DRAFT

AUTOMOTIVEINDUSTRY STANDARD

Bharat New Car Assessment Program

(Revision1)

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INTRODUCTION

The Government of India felt the need for a setting up a program, Bharat New Car Assessment Program (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 is a voluntary program monitored by the Ministry of Road Transport and Highways (MoRTH), Government of India.

First phase of Bharat NCAP, is implemented w.e.f. 1st October 2023 and is valid till 30th September 2027. An AISC committee was constituted to review the standard and give proposals for 2nd phase of Bharat NCAP. Accordingly, AISC is publishing the draft scheme described under AIS-197 Revision 1: Bharat New Car Assessment Program 2.0. 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 05 different verticals namely, Safe Driving, Crash Avoidance, Crash Protection, Vulnerable Road User Protection and Post-Crash Safety.

For each of the assessment verticals, there are individual test and assessment protocols covered in separate annexures of AIS-197 Revision 1

DISCLAIMER: Bharat NCAP has taken all reasonable care to ensure that the information published in this document is accurate and reflects the technical decisions taken by MoRTH. In the unlikely event that this document contains a typographical error or any other inaccuracy, MoRTH reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

ACKNOWLEDGMENT: This standard derives considerable original text from EuroNCAP and other consumer rating programs such as Global NCAP, ASEAN NCAP. Permission is being sought / granted for this material to be shared for non-commercial and educational purposes.

1.	SCOPE
1.1.	Bharat New Car Assessment Program (Bharat NCAP) will be applicable to the vehicles of category M1 with their Gross Vehicle Weight less than or equal to 3500 kg.
1.2.	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. 4.5
1.3.	Bharat NCAP will be applicable only for Right-Hand Drive (RHD) vehicle models marketed in India as RHD configuration is the only prescribed configuration under motor vehicles as per Motor Vehicle Act. (MVA) 1988.
1.4.	The validity of the rating methodology and test protocols specified in this standard shall be for a period of 4-years from the date of notification of this standard.
1.5.	M1 category vehicles with following conditions are prohibited for award of star rating. • Vehicle models not meeting the minimum type approval requirements • Vehicle models not equipped with Electronic Stability Control system as standard fitment • Vehicle models not equipped with Side Head Protection Device or Curtain Airbags as standard fitment • Vehicle models equipped with side facing passenger seats

2.	INTRODUCTION
2.1.	Bharat NCAP has created the five-star safety rating system for eligible vehicle models to help consumers compare vehicles more easily and to help them identify the safest choice for their needs. The safety rating is determined from a series of vehicle tests/assessments, designed and carried out by Bharat NCAP. These tests represent, in a simplified way, important real-life accident scenarios that could result in injuries to car occupants or other road users. While a safety rating can never fully capture the complexity of the real world, the vehicle improvements and the technology brought over the past years by the application of high safety standards have potential to benefit consumers and to society as a whole. Further, the star rating goes beyond the minimum type approval requirements and as mentioned above is voluntary in nature. Therefore, not all new vehicles need to undergo Bharat NCAP tests. A vehicle model that just meets the type approval requirements may or may not qualify for star rating as it would not have been assessed by Bharat NCAP. This document introduces revision to the current Bharat NCAP scheme.

2.2.	The overall rating will be composed of scores achieved by the vehicle model in five areas of assessment, also referred to as "assessment verticals or assessment boxes" • Safe Driving • Accident Avoidance • Crash Protection • Vulnerable Road User Protection and • Post-crash Safety These assessment verticals are evolved to cover various aspects of vehicular safety and contents are decided to assess overall safety of a modern day passenger vehicle which comprises of advanced active and passive safety systems. For each of the assessment verticals, there are individual requirements, tests and assessment protocols covered in this standard.
2.3.	• Each test in the assessment verticals has been allocated with a maximum achievable score • Maximum score achievable in each assessment vertical is calculated as the sum of test scores in that vertical. • The score so achieved in each vertical is then multiplied by a weightage factor and added together to achieve a normalized overall score, with maximum 100 points across all assessment verticals. • Eligible star rating is decided based on the cut-off limits further specified in this document. • Additional conditions and penalties on poor or improper performance of the vehicle model are specified which help in identifying vehicle models that offer a robust safety performance.

3.	**REFERENCES**
3.1.	EuroNCAP v1.1 June 2015 (Test Protocol - AEB Systems)
3.2.	EuroNCAP v7.1.3 Sep 2018 (Frontal Offset Deformable Barrier Test)
3.3.	EuroNCAP v7.2.1 Nov 2017 (Child Occupant Protection)
3.4.	EuroNCAP v7.0.2 Apr 2015 (Adult Occupant Protection)
3.5.	EuroNCAP v9.1.2 June 2020 (Adult Occupant Protection)
3.6.	EuroNCAP v7.1.1 Nov 2015 (AE-MDB Side Impact Test)
3.7.	EuroNCAP: Rescue and Extrication Test and Assessment Protocol v1.0 March 2025
3.8.	EuroNCAP v8.2 Nov 2015 (Pedestrian Impact Testing Protocol)
3.9.	EuroNCAP v8.1 June 2015 (Pedestrian Impact Assessment Protocol)
3.10.	ASEAN NCAP – v2.0 May 2024 (BSD/BSV Test Protocol)
3.11.	ASEAN NCAP – v1.1 Mar 2025 (AEB Car to Motorcyclist)
3.12.	ASEAN NCAP - v2.0 May 2024 (Motorcyclist Safety Assessment Protocol)

3.13.	AIS-098: Requirements for the Protection of the Occupants in the event of an Offset Frontal Collision
3.14.	AIS-099: Approval of Vehicles with regards to the Protection of the Occupants in the event of a Lateral Collision
3.15.	AIS 101: Requirements for the Protection of Fuel System in the Event of Rear Impact of a Motor Vehicle
3.16.	AIS-133: Electronic Stability Control Systems
3.17.	AIS-145: Additional Safety features for Category M and N Vehicles
3.18.	AIS-182: Approval of vehicles with regard to ISOFIX anchorage systems ISOFIX top tether anchorages
3.19.	AIS-184: Driver Drowsiness and Attention Warning Systems for M, N2 and N3 category vehicles
3.20.	AIS-185: Approval of vehicles with regard to the Advanced Emergency Braking System (AEBS) for M1 and N1 vehicles
3.21.	AIS-191: Approval of vehicles with regards to Emergency Lane Keeping System
3.22.	AIS-201: Requirements for the Protection of the Occupants in the event of a Frontal Collision with focus on Restraint Systems
3.23.	UN Regulation No.16: Uniform Provisions Concerning the Approval of Vehicles equipped with safety-belts, safety-belt reminders, restraint systems, child restraint systems and ISOFIX child restraint systems and i-Size child restraint systems
3.24.	UN Regulation No.17: Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages and any head restraints
3.25.	UN Regulation No. 129: Uniform provisions concerning the approval of enhanced Child Restraint Systems used on board of motor vehicles (ECR)
3.26.	UN Regulation No. 135: Uniform provisions concerning the approval of vehicles with regard to their Pole Side Impact performance (PSI)
3.27.	UN Regulation No. 144: Uniform provisions concerning the Accident Emergency Call Systems (AECS)
3.28.	ISO 17840: Rescue sheet for passenger cars and light commercial vehicles
3.29.	ISO 19206: Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions
3.30.	ISO 17387 : Lane change decision aid systems (LCDAS)

4.	**DEFINITIONS**
4.1.	Bharat New Car Assessment Program (Bharat NCAP): For the purpose of this standard Bharat NCAP is an assessment program for safety rating of new vehicle models sold or being sold in India.
4.2.	Bharat NCAP 1.0: For the purpose of this standard, Automotive Industry Standard (AIS) 197 is referred to as Bharat NCAP 1.0
4.3.	Bharat NCAP 2.0: For the purpose of this standard, AIS 197 Revision 1 is referred to as Bharat NCAP 2.0

4.4.	Designated Agency under Bharat NCAP: 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.
4.5.	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.
4.6.	'Make (brand)'; The make of a motor vehicle or name by which that range of motor vehicles is popularly known, or the name of the manufacturer
4.7.	Vehicle Model: All the variants (i.e. all body styles, engine and equipment grades) available under a common model name
4.8.	'Model Name': the name by which the vehicle is advertised or sold.
4.9.	'Variant': is a version of the originally-tested vehicle which shares • Make (brand) • Model Name (additional descriptions such as 'hatch', 'sportswagon' etc are allowed so long as the basic model name is the same) • All equipment having an influence on safety • All the important structural elements related to safety performance Where these differ (for example number of side entry doors, etc.), additional data is required and which can be shown not to differ from the originally-tested vehicle in terms of the Bharat NCAP star rating
4.9.1.	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 and have influence on the safety of the occupants or pedestrians. Base Variant will be determined based on the Specimen Equipment Matrix template (Annexure-XIII) which will be provided by the Designated Agency and duly filled by the Vehicle Manufacturer. In the matrix, the vehicle manufacturer must identify all items of safety equipment and design features available in the model range and state whether they are standard on all variants or optional on some. Such Base variant/s will be tested for determining the star rating of the vehicle model as minimum applicable rating. Separate 'Base Variants' may be identified for separate tests listed in this standard.
4.9.2.	Basic Level Safety Equipment That equipment which is clearly aimed at improving safety. It includes but is not necessarily limited to: Restraint systems, including head restraints, child restraint anchorages; Knee and leg protection; Breakaway pedal arrangements; Pedestrian friendly devices (unless they are only required for particular engine compartment packages); Seat belt reminder systems, Safety marking/labels and switches; AEB Systems
4.10.	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.
4.11.	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.
4.12.	Assessment Year: The Assessment Year is defined as the calendar year in which the rating is first published by Bharat NCAP.
4.13.	Reassessment The re-assessed rating is based on all requirements (Minimum Percentage for Basic Level Safety Equipment, threshold, balance values etc.) applicable at the time of reassessment. Depending on the changes made to the vehicle, it may not be necessary to repeat all aspects of the assessment. The results of a reassessment are published alongside the original rating.
4.14.	Retest A repeat of one or more tests of a vehicle's assessment which replaces the original result. The original invalid result is not published by Bharat NCAP.
4.15.	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.

5.	**STAR RATING METHODOLOGY**
5.1.	**Areas of Assessment: Safe Systems Approach**
5.1.1.	Bharat NCAP will award a combined rating based on performance of the vehicle model in the following five areas of assessment termed as "assessment verticals or assessment boxes" • Safe Driving • Accident Avoidance • Crash Protection • Vulnerable Road User Protection and • Post-Crash Safety

Safe Driving	Max Score	Accident Avoidance	Max Score	Crash Protection	Max Score		VRU Protection	Max Score	Post Crash	Max Score
					AOP	COP				
Occupant Detection for SBR System	5	ESC	5	Offset Deformable Barrier Test	16	16	Impact Assessment Tests	36	Rescue Sheet	7
Driver Drowsiness and Attention Warning (DDAW)	5	AEB Rear Stationary	5	Full Width Rigid Barrier Test	16	-	a. Child Crossing (Impact at Centre)	5	Multi Collision Braking	2
Forward Collision Warning	5	AEB Rear Moving	5	MDB Test	16	8	b. Adult Crossing (Impact at Centre)	5	SOS Call	2
Lane Departure Warning	5	AEB Rear Braking	10	Oblique Side Pole Test	8	-	AEB Car-to-Motorcyclist		Hazard Light Warning	1
Blind Spot Visualization / Blind Spot Detection	5			Moving Rigid Barrier Test	5	-	a. Car to Motorcycle Rear-end Moving (Centre)	10	Energy Management	3
Rear Cross Traffic Alert	5			Whiplash (Static) Test	5	-			Occupant Extrication	5
Traffic Sign Recognition / Speed Limit Information System	5			CRS Installation Test	-	12				
Hill Hold Assist	5			Vehicle Based Assessment	-	12				
MAX SCORE	**25**	**MAX SCORE**	**25**	**MAX SCORE**	**66**	**48**	**MAX SCORE**	**56**	**MAX SCORE**	**20**
WEIGHTAGE	**10%**	**WEIGHTAGE**	**10%**	**WEIGHTAGE**	**55%**		**WEIGHTAGE**	**20%**	**WEIGHTAGE**	**5%**

Image 1: Scheme of Bharat NCAP 2.0 Program – Assessment Verticals, Tests, Maximum Scores, Weightages

5.1.2.	**Safe Driving Vertical:** Under this assessment vertical, Bharat NCAP specifies a list of technologies that can warn or alert the driver of a passenger vehicle from unsafe or potentially hazardous driving conditions. 08 such technologies are listed below. • Seat-Belt Reminder System with occupant detection capability • Driver Drowsiness and Attention Warning System • Forward Collision Warning System • Lane Departure Warning System • Blind Spot Visualization / Detection System • Rear Cross Traffic Alert System • Traffic Sign Recognition / Speed Limit Information System • Hill Hold Assist System
5.1.2.1.	Vehicle manufacturer can choose to offer any number of listed 'Safe Driving Technologies'.
5.1.2.2.	For the purpose of calculation of star rating, score will be awarded for a maximum of 05 such technologies offered.
5.1.2.3.	Weightage Factor of 10% will be applied to the score achieved by the vehicle model to calculate the overall assessment score
5.1.2.4.	Wherever available, technologies listed in the assessment vertical, will be evaluated according to the applicable Automotive Industry Standard (AIS) published by MoRTH.
5.1.2.5.	For technologies, where AIS are not published or available, separate assessment methods are specified in this standard.

Table 1: Safe Driving Assessment Vertical

Description	Maximum Test Score	Assessment Method
Occupant Detection for SBR System	Upto 5	AIS – 145
Driver Drowsiness and Attention Warning (DDAW)	5	AIS - 184
Forward Collision Warning	5	AIS - 185
Lane Departure Warning	5	AIS – 191
Blind Spot Visualization / Detection	5	Refer Annexure - I
Rear Cross Traffic Alert	5	Refer Annexure - I
Traffic Sign Recognition / Speed Limit Information System	5	Refer Annexure - I
Hill Hold Assist	5	Refer Annexure - I
Maximum Score of the Safe Driving Vertical	**25**	
Weightage	**10 %**	

5.1.3.	**Accident Avoidance Vertical:** Under this assessment vertical, Bharat NCAP specifies a list of technologies that can aid the driver of a passenger vehicle to avoid an imminent accident by virtue of autonomous mode of operation of such technologies installed in the vehicle. • Electronic Stability Control (ESC) • Autonomous Emergency Braking System (AEBS)
5.1.3.1.	Electronic Stability Control (ESC) System will be mandatory technology for eligibility to the star rating program. Vehicle manufacturer can choose to offer AEBS voluntarily.
5.1.3.2.	Such autonomous technologies however, may not be able to avoid 100% accidents and are assessed for performance only in the standard test conditions specified in this document.
5.1.3.3.	Wherever available, technologies listed in the assessment vertical, will be evaluated according to the applicable Automotive Industry Standard (AIS) published by MoRTH.
5.1.3.4.	For technologies, where AIS are not published or available, assessment methods are specified in this standard.
5.1.3.5.	Weightage Factor of 10% will be applied to the score achieved by the vehicle model to calculate the overall assessment score

Table 2: Accident Avoidance Assessment Vertical

Description	Maximum Test Score	Assessment Method
ESC	5	AIS – 133
AEB Rear Stationary (CCRs)	5	AIS – 185
AEB Rear Moving (CCRm)	5	AIS – 185
AEB Rear Braking (CCRb)	10	Refer Annexure - II
Maximum Score of the Accident Avoidance Vertical	**25**	
Weightage	**10 %**	

5.1.4.	**Crash Protection Vertical:** Under this assessment vertical, Bharat NCAP will perform 'five' mandatory crash tests on the base variant/s identified for each of the test. • 64kph offset frontal impact test against deformable barrier (ODB64) • 50kph frontal impact against full width rigid barrier (FWRB50) • 50kph lateral impact against a mobile deformable barrier (MDB50) • 32kph oblique side impact against rigid pole (PSI32) • 50kph rear impact against a mobile rigid barrier (MRB50)
5.1.4.1.	An assessment of potential injuries to adult occupants (male and female occupants) at driver, passenger and rear seating positions and child occupants will be carried out during these tests using Anthropomorphic Test Devices (ATDs) defined in this standard.
5.1.4.2.	In addition, installation of specific devices or features such as head-restraints, ISOFIX anchorages, automatic airbag deactivation switches for child safety etc. which can overtly enhance occupant safety in the event of impacts will be verified.
5.1.4.3.	A separate score for adult occupant protection (AOP) and child occupant protection (COP) will be calculated. Additional conditions will be applicable for minimum scoring requirements for specific star rating.
5.1.4.4.	Weightage Factor of 55% will be applied to the score (sum total of AOP and COP score) achieved by the vehicle model to calculate the overall assessment score
5.1.4.5.	Detailed test procedure, test equipment and score calculation methodologies are listed in this standard.

Table 3: Crash Protection Assessment Vertical

Description	Maximum AOP Score	Maximum COP Score	Assessment Method
Frontal Offset Deformable Barrier Test	16	16	Refer Annexure - III
Frontal Full Width Rigid Barrier Test	16	--	
MDB Side Impact Test	16	08	
Oblique Side Pole Test	08	--	
Moving Rigid Barrier Rear Impact Test	05	--	
Whiplash (Static) Test	05	--	
CRS Installation Test	--	12	
Vehicle Based Assessment	--	12	
Maximum Score of the Crash Protection Vertical	**114**		
Weightage	**55 %**		

5.1.5.	**Vulnerable Road User Protection Vertical:**
	Under this assessment vertical, Bharat NCAP will perform following assessments on a passenger vehicle
	• Mandatory Impact Tests and Assessments on vehicle front end
	  ○ Pedestrian Legform Impacts against bumper
	  ○ Adult headform impacts against windshield and engine hood area
	  ○ Child headform impacts against engine hood area
	• Optional Assessment of the Autonomous Emergency Braking System (AEBS)
	  ○ AEBS – Adult pedestrian
	  ○ AEBS – Child pedestrian
	  ○ AEBS – Car to Motorcyclist in rear moving scenario

5.1.5.1.	Autonomous technologies such as AEBS may not be able to avoid 100% accidents and are assessed for performance only in the standard test conditions specified in this document.
5.1.5.2.	Weightage Factor of 20% will be applied to the score (sum total Impact Tests and AEBS Assessment score) achieved by the vehicle model to calculate the overall assessment score
5.1.5.3.	Detailed test procedure, test equipment and score calculation methodologies are listed in this standard.

Table 4: Vulnerable Road User Protection Assessment Vertical

Description	Maximum Test Score	Assessment Method
Impact Assessments	36	Refer Annexure - IV
AEB Pedestrian (Child Crossing)	5	AIS – 185
AEB Pedestrian (Adult Crossing)	5	AIS – 185
AEB Car to Motorcycle Rear-end Moving	10	Refer Annexure - IV
Maximum Score of the Vulnerable Road User Protection Vertical	**56**	
Weightage	**20 %**	

5.1.6.	**Post-Crash Safety Vertical:**
	Under this assessment vertical, Bharat NCAP will perform following assessments of technologies and design features that can aid the driver or other occupants of a passenger vehicle to mitigate post-crash consequences and facilitate evacuation, avoid fire and electrical hazards, risk of secondary impacts and can facilitate connectivity with SOS calling systems etc. List of such technologies and design features is given below
	• Mandatory Assessments
	  ○ Energy Management for Fire and Electrical Hazards
	  ○ Occupant Extrication
	• Optional Assessments
	  ○ Multi Collision Braking System (MCB)
	  ○ SOS Call / E-Call System (SOS/E-Call)
	  ○ Rescue Sheet System (RS)
	  ○ Hazard Warning Light System (HWLS)

5.1.6.1.	Assessment of energy management systems and occupant extrication systems will be performed during official crash tests specified under 'Crash Protection' vertical.
5.1.6.2.	If fitted, optional technologies listed above will be assessed as per procedure laid down in this standard.
5.1.6.3.	Assessment score will be sum total of score of the technologies installed and assessed
5.1.6.4.	Weightage Factor of 5% will be applied to the score achieved by the vehicle model to calculate the overall assessment score
5.1.6.5.	Detailed test procedure and score calculation methodologies are listed in this standard.

Table 5: Post Crash Safety Assessment Vertical

Description	Maximum Test Score	Assessment Method
Rescue Sheet	7	Refer Annexure - V
Multi Collision Braking	2	
SOS Call	2	
Hazard Light Warning	1	
Energy Management	3	
Occupant Extrication	5	
Maximum Score of the Post Crash Safety Vertical	**20**	
Weightage	**5 %**	

5.2.	**Maximum Score, Weight Factors and Star Rating Limits**
5.2.1.	Maximum score achievable in each assessment vertical, applicable weightage factor and maximum weighted score of these assessment verticals is shown in Table No. 6 below

Table 6: Maximum Score for assessment verticals, weightage factors, maximum overall score

	Safe Driving	Accident Avoidance	Crash Protection	Vulnerable Road User Protection	Post-Crash Protection
Maximum achievable score	25	25	114	56	20
Weightage	10 %	10 %	55 %	20 %	5 %
Maximum Weighted Score	10	10	55	20	5
Overall Weighted Score	**Maximum 100** (Sum of Maximum Weighted Score for each assessment vertical)				

5.3.	**Cut-off Limits for Star Rating, Additional Star-Rating Conditions**
5.3.1.	Overall weighted score achieved by the vehicle will be calculated as per Table 6 above.
5.3.2.	This overall weighted score will be compared to the cut-off limits specified in Table No. 7 below.
5.3.3.	Additional star rating conditions as listed in section 5.4 will be verified
5.3.4.	Overall star rating will be awarded to the vehicle model.

Table 7: Cut-Off Limit for Star Rating on Weighted Score

	[2027-2029]	[2029-2031]
5-star	70	80
4-star	60	65
3-star	50	50
2-star	40	40
1-star	30	30

5.4.	**Star Rating Conditions:** In addition to cut-off limits, following conditions will be applicable for award of respective star-rating
5.4.1.	For 3-star and above, the Adult Occupant Protection (AOP) score shall be at least 55% of the total Crash Protection Vertical score. If this requirement is not met, a 1-star penalty shall be applicable on the star rating of the vehicle.
5.4.1.1.	5-star rated vehicle cannot have any assessment vertical with a 'zero' score. In such case, the vehicle rating will be restricted to a 4-star rating
5.4.1.2.	5-star rated vehicle cannot have any injury values in 'red' color zone for the adult and child ATDs used across respective crash tests before the modifiers are applied. This condition will be applicable for official crash tests as well as sub-system level tests conducted in-house by vehicle manufacturer for submission to Bharat NCAP. ATD body regions that will be monitored for this observation are listed in table below. In such case, the vehicle rating will be restricted to 4-star rating.

Table 8: Body Regions assessed for each Tests

Full Scale Test	**Body Regions per Occupant**		
	Driver	Front Passenger	Rear Passenger(s)
Frontal ODB	Head and Neck Chest	Head and Neck Chest	Head Chest
Frontal FW	Head Neck Chest	Head Chest	Head
Side MDB	Head Chest Abdomen Pelvis		Head
Side Pole	Head		

5.5.	**Rounding**
	The following rounding rules will be applied in the calculation of the overall rating.
5.5.1.	Score for each of the individual tests in each vertical are rounded to 3 decimal points.
5.5.2.	For crash tests and pedestrian impact tests, calculation of points scored in the impact tests are rounded to 3 decimal points. For e.g. in a crash test, the head score of 3.1238 in frontal impact would be rounded to 3.124.
5.5.3.	The total points score in each box is the sum of individual test scores and is rounded to 2 decimal points. To calculate the normalized score in each box, the 2 decimal points total is divided by the maximum points available for that box and multiplied by the weight factor. This final normalized score is rounded to 2 decimal places.
5.5.4.	For example, for a crash protection score of 89.00 points leads to a weighted score of 42.94 points ($\frac{89}{114}$ x 55 = 42.9386 rounded to 42.94 points)
5.5.5.	The weighted scores for each vertical / box are then added and the final sum is then compared with the weighted score star rating limit specified in Table No. 7 above.
5.6.	**Vehicle Selection Guidelines**
5.6.1.	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.
5.6.1.1.	Any vehicle model within the scope of this standard can be submitted for assessment voluntarily by the 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 as family rating.
5.6.1.2.	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. Additional variant equipped with additional safety feature will be assessed only if the official rating for the base variant is atleast 3-star and above.
5.6.1.3.	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.
5.6.2.	In any of the above cases, the test vehicles have to be submitted by the vehicle manufacturer along with all the charges applicable for assessment including the cost of test vehicle/s.
5.6.3.	The base test variant as defined above 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. A vehicle model may or may not have different base variants for Active Safety systems and Passive Safety systems.
5.6.4.	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 manufacturers.

5.6.5.	Application for partial rating of variants of vehicle model shall not be accepted unless base variant rating is published.
5.6.6.	In case of a vehicle selected by Bharat NCAP, a manufacturer may advise Bharat NCAP that the 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.
5.6.7.	**Sampling of Test variants**
5.6.7.1.	To ensure that the rating always remain credible, it is essential that the variants of the vehicle model selected for testing are the same as those vehicles offered for sale to consumers. Ideally this means that test vehicles are taken from the authorized dealer's premises, which are ready for sale. Many times, however, this may be conflicting with the manufactures' vehicle inventory management, sale and other statutory provisions such as taxation, etc. In such cases, manufacturer can propose to offer selection of test samples from production plant premises. When the samples are to be selected from vehicle manufacturer production plant premises, following clauses provides guidance on these matters. As far as possible, the vehicle will be selected from the distribution area of the vehicle manufacturer and not from a pre-selected lot or from a limited number of units especially set aside for Bharat NCAP.
5.6.7.1.1.	The vehicles offered for sampling 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.
5.6.7.1.2.	certified as per CMVR 1989; and
5.6.7.1.3.	from serial production; and
5.6.7.1.4.	selected as a random sample. It is preferred to offer a sample size of at-least 25 samples of worst-case / base variants identified by Designated Agency.
5.6.7.2.	Once the Vehicle Model is selected for evaluation, for sampling purpose, the Designated Agency may appoint representatives to visit the production line of the vehicle manufacturer, who shall identify the test specimen as per above guidelines and shall seal the vehicles proposed for further submission to test agencies.
5.6.7.3.	Vehicle manufacturer can opt to offer the cars from the dealer / sales representative of the vehicle manufacturer adhering to the requirements specified in Cl. 5.6.7.1 above.
5.6.7.4.	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.
5.6.7.5.	Once the test vehicles are identified by the Designated Agency, vehicle manufacturer 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.
5.6.8.	In addition to fully built vehicles for crash testing, the vehicle manufacturer shall provide the required number of bonnets, bumpers, fenders, windshields, etc. as per the test requirements before beginning the official pedestrian protection tests.

5.6.9.	It is not permitted for the vehicle manufacturer to change the respective components affecting the pedestrian protection tests once the respective tests have begun.
5.6.10.	If such a change has to be done by the manufacturer, the application for the star rating of the model will be put on hold.
5.6.11.	For the assessment of AEB Systems, vehicle manufacturer can offer separate vehicle than those selected for crash testing as per the identified base variant for Active Safety systems.

