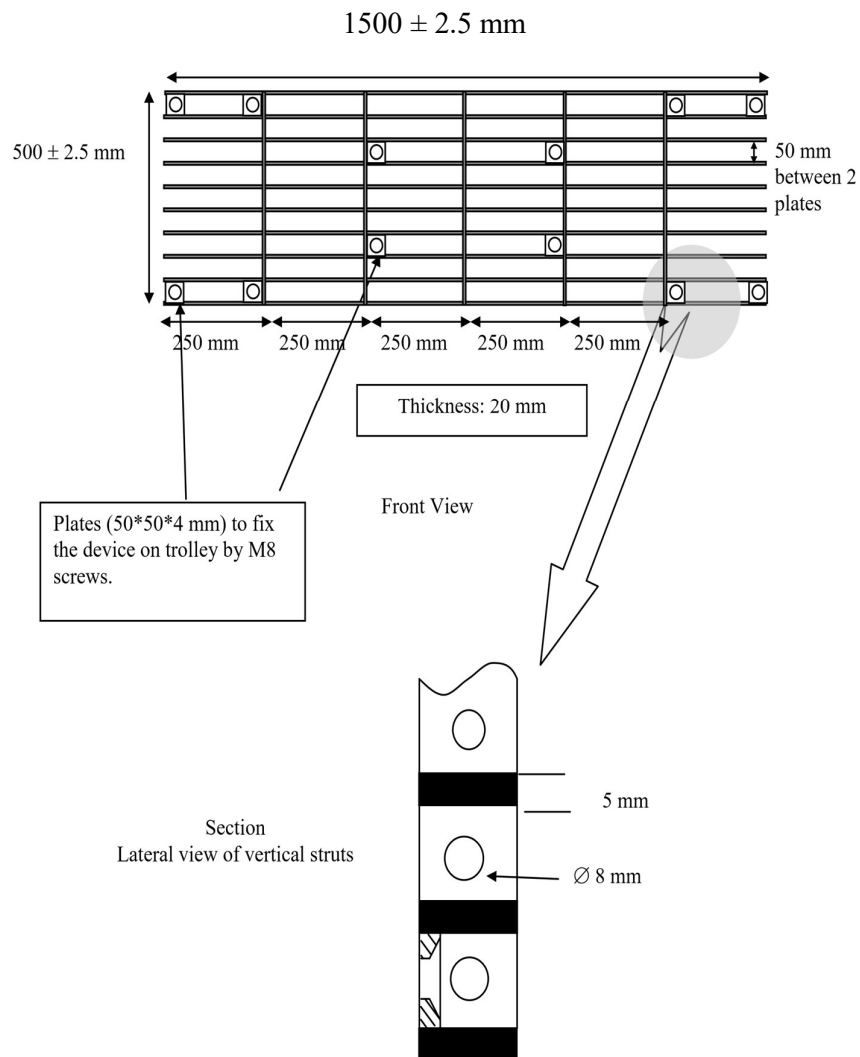


Figure 8

VENTILATION FRAME

The ventilation device is a structure made of a plate that is 5 mm thick and 20 mm wide. Only the vertical plates are perforated with nine 8 mm holes in order to let air circulate horizontally.



**Figure 9
Side View**

Appendix 2
FORCE-DEFLECTION CURVES FOR STATIC TESTS

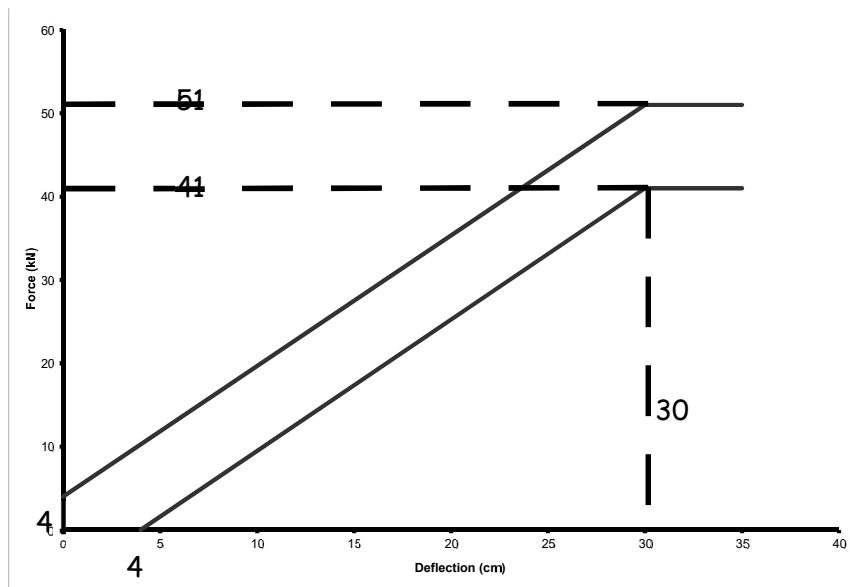


Figure 1a
Blocks 1 & 3

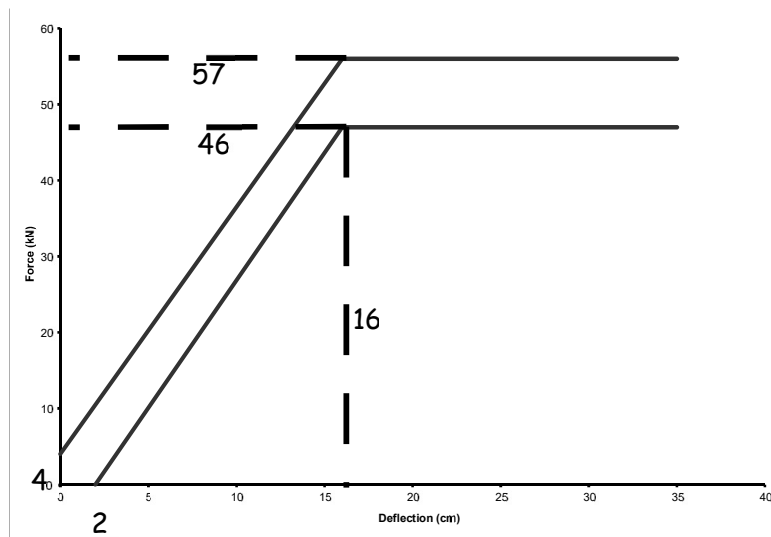


Figure 1b
Block 2

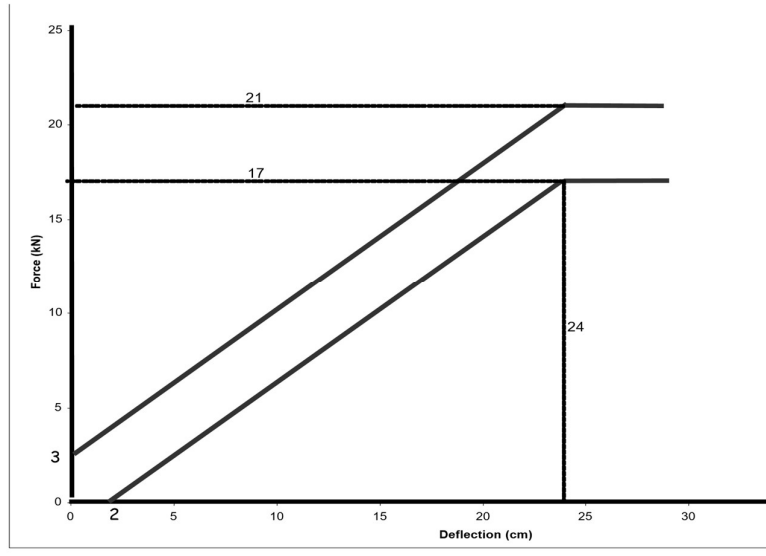


Figure 1c
Block 4

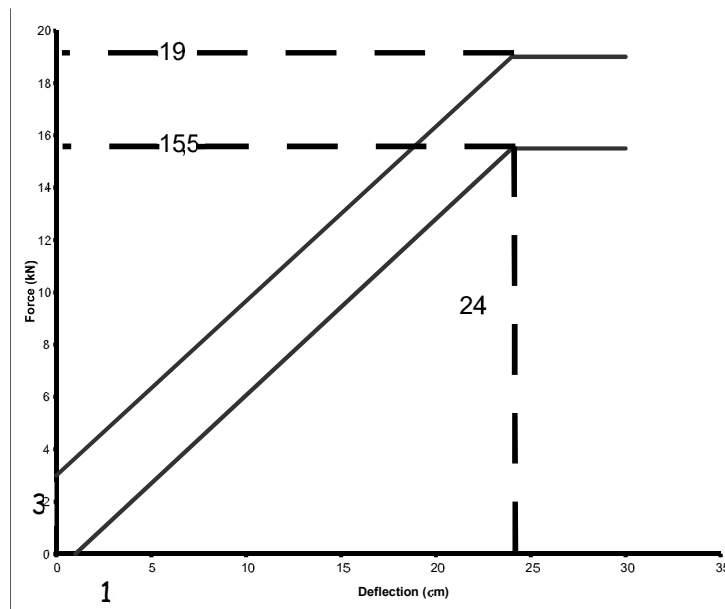


Figure 1d
Blocks 5 & 6

FORCE-DEFLECTION CURVES FOR DYNAMIC TESTS

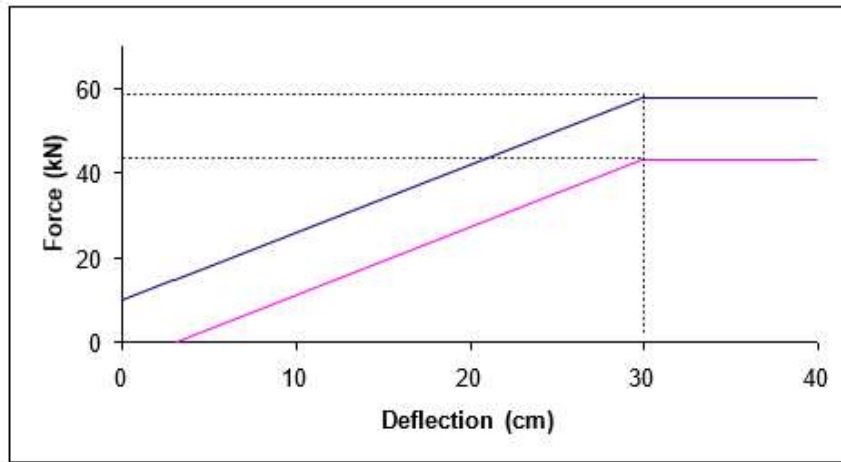


Figure 2a Blocks 1 & 3

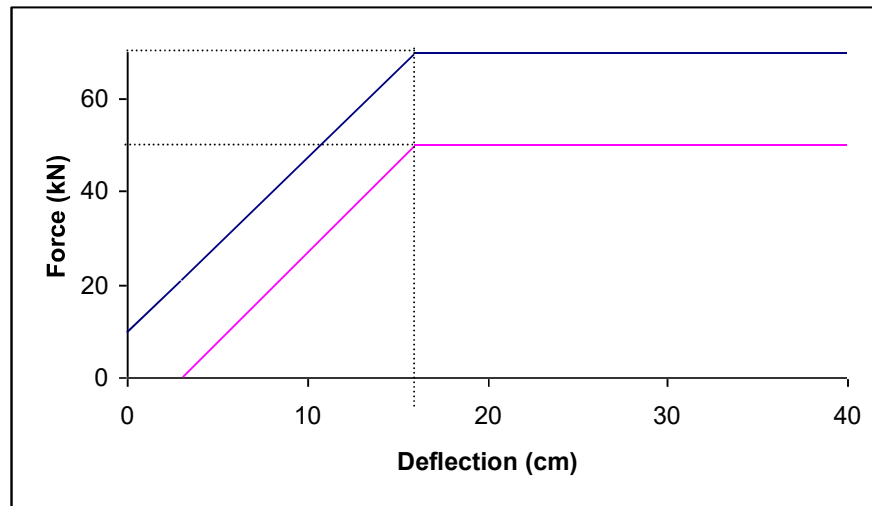


Figure 2b Block 2

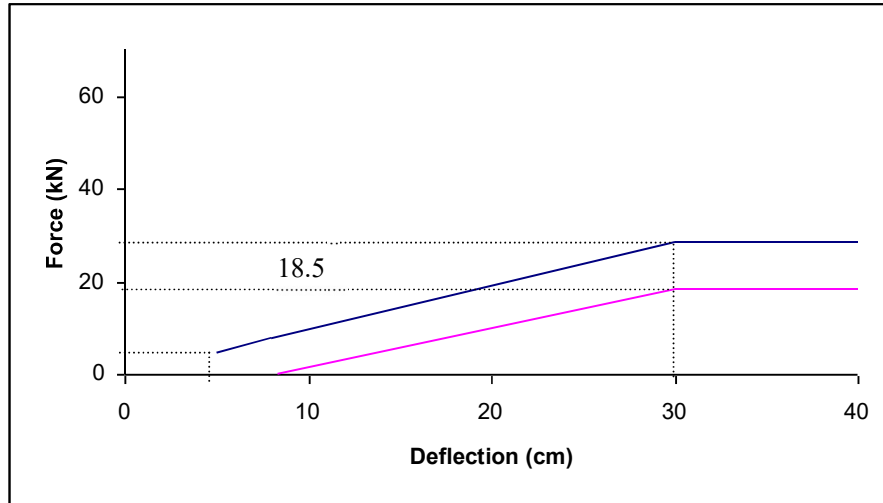


Figure 2c Block 4

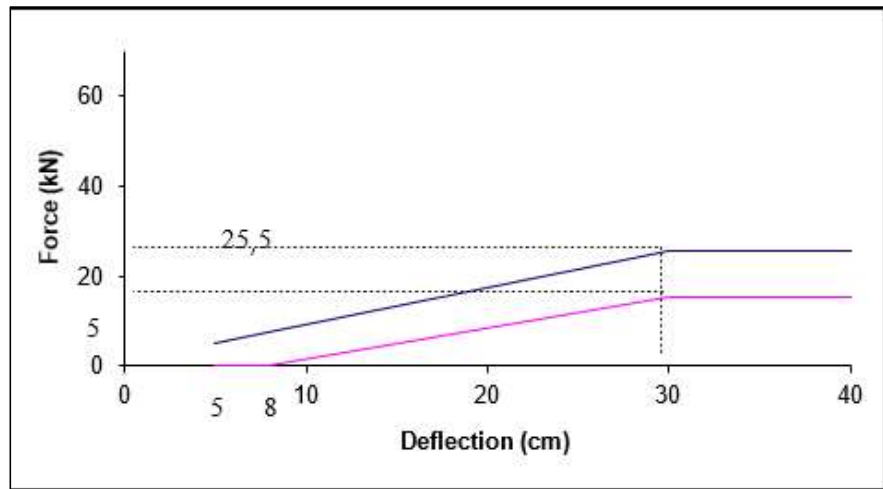


Figure 2d Block 5 & 6

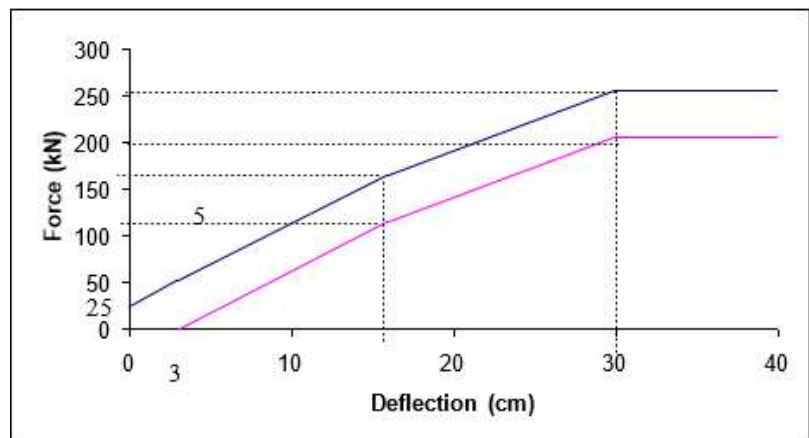


Figure 2e Block Total

ANNEXURE III
POLE SIDE IMPACT TEST PROTOCOL
CONTENTS

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5.	PASSENGER COMPARTMENT ADJUSTMENTS	102
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1.0 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 an ES-2 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 cannot 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 coordinates 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 affect the crash performance of the vehicle.

- 1.5.2 Ensure that the vehicle's 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 an ES-2 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 has 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 BHARAT NCAP 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 BHARAT NCAP markings. Suitable locations for such markings would be the middle of the roof and on the bonnet at the base of the windscreen.
- 1.7 **Electrical power train adjustments for Electric Vehicles**
- 1.7.1 Test conditions provided in UNECE R135 shall be followed for testing of high voltage Electric Vehicles and assessment of post-crash electrical safety
- 2.0 DUMMY PREPARATION AND CERTIFICATION**
- 2.1 **General**
- 2.1.1 An ES-2 test dummy shall be used in the front driver's position. It shall conform to the requirements given Annexure 3B of AIS-099.
- 2.2 **Certification**
- Full details of the ES-2 certification requirements are available in the document mentioned in Section 2.1.1, TRANS-WP29-GRSP-2002-11e, and the procedures followed are set out in the ES-2 User Manual. No manufacturer shall have access to any pre-test information regarding any of the test equipment to be used by BHARAT NCAP, or be permitted to influence its selection in any way.
- 2.2.1 The ES-2 dummy should be re-certified after every THREE pole side impact tests.
- 2.2.2 If an injury criterion reaches or exceeds its normally accepted limit (e.g., HIC of 1000) then that part should be re-certified.
- 2.2.3 If any part of the dummy is broken in a test, then the part shall be replaced with a fully certified component.
- 2.2.4 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 ES-2 Dummy**
- 2.3.1 The ES-2 dummy neck shall be fitted only with neck buffer 80 shore colour blue, part number: E2.BBC. The assembly must meet the certification procedure detailed below.
- 2.4 **Dummy Clothing and Footwear**
- 2.4.1 The dummy will be clothed in an ES-2 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 stabilized temperature in the range of 18°C to 26°C.
- 2.5.1.2 A stabilized 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 Stabilize 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 obtain a 1-2G holding force of the arm on its pivot.
- 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°C 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.

ES-2		
Head	Red	<i>100mm square, centreline of head with lower edge at C of G. Only paint outer edge of tape.</i>
Shoulder/Arm	Blue	<i>25mm x 150mm, starting at bottom edge of shoulder fixing hole</i>
Top Rib	Red	<i>150mm strip, starting at accessible point at seat back the rearmost</i>
Mid Rib	Yellow	<i>150mm strip, starting at accessible point at seat back the rearmost</i>
Bottom Rib	Green	<i>150mm strip, starting at the rearmost accessible point at seat back</i>
Abdomen	Red	<i>50mm square</i>
Pelvis	Orange	<i>50mm x 100mm, centered on hip joint point.</i>
<i>NOTE: The tape should be completely covered with the coloured paints specified.</i>		

2.7 Post Test Dummy Inspection

- 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.
- 2.7.1

3.0 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 ES-2 dummy to be used shall be instrumented to record the channels listed below.

Location	Parameter	Minimum Amplitude	No. of channels
Head	Accelerations, Ax Ay Az	250g	3
Shoulder	Forces, Fx Fy Fz	8kN	3
Thorax T1	Accelerations, Ax Ay Az	200g	3
Thorax T12	Acceleration, Ay	200g	1
Ribs - Upper Middle Lower	Acceleration, Ay	700g	3
	Deflection, Drib	90mm	3
Abdomen - Front Middle Rear	Forces, Fy	5kN	3
Backplate	Forces, Fx Fy	5kN	4
	Moments, My Mz	200Nm	
T12	Forces, Fx Fy	5kN	4
	Moments, Mx My	300Nm	
Pelvis	Accelerations, Ax Ay Az	150g	3
Pubic Symphysis	Force, Fy	20kN	1
Femur (L & R)	Forces, Fx Fy Fz	22kN	6
	Moments, Mx My Mz	350Nm	6
Total Channels per Dummy			43
1 x ES-2			43

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 (Ay).
- 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 $\pm 5^\circ$.

VEHICLE

Location	Parameter	Minimum Amplitude	No. of channels
B-Post (unstruck)	Acceleration, Ay	350g	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 (AX).

CARRIER

Location	Parameter	Minimum Amplitude	No. of channels
Carrier C of G	Acceleration, AX	350g	1
Total Channels per Carrier			1

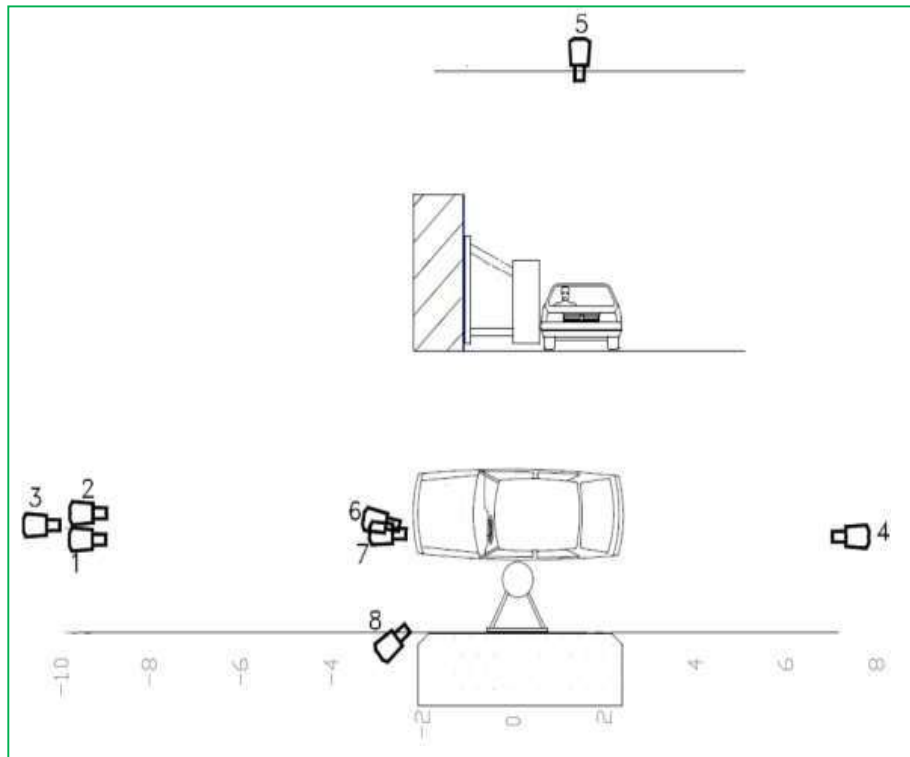
TOTAL CHANNELS

1x Driver ES-2	43
1x Vehicle	1
1x Carrier	1
TOTAL	45

4.0 CAMERA LOCATIONS

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

Camera No.	Camera Type	Shot Content
1	500 fps high speed	Front view of vehicle and carrier (wide)
2	500 fps stills camera	Front view of vehicle and carrier (wide)
3	500 fps stills camera	Backup for 2 (optional)
4	500 fps high speed	Rear view of vehicle and carrier (wide)
5	500 fps high speed	Plan view of car and carrier (wide)
6	1000 fps high speed	Front view of driver head (impact area) (tight)
7	1000 fps high speed	Front angled view of driver rib and abdomen area (tight)
8	500 fps high speed	30° Side view from front on impact area (wide)



5.0 PASSENGER COMPARTMENT ADJUSTMENTS

5.1 Overview of settings

Adjustment ¹	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 5.2
Seat Base Tilt	Manufacturer's design riding position	Permissible Up to mid position	See Section 5.3
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 6.1
Seat Lumbar Support	Fully retracted		See section 5.3
Front Head Restraints	Highest position		
Rear Head Restraints	Remove or Lowest	Unless instructed Otherwise by the manufacturer	
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/After 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 5.4
Rear Seat Facing	Forward		See Section 5.4
Rear seats arm-rests	Stowed position		
Doors	Closed, not locked		
Roof	Raised	Where applicable	
Adjustment ¹	Required Setting	Notes	Methods
Glazing	Movable windows		

	and vents in fully opened position		
Steering wheel –horizontal	Mid position		See Section 5.5
Steering wheel – vertical	Mid position		See Section 5.6
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 (where adjustable)	Same position as that used in the side impact		
<i>¹Adjustments not listed will be set to mid-positions or nearest positions rearward, lower or outboard.</i>			

- 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
- 5.2.10 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.

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

5.5.6 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.

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

5.5.8 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.

6.0 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?
Determine the H-point of the driver's seat	Before test day
Dummy installation (on boards)	Before test day
Dummy placement	Test day
Dummy positioning	Test day
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 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 centreline. 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 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 detail 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 ES-2 dummy is situated 21mm forward of that of the H-point determined by the H-point manikin (Section 6.1). The H-point of the manikin is indicated by 'Hm' on the H-point back plate of the dummy.

- 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 Visually check that the dummy sits square and level in the seat before taking any measurements of the H-point position.
- 6.3.1.3 Manoeuvre the dummy until its "Hm" position is in a circle with a radius of 10 mm round the H-point of the H-point Manikin as determined in Section 6.1.

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 floor pan.
- 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 ES-2 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*

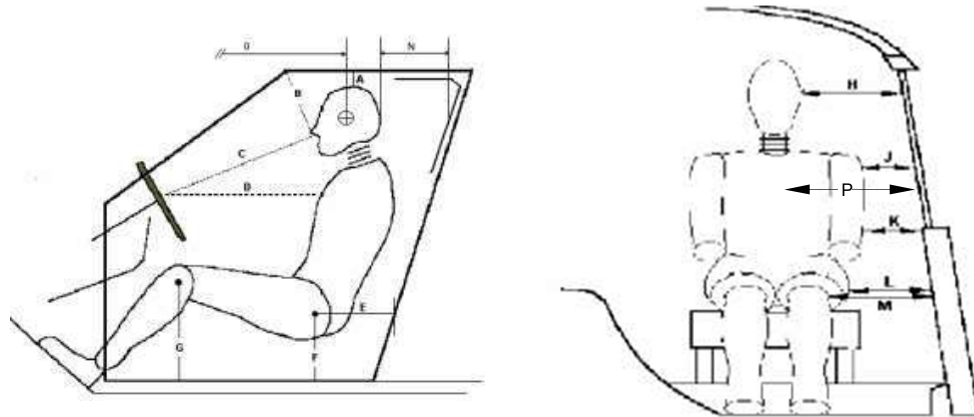
- 6.3.4.1 Locate the horizontal plane passing through the dummy head centre of gravity. Identify the rearmost point on the dummy head in that plane. Construct a line rearwards in the plane that intersects the front door daylight opening at the same horizontal location and is perpendicular to the longitudinal vehicle centreline. Measure the longitudinal distance between the rearmost point on the dummy head and this line. Refer to the USA Safety Standard FMVSS 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 50mm 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 50mm distance is achieved. The dummy must only be moved forward by the adjustment of the seat back, not by hand, during this process. If this is not sufficient to produce the 50mm distance, the seat is moved forward until the 50mm distance is achieved or until the knees of the dummy contact the dashboard or knee bolster 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 50mm distance is obtained or until the seat back is in its full upright locking position.

6.3.5 *Seat belt*

- 6.3.5.1 Where possible, initially position the upper seat belt anchorage in the manufacturers 50th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the mid-position or nearest notch upward.
- 6.3.5.2 Carefully place the seat belt across the dummy and lock as normal.
- 6.3.5.3 Remove the slack from the lap section of the webbing until it is resting gently around the pelvis of the dummy. Only minimal force should be applied to the webbing when removing the slack. The route of the lap belt should be as natural as possible.
- 6.3.5.4 Place one finger behind the diagonal section of the webbing at the height of the dummy sternum. Pull the webbing away from the chest horizontally forward and allow it to retract in the direction of the D-loop using only the force provided by the retractor mechanism. Repeat this step three times, only.
- 6.3.5.5 After following the above steps, the seatbelt should lie in a natural position across the dummy sternum and shoulder clavicle. Where this is not the case, for example the belt is close to or in contact with the neck or the belt is above the shoulder rotation adjustment screw, and the upper belt anchorage is adjustable the anchorage should be lowered and steps 6.3.5.3 and 6.3.5.4 repeated.
- 6.3.5.6 The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of .steps 6.3.5.3 and 6.3.5.4 repeated. This may require multiple attempts.
- 6.3.5.7 Once the belt is positioned the location of the belt should be marked across the dummy chest to ensure that no further adjustments are made. Mark also the belt at the level of the D-loop to be sure that the initial tension is maintained during test preparation.
- 6.3.5.8 Measure the vertical distance between the dummy nose and the diagonal webbing.
- 6.3.5.9 Measure the horizontal distance between the diagonal webbing and the door/window.
- 6.3.6 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.



Driver measurements

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
P	Belt webbing to door	Horizontal

7.0 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.

<u>No.</u>	<u>View</u>
<i>Car on carrier against pole:</i>	
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.
<i>Car and carrier away from pole:</i>	
6	Side view car/carrier impact side, showing full car.
7	Side view car/carrier non-impact side, showing full car.
8	*To show position of all door latches and/or open doors.
9	^ Side view through open driver's door on driver & seat to show driver compartment and position of seat relative to the sill.
10	^ Detail view on driver's legs and feet through open door.
11	Side view through open front passenger door to show driver.
12	Side view of car/carrier impact side centred on impact line showing front door and B-post
13	^ Front/side view of pole.
14	* Front view of dummy through front windscreen.
15	* Inside car view on abdomen/pelvis area.
^ = Pre-test only, * = Post test only.	
<i>After Dummy Removal:</i>	
16	* Detail view(s) on paint marks on the driver's door and seat

8.0 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 1000mm 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 10m before the point of impact. Crumple tubes or a comparable device will decelerate the carrier not earlier than 100ms 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 1 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.

TEST SPEED = 29 ± 0.5 km/h

8.4 **Impact Angle**

8.4.1 The impact angle should be $90^\circ \pm 3^\circ$. 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, BHARAT NCAP reserves the right to decide whether or not the test will be considered as valid.

9.0 **AFTER TEST**

9.1 **Door Opening Force**

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

9.1.2 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.

9.1.3 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.

9.1.4 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° 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 seatback and try again.

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

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

9.3 **Liquid Fuel Leakage Measurement**

9.3.1 Immediately after test, measure the leakage of liquid fuel if any at the intervals of 1-minute for atleast 05 minutes.

9.3.2 If the liquid from the fuel-feed system mixes with liquids from the other systems and the various liquids cannot easily be separated and identified, all the liquids collected shall be taken into account in evaluating the continuous leakage

9.4 **EV High Voltage Protection Against electrical shock Measurements**

Following the test conducted, the electrical power train operating on high voltage and the high voltage components and systems which are galvanically connected to the high voltage bus of the electrical power train shall be verified for the Protection against electrical shock requirements specified in AIS-099.

ANNEXURE IV		
ASSESSMENT PROTOCOL FOR ADULT OCCUPANT PROTECTION		
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5.	POLE SIDE IMPACT	125

1.0 INTRODUCTION

This annexure lays down the criteria of assessment for adult occupant in frontal, side and pole side impact tests.

2.0 METHOD OF EVALUATION

- 2.1 The starting point for the assessment of adult occupant protection is the dummy response data recorded in the frontal, side and pole side impact tests. Initially, each relevant body area is given a score based on the measured dummy parameters. These scores can be adjusted after the test based on supplementary requirements. For example, consideration is given to whether the original score should be adjusted to reflect occupant kinematics or sensitivity to small changes in contact location which might influence the protection of different sized occupants in different seating positions. The assessment also considers the structural performance of the car by taking account of such aspects as steering wheel displacement, pedal movement, foot well distortion and displacement of the A pillar. The adjustments, or modifiers, are based on both inspection and geometrical considerations and are applied to the body area assessments to which they are most relevant.
- 2.2 For Adult occupant protection, the overall rating is based on the driver data, unless part of the passenger fared poorly. It is stated that the judgement relates primarily to the driver. The adjusted rating for the different body regions shall be presented in a visual format of coloured segments within a human body outline for the driver and passenger.
- 2.2.1 Points Calculation
- 2.2.1.1 A sliding scale system of points scoring has been adopted for the biomechanical assessments. This involves two limits for each parameter, a more demanding limit (higher performance), beyond which a maximum score is obtained and also a less demanding limit (lower performance), below which no points are scored. For the adult rating, the maximum score for each body region is four points. Where a value falls between the two limits, the score is calculated by linear interpolation.
- 2.2.2.2 For all tests that are part of the adult occupant protection assessment, capping limits are maintained for criteria related to critical body regions: head, neck and chest. Exceeding a capping limit generally indicates unacceptable high risk at injury. In all cases, this leads to loss of all points related to the tests. Capping limits can be equal to or higher than the lower performance limit, depending on the test.