6.	**APPLICATION TO BHARAT NCAP**
6.1.	Once the Designated Agency selects a vehicle model; it shall inform the vehicle manufacturer regarding such a nomination / sponsorship / selection.
6.1.1.	Upon intimation from the Designated Agency, the vehicle manufacturer shall submit additional information about the vehicle model with details as specified in Form 70-A of CMVR 1989.
6.1.1.1.	Details of the vehicle model recommended.
6.1.1.2.	Details of the variants of the vehicle model along with details of the safety equipment fitted in them (safety equipment matrix).
6.1.1.3.	Proposal of the base test variant.
6.1.1.4.	CMVR Type Approval details.
6.1.1.5.	All sufficient supporting information as required by the designated agency with respect to the vehicle model.
6.1.1.6.	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).
6.1.2.	Upon application, the Designated Agency shall evaluate the application and if required, seek additional details from the vehicle manufacturer regarding the vehicle model.
6.1.3.	The Designated Agency shall further inform the vehicle manufacturer with regard to;
6.1.3.1.	Payment of Bharat NCAP Fees
6.1.3.2.	Selection of test samples from production line OR dealership as per the selection guidelines stated above
6.1.4.	Upon selection of test samples, the Designated Agency shall notify the identified Test Agency and inform the same to the vehicle manufacturer to make further arrangements for submission of the test samples to the allocated Test Agency.
6.1.5.	Allocated Test Agency shall carry out tests as per Bharat NCAP protocols (detailed in further sections) and shall submit a consolidated test report to the Designated Agency (as per Form No. 70-B)
6.1.6.	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.
6.1.7.	Vehicle manufacturer should clearly mention the type of rating which he wants to apply for (base only or base and optional both) and aspiration if any for corporate twin rating at the time of application.

7.	**TESTING, RETESTING AND REASSESSMNET**
7.1.	**Testing**
7.1.1.	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.
7.1.2.	Before each test, the test agency must check that vehicles and other components scheduled for testing meet the vehicle test specification.
7.1.3.	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.
7.1.4.	The manufacturer may advise Bharat NCAP that a vehicle scheduled for testing will have certain safety components changed prior to the expected publication date. Where this happens, the updated components may be retrofitted to the test vehicles before their respective tests begin, provided the following requirements are met: • The components are installed to the same standard as used in production. • The components are manufactured using production procedures. Prototype components are not allowed. • Where the component has to be certified by an approval authority, such certification has been carried out. • Once a vehicle has been tested, assessment and testing of modified components are subject to the requirements of the 'Retest' section as mentioned in this standard
7.2.	**Retest**
7.2.1.	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
7.2.1.1.	Test result presented by the Test Agency is inadequate to assess and compute the final star rating for the submitted model.
7.2.1.2.	In the instances of missing channel data from the test dummies or any other test parameter, the Designated Agency may request the vehicle manufacturer 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 the vehicle manufacturer conforming to the tested vehicle model.
7.2.1.3.	If such a data is presented by the vehicle manufacturer or Test Agency, the Designated Agency will review the submitted results and if found satisfactory, use the results for further computation of star ratings for the vehicle model
7.2.1.4.	Incase such a data is not available, or is not submitted by the vehicle manufacturer, the Designated Agency reserves the right to suitably assess the available data and decide on consideration of values for the missing data. Decision of the Designated Agency will be final in all cases.
7.2.1.5.	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.
7.2.1.6.	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 Designated Agency
7.2.1.7.	Where a test does not meet requirements of this standard subject to assessment of clause 7.2.1.1 to 7.2.1.5 above, it shall be repeated
7.2.1.8.	In case of 7.2.1.7, 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 vehicle manufacturer
7.2.2.	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:
7.2.2.1.	The manufacturer has identified deficiencies and can submit satisfactory explanation on the same to the Designated Agency.
7.2.2.2.	The proposed modifications will significantly improve safety
7.2.2.3.	The manufacturer has submitted the rationale (internal investigation report) on the identified deficiencies/problem/issue observed and that how safety can be improved with a repeat test.
7.2.3.	Where there is a partial or complete failure of any safety related equipment, or if any of the safety related equipment has not performed completely or partially as per its normal function (eg: Airbags, Airbag ECU, Belt Pretensioners, etc.), then the following conditions apply
7.2.3.1.	the *Designated Agency* may consider the particular test as invalid and withhold publication of the test results, pending investigation of the failure. The decision on the validity of the test of the Designated Agency shall be final in such a case.
7.2.3.2.	The vehicle manufacturer is then expected to submit further actions to be taken to against the observed failure or performance lapse on the safety equipment
7.2.3.3.	A timeline would be communicated by the Designated Agency for submission of such a ‘failure observation and correction’ report
7.2.3.4.	On successful submission and evaluation of this report, the Designated Agency shall then decide on further resumption of star rating assessments. The decision of the Designated Agency shall be final in such a case.
7.2.4.	The test results of the repeat test will be applicable in full, if the request of Retest is accepted and that the previous test will stand null and void and shall be the part of the records of the assessment. The internal investigation report submitted by the manufacturer will be the part of the detailed technical report submitted by the test agency to the Designated Agency.
7.3.	**Reassessment**
7.3.1.	The Designated Agency will reserve all the rights to decide upon the reassessment requests put up, if any, by the vehicle manufacturer.
7.3.2.	If such a request is approved, the entire cost of the reassessment shall be borne by the vehicle manufacturer.
7.3.3.	In case the reassessment leads to change in the results or significant improvement to safety to the previous assessment published, the Designated Agency reserves the rights to publish the result on their website

7.3.4.	Clear information will be published with the reassessment results (if published) in order to maintain better understanding for the consumers and clear dissemination of the information.

8.	**PUBLICATION OF RESULTS**
8.1.	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. Vehicle 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.
8.2.	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.
8.3.	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. For models already in the market, the results shall be published as per regular release schedule once the assessment in all respect has been completed.
8.4.	The Designated Agency will publish the base star rating (and optional rating, if available) and additional information (scores, summary report presented with coloured occupant assessments etc.) on its website on separate web pages. In all cases, first right to publish the results of a nominated model will be with the Designated Agency.
8.5.	The vehicle manufacturer, post to the release of results by Designated Agency can make use of the rating following the guidelines/requirements set as per Bharat NCAP and made available on the website. In all respects, it is the responsibility of the vehicle manufacturer to represent and use the star ratings awarded to the vehicle model only to the particular vehicle model and its applicable variants that were the part of the assessment.
8.6.	Reserved

9.	**VALIDITY AND APPLICABILITY OF STAR RATINGS**
9.1.	New Vehicle models Type Approved after implementation date of AIS-197 Revision-1 are eligible for the award of star ratings as per Bharat NCAP 2.0.
9.2.	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 of 4-years or till such time AIS-197-Revision 1 is further revised and notified by MoRTH. The rating shall clearly mention the year of publication, protocol version and the respective logo used for the assessment.
9.3.	Once a vehicle has been rated as per Bharat NCAP 2.0, any new variant or facelift model introduced by the vehicle manufacturer can seek for extension of star rating. While considering the new variant(s)/facelift for extension to current ratings, following parameters shall be considered: • Model Name (additional descriptions such as ‘hatch’, ‘sportswagon’ etc are allowed so long as the basic model name is the same)

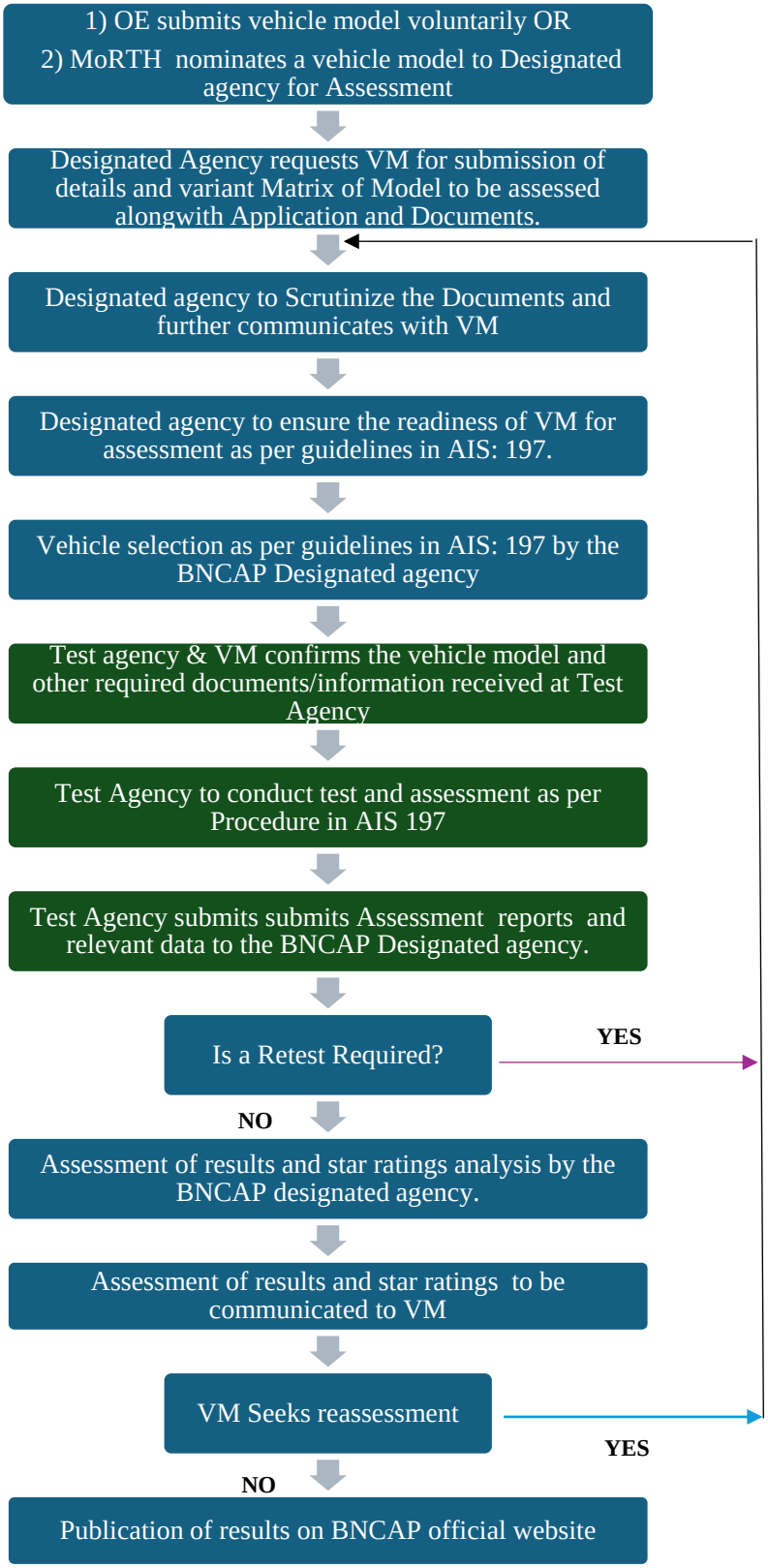
	• All equipment having an influence on safety • All the important structural elements related to safety performance Any of the above parameters having a negative influence on the safety performance of the vehicle, may need a retest or in-house test data as decided by the Designated Agency.
9.3.1.	Such a rating, if issued shall also be valid for a period of 4-years from the date of publication of this rating.
9.4.	Design modifications in the vehicle having bearing on star rating to vehicle already rated shall render the rating invalid.

10.	**PARTNER MODELS and CORPORATE TWINS**
10.1.	**Partner Models**
10.1.1.	Certain variants may be marketed under a different model name to the originally-tested vehicle.
10.1.2.	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.
10.2.	**Corporate Twins**
10.2.1.	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 tested in all ways related to safety. • The Twin has the same base safety specification as the vehicle tested, or better. • The vehicle manufacturer has informed the Designated Agency about his aspiration for Corporate Twin Rating at the time of application.
10.2.2.	A safety equipment matrix should be completed for all brand models to which the rating will be applied. If the vehicle manufacturer does not submit the safety equipment matrix, the Designated Agency will test the vehicle with the lowest specification.
10.2.3.	Consideration and combination of the test variants (from both brands) to be included in the tests will be decided by the Designated Agency.

11.	**TRANSITIONAL PROVISIONS FOR BHARAT NCAP 1.0 RATINGS**
11.1.	The guidelines below are intended to facilitate transition of vehicle models qualifying for Bharat NCAP ratings at the time of implementation of Bharat NCAP 2.0.
11.1.1.	Ratings issued under Bharat NCAP 1.0 scheme are valid for a period of 4-years from the date of publication of the ratings.
11.1.2.	Vehicle models with existing Bharat NCAP 1.0 ratings can continue to seek extension of Bharat NCAP 1.0 ratings for new variants or facelift models, provided the changes in the variant or facelift model do not have changes significantly affecting the occupant protection.
11.1.3.	Such extended ratings shall be valid for a period of 4-year from the date of publication of the rating.

11.1.4.	Those changes that lead to a retest will be assessed as a new assessment and will have to be assessed as per Bharat NCAP 2.0. In such a case, the ratings of Bharat NCAP 1.0 will not be extended as per the application.
11.1.5.	New vehicle models type approved before the date of implementation of Bharat NCAP 2.0 can continue to apply for star ratings as per Bharat NCAP 1.0.
11.1.6.	For such vehicle models that are tested as per Bharat NCAP 1.0 but results are published after the date of implementation of Bharat NCAP 2.0, shall carry a tagline that says 'Rated as per Bharat NCAP 1.0' and carry the BNCAP 1.0 logo duly issued by the Designated Agency.
11.1.7.	Such tagline and logo shall be a part of all media advertisements, communications, car shows and dealership displays for applicable star rated vehicles.
11.1.8.	Such tagline and logo shall also appear across all the vehicle ratings published on the Bharat NCAP website.
11.1.9.	Guidelines related to the addition of tagline, logo, etc. mentioned in Cl 11.1.5 to 11.1.7 will be also applicable to vehicle models for which Bharat NCAP 1.0 ratings are extended.
11.1.10.	Bharat NCAP 1.0 base and extended ratings will remain valid till [September 2031].

12.	FLOW CHART OF BHARAT NCAP



13.	SPECIMEN EQUIPMENT TEST MATRIX
13.1.	Specimen equipment matrix for the crash tests specified in this document are given in Annexure-XIII of this document
13.2.	Designated Agency shall furnish the formal equipment matrix upon request to vehicle manufacturer

ANNEXURE I
SAFE DRIVING TEST PROTOCOL

TABLE OF CONTENTS

1.	**OCCUPANT DETECTION FOR SEAT BELT REMINDER SYSTEM**
1.1.	Test variant shall be installed with seat-belt reminder system complying to AIS-145 Amendment 7.
1.2.	In addition, vehicle manufacturer can install occupant detection feature at all /partial designated seating positions as applicable
1.3.	If installed, the occupant detection feature shall be tested in accordance to Appendix-1 to Annexure 3A of AIS-145 using an object or human representing a 5th percentile adult female dummy.
1.4.	Vehicle manufacturer can submit Test report issued from Test Agencies issued in accordance to AIS-145 with additional evidence for compliance to Appendix-1 to Annexure 3A for occupant detection function on rear rows.
1.5.	Such a report must clearly identify the designated seating positions equipped with occupant detection function in addition to standard SBR system
2.	**DRIVER DROWSINESS AND ATTENTION WARNING (DDAW) SYSTEM**
2.1.	The test variant shall be installed with DDAW Systems in accordance to AIS-184.
2.2.	To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-184 or shall submit a valid Test Report issued from Test Agency
3.	**FORWARD COLLISION WARNING SYSTEMS**
3.1.	The test variant shall be installed with FCW System in accordance to AIS-185
3.2.	For the purpose of consideration to Bharat NCAP requirements, the FCW system shall be tested at a VUT speed of 80 kmph with all other conditions as defined in AIS-185.
3.3.	To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-185 or shall submit a valid Test Report issued from Test Agency
4.	**LANE DEPARTURE WARNING SYSTEM (LDWS)**
4.1.	The test model shall be fitted with LDW Systems as in accordance to AIS-191.
4.2.	To demonstrate functionality, the vehicle manufacturer shall sponsor a test according to AIS-191 or shall submit a valid Test Report issued from Test Agency

5.	**BLIND SPOT VISUALIZATION / BLIND SPOT DETECTION**
5.1.	**Blind Spot Visualization (BSV)**
5.1.1.	Definitions
5.1.1.1.	Subject vehicle (SV): The test vehicle that is being assessed also called as Vehicle Under Test (VUT)
5.1.1.2.	Target vehicle (TV): Motorcycle that is closing in on the subject vehicle from behind. A Motorcyclist Target as defined in ISO 19206:3 shall be use for the assessment.
5.1.1.3.	Coverage zone: The entire area to be monitored by a Blind Spot Technology is a system's coverage zone, consisting of a specific subset of the following zones: left adjacent zone, right adjacent zone, left rear zone, and right rear zone
5.1.1.4.	Adjacent zones: Zones to the left and right of the subject vehicle
5.1.1.5.	Visualization function: As for the non-detection type, the system shall be able to provide a live visual of the vehicles moving in the same direction and on the side and/or rear of the subject vehicle, which can be activated manually or via turn signal action, thus enabling a target vehicle located within the coverage zone to be visualized by the system.
5.1.2.	Reference System
5.1.2.1.	The International Standard (ISO : 17387) specifies the system requirements and test methods for Lane Change Decision Aid Systems (LCDAS) that are fundamentally intended to warn the driver of the subject vehicle against potential collisions with vehicles to the side and/or rear of the subject vehicle and moving in the same direction as the subject vehicle during lane change manoeuvres.
5.1.3.	Test Conditions
	The test location shall be on a flat, dry asphalt or concrete surface. The ambient temperature during testing shall be within the range of 5 °C to 40 °C. The test shall be conducted during the day.
5.1.4.	Test Track
5.1.4.1.	Conduct tests on a dry (no visible moisture on the surface), uniform, solid-paved surface with a consistent slope between level and 1%.
5.1.4.2.	The surface must be paved and may not contain any irregularities (e.g., large dips or cracks, manhole covers, or reflective studs).
5.1.5.	Test Procedure
5.1.5.1.	Test Conduct
5.1.5.1.1.	Static Straight-lane Tests
	• The test SV is subjected to one type of performance test, namely static straight-lane tests. • In the static straight-lane test series, both SV and TV are placed on separate but parallel lanes, with the target vehicle positioned in the lane next to the SV either on the driver or passenger side, as depicted in Figure 1.

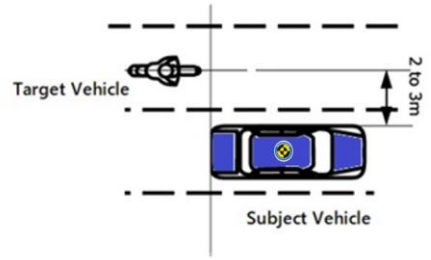


Figure 1: Target vehicle and subject vehicle's positions

- The static straight-lane tests are performed on a controlled straightaway test facility containing equal or more than three parallel lanes of concrete surface roadway. All tests are performed during the day.
- Once these measurements are completed for the passenger side, the entire test is repeated for the driver-side sensor. In order to identify the system's interaction with the application of the SV's turn signals, the test series are repeated with the turn signal activated.

5.1.5.1.2. Functionality Check and Scoring

Check the functionality of whether the BSV system provides adequate live visual of the static vehicle when a test is performed according to the test procedure with the target vehicle described in next step.

5.1.5.1.3. Static Test

- In the static test, the target vehicle will be positioned at five different locations in the lane next to the subject vehicle, between 2 to 3 meters adjacent, as described in Figure 2. Confirm that the target vehicle is visible at each place and distance.
- The locations of the target vehicle must be as follows (with respect to the subject vehicle's rear):

a) 30 m zone
b) 20 m zone
c) 10 m zone
d) 3 m zone
e) Blind spot zone

- The result should be based on the following Table 1.

Table 1: Blind Spot visualization requirements

Live visual video	Must be clearly visible
Distance	In the 30-meter zone from SV trailing edge to blind spot zone

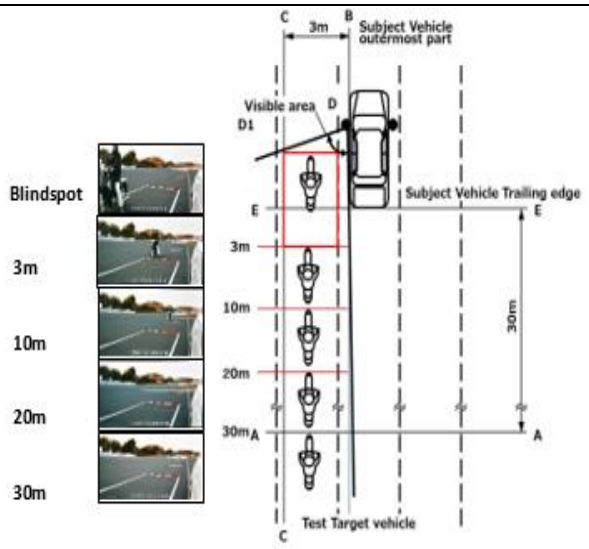


Figure 2: Functionality check and score

- If the subject vehicle does not meet all the requirements as described in Table 1, no point will be rewarded.
- The subject vehicle should be able to visualize other vehicles in the blind spot zones, especially smaller ones such as motorcycles (the target vehicle), and provide adequate visibility as described in Figure 3.

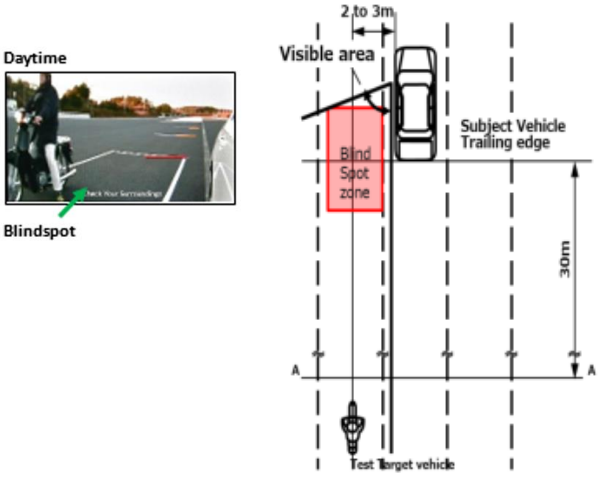
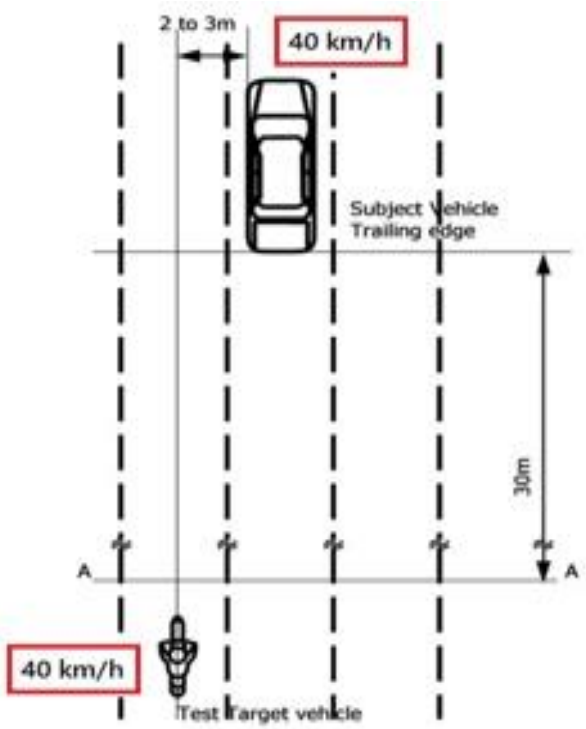
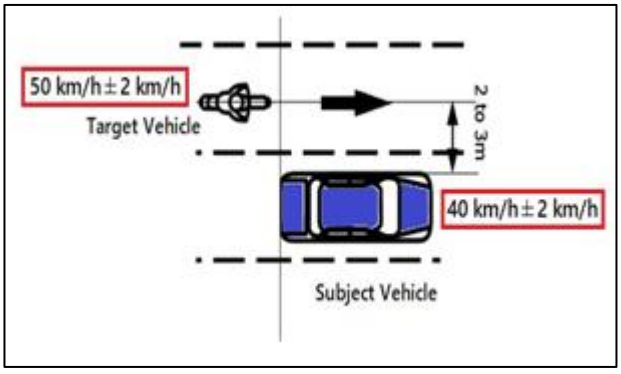


Figure 3: Zone requirements for BSV system live visual

5.2.	**Blind Spot Detection (BSD)**
5.2.1.1.	Coverage Zone
	The entire area is to be monitored by a BSD. A system's coverage zone comprises a specific subset of the following zones: left adjacent zone, right adjacent zone, left rear zone and right rear zone.
5.2.1.2.	Adjacent Zones
	Zones to the left and right of the subject vehicle.
5.2.1.3.	Closing Speed
	⟨of a target vehicle⟩ the difference between the target vehicle's speed and the subject vehicle's speed. NOTE: This definition applies to target vehicles in the rear zones only. A positive closing speed indicates that the target vehicle is closing in on the subject vehicle from the rear.
5.2.1.4.	Overtaking Speed
	⟨of the subject vehicle⟩ the difference between the subject vehicle's speed and the target vehicle's speed when the subject vehicle is overtaking the target vehicle.
5.2.1.5.	Blind Spot Warning Function
	Function that detects the presence of target vehicles in one or more of the adjacent zones and warns the subject vehicle driver *NOTE: A target vehicle located within the coverage zone will thus be detected by the system.*
5.2.1.6.	Test Track
5.2.1.6.1.	The tests are done on a dry (no visible moisture on the surface), uniform, solid-paved surface with a consistent slope between level and 1%.
5.2.1.6.2.	The surface must be paved and may not contain any irregularities (e.g., large dips or cracks, manhole covers, or reflective studs) that may give rise to abnormal sensor measurements within a lateral distance of 10.0 m to either side of the test path and with a longitudinal distance of 10 m ahead of the VUT when the test ends.
5.2.2.	Test Procedure
	• The assessment is to evaluate whether the blind spot warning system gives warnings when required as the target vehicle overtakes the subject vehicle. Referring to Figure 1, the test shall be conducted as follows. • On a straight and flat test course, the test Subject Vehicle (SV) shall be driven in a straight line at a maximum steady speed of 40 km/h±2 km/h. The tested Target Vehicle (TV) shall be ridden in a straight line, as shown in Figure 1, so that its closing speed is 10 km/h±2 km/h. • Both vehicles shall be driven/ridden such that the lateral distance between the outermost edge of the subject vehicle's body (excluding the exterior mirror) and the centreline of the TV is between 2.0 to 3.0 meter for the true warning test and atleast 6.0 meter for the false warning test.

	• The assessment will start when both vehicles reach a steady speed of 40 km/h±2 km/h and the TV is completely behind line A (> 30-meter distance) as illustrated in Figure 1.  Figure 1: Target vehicle entering 30-meter zone with steady speed
5.2.2.1.	Test Conduct
5.2.2.1.1.	Straight-Lane Tests
	• The test SV is subjected to one type of performance test: the straight-lane test. • In the straight-lane test series, both SV and TV are driven and ridden in separate but parallel lanes, with the target vehicle riding longitudinally past the subject vehicle. TV is ridden in the lane next to the SV, either on the driver's or passenger's side, as depicted in Figure 2.  Figure 2: Target vehicle overtaking subject vehicle speed

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- The straight-lane tests are performed on a controlled straightaway test facility containing equal or more than three parallel lanes of concrete surface roadway. All tests are performed during the day.
- Once these measurements are completed for the passenger's side, the entire test is repeated for the driver's side sensor.

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<tr><td>5.2.2.1.2.</td><td>True Warning Test</td></tr>
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- In the true warning test, the target vehicle overtakes the subject vehicle in the area between 2 to 3 meters adjacent, as described in Figure 2.
- BSD warning requirements are divided into three sections: must give warning, might give warning, and must not give warning. The result should be based on Table 2. The subject vehicle must be in fully prepared condition while running at **40 km/h±2 km/h**. The target vehicle speed is at **50 km/h±2 km/h** to overtake the subject vehicle. All tests cover both the driver's and passenger's sides of the subject vehicle.
- Refer Section 5.2.5.3.5 for additional details on the acceleration and overtaking zone.