3.0 FRONTAL IMPACT

3.1 Calculation of Injury Parameters

3.1.1. Head

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

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

3.1.1.2. Determine the highest value of the resultant head acceleration

Calculate the Head Injury Criterion (HIC) according to

3.1.1.3.
$$HIC = (t_2 - t_1) \left[\frac{\int_{t_1}^{t_2} A_R \cdot dt}{(t_2 - t_1)} \right]^{2.5}$$

where A_R is expressed in multiples of g. Maximise HIC for any time 'window' ($t_2 - t_1$) up to 15 milliseconds.

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

3.1.2. Neck

Calculate the neck extension bending moment from

3.1.2.1.
$$(M_y)_i = M_y - F_x \cdot d$$

Where M_y and F_x 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.

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

3.1.3. Chest

3.1.3.1. Determine the greatest value of the chest deflection D_{chest}

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 $D_{(t)}$

3.1.3.2.
$$C_{(t)} = \frac{D_{(t)}}{0.229}$$

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.

3.1.4. Femurs

3.1.4.1. For each of the femurs, calculate the continuous exceedance in compression (F_z negative)

3.1.5. Knees

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

3.1.6. Tibia

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.

3.1.6.1

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

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

3.1.6.2.
$$TI_{(t)} = \left| \frac{M_{R(t)}}{(M_R)_C} \right| + \left| \frac{F_{Z(t)}}{(F_Z)_C} \right|$$

$TI_{(t)}$ 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.

3.1.6.3. Determine the highest value of the Tibia Index.

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

3.2 **Criteria and Limit Values**

The basic assessment criteria, with the upper and lower performance limits for each parameter, are summarised below. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. The lowest scoring body region of driver or passenger is used to determine the score. For frontal impact, capping is applied on the critical body regions: head, neck and chest. When the vehicle already results in zero stars in either the frontal or side impact test, the remaining test may not be performed. Capping can be reached by biomechanical value reading (in this case the result is capped to zero stars) or when one critical body region scores zero after modifiers are applied (in this case the result is capped to one star).

3.2.1 Head: Following criteria are used to assess the protection of the head for the driver and passenger. (Note: HIC15 levels above 700 have been recorded with airbags, where there is no hard contact and no established risk of internal head injury. A hard contact is assumed, if the peak resultant head acceleration exceeds 80g, or if there is other evidence of hard contact.)

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

<i>Higher performance limit</i>		
HIC ₁₅	500	
Resultant Acc. 3 msec exceedance 72g		
<i>Lower performance and capping limit</i>		
HIC ₁₅	700	(20% risk of injury ≥ AIS3 [1,2])
Resultant Acc. 3 msec exceedance 88g (*EEVC limit)		

3.2.2 Neck

<i>Higher performance limit</i>			
Shear	1.9kN @ 0 msec,	1.2kN @ 25 - 35msec,	1.1kN @ 45msec
Tension	2.7kN @ 0 msec,	2.3kN @ 35msec,	1.1kN @ 60msec
Extension	42Nm		
<i>Lower performance and capping limit</i>			
Shear	3.1kN @ 0msec,	1.5kN @ 25 - 35msec,	1.1kN @ 45msec*
Tension	3.3kN @ 0msec,	2.9kN @ 35msec,	1.1kN @ 60msec*
Extension	57Nm*		(Significant risk of injury [4]) (*EEVC Limits)
(Note: Neck Shear and Tension are assessed from cumulative exceedance plots, with the limits being functions of time. By interpolation, a plot of points against time is computed. The minimum point on this plot gives the score. Plots of the limits and colour rating boundaries are given in Appendix I to this Annexure.)			

3.2.3 Chest

<i>Higher performance limit</i>		
Compression	22 mm	(5% risk of injury \geq AIS3 [5])
Viscous Criterion	0.5 m/sec	(5% risk of injury \geq AIS4)
<i>Lower performance and capping limit</i>		
Compression	42 mm	(50% risk of injury \geq AIS3 [5])
Viscous Criterion	1.0 m/sec	(25% risk of injury \geq AIS4) (*EEVC Limits)

3.2.4 Knee, Femur and Pelvis

<i>Higher performance limit</i>		
Femur compression	3.8kN	(5% risk of pelvis injury [6])
Knee slider compressive displacement	6 mm	
<i>Lower performance and capping limit</i>		
Femur Compression	9.07kN @ 0msec, 7.56kN @ \geq 10msec*	(Femur fracture limit [4])
Knee slider compressive displacement	15 mm*	(Cruciate ligament failure limit [4,7]) (*EEVC Limits)
(Note: Femur compression is assessed from a cumulative exceedance plot, with the limits being functions of time. By interpolation, a plot of points against time is computed. The minimum point on this plot gives the score. Plots of the limits and colour rating boundaries are given in Appendix I to this Annexure.)		

3.2.5 Lower Leg

<i>Higher performance limit</i>		
Tibia Index	0.4	
Tibia Compression	2 kN	
<i>Lower performance and capping limit</i>		
Tibia Index	1.3*	
Tibia Compression	8 kN*	(10% risk of fracture [4,8]) (*EEVC Limits)

3.2.6 Foot / Ankle

<i>Higher performance limit</i>		
Pedal rearward displacement	100 mm	
<i>Lower performance and capping limit</i>		
Pedal rearward displacement	200 mm	
Notes:		
a. Pedal displacement is measured for all pedals with no load applied to them		
b. If any of the pedals are designed to completely release from their mountings during the impact, no account is taken of the pedal displacement provided that release occurred in the test and that the pedal retains no significant resistance to movement		
c. If a mechanism is present to move the pedal forwards in an impact, the resulting position of the pedal is used in the assessment.		
d. The passenger's foot/ankle protection is not currently assessed.		

4.0 SIDE IMPACT

4.1 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. Ringing or other anomalous spikes in the data traces should be removed and peak values/HIC calculated without consideration of the anomaly. A copy of both the original and unmodified traces must always be provided in the data.

<i>ES-2</i>			
Location	Parameter	CFC	Injury Calculation
Head	Accelerations Ay Az	1000	HIC Peak acceleration 3msec exceedance (cumulative)
Shoulder	Forces, Fx Fy Fz	600	Peak shoulder forces Resultant
Thorax T1	Accelerations, Ax Ay Az	180	Peak lateral acceleration on T1 and T12
Thorax T12	Acceleration, Ay	180	
Ribs – Upper, Middle, Lower	Acceleration, Ay	180	Viscous Criterion Peak rib acceleration Peak rib deflection
	Deflection, Drib	180	
Abdomen – Front, Middle, Rear	Force, Fy	600	Peak of sum of 3 abdomen forces
Backplate	Forces, Fx Fy	600	Peak forces and moments Fx Fy Resultant
	Moments, My Mz	600	
T12	Forces, Fx Fy	600	Peak forces and moments
	Moments, Mx My	600	
Pelvis	Accelerations, Ax Ay Az	180	Peak lateral acceleration
Pubic Symphysis	Force, Fy	600	Peak Force
Femurs (L & R)	Forces, Fx Fy Fz	600	Peak forces and moments
	Moments, Mx My Mz	600	

Q3			
Location	Parameter	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	1000	Peak Resultant acceleration Resultant (+ve) 3msec exceedance
Chest	Accelerations, A_x A_y A_z	180	Peak resultant acceleration Resultant (+ve) 3msec exceedance
Q1.5			
Location	Parameter	CFC	Injury Calculation
Head	Accelerations, A_x A_y A_z	1000	Peak Resultant acceleration Resultant (+ve) 3msec exceedance
Chest	Accelerations, A_x A_y A_z	180	Peak resultant acceleration Resultant (+ve) 3msec exceedance

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

4.1.1 **Head**

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

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

- 4.1.1.2 Calculate the Head Injury Criterion (HIC) according to

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

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

- 4.1.1.3 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 exceedance.

4.1.2 **Ribs**

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

- 4.1.2.2 Calculate the Viscous Criterion according to the equation

$$\text{Viscous Criterion} = V * C$$

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

related to the rib deflection $D(t)$

$$C(t) = \underline{D}(t) / 0.140$$

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.

4.1.3 **Abdomen**

Find the sum of the three abdomen force transducers as a function of time after the individual components have been filtered. Determine the maximum value of the total abdominal force

4.1.4 **Pelvis:** Determine the peak lateral acceleration of the pelvis

4.1.5 **Pubic Symphysis:** Determine the peak value of the lateral force measured on the pubic symphysis.

4.1.6 **Child Dummies**

4.1.6.1 For the Q3 and Q1½ dummies, calculate the resultant head and chest acceleration A_R from the three components A_x , A_y and A_z after they have been filtered and determine the maximum value of A_R .

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

4.1.6.2 For the Q3 and Q1½ dummies, determine the level which head resultant acceleration ($+A_R$) exceeds for a cumulative time of three milliseconds.

4.2 **Criteria and Limit Values**

The basic assessment criteria used for side impact, with the upper and lower performance limits for each parameter, are summarized below. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. There is no limit to the number of modifiers that can be applied. The concepts behind the modifiers are explained in section 5. For side impact, capping is applied on the head, chest, abdomen and pelvis. To ensure robustness in engineering solutions, the Designated Agency decides if testing will be conducted at the passenger or driver side of the vehicle using the same biomechanical and modifiers criteria. Capping can be reached by direct biomechanical value reading (in this case the result is capped to zero stars) or when one critical body region scores zero after modifiers are applied (in this case the result is capped to one star).

4.2.1 **Head**

<i>Higher performance limit</i>		
HIC 15	500	
Resultant Acc. 3 msec exceedance	72 g	
<i>Lower performance and capping limit</i>		
HIC 15	700	
Resultant Acc. 3 msec exceedance	88 g	

4.2.2 **Chest**

The assessment is based on the worst performing individual rib		
<i>Higher performance limit</i>		
Compression	22 mm	(5% risk of injury \geq AIS3 [10])
Viscous Criterion	0.32 m/sec	(5% risk of injury \geq AIS3 [10])
<i>Lower performance and capping limit</i>		
Compression	42 mm*	(30% risk of injury \geq AIS3 [10])
Viscous Criterion	1.0* m/sec	(50% risk of injury \geq AIS3[10]) (*EEVC Limits)

4.2.3 **Abdomen**

<i>Higher performance limit</i>		
Total Abdominal Force	1.0 kN	
<i>Lower performance and capping limit</i>		
Total Abdominal Force	2.5* kN	(*EEVC Limits)

4.2.4 **Pelvis**

<i>Higher performance limit</i>		
Pubic Symphysis Force	3.0 kN	
<i>Lower performance and capping limit</i>		
Pubic Symphysis Force	6.0* kN	(Pelvic fracture in young adults) (*EEVC Limits)

5.0 POLE SIDE IMPACT

A side head protection system (curtain airbag) must be fitted on the test model. To ensure robustness in engineering solutions, Test Agency appointed by the Designated Agency decides if testing will be conducted at the passenger or driver side of the vehicle using the same biomechanical and modifiers criteria. Following Injury Criteria shall be measured during Side Pole Impact Test.

5.1 Head

- 5.1.1 Calculate the resultant head acceleration A_R from the three components A_X , A_Y and A_Z after they have been filtered.

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

- 5.1.2 Calculate the Head Injury Criterion (HIC) according to

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

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

- 5.1.3 Determine the peak acceleration level of A_R and the level it exceeds for a cumulative time period of three milliseconds i.e. the end 3 msec exceedance.

5.2 Limiting Values

Head

HIC15 <700

Peak Resultant Acc <80g

No direct head contact with the pole

5.3 Modifiers

Modifiers applicable are specified in Annexure-VII

ANNEXURE V		
ASSESSMENT PROTOCOL FOR CHILD OCCUPANT PROTECTION		
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1.0 INTRODUCTION

This annexure specifies the guidelines for the assessment of child occupant based on the tests specified in BHARAT NCAP. There are three areas of Child Protection that are assessed; the requirements for each are detailed in the following sections. All contribute to the overall child protection rating, the assessments are

- Installation of child restraints (Section 3.2)
- Dynamic performance (Section 3.9)
- Vehicle Based Assessments (Section 3.10)

2.0 CHILD OCCUPANT PROTECTION ASSESSMENT

A number of child seats available in the local market(s) covered by the assessment will be used to assess vehicle to CRS compatibility and Q Series dummies representing 1½ year old and 3 years old children will assess dynamic performance.

The protocol is applicable to all classes of vehicles currently assessed by BHARAT NCAP, including vehicles where there is no rear bench or where there is limited space for carrying CRS on the rear seats.

Dummy response data will be recorded in the frontal impact and side impact tests. Two Q series crash dummies, representing a 1½ year old and 3 years old child are placed in child seats recommended by the vehicle manufacturer. The dynamic assessment remains focused on head, neck and chest only.

During a post-crash vehicle inspection, the car will be assessed on aspects such as labelling, airbag disabling, ISOFIX, ISOFIX usability, i-Size readiness and more. The scores achieved in the three main categories (fitment of CRS, dynamic performance and vehicle based assessments) are combined to calculate the total Child Occupant Protection Score.

Cars with limited or no rear space such as two seaters do not allow a typical dynamic assessment using dummies in the rear. For these classes of vehicles, special provisions have been made to the protocol.

2.1 Car Manufacturer's Recommendation

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

2.1.1 The vehicle manufacturer must recommend two CRS for use in dynamic assessments. Of those two recommended seats, one CRS must be suitable for 18 month and one for 3 years old children. The compatibility of the recommended CRS with the vehicle will be separately assessed as part of the installation check. In order to be used in the dynamic tests, both CRS must meet the installation requirements detailed in Section 3 on the two rear outboard seating positions.

2.1.2 For the dynamic test, the vehicle manufacturer is given the choice to recommend appropriate Child Restraint Systems (CRS). An installation assessment using specific CRSs, models and sizes will be performed following the installation mode

identified in the installation list. The CRS recommended by the vehicle manufacturer will also be assessed for installation in the same mode as the one recommended for the dynamic test. In both scenarios, the following preconditions must be met for the vehicle's manufacturer recommended CRS to be accepted:

- 2.1.2.1 The CRSs must be recommended by the vehicle manufacturer, to their customers
- 2.1.2.2 The recommended CRS must be available for purchase by all consumers from authorized dealers.
- 2.1.3 Where a vehicle is equipped with an integrated seat(s) covering 18 month and/or one 3 years old children on the rear outboard test positions, the integrated seat will be used in the dynamic tests. Integrated seats will be used even if they are optional equipment. However, they must be standard equipment in order to gain points in the vehicle based assessments (Section 3.10). Where a vehicle is equipped with only one integrated restraint on either outboard position covering both or only one of two child ages, the integrated seat will be used only where applicable. An alternative installable CRS must be recommended for the case where the integrated seat is not suitable for the age of the dummy of choice.
- 2.1.4 Where no or not appropriate recommendation is provided, for example where the requirements of Section 3 are not met, BHARAT NCAP will select possible seats available in the local market, or in case this is not feasible, acquire fitting seats for use in the full scale tests. Where this is the case, the dynamic points for CRS will not be awarded. Additional preconditions exist for vehicles equipped with two seats or have limited space in the rear. Refer to Section 6 for further details.

3.0 INSTALLATION OF CHILD RESTRAINTS

BHARAT NCAP rewards vehicles that can accommodate a broad variety of child seats available in the Indian market. Currently, for the purpose of assessment, CRSs used by Global NCAP are recommended as Standard Seats for Installation Checks. Alternately, OEM can recommend alternate CRSs for each mass group and ensure availability of the same to the consumer through dealer network.

3.1 Installation List and Recommended Seats

- 3.1.1 The child seats on the "Installation List" are detailed in Appendix III to this Annexure. This list contains child seats currently referred by Global NCAP 2022-2025 protocol. The list will be checked on a regular basis to update with alternate seats available in India market. BHARAT NCAP does not assess or rate the child seats individually.
- 3.1.2 All CRS on the "Installation List" will be considered for installation in the vehicle. Where the vehicle manufacturer has recommended CRS for dynamic testing that are not on the above list, these will also be included in the fitment assessment using the installation mode used in dynamic testing (the total list of seats is referred to as the CRS installation list). The preconditions for acceptance of CRS are listed in Section 2.1.
- 3.1.3 In addition to the above, the fitment assessment results of the selected seats (available in the assessed market(s)) will also be published. Placing these recommended seats on the "Installation List" is exclusively done at the request of

the sponsor at the time of nomination of the vehicle and does not contribute toward the score. This is for information only

- 3.1.4 To be eligible for assessment and scoring, any CRS on the “extended installation list” (Installation list + CRS recommended by the OEM for the dynamic test) must be detailed on the approved vehicle list when the CRS is not approved as Universal. Where this is not the case, no award will be given for CRS installation of these seats.

3.2 **Installation Matrix**

- 3.2.1 The score for Installation of Child Seats is based on the CRS from the “extended installation list” that can be successfully installed in the vehicle considering all eligible seating positions. Hence, before the assessment starts, the total number of passenger seating positions in the vehicle must be identified including 1st, 2nd and 3rd row if available. Where a vehicle is available with an optional 3rd row on any variant, the installation assessment will be based on a vehicle fitted with the optional seats.

- 3.2.2 Provided that the CRS can be placed in the vehicle without problems (Section 3.3.1), a list of CRS representing the most demanding scenarios for installation (plus those recommended by the vehicle manufacturer) will be fitted on each seating position, using the installation modes identified in Appendix II to this Annexure.

3.2.3 Universal (Belted) CRS

Seating positions must meet the extended Gabarit check (Section 5.2) to be included in the Installation Matrix for the Universal CRS’s. In addition, these seating positions must be marked with ‘U’ or ‘UF’ in the Universal CRS table. A combination of Universal CRS group and seating position that do not meet these requirements will automatically fail the CRS installation assessment for Universal CRS of that group on the list.

Where a vehicle can be equipped with optional inflatable seatbelts or other advanced adult restraint systems, this equipment will not be assessed provided that the vehicle handbook clearly states that CRS cannot be installed when this equipment is present. The vehicle manufacturer is asked to contact BHARAT NCAP in advance of the vehicle assessment to confirm this exemption.

The semi-universal CRS on the list that are installed with the adult belt and support leg will be exempted from installation on any seating position when the CRS vehicle list identifies that the CRS cannot be used on this seating position and that it is clearly identified in the vehicle handbook (adjacent to the Universal CRS table) not to install a belted CRS with a support leg. When this is the case, the belted semi-universal CRS installation score on that seating position will be awarded the available points.

3.2.4 I-Size CRS

I-Size seating positions must meet the i-Size technical requirements (Section 5.4 C) to be included in the Installation Matrix for the i-Size/ISOFIX CRS’s. In addition, these seating positions must be marked with ‘i-U’ in the i-Size CRS table (‘i-UF’ will be accepted only for seating positions equipped with airbags). A seating position that does not meet these requirements will automatically fail the CRS installation assessment for i-Size CRS in case it is listed.

3.2.5 ISOFIX CRS

ISOFIX seating positions must either meet the i-Size marking requirements (Section 5.4 C) or simply be labelled according to the ISOFIX marking requirements in UN Regulation 14/UN Regulation 145/AIS-182 to be included in the Installation Matrix for the ISOFIX CRS's. In addition, these seating positions must be marked with 'IL' or 'IUF' in the ISOFIX CRS table. A combination of ISOFIX size class and seating position that does not meet these requirements will automatically fail the CRS installation assessment for ISOFIX CRS of that size class in case that it is listed.

ISO/R3 size class seats will be exempted from installation on any seating position when the CRF ISO/ R3 cannot be installed according to section 3.2 and is clearly identified with an "X" in the ISOFIX CRS table as unsuitable for this size. When this is the case, the combination of ISO/R3 size class CRS given installation score on that seating position will be awarded the available points (see section 3.7).

3.2.6 Passenger Airbag Warning and Disabling

Seating positions which have a frontal passenger airbag present must meet the requirements for Passenger Airbag Warning Marking and Disabling (Section 5.6) to be included in the Installation Matrix. A seating position except the Front Row Passenger Seating Position, that does not meet these requirements will automatically fail the CRS installation assessment for all rearward facing Universal belted, ISOFIX and i-Size seats on the list for these seating positions.

3.2.7 Integrated Child Restraints

Where an integrated CRS is offered as standard and indicated as such in the vehicle handbook, this seating position will automatically pass the assessments and no installation check is required with the CRS installation list of the weight/size group covered by the integrated CRS.

3.2.8 In practice, for the purpose of assessing the vehicle to child seat compatibility, it may not be necessary to verify each eligible CRS-seating position combination. For example, where for a given passenger seating position an integrated CRS is available (optional or standard fit), no installation check is required with the CRS of the age group covered by the integrated CRS

3.2.9 Finally, it is important to note that for each passenger seating position except the front Row passenger seating position at least one of the Installation List CRS covering groups 0+ and I must be accommodated. Additionally, at least one CRS from the Installation List of each group (0-III) must be accommodated by the vehicle. Where one or both of the above conditions are not met, the final CRS Installation score, out of 12 points, (Section 3.7) will be halved. When a recommended CRS fails in the position to be tested it will be considered as no recommended CRS by the car manufacturer.

3.3 **Assessment of Problem-Free Installation & Requirements for all CRS**

All combinations of CRS and vehicle seat position will be subsequently checked by installing the CRSs on all Point seat belt on all Outboard Forward facing seating

positions seating positions. If any outboard seating positions are identical (adult belts, anchorages, etc) then installation may be performed on one side only, all other positions will be assessed. Where there is any asymmetry in a vehicle, including sliding doors, B-pillar position etc. then all seating positions must be assessed individually.

CRS that use more than one installation mode or are equipped with anti rotation devices must meet the requirements of all applicable sections for a successful installation. For example, a CRS using the adult belt AND ISOFIX must meet the full requirements of both Sections 3.4 and 3.5 for a successful installation. A CRS that uses the adult belt AND a support leg must meet the full requirements of Section 3.4 and Section 3.6.

The vehicle seating position is compatible with the CRS fitted as long as the following conditions are met:

3.3.1 Ease of installation in car

This assessment is of the vehicles ability to allow for easy installation of a range of different CRS by evaluating its provision of sufficient space and access. This does not include fastening the CRS to the vehicle, only positioning on the rear or front seat in preparation for fastening.

3.3.1.1 Initial vehicle settings

Installations on the rear seat:

- The front row seats shall initially be set in the BHARAT NCAP Frontal ODB (Mid-Low) impact test position unless clearly instructed otherwise in the vehicle handbook.
- If the vehicle has only 3 doors, then it is acceptable to utilise any ‘easy entry’ function to move the front seat forward and allow access to the rear seats.
- Vehicles with adjustable rear seats shall have the seat back angle and fore/aft set to the mid in-use position and are to be used, unless clearly instructed otherwise in the vehicle handbook. The flat folded position of a seat is not considered as an in use position. If the mid position cannot be obtained due to notched adjustments, the next most vertical position for the seat back or the next rearward position for fore/aft shall be used.
- Head restraints shall be in the lowest/not in use position, unless clearly instructed otherwise in the vehicle handbook.
- Movable arm rests shall be set to the position recommended in the vehicle handbook. Where there is no recommendation they shall be positioned so as not to interfere with the CRS installation.
- Where the front seat interacts with the steering wheel, for example with easy entry functions, the steering wheel shall be set to mid/mid.

Installations on the front seat:

- The front seat(s) shall initially be set in the BHARAT NCAP Frontal ODB (Mid-Low) impact test position unless instructed otherwise in the vehicle handbook.

- The front seat adjustments shall remain the same for all further assessments. Where the vehicle handbook contains details of alternative front seat positions for individual CRS, this alternative position will be used.
- Head restraints shall be in the lowest position, unless clearly instructed otherwise in the vehicle handbook.
- Movable arm rests shall be set to the not in use position or fully vertical

3.3.1.2 CRS Placement

Procedure:

- Where necessary, ready the CRS for installation by lengthening straps and top-tethers so they are accessible once the CRS is in place.
- Pass the CRS through the nearest occupant entry door. Vehicles with moveable roofs shall have the roof closed during this assessment. No other access routes shall be used, such as the rear hatch/ boot.
- If the CRS cannot be easily placed in the vehicle due to the position of the front seat, adjust the front seat to allow CRS placement. Following this, the front seat should then be repositioned back to the handbook/initial position.
- For CRSs that allow the child to be carried in the seat the orientation of the CRS may be changed by up to 40 degrees about its axes (x, y,) is acceptable to enable the CRS to fit into the vehicle. For CRSs that are not intended as carry-cots then any orientation may be used to place the CRS in the vehicle.
- Where the CRS contains multiple parts, e.g. base and seat, then both items may be installed sequentially and assessed in the same way.
- For CRS that do not allow installation with the child in the CRS, there must be sufficient space within the vehicle to allow an adult to place and child in the CRS. This will be assessed using the appropriate sized child dummy.

The vehicle meets the requirements if all of the following are met:

- The CRS can be placed on the rear seats without excessive force, difficulty or interaction with the door aperture.
- After adjustment of the front seat, it does not prevent or interfere with correct placement of the CRS. An easy entry function may be used.
- Where applicable, the easy entry function allows the front seat to return and lock in the same seating position after placement of the CRS. If the easy entry function does not return the front seat to the position mentioned in the handbook, it will be adjusted to and assessed in the handbook position.
- If there is sufficient space within the vehicle for a child to be correctly placed in the CRS and the child is not prevented from sitting normally in the CRS.

The vehicle would not meet the requirements if any of the following occur:

- The child seat or base does not individually fit through the door aperture.
- The CRS cannot be placed in the vehicle.

- The CRS must be rotated more than the permissible amount to enable placement or where applicable.
- An easy entry system does not allow the front seat to return and lock in the position detailed in the handbook.
- Vehicle structures prevent a child from being placed correctly in the CRS.
- There is insufficient space within the vehicle to allow the child to occupy the CRS as normal.

3.4 **Requirements for seat belt mounted CRS**

3.4.1 Use of 3-point belts

3.4.1.1 Ease of fastening seatbelt

Procedure:

- Once placed in the vehicle, the CRS shall be positioned along the centreline of the chosen seating position.
- Route the adult seatbelt around the CRS in accordance with the instructions on the CRS
- Engage the buckle tongue into the buckle.
- If necessary, some small movement of the CRS is permitted to expose the seat belt buckle. This is limited to rotation of up to 20 deg about the x and z-axes or 50mm lateral movement from the seat centreline.
- For CRS that are not equipped with integral harnesses an appropriate sized dummy shall be placed in the CRS during this procedure.

The vehicle meets the requirements if all of the following are met:

- The tongue can be engaged in the buckle with the use of only one hand and without the need to reposition the CRS to enable access to the buckle, or the tongue can be engaged using two hands to insert the buckle, where one supports the buckle, and the other is used to insert the tongue.
- The adult seat belt adjacent to the assessed seating position does not prevent installation of the CRS or lead to any instability.
- With the CRS installed, the three point belt on another seating position in that same row should be capable of restraining one other occupant.

The vehicle would not meet the requirements if any of the following occur:

- The belt cannot be buckled due to insufficient belt length.
- The belt length is such that the CRS is not in the correct position on the seat.
- The CRS has to be moved or rotated more than prescribed above to allow access to the buckle, e.g. the buckle is positioned underneath the CRS.
- The installation of the CRS means that an adult cannot occupy another seating position on that row, for example due to limited space or interference with the adult belt system.

3.4.1.2 Ease of tightening belt (Ease of operating the lock-off clip)

This assessment is of the vehicles ability to correctly restrain the CRS using the adult belt systems.

Procedure:

- With the seat belt buckled and belt routed correctly around the CRS, tension shall be introduced into the adult seatbelt by pulling on the diagonal section of the belt in the direction of the reel.
- Tension in the lap section is established by pulling the diagonal section of the belt with no more than 150N force. The tension shall be applied to the diagonal part of the belt before it passes through any upper belt guide or lock off next to the buckle. Away from friction points.
- Seatbelt load cells will be required for this installation.
- For seats that do not have an integral harness, a child dummy of the appropriate size shall be placed in the CRS during this process.

The vehicle meets the requirements if all of the following are met:

- When 150N is applied to the diagonal section of the adult belt, the slack in all parts of the lap section is removed.
- The CRS is held firmly against the seat back and seat base by the adult belt.
- Any movement of the CRS base or back must result in increasing tension within the belt system, e.g. with forward movement of the CRS. The belt reel shall be prevented from spooling out during this check.
- Where applicable, the seat belt must restrain the dummy and the seat correctly.

The vehicle would not meet the requirements if any of the following occur:

- When slack has been removed from the belt system, the buckle tongue stops interfere with the belt lock off.
- It is not possible to remove the slack in any part of the lap section.

3.4.2 Additional tethers and/or support leg

Where the chosen CRS is equipped with an additional tether or support leg apply the relevant assessment outlined in Section 3.7 before moving on to the next section

3.4.3 Obstruction & Stability of the CRS

Procedure:

- The CRS shall be installed in the vehicle with the seat belt buckled and any tethers or support legs attached as per the previous steps. The largest appropriate P or Q dummy shall also be installed in the CRS.
- Any comfort adjustments on the CRS shall be changed e.g. incline, recline etc
- Check any contact points between the CRS, dummy and vehicle.

- The CRS shall be rocked from side to side about the x axis over a 10° to 15° arc. No other restraint shall be placed on the CRS during rocking.
- The CRS shall be pulled toward the front of the vehicle and twisted about the z axis
- The CRS shall be returned to the initial position with the belt tightened as per Section 3.4.1.2 and a force of 100N shall be applied perpendicular to the CRS in the y direction at the shoulder level of the dummy. This assessment will not be applied to the Group 0+ CRS.
- The CRS shall be returned to the initial position with the belt tightened as per Section 3.4.1.2 and a force of 100N shall be applied perpendicular to the CRS in the y direction at a small distance above the vehicle seat. This assessment will not be applied to the Group 0+ CRS.

The vehicle meets the requirements if all of the following are met:

- The vehicle interior can accommodate installation of the CRS in all orientations and adjustments without interaction with other parts of the vehicle. E.g. booster seats with adjustable head restraints must not be restricted by the rear head restraints or C-pillars
- The presence of head restraints does not prevent correct installation of the CRS and does not lead to significant forward rotation of the CRS or create lateral instability.
- Contact between the CRS and vehicle interior is permitted provided that the CRS is correctly installed, stable and is not rotated by more than 5 degrees.
- The measured backrest angle of the CRS does not exceed 90 degrees. This can be measured using the device described in APPENDIX I to this Annexure.
- The vehicle interior provides stable support for the CRS in the selected installation modes and adjustments. E.g. the CRS back or base tensioning system must be in contact with the vehicle seat base and seat back cushions.
- The CRS sits flat on the seat base cushion and, for forward facing CRS, is supported by the seat back and/or head restraint
- With the load applied to the CRS the rotation about the X axis does not exceed 20 degrees and the CRS remains secured and has a tendency to return back to the original position
- As any load is applied, the tension in the belt system increases with the displacement of the CRS.

The vehicle would not meet the requirements if any of the following occur:

- The CRS does not sit correctly on the seat base cushion or is not supported by the seat back including head restraint.
- The vehicle interior can accommodate installation of the CRS with only limited adjustments of the CRS i.e. tilt or adjustable backrests cannot be used due to interference from the vehicle
- The vehicle interior encroaches into the space in which the child dummy sits resulting in any contact between the dummy head and legs. For example, where

the roof is too low or the knees or tibia are against the back of the front seat. Contact with the toes or feet is acceptable.

- Any part of the vehicle interior, including bolsters, arm rests, pillars obstruct the CRS or prevents a particular adjustment from being made. E.g. C-pillar, roof or rear head restraints prevent correct installation of CRS
- With the appropriate child dummy installed, the size of the car limits the possible age groups that can be installed and exclusions are not made clear in the vehicle handbook
- There is limited support offered to the CRS through lack of contact with the supporting structures, e.g. large side bolsters prevent the CRS from sitting flat on the seat base; or where applicable, poor or inadequate support is provided to CRS support legs.
- When load is applied to the CRS it can move more than the allowed amount or the CRS can move without increasing tension on the belt system

3.5 **Requirements for ISOFIX CRS**

3.5.1 Insert and locking ISOFIX probes (only)

This is an assessment of the ease of which the CRS ISOFIX probes can be engaged with the vehicle ISOFIX anchorages. It does not include assessment of any other tethers, straps or supports.

Procedure:

- The position and orientation of the vehicle anchorages shall be identified and prepared for CRS attachment. Simple, preparatory actions such as sliding a seat belt away from the anchorage, lifting a dedicated flap or covering to expose the anchorage are permissible. Plastic guide funnels supplied with CRS will NOT be used.
- The CRS shall be placed on the seat centreline, the CRS ISOFIX probes shall be made ready for attachment to the vehicle.
- The CRS and probes shall be pushed toward the anchorages until they are engaged, keeping the CRS on the vehicle seat cushion. Lifting of the CRS from the seat base is not allowed, but some rotation/ tilting of the CRS is permissible provided there is still contact with the seat cushion. Separate support frames and bases (if available) may be lifted.
- If necessary, 50mm of lateral movement of the CRS is permitted to allow engagement with the ISOFIX anchorages. Where the CRS has movable ISOFIX probes, they may be adjusted to facilitate engagement provide the CRS remains on the vehicle seat.
- Where the adult belt prevents engagement with the ISOIFX anchorages, it is permissible to reposition the belt to improve access provided that the belt does not have to be held in that position.