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Table 1: BSD warning requirements

BSD indicator/ audible/visual warning	**Must not on**	**Might be on**	**Must be on**
Distance	Beyond 30 meters behind car	In 30meter zone behind car	In 3-meter zone behind car to 95th percentile eyellipse

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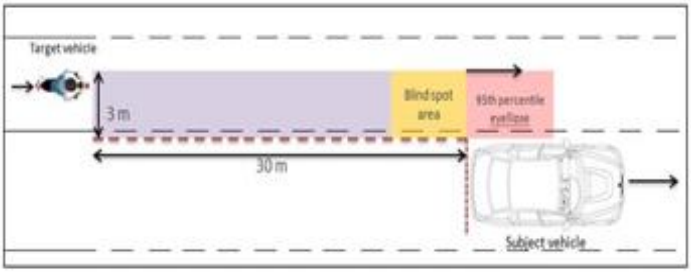


Figure 3: Must not give blind spot warning to the driver

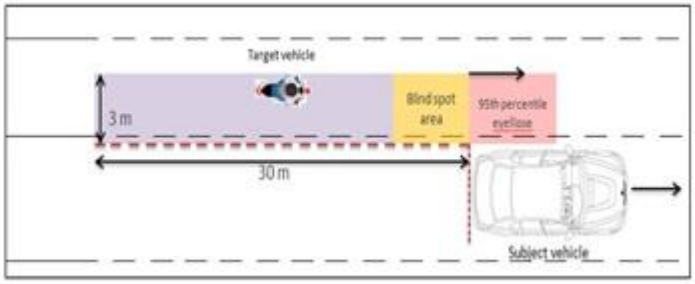


Figure 4: Might give blind spot warning to the driver

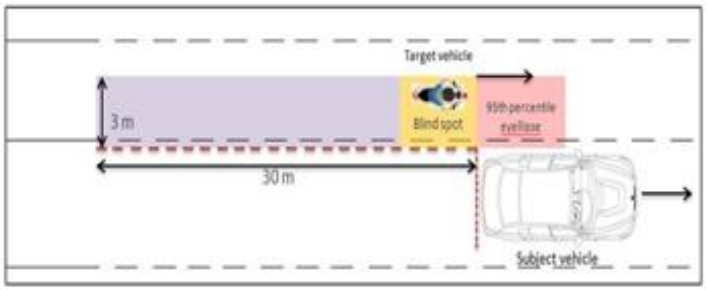
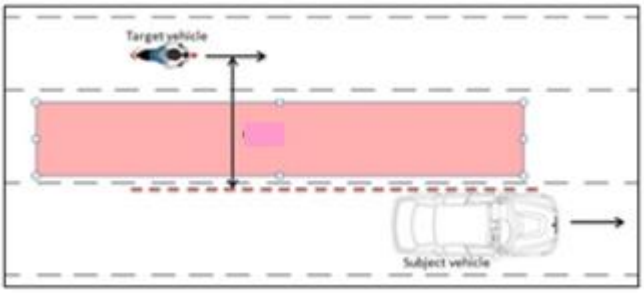
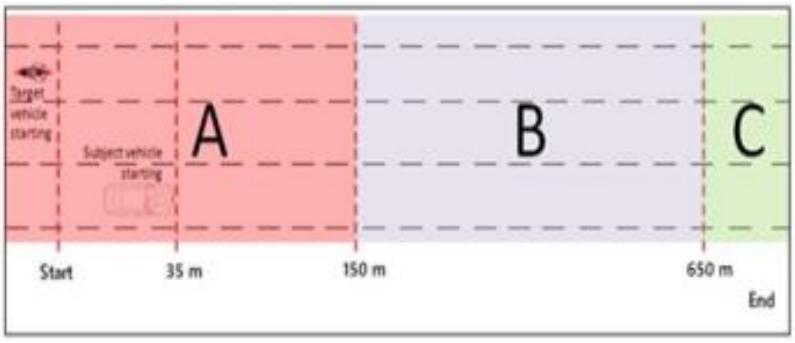
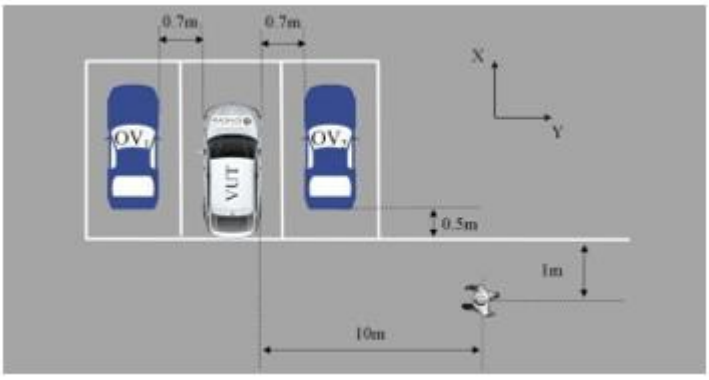


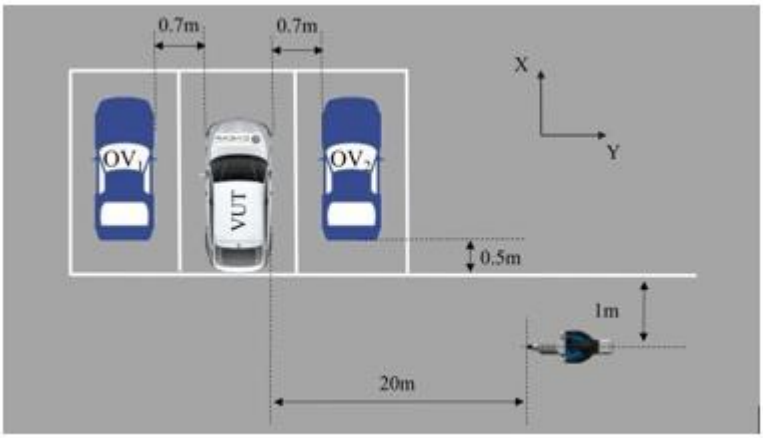
Figure 5: Must give blind spot warning to the driver

- Three (3) repeated runs of each side sequence are to be completed to determine sensitivity and repeatability.
- If the subject vehicle does not meet the requirements for all three runs as described in Table 1, no points will be rewarded.

5.2.5.3.4	False Warning Test
	• The purpose of this test is to determine that the lane change warning system gives no warning when the target vehicle is in the lane beyond the adjacent lane. • In each test, the lateral distance between the outermost edge of the subject vehicle's body (excluding the exterior mirror) and the centerline of the test target vehicle shall be maintained at 6.0 meters. • The system shall give no warning signal during these trials. All tests cover both the left and right sides of the subject vehicle.

	• A single test run is adequate to complete the assessment  Figure 6: Target vehicle shall be maintained at 6.0 meters during test
5.2.5.3.5	Test Facility Layout
	• The layout of the BSD test facility is shown in figure 7 below. This layout area includes length (minimum) of 700-meter and 11-meter wide, which is sufficient for the testing. This layout is divided into three zones: A, B, and C. • A is the starting area for the test vehicle. • B is the bypass area where the target vehicle needs to overtake the subject vehicle. • C is for braking area and U-turn. • Subject and target vehicles start moving at the same time laterally and achieve constant or steady speed at 40 km/h±2 km/h before entering Zone B. • In Zone B, the target vehicle needs to accelerate to 50 km/h±2 km/h to overtake the subject vehicle within a 500-meter range. Zone B is a critical area for the test where the blind spot technology needs to function and give a warning to the driver. • Both vehicles need to slow down before making a U-turn when entering Zone C and returning to the starting line for the next run. The minimum repetition is three (3) runs for each side.  Figure 7: Test facility layout

6.	**REAR CROSS TRAFFIC ALERT (RCTA)**
	When the vehicle is reversing, other road users approaching horizontally from the rear of the vehicle are monitored in real time, and a warning message is issued when a risk of collision is likely to occur.
6.1.	**Definitions**
6.1.1.	PTC (Pedestrian Target Child)
	Child Target as referred in AIS-185 shall be used for the assessment.
6.1.2.	Motorcyclist Target
	Motorcyclist Target as defined in ISO 19206 shall be used for the assessment
6.1.3.	TTC (Time To Collision)
	The time that maintains the current state of motion, and is required for the VUT to collide with the target.
6.1.4.	T_{RCTA}
	It is the time of the RCTA system issues an alarm after the signal T_0 In the RCTA test, T_0 is the moment when TTC=3s
6.2.	Test Equipment, Data Filtering, Test site requirements for the test shall be as per the requirements of AIS-185.
6.3.	**Obstacle Vehicle / Target requirements**
6.3.1.	Obstacle vehicle (OV) as shown in Figure 1 below shall be a GVT as defined in ISO 19206. Alternatively, mass-produced automobiles, having dimensions similar to the GVT may also be used as OV.
6.4.	**Vehicle control and setup**
6.4.1.	R gear is selected for the automatic and manual VUT. The vehicle is reversed at a speed such that where the engine speed is reached and maintained at atleast 1500 RPM during the entire test. If necessary, the VUT can be kept on the planned path by turning the steering wheel slightly
6.4.2.	Test scenario of a child target passing through the back of the vehicle.  Figure 1: Schematic diagram of test scenario where a child pedestrian target passes through the back of the vehicle

	▪ The central axis of the VUT is parallel to the X axis, and the end of the VUT body is flush with the parking line. An obstruction vehicle OV is placed on each side of the VUT. The distance between the obstacle vehicle OV and the outermost edge of the body of the test vehicle VUT (excluding the outer rear-view mirror) is 0.7m. The distance between the rear end of the OV body of the obstacle vehicle and the rearmost end of the VUT body along the X axis is 0.5m, as shown in Figure 1. ▪ At the beginning of the test, the VUT should be put into reverse, the steering wheel is within the free play, and is centred in the vehicle's parking space; the child moves at a speed of 5 km/h in a direction perpendicular to the driving direction of the vehicle. A target child from left-to-right passing test and a right-to-left passing test of the VUT are carried out separately.
6.4.3.	Test scenario of a Motorcyclist target passing through the back of the vehicle  Figure 2: Schematic diagram of test scenario where Motorcyclist target passes through the back of the vehicle • The VUT is placed in the same configuration as during the child pedestrian target test. The configuration to be followed for this test is also shown in Figure 2 above. • At the beginning of the test, the VUT should be put into reverse, the steering wheel is within the free play, and is centred in the vehicle's parking space; the motorcyclist moves at a speed of 20 km/h in a direction perpendicular to the driving direction of the vehicle. A target motorcyclist left-to-right passing test and a right-to-left passing test of the VUT are carried out separately.
6.4.4.	Test accuracy (1) Child/Motorcyclist lateral offset: 0 ± 0.05 m; (2) Child target steady-state speed: 5 ± 0.2 km/h; (3) Motorcyclist Target steady state speed: 20 ± 0.5 km/h

7.	**TRAFFIC SIGN RECOGNITION**
7.1.	**Introduction**
7.1.1.	Traffic Sign Recognition is considered as a safe driving feature which is based on providing speed limit information to the vehicle driver based on the perceived speed limit, while driving.
7.1.2.	The reference document for deriving the requirements for Traffic Sign Recognition system is EU 2021/ 1958.
7.1.3.	Due to concerns about uniformity and consistency of road signs, only Traffic Sign Recognition system with explicit speed signs is considered for assessment under BNCAP.
7.1.4.	The applicable standard for requirements of speed signs in India is IRC 067.
7.2.	**Definitions**
7.2.1.	Traffic Sign Recognition (TSR) - a function that is comprised of the speed limit determination system that determines the perceived speed limit, and a human machine interface that communicates the perceived speed limit to the driver.
7.2.2.	Perceived Speed Limit - the applicable speed limit as obtained by the speed limit determination system.
7.2.3.	Speedometer Speed - the driving speed of the vehicle as displayed by its on-board speedometer
7.2.4.	Applicable Speed Limit - the maximum permitted legal driving speed for the road travelled, as applicable for the category of vehicle that the Traffic Sign Recognition system is fitted to.
7.2.5.	Catalogue of Road Signs - the list of national variants of road sign types and variable message sign types based upon which the Traffic Sign Recognition system obtains the perceived speed limit; IRC 067 is the reference document for speed limit signs in India.
7.2.6.	Explicit Numerical Speed Limit Sign - an applicable road sign which shows a temporary or permanent numerical value.
7.2.7.	Speed Limit Determination System - the specific hardware required to obtain the speed limit through the observation of road signs, based on infrastructure signals or electronic map data, or both.
7.2.8.	National Speed Limit - the default maximum permitted legal driving speed for the road type travelled, unless indicated otherwise, as applicable for the category of vehicle that the Traffic Sign Recognition system is fitted to.
7.3.	**Technical Requirements**
7.3.1.	TSR Display
7.3.1.1.	The TSR display shall be located in the direct field of view of the driver and be clearly identifiable and legible both day and night. Additional displays of similar information at other locations in the vehicle (e.g. on navigation screen, as projected

	information, etc.) are permitted and they shall not be subject to the requirements in this point.
7.3.1.2.	In the absence of conditions leading to the deactivation of the system, the TSR display shall display the perceived speed limit to the driver at least when the speedometer speed is more than the perceived speed limit, for speeds from 5 km/h or less.
7.3.1.3.	The perceived speed limit shall be displayed in any of the following ways: • on the speedometer in a manner that is clearly noticeable and distinguishable, and which does not reduce the speedometer's legibility (e.g. optical mar) • as a numerical value, using a symbol resembling a model of speed limit road sign referred to in IRC 067 • text consisting of the value and the unit of measurement. Display of additional sub-sign information is permitted in all cases.
7.3.1.4.	When no perceived speed limit is available to the TSR system, a dedicated optical signal, making clear this particular situation, shall be provided to the driver. The failure warning signal specified in clause 7.5, shall not be used for the purpose.
7.3.1.5.	When the TSR display displays the perceived speed limit, even when the speedometer speed is lower than the perceived speed limit, the system shall also provide a subtle and not-annoying audible notification each time when the perceived speed limit changes. This feature may be user configurable (e.g. sound, volume, permanently switched off, etc.).
7.3.2.	Speed Limit Determination
7.3.2.1.	Perceived speed limit determination through observation of explicit speed limit signs: In the absence of conditions leading to the deactivation of the system, the TSR SLIF shall be able, through direct visual observation of road signs or other effective methods, to recognise all explicit numerical speed limit signs where the associated applicable speed limit for the category of vehicle to be approved matches the numerical value shown on the sign, and determine the applicable speed limit at the latest 2 seconds after the manufacturer's declared reference point on the motor vehicle passes the road sign. This requirement shall be met at least when the following conditions are satisfied:
7.3.2.1.1.	The signs meet the road sign conditions at the time of assessment as per clause 7.3.2.3
7.3.2.1.2.	the signs are encountered in the operational and environmental conditions as per clause 7.3.2.4
7.3.2.1.3.	For vehicle driving speeds below 20 km/h, the applicable speed limit may be determined at the latest 10 m rearward of the manufacturer's declared reference point.
7.3.2.2.	Speed limit sign conditions at time of the assessment
7.3.2.2.1.	of a design and size conforming to the IRC 067 standard
7.3.2.2.2.	positioned in a way conforming to the IRC 067 standard
7.3.2.2.3.	showing no significant damage (e.g. fading, reduced retro-reflectivity, bending, cracking, vandalism) that materially affects their visual properties

7.3.2.2.4.	not partially or fully covered (e.g. foliage, snow or dirt obscuring the sign, or deliberate invalidation during roadworks)
7.3.2.3.	Operational and environmental conditions at time of the assessment
7.3.2.3.1.	full operating speed range of the vehicle
7.3.2.3.2.	with unobstructed view of the road sign for a continuous period of at least 1.0 seconds
7.3.2.3.3.	in all illumination conditions without direct blinding sunlight and with passing beam head lamps illumination if appropriate, day or night
7.3.2.3.4.	in the absence of weather conditions affecting the visibility of road signs (e.g. fog, heavy rain, snow)
7.3.3.	When, within 12 months before the type-approval test, a change occurred in the country as regards the applicable speed limit, or a new sign is introduced, as included in the IRC 067 at time of the type-approval test of the vehicle, the sign should not be considered for testing, unless requested by the manufacturer.
7.3.4.	Any correct perceived speed limit determination events and associated distance driven may be taken into account on the request of the manufacturer, on case-by-case basis, when the system outperforms the basic technical requirements, especially in the case where manufacturers employ a combination of an optical observation sensor + GNSS based location determination system + digital maps, being the preferred option with the greatest reliability.
7.4.	**Test Procedure**
7.4.1.	Subject vehicle conditions
7.4.1.1.	Test mass - The vehicle mass shall be the mass in running order.
7.4.1.2.	Tyres - The tyres shall be bedded in and the tyre pressures shall be adjusted in accordance with the vehicle manufacturer's specifications
7.4.1.3.	Pre-test conditioning - If requested by the manufacturer the subject vehicle may be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to calibrate the sensor system
7.4.2.	Road signs
7.4.2.1.	The road signs used for the tests shall be explicit speed limit signs where the associated applicable speed limit for the category of vehicle to be approved matches the numerical value shown on the sign. These signs shall meet all conditions specified in the road sign conditions at the time of assessments.
7.4.2.2.	The signs shall be positioned in a way to avoid multiple signs being in the system's field of view simultaneously.
7.4.2.3.	• For testing, three different explicit speed limit signs shall be selected by the BNCAP authorities from the list of national speed limits. The signs selected should be national speed limits. The signs used for the tests shall be recorded in the test report. • To test the perceived speed limit determination through direct or indirect visible observation, the position of the explicit speed limit signs used for testing shall not be included in the electronic map data of the vehicle at the

	start of the test. • The manufacturer shall demonstrate, through the use of documentation, compliance with all other explicit speed limit signs as included in IRC 067 standard, for the category of vehicle to be approved, where the associated applicable speed limit for the category of vehicle to be approved matches the numerical value shown on the sign. Any such documentation shall be appended to the test report dossier.
7.4.3.	Testing conditions
7.4.3.1.	The tests shall be carried out as per below conditions:
7.4.3.1.1.	on a flat surface which is free from uneven patches, standing water, snow and ice, and provides the driver an unobstructed view of the road sign for a continuous period of at least 1.0 seconds
7.4.3.1.2.	in all illumination conditions without direct blinding sunlight and with passing beam head lamps switched on if appropriate
7.4.3.1.3.	in the absence of weather conditions affecting the visibility of signs
7.4.3.2.	At the manufacturer's discretion and with the agreement of the BNCAP authorities the tests may be performed under conditions deviating from the conditions referred to in 7.4.1
7.4.3.3.	With agreement between the manufacturer and the BNCAP authorities, the tests can be performed in either of the following locations: • on a public road; or • on a test track, provided the TSR SLIF does not require electronic map data to function correctly, unless it is included in the electronic map data.
7.4.3.3.1.	By agreement between the manufacturer and the BNCAP authorities the test track-based procedure described above can be replaced with a laboratory-based procedure that has been shown to be equivalent.
7.4.4.	Testing Procedure
7.4.4.1.	The subject vehicle shall be driven in a smooth manner so that its attitude is stable past the road sign selected for testing in the following conditions:
7.4.4.1.1.	a speedometer speed exceeding the speed indicated on explicit speed limit sign
7.4.4.1.2.	in the centre of the test lane.
7.4.4.2.	The technical requirements are fulfilled if the TSR displays the perceived speed limit value that is equal to the speed limit shown on all explicit speed limit signs tested at the latest 2.0 seconds after the vehicle's reference point passes the relevant signs.
7.4.4.3.	For vehicle speeds slower than 20 km/h this shall be at the latest 10 m rearward of the vehicle's reference point.
7.5.	**TSR Failure Warning**
7.5.1.	A constant optical signal shall be provided when there is a failure in the TSR system that prevents the performance requirements of this Regulation of being met.
7.5.2.	There shall not be an appreciable time interval between each TSR self-check, and subsequently there shall not be a delay in displaying the warning signal, in the case

	of an electrically detectable failure.
7.5.3.	Upon detection of any non-electrical failure condition (e.g. sensor obscuration excluding temporary obscuration such as sun glare) a failure warning signal shall be activated.
7.5.4.	The status of a failure that must activate the warning signal, but which is not detected under static conditions, shall be retained upon detection of such a failure and continue to be displayed after each activation of the vehicle master control switch, as long as the failure or defect persists.
7.6.	**TSR Vehicle Settings**
7.6.1.	It shall be possible for the driver to manually deactivate the TSR system. The conditions set out in clause 7.6.2, 7.6.3 and 7.6.4 shall apply as appropriate.
7.6.2.	The TSR system shall be automatically reinstated in normal operation mode upon each activation of the vehicle master control switch/ ignition switch. Automatic reactivation of TSR system may be conditional upon the driver's door having been opened.
7.6.3.	A constant optical signal shall inform the driver that the TSR system has been deactivated. The failure warning signal specified in clause 7.5 may be used for this purpose.
7.6.4.	Following manual deactivation of the TSR system, it shall be possible for the driver to re-activate the system with no more than the number of actions required to deactivate it.
8.	**HILL HOLD ASSIST**
8.1.	Hill Hold Assist is a driver's assistance system that prevents a vehicle from rolling backward on an incline by automatically holding the brakes for a few seconds after the driver's foot leaves the brake pedal, allowing ample time to press the accelerator and move forward smoothly.
8.2.	The system shall be so designed that it can prevent vehicles backward rolling on terrains with cross slope of atleast 25 percent (as defined in IRC:52-2019)
8.3.	Vehicle manufacturer shall declare the specification of the Hill Hold Assist System typically the slope of the gradient and the time duration for which the brakes can hold the vehicle on the slope. For example, vehicle manufacturer can declare the system prevents backward rolling for slopes from 4 to 55 percent as defined by IRC.

ANNEXURE II
ACCIDENT AVOIDANCE TEST PROTOCOL

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2.1.	**Car-to-Car Rear Stationary**	
2.1.1.	The test vehicle shall be fitted with AEB System complying to requirements given in AIS-185 for Car-to-Car Autonomous-emergency Braking.	
2.1.2.	To verify compliance, the vehicle manufacturer may sponsor a test according to AIS-185 or shall submit a Test Report issued by a Test Agency conducted per AIS-185	
2.2.	**Car-to-Car Rear Moving**	
2.2.1.	The test vehicle shall be fitted with an AEB System complying to requirements given in AIS-185 for Car-to-Car Autonomous emergency Braking.	
2.2.2.	To verify compliance, the vehicle manufacturer may sponsor a test according to AIS-185 or shall submit a Test Report issued by a Test Agency conducted per AIS-185	
2.3	**Car-to-Car Rear Braking**	
2.3.1	Definitions for vehicle target, etc. as stated in AIS-185 shall apply. Specific definitions for the purpose of this protocol are stated below.	
2.3.1.1	Car-to-Car Rear Braking (CCRb) Collision	
	A collision in which a vehicle travels forwards towards another vehicle that is travelling at constant speed and then decelerates, and the frontal structure of the vehicle strikes the rear structure of the other.	
2.3.1.2	V_{impact}	
	Means the speed at which the VUT hits the VT	
2.3.1.3	V_{rel_impact}	
	Means the relative speed at which the VUT hits the GVT by subtracting the velocity of the GVT from V_{impact} at the time of collision	
2.3.2	Measurements and Variables	
2.3.2.1	Speed of the VUT during the entire test • V_{impact}, speed when VUT impacts VT • $V_{rel,impact}$ relative speed when VUT impacts VT	**V**$_{VUT}$ **V**impact **V**rel,impact

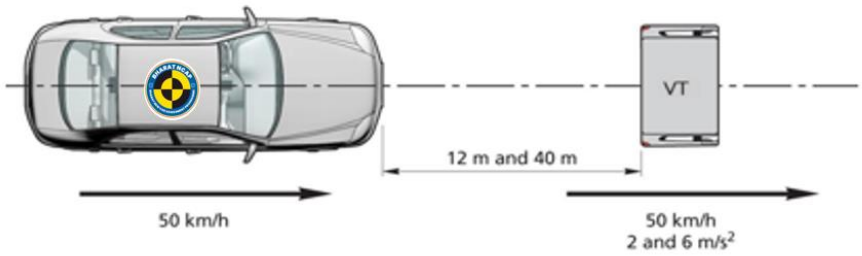
<table>
<tr><td>2.3.2.2</td><td>Speed of the VT during the entire test</td><td>V_{VT}</td></tr>
<tr><td>2.3.3</td><td colspan="2">Test Scenarios</td></tr>
<tr><td>2.3.3.1</td><td colspan="2">The test shall be conducted in accordance to the ambient conditions and pre-test conditioning specified in AIS-185 with VT speed and deceleration conditions as specified in Cl 2.3.3.6 below.</td></tr>
<tr><td>2.3.3.2</td><td colspan="2">The vehicle mass condition of ’Maximum Mass’ as defined in AIS-185 shall be followed. This maximum mass shall include the mass of onboard equipment’s, driver and any secondary person if present for noting the results.</td></tr>
<tr><td>2.3.3.3</td><td colspan="2">The front/rear axle load distribution needs to be within 5% of the front/rear axle load distribution as specified by the vehicle manufacturer for maximum mass condition.</td></tr>
<tr><td>2.3.3.4</td><td colspan="2">The performance of the VUT AEB system is assessed in the CCRb scenarios as shown in Figure 1.</td></tr>
<tr><td>2.3.3.5</td><td colspan="2">For testing purposes, assume a straight line path equivalent to the centreline of the lane in which the collision occurred, hereby known as the test path. Control the VUT with driver inputs or using alternative control systems that can modulate the vehicle controls as necessary to perform the tests.
 

Figure 1: CCRb scenario</td></tr>
<tr><td>2.3.3.6</td><td colspan="2">The CCRb tests will be performed at a fixed speed of 50km/h for both VUT and VT with all combinations of 2m/s^2 and 6m/s^2 deceleration and 12m and 40m headway.</td></tr>
<tr><td></td><td colspan="2">Table 1: CCRb scenario parameters
<table>
<tr><td rowspan="4">AEB Car-to-Car Rear Braking</td><td>Deceleration</td><td>2 m/s^2</td><td>6 m/s^2</td></tr>
<tr><td>Headway</td><td>12 m</td><td>40 m</td></tr>
<tr><td>VUT</td><td>50 km/h</td><td>50 km/h</td></tr>
<tr><td>VT</td><td>50 km/h</td><td>50 km/h</td></tr>
</table></td></tr>
<tr><td>2.3.4</td><td colspan="2">Test Execution</td></tr>
<tr><td>2.3.4.1</td><td colspan="2">The desired deceleration of the Vehicle Target (VT) shall be reached within 1.0 seconds and shall not vary by more than ± 0.25 m/s^2 of the desired level at any point in time until the end of test.</td></tr>
</table>

2.3.4.2	For vehicles with an automatic transmission select D. For vehicles with a manual transmission select the highest gear where the RPM will be at least 1500 at the test speed. If fitted, a speed limiting device or cruise control may be used to maintain the VUT speed, unless the vehicle manufacturer shows that there are interferences of these devices with the AEB system in the VUT. Apply only minor steering inputs to maintain the VUT tracking along the test path.	
2.3.4.3	Perform the first test for a minimum of 90s and a maximum of 10 minutes after completing the tyre conditioning, and subsequent tests after the same time period. If the time between consecutive tests exceeds 10 minutes, repeat the tyre conditioning procedures and recommence testing. Between tests, manoeuvre the VUT at a maximum speed of 50km/h and avoid riding the brake pedal and harsh acceleration, braking or turning unless strictly necessary to maintain a safe testing environment.	
2.3.4.4	The functional part of the test shall start when the VUT is travelling at a constant speed and is at a distance corresponding to a TTC of at least 4 seconds from the VT.	
2.3.4.5	Speed of VUT	Test speed ± 1.0 km/h
	Speed of VT	Test speed ± 1.0 km/h
	Lateral deviation from test path	0 ± 0.1 m
	Relative distance VUT and VT (CCRb)	12m or 40m ± 0.5m
2.3.4.6	The end of a test is considered when one of the following occurs: - V_{VUT} = 0km/h - $V_{VUT} < V_{VT}$ - Contact between VUT and VT	
2.3.4.7	Braking will be applied such that it results in a maximum brake level of -4 m/s^2 to 0.25 m/s^2 when applied in a non threat situation. The particular brake profile to be applied (pedal application rate applied in 200ms (max. 400mm/s) and pedal force) shall be specified by the manufacturer. When the brake profile provided by the manufacturer results in a higher brake level than allowed, the iteration steps as described in Appendix A to this protocol will be applied to scale the brake level to -4 m/s^2 to 0.25 m/s^2 .	
2.3.4.8	When no brake profile is provided, the default brake profile as described in Appendix A will be applied.	