The vehicle meets the requirements, once preparatory steps have been performed, if all of the following are met:

- Each vehicle ISOFIX anchorage can be easily engaged. For example, the anchorages are easily accessible or they are equipped with permanent guidance

(plastic funnel, fabric slit, etc) which helps the CRS ISOFIX probes align with the vehicle anchorages avoiding any obstruction from the seat, such as the fabric or cushion etc.

- For CRS where the probes are attached to the shell, the CRS can be attached to the vehicle by simply pushing it toward the anchorages, with some tilting but without any other actions that are not described on the CRS itself.
- If the CRS uses a separate support frame, the frame can be easily engaged onto the ISOFIX anchorages without removing fabric, etc.
- With the CRS installed, one of the three point belts on another seating position in that same row should be capable of restraining one other occupant.

The vehicle would not meet the requirements if any of the following occur:

- If the anchorages cannot be engaged without further actions. For example, where the seat cushions have to spread apart by hand in order to create access to the anchorages.
- The CRS has to be lifted off the seat cushion to allow engagement with the anchorages. Lifting of separate support frames is permissible.
- Any part of the seat or cushion prevents attachment of the CRS.
- Where the CRS probes are clearly misaligned with the ISOFIX anchorages.
- Where physical guidance is required, such as plastic funnels, they are not permanently attached to the vehicle.

3.5.2 Additional tethers and/or support leg

Where the chosen CRS is equipped with an additional tether or support leg apply the relevant assessment outlined in Section 3.6 before moving on to the next section

3.5.3 Obstruction & Stability of the ISOFIX CRS

The principle here is identical to that of Section 3.4.3.

Procedure:

- The CRS shall be installed in the vehicle with ISOFIX and any tethers or support legs attached. A child dummy of the appropriate size shall also be installed in the CRS.
- Any comfort adjustments on the CRS shall be changed e.g. incline, recline etc.
- Check any contact points between the CRS and vehicle.
- The CRS shall be pulled toward the front of the vehicle and twisted about the z-axis.

The vehicle meets the requirements if all of the following are met:

- The vehicle interior can accommodate installation of the CRS in all orientations and seat adjustments without interaction with other parts of the vehicle. E.g. booster seats with adjustable head restraints must not be restricted by the rear head restraints or C-pillars.

- The presence of head restraints must not lead to significant forward rotation of the CRS or create lateral instability.
- Contact between the CRS and vehicle interior is permitted provided that the CRS is correctly installed, stable and is not rotated by more than 5 degrees.
- The measured backrest angle of the CRS does not exceed 90 degrees. This can be measured using the device described in Appendix III to this Annexure.
- The vehicle interior provides stable support for the CRS and its attachments with the vehicle in all installation modes and adjustments.
- There is little or no rotation of the CRS about all axes.

The vehicle would not meet the requirements if any of the following occur:

- The vehicle interior can accommodate installation of the CRS with only limited adjustments of the CRS i.e. tilt or adjustable backrests cannot be used due to interference from the vehicle.
- The vehicle interior encroaches into the space in which the child dummy sits resulting in any contact between the dummy head and legs. For example, where the roof is too low or the knees or tibia are against the back of the front seat. Contact with the toes or feet is acceptable.
- Any part of the vehicle interior, including bolsters, arm rests, pillars, obstructs the CRS or prevents a particular adjustment from being made. E.g. C-pillar or rear head restraint prevents correct installation of CRS.
- The size of the car limits the possible age groups that can be installed and insufficient exclusions are not made clear in the vehicle handbook.
- There is limited support offered to the CRS through lack of contact with the supporting structures. E.g. poor or inadequate support is provided to CRS support legs or the support legs cannot be correctly positioned.

3.6 **CRS Installed Using Additional Tethers, Straps and Support Legs**

3.6.1 Ease of use of tethers & straps

This is an assessment of the ease of which the additional tether anchorages such as top tethers can be engaged with the vehicle, where applicable.

Procedure:

- Once the CRS has been attached to the vehicle with the belt or ISOFIX, any additional tethers, straps and corresponding anchorages or brackets shall be readied. Simple, preparatory actions such as lifting a dedicated flap or covering to expose the attachment point are permissible.
- The removal or repositioning of a parcel shelf or cover is allowable. It must be possible to replace these parts once the CRS installation has been completed.
- Head restraints may be repositioned or removed for CRS installation if instructed in the vehicle handbook.

The vehicle meets the requirements if all of the following are met:

- The top tether can be engaged and tightened easily, without having to carry out any further actions other than already mentioned
- Where equipped, any additional tethers can be easily attached to the anchorage and tightened, for example the front seat rail or any other attachment points.

The vehicle would not meet the requirements if any of the following occur:

- The strap(s) or tether(s) cannot be engaged without any further actions of vehicle adjustments, e.g. it would not be acceptable to tilt the rear seat forward to be able to engage the tether.
- The strap(s) or tether(s) pass through luggage or occupant space and prevent the use of other parts of the vehicle, including rear seats. Top tether straps that remain above the top of the vehicle seat back are acceptable.
- The strap(s) or tether(s) obstruct the function or movement of other parts of the vehicle, such as the front seats or luggage space.

3.6.2 Ease of use of support legs

This is an assessment of the vehicles ability to provide adequate support to any support legs, where applicable.

The vehicle meets the requirements if all of the following are met:

- The vehicle provides sufficient space to allow stable placement of any support legs.
- The support leg must be installed in the intended positions, for example fully locked out.
- The area upon which a support rests must also be capable of providing adequate restraint during an impact as described in ECE-TRANS-WP29-2012-53e and Regulation No 14.

The vehicle would not meet the requirements if any of the following occur:

- Poor or inadequate support is provided to CRS support legs or where the support leg cannot be positioned correctly due to interference from the front seat or other vehicle structures.
- The support leg cannot be fully locked out or cannot provide the intended level of support for any reason, such as due limited space.

3.7 CRS Installation Scoring

3.7.1 Each eligible CRS-seating position combination from the Installation Matrix will be deemed successful when the requirements of Section 3 are met. Where an integrated seat is provided for a similar age group as the respective CRS on the CRS Installation List, the case will be treated as if the CRS-seating combination meets the requirements of Section 3. Where the requirements of Section 3 are not met, the CRS-Seating position combination is considered as a fail.

3.7.2 The score for each individual CRS on the installation matrix will be calculated by dividing the number of successful installations in the vehicle by the total number of eligible positions in which it was fitted.

$$\text{The installation score CRS}_i = \sum \frac{T_i - F_i}{T_i}$$

T_i = Total number of eligible positions in the vehicle for the CRS_i.

F_i = Number of failed installations,

and where i = 1, ..., M; the total number of CRS on the extended Installation List.

- 3.7.3 Where the total number of eligible seating positions for any CRS equals zero, this CRS will not be considered as a ‘FAIL’ but it will get zero points in installation’.
- 3.7.4 Separate points will be given for fitment of the CRS from each category as follows:
 Installation listed CRS **10 points**
 OEM Recommended CRS **2 points**
- 3.7.5 The CRS score is calculated by taking the average of the CRS_i scores of all CRS on the original Installation List (excluding those exempted for all seating positions only for the case of single seat row cars) and applying the percentage to 10 points.
- 3.7.6 The OEM Recommended CRS score is calculated by taking the average of the CRS_i scores of the two recommend seats and applying the percentage to 2 points. The calculation is performed regardless whether the recommended CRS are taken from the original Installation List or not.
- 3.7.7 The resulting point scores are expressed as numbers, with 3 decimal points. The total score for CRS installation is the sum of the points for fitment of all CRS (see Table No. 1) below.
- 3.7.8 The maximum available score for the installation assessment will be 12 points and is independent on the number of seats on the CRS Installation List and recommended seats
- 3.7.9 If there is no recommendation for CRS, the maximum available score for CRS fitment will be **10 points**.

Table 1: Example of CRS installation scoring

CRS Installation Assessment				2nd row					3rd row				SCORING			
				Right	Left	Centre	Right	Left	Pass	Fail	Exempt	Score				
Reference List	Group 0+	Peg Perego Viaggio Switchable	B_ _ _	Exempt	Pass	Exempt	Pass	N/A	2	0	2	100.0%				
	Group 0+	Roemer Baby Safe	_ I _ I	Exempt	Pass	Exempt	Pass	N/A	2	0	2	100.0%				
	Group 0+	Bébé Confort Streety Fix / Maxi Cosi Citi SPS	B_ _ _	Exempt	Fail	Exempt	Fail	N/A	0	2	2	0.0%				
	Group I	Peg Perego Viaggio Switchable FWF	B_ _ _	Pass	Pass	Exempt	Pass	N/A	3	0	1	100.0%				
	Group I	Graco Cadeira Nautilus FWF	B_ _ _	Pass	Fail	Exempt	Fail	N/A	1	2	1	33.3%				
	Group II/III	Cybex Solution M-Fix	B_ _ _	Fail	Pass	Exempt	Pass	N/A	2	1	1	66.7%				
OEM	Group II/III	Graco Cadeira Nautilus	B_ _ _	Pass	Pass	Exempt	Pass	N/A	3	0	1	100.0%				
	Q1.5	Manufacturer CRS for Q1.5	_ I _ I	Exempt	Pass	Exempt	Pass	N/A	2	0	2	100.0%				
	Q3	Manufacturer CRS for Q3	_ I _ I	Exempt	Pass	Exempt	Pass	N/A	2	0	2	100.0%				
N/A																
SUMMARY																
Reference list				7.143												
OEM assessment				2.000												
Group 0+ and I coverage				PASS												
TOTAL INSTALLATION ASSESSMENT				9.143												

Note: Red/fail means safety critical issues exist, 0 points awarded;

4.0 DYNAMIC ASSESSMENT

The protection offered by the combination of vehicle and recommended CRS in the event of a crash is assessed by Q-series of child dummies in the full scale front and side impact test. This section is only applicable to vehicles equipped with rear seats; vehicles without rear seats shall be assessed according to Section 6.

4.1 Ejection

If the child dummy is ejected or partially ejected from the CRS at any time throughout the impact including rebound, that CRS is awarded zero points for its dynamic performance in front and side impact. If the CRS is partially or wholly unrestrained by any of the vehicle interfaces at any time throughout the impact including rebound, that CRS is awarded zero points for its dynamic performance in front and side impact. The vehicle interfaces for ISOFIX restraints are the two ISOFIX anchorages, top tether anchorage or any other means of rotation limiting device such as a support leg resting on the floor. Seat belt lock-offs, tethers, straps or any other attachments which are specifically used to anchor the CRS to the vehicle will also be penalised if their failure presents a risk of total or partial ejection of the child or child restraint. Ejection is an unusual and highly undesirable situation. The idea of “partial ejection” has been included to allow BHARAT NCAP to deal with situations where the dummy is only partly held within the restraint, such as: by a foot under the impact shield. Where the child dummy and CRS are fully restrained throughout the impact, points are awarded as given below.

- 4.1.1 Use of a FWF seat for Q1,5 the score will be reduced by 6 points, 4 for head and 2 for neck dynamic assessment.

CONCEPT: The child should be held securely in the restraint and not be ejected from the restraint

4.2 Head Contact with the Vehicle

- 4.2.1 If there is head contact with any part of the vehicle at any time throughout the impact including rebound, the CRS containing that dummy is awarded zero points for its head performance, in that test. This will reduce the maximum achievable number of points in that test to 4 points (neck and chest). Otherwise, points are awarded as given below

4.2.2 Frontal Impact

4.2.2.1 Head Contact with the CRS

Contact with the CRS is defined by either

Direct evidence of contact $Q1.5 \geq 80 \text{ g}$

Peak resultant acceleration $Q3 \geq 96 \text{ g}$

In the absence of contact:

Q1.5 and Q3 are awarded **4 points**

In the presence of contact, the score is based on the Head Resultant Acceleration, 3msec exceedance. Hard contacts occurring during the head rebound will not be considered.

Q1.5 4 points $\leq 72g$; 0 points $\geq 88g$

Q3 4 points $\leq 87g$; 0 points $\geq 100g$

Note: Between limit values, a sliding scale will be used, for this and other parameters

4.2.2.2 Head Excursion (Forward Facing CRS)

Where possible the maximum forward excursion of the head, relative to the Cr point, is estimated. If the forward excursion cannot be estimated, it will be deemed to be $\leq 549mm$; otherwise the points will be based on the following:

Q1.5 and Q3 **4 points** $\leq 549mm$; **0 points** $\geq 550mm$

If in future a more precise method of measuring head excursion becomes available, a sliding scale may be introduced. Again, in future, consideration may be given to basing the limits on internal geometry of the vehicle.

4.2.2.3 Head Exposure (Rearward Facing CRS)

CONCEPT: The CRS shell must be in a position to provide some energy absorption between the child's head and an intruding object at all times during the forward excursion of the dummy.

Where the following requirements are complied with, the Q1.5 and Q3 will be awarded 4 points

- a) No compressive loads shall be applied to the top of the head.
- b) The head must remain fully contained within CRS shell, during the forward movement of the dummy (i.e. the top of the head must not be exposed to the possibility of direct contact with parts of the vehicle)

4.2.2.4 Neck Tension

The neck tension assessment is based on the parameter detailed below.

Upper neck Fz

Q1.5 and Q3 **2 points** $\leq 1.70kN$; **0 points** $\geq 2.62kN$

4.2.2.5 Chest

The chest score is based on the chest resultant acceleration, as detailed below.

Chest resultant acceleration, 3msec exceedance

Q1.5 **2 points** $\leq 41g$; **0 points** $\geq 55g$

Q3 **2 points** $\leq 50g$; **0 points** $\geq 66g$

4.2.2.6 Overall Dynamic Score for Frontal impact

The Overall Dynamic Score for the Frontal Impact is calculated as:

Worst score from	Head Contact with the CRS (Section 4.3.1) Head Excursion (Section 4.3.1.2) Head Exposure (Section 4.3.1.3)	4 points
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+ Score from Neck Tension (Section 4.2.2.4)	2 points
+ Score from Chest (Section 4.2.2.5)	2 points

4.2.3 Side Impact

4.2.3.1 Head Containment

If the head is not contained within the shell of the CRS at any time throughout the impact including rebound, the CRS containing that dummy is awarded **zero points**. Otherwise, points are awarded as given in section 4.2.3.2 below.

“Contained” requires that some energy absorbing section of the side wing remains between the head and a virtual intruding vertical plane, representing the side structure of the vehicle. There must also be no fracturing of the CRS which might compromise the performance of the side wing of the CRS.

CONCEPT: *The CRS shell must be in a position to provide some energy absorption between the child’s head and an intruding vertical plane striking the seat from the struck side.*

4.2.3.2 Head Contact with the CRS

Contact with the CRS is defined by either:

Direct evidence of contact $Q1.5 \geq 80 \text{ g}$

Peak resultant acceleration $Q3 \geq 96 \text{ g}$

In the absence of contact: $Q1.5$ and $Q3$ are awarded 4 points

In the presence of contact, the score is based on the Head Resultant Acceleration,

3msec exceedance: $Q1.5$ and $Q3$ 4 points $\leq 72\text{g}$; 0 points $\geq 88\text{g}$

5.0 VEHICLE BASED ASSESSMENTS

All vehicle based assessments will be only performed on vehicles that meet the relevant fitment requirements at the time of assessment.

5.1 Provision of Three-point Seat Belts

If any passenger seat is not equipped with three-point automatic lap and diagonal seatbelts and/or they do not meet UN or Indian standard regulations, 0 points shall be awarded for the vehicle based assessments.

CONCEPT: *All forward or rearward facing seats should be equipped with a three-point automatic belt that meets a technical standard.*

5.2 Gabarit Installation on all Passenger Seats

Where all other passenger seats are in compliance with the requirements in section 5.2.2 which are based on UN Regulation 16.05 [2], 2 points shall be awarded to the Child Protection score

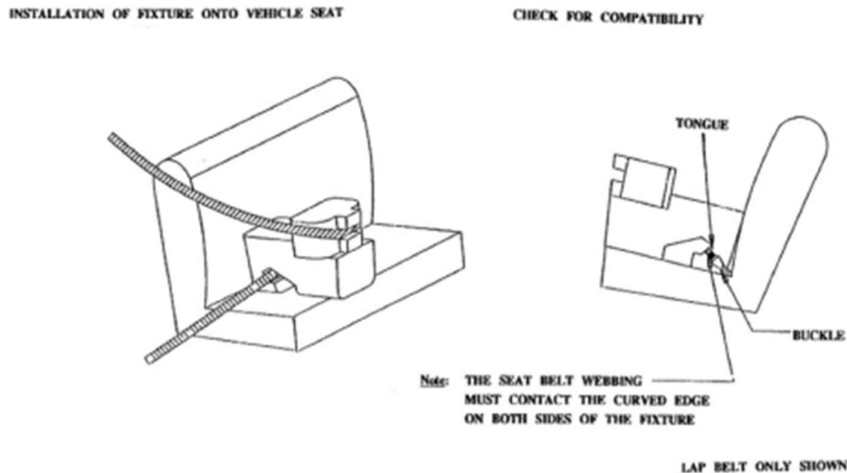
5.2.1 To assess compliance, the Gabarit, as specified in APPENDIX II to this Annexure, shall be installed on all passenger seats according to the following procedure:

- Adjust the seat to its fully rearward and lowest position, the seat back to an angle of 25 degrees from the vertical or nearest fixed position and the upper seat belt

anchorage to its lowest position. Adjustable rear seats shall be set fully rearward.

- If alternative seat, seat-back or safety-belt anchorage adjustments are to be used for either front or rear seats when installing CRS, information about the alternative position must be included in the Vehicle Handbook giving the information required in 5.2.2f). Where this information is provided, set the seat to this position.
- Place a cotton cloth on the seat-back and cushion.
- Place the Gabarit on the vehicle seat.
- Arrange the safety-belt strap around the fixture in approximately the correct position as shown in Figures 1 and 2, and then latch the buckle.
- Ensure that the fixture is located with its centreline on the apparent centreline of the seating position ± 25 mm with its centreline parallel with the centreline of the vehicle.
- Ensure that all webbing slack is removed. Use sufficient force to remove the slack, do not attempt to tension the webbing.
- Push rearwards on the centre of the front of the fixture with a force of $100 \text{ N} \pm 10 \text{ N}$, applied parallel to the lower surface, and remove the force.
- Push vertically downwards on the centre of the upper surface of the fixture with a force of $100 \text{ N} \pm 10 \text{ N}$ and remove the force.

Figure 1



5.2.2 Requirements:

- a) With correct routing of the adult seat belt around the Gabarit, the base of the Gabarit shall contact both the forward and rearward parts of the seat cushion upper surface. If such contact does not occur due to the belt access gap in the Gabarit, this gap may be covered in line with the bottom surface of the Gabarit.
- b) The lap portion of the belt shall touch the fixture on both sides at the rear of the lap belt path.
- c) There shall be sufficient seat belt webbing to fit around the entire Gabarit while allowing the contact between the Gabarit and both the forward and rearward

parts of the seat cushion upper surfaces.

- d) Once the belt is correctly routed around the fixture, it should be possible to draw a further 150mm of belt webbing from the reel.
- e) With the Gabarit in position and the buckle fastened, it must be possible to establish a tension of at least 50 N in the lap section of the belt by external application of tension in the diagonal section of the belt in the direction of the upper seat belt guide. This may result in movement of the lower anchorages and/or buckles from their anticipated 'design position'. For example, the tension may cause the lap section of the belt to slide between the rear of the seat base and bottom of the seat back, hence shortening the length of the lap section. However, if this is considered to be achievable through 'normal use' then the assessment will be made with the anchorage/buckle in this position.

To achieve the 1 point for all seating passenger positions, the following requirements must be met in addition to those detailed above:

- f) The Vehicle Handbook must indicate which passenger seats are suitable for use with a Group 0 and Group 1 CRS.
- g) Where a passenger frontal airbag is fitted, the vehicle handbook must clearly indicate that when the passenger airbag is active the seat is NOT suitable for RWF CRS as well as indicating that it is suitable for CRS when the airbag has been disabled.
- h) Where a passenger frontal airbag is fitted, it must be possible to activate and deactivate the passenger airbag, either automatically or manually. The requirements of Section 5.6 need not be met to qualify for this award, but airbag disabling equipment must be standard.

5.3 **Three Simultaneous Use Seating Positions**

5.3.1 Where the vehicle is provided with three seating positions that can simultaneously accommodate any combination of the CRS in the Installation List covering Groups 0 to III, 1 point shall be awarded to the Child Protection score. A combination of three CRS will be used to assess this, which may be proposed by the vehicle manufacturer.

5.3.1.1 If the assessment includes the front passenger seat, it must be possible to activate and deactivate the passenger airbag, either automatically or manually for RWF CRS. The requirements of Section 5.6 need not be met to qualify for this award, but airbag disabling equipment must be standard. Car Manufacturer recommended combinations of CRS and seating positions will be considered where provided.

5.3.1.2 There must be sufficient space within the vehicle to accommodate simultaneously the CRS and relevant sized child dummies. For example, if the handbook recommends that the front passenger seat is moved fully rearward, it must not prevent the relevant CRS and child from being installed on the seating position behind.

5.3.1.3 Where the vehicle is provided with three seating positions that can simultaneously accommodate i-Size CRS, 1 point shall be awarded to the Child Protection score. For a period of 3 years after i-Size is adopted within Regulation, it will only be necessary for the vehicle to meet the geometric and strength testing requirements of Regulations UN 14 or and 16.

5.4 ISOFIX Usability

Where two passenger follow the following requirements (detailed in A, B and C simultaneously), up to 2 points shall be awarded to the Child Protection score. If the vehicle is a 2 seater, then only the passenger seat(s) is required to meet the requirements.

CONCEPT: The car must have ISOFIX according to UN regulation, the user of a vehicle equipped with ISOFIX anchorages should be made aware of the existence and location of the anchorages, including any top tether anchorages.

- A) ISOFIX system is present and approved according to UN14 or AIS-182
- B) When the requirement in A) is met and the car meets the following requirements: 1 point shall be awarded to the Child Protection Score.
 - a) Each seat which is equipped with ISOFIX anchorages must be marked. It must be clear which pairs anchorages should be used together.
 - b) The location of each ISOFIX anchorage must be marked.
 - c) The location of each top tether anchorage must be marked.
 - d) The ISOFIX and top tether markings must include both text and a pictogram.
 - e) All markings must be of conspicuous design and both the text and pictogram must have colours which contrast with their background.
 - f) All markings must be permanently visible. Flag type labels are not acceptable.
 - g) All marking must be permanently attached to the vehicles.
 - h) ISOFIX relevant information must be presented in the vehicle handbook.

C) When the i-size requirements are met [i-size ready] by the ISOFIX system and requirements in A) and B) are met then 1 extra point shall be awarded to the Child Protection Score

Where i-Size seating positions are offered, they need to comply with the following marking requirements to be eligible for scoring the available points specified below.

- a) The location of each i-Size anchorage must be marked.
- b) The location of each top tether anchorage must be marked and include both text and a pictogram.
- c) The i-Size markings must show the relevant i-Size pictogram detailed in UN Regulation 14, Annex 10. It is allowed to add the word ISOFIX adjacent to the i-Size pictogram.
- d) All markings must be of conspicuous design and both the text and pictogram must have colours which contrast with their background.
- e) All markings must be permanently visible. Flag type labels are not acceptable.
- f) All marking must be permanently attached to the vehicle.

Summary

Meeting just A will award 0 point. Meeting just A and B will award 1 point

Meeting A, B and C will award 1 extra point
A is a precondition to B and B a precondition to C.

5.5 **Two or more Largest ISOFIX Positions**

Where two seating positions are in compliance with the following requirements, 1 point shall be awarded to the Child Protection score

CONCEPT: *Vehicles in which at least two ISOFIX positions are capable of accommodating the largest size of rearward-facing ISOFIX CRS should be rewarded*

- a) For vehicles with rear seats, two or more passenger seats are suitable for simultaneous use with the largest size of rearward facing (Class C) ISOFIX CRS, Fixture (CRF) ISO/R3.

Note: When checking a CRF on a rear seat, the vehicle seat located in front of this rear seat may be adjusted longitudinally forward but not further than the mid position between its rearmost and foremost positions. The seat backrest angle may also be adjusted, but not to a more upright angle than corresponding to a torso angle of 15 degrees.

- b) For vehicles without rear seats, one or more passenger seats are suitable for simultaneous use with the largest size of rearward facing (Class C) ISOFIX CRS, Fixture (CRF) ISO/R3
- c) This information must be presented in the vehicle handbook.

5.6 **Passenger Airbag Warning Marking and Disabling**

If the vehicle is fitted with a serial front seat passenger's frontal protection airbag, and is marked with a permanent airbag warning label that meets either the requirements of the Child protection protocol or UN Regulation 94 latest version, and the requirements of Section 5.6.1 are met, a maximum of 4 points will be awarded.

Alternatively, 3 points will be awarded where a label meets the above requirements and those of Section 5.6.2 are met

When no passenger airbag disconnection is possible and the permanent airbag warning label meets either the requirements of the Child protection protocol version 1.0 or Regulation 94, **1 point** shall be awarded.

CONCEPT: *A warning regarding the hazard posed by a frontal protection air bag to the occupant of a rearward-facing child restraint should be permanently and explicitly marked on the vehicle and be designed to last the lifetime of the vehicle.*

The vehicle should make provision for the safe carrying of a child in a rearward facing CRS in the front passenger seat, without additional actions by the installer.

Where a manual switch is used to disable the airbag, precautions should be taken to ensure that the switch cannot be operated by a child, without the knowledge of the driver.



Where BHARAT NCAP refers to the airbag deactivation components as 'the system', this refers to the switch, airbag status indicator, airbag and any other components associated with the deactivation of the airbag.

- 5.6.1 The airbag can be de-activated manually and the following requirements are met, **2 extra points** will be awarded:

General requirements:

- a) Any text, labelling and instructions in relation to airbag disabling must be permanently attached to the vehicle
- b) The information provided must be clear, without reference to the vehicle's handbook or other source.
- c) There must be no possibility of the users being given false information.

Airbag status indicator requirements:

- d) Easily visibly information and warnings must be provided for the driver and front seat passenger, showing the status of the airbag
- e) The status indicator must be labelled with the words 'Passenger AIRBAG OFF/ON'. Abbreviations such as 'Pass', 'AB' or any other combination is NOT acceptable.
- f) The AIRBAG ON pictogram must be based upon that of the sun visor label (ECE R94 or AIS-098) as shown:
 
- g) The AIRBAG OFF pictogram must be based upon that detailed in ECE R121 as shown
 
- h) Slight alterations to the ON/OFF pictograms above are acceptable provided that the basic geometry of the pictogram remains the same. Mirroring and monochrome colours are acceptable.
- i) If the information to indicate that the airbag is enabled is provided by an illuminated signal, the signal is only required to be illuminated for a period of 60 seconds after the ignition is switched on.
- j) Information to indicate that the airbag is disabled must be permanently displayed, when the ignition is on.
- k) If at any time the airbag is switched from the OFF position to the ON position, the status indicator showing that the airbag is ON must signal this immediately after checking period for at least 60 seconds, regardless of the length of time the ignition has been switched on, or until the ignition is switched off again.

Manual airbag deactivation requirements:

- l) Where a switch is used, it must be labelled with the words 'Passenger AIRBAG OFF/ON' and the same pictograms detailed above indicating ON and OFF.
- m) The individual switch positions must be marked with the same pictograms that are used to indicate the airbag status. The two positions must be marked with the text ON & OFF along with the corresponding pictogram.
- n) Where the two switch positions are marked not on the switch but on an adjacent label, the label must be sufficiently close to the switch, such that the user clearly associates one with the other.

- o) Where a hardware switch is used, it must be accessible and clearly visible when installing CRS.

For example, where a switch is located in the glove box, the presence of the switch must be clearly highlighted either by switch itself or an additional, permanent, label when the lid is open. For example, the switch may not be located on the driver's side of the vehicle.

- p) It must not be possible for a rearward facing child; restrained on the front passenger seat; to operate the switch at any time.
- q) Where a software based switch is used, clear instructions detailing 'Passenger AIRBAG OFF/ON' (no abbreviations) must be presented in the menu at the same time as the corresponding pictograms used for the status indicator.
- r) If, with the ignition on and with engine running or not, the airbag status can be changed, the system must react correctly to the change immediately. Systems will be checked once the vehicle diagnostics/ system checks have been completed.

5.6.2 If the vehicle is equipped with a system which automatically switches the airbag off for ANY rearward facing CRS and obviates any risk associated with airbag deployment, **3 extra points** will be awarded

- a) The General and Airbag status indicator requirements detailed in Section 5.6.2 are met.
- b) If, with the ignition on and with engine running or not, the airbag status can be changed, the entire system must react correctly to the change immediately. Systems will be checked once the vehicle diagnostics/system checks have been completed.
- c) The system must automatically re-activate the airbag when an adult occupant occupies the seat.

Summary:

Passenger Airbag as standard:

Label not Ok: total 0 point.

Label Ok, but no airbag disconnection: total 1 point.

Manual disconnection possible and label OK: total 3 points (Label is pre-condition)

Automatic disconnection possible and label OK: total 4 points (Label is pre-condition)

5.7 **Integrated Child Restraints**

5.7.1 Where the vehicle is provided with an integrated CRS as standard equipment, 1 point shall be awarded to the Child Protection score. For vehicles without rear seats, 1 point will be awarded in case one or more passenger seats are provided with integrated CRS

5.7.2 Where the vehicle is provided with one or more "Group I-III" integrated CRS, as standard equipment, 1 additional point shall be awarded to the Child Protection score. For vehicles without rear seats, 1 point will be awarded in case one or more passenger seats are provided with integrated CRS.

6.0 TWO SEATERS AND VEHICLES WITH LIMITED REAR SPACE

This Section details how protection for children is assessed by BHARAT NCAP in vehicles equipped with two seats and in vehicles where space is limited in the rear

6.1 Vehicles with only Two Seats

6.1.1 CRS installation assessment

6.1.1.1 The “Installation CRS List” and any car manufacturer recommended seats will be installed on the passenger seats as detailed in Section 3. Where the passenger seat is able to meet the requirements of Sections 3.3, 3.4 and 3.5 for CRS the vehicle will be awarded **12 points**. The score will be calculated as described in Section 3.7.

6.1.1.2 All groups (0-III) are represented by the CRS Installation List and the car must pass the installation for all these CRS. Exemptions by user manual will only be accepted when there is sufficient technical evidence to justify the excluded position. For example, positions where 3-point belts can be installed, 2 points belts will be rated as “Fail” independently from manual indications.

6.1.1.3 When the manufacturer exempts the front passenger seat, **0 points** will be awarded for the CRS installation assessment.

6.1.2 Dynamic assessment

6.1.2.1 For two seater sports cars there will be no dynamic assessment, therefore the maximum number of points is 12+10.

6.1.2.2 To ensure that these vehicles are not penalised for having no dynamic assessment, the relative score weighting of the available assessments remains the same between the applicable assessments. The score out of 22 points for two seaters is scaled to be equivalent to any other vehicle that is assessed out of the full 49 points.

6.1.3 Vehicle based assessments

6.1.3.1 The following vehicle based assessments will be applied to two seater vehicles: (Expected that no front passenger seat to be equipped with only a 2 point belt)

6.1.3.2 Gabarit Installation on all Passenger Seats

When the passenger seat is in compliance with the requirements in Section 5.2.2, 1 point shall be awarded to the Child Protection score.

6.1.3.3 ISOFIX Usability

When the passenger seat is in compliance with the requirements, **2 points** shall be awarded to the Child Protection score.

6.1.3.4 Largest ISOFIX Positions

When the passenger seat can accommodate a largest ISOFIX, **1 point** shall be awarded to the Child Protection score.

6.1.3.5 Passenger Airbag Warning Marking and Disabling

When the vehicle is in compliance with the requirements, a maximum of **4 points** shall be awarded to the Child Protection score.

6.1.3.6 Integrated Child Restraints

When the vehicle is provided with an integrated CRS as standard equipment, **1 point** shall be awarded to the Child Protection score. Where the vehicle is provided with one “Group I-III” integrated CRS as standard, **1 additional point** shall be awarded to the Child Protection score.

- 6.1.4 Two seater vehicles with passenger airbag that are not equipped with a passenger airbag deactivation switch will not be eligible to score in the vehicle based assessments. Where this is the case, the vehicle based assessment will be **0 points**.

6.2 Vehicles with Limited Rear Space

Vehicles will be considered as having limited rear space when the normal CRSs recommended by the car manufacturer cannot be installed with the front seats in the BHARAT NCAP Frontal ODB impact test position. Where this is the case, the vehicle manufacturer should provide evidence showing that the CRS and/or child cannot be installed without interference from the vehicle.