APPENDIX – A

BRAKE APPLICATION PROCEDURE

	BRAKE APPLICATION PROCEDURE	
	The braking input characterisation test determines the brake pedal displacement and force necessary to achieve a vehicle deceleration typical of that produced by a typical real-world driver in emergency situations.	
B.1	**Definitions**	
B.1.1	**T_{BRAKE}**	The point in time where the brake pedal displacement exceeds 5 mm.
B.1.2	**T_{-6m/s^2}**	The point in time is defined as the first data point where filtered, zeroed and corrected longitudinal acceleration data is less than -6 m/s^2.
B.1.3	**T_{-2m/s^2}, T_{-4m/s^2}**	similar to T_{-6m/s^2}.
B.2	**Measurements**	
	Measurements and filters to be applied as described in relevant sections of AIS 185.	
B.3	**Brake Characterization Procedure**	
	First perform the brake and tyre conditioning tests as described AIS 185. The brake input characterisation tests shall be undertaken within 10 minutes after conditioning the brakes and tyres.	
B.3.1	Brake Displacement Characterisation Tests	
	• Push the brake pedal through the full extent of travel and release. • Accelerate the VUT to a speed in excess of 85 km/h. Vehicles with an automatic transmission will be driven in D. For vehicles with a manual transmission, select the highest gear where the RPM will be at least 1500 at the 85 km/h. • Release the accelerator and allow the vehicle to coast. At a speed of 80 ± 1.0 km/h, initiate a ramp braking input with a pedal application rate of 20±5 mm/s and apply the brake until a longitudinal acceleration of -7 m/s^2 is achieved. For manual transmission vehicles, press the clutch as soon as the RPM drops below 1500. The test ends when a longitudinal acceleration of -7 m/s^2 is achieved. • Measure the pedal displacement and applied force normal to the direction of travel of the initial stroke of the brake pedal, or as close as possible to normal as can be repeatedly achieved. • Perform three consecutive test runs. A minimum time of 90 seconds and a maximum time of 10 minutes shall be allowed between consecutive tests. If the maximum time of 10 minutes is exceeded, the tyre and brake conditioning	

	procedures shall be repeated before restarting the brake pedal force characterisation tests. • Using second order curve fit and the least squares method between T_{-2m/s^2}, T_{-6m/s^2}, calculate the pedal travel value corresponding to a longitudinal acceleration of -4 m/s² (=D4, unit is m). Use data of at least three valid test runs for the curve fitting. This brake pedal displacement is referred to as D4 in the next chapters. • Using second order curve fit and the least squares method between T_{-2m/s^2}, T_{-6m/s^2}, calculate the pedal force value corresponding to a longitudinal acceleration of -4 m/s² (=F4, unit is N). Use data of at least three valid test runs for the curve fitting. • This brake pedal force is referred to as F4 in the next chapters.
B.3.2	Brake Force Confirmation and Iteration Procedure
	• Accelerate the VUT to a speed of 80+1 km/h. Vehicles with an automatic transmission will be driven in D. For vehicles with a manual transmission, select the highest gear where the RPM will be at least 1500 at the 80 km/h. • Apply the brake force profile as specified in B.4, triggering the input manually rather than in response to the FCW. Determine the mean acceleration achieved during the window from T_{BRAKE} +1s to T_{BRAKE} +3s. If a mean acceleration is outside the range of -4 m/s^2 - 0.25 m/s^2 results, apply the following method to ratio the pedal force applied. F4new = F4original * (-4/mean acceleration), i.e. if F4original results in a mean acceleration of -5 m/s2, F4new = F4original * -4 / -5 • Repeat the brake force profile with this newly calculated F4, determine the mean acceleration achieved and repeat the method as necessary until a mean acceleration within the range of -4m/s^2- 0.25 m/s2 is achieved. • Three valid pedal force characteristic tests (with the acceleration level being in the range as specified) are required. A minimum time of 90 seconds and a maximum time of 10 minutes shall be allowed between consecutive tests. If the maximum time of 10 minutes is exceeded, the tyre and brake conditioning procedures shall be repeated before restarting the brake pedal force characterisation tests. This brake pedal force is referred as F4 in the next chapters.
B.4	**Brake Application Profile**
	• Detect T_{FCW} during the experiment in real-time. • Release the accelerator at T_{FCW} + 1 s. • Perform displacement control for the brake pedal, starting at T_{FCW} + 1.2 s with a gradient of the lesser of 5 x D4 or 400 mm/s (meaning the gradient to reach pedal position D4 within 200 ms, but capped to a maximum application rate of 400 mm/s).

	• Monitor brake force during displacement control and use second-order filtering with a cutoff frequency between 20 Hz and 100 Hz (online) as appropriate. • Switch to force control with a desired value of F4 when: i. the value D4 as defined in B.3 is exceeded for the first time, ii. the force F4 as defined in B.3 is exceeded for the first time, whichever is reached first. • The point in time where position control is switched to force control is noted as T_{switch}. • Maintain the force within boundaries of F4 ± 25% F4. A stable force level should be achieved within a period of 200ms maximum, after the start of force control. Additional disturbances of the force over ± 25% F4 due to further AEB interventions are allowed, as long as they have a duration of less than 200ms. • The average value of the force between T_{FCW} + 1.4s and the end of the test should be in the range of F4 ± 10 N**.**

ANNEXURE III
CRASH PROTECTION TEST PROTOCOL

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1. FRONTAL OFFSET DEFORMABLE BARRIER TEST PROTCOL

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1.3.	**Dummy Preparation and Certification**
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1.4.2.	Refer Appendix B
1.5.	**Passenger Compartment Adjustments**
1.5.1.	Refer Appendix C for methods on setting the seat position for the test
1.5.2.	Adjustments not listed below will be set to mid-positions or nearest positions rearward, lower or outboard.

Adjustment	Required Setting	Notes
Seat fore/aft	Mid position as specified in Appendix C	May be set to first notch rearwards of mid position if not lockable at mid position
Seat base tilt	Manufacturer's design position	Permissible up to mid position, otherwise lowest
Seat height	Lowest position	
Seat back angle (as defined by torso angle)	Manufacturer's design position	Otherwise 25 to vertical As defined by Torso angle
Seat lumbar support	Manufacturer's design position	Otherwise fully retracted
Front head restraint height and tilt	Mid locking position	As whiplash test position. If there is any interference with the rear of the dummy head, move the HR to the most rearward position.
Front seat belt anchorage (where adjustable)	Manufacturer’s 50th percentile design position	If no design position then set to mid-position, or nearest notch upwards
Steering wheel - vertical	Mid position	
Steering wheel - horizontal	Mid position	

Rear seat fore/aft (where adjustable)	Manufacturer's design position	Where no details are provided in the handbook, set to mid
Rear seat back angle (where adjustable)	Manufacturer's design position	Otherwise 25^{o} to Vertical
Rear seat facing	Forwards	
Rear seat cushion tilt	Manufacturer's design position	Where no details are provided in the handbook, set to mid
Rear seat height	Manufacturer's design position	Where no details are provided in the handbook, set to lowest
Rear seat lumbar support	Manufacturer's design position	Otherwise fully retracted
Rear seat cushion length	Manufacturer's design position	Otherwise fully retracted
Rear head restraint height and tilt	As recommended in vehicle handbook	Where no details are provided in the handbook, set to mid or next lowest position for height and mid locking position for tilt. Must not interfere with child/CRS installation.
Rear seat belt anchorage (where adjustable)	As recommended in vehicle handbook for CRS installation	If no recommendation then set to mid-position, or nearest notch upwards
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering
Arm-rests (Rear seats)	Stowed position	
Glazing	Front - Lowered Rear - Lowered or Removed	This applies to opening windows only
Gear change lever	In the neutral position	
Pedals	Normal position of rest	
Doors	Closed not locked. Rear child locks disengaged	
Roof	Lowered	Where applicable
Sun visors	Stowed position	
Rear view mirror	Normal position of use	

1.6.	**Setting the Steering Wheel Horizontal Adjustment**
1.6.1.	Choose a part of the facia that is adjacent to the steering column and can be used as a reference.
1.6.2.	Move the steering wheel to the most forward position of its travel.
1.6.3.	Mark the steering column in line with an unmoving part of the facia. This corresponds to the most forward travel of the steering wheel.
1.6.4.	Move the steering wheel to the most rearwards position of its travel
1.6.5.	Mark the steering column in line with an unmoving part of the facia. This corresponds to the most rearwards travel of the steering wheel.
1.6.6.	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.
1.6.7.	Move the steering wheel so that the mark on the steering column aligns with the facia.
1.6.8.	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.
1.7.	**Setting the Steering Wheel Vertical Adjustment**
	A method that is in principle the same as Section 1.6 above should be used to determine and set the steering wheel vertical adjustment to the mid position. It is unlikely that the same part of the facia used during the setting procedures for the horizontal adjustments could be used for the vertical adjustment. Care should be taken to avoid unintentional adjustment of the horizontal setting during the vertical adjustment procedure.
1.8.	**Automatically Activated Door Locking (AADL)**
	The AADL conditions as defined in Annexure V shall be followed for the tests.
1.9.	**Electric Door Handle (if available)**
	• For electric door handles, the door handle should be in the retracted / vehicle in motion position for the test. • The vehicle manufacturer should inform both the Designated Agency and the test laboratory if any special action is needed, for example if the engine must be running for the retracting door handles to operate as normal in the test.
1.10.	**State of Charge (SoC)**
	The SOC for Electric / Hybrid vehicles shall be adjusted to a charge level as specified in AIS 098 Revision 1 for such vehicles.

1.11.	**DUMMY POSITIONING AND MEASUREMENTS**
	Refer Appendix C
1.12.	**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.
1.13.	**Deformable Barrier**
	Fix a deformable barrier as specified in UNECE Regulation 94 to the concrete block. The height of this barrier should be 200mm ±5mm from the ground.
1.14.	**Speed**
1.14.1.	Measure the speed of the vehicle as near as possible to the point of impact.
1.14.2.	Target Speed = 64km/h ± 1km/h
	Post Test
1.15.	**Door Opening Force**
1.15.1.	Check that none of the doors have locked during the test.
1.15.2.	The door opening procedure and force measurement shall be as specified in Annexure V
1.16.	**Buckle Opening Force**
1.16.1	Any position where the seat belt is used for any of the full scale tests shall be checked post-test, once all of the door opening forces have been measured. This applies to both adult and child occupants where the vehicle seatbelt is used to restrain them and/or a CRS in the test.
1.16.2	The seat belt buckle opening procedure and measurement shall be as specified in Annexure V

1.17.	**Dummy Removal**
1.17.1.	Do not move the driver or passenger seats. Try to remove the dummies.
1.17.2.	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.
1.17.3.	If the dummies can still not be removed, try to slide the seats back on their runners.
1.17.4.	If the dummies can still not be moved, the seats can be cut out of the car.
1.17.5.	Record the method used to remove the dummies.
1.18.	**Intrusion Measurements**
	Take the vehicle intrusion measurements as detailed in Annexure A

2. FRONTAL FULL WIDTH IMPACT TEST

2.	**FRONTAL FULL WIDTH IMPACT TEST**
2.1.	**Vehicle preparation**
	Refer Appendix - A
2.2.	**Intrusion Measurements**
	Refer Appendix - A
2.3.	**Dummy Preparation and Certification**
	Refer Appendix - B
2.4.	**Dummy Instrumentation**
	Refer Appendix - B
2.5.	**Passenger Compartment Adjustments**
2.6.	**Driver Compartment Adjustments**

Adjustment	Required Setting	Notes
Seat fore/aft	Mid position as specified in Appendix C	May be set to first notch rearwards of mid position if not lockable at mid position
Seat base tilt	Manufacturer's design position	Permissible up to mid position, otherwise lowest
Seat height	Lowest position	
Seat back angle (as defined by torso angle)	Manufacturer's design position	Otherwise 25 to vertical As defined by Torso angle
Seat lumbar support	Manufacturer's design position	Otherwise fully retracted
Front head restraint height and tilt	Mid locking position	As whiplash test position. If there is any interference with the rear of the dummy head, move the HR to the most rearward position.
Front seat belt anchorage (where adjustable)	Manufacturer’s 50th percentile design position	If no design position then set to mid-position, or nearest notch upwards
Steering wheel - vertical	Mid position	
Steering wheel - horizontal	Mid position	
Rear seat fore/aft (where adjustable)	Manufacturer's design position	Where no details are provided in the handbook, set to mid
Rear seat back	Manufacturer's design	Otherwise 25 to Vertical

angle (where adjustable)	position	
Rear seat facing	Forwards	
Rear head restraint height and tilt	As recommended in vehicle handbook	Where no details are provided in the handbook, set to mid or next lowest position for height and mid locking position for tilt. Must not interfere with child/CRS installation.
Rear seat belt anchorage (where adjustable)	As recommended in vehicle handbook for CRS installation	If no recommendation then set to mid-position, or nearest notch upwards
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering
Arm-rests (Rear seats)	Stowed position	
Glazing	Front - Lowered Rear - Lowered or Removed	This applies to opening windows only
Gear change lever	In the neutral position	
Pedals	Normal position of rest	
Doors	Closed, not locked	found in cl 5.3
Roof	Lowered	Where applicable
Sun visors	Stowed position	
Rear view mirror	Normal position of use	

2.6.2	Refer Appendix C for methods on setting the seat position for the test

2.7.	**Front Passenger Adjustments**

Adjustment	**Required Setting**	**Notes**
Seat Fore/Aft	Initially Manufacturer's 5th percentile design position	Permissible between fully forward and 25% of travel, measured in lowest position. Otherwise most forward.
Seat Base Tilt	Manufacturer's 5th percentile design position	Permissible up to mid position, when in 5th percentile for/aft position Otherwise mid position
Seat Height	Initially Manufacturer's 5th percentile design position	Permissible between fully upward and 75% travel downwards, when in 5th percentile for/aft position. Otherwise mid position
Seat Back Angle	Manufacturer's 5th percentile design position	Otherwise 23 to vertical, as defined by Torso angle
Head Restraint Height	Lowest position	
Head Restraint Tilt	Manufacturer's 5th percentile design position	Otherwise mid position
Seat Lumbar Support	Manufacturer's 5th percentile design position	Otherwise fully retracted
Arm-rests (Front seats)	In-use position	May be stowed if dummy positioning does not allow in-use position
Steering wheel - vertical	Mid position	
Steering wheel - horizontal	Manufacturer's 5th percentile design position	Otherwise Mid position with a minimum horizontal distance to the dummy of 250mm measured from the centre of the steering wheel*
Seat belt anchorage (where adjustable)	Initially Manufacturer's 5th percentile design position	If no design position then set to lowest position

2.7.2	Refer Appendix C for methods on setting the seat position for the test

2.8.	Rear Passenger Seat Adjustments

Adjustment	Required Setting	Notes
Rear Seat Facing	Forwards	
Rear Seat Lateral position	Most Outboard	
Rear Seat Fore/Aft	Manufacturer's design position	Where no details are provided in the handbook, set to mid
Rear Seat Height	Manufacturer's design position	Feet need to be flat on the floor, if not or no design position set seat to lowest position
Rear Seat Base Tilt	Manufacturer's design position	Permissible up to Mid Position
Rear Seat Lumbar Support	Manufacturer's design position	Otherwise fully retracted
Rear Seat Back Angle	Manufacturer's design position	Otherwise 23^{o} to vertical or as close as possible to 23^{o} as defined by Torso angle
Rear Head Restraint Height	Lowest in-use position	
Rear Head Restraint Tilt	Manufacturer's design position	Otherwise mid position
Rear Seat Arm-rests	Stowed position	
Seat belt anchorage (where adjustable)	Initially, manufacturer’s 5th percentile design position	If no design position then set to lowest position

2.9.	Other Vehicle Adjustments

Adjustment	Required Setting	Notes
Glazing	Front – Lowered Rear - Lowered or removed	This applies to opening windows only
Gear change lever	In the neutral position	
Pedals	Normal use position	
Doors	Closed, not locked	
Roof	Lowered	Where applicable
Sun Visors	Stowed position	
Rear view mirror	Normal position of use	
Front passenger airbag	Disabled using vehicle switch where possible	Enable when testing with FSP

2.10.	**Setting the Steering Wheel Horizontal Adjustment**
2.10.1.	Choose a part of the facia that is adjacent to the steering column and can be used as a reference.
2.10.2.	Move the steering wheel to the most forward position of its travel.
2.10.3.	Mark the steering column in line with an unmoving part of the facia. This corresponds to the most forward travel of the steering wheel.
2.10.4.	Move the steering wheel to the most rearwards position of its travel.
2.10.5.	Mark the steering column in line with an unmoving part of the facia. This corresponds to the most rearwards travel of the steering wheel.
2.10.6.	Measure the distance between the forwards and rearwards marks on the steering column. Place a third mark on the steering column at the manufacturers design position. If no position is given, place a mark mid-way between the forwards and rearwards marks, which corresponds to the centre of travel of the steering wheel.
2.10.7.	Move the steering wheel so that the mark on the steering column aligns with the facia.
2.10.8.	Lock the steering column at this position. The vehicle will be tested with the steering wheel in this position.
2.11.	**Setting the Steering Wheel Vertical Adjustment**
	The same method as in Section 2.10 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.
2.12.	**Automatic Door Locking (ADL)**
	The AADL conditions as defined in Annexure V shall be followed for the tests.
2.13.	**Electric Door Handle (if available)**
	• For electric door handles, The door handle should be in the retracted / vehicle in motion position for the test. • The vehicle manufacturer should inform both the Bharat NCAP Secretariat and the test laboratory if any special action is needed, for example if the engine must be running for the retracting door handles to operate as normal in the test.
2.14.	**State of Charge (SoC)**
	The SOC for Electric / Hybrid vehicles shall be adjusted to a charge level as specified in AIS 098 Revision 1 for such vehicles.

2.15.	**Setting the Rear Seat (if adjustable)**
	As detailed in 2.8 above.
2.16.	**Marking the Rear Dummy Head Excursion Lines**
2.16.1.	The Head Excursion Lines are: • 450 mm forward of the rear dummy H-point XAF05, dummy as determined in Annexure C - section 1.2 (-2 points line) • 550 mm forward of the rear dummy H-point XAF05, dummy as determined in Annexure C - section 1.2 (-4 points line) However, none of the head excursion lines shall be more forward than the most rearward point on the seatback of the front passenger seat, when in the 5th female position. In this case the head excursion line(s) aligns with the most rearward point on the seatback of the front passenger seat, when in the 5th female position.
2.16.2.	The rear passenger excursion lines shall be marked on the vehicle interior and exterior.
2.17.	**Dummy Positioning And Measurements**
	Refer Appendix C
2.18.	**Test Parameters**
	An on-board data acquisition unit will be used. This equipment will be triggered by a contact plate at the point of first contact (t=0) and will record digital information at a sample rate of 20kHz (alternatively a sample rate of 10kHz may be used). The equipment conforms to SAE J211. BEFORE THE TEST, ENSURE THAT THE LIVE BATTERY IS CONNECTED, A SINGLE KEY IS IN THE IGNITION, THE IGNITION IS ON AND THAT THE AIRBAG LIGHT ON THE DASHBOARD ILLUMINATES AS NORMAL (WHERE FITTED) If the vehicle is fitted with a brake pedal retraction mechanism which requires a vacuum present in the brake system, the engine may be run for a predetermined time, specified by the manufacturer.
2.19.	**Barrier**
	The barrier shall consist of a block of reinforced concrete not less than 3 m wide in front and not less than 1.5 m high. The barrier shall be of such thickness that it weighs at least 70 metric tons. The front face shall be flat, vertical and perpendicular to the axis of the run-up track. It shall be covered with plywood boards 20 ± 2 mm thick, in good condition.

2.20.	**Speed**
2.20.1	Measure the speed of the vehicle as near as possible to the point of impact.
2.20.2	This speed should be 50km/h ± 1km/h. Record the actual test speed in the test details. TARGET SPEED = 50km/h ± 1km/h
2.21.	**Door Opening Force**
2.21.1.	Check that none of the doors have locked during the test
2.21.2.	The door opening procedure and measurement shall be as specified in Annexure V
2.22.	**Buckle Opening Force**
2.22.1	Any position where the seat belt is used shall be checked post-test, once all of the door opening forces have been measured.
2.22.2	The seat belt buckle opening procedure and measurement shall be as specified in Annexure V
2.23.	**Dummy Removal**
2.23.1.	Do not move the seats. Try to remove the dummies
2.23.2.	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.
2.23.3.	If the dummies can still not be removed, try to slide the seats back on their runners.
2.23.4.	If the dummies can still not be moved, the seats can be cut out of the car.
2.23.5.	Record the method used to remove the dummies.
2.24.	**Intrusion Measurements**
	Refer Appendix A

3. MOBILE DEFORMABLE BARRIER (MDB) SIDE IMPACT TEST

3.	MOBILE DEFORMABLE BARRIER (MDB) SIDE IMPACT TEST
3.1.	**Vehicle Preparation**
	Refer Appendix A
3.2.	**Dummy Preparation and Certification**
	Refer Appendix B
3.3.	**Instrumentation**
	Refer Appendix B
3.4.	**Passenger Compartment Adjustments**
3.5.	**Overview of Settings**
3.5.1	Adjustments not listed will be set to mid-positions or nearest positions rearward, lower or outboard.

Adjustment	Required Setting	Notes
Seat fore/aft	As defined in Appendix C	
Seat base tilt	As defined in Appendix C	
Seat height	As defined in Appendix C	
Torso angle	Manufacturer's design position	Otherwise 23degto Vertical
Seat lumbar support	Fully retracted	
Front head restraint height and tilt	Mid locking position	As whiplash test position. If there is any interference with the rear of the dummy head, move the HR to the most rearward position.
Front 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
Steering wheel	Highest position and most outward	
Rear seat fore/aft (where adjustable)	Manufacturer's design position	Where no details are provided in the handbook, set to mid
Rear seat back angle (where adjustable)	Manufacturer's design position	Otherwise 25deg to Vertical
Rear seat facing	Forwards	
Rear head restraint height and tilt	As recommended in vehicle handbook.	Where no details are provided in the handbook, set to mid or next lowest position

		for height and mid locking position for tilt. Must not interfere with child/CRS installation
Rear seat belt anchorage (where adjustable)	As recommended in vehicle handbook for CRS installation.	If no recommendation then set to midposition, or nearest notch upwards. MUST be same as ODB
Arm-rests (Front seats)	Lowered position	May be left up if dummy positioning does not allow lowering. Where adjustable place in horizontal position
Arm-rests (Rear seats)	Stowed position	
Side window glazing	All raised	
Gear change lever	In the neutral position	
Parking brake	Engaged	
Pedals	Normal position of rest	Adjustable pedals fully forward
Doors	Closed, not locked	
Roof / sunroof	Raised / fully closed	Where applicable
Sun visors	Stowed position	
Rear view mirror	Normal position of use	

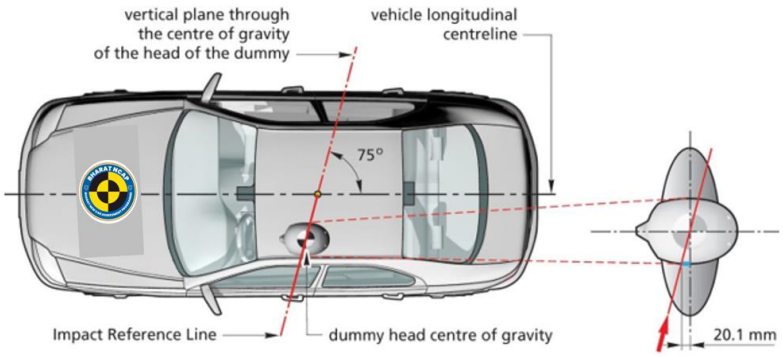
3.5.2	Refer Appendix C for methods on setting the seat position for the test
3.6.	**Setting the steering wheel**
3.6.1.	Set the steering wheel at the geometric highest driving position considering the full range of telescopic and tilt adjustment possibilities, in order to provide clearance for the legs and thorax.
3.7.	**Setting the rear seat (if adjustable)**
3.7.1.	If the vehicle rear seat position is adjustable put it in the same fore/aft position as that used in the frontal impact ODB test with the same seat back angle
3.8.	**Dummy Positioning and Measurements**
	Refer Appendix C
3.9.	**State of Charge (SOC)**
	The Electric / Hybrid vehicles shall be charged to a state as specified in AIS 099 Revision 1
3.10.	**Barrier and Trolley**
	The trolley will be fitted with the Advanced European Mobile Deformable Barrier face (AE-MDB) and ventilation frame conforming to the specifications of AIS 099.

3.11.	**Trolley Preparation**
3.11.1.	The mobile deformable barrier (MDB) includes both an impactor and a trolley.
3.11.2.	The total mass shall be 1300 ± 20kg.
3.11.3.	The centre of gravity shall be situated in the longitudinal median vertical plane within 10mm, 1000 ± 30mm behind the front axle and 500 ± 30mm above the ground.
3.11.4.	The distance between the front face of the impactor and the centre of gravity of the barrier shall be 2000 ± 30mm.
3.11.5.	The height of the barrier shall be such that the uppermost part of the front face of the beam element (the intersection between the upper and lower row of blocks) is 550mm ± 5mm above ground level measured statically prior to impact.
3.11.6.	The front and rear track width of the trolley shall be 1500 ± 10mm.
3.11.7.	The wheelbase of the trolley shall be 3000 ± 10mm.
3.11.8.	The trolley may be fitted with an emergency abort system. This is optional, the test facility may elect to test without an abort system.
3.11.9.	Inflate all tyres of the trolley to the same pressure.
3.11.10.	Mark a line along the vertical centreline of the barrier which may be used to check the alignment of the barrier with the impact location of the test vehicle.
3.11.11.	Measure the wheelbase of the trolley, left and right.
3.11.12.	Determine the average wheelbase from Section 3.10.11 and record in the test details.
3.11.13.	Record in the test details the track of the trolley at the front and at the rear.
3.11.14.	Ensure that the weight distribution is as even as possible left to right.
3.11.15.	Record in the test details the final weights measured at each of the wheels.
3.12.	**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 (2007). **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.

3.13.	**IMPACT SPEED**
3.13.1.	Measure the speed of the trolley as near as possible to the point of impact.
3.13.2.	Record the actual test speed in the test details. TARGET SPEED = 50km/h ± 1km/h
3.14.	**POST-IMPACT BRAKING**
3.14.1.	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.
3.14.2.	Do Not start the braking at the point of initial impact or the trolley will be decelerating during the test.
3.15.	**ALIGNMENT**
3.15.1.	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.
3.15.2.	This pin should align with the vertical impact point line previously marked on the car
3.15.3.	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.
3.15.4.	TARGET ALIGNMENT = CENTRELINE OF BARRIER COINCIDENT WITH PLANE 250mm REARWARD OF ‘R’ POINT ± 25mm
3.15.5.	Target vertical alignment = ± 25mm
3.16.	**Post test**
3.16.1.	Door Opening
3.16.1.1.	Check that none of the doors, including boot lids and any movable roofs, have opened or partially opened during the test. Where this is the case photographic evidence shall be obtained and provided in the test report.
3.16.1.2.	The door opening procedure and measurement shall be as specified in Annexure V
3.16.2.	Buckle Opening Force
3.16.2.1	Any position where the seat belt is used for any of the full scale tests shall be checked post-test, once all of the door opening forces have been measured.
3.16.2.2	The seat belt buckle opening procedure and measurement shall be as specified in Annexure V

3.17.	**DUMMY REMOVAL**
3.17.1.	Do not move the driver seat. Try to remove the dummy.
3.17.2.	If the dummy cannot be removed with the seats in its original position, recline the seat back and try again.
3.17.3.	If the dummy still cannot be removed, try to slide the seat back on its runners or remove the steering wheel.
3.17.4.	If the dummy still cannot be removed, the seat can be cut out of the car.