6.2.1 CRS installation assessment

- 6.2.1.1 The CRS Installation List seats and any car manufacturer recommended seats will be installed on the passenger and rear seats as detailed in Section 3, using the front seat settings as specified in the vehicle handbook. Where the passenger seat is able to meet the requirements of Sections 3.3, 3.4 and 3.5 for CRS the vehicle will be awarded 12 points. The score will be calculated as described in Section 3.7.

6.2.2 Dynamic assessment

- 6.2.2.1 When a car manufacturer wishes to avoid being awarded zero points for the CRS dynamic assessments, data from additional full scale frontal and side impact tests may be provided by the car manufacturer. These tests shall be performed using the appropriate CRS with the front seats positioned as required to allow for installation of the CRS. This front seat position should be mentioned in the vehicle handbook. The tests must be equivalent to the BHARAT NCAP front and side impact tests and contain an equivalent level of instrumentation. Adult dummies are not required. It is the responsibility of the vehicle car manufacturer to ensure that adequate film coverage of the impact, and specifically child head excursion and head containment, is provided.

A “hybrid rating” would be produced using the adult data from the normal full scale test (performed without CRS) and the child data from the additional tests. In the final vehicle rating, BHARAT NCAP will indicate that it was not possible to install the CRS with and adult in the normal BHARAT NCAP front seat test position. A maximum of **24 points** can be achieved.

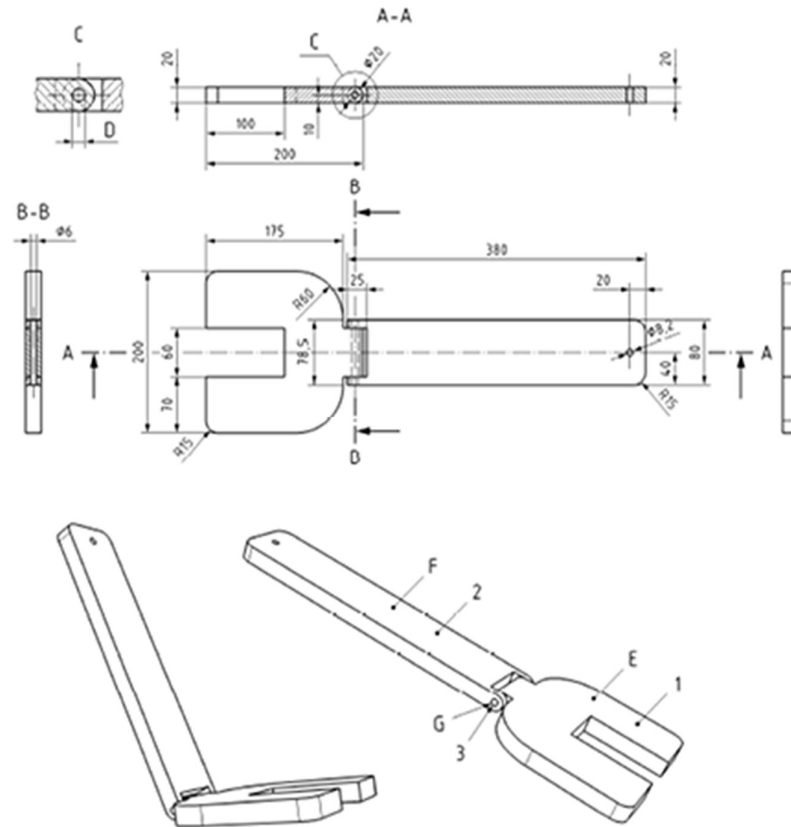
6.2.3 Vehicle based assessment

All vehicle based assessments will apply as detailed in Section 5 and be assessed out of a maximum **13 points**.

APPENDIX – I

ANGLE MEASURING DEVICE

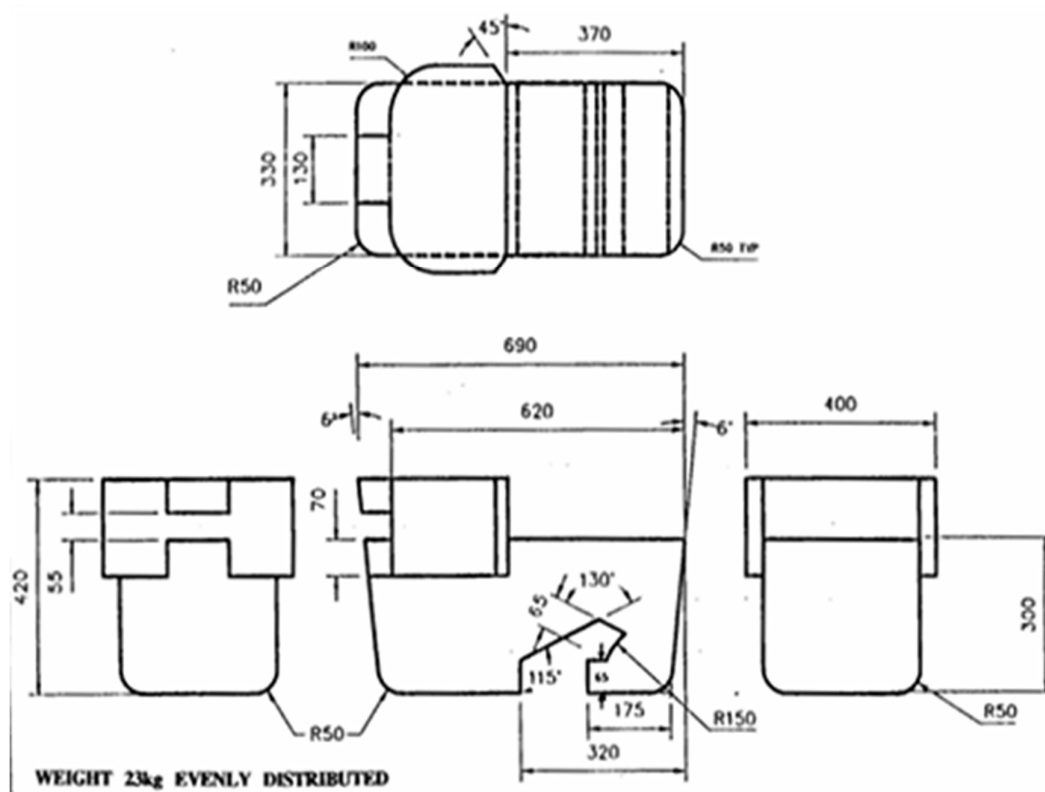
A 9 kg articulated steel device used to measure the angle between the seat and the backrest. Extract taken from EN1888:2012: Child care articles - Wheeled child conveyances – Safety requirements and test methods.



KEY

- 1 part to be placed onto the seat surface made of steel.
- 2 part to be placed onto the backrest surface made of steel.
- 3 hinge pin made of steel.
- E mass: 4495 ± 50 g.
- F mass: 4501 ± 50 g.
- G mass of hinge axle: $17 \pm 0,5$ g, length: 79,5 mm.
- Total mass tolerance: $(9 \pm 0,1)$ kg dimensions tolerance: ± 2 mm.
- All edges shall be chamfered.

**APPENDIX – II
GABARIT SPECIFICATION**



All dimensions are in mm

APPENDIX – III

REFERENCE CRS LIST FOR INSTALLATION TESTS

Sr. No	Reference CRS	Representative Age Group
1.	Peg Perego Viaggio Switchable FWF and RWF (Belted)	Group 0+/1
2.	Roemer Babysafe Plus w/Isofix base (ISOFIX/support Leg)	Group 0+
3.	Maxi Cosi Citi SPS (belted)	Group 0+
4.	Graco Cadeira Nautilus, (belted)	Group I/II/III
5.	Cybex Solution M-Fix (Belted / ISOFIX)	Group II/III

ANNEXURE -VI
REQUIREMENTS FOR SAFETY ASSIST TECHNOLOGIES
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1.0 INTRODUCTION

This annexure lays down the conditions for additional requirements for achieving the STAR RATING on the basis of fitment of 'SAFETY ASSIST TECHNOLOGIES'.

Table 1 below specifies the fitment requirements for Safety Assist Technologies and requirements applicable for the same.

Table 1 – Safety Assist Technologies

Sr. No	Safety Assist Technologies	1-STAR	2-STAR	3-STAR	4-STAR	5-STAR
1.	Electronic Stability Control	Optional	Optional	Yes (Refer Section 4.1)	Yes (Refer Section 3.1)	Yes (Refer Section 2.1)
2.	Side Head Protection	Optional	Optional	Yes (Refer Section 4.2)	Yes (Refer Section 3.2)	Yes (Refer Section 2.2)
3.	Pedestrian Protection	Meeting AIS-100 as applicable				
4.	Seat Belt Reminder	Meeting AIS-145				

2. REQUIREMENTS FOR 5-STAR PERFORMANCE

2.1 ESC (Electronic Stability Control)

- The test model shall be fitted with Electronic Stability Control (ESC).
- To demonstrate functionality, the car manufacturer shall sponsor an ESC test according to the UN GTR No.8 or UNECE R140 or AIS-133 test conditions and pass/fail requirements or shall submit a valid Type Approval Report issued by designated Test Agencies in accordance to AIS 133
- Vehicle manufacturer shall commit to install the ESC in 100% of the units of this model in no more than 2 years after the result publication. During the 2 years period the ESC must be offered as “stand alone” optional (not linked to other equipment or packages in all variants) until the 100% of units are equipped with ESC.

2.2 Side Head Protection

- A side head protection system shall be fitted on the test model and fulfilling the fitment requirements described below. Where no side head protection systems are present, the pole test will not be allowed.
- Note: The requirement is for the fitment of a side head protection system, meaning that the manufacturer is free to use a solution other than an airbag. However, for technologies other than conventional curtain or side head airbags, the manufacturer is requested to provide evidence that the system is effective, at least in principle, before a test can be allowed.
- To demonstrate functionality, a side pole test must be performed to Annexure III at the designated test agency.
- The side head protection shall be fitted in a minimum of the total production volume as given below as standard fitment. Further, as from Oct. 2027 it shall be fitted in 100% of the units of this model.

Side head protection minimum fitment per publication year

Oct.2023 to Sept. 2024	Oct.2024 to Sept. 2025	Oct.2025 to Sept. 2026	Oct.2026 to Sept. 2027
30%	50%	70%	90%

2.3 Pedestrian Protection

The test model shall be standard fitted with Pedestrian Protection Systems as in accordance to AIS-100. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-100 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-100 as amended from time to time.

2.4 Seat Belt Reminder (SBR)

The test model shall be standard fitted with SBR systems in accordance to AIS-145. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-145 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-145 as amended from time to time.

3.0 REQUIREMENTS FOR 4-STAR PERFORMANCE

3.1 ESC (Electronic Stability Control)

- The test model shall be fitted with Electronic Stability Control (ESC).
- To demonstrate functionality, the car manufacturer shall sponsor an ESC test according to the UN GTR No.8 or UNECE R140 or AIS-133 test conditions and pass/fail requirements or shall submit a valid Type Approval Report issued by designated Test Agencies in accordance to AIS 133
- Vehicle manufacturer shall commit to install the ESC in 100% of the units of this model in no more than 2 years after the result publication. During the 2 years period the ESC must be offered as “stand alone” optional (not linked to other equipment or packages in all variants) until the 100% of units are equipped with ESC.

3.2 Side head protection

- A side head protection system shall be fitted on the test model and fulfilling the fitment requirements described below. Where no side head protection systems are present, the pole test will not be allowed.
- Note: The requirement is for the fitment of a side head protection system, meaning that the manufacturer is free to use a solution other than an airbag. However, for technologies other than conventional curtain or side head airbags, the manufacturer is requested to provide evidence that the system is effective, at least in principle, before a test can be allowed.
- To demonstrate functionality, a side pole test must be performed to Annexure III at the designated test agency.
- The side head protection shall be fitted in a minimum of the total production volume as given below as standard fitment. Further, as from October 2030 it shall be fitted in 100% of the units of this model

Side head protection minimum fitment per publication year

Oct.2023 to Sept. 2024	Oct.2024 to Sept. 2025	Oct.2025 to Sept. 2026	Oct.2026 to Sept. 2027
Side head protection optional in at least one variant of the model	Side head protection optional in at least one variant of the model	30%	50%

3.3 Pedestrian Protection

The test model shall be standard fitted with Pedestrian Protection Systems as in accordance to AIS-100. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-100 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-100 as amended from time to time.

3.4 Seat Belt Reminder (SBR)

The test model shall be standard fitted with SBR systems in accordance to AIS-145. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-145 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-145 as amended from time to time.

4.0 REQUIREMENTS FOR 3-STAR PERFORMANCE

4.1 ESC (Electronic Stability Control)

- From October 2023 to September 2025 ESC shall be optional without a minimum fitment rate. From October 2025 onwards identical requirements as set in section 2.1 shall apply

4.2 Side Head Protection

- From October 2023 to October 2027 the models must offer side head protection as optional in at least one variant.
- To demonstrate functionality, a side pole test must be performed to Annexure III at the designated test agency.

4.3 Pedestrian Protection

The test model shall be standard fitted with Pedestrian Protection Systems as in accordance to AIS-100. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-100 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-100, as amended from time to time.

4.4 Seat Belt Reminder (SBR)

The test model shall be standard fitted with SBR systems in accordance to AIS-145. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-145 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-145, as amended from time to time.

5.0 REQUIREMENTS FOR 2-STAR PERFORMANCE**5.1 ESC (Electronic Stability Control) – Optional****5.2 Side Head Protection – Optional****5.3 Pedestrian Protection**

The test model shall be standard fitted with Pedestrian Protection Systems as in accordance to AIS-100. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-100 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-100 as amended from time to time.

5.4 Seat Belt Reminder (SBR)

The test model shall be standard fitted with SBR systems in accordance to AIS-145. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-145 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-145 as amended from time to time.

6.0 REQUIREMENTS FOR 1-STAR PERFORMANCE**6.1 ESC (Electronic Stability Control) – Optional****6.2 Side Head Protection – Optional****6.3 Pedestrian Protection**

The test model shall be standard fitted with Pedestrian Protection Systems as in accordance to AIS-100. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-100 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-100 as amended from time to time.

6.4 Seat Belt Reminder (SBR)

The test model shall be standard fitted with SBR systems in accordance to AIS-145. To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-145 or shall submit a valid Type Approval Report issued by notified Test Agencies in accordance to AIS-145 as amended from time to time.

ANNEXURE -VII
MODIFIERS FOR BHARAT NCAP
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1. INTRODUCTION

This annexure specifies the various modifiers that will be applicable for the full vehicle crash tests conducted under BHARAT NCAP. Modifiers will be applicable as per the detailed criteria specified below and will lead to moderation in the overall score achieved by the new vehicle.

2. MODIFIERS FOR FRONTAL IMPACT

2.1 Driver

The score generated from driver dummy data may be modified where the protection for different sized occupants or occupants in different seating positions, or accidents of slightly different severity, can be expected to be worse than that indicated by the dummy readings or deformation data alone. There is no limit to the number of modifiers that can be applied, neither per body region nor in total amount. The concepts behind the modifiers are explained in Section 2.3.

2.1.1 Head

2.1.2 Unstable Contact on The Airbag

If during the forward movement of the head, its centre of gravity moves further than the outside edge of the airbag, head contact is deemed to be unstable. The score is reduced by one point. If for any other reason head protection by the airbag is compromised, such as by detachment of the steering wheel from the column, or bottoming-out of the airbag by the dummy head, the modifier is also applied. In case the head contacts any interior part of the car, excluding the rebound phase, the modifier will also be applied e.g. the dashboard.

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

2.1.3 Hazardous Airbag Deployment

If, within the head zone, the airbag unfolds in a manner in which a flap develops, which sweeps across the face of an occupant vertically or horizontally the -1 point modifier for unstable airbag contact will be applied to the head score. If the airbag material deploys rearward, within the “head zone” at more than 90 m/s, the -1 point modifier will be applied to the head score.

2.1.4 Incorrect Airbag Deployment

Any airbag(s) which does not deploy fully in the designed manner will attract a -1 point modifier applicable to each of the most relevant body part(s) for the affected occupant. For example, where a steering wheel mounted airbag is deemed to have deployed incorrectly, the penalty will be applied to the frontal impact driver's head (-1). Where, a passenger knee airbag fails to deploy correctly, the penalty will be applied to the frontal impact passenger left and right knee, femur and pelvis (- 1). Where the incorrect deployment affects multiple body parts, the modifier will be applied to each individual body part. For example, where a seat or door mounted side airbag deploys incorrectly in the frontal impact that is intended to provide protection to the head as well as the thorax, abdomen and pelvis, the penalty will be applied to two body regions, -1 to the head and -1 to the chest.

The modifier(s) will be applied to the scores of the impacts for which the airbag was intended to offer protection, regardless of the impact in which it deployed incorrectly. For example, the penalty will be applied if a seat mounted side airbag deploys incorrectly in the frontal impact. Where any frontal protection airbag deploys incorrectly, the Designated Agency will not accept knee mapping data for that occupant.

2.1.5 Displacement of The Steering Column

The score is reduced for excessive rearward, lateral or upward static displacement of the top end of the steering column. Up to 90 percent of the EEVC limits, there is no penalty. Beyond 110 percent of the EEVC limits, there is a penalty of -1 point. Between these limits, the penalty is generated by linear interpolation. The EEVC recommended limits are: 100mm rearwards, 80mm upwards and 100mm lateral movement. The modifier used in the assessment is based on the worst of the rearward, lateral and upward penalties.

2.1.6 Chest

2.1.6.1 Displacement of the A Pillar

The score is reduced for excessive rearward displacement of the driver's front door pillar, at a height of 100mm below the lowest level of the side window aperture. Up to 100mm displacement there is no penalty. Above 200mm there is a penalty of -2 points. Between these limits, the penalty is generated by linear interpolation.

2.1.6.2 Integrity of the Passenger Compartment

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

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

2.1.6.3 Asymmetry of reinforcements

In the Frontal Impact Test, in case of asymmetry (reinforcements, layers, and spot welds density) Test Agencies will apply modifiers for structural instability and footwell area. The manufacturer can always show evidence of a passenger side ODB test to have the modifiers removed. For the Side Impact and Pole impact tests, T12 and Backplate load modifiers will be applied under the same concept. No CAD data will be accepted as evidence. When this modifier is applied, knee mapping data will not be accepted

2.1.6.4 Steering Wheel Contact

Where there is obvious direct loading of the chest from the steering wheel, a -1 point penalty is applied

2.1.6.5 Shoulder Belt Load

Where the shoulder belt load measured exceeds 6kN, -2 point penalty is applied for the chest.

2.1.7 Knee, Femur & Pelvis

2.1.7.1 Variable Contact

The position of the dummy's knees is specified by the test protocol. Consequently, their point of contact on the facia is pre-determined. This is not the case with human drivers, who may have their knees in a variety of positions prior to impact. Different sized occupants and those seated in different positions may also have different knee contact locations on the facia and their knees may penetrate into the facia to a greater extent. In order to take some account of this, a larger area of potential knee contact is considered. If there is contact at other points within this greater area, more aggressive penalties are applied. The area considered extends vertically 50mm above and below the maximum height of the actual knee impact location. Vertically upwards, consideration is given to the region up to 50mm above the maximum height of knee contact in the test. If the steering column has risen during the test it may be repositioned to its lowest setting if possible. Horizontally, for the outboard leg, it extends from the centre of the steering column to the end of the facia. For the inboard leg, it extends from the centre of the steering column the same distance inboard, unless knee contact would be prevented by some structure such as a centre console. Over the whole area, an additional penetration depth of 20mm is considered, beyond that identified as the maximum knee penetration in the test. The region considered for each knee is generated independently. Where, over these areas and this depth, femur loads greater than 3.8kN and/or knee slider displacements greater than 6mm would be expected, a -1 penalty is applied to the relevant leg.

2.1.7.2 Concentrated Loading

The biomechanical tests, which provided the injury tolerance data, were carried out using a padded impactor which spread the load over the knee. Where there are structures in the knee impact area which could concentrate forces on part of the knee, a -1 point penalty is applied to the relevant leg. Where a manufacturer is able to show, by means of acceptable test data, that the Variable Contact and/or Concentrated Loading modifiers should not be applied, the penalties may be removed.

If the Concentrated load modifier is not applied to any of the driver's knees, the left and right knee zones (defined above) will both be split into two further areas, a 'column' area and the rest of the fascia. The column area for each knee will extend 75mm from the centreline of the steering column and the remainder of the fascia will form the other area for each knee. As a result, the -1 point penalty for Variable Contact will be divided into two with one half of a point being applied to the column area and one half of a point to the remainder of the fascia for each knee.

2.1.7.3 Removal of Knee Modifiers

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

- The driver and front passenger's head, neck, chest score are orange, yellow or green.
- Femur loads <3.8kN in the full vehicle test.
- Knee Slider <6mm in the full vehicle test.
- No structural modifiers applied i.e. integrity of the passenger compartment and/or footwell rupture.
- A-pillar displacements must be below 65mm (using the standard Euro NCAP measurement).

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

2.1.8 Lower Leg

Upward Displacement of the Worst Performing Pedal

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

2.1.9 Foot & Ankle

2.1.9.1 Footwell Rupture

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

2.1.9.2 Pedal Blocking

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

2.2 Passenger

The score generated from passenger dummy data may be modified where the protection for different sized occupants or occupants in different seating positions, or accidents of slightly different severity, can be expected to be worse than that indicated by the dummy readings alone. There is no limit to the number of modifiers that can be applied. The concepts behind the modifiers are explained in section 2.3. The modifiers applicable to the passenger are:

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

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

2.3 Door Opening during the Impact

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

2.4 Door Opening Forces after the Impact

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

Door opening forces are categorized as follows:

Opens normally	Normal hand force is sufficient.
Limited force	$\leq 100\text{N}$
Moderate force	$> 100\text{N}$ to $< 500\text{N}$
Extreme hand force	$\geq 500\text{N}$
Tools had to be used	Tools necessary

2.5 **Fuel Leakage**

2.5.1 In the case of liquid fuel vehicle, fuel leakage (exceeding 30g/min) after the crash test, -1-point modifier will be included in the ODB full score.

2.5.2 In case of Electric Vehicle / Hybrid Vehicles, after the official BHARAT NCAP crash tests a compliance check will be made to assess if the post-crash requirements from AIS-098, for EVs and Hybrids have been met. A maximum -1-point penalty will be applied if it is not compliant.

3. SIDE IMPACT

3.1. Incorrect Airbag Deployment

Any airbag(s) which does not deploy fully in the designed manner will attract a -1 point modifier applicable to each of the most relevant body part(s) for the affected occupant.

For example, where a head curtain airbag is deemed to have deployed incorrectly, the penalty will be applied to the side impact driver's or passenger's head (-1). Where the incorrect deployment affects multiple body parts, the modifier will be applied to each individual body part. For example, where a seat or door mounted side airbag fails to deploy correctly that is intended to provide protection to the head as well as the thorax, abdomen and pelvis, the penalty will be applied to two body regions, the head (-1) and the chest (-1).

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

3.2. Backplate Loading

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

Higher performance limit: F_y	1.0 kN
Lower performance limit: F_y	4.0 kN

3.3 T12 Modifier

Where the T12 loads F_y and M_x exceed 2.0kN or 200Nm respectively, a two point penalty is applied to the driver's or passenger's chest assessment. Between 1.5kN – 2.0kN or 150Nm – 200Nm the penalty is calculated using a sliding scale from 0 to 2 points. The assessment is based upon the worst performing parameter. Only loads which are transmitted up the spine, which might unload the chest during the loading phase of the impact will be considered.

Higher performance limit	F_y :	1.0 kN	M_x :	150 Nm
Lower performance limit	F_y :	2.0 kN	M_x :	200 Nm

Using SAE J211 sign convention

$F_y > 0$ and $M_x < 0$ for LHD vehicles

$F_y < 0$ and $M_x > 0$ for RHD vehicles

3.4 Door Opening during the Impact

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

3.5 Door Opening Forces after the Impact

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

3.6 Fuel Leakage

3.6.1 In the case of liquid fuel vehicle, fuel leakage (exceeding 30g/min) after the crash test, -1-point modifier will be included in the MDB full score.

3.6.2 In case of Electric Vehicle / Battery Electric Vehicle or Hybrid Vehicles, after the official BHARAT NCAP crash tests a compliance check will be made to assess if the post-crash requirements from AIS-099, for EVs and Hybrids have been met. A maximum -1-point penalty will be applied if it is not compliant.

4. POLE SIDE IMPACT

4.1 Lower Performance Limit

For thorax, abdomen and pelvis, dummy readings must not exceed the lower performance limits set in sections in Annexure IV 4.2. Modifiers will not be applied.

4.2 Hazardous airbags deployment

In case Hazardous airbags deployment is noticed in the side pole impact test and the same hazardous deployment is possible in the Side MDB, the modifier of -1 point can be carried over to the Side MDB assessment.

4.3 Fuel Leakage

4.3.1 In the case of liquid fuel vehicle, fuel leakage (exceeding 30g/min) after the crash test, -1-point modifier will be included in the MDB full score.

4.3.2 In case of Electric Vehicle / Battery Electric Vehicle or Hybrid Vehicles, after the official BHARAT NCAP crash tests a compliance check will be made to assess if the post-crash requirements from UN R135, for EVs and Hybrids have been met. A maximum -1-point penalty will be applied if it is not compliant

5. GENERAL MODIFIERS

Below specified modifiers shall be applicable for all the tests

5.1 STAR RATING LIMIT

In order to avoid the highly undesirable situation of a vehicle gaining a rating of multiple stars when an important and vital body region is poorly protected (colour red), the rating will be limited to no more than 1 star regardless of the total number of points scored.

5.2 RELATIONSHIP BETWEEN POINTS AND STARS FOR FRONTAL AND SIDE TESTS

In order to avoid the indescribable situation of a vehicle performing very poorly in the frontal or side tests, with a difference of scores in front and side above 35%, the car will have its Adult star rating reduced by one star to show that do not provide similar good all-around protection. This modifier shall not be applicable if:

- The score is greater 8.2 points on both ODB Frontal Impact Test and MDB Side Impact test and,
- Total score obtained by the test model is greater than 22

**ANNEXURE VIII
SCORING & VISUALISATION
CONTENTS**

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1. INTRODUCTION

This annexure provides guidelines on the scoring and visualization concept adopted for publication of BHARAT NCAP. A colour scheme is adopted for representing the score achieved by individual body region. A detailed description of the scoring and visualization scheme for Adult and Child occupant in different tests is provided in below sections.

2. FRONTAL IMPACT

The contribution of the frontal impact tests to the Adult Occupant Protection Score is calculated by summing the body scores for the relevant body regions. The total score in the frontal impact test is limited to 16 points. For frontal impact, the body regions are grouped together for driver and front passenger, with the score for the grouped body region being that of the worst performing region or limb between the two occupants.

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

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

Results are shown separately for driver and passenger. The grouped regions are:

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

3. SIDE IMPACT

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

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

Green	4.000 points
Yellow	2.670 - 3.999 points
Orange	1.330 - 2.669 points

Brown	0.001 - 1.329 points
Red	points

4. CHILD OCCUPANT PROTECTION

4.1 Scoring

The maximum number of points available for child protection is 49 points. For vehicles without rear seats, the maximum score is 22 points. The maximum points available in each assessment area are as follows:

	With rear seats	Without rear seats
Dynamic Assessment	24	0
Installation of Child Restraints	12	12
Vehicle Based Assessments	13	10

The child protection score will be the sum of all three areas. The tables below summarise the maximum possible score in each (sub)category for vehicles with limited rear space and for vehicles with no rear seats (such as two seaters).

4.2 Child Protection Assessment Points Table (Normal and Limited Rear Space)

SECTION (ANNEX.--)	CATEGORY	TOTAL POINTS (49)
4	DYNAMIC ASSESSMENT	(24)
4.1	Ejection	switch
4.2	Head Contact with the Vehicle	switch
4.2.2	FRONTAL IMPACT	(16)
4.2.2.1	Head Contact with the CRS	8
4.2.2.2	Head Excursion (Forward Facing CRS)	
4.2.2.3	Head Exposure (Rearward Facing CRS)	
4.2.2.4	Neck Tension	4
4.2.2.5	Chest	4
4.2.3	SIDE IMPACT	(8)
4.2.3.1	Head Containment	Switch
4.2.3.2	Head Contact with the CRS	8

SECTION (ANNEX.--)	CATEGORY	TOTAL POINTS (49)
3	INSTALLATION OF CHILD RESTRAINTS	(12)
	CRS Installation list	10
	OEM Recommended CRS	2
5	VEHICLE BASED ASSESSMENTS	(13)
5.1	3-Point belt at all seating positions	switch
5.2	Gabarit Installation on all Passenger Seats	2
2.3	Three Simultaneous Use Seating Positions	2
5.4	ISOFIX Usability	2
5.5	Two or more Largest ISOFIX Positions	1
5.6	Passenger Airbag Warning Marking and Disabling	0 to 4
5.7	Integrated CRS	2

Child Protection Assessment Points Table (No Rear Seats)

SECTION (ANNEX.--)	CATEGORY	TOTAL POINTS (22)
2.1	INSTALLATION OF CHILD RESTRAINTS	(12)
	CRS Installation list	10
	Recommended seats	2
5	VEHICLE BASED ASSESSMENTS	(10)
5.2	Gabarit Installation on front Passenger Seat	1
5.3	Three Simultaneous Use Seating Positions	NA
5.4	ISOFIX Usability	2
5.5	Largest ISOFIX Position on front Passenger Seat	1
5.6	Passenger Airbag Warning Marking and Disabling	0 to 4
5.7	Integrated CRS	2

4.3 Score and stars correlation

Passenger cars and limited rear space:		2 seater vehicles	
41.00 - 49.00 points	5 stars	20.00 - 22.00 points	5 stars
35.00 - 40.99 points	4 stars	17.00 - 19.99 points	4 stars
27.00 - 34.99 points	3 stars	13.00 - 16.99 points	3 stars
18.00 - 26.99 points	2 stars	9.00 - 12.99 points	2 stars
9.00 - 17.99 points	1 star	5.00 - 8.99 points	1 star
0.00 - 8.99 points	0 star	0.00 - 4.99 points	0 star

ANNEXURE IX
CONCEPTS BEHIND THE ASSESSMENTS
CONTENTS

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1. **FRONTAL IMPACT**

1.1 **Head**

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

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

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

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

1.2 **Neck**

Neck injuries are frequent, but relatively little is known about appropriate injury criteria. The neck criteria recommended by EEVC are used to identify poorly designed restraint systems. It is assumed that good restraint systems will have no problems meeting these criteria.

1.3 **Chest**

Rib compression is used as the main guide to injury risk. It is expected that the Viscous Criterion will only identify cars with poorly performing restraint systems. The injury risk data is relevant for seat belt only loading rather than combined seat belt and airbag loading. No change is made in the event of combined seat belt and airbag restraint. This avoids value judgements about the extent of airbag restraint on the chest and is in line with the EEVC recommendation.

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

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

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

1.4 **Abdomen**

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

1.5 **Knee, Femur & Pelvis**

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

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

The knee impact area should have uniformly good properties over a wide area of potential impact sites. This is to account for people sitting with their knees in different positions and slight variations in impact angle. The characteristics of the area should not change markedly if knee penetration is slightly greater than that observed with the 50th percentile dummy in this test. This takes into account the protection of different sized occupants or occupants in different seating positions.

Loading on the knee should be well distributed and avoid concentration that could result in localised damage to the knee. The injury tolerance work that supports the legislative femur criterion was conducted with padded impactors that spread the load over the knee.

1.6 **Lower Leg**

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

Pedal blocking: There should be no blocking of any foot operated pedals which have displaced rearward after the impact; blocked pedals represent a greater hazard to the lower limbs of the driver than non- blocked pedals.

1.7 **Foot and Ankle**

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

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

2. **SIDE & POLE IMPACT**

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

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

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

- 2.4. **Seat position in side impact:** Effective side impact protection needs to consider all sizes of occupants. Currently, side impact tests are conducted with the seat in the design position. In future, consideration may be given to the level of protection in other seating positions.
3. **DOOR OPENING (Front, Side and Pole, Impact):**
The intention is to ensure that the structural integrity is maintained. The underlying principle is to minimise the risks of occupant ejection occurring. The ‘door opening’ modifier will be applied if any of the following have occurred:
- 3.1 the latch has fully released or shows significant partial release, either by release of its components from one another, or effective separation of one part of the latch from its supporting structure.
 - 3.2 the latch has moved away from the fully latched condition.
 - 3.3 if any hinge has released either from the door or bodyshell or due to internal hinge failure.
 - 3.4 if there is a loss of structure between the hinges and latches.
 - 3.5 if door or hinges fail whilst the door opening tests are being conducted post impact, as loading from an occupant could have a similar effect.
 - 3.6 if there was any potential risk of occupant ejection and/or partial ejection/entrapment from openings such as sliding doors or moveable roofs. Dynamic opening during the impact of any apertures, such as roofs, will also be considered even if the openings have closed during or post the test.
 - 3.7 if both side doors latch together with no b-pillar or other form of restraint, the modifier may apply to both the front and rear doors.

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