4. OBLIQUE SIDE POLE IMPACT

4.	**OBLIQUE SIDE POLE IMPACT**
4.1.	**Vehicle Preparation**
	Refer Appendix A
4.1.1.	Impact location
4.1.1.1.	To measure vehicle dimensions and to apply markers, a pointer used to measure coordinates in three dimensions will be used.
4.1.1.2.	The 'Impact Reference Line' is the line formed on the driver side of the test vehicle by the intersection of the exterior surface of the vehicle and a vertical plane passing through the centre of gravity of the head of the dummy positioned in accordance with Appendix C. The vertical plane forms an angle of 75° with the vehicle longitudinal centreline, see Figure 1.
4.1.1.3.	Mark the impact reference line on the side of the vehicle on the exterior, from roof to sill.
4.1.1.4.	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.  Figure 1: Impact reference line
4.2.	**Dummy Preparation and Certification**
	Refer Appendix B
4.3.	**Instrumentation**
	Refer Appendix B

4.4.	**Passenger Compartment Adjustments**
4.4.1.	Overview of Settings

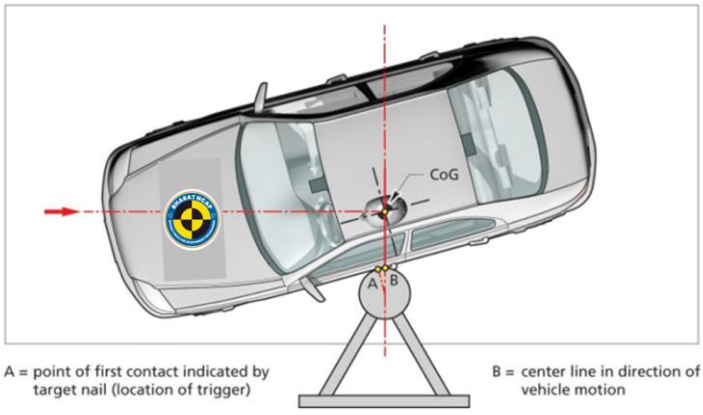
Adjustment	Required setting	Notes
Front seat fore/aft	As defined in Appendix C	
Front seat cushion tilt		Set cushion pitch to mid-angle.
Front seat height		Lowest vertical location
Front seat torso angle	Manufacturer's design position.	Where no design position is given, set to 23° to vertical, as defined by Torso angle. Must be the same in MDB test
Front seat lumbar support	Fully retracted	
Front seat cushion length	Fully retracted	
Front head restraint height and tilt		As whiplash test position. If there is any interference with the rear of the dummy head, move the HR to the most rearward position
Front seat belt anchorage	Manufacturer's 50th percentile design position	If no design position, then set to mid position, or nearest notch upwards
Steering wheel	Highest position and most outward	
Rear seat facing	Forwards	
Rear seat lateral position	Most outboard	
Rear seat fore/aft	Fully rearward	
Rear seat cushion tilt	Manufacturer's design position	Permissible up to mid position, otherwise lowest
Rear seat height	Manufacturer's design position	Where no design position is given, set to lowest
Rear seat back angle	Manufacturer's design position	Where no design position is given, set to 25° to vertical, as defined by torso angle
Rear seat lumbar support	Fully retracted	
Rear seat cushion length	Fully retracted	
Rear head restraint height	As recommended in vehicle handbook.	Where no details are provided in the handbook, set to mid or next lowest position for height and mid

and tilt		locking position for tilt. Must not interfere with child/CRS installation
Rear seat belt anchorage	As recommended in vehicle handbook for CRS installation.	If no recommendation then set to mid-position, or nearest notch upwards. MUST be same as ODB
Arm-rests (Front seats)	Lowered / in use position	May be left up if dummy positioning does not allow lowering. Single occupancy test only
Arm-rests (Rear seats)	Stowed	
Side window glazing	All raised	
Gear change lever	In the neutral position	
Parking brake	Engaged	
Pedals	Normal position of rest	Adjustable pedals fully forward
Doors	Closed, not locked	For automatic door locks, refer to the Rescue and Extrication protocol. Rear child locks disengaged.
Roof	Raised	
Sunroof	Closed	Fixed sunroofs should not be modified for test
Sun visors	Stowed	
Rear view mirror	Normal position of use	
Front passenger airbag	Enabled	

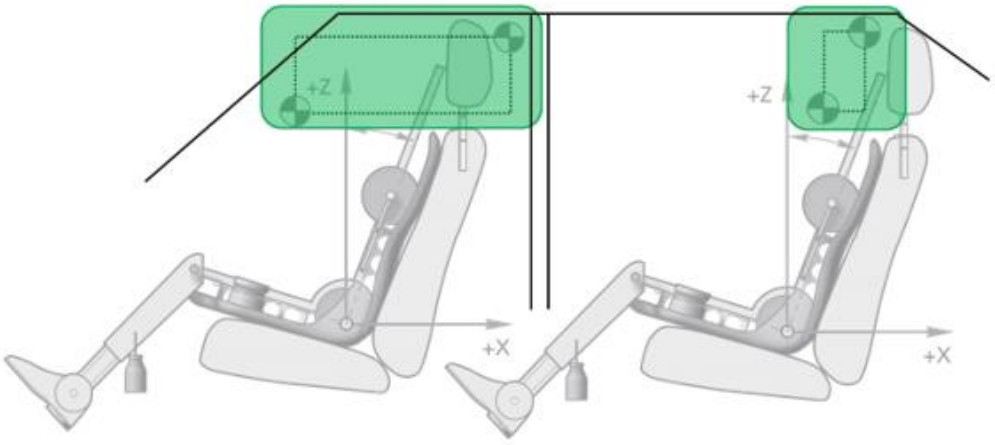
4.4.2	Refer Appendix C for methods on setting the seat position for the test

4.5.	**Setting the Steering Wheel**
4.5.1.	Set the steering wheel at the geometric highest driving position considering the full range of telescopic and tilt adjustment possibilities, in order to provide clearance for the legs and thorax.
4.6.	**Setting the rear seat (if adjustable)**
4.6.1.	If the vehicle rear seat position is adjustable put it in the most rearward fore/aft position and the same seat back angle (where adjustable) as that used in the frontal ODB impact.
4.7.	**Dummy Positioning and Measurements**
	Refer Appendix C

4.8.	**State of Charge (SOC)**
	The Electric / Hybrid vehicles shall be charged to a state as specified in AIS 099 Revision 1
4.9.	**Carrier and Pole**
4.9.1.	Carrier
4.9.1.1.	A carrier should be used which has a horizontal flat surface with a sufficiently large area to allow unobstructed longitudinal displacement of the vehicle of about 1000mm and rotation of the vehicle during the deformation phase of the impact.
4.9.1.2.	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.
4.9.1.3.	To avoid vehicle movement prior to the impact, the vehicle may be fixed to the carrier until 5m before the point of impact. The impact speed should be reached 10m before the point of impact.
4.9.1.4.	Crumple tubes or a comparable device will decelerate the carrier not earlier than 80ms after the moment / point of impact.
4.9.1.5.	The carrier may be fitted with an emergency abort system. This is optional; the test facility may elect to test without an abort system.
4.9.2.	Pole
4.9.2.1.	The rigid pole is a vertical metal structure beginning no more than 102mm above the lowest point of the tires on the striking side of the test vehicle when the vehicle is loaded and extending at least 100mm above the highest point of the roof of the test vehicle.
4.9.2.2.	The pole is 254 ±3mm 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 100ms of the initiation of the vehicle to pole contact
4.9.2.3.	Where floor deceleration occurs before head to head contact it must be shown that there has not been an influence on the dummy kinematics.
4.9.2.4.	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.
4.10.	**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 10 kHz may be used). The equipment conforms to SAE J211 (2007). 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.
4.10.1.	Impact Speed
4.10.1.1.	During the acceleration phase of the test, the acceleration of the carrier shall not exceed 1.5m/s2.
4.10.1.2.	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.
4.10.1.3.	Record the actual test speed in the test details. TARGET SPEED = 32 ± 0.5km/h
4.10.2.	Alignment
4.10.2.1.	The test vehicle shall be propelled so that, when the vehicle-to-pole contact occurs, the direction of vehicle motion forms an angle of 75° ± 3° with the vehicle longitudinal centreline.
4.10.2.2.	The impact angle shall be measured between the vehicle longitudinal centreline and a vertical plane parallel to the vehicle impact velocity vector.
4.10.2.3.	The impact reference line shall be aligned with the centreline of the rigid pole surface, as viewed in the direction of vehicle motion, so that, when the vehicle-to-pole contact occurs, the centreline of the pole surface contacts the vehicle area bounded by two vertical planes parallel to and 25 mm forward and aft of the impact reference line.
4.10.2.4.	With the vehicle offered up against the pole, tape a small rivet on the centreline of the pole such that it is aligned with the vertical impact reference line
4.10.2.5.	It should be noted that the point of first contact between the pole and vehicle does not align with the impact reference line marked on the vehicle, see Figure 2.  Figure 2: Point of first contact
4.10.3.	Post Test
4.10.3.1.	Door Opening
4.10.3.1.1.	Check that none of the doors, including boot lids and any movable roofs, have opened or partially opened during the test. Where this is the case photographic

	evidence shall be obtained and provided in the test report.
4.10.3.1.2.	Struck side doors handles shall be immediately covered with tape to prevent inadvertent opening. Reference measurements shall be taken between the door skin and aperture to ensure that the door has not move or been disturbed between the test and inspection.
4.10.3.1.3.	Try to open the unstruck side 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 750N, until the door unlatches. If the door does not open record this then try to unlatch the door using the internal handle. Again, attempt to open the door using the spring-pull attached to the external handle. Record the forces required to unlatch the door and to open it to 45o in the test details.
4.10.3.1.4.	If the doors do not open, record this in the test details.
4.10.3.2.	For sliding doors, the opening force of [750N] * shall be applied in a direction parallel to the vehicle centreline. The door shall be pulled in this direction once the door unlatching forces have been carried out. An open sliding door is defined as a door that, when opened, presents a minimum opening of at least 500mm compared to the closed position of the door, that would allow the extrication of an occupant. (*The force shown is monitored for sliding doors at present, value may be adjusted depending on test experience)
4.10.3.3.	Buckle Opening Force
	• Any position where the seat belt is used for any of the full-scale tests shall be checked post-test, once all of the door opening forces have been measured. • The seat belt buckle shall completely release under a load of no more than 100N for the belted occupants.
4.10.4.	Dummy removal
4.10.4.1.	Do not move the driver seat. Try to remove the dummy.
4.10.4.2.	If the dummy cannot be removed with the seats in its original position, recline the seat back and try again.
4.10.4.3.	If the dummy still cannot be removed, try to slide the seat back on its runners or remove the steering wheel.
4.10.4.4.	If the dummy still cannot be removed, the seat can be cut out of the car.
4.10.5.	Side Airbag Head Protection Evaluation (for near-side impact protection devices)
4.10.5.1.	Curtain airbags
4.10.5.1.1.	After the pole test, deploy the head protection device on the non-struck side of the vehicle. Make sure that the airbags are identical on both sides of the vehicle. Where this is not the case, the assessment must be performed on both sides
4.10.5.1.2.	Inflate the airbag to the pressure recommended by the vehicle manufacturer
4.10.5.1.3.	Project the HPD assessment zone onto the inflated airbag, using a laser, for front

	and rear seating positions using the measurements marked/recorded
4.10.5.2.	Seat mounted head protection devices
4.10.5.2.1.	Based on the head CoG paint mark on the airbag, mark the HPD assessment zone defined as a rounded rectangle extending 95mm forward, 90mm rearward, 120mm upward and 115mm downward on the flattened airbag.
4.10.5.2.2.	When the paint mark cannot be used, the vehicle manufacturer needs to supply Bharat NCAP in-house data for the Side Airbag Head Protection Evaluation.
4.10.5.3.	Evaluate coverage area of the airbag(s), record and check the dimensions of any joined, stitched or seamed areas, see Figure 7.  Figure 3: 3D Manikin axis and position

5.	**STATIC WHIPLASH TESTS**	
5.1	The front row head restraint requirements shall be demonstrated for compliance with the provisions of IS 15546 Rev 1 or ECE R17.10	
5.2	The rear row head restraint height requirements shall be demonstrated for compliance with the provisions of IS 15546 Rev 1 or ECE R17.10	
6.	**FULL WIDTH REAR IMPACT TEST**	
6.1.	The test shall be conducted in accordance with AIS 101 Revision 1. The vehicle settings as per section 6.2 below shall be followed	
6.2.	Vehicle Settings	
	Movable Windows	Movable vehicle windows and vents are placed in the fully open position
	Spare Tire, Jack and Other Removable Components	All components to be Secured in the trunk as per manufacture's instruction manual
	Door Locking	Doors are fully closed and latched but not locked
	AADL	Activated
	Parking Brake	Disengaged
	Transmission	Neutral
6.3.	The vehicle fuel tank shall be filled as per the test procedure defined in AIS 101	
6.4.	For Electric Vehicles, the vehicle SOC shall be as per the test procedure defined in AIS 101.	

7. CHILD RERSTRAINT SYSTEM (CRS) INSTALLATION TESTS

7.1.	**Introduction**
7.1.1.	This section specifies the guidelines for the assessment of child occupant based on the tests specified in BNCAP. 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
	• Dynamic performance
	• Vehicle Based Assessments
7.1.2.	A number of child seats available in the local market(s) will be used to assess vehicle to CRS compatibility and Q Series dummies representing 6 and 10 years old children will assess dynamic performance.
	The protocol is applicable to all classes of vehicles currently assessed by BNCAP, 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 6 and 10 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, airbag disabling, ISOFIX usability 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.
7.2.	**Car Manufacturer's recommendation**
7.2.1.	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 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.
7.2.2.	The vehicle manufacturer must recommend two CRS for use in dynamic assessments. Of those two recommended seats, one CRS must be suitable for 6 year and one for the 10 year old child. 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 on the two rear outboard seating positions.

7.2.3.	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:
7.2.4.	The CRSs must be recommended by the vehicle manufacturer to their customers in their vehicle or owner's manual.
7.2.5.	The recommended CRS must be available for purchase by all consumers from authorized dealers or OEM specified provisions.
7.2.6.	Where no or not appropriate recommendation is provided, BNCAP will select possible seats, from the installation list 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.
7.3.	**Installation of Child restraints**
7.3.1.	BNCAP shall reward vehicles that can accommodate a broad variety of child seats available in the Indian market. Additionally, vehicle manufacturer can recommend alternate CRSs for each mass group and ensure availability of the same to the consumer through dealer network.
7.3.2.	All CRS on the "Installation List" will be considered for installation in the vehicle only on the seating positions that are recommended by the manufacturer. For seating positions not recommended by the manufacturer for any group, the same shall be marked as exempt in the installation matrix
7.3.3.	**Installation List and Recommended Seats**
7.3.3.1.	The child seats on the "Installation List" are detailed in Table-1 of COP Assessment Protocol. The list will be checked on a regular basis to update with alternate seats available in India market.
7.3.3.2.	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 below
7.3.3.3.	To be eligible for assessment and scoring, any CRS on the "extended installation list" (Installation list + CRS recommended by the vehicle manufacturer 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.

7.3.4.	**Installation Matrix**
7.3.4.1.	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 and declared 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 or if row 2 has options of 2/3 seating positions, then both options will be evaluated.
7.3.4.2.	Provided that the CRS can be placed in the vehicle without problems, 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 mentioned by the CRS manufacturer.
7.3.5.	**Universal (Belted) CRS**
7.3.5.1.	Recommended Seating positions are 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 the Designated agency in advance of the vehicle assessment to confirm this exemption.
7.3.5.2.	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 for exemption.
7.3.6.	**I-Size CRS**
	I-Size seating positions must meet the i-Size technical requirements or simply be labelled according to the ISOFIX marking requirements in UN regulation No.14 or UN regulation No.145 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. 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.

7.3.7.	**ISOFIX CRS**
	ISOFIX seating positions must either meet the i-Size technical requirements or simply be labelled according to the ISOFIX marking requirements in UN Regulation No. 14 or UN Regulation No. 145 to be included in the Installation Matrix for the i-Size/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 the specified procedure given below and is clearly identified with an "X" in the ISOFIX CRS table as unsuitable for this size.
7.4.	**Passenger Airbag Warning and Disabling**
7.4.1.	• If the vehicle does not have a provision for deactivating the Passenger Airbag, no Rearward facing CRS is allowed at this position (i.e. Front passenger). • If the vehicle manufacturer does not recommend a Rearward Facing CRS on the Front Passenger seating position in the absence of a provision for deactivating the Passenger Airbag, the position shall be marked as 'Exempt' in the CRS Installation Score. • If the vehicle manufacturer recommends a Rearward Facing CRS on the Front Passenger seating position and a provision for deactivating the Passenger Airbag is also available, the position shall then be assessed and accordingly marked as 'Pass' or 'Fail' in the CRS Installation Score.
7.4.2.	• Finally, it is important to note that for each passenger seating position (Front Row passenger seating position will not be considered if the same is described in the vehicles owner or user manual) 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, 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.

7.5.	**Assessment of Problem-Free Installation and Requirements for all CRS**
7.5.1.	All combinations of CRS and vehicle seat position will be subsequently checked by installing the CRSs on recommended 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 7.6 and 7.7 for a successful installation. A CRS that uses the adult belt and a support leg must meet the full requirements of Section 7.6 and Section 7.8.
	The vehicle seating position is compatible with the CRS fitted as long as the following conditions are met:
7.5.2.	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.
7.5.3.	Initial vehicle settings
	Installations on the rear seat:
	• The front row seats shall initially be set in the BNCAP Frontal ODB 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. Normal day-to-day adjustments will also be permitted.
	• Head restraints shall be in the lowest/not in use position, unless clearly instructed otherwise in the vehicle handbook. However, head restraint removal is permitted but this must be clearly detailed in the vehicle handbook. It must be clear that head restraints must not be removed when using booster cushions only.

	• 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 BNCAP Frontal ODB impact test position unless instructed otherwise in the vehicle handbook.
	• The front seat(s) may be adjusted during the assessment. The adjustments allowed are limited to normal day-to-day adjustments to ensure the best possible installation, the full range of fore/aft movement is permissible to create sufficient space for the seat to be installed. The seatback angle must be no further forward than a torso angle of 15 degrees. The full range of seat height is permitted.
	• 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. But the full range of height adjustment is considered as a day to day adjustment. However, head restraint removal is permitted but must be clearly detailed in the vehicle handbook.
	• Movable arm rests shall be set to the not in use position or fully vertical.
7.5.4.	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 meeting the requirements defined in 7.5.2. The front passenger seat does not need to be adjusted further from the positioned defined in 7.5.2
	• 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 it 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. Infant carriers

	must be installed with any handles in the carrying position.
	• 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 a child in the CRS and attached any harnesses or tighten any webbing. 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 meeting the requirements specified in 7.5.2. 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.
	• The driver’s seat cannot be returned to the position defined in 7.5.2 or the passenger’s seat cannot be returned to the position defined in 7.5.2.
	• There is insufficient space within the vehicle to allow the child to occupy the CRS as normal.

7.6.	**Requirements for Seat belt mounted CRS**
	Use of 3-point belts
7.6.1.	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 on another 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.
7.6.2.	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.
7.6.3.	Additional tethers and/or support leg
	Where the chosen CRS is equipped with an additional tether or support leg apply the relevant assessment before moving on to the next section
7.6.4.	Obstruction and 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 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 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 is not forwards from vertical. This can be measured using the device described in Section 8 below.
	• 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
7.7.	**REQUIREMENTS FOR ISOFIX CRS**
7.7.1.	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.
7.7.2.	• 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.

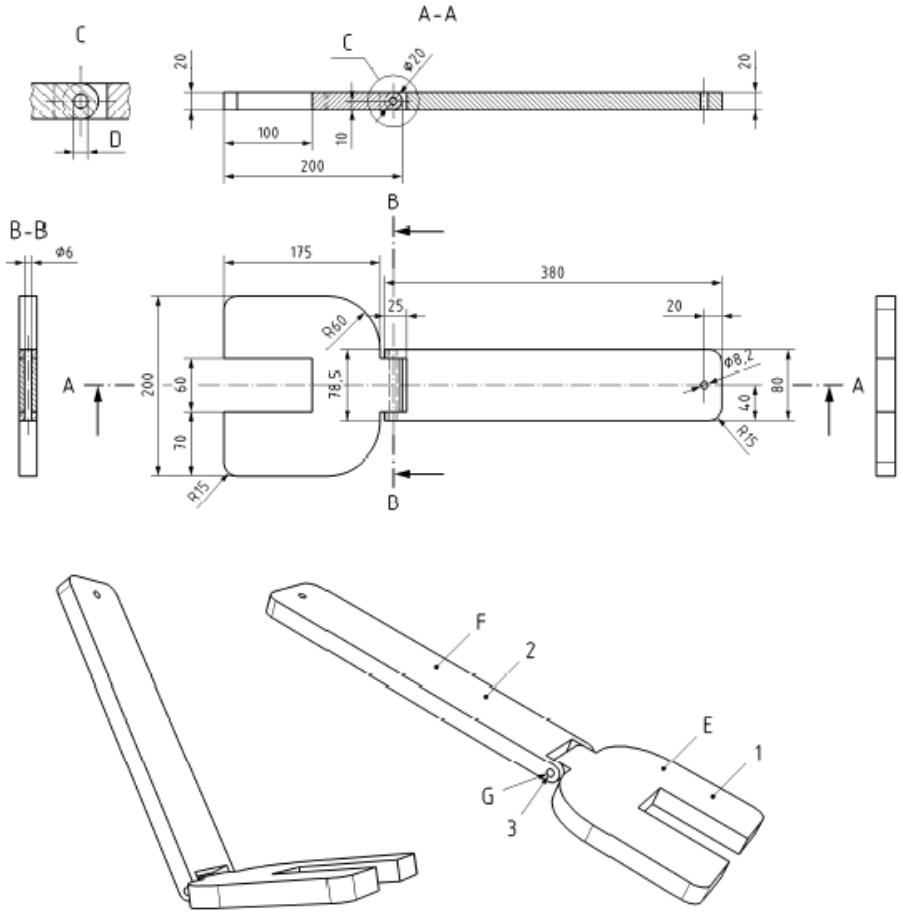
	• Where the adult belt prevents engagement with the ISOIFX anchorages, it is permissible to reposition the belt to improve access provided that the belt does not have to be held in that position.
7.7.3.	The vehicle meets the requirements, once preparatory steps have been performed, if all of the following 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.
7.7.4.	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.
7.7.5.	Additional tethers and/or support leg
	Where the chosen CRS is equipped with an additional tether or support leg apply the relevant assessment before moving on to the next section
7.7.6.	Obstruction and Stability of the ISOFIX CRS
	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 up to a maximum stature of 135cm. E.g. incline, recline, head restraint height etc. Adjustments for

	children larger than 135cm will not be used.
	• 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 upto a stature of 135cm 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 below.
	• 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.
7.7.7.	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. Where applicable, the vehicle interior prevents the seat shell from engaging on the frame or base without the use of excessive force.
	• 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.

7.8.	**CRS Installed Using Additional Tethers, Straps and Support Legs**
7.8.1.	Ease of use of tethers and 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 provided they do not obstruct any other space required for occupants or interfere with the use of the adult belts.
	• 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.
7.8.2.	Ease of use of support legs
	This is an assessment of the vehicles ability to provide adequate support to any support legs, where applicable. Where optional storage compartments are available, they will be included in the CRS installation assessment.
	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 Regulation R145 with any storage cover closed.
	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.
	• It is necessary to open any storage cover or use additional components/inserts to support the lid, such as foam blocks.

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



Key

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

APPENDIX A - CRASH PROTECTION

TABLE OF CONTENTS

1.	**VEHICLE PREPARATION**
1.1.	**Unladen kerb mass**
1.1.1.	The unladen kerb mass is the nominal mass of a complete vehicle with bodywork and all factory fitted equipment, electrical and auxiliary equipment for normal operation of the vehicle, including liquids, tools, fire extinguisher, standard spare parts, chocks and spare wheel, if fitted.
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 calculation in the test details.
1.1.4.	Refill the tank with fuel, water or other ballast to a mass equivalent to 90% of the tank's capacity of fuel for all tests except the Side Pole test. For the Side Pole test, fill this ballast to 100% of the tank's capacity of fuel
1.1.5.	Put water, or other ballast, to this mass in the fuel tank.
1.1.6.	The fuel tank shall be filled to 90 percent of the manufacturer rated capacity and the other liquid containing systems to 100 percent of the capacity specified by the manufacturer.
1.1.7.	Ensure that the front seat track positions are in mid and that the vehicle has its spare wheel onboard along with any other equipment supplied with the vehicle as defined by the unladen kerb mass. Nothing else shall be in the car.
1.1.8.	Ensure that Inflated all tyres to manufacturer's instruction for half load.
1.1.9.	Measure and record the front and rear axle weights and determine the total weight of vehicle. The total weight is unladen kerb mass of the vehicle.
1.1.10.	Measure and record the ride heights of the vehicle at all four wheels.
1.2.	**Rated cargo and luggage mass (Oblique Side pole test)**
	Calculate the rated cargo and luggage mass as follows: Subtract the sum of 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 mass**
1.3.1.1.	Place both front seats in their middle, seat-track positions. If there is no notch at this position, set the seat in the nearest notch rearward.
1.3.1.2.	Place a mass of equivalent to the specified dummy as per Table-1
1.3.1.3.	For luggage mass in the compartment a) For ODB and FWRB test - Add 36 kg in the luggage compartment b) For MDB test - 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

<table>
<tr><td></td><td>c) For the Side Pole test - Place weights with a mass of the rated cargo and luggage mass or 136kg 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.</td></tr>
<tr><td>1.3.1.4.</td><td>In the child restraints to be used for testing, place masses equivalent to Q6 and Q10 child dummies on the second-row passenger’s side seat and driver’s side seat respectively (23kg and 36kg). If the child restraints are not available at this time then default masses of 7kg and 2kg should be added to the dummy masses.

Place the following masses on the front seats representing the vehicle occupants and luggage as per the below table 1.</td></tr>
<tr><td></td><td>Table 1: Occupants and the relevant masses

<table>
<tr><th>Test</th><th>Driver</th><th>Passenger</th><th>Pos 6</th><th>Pos 4</th><th>Luggage</th></tr>
<tr><td>ODB</td><td>88kg</td><td>88kg</td><td>23kg*</td><td>36kg*</td><td>36kg</td></tr>
<tr><td>FWRB</td><td>57kg</td><td>88kg</td><td>-</td><td>57kg</td><td>36kg</td></tr>
<tr><td>MDB</td><td>75kg</td><td>-</td><td>36kg*</td><td>23kg*</td><td>#</td></tr>
<tr><td>Pole</td><td>75kg</td><td>-</td><td>-</td><td>-</td><td>As calculated</td></tr>
</table></td></tr>
<tr><td>1.3.2.</td><td>Add the mass of the CRS to be used in the tests to the child dummy masses. If CRS are not available, add default masses of 7kg and 2kg.</td></tr>
<tr><td>1.3.3.</td><td>For the luggage mass, the normal luggage compartment shall be used, i.e. rear seats must not be folded to increase the luggage capacity. Spread the weight 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.</td></tr>
<tr><td>1.3.4.</td><td>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.</td></tr>
<tr><td>1.3.5.</td><td>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.</td></tr>
<tr><td>1.3.6.</td><td>Record the axle reference loads and reference mass in the test details.</td></tr>
<tr><td>1.3.7.</td><td>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.</td></tr>
<tr><td>1.3.8.</td><td>Remove the weights from the luggage compartment and the front and rear seats</td></tr>
</table>

1.4.	**Vehicle width and overlap**
1.4.1.	Determine the widest point of the vehicle ignoring the rearview mirrors, side marker lamps, tyre pressure indicators, direction indicator lamps, position lamps, flexible mudguards and the deflected part of the tyre sidewalls immediately above the point of contact with the ground. These details may also be shared by the vehicle manufacturer.
1.4.2.	Record this width in test details.
1.4.3.	Determine the centreline of the vehicle, y=0, and mark a line on the bonnet and bumper on the centreline of the car.
1.4.4.	For the ODB test, 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. Both the horizontal and vertical alignments shall be noted in the test report. TARGET OVERLAP = 40% ± 20mm TARGET VERTICAL ALIGNMENT = ± 25mm
1.5.	**R Point Marking – MDB Test**
1.5.1.	To measure vehicle dimensions and to apply markers, a pointer used to measure co-ordinates in three dimensions will be used.
1.5.2.	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.
1.5.3.	Mark a point on the driver's side of the vehicle which has X (longitudinal) co-ordinate not more than 1mm different to the theoretical R point location provided by the vehicle manufacturer.
1.5.4.	Mark a vertical line on the drive 's side of the car and roof which is 250mm rearward of the R point location. This is the target impact point for the MDB test. Mark clearly on the tape which of its edges aligns with the impact point.
1.5.5.	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 impact point. This edge may be used to assess the alignment of the barrier with the impact point.
1.6.	**VUT Impact Weight**
1.6.1.	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.
1.6.2.	If 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.

1.6.3.	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.
1.6.4.	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.
1.6.5.	Fit the on-board data acquisition equipment in the boot of the car. Also fit any associated cables, cabling boxes and power sources.
1.6.6.	Place weights on the vehicle seating positions to represent the occupants, CRS Weigh the front and rear axle weights of the vehicle and make sure the following conditions are met: • Individual axle weights shall be within 5% and 20kg of the reference mass whichever is lower. • The total vehicle mass shall be within 1% and 20kg of the reference mass whichever is lower. If the weights differ by more than the specified tolerances, add or remove items which do not influence the structural crash performance of the vehicle. The ballast in the fuel tank may also be adjusted to help achieve the desired weights. Any additional mass that is added to the vehicle should be securely and rigidly attached. Record the final vehicle mass and axle weights in the test details.
1.6.7.	Record the final vehicle mass and axle weights in the test details.
1.6.8.	For fully electric vehicles, if a total vehicle mass within 25kg of the reference mass cannot be achieved, it is acceptable for the total mass to be within 2% of the reference mass. A heavier test mass may be used with the agreement of the vehicle manufacturer, the test mass must not be below the minimum value of the specified tolerances.
1.6.9.	The vehicle manufacturer is 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.
1.7.	**Vehicle markings**
1.7.1.	ODB
1.7.1.1.	If applicable, position the rear seats in accordance with the passenger compartment adjustments as defined for the test. Install the H-point machine on the Q6 position following the procedure detailed for a 5th female occupant and mark the H-point location on the vehicle.

1.7.1.2.	Mark head excursion lines at 400mm-600mm forward of the H-point location of the 5th female occupant in 50mm increments. The 450mm and 550mm excursion lines shall be clearly distinguished from the other markings in some way, for example using a different colour. Head excursions are currently monitored in Bharat NCAP.
1.7.1.3.	The excursion lines shall be marked on both sides of the vehicle, on the interior and. These lines shall be marked in such a way that they are clearly visible to the onboard cameras. Alternatively, it is acceptable for the lines across the vehicle to be superimposed during post film processing.
1.7.2.	FWRB
1.7.2.1.	Mark 5th female rear passenger head excursion markings at: • 450mm forward of the rear dummy H-point $X_{AF05,dummy}$. • 550mm forward of the rear dummy H-point $X_{AF05,dummy}$.
1.7.2.2.	The excursion lines shall be marked on both sides of the vehicle, on the interior and. These lines shall be marked in such a way that they are clearly visible to the onboard cameras. Head excursions are currently only monitored in Bharat NCAP.
1.7.2.3.	None of the rear occupant's head excursion lines shall be more forward than the most rearward point on the seatback of the front passenger seat, when in the 5th female position. In this case the head excursion line(s) aligns with the most rearward point on the seatback of the front passenger seat, when in the 5th female position.
1.7.3.	MDB and Pole
1.7.3.1.	Mark the centreline of the vehicle on the facia and centre console so that it can be seen from the offboard camera views.
1.7.3.2.	Mark the centreline of both rear outboard seating positions (including head restraint centreline if necessary) and on the CRS used for test. Markings placed on hard parts of the CRS, rather than seat fabric, are preferable. If an ISOFIX CRS is used no markings are needed.
2.	**INTRUSION MEASUREMENTS**
2.1.	**General**
2.1.1.	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. For vehicle deformation and intrusion measurements a 3D measuring system which is capable of recording three dimensional co-ordinates of a point in space shall be used. A tolerance of +/1mm is applicable to such a system.
2.1.2.	The vehicle shall be supported during measuring of all points.
2.1.3.	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.
2.2.	**Pre-Test – ODB and FWRB**
2.2.1.	Determine and mark the centre of the clutch, brake and accelerator pedals.
2.2.2.	Set the steering wheel to its mid-position, if it is adjustable for either rake or reach
2.2.3.	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.
2.2.4.	Determine and mark the centre of the top of the steering-column.
2.2.5.	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.
2.2.6.	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.
2.2.7.	Apply the manufacturer's co-ordinate system onto the vehicle so that three defined locations are established. Alternatively, locate the vehicle axis reference frame centrally to the rear of the vehicle, see Figure 1. Level the reference frame and measure the stud heights of the reference frame. These will be used after the test to help reset the reference frame, if required.
2.2.8.	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.
2.2.9.	Set up the vehicle co-ordinate axes in the 3D arm or similar device.
2.2.10.	Measure 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.  Figure 1 Setting up axis reference frame Measure Measure the pretest positions of the following points: Pedal centres — In test position Clutch, brake, accelerator, foot operated parking brake - undepressed

	Steering wheel centre	In pretest position, airbag removed
	A-pillar, driver's side	100mm above the sill
	B-pillar, driver's side	100mm beneath the lowest level of the side window aperture. All points shall be as close as possible to the rubber seal around the door aperture such that they can be measured after impact
	B-pillar, passenger's side	100mm above the sill 100mm beneath the lowest level of the side window aperture. All points shall be as close as possible to the rubber seal around the door aperture such that they can be measured after impact
2.2.11.	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.	
2.2.12.	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.	
2.2.13.	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.	
2.3.	**Post-Test - ODB and FWRB**	
2.3.1.	Before dummy removal taking care not to disturb any pedals and then record the measurement with the 3D measuring system	
2.3.2.	Remove the dummies and remove the data acquisition and emergency abort equipment (if fitted) from the luggage compartment.	
2.3.3.	Remove the centre of the steering wheel or airbag assembly	
2.3.4.	Use any 3 of the 5 datum points at the rear of the vehicle, and their pretest measurements, to redefine the measurement axes.	
2.3.5.	If the axes cannot be redefined from any three of the datum points relocate the axis reference frame in the pretest position. Set the studs of the frame to the same heights as in pretest, see Figure 2. Set up the measurement axes from the frame.	
2.3.6.	Record the positions of the B-pillar points on the passenger's side of the vehicle. Compare the vertical co-ordinates of the B-pillar sill points pre and post-test.	

<table>
<tr><td>2.3.7.</td><td>For the B-pillar sill point, find the angle θ that best satisfies the following equation:
z = - x'sinθ + z'cosθ
for the B-post sill point (where z = pretest vertical measurement x',z' = posttest longitudinal and vertical measurement)
 

Figure 2: Re-setting axis reference frame

Measure the posttest positions of the following points.</td></tr>
<tr><td></td><td>
<table>
<tr><td>Pedal centres</td><td>In posttest position.
(a) Clutch, brake, accelerator, foot operated parking brake – undepressed
(b) Clutch, brake, accelerator, foot operated parking brake – with 200N to produce the maximum moment about the pedal pivot, brake fluid must be drained prior to measurement</td></tr>
<tr><td>Steering wheel centre</td><td>In posttest position, airbag removed
If disconnected posttest, reposition so that it is in contact with whatever structure(s) last constrained it from further movement</td></tr>
<tr><td>A-pillar, driver's side
B-pillar, driver's side</td><td>100mm above the sill
100mm beneath the lowest level of the side window aperture.</td></tr>
<tr><td>B-pillar, passenger's side</td><td>100mm above the sill.
100mm beneath the lowest level of the side window aperture.</td></tr>
</table>
</td></tr>
<tr><td>2.3.8.</td><td>Transform the posttest longitudinal and vertical measurements (x',z') using the following equations are:
$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x' \\ y' \end{bmatrix}$$
X and Z should now be in the same frame of reference as the pre-impact measurements, assuming that the point on the passenger's side B-pillar sill is not displaced vertically or laterally during the impact.</td></tr>
</table>

<table>
<tr><td>2.3.9.</td><td>From the pre and posttest measurements determine:

<table><tr><td>Pedal centres</td><td>Longitudinal and vertical movement of all of foot operated pedals.</td></tr><tr><td>Steering wheel centre</td><td>Longitudinal, lateral and vertical movement of the centre of the top of the steering column.</td></tr><tr><td>A-pillar waist, driver</td><td>Rearward movement</td></tr><tr><td>Door aperture</td><td>reduction in width at waist and sill levels.</td></tr></table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.4.</td><td>Post-Test MDB and Pole (Monitoring Purpose Only)</td></tr>
<tr><td></td><td>Posttest intrusion measurements to be taken using the intrusion area limited by the following lines:

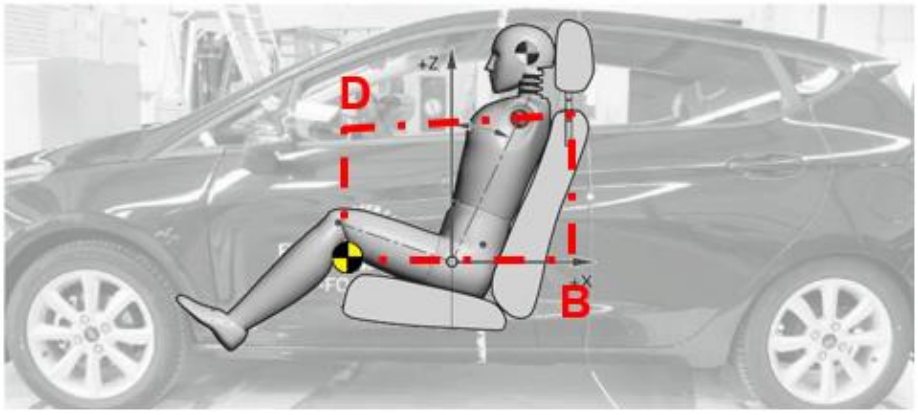
 

Figure 3: Intrusion area</td></tr>
<tr><td></td><td><table><tr><td>A</td><td>Vertical line at x-position 700mm forward of the R-point</td></tr><tr><td>B</td><td>Horizontal line at z-position of R-point (sagittal plane)</td></tr><tr><td>C</td><td>Vertical line at x-position at the back of headrest stems</td></tr><tr><td>D</td><td>Horizontal line at door waist (sagittal plane)</td></tr></table></td></tr>
<tr><td>2.4.1.</td><td>The maximum inboard intrusion point is determined within the intrusion area, the method to find this point is described as follows. There is no compulsory procedure how to measure the maximum inboard point. It is acceptable to use 3D scan, 3D arm or a tape measure.</td></tr>
<tr><td>2.4.2.</td><td>In most cases the armrest will be the most inboard part. Therefore, the measurement will be taken from the most inboard surface of the armrest.</td></tr>
</table>

2.4.3.	At waistline level, if this is the most inboard area, the inner door trim/cover shall be measured for reference. The intrusion point is defined as the most inboard part of the metal door structure +50mm inboard (see example below).  Figure 4: Intrusion measurement

APPENDIX B - CRASH PROTECTION

DUMMY PREPARATION AND CERTIFICATION

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1.	**HYBRID III 50th SPECIFICATION**
1.1.	**General**
1.1.1.	Hybrid III test dummies should be used for the front seat driver and passenger positions. They should conform to U.S. Department of transportation, Code of Federal Regulations Part 572 Subpart E and ECE Regulation No. 94, except for modifications and additions stated later
1.1.2.	Details of the child dummy preparation and certification are contained in the Bharat NCAP Child Occupant Protection Testing Protocol.
1.2.	**Dummy Certification**
1.2.1.	Full details of the certification procedure for the Hybrid-III dummy are available in Part 572 Subpart E of US Department of Transportation Code of Federal Regulations, SAE J2856 and Annex 10 of UN Regulation No. 94.
1.2.2.	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.
1.2.3.	The Hybrid-III dummies shall be re-certified after every THREE impact tests
1.2.4.	The chest shall be certified according to the frequency above and shall 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.
1.2.5.	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.
1.2.6.	If an injury criterion reaches or exceeds its normally accepted limit (eg HIC of 700) then that part of the dummy shall be re-certified.
1.2.7.	If any part of a dummy is broken in a test then the part shall be replaced with a fully certified component.
1.2.8.	Copies of the dummy certification certificates will be provided as part of the full report for a test.
1.3.	**Dummy 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 (2007). The Hybrid III dummies to be used shall be instrumented to record the channels listed below.

Table 1: Details of the child dummy instrumentation

Location	Parameter		Minimum Amplitude	Driver No of channels	Passenger No of channels
Head	Accelerations, A_x A_y A_z		250g	3	3
Neck	Forces	F_x F_y	9kN	2	2
		F_z	14kN	1	1
	Moments, M_x M_y M_z		290Nm	3	3
Chest	Accelerations, A_x A_y A_z		150g	3	3
	Deflection, D_{chest}		100mm	1	1
Pelvis	Accelerations, A_x A_y A_z		150g	3	3
Lumbar Spine	Forces, F_x F_z			2	2
	Moments, M_y			1	1
Femurs (L and R)	Forces, F_z		20kN	2	2
Knees (L and R)	Displacements, D_{knee}		19mm	2	2
Upper Tibia (L and R)	Forces, F_x F_z		12kN	4	4
	Moments, M_x M_y		400Nm	4	4
Lower Tibia[1] (L and R)	Forces, F_x F_z (F_y)		12kN	4	4
	Moments, M_x M_y		400Nm	4	4
	Total Channels			78	

1.4.	**Additions and Modifications to the Hybrid III Dummies**
1.4.1.	The additions and modifications which will change the dynamic behavior of the test dummies from Part 572E specification dummies is listed below.
1.4.1.1.	Roller ball-bearing knees shall be fitted.
1.4.1.2.	Extra instrumentation is also fitted such as enhanced instrumented lower legs and a 6axis neck.
1.4.1.3.	Foam neck shields (Part 93051-1-DN or equivalent) must be fitted to the driver and passenger if a frontal protection airbag is present.
1.5.	**Hybrid III Dummy Test Condition**
1.5.1.	Dummy Temperature
1.5.1.1.	The dummy shall have a stabilised temperature in the range of 19°C to 22°C.
1.5.1.2.	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.

1.5.1.3.	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.
1.5.1.4.	A printout of the temperature readings is to be supplied as part of the standard output of the test.
1.5.2.	Dummy Joints
	All constant friction joints should have their 'stiffness' set by the following method.
1.5.2.1.	Stabilise the dummy temperature by soaking in the required temperature range for at least 5hours.
1.5.2.2.	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.
1.5.2.3.	The dummy joints stiffness should be set as close as possible to the time of the test and, in any case, not more than 24 hours before the test.
1.5.2.4.	Maintain the dummy temperature within the range 19º to 22ºC between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.
1.5.2.5.	All constant friction joints should have their 'stiffness' set by the following method: a) Stabilise the dummy temperature by soaking in the required temperature range for at least5 hours. b) Set the torque on the shoulder screws to obtain a 1g holding force of the shoulder and elbow. c) For the knee joint, the tensioning screw or bolt which acts on the constant friction surfaces should be adjusted to obtain a 1g holding force. d) The dummy joints shall be set as close as possible to the time of the test and, in any case, not more than 24 hours before the test. e) Maintain the dummy temperature within the permissible temperature range between the time of setting the limbs and up to a maximum of 5 minutes before the time of the test
1.6.	**Hybrid III Dummy Clothing and Footwear**
1.6.1.	Each dummy will be clothed with formfitting cotton stretch garments with short sleeves and pants which should not cover the dummy's knees.
1.6.2.	Each dummy shall be fitted with shoes equivalent to those specified in MIL-S13192 rev P. (size 11EEE)

1.7.	**Dummy face painting**
	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,Red,Yellow,Green Right Tibia (top to bottom) Blue,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.
1.8.	**Post Test Dummy Inspection**
1.8.1.	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.

2.	**HYBRID III 5TH SPECIFICATION**
2.1.	**General**
	Hybrid III 05F test dummies should be used for the front driver seat and the rear passenger seat, at the opposite to the driver. They should conform to U.S. Department of transportation, Code of Federal Regulations Part 572 Subpart O, except for modifications and additions stated laterRegulations Part 572 Subpart O, except for modifications and additions stated later. The parts of the dummy should be following the latest agreed brand harmonised design: Part — Original manufacturer Head — Denton Neck — Denton Upper Torso — FTSS Arms — FTSS Hands — Denton Lower Torso — FTSS Legs and Feet — FTSS
2.2.	**Dummy Certification**
2.2.1.	Full details of the certification procedure for the Hybrid-III 05F dummy are available elsewhere (see Part 572 Subpart O of US Department of Transportation Code of Federal Regulations). 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.
2.2.2.	The Hybrid-III 05F dummies shall be re-certified after every THREE impact tests.
2.2.3.	The chest shall be certified according to the frequency above and should meet both the low speed thorax test as prescribed by SAE J2878, 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.
2.2.4.	If an injury criterion reaches or exceeds its normally accepted limit (eg. HIC_{15} of 700) then that part of the dummy shall be re-certified.
2.2.5.	If any part of a dummy is broken in a test then the part shall be replaced with a fully certified component.
2.2.6.	Copies of the dummy certification certificates will be provided as part of the full report for a test.

2.3.	**Dummy 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 recalibrated after one year, regardless of the number of tests for which it has been used. A list of instrumentation along with calibration dates should be supplied as part of the standard results of the test. Transducer mounting and sign convention is in accordance with SAE J211 (1995).

Table 2: The HIII-05F dummies and the number of channels recorded.

Location	Parameter		Minimum Amplitude	Front Passenger No of channels	Rear Passenger No of channels
Head	Accelerations, A_x A_y A_z		250g	3	3
Neck	Forces	F_x F_y	9kN	2	2
		F_z	14kN	1	1
	Moments, M_x M_y M_z		290Nm	3	3
Chest	Accelerations, A_x A_y A_z		150g	3	3
	Deflection, D_{chest}		100mm	1	1
Pelvis	Accelerations, A_x A_y A_z		150g	3	3
Iliac (L and R)	Force, F_x			2	2
	Moment, M_y			2	2
Lumbar Spine	Force, F_x, F_z			2	2
	Moment, M_y			1	1
Femurs (LandR)	Forces, F_z		20kN	2	2
Knees (LandR)	Displacements, D_{knee}		19mm	2	
Upper Tibia (LandR)	Forces, F_x F_z		12kN	4	

	Moments, M_x M_y	400Nm	4	
Lower Tibia[2] (LandR)	Forces, F_x F_z (F_y)	12kN	4	
	Moments, M_x M_y	400Nm	4	
	Total Channels per Dummy		43	25
Total Channels			68	

2.4.	**Additions and Modifications to the Hybrid III Dummies**
	The additions and modifications which will change the dynamic behaviour of the test dummies from Part 572 O specification dummies are:
2.4.1.	Neoprene neck shields, with part number ABA-211-DN, must be fitted to the driver and rear passenger.
2.4.2.	The harmonized jacket, according to SAE J2921, must be fitted to the driver and rear passenger.
2.4.3.	The "Denton" lower leg cavity must be fitted to the driver and passenger.
2.5.	**Dummy Test Condition**
2.5.1.	Dummy Temperature
2.5.2.	The dummy shall have a stabilised temperature in the range of 19ºC to 22ºC.
2.5.3.	A stabilised temperature shall be obtained by soaking the dummy in temperatures that are within the range specified above for at least 5 hours prior to the test.
2.5.4.	Measure the temperature of the dummy using a recording electronic thermometer placed inside the dummy's thorax. The temperature should be recorded at intervals not exceeding 10 minutes.
2.5.5.	A printout of the temperature readings is to be supplied as part of the standard output of the test.
2.5.6.	Dummy Joints
2.5.7.	All constant friction joints should have their 'stiffness' set by the following method:
2.5.8.	Stabilise the dummy temperature by soaking in the required temperature range for at least 5 hours.
2.5.9.	The tensioning screw or bolt which acts on the constant friction surfaces should be adjusted until the joint can just hold the adjoining limb in the horizontal. When a small downward force is applied and then removed, the limb should continue to fall.
2.5.10.	The dummy joints stiffness should be set as close as possible to the time of the test and, in any case, not more than 24 hours before the test.
2.5.11.	Maintain the dummy temperature within the range 19°C to 22°C between the time of setting the limbs and up to a maximum of 10 minutes before the time of the test.

<table>
<tr><td>2.6.</td><td>Dummy clothing and footwear</td></tr>
<tr><td>2.6.1.</td><td>Each dummy will be clothed with formfitting cotton stretch garments with short sleeves and bottoms which should not cove the dummy’s knees.</td></tr>
<tr><td>2.6.2.</td><td>Each dummy shall be fitted with shoes equivalent to those specified in UN Regulation No. 137.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.7.</td><td>Dummy painting and marking</td></tr>
<tr><td>2.7.1.</td><td>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.

Eyebrows (left and right) — Red
Top of head (rear passenger only) — Blue
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

Paint Area Sizes:

Eyebrow (L/R) — (25/2) x 50mm.
Top of Head — 50 x 50mm square.
Nose — 25 x 40mm strip, down nose centre line.
Chin — 25 x 25mm square, centre line of chin.
Knee (L/R) — 45 x 45mm 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.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.8.</td><td>Post Test Dummy Inspection</td></tr>
<tr><td>2.8.1.</td><td>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.</td></tr>
</table>

3.	**WORLDSID 50TH SPECIFICATION**
3.1.	**General**
3.1.1.	A WorldSID 50th percentile male test dummy shall be used in the front driver's position. It shall conform to the specification detailed in ISO 15830, parts 1-5
3.1.2.	Details of the child dummy preparation and certification are contained in the Bharat NCAP Child Occupant Protection Testing Protocol.
3.2.	**Certification**
3.2.1.	Full details of the WorldSID certification requirements are available in the documents mentioned in Section 1.1.1 above.
3.2.2.	The WorldSID shall be re-certified after every FOUR impact tests.
3.2.3.	Deatils of the IR Tracc length calculation procedure are described in EuroNCAP Technical Bulletin TB017.
3.2.4.	If an injury criterion reaches or exceeds its normally accepted limit (e.g. HIC of 700) then that part shall be re-certified.
3.2.5.	If any part of the dummy is broken in a test, the part shall be replaced with a fully certified component.
3.2.6.	A copy of the dummy certification certificate will be provided as part of the full report for a test.
3.3.	**Dummy Instrumentation**
3.3.1	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 (2007).
3.3.1.1.	The WorldSID dummy shall be instrumented to record the channels listed below. Additional channels may be recorded.
3.3.1.2.	Where the number of channels in the WorldSID dummy is 45 or more, only in-dummmy data acquisition systems may be used. Where there are less than 45 channels, the use of umbillical cables is at the laboratories discretion. Details of the child dummy instrumentation is contained in the Bharat NCAP Child Occupant Protection Testing Protocol. *The onboard temperature sensor shall be attached in accordance with ISO TR 27957, and the temperature sensor shall meet the requirements of ISO 6784. It is not necessary for this channel to be recorded through the dummy onboard DAU.

Table 3: Details of Child dummy Parameters, Altitude and channel

Location	Parameter	Minimum amplitude	Channel count
Head	Linear acceleration, Ax, Ay, Az	250g	3
Upper neck	Forces and moments Fx, Fy, Fz, Mx, My, Mz	5kN, 300Nm	6
Shoulder – Joint	Forces, Fx, Fy, Fz	8kN	3
Shoulder – Rib	Displacement and rotation	100mm	2
Thorax - Upper rib	Displacement and rotation	100mm	2
Thorax - Mid rib	Displacement and rotation	100mm	2
Thorax - Lower rib	Displacement and rotation	100mm	2
Thoracic temperature*	Temperature, see 2.5.1.3	30□C	1
Abdomen - Upper rib	Displacement and rotation	100mm	2
Abdomen - Lower rib	Displacement and rotation	100mm	2
Spine - T12	Acceleration, Ax, Ay, Az	200g	3
Pelvis	Acceleration, Ax, Ay, Az	200g	3
Pelvis – Pubic	Force	5kN	1
Femoral neck – struck side only	Force, Fx, Fy, Fz	5kN	3
	Total Channels		35

3.4.	**Additions and Modifications to the WorldSID Dummy**
3.4.1.	The WorldSID dummy shall be equipped with the half arm assembly on both sides.
3.4.2.	It is acceptable for the dummy to be equipped with build level E ankle joins.
3.5.	**WorldSID Dummy Test Condition**
3.5.1.	Dummy Temperature
3.5.1.1.	The dummy shall have a stabilised temperature in the range of 20.6ºC to 22.2ºC.
3.5.1.2.	A stabilised temperature shall be obtained by soaking the dummy in temperatures that are within the range specified above for at least 1 hour prior to the test.
3.5.1.3.	Measure the temperature of the driver dummy for at least 5 hours before test at intervals not exceeding 10 minutes and not exceeding 5 minutes before test.
3.5.1.4.	The temperature shall be measured using an onboard sensor located on the blue band of the first thoracic non struck side rib as far from the spine box as possible.
3.5.1.5.	A copy of the temperature readings is to be supplied as part of the standard output of the test.

3.5.2.	Dummy Joints
3.5.2.1.	Stabilise the dummy temperature by soaking in the required temperature range for at least 5 hours.
3.5.2.2.	Set the torque on the shoulder screws to obtain a 1-2g holding force of the arm on its pivot
3.5.2.3.	For adjustable joints in the legs, the tensioning screw or bolt which acts on the constant friction surfaces should be adjusted to obtain a 1-2g holding force.
3.5.2.4.	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.
3.5.2.5.	Maintain the dummy temperature within the permissible temperature range between the time of setting the limbs and up to a maximum of 5 minutes before the time of the test.
3.6.	**Dummy Clothing and Footwear**
3.6.1.	WorldSID
3.6.1.1.	The dummy shall be clothed in a sleeveless suit or a modified version of the sleeved suit with sleeves removed
3.7.	**WorldSID Dummy painting and marking**
3.7.1.	The dummies shall have masking tape placed on the areas to be painted using the sizes detailed 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. Driver Head (Paint tape outline) — Red Head CoG (circle Ø40mm) — Yellow Head top along mid sagittal plane — Green Shoulder/Arm — Blue 2nd Thorax Rib — Green 3rd Thorax Rib — Red 1st Abdomen Rib — Blue 2nd Abdomen Rib — Green Pelvis — Orange NOTE: The tape should be completely covered with the coloured paints specified, with the exception of the driver 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: Driver Head = 100mm square, centreline of head with lower edge at C of G. Arm = 25mm x 150mm, starting at bottom edge of shoulder fixing hole.

	Ribs = 25mm x 150mm strip, starting at the rearmost accessible point at seat back. Pelvis = 50mm x 100mm, centred on hip joint point
3.8.	**Post Test Dummy Inspection**
3.8.1.	All dummies shall be visually inspected immediately after the test.
3.8.2.	Any lacerations of the skin or breakages should be noted in the test details, a dummy may have to be re-certified in this case.
3.8.3.	Any screws that have become loose or detached shall be re-tightened to the required torque or replaced as necessary
4.	**Q6 AND Q10 SPECIFICATION**
4.1.	**General**
	The Q6 dummy shall be standard build level A. The Q10 shall be based on standard build level C, but must include the upgrades detailed below : a) The Q6 and Q10 child dummies shall be re-certified after every TWENTY impact tests (e.g. 10 frontal and 10 side impacts, or any combination of the two test types). Hip shields shall be replaced after every dummy certification, hip liners shall be replaced after every twenty impact tests. b) The Q10 dummy shoulder lateral impact certification test is to be performed with the side impact shoulder kit only. c) If an injury criterion reaches or exceeds its normally accepted limit (eg HIC of 700) then that part should be re-certified. d) If any part of a dummy is broken in a test then the part shall be replaced with a fully certified component. e) Copies of the dummy certification certificates shall be provided by the laboratory as part of the full report for a test
4.2.	**Certification**
4.2.1.	Details of certification are in the respective dummy user manual.
4.2.2.	The Q6 and Q10 child dummies shall be re-certified after every TWENTY impact tests (e.g. 10 frontal and 10 side impacts, or any combination of the two test types). Hip shields shall be replaced after every dummy certification, hip liners shall be replaced after every twenty impact tests.
4.2.3.	The Q10 dummy shoulder lateral impact certification test is to be performed with the side impact shoulder kit only.
4.2.4.	If an injury criterion reaches or exceeds its normally accepted limit (e.g. HIC of 700) then that part shall be re-certified.
4.2.5.	If any part of the dummy is broken in a test, the part shall be replaced with a fully certified component.
4.2.6.	A copy of the dummy certification certificate will be provided as part of the full report for a test.

4.3.	**Dummy instrumentation**
	All instrumentation used in the dummy shall be:
4.3.1.	Calibrated before the test programme.
4.3.2.	Re-calibrated after one year, regardless of the number of tests for which it has been used.
4.3.3.	Re-calibrated if it reaches its channel amplitude class (CAC) during any test.
4.3.4.	Listed in the test report along with calibration dates Mounted according to procedures laid out in SAE J211.
4.3.5.	Transducer sign convention is detailed in SAE J1733.
4.3.6.	In compliance with the thorax displacement sensors and their data processing as specified in ISO/TS21002:2021 The 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 may not be used.
4.3.7.	The dummies to be used shall be instrumented to record the channels listed in the following tables. The onboard temperature sensor shall be attached in accordance with ISO TR 27957, and the temperature sensor shall meet the requirements of ISO 6784.

Table 4: Q10 Dummy Parameters and Channels

Location	Parameter		CAC	No of Channels
Head	Accelerations, A_x A_y A_z		200g	3
Head Tilt sensor (static)	Angle		NA	NA
Upper Neck (OC)	Forces	F_x F_y	8.0kN	2
		F_z	10.0kN	1
	Moments	M_x M_y	90Nm	2
		M_z	45Nm	1
Shoulder (side only)	Forces	F_x F_z	2.0kN	2
		F_y	4.0kN	1
T1 (side only)	Accelerations, A_y		200g	1
Chest (T4)	Accelerations, A_x A_y A_z		200g	3
	Displacement and rotation		90mm 40deg	4
Thoracic temperature	Temperature		30□C	
Lumbar spine (Lower)	Forces	F_x F_y	6.0kN	2
		F_z	8.0kN	1
	Moments	M_x M_y	150Nm	2

		M_z	75Nm	1
Pelvis - Sacrum	Accelerations, A_x A_y A_z		200g	3
Pelvis – Pubis (side only)	Forces, F_y		2.0kN	1
Iliac (L and R) (OPTIONAL)	Force, Fx		9kN	(2)
	Moment, My		220Nm	(2)
Pelvis Tilt sensor (static)	Angle		NA	NA
Total Channels				**30 (34)**

Table 5: Q6 Dummy Parameters and Channels

Location	Parameter		CAC	No of Channels
Head	Accelerations, A_x A_y A_z		200g	3
Upper Neck (OC)	Forces	F_x F_y	5.0kN 5.0kN	2
		F_z	6.0kN	1
	Moments	M_x M_y	90Nm	2
		M_z	45Nm	1
Chest	Accelerations, A_x A_y A_z		200g	3
	Displacement		90 mm	1
Iliac (L & R) Optional	Force Fx		9 kN	(2)
	Moment, My		220 Nm	(2)
	Total Channels			**13 (17)**

4.4.	**Additions and Modifications to the Hybrid III Dummies**
	a) The Q6 dummy shall be standard build level A, and the Q10 standard build level C. See the relevant user manual for each dummy. b) The Q10 dummy is used with the full arms for frontal impact testing. The approved Q10 upgrade kit, defined in EuroNCAP Technical Bulletin TB029, shall be used
4.5.	**Dummy Test Condition**
	a) The Q6 and Q10 shall have a stabilised temperature, measured in the chest cavity, of 18ºC to 22ºC, for at least 1 hour immediately prior to the test. b) The temperature of the dummies shall be measured for at least 5 hours before test at intervals not exceeding 10 minutes and not exceeding 5 minutes before test. c) A copy of the temperature readings is to be supplied as part of the standard output of the test

4.6.	**Dummy Clothing and Footwear**
	a) Each child dummy shall wear their appropriate suits, Q6 (with Cordura patches) and Q10. b) The Q10 shall be installed with left and right hand hip shields. Hip liners may only be used for the Q10 when seated on an integrated CRS. c) The Q6 shall be installed without either hip shields or a hip liner when using a booster seat. Hip liners may only be used for the Q6 when seated on an integrated CRS
4.7.	**Dummy face painting**
	Child dummies Top of Head — Blue Head-band (colours from left to right) — Red, Yellow, Green Paint Area Sizes: Child Dummies Top of Head — 75 x 75mm square Headbands — 25mm wide, widest circumference at eyebrow level at front, extending to the head C of G at each side.
4.8	**Post Test Dummy Inspection**
4.8.1	All dummies shall be visually inspected immediately after the test.
4.8.2	Any lacerations of the skin or breakages should be noted in the test details, a dummy may have to be re-certified in this case.
4.8.3	Any screws that have become loose or detached shall be re-tightened to the required torque or replaced as necessary

APPENDIX C – CRASH PROTECTION

DUMMY POSITIONING AND MEASUREMENT

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1.	**HYBRID-III 50th PERCENTILE**
	The following chapter deals with all aspects of seating the dummy in the vehicle to be tested.
1.1.	**Determination of and Setting the Fore/aft, Tilt and Lumbar Settings of Seat**
1.1.1.	The manufacturers' seat fore/aft position which corresponds to the 95th percentile male seating position will have been provided.
1.1.2.	Place a mark on the moving part of seat runner close to the unmoving seat guide.
1.1.3.	Move the seat to its most forward position of travel.
1.1.4.	Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the seat in its most forward position.
1.1.5.	Move the seat to the position of its travel provided for the 95th percentile male.
1.1.6.	Mark the unmoving seat guide in line with the mark on the seat runner. This corresponds to the 95th percentile male's seating position.
1.1.7.	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.
1.1.8.	Move the seat so that the mark on the seat runner aligns with the mark on the seat guide.
1.1.9.	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.
1.1.10.	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.
1.1.11.	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.
1.1.12.	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.
1.2.	**Determine the H-point of the driver's seat**
	The device to be used is the H-point machine as described in SAE J826. If the seat is new and has never been sat upon, a person of mass 75 ± 10kg should sit on the seat for 1 minute twice to flex the cushions. The seat shall have been at room temperature and not been loaded for at least 1 hour previous to any installation of the machine.

1.2.1.	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.
1.2.1.1.	The driver and passenger seatback angle and seat base shall be set to the same position.
1.2.1.2.	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.
1.2.1.3.	Where both seats are adjustable, the manufacturer is asked to supply recommended settings. These should not differ from the nominal settings by more than a reasonable amount. In any of the above situations, the manufacturer may provide convincing information that the seat adjustments should be different from that specified here. If so the fully supported request to vary the set up should be made to the Secretariat
1.2.2.	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.
1.2.3.	Place the seat and back assembly of the H-point machine on the seat at the centre line of the seat.
1.2.4.	Set the thigh and lower leg segment lengths to 401 and 414mm respectively.
1.2.5.	Attach lower legs to machine, ensuring that the transverse member of the T-bar is parallel to the ground.
1.2.6.	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.
1.2.7.	Place left foot at equal distance from centre line of machine as the right leg is from centre
1.2.8.	Apply lower leg and thigh weights.
1.2.9.	Tilt the back-pan forwards to the end stop and draw the machine away from the seatback.
1.2.10.	Allow the machine to slide back until it is stopped by contacting the seat back.
1.2.11.	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.
1.2.12.	Return the machine back to the seat back.
1.2.13.	Install the right and left buttock weights.
1.2.14.	Apply the torso weights alternately left and right.

1.2.15.	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.
1.2.16.	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.
1.2.17.	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.
1.2.18.	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.
1.2.19.	Adjust the seat back angle to the angle determined in 1.1.1, measured using the spirit level and torso angle gauge of the H-point machine. Ensure that the torso remains in contact with the seat back at all times. Ensure that the machine pan remains level at all times.
1.2.20.	Measure and record in the test details the position of the H-point relative to some easily identifiable part of the vehicle structure
1.3.	**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.
1.4.	**Dummy Installation**
	It is the intention that the dummy should not be left to sit directly on the seat for more than 2 hours prior to the test. It is acceptable for the dummy to be left in the vehicle for a longer period, provided that the dummy position is checked no more than 1 hour prior to test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.
1.5.	**Dummy Placement**
	If the vehicle has only two side doors, it may be necessary to fit the child restraint systems and child dummies (section 1.6) before setting up the Hybrid-III dummies in the front seats.
1.5.1.	Ensure that the seat is in the correct position as defined by Section 1.1.
1.5.2.	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.

1.6.	**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.
1.6.1.	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. Record the position of the dummy H-point in the test details.
1.6.2.	Pelvic Angle
	The pelvic angle measurement gauge should read 22.5o ± 2.5o from the horizontal. Record the measured angle in the test details.
1.6.3.	Head
	The transverse instrumentation platform of the head shall be horizontal to within 2.5^{o} Levelling of the head shall be carried out in this order: o Adjust the H-point within the limit (par. 1.6.1) o Adjust the pelvic angle within the limits (par. 1.6.2) o Adjust the neck bracket the minimum to ensure that the transverse instrumentation platform is level within limits. o Record the measured angle in the test details.
1.6.4.	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.
1.6.5.	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.
1.6.6.	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.
1.6.7.	Legs
	If the knees are in contact with the facia or the gap is less than 30mm, move the dummy and seat rearwards until a gap of 30mm is achieved, or to the nearest notch rearwards.

	The upper leg (femur) of both dummies shall be in contact with the seat cushion as far as possible. The distance apart of the outside metal surfaces of the knees of each dummy shall be 270mm ± 10mm. When the left foot is placed on a footrest or dead pedal and the right foot is positioned onto the accelerator pedal as described in 1.6.8 below, the distance between the knees may be altered for the driver dummy. The femur and tibia for each leg shall be as close as possible to a vertical plane.
1.6.8.	Feet
	• The driver dummy's right foot shall rest on the undepressed accelerator pedal with the heel on the floor. To keep the upper and lower legs in the same vertical plane, move the upper leg accordingly. 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. If a dedicated foot-rest is present, place the left foot fully on this rest providing a normal seating position can still be achieved. The knee gap requirement of 270mm ± 10mm may be ignored in this case. Where there is no footrest, position the left foot at an equal distance from centre line of seat as the right leg is from centre line. The left foot should be placed as flat as possible on the toe-board parallel to the centre line of the vehicle. • 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 • Note the knee gap in the test details
1.6.9.	Seat Belt
1.6.9.1.	Where possible, initially position the upper seat belt anchorage in the manufacturers 50th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the mid-position or nearest notch upward.
1.6.9.2.	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 1.5.5.
1.6.9.3.	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.
1.6.9.4.	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.
1.6.9.5.	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 above repeated.

1.6.9.6.	The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position. This may require multiple attempts.
1.6.9.7.	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.
1.6.9.8.	Where the fitment of the shoulder belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non-metallic wire or thread. The Seat belt shall be set no higher than adjustment screw as shown in the reference image below:  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

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

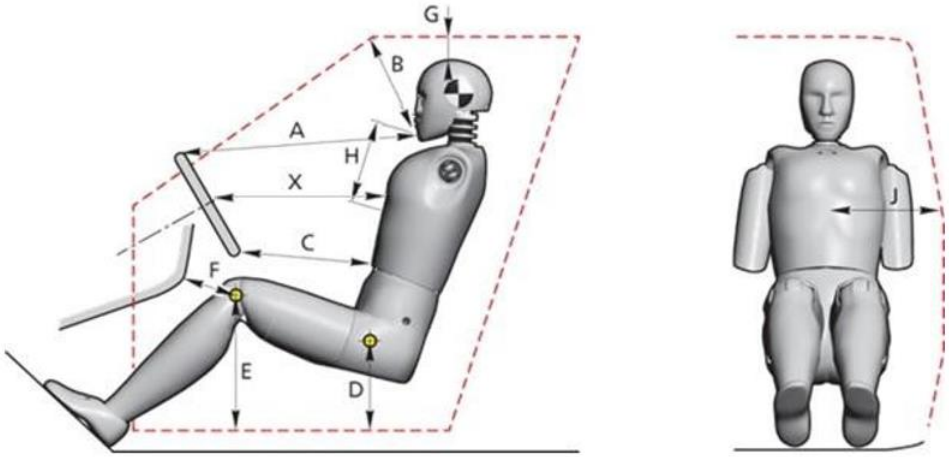
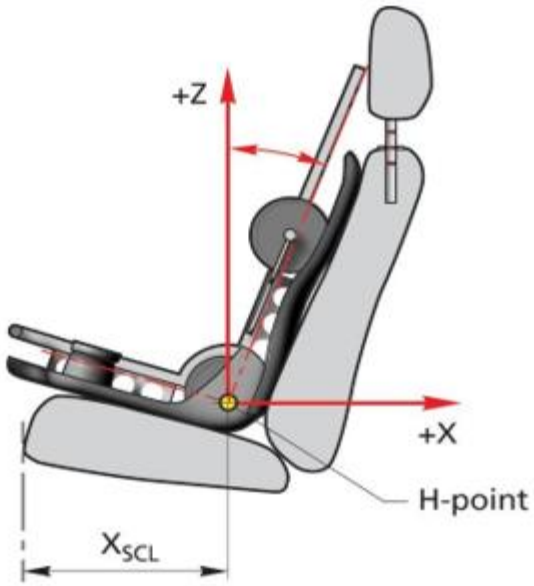


Figure 1 Dummy measurements

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	Chin to webbing (vertically)	H	Chin to webbing (vertically)
X	200mm below chin to closet part of facia (horizontally)	X	200mm below chin to closet part of front passenger's seat back (horizontally)
J	Belt webbing to door (horizontally)	J	Belt webbing to door (horizontally)
	Neck Angle		Neck Angle
	Seat back angle (as defined by torso angle)		Seat back angle (as defined by torso angle)

2.	**HYBRID III 5TH PERCENTILE**
2.1.	**Front Passenger Seating Position for Test**
2.1.1.	Position the test seat's adjustable lumbar supports so that the lumbar supports are in the lowest, retracted or deflated adjustment positions.
2.1.2.	Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position.
2.1.3.	Position an adjustable seat cushion length to the retracted position.
2.1.4.	Position an adjustable leg support system in its rearmost position.
2.1.5.	Place adjustable pedals in the full forward position (towards the front of the vehicle.)
2.1.6.	Identify one seat cushion reference point at the rear side of the seat cushion (SCRP-REAR).
2.1.7.	Locate and mark the longitudinal centreline of the seat cushion.
2.1.8.	Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the upper most vertical location.
2.1.9.	Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the rear most location.
2.1.10.	Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the lowest vertical location.
2.1.11.	Use the seat control that primarily moves the seat fore-aft to adjust the SCRPREAR to the rear most location. Record the position XRD.
2.1.12.	Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the forward most location. Record the position XFD.
2.1.13.	Measure and mark the position at the manufacturer design position X05. If no design position given, X05 is the forward most location.
2.1.14.	Use the seat control that primarily moves the seat fore-aft to adjust the $SCRP_{REAR}$ to the X05 position marked in 2.1.13.
2.1.15.	Determine and record the range of angles of the seat cushion pitch and using only the control(s) that primarily adjust(s) the cushion pitch, set cushion pitch to the manufactures design position. If no design position given, set cushion pitch to midangle. Note, for some vehicles this step may change the X05 position as established in 2.1.13, this is acceptable.
2.1.16.	Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the lowest vertical location. Record the position Z05D.
2.1.17.	Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the highest vertical location. Record the position Z05U.

2.1.18.	Measure and mark a position at the manufacturer design position Z05. If no design position given, Z05 is the mid position of the vertical range.
2.1.19.	Use the seat control that primarily moves the seat vertically to adjust the $SCRP_{REAR}$ to the Z05 position marked in 2.1.18. Note, for some vehicles this final step may change the X05position established in 2.1.13 and/or the cushion pitch as established in 2.1.15, this is acceptable.
2.1.20.	Record test seat base position co-ordinates of the $SCRP_{REAR}$.
2.2.	**Determine the H-point**
	The device to be used is the H-point machine as described in SAE J826. If the seat is new and has never been sat upon, a person of mass 75 ± 10kg should sit on the seat for 1 minute twice to flex the cushions. The seat shall have been at room temperature and not been loaded for at least 1 hour previous to any installation of the machine.
2.2.1.	Front Passenger seat
2.2.1.1.	Set the seat back so that the torso of the H-point machine is as close as possible to the manufacturer's reasonable recommendations for normal use or to the standard setting as tabulated earlier.
2.2.1.2.	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.
2.2.1.3.	Place the seat and back assembly of the H-point machine on the seat at the centre line of the seat.
2.2.1.3.1.	For seats with defined bolsters, or individual auxiliary seats, C/LO is the seat centerline.
2.2.1.3.2.	For bench seats (or other) seats, C/LO is the middle of the head restraint. If a head restraint is not fitted, find C/LO between the belt anchors.
2.2.1.3.3.	If the C/LO cannot be found with the procedures 2.2.1.3.1 through 2.2.1.3.3 the C/LO is located 381mm outboard from the vehicle centreline.
2.2.1.4.	Apply thigh weights. Do not install legs and/or T-bar.
2.2.1.5.	Tilt the back pan forwards to the end stop and draw the machine away from the seatback. If required, it is allowed to temporarily adjust the steering wheel postion to allow installation of the H-point machine. If the steering wheel is interfering with the H-point machine, the seat may be positioned more rearward or the steering wheel may be removed to allow installation of the H-point machine.
2.2.1.6.	Allow the machine to slide back until it is stopped by contacting the seat back.
2.2.1.7.	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.

2.2.1.8.	Return the machine back to the seat back.
2.2.1.9.	Install the right and left buttock weights.
2.2.1.10.	Apply the torso weights alternately left and right.
2.2.1.11.	Tilt the machine back forwards to a vertical position and while holding the T-bar rock the pan by 5 degrees either side of the vertical. After rocking the T-bar should be parallel to the ground.
2.2.1.12.	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.
2.2.1.13.	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.
2.2.1.14.	Adjust the seat back angle to the angle determined in 3.2.1.1, 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.
2.2.1.15.	Measure and record in the test detail the position of the H-point relative to some easily identifiable part of the vehicle structure
2.2.1.16.	Measure and record in the test detail the angle of the seat assembly of the H-point machine and the position of the seat cushion front end
2.2.1.17.	Use the following measurement and formula to calculate the H-point coordinates for the HIII-05F, where X_{SCL} is defined as the horizontal distance between the H-point and the most forward point on the seat base cushion. Note that X_{AF05} should always be more forward than the X_{AM50}.  XAF05,dummy = XAM50,H-point manikin + (93mm – 0.323 x XSCL) ZAF05, dummy = ZAM50, H-point manikin – 6mm

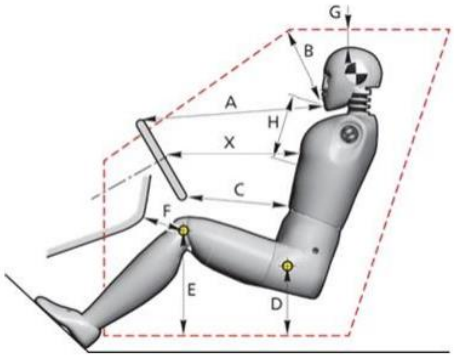
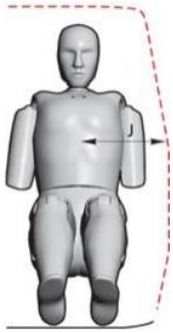
2.2.2.	Determine the H-point of the Rear Passenger's Seat
	Follow the same procedure as described in 2.2.1 for the determination of the rear passenger's H-point.
2.3.	**Dummy Installation**
	It is the intention that the dummy should not be left to sit directly on the seat for more than 6 hours prior to the test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.
2.4.	**Dummy Placement**
2.4.1.	If the vehicle has only two side doors, it may be necessary to fit the rear passenger dummy before setting up the Hybrid-III 05F dummy in the front seat.
2.4.2.	Ensure that the seat is in the correct position as defined by Section 2.2.
2.4.3.	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.
2.5.	**Front Passenger 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.
2.5.1.	H-point
	The dummy's H-point shall be within a square of ±13mm in X and Z of the manikin H-point of the 5th percentile, with a point 6 mm below the position of the H-point determined using the procedure described in in Section 2.2. Record the position of the dummy H-point in the test details.
2.5.2.	Pelvic Angle
	The pelvic angle measurement gauge should read 20° ± 2.5° from the horizontal. Record the measured angle in the test details.
2.5.3.	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 • Adjust the pelvic angle within the limits • Adjust the neck bracket the minimum to ensure that the transverse instrumentation platform is level within limits. Record the measured angle in the test details.
2.5.4.	Arms
	The upper arms shall be positioned in contact with the seatback. The forearms and the hands shall be positioned as close as possible to the outer sides of the thighs while the little fingers are lightly in contact with the seat cushion
2.5.5.	Hands
	The palms must be in contact with the outside of the legs and the little finger in contact with the seat cushion.
2.5.6.	Torso
	The dummy's backs should be in contact with the seat back and the centre line of the dummy’s should be lined up with the centre line of the respective seat.
2.5.7.	Legs
	The upper legs of the dummy shall be in contact with the seat cushion as far as possible. The initial distance apart of the outside metal surfaces of the knees of each dummy shall be 210mm ± 5mm. The legs of the dummies should be in vertical longitudinal planes as far as is possible.
2.5.8.	Feet
	The right and left foot should be placed as flat as possible on the toe-board parallel to the centre line of the vehicle with the heel as far forwards as possible and shall be at equal distance from the seat centre line so that the legs are symmetrical. 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. Note the final knee gap in the test details
2.5.9.	Seat Belt
2.5.9.1.	Where possible, initially position the upper seat belt anchorage in the manufacturers 5th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the lowest position.
2.5.9.2.	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 2.5.5.
2.5.9.3.	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.
2.5.9.4.	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.
2.5.9.5.	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 2.5.9.3 and 2.5.9.4 repeated.
2.5.9.6.	The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 2.5.9.3 and 2.5.9.4 repeated. This may require multiple attempts
2.5.9.7.	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.
2.5.9.8.	Where the fitment of the shoulder belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non metallic wire or thread.
2.6.	**Rear Passenger Dummy Positioning**
2.6.1.	H-point
	The dummy's H-point shall be within a square of ±13mm in X and Z of the manikin H-point of the 5th percentile, with a point 6 mm below the position of the H-point determined using the procedure described in in Section 2.2.2. Record the position of the dummy H-point in the test details.
2.6.2.	Pelvic Angle
	The pelvic angle measurement gauge should read 20° ± 2.5° from the horizontal. Record the measured angle in the test details. If pelvic angle cannot be achieved, use the design torso angle as a reference value.
2.6.3.	Head
	The transverse instrumentation platform of the head shall be horizontal to within 2.5° Levelling of the head shall be carried out in this order: • Adjust the H-point within the limit • Adjust the pelvic angle within the limits • Adjust the neck bracket the minimum to ensure that the transverse

	instrumentation platform is level within limits. Record the measured angle in the test details.
2.6.4.	Upper Arms
	The upper arms shall be positioned in contact with the seatback.
2.6.5.	Hands
	The forearms and the hands shall be positioned as close as possible to the outer sides of the thighs while the little fingers are lightly in contact with the seat cushion. If there is interference by trim or other interior parts, the interfered upper limb shall be placed on the armrest of the same side to avoid any interference.
2.6.6.	Torso
	The dummy's 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.
2.6.7.	Legs
	• The upper legs of the dummy 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 210mm ± 5mm. The legs of the dummies should be in vertical longitudinal planes as far as is possible. • The legs shall be positioned as distant as possible from the front end of the rear seat cushion while the thighs are kept in contact with the seat cushion. • Each leg shall be lowered until the foot comes in contact with the floor while the foot and tibia are kept in a right angle to one another and the thigh inclination angle kept constant.
2.6.8.	Feet
	• When each heel is in contact with the floor, the foot shall be rotated so that the toe comes as much in contact as possible with the floor. • If it is not possible to have each foot in contact with the floor, the foot shall be lowered until the calf comes in contact with the front end of the seat cushion or the back of the foot comes in contact with the vehicle interior. The foot shall be kept as parallel as possible to the floor. • In case of interference by front seat anchorages or by a vehicle body protrusion, the foot shall be rotated as minimally as possible around the tibia. In case interference still remains, the femur shall be rotated to resolve or minimize the interference. The foot shall be moved inward or outward while the separation distance between the knees is kept constant. • In case of significant interference by the front seat in its test position or by a vehicle body protrusion, the leg shall be moved toward the occupant side by lifting and keeping the thigh as much in contact as possible with the rear seat cushion.

2.6.9.	Finalization of torso position and readjustment of foot position (if any)
	After adjustments of the lower limbs according to 2.6.7 and 2.6.8 above, the dummy position has to be reconfirmed in accordance with the H point tolerances and specified limits of pelvic angle and head angle. Any foot displacement during the final positioning of the torso should be undone.
2.6.10.	Seat Belt
2.6.10.1.	Where possible, initially position the upper seat belt anchorage in the manufacturers 5th percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the lowest position.
2.6.10.2.	Carefully place the seat belt across the dummy and lock as normal. It will be necessary to re-position the upper limbs as described in Section 2.6.4 and 2.6.5
2.6.10.3.	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.
2.6.10.4.	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
2.6.10.5.	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 2.6.10.3 and 2.6.10.4 repeated.
2.6.10.6.	The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 2.6.10.3 and 2.6.10.4 repeated. This may require multiple attempts.
2.6.10.7.	Where the fitment of the shoulder belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non metallic wire or thread.

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

Front Passenger's Side		Rear Passenger's Side	
A	Chin to top of rim	A	Chin to front passenger seat back
B	Nose to top edge of glass		
C	Stomach to facia	C	Stomach to front passenger's seat back
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 rear of front passenger's seat back
G	Head to roof surface	G	Head to roof surface
H	Chin to webbing (vertically)	H	Chin to webbing (vertically)
J	Belt webbing to door (horizontally)	J	Belt webbing to door (horizontally)
X	200mm below chin to closet part of facia (horizontally)	X	200mm below chin to closet part of front passenger's seatback (horizontally)
	Neck Angle		Neck Angle
	Seat back angle (as defined by torso angle)		Seat back angle (as defined by torso angle)

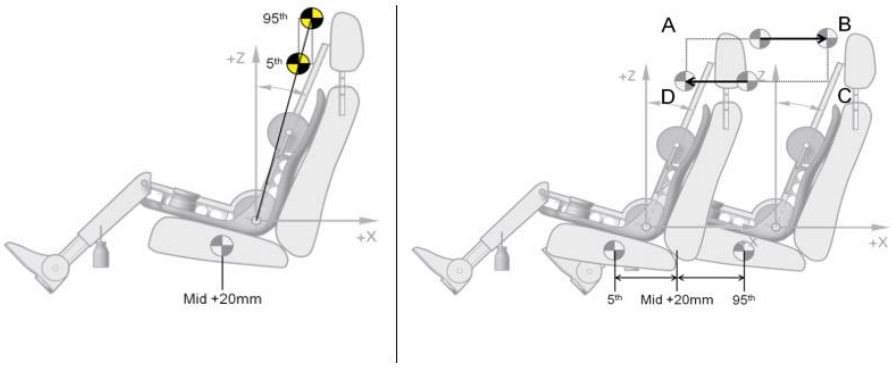
3.	**WORLDSID 50th PERCENTILE**
3.1.	**Seat adjustments**
3.1.1.	Position the seat's adjustable lumbar supports so that the lumbar supports are in the lowest, retracted or deflated adjustment positions.
3.1.2.	Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position.
3.1.3.	Position an adjustable seat cushion length to the retracted position.
3.1.4.	Position an adjustable leg support system in its rearmost position.
3.1.5.	Place adjustable pedals in the full forward position (towards the front of the vehicle.)
3.2.	**Seat Markings**
3.2.1.	Identify and mark one seat reference point (SRP_1) at the rear side of the seat cushion, SRP_1
3.2.2.	Where the seat cushion pitch is adjustable, identify and mark a second reference point, SRP_2, that is at least 300mm forward of the rear reference point ($SRP_{1)}$ and draw a line through the two reference points.
3.2.3.	Locate and mark the longitudinal centerline of the seat cushion. The intersection of the vertical longitudinal plane that passes through the SRP_1 and the seat cushion upper surface determines the longitudinal centerline of a bucket seat cushion.
3.2.4.	Where the front seats are bench seats, locate and mark the longitudinal line on the seat cushion that marks the intersection of the vertical longitudinal plane through the centerline of the steering wheel and the seat cushion upper surface.
3.3.	**Positioning the seat**
3.3.1.	Use the seat control that primarily moves the seat vertically to adjust the rearmost seat reference point, $SRP_{1,}$ defined in 2.2.1 to the upper most vertical location.
3.3.2.	Use the seat control that primarily moves the seat fore-aft to adjust the rearmost seat reference point, $SRP_{1,}$ defined in 2.2.1 to the rearmost location.
3.3.3.	Determine and record the range of angles of the seat cushion pitch and using only the control(s) that primarily adjust(s) the cushion pitch, set cushion pitch to the mid-angle
3.3.4.	Use the seat control that primarily moves the seat vertically to adjust the rearmost seat reference point defined in 2.2.1, $SRP_{1,}$ to the lowest vertical location. Verify that you are still at the rearmost seat track location. Record the X position of SRP_1.

3.3.5.	Use the seat control that primarily moves the seat fore-aft to adjust the rearmost seat reference point, SRP_1, to the rearmost location. Record the X position of SRP_1.
3.3.6.	Use the seat control that primarily moves the seat fore-aft to adjust the rearmost seat reference point, SRP_1, to the forward most location; Record the X position of SRP_1.
3.3.7.	Measure and mark an X position 20mm rearward of the midpoint (MP +20mm).
3.3.8.	Use the seat control that primarily moves the seat fore-aft to adjust the rearmost seat reference point, SRP_1, to the X position marked in 2.3.7 or, if this is not possible, to the first X possible position rearward the marked position in 2.3.7. If the seat cannot be placed at exactly 20mm rearward of the midpoint select the next closest available rearward setting.
3.3.9.	For some vehicles this final step may change the cushion pitch as established in 2.3.8, this is acceptable.
3.3.10.	Record test seat position using the seat reference point, SRP_1. The settings for the passenger seat should be as near as possible to being the same as that of the driver's seat.
3.4.	**Determine the H-point of the driver's seat**
	The device to be used is the H-point machine as described in SAE J826. If the seat is new and has never been sat upon, a person of mass 75 ± 10kg should sit on the seat for 1 minute twice to flex the cushions. The seat shall have been at room temperature and not been loaded for at least 1 hour previous to any installation of the machine.
3.4.1.	Set the seat back so that the torso of the H-point manikin is as close as possible to the manufacturer's recommendations for normal use. In absence of such recommendations, an angle of 23 degrees ±1° towards the rear from vertical will be used.
3.4.2.	The driver and passenger seatback angle and seat base shall be set to the same position.
3.4.3.	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.
3.4.4.	Place the seat and back assembly of the H-point machine on the seat at the centre line of the seat.
3.4.5.	The length of the lower leg and thigh segments of the H-point manikin shall be adjusted to the 50th percentile (418mm) and 10^{th} percentile (408mm) positions respectively.
3.4.6.	Attach lower legs to machine ensuring that the transverse member of the T-bar is parallel to the ground.
3.4.7.	Place the right foot on the undepressed accelerator pedal, with the heel as far forwards as allowable. The distance from the center line of the machine to be noted.

3.4.8.	Place left foot at equal distance from center line of machine as the right leg is from center line. Place the foot flat on the footwell.
3.4.9.	Apply lower leg and thigh weights.
3.4.10.	Tilt the back-pan forwards to the end stop and draw the machine away from the seatback.
3.4.11.	Allow the machine to slide back until it is stopped by contacting the seat back.
3.4.12.	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.
3.4.13.	Return the machine back to the seat back.
3.4.14.	Install the right and left buttock weights.
3.4.15.	Apply the torso weights alternately left and right.
3.4.16.	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. 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.
3.4.17.	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.
3.4.18.	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.
3.4.19.	Adjust the seat back angle to the angle determined in 2.4.1, 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.
3.4.20.	If the measured angle is not within ±1° of the target, the chest and buttocks weights shall be removed, the seat back readjusted, and the steps to position the H-point manikin shall be repeated, beginning with tilting the back pan forward as in 2.4.10.
3.4.21.	Measure and record in the test detail the position of the H-point relative to some easily identifiable part of the vehicle structure.
3.5.	**Dummy Placement**
3.5.1.	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 checked no more then one hour prior to test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.

3.5.2.	If the vehicle has only two side doors, it may be necessary to fit the child restraint systems and child dummies before setting up the driver dummy in the front seat.
3.5.3.	H-point
	Note that the H-point of the WorldSID dummy is situated 20mm forward of that of the H-point determined by the H-point manikin.
3.5.3.1.	Using only the controls that move the seat fore-aft, move the test seat to the rearmost position to facilitate placement of the dummy.
3.5.3.2.	Position the dummy in the seat such that the mid-sagittal plane is coincident with the centerline markings and the upper torso resting against the seat back.
3.5.3.3.	Apply a fore-aft and lateral rocking motion to settle the pelvis rearward in the seat.
3.5.3.4.	To ensure a repeatable and stable pelvis position, ensure that the pelvis is in contact with the seat cushion over the whole length.
3.5.3.5.	To ensure a repeatable placement of the lower abdominal rib, make sure it is inside the pelvis flesh and not on top of it.
3.5.3.6.	Move the seat together with the dummy to the test seat position defined in 4.4.9. If it is not possible to reach the seat test position due to knee contact, shift the targeted test seat position rearwards in the stepwise increments to the closest position where the knee clearance is at least 5mm. Modify the target H-point accordingly.
3.5.3.7.	Verify that the H-point is reasonably close (±10mm) to the target H-point 2.2.21 or as defined in 2.5.3.6 if the target H-point has been modified. If not, repeat step 2.5.3.3. If it is still not possible, record the rearmost seat cushion reference point and the dummy H-point and proceed to the next step.
3.5.3.8.	Extend the right leg without displacing the thigh from the seat cushion. Allow the sole of the foot to settle on the accelerator pedal; the heel of the shoe should be in contact with the floor pan. Where a lack of ankle articulation prevents the foot from sitting flat on the accelerator pedal, keep the foot at a 90-degree angle to the tibia and ensure that the heel is in contact with the floor.
3.5.3.9.	Extend the left leg without lifting the thigh from the seat cushion and allow the sole of the foot to settle on the footrest or floor if no footrest is present. The heel of the shoe should be in contact with the floor. In case of tibia contact, slide the foot rearward toward the seat until a 5mm clearance is obtained. Where a lack of ankle articulation prevents the foot from sitting flat on the floor, keep the foot at a 90 degree angle to the tibia and ensure that the heel is in contact with the floor.
3.5.3.10.	Position the H-point of the dummy to match the WorldSID H-point coordinates recorded following Section 2.4 to within ±10mm. Prioritize the X coordinate.
3.5.4.	Head and Torso
3.5.4.1.	Adjust the dummy until the thorax tilt sensor coincides with the angle specified by the manufacturer.

3.5.4.2.	If the rib angle is not specified by the manufacturer and the seat back is 23° ± 1°, adjust the dummy until the thorax tilt sensor reads −2° (2° downwards) ± 1°.
3.5.4.3.	If no rib angle is specified and the seat back angle is not 23° ± 1°, no further adjustment of rib angle is required.
3.5.4.4.	Adjust the dummy neck bracket to level the head at the closest position to 0° ± 1°.
3.5.5.	Legs and feet
3.5.5.1.	Proceed to the final foot and leg positioning by repeating Section 2.4.7 and 2.4.8. Where a lack of ankle articulation prevents the foot from sitting flat on the accelerator pedal/floor, keep the foot at a 90 degree angle to the tibia and ensure that the heel is as far forward as possible and in contact with the floor.
3.5.5.2.	No distance is specified for the knee spacing. However, priority should be given to ensure the following:
3.5.5.3.	There is 5 mm clearance between the knees/legs and the steering shroud and center console.
3.5.5.4.	There is a stable foot and ankle position.
3.5.5.5.	The legs are as parallel as possible to the sagittal plane.
3.5.6.	Arms
3.5.6.1.	Place both arms at the first detent downward of the most upward detent that corresponds to a differential angle of 32° between rib angle sensor and the arm angle.
3.5.7.	Seat Belt
3.5.7.1.	Where possible, initially position the upper seat belt anchorage in the manufacturers 50^{th} percentile design position. If no design position is provided, set the adjustable upper seat belt anchorage to the mid-position or nearest notch upward.
3.5.7.2.	Carefully place the seat belt across the dummy and lock as normal.
3.5.7.3.	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.
3.5.7.4.	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.
3.5.7.5.	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 2.5.7.3 and 2.5.7.4 repeated.
3.5.7.6.	The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 2.5.7.3 and 2.5.7.4. This may require multiple attempts.
3.5.7.7.	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.
3.5.7.8.	Measure the vertical distance between the dummy nose and the diagonal webbing.
3.5.7.9.	Measure the horizontal distance between the diagonal webbing and the door/window.
3.5.8.	After positioning the dummy measure and record the dummy position and determine the impact location as described in Section 1.4.
3.6.	**Head Protection Device Assessment (HPDA) Marking (Oblique side pole test)**
3.6.1.	Using the location of the H-point for the front seating position, calculate and record the corresponding 5^{th} female and 95^{th} male head centre of gravity positions for the front seat to determine the corners of the head CoG-box (Figure 2): 5^{th} female Head CoG: $X_{CoG,5th}$ = H-point(X) + 126 - seat travel 5^{th}-50^{th} $Z_{CoG,5th}$ = H-point(Z) + 594 95^{th} male Head CoG: $X_{CoG,95th}$ = H-point(X) + 147 + seat travel 50^{th}-95^{th} $Z_{CoG,5th}$ = H-point(Z) + 594  Figure 2: 3D manikin bench

<table>
<tr><td>3.6.2.</td><td>Table : The four corners of the Head CoG-box

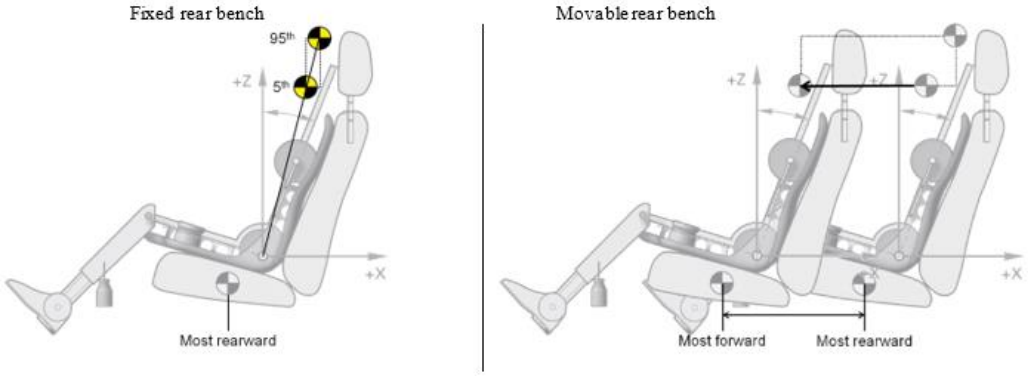
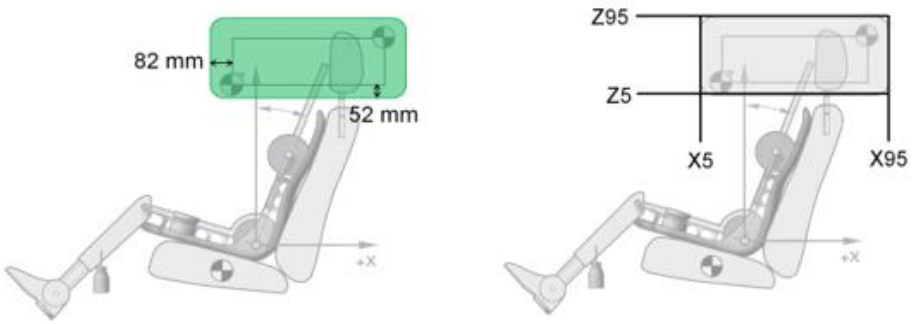
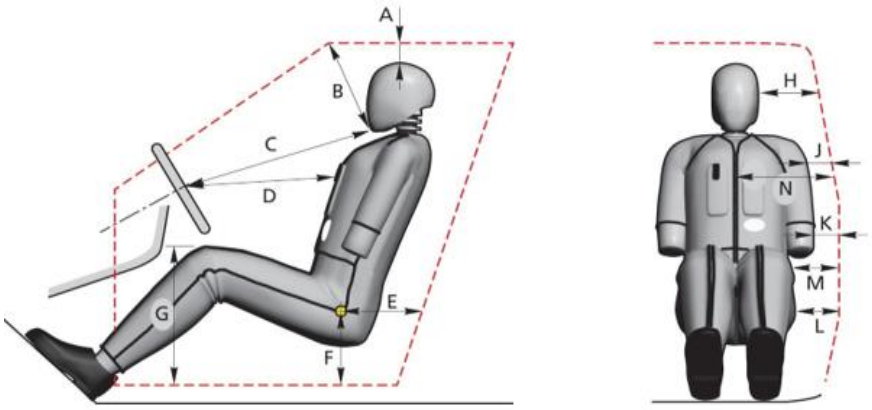
<table>
<tr><th></th><th>X-position</th><th>Z-position</th></tr>
<tr><td>A</td><td>XCoG,5th</td><td>ZCoG,95th</td></tr>
<tr><td>B</td><td>XCoG,95th</td><td>ZCoG,95th</td></tr>
<tr><td>C</td><td>XCoG,95th</td><td>ZCoG,5th</td></tr>
<tr><td>D</td><td>XCoG,5th</td><td>ZCoG,5th</td></tr>
</table>
</td></tr>
<tr><td>3.6.3.</td><td>The seat travel for the 5th and 95th positions will be required from the vehicle manufacturer</td></tr>
<tr><td>3.6.4.</td><td>Using the location of the H-point for the rear seating position, calculate and record the corresponding head centre of gravity positions in the most forward and rearward seating positions (Figure 3):
5th female Head CoG in most forward seating position:
$X_{CoG,5th}$ = H-point(X) + 126 – remaining seat travel (if applicable)
$Z_{CoG,5th}$ = H-point(Z) + 594
95^{th} male Head CoG in most rearward seating position:
$X_{CoG,95th}$ = H-point(X) + 147 + remaining seat travel (if applicable)
$Z_{CoG,95th}$ = H-point(Z) + 693
 

Figure 3: 3D Manikin Rear bench and Movable Rear bench</td></tr>
<tr><td>3.6.5.</td><td>The head protection device (HPD) evaluation zone is defined as a rounded rectangle around the head CoG box at a distance of 82mm from the upper and fore/aft edges and 52mm below the bottom edge. It is acceptable for the 82mm radius in the lower corners of the airbag to be cut-off at 52mm below the CoG box.</td></tr>
<tr><td>3.6.6.</td><td>The zone shall be constructed parallel and perpendicular to the ground reference level.</td></tr>
</table>

3.6.7.	Mark the vertical lines X5 and X95 and the horizontal lines Z95 and Z5 on both the vehicle interior at the struck side and on the vehicle exterior on the non-struck side (Figure 4).  Figure 4: Markings in 3D Manikin
3.7.	**Dummy Placement**
3.7.1.	It is the intention that the dummies should not be left to sit directly on the seat for more than 2 hours prior to the test. It is acceptable for the dummy to be left in the vehicle for a longer period, provided that the dummy position is checked no more then one hour prior to test. It is not acceptable for the dummy to be left in the vehicle overnight or for a similarly lengthy period.
3.7.2.	H-Point
	Note that the H-point of the WorldSID is situated 20mm forward of that of the H-point determined by the H-point manikin.
3.7.2.1.	Using only the controls that move the seat fore-aft, move the test seat to the rearmost position to facilitate placement of the dummy.
3.7.2.2.	Position the dummy in the seat such that the mid-sagittal plane is coincident with the centreline markings and the upper torso resting against the seat back.
3.7.2.3.	Apply a fore-aft and lateral rocking motion to settle the pelvis rearward in the seat.
3.7.2.4.	To ensure a repeatable and stable pelvis position, ensure that the pelvis is in contact with the seat cushion over the whole length.
3.7.2.5.	To ensure a repeatable placement of the lower abdominal rib, make sure it is inside the pelvis flesh and not on top of it.
3.7.2.6.	Move the seat together with the dummy to the test seat position defined in 4.4.9. If it is not possible to reach the seat test position due to knee contact, shift the targeted test seat position rearwards in the stepwise increments to the closest position where the knee clearance is at least 5mm. Modify the target H-point accordingly.
3.7.2.7.	Verify that the H-point is reasonably close (±10mm) to the target H-point 2.4.21 or as defined in 2.7.2.6 if the target H-point has been modified. If not, repeat step 2.7.2.3.

	If it is still not possible, record the rearmost seat cushion reference point and the dummy H-point and proceed to the next step
3.7.2.8.	Extend the right leg without displacing the thigh from the seat cushion. Allow the sole of the foot to settle on the accelerator pedal; the heel of the shoe should be in contact with the floor pan. Where a lack of ankle articulation prevents the foot from sitting flat on the accelerator pedal, keep the foot at a 90 degree angle to the tibia and ensure that the heel is in contact with the floor
3.7.2.9.	Extend the left leg without lifting the thigh from the seat cushion and allow the sole of the foot to settle on the footrest or floor if no footrest is present. The heel of the shoe should be in contact with the floor. In case of tibia contact, slide the foot rearward toward the seat until a 5mm clearance is obtained. Where a lack of ankle articulation prevents the foot from sitting flat on the floor, keep the foot at a 90 degree angle to the tibia and ensure that the heel is in contact with the floor.
3.7.2.10.	Position the H-point of the dummy to match the WorldSID H-point coordinates recorded following Section 3.3 to within ±10mm. Prioritise the X coordinate.
3.7.3.	Head and Torso
3.7.3.1.	Adjust the dummy until the thorax tilt sensor coincides with the angle specified by the manufacturer.
3.7.3.2.	If the rib angle is not specified by the manufacturer and the torso angle is 23° ± 1°, adjust the dummy until the thorax tilt sensor reads −2° (spine flexion) ± 1°.
3.7.3.3.	If no rib angle is specified and the seat back angle is not 23° ± 1°, no further adjustment of rib angle is required.
3.7.3.4.	Adjust the dummy neck bracket to level the head at the closest position to 0° ± 1°.
3.7.4.	Legs and Feet
3.7.4.1.	Proceed to the final foot and leg positioning by repeating Section 2.7.7 and 2.7.8.Where a lack of ankle articulation prevents the foot from sitting flat on the accelerator pedal/floor, keep the foot at a 90 degree angle to the tibia and ensure that the heel is as far forward as possible and in contact with the floor.
3.7.4.2.	No distance is specified for the knee spacing. However, priority should be given to ensure the following:
3.7.4.3.	There is 5 mm clearance between the knees/legs and the steering shroud and centre console.
3.7.4.4.	There is a stable foot and ankle position.
3.7.4.5.	The legs are as parallel as possible to the sagittal plane.
3.7.5.	Arms
3.7.5.1.	Place both arms at the first detent downward of the most upward detent that corresponds to a differential angle of 32° between rib angle sensor and the arm angle

3.7.6.	Seat Belt
3.7.6.1.	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.
3.7.6.2.	Carefully place the seat belt across the dummy and lock as normal.
3.7.6.3.	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.
3.7.6.4.	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.
3.7.6.5.	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 2.7.6.3 and 2.7.6.4 repeated.
3.7.6.6.	The upper anchorage should be lowered by a sufficient amount to ensure a natural belt position following the repetition of steps 2.7.6.3 and 2.7.6.4. This may require multiple attempts.
3.7.6.7.	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.
3.7.6.8.	Measure the vertical distance between the dummy nose and the diagonal webbing
3.7.6.9.	Measure the horizontal distance between the diagonal webbing and the door/window.
3.7.7.	After positioning the dummy measure and record the dummy position and determine the impact location.

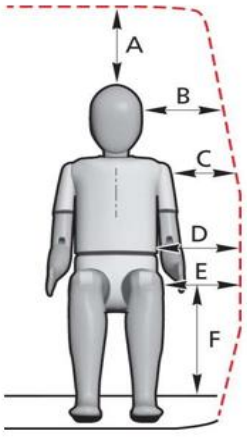
3.8.	**Dummy Positioning Measurements**
	The following measurements are to be recorded prior to the test after the dummy settling and positioning procedures have been carried out. 

Driver measurements	
A	Head to roof panel
B	Chin to windscreen joint
C	Chin to centre of the steering / facia
D	Thorax strap to centre of the steering wheel / facia (Horizontal)
E	Hip-joint point to inside opening of the door (Horizontal)
F	Hip-joint point to inside opening of the door (vertical)
G	Knee to floor covering (vertical)
H	Head to side window pane (or padding)
J	Shoulder to window pane (or padding)
K	Elbow to door (or padding)
L	Pelvis to door (or padding)
M	Knee to door (or padding)
N	Belt webbing to door (horizontally)

4.	**CHILD DUMMY POSITIONING**
	Two CRS's are to be fitted on the rear seat, one suitable for a 10 year old child, the other for a 6 year old child. 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. The use of additional belt guides, clips or other components that are not an integral part of the CRS is prohibited. Belt guides that are fitted to the vehicle must be permanently attached and information on their use must be contained in the vehicle handbook, where this is not the case they MUST NOT be used for testing.
4.1.	**General**
	Before installing the dummies and child restraint systems, ensure that the passenger compartment adjustments for the rear seats is performed. Leave the front seats as far forward as possible to ensure easy access.
4.2.	**Position of the Front Seat**
	a) Reposition the front seat 30mm forward of its test position. If there is no notch at this position, set the seat in the nearest notch forwards of 30mm. b) During repositioning, check for interaction between the Q dummy lower legs, feet and the front seat. c) With the front seats 30mm forward, if there is no contact between the front of the dummy toes and the seat in front, it is acceptable for the top of the foot/toes to contact the underside of the front seat, reposition the front seats in their test positions and proceed to belt routing. The interaction between the Q dummy lower legs, feet and the front seat is acceptable. Record the pelvic angle. d) If there is contact between the dummy and the front seats when they are 30mm forward of their test position, follow the steps below to limit contact between dummy and front seat. Note: this is not relevant if there is only contact between the top of the foot/toes and the underside of the front seat. i. Try to reposition the feet and tibias by pushing them beneath the front seat or rotating the tibias about the Z axis. If this is not sufficient then: ii. Move the pelvis of the dummy forwards, while keeping the CRS in place, until there is no more contact with the seat in front. It is permitted to change the pelvic angle up to 5 degrees relative to the initial pelvic angle. This should be done in incremental steps until the contact between the

	toes and front seat is removed. It is acceptable for the top of the foot/toes to contact the underside of the front seat. Record the final pelvic angle. e) When the dummy toes remain in contact with the front seat after repositioning the dummy as mentioned above, the vehicle will be treated as limited rear space for that particular test. It is acceptable for the top of the foot to contact the underside of the front seat. The front seat must be returned to the test position.
4.3.	**Marking centrelines**
	Mark the centreline of both of the rear outboard seating positions (including head restraint centreline if necessary) and on the CRS used for test. Markings placed on hard parts of the CRS, rather than seat fabric, are preferable. If an ISOFIX CRS is used no markings are needed. The vehicle manufacturer shall confirm whether or not the centreline of the head restraints aligns with the centreline of the vehicle's rear seat cushion. Where this is not the case the vehicle manufacturer shall supply details of the seat base centreline in accordance with the rear seat whiplash assessment. Where no information is provided, either the centreline of the head restrains, seat cushion or the ISOFIX anchorages shall be used, whichever is the most appropriate for the CRS installation.
4.4.	**Q6 Installation**
4.4.1.	Placing the CRS in the vehicle
	a) Place the CRS on the relevant seating position and mark the fore/aft position on the CRS on the side of the CRS and vehicle. Align the CRS with the markings on the vehicle seat cushion and check that there is no interaction between the CRS and side door when it is closed. If there is some interaction, the CRS may be moved inboard by up to 50mm. b) If an ISOFIX CRS is used no markings are needed, the CRS shall be aligned with the anchorages and engaged with the vehicle.
4.4.2.	Placing the Q6 dummy in the vehicle a) Place the dummy in the booster seat and ensure that the suit has not moved in the gap between femur and hip by pulling the suit towards the knees. b) Align the dummy and CRS with the marked centreline. c) Buckle the seatbelt. If the buckle is not accessible because of interaction with the CRS, move the CRS and dummy outboards by the minimum distance (with a maximum of 50mm) required to get free access to the buckle. Remove the slack from the webbing but do not tighten the webbing.

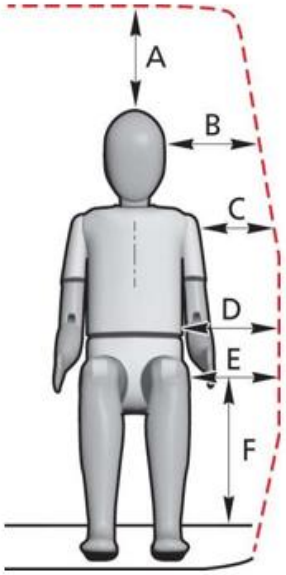
	d) Try to realign the CRS with the marks on the seat cushion. If the CRS cannot easily be aligned with the original marks due to the shape of the vehicle seat or position of the seat belt buckle, then re-mark the new lateral position of CRS relative to vehicle seat e) Ensure that the rear of the CRS is in contact with the seat back by pressing the CRS backwards against the seat and making sure that the fore/aft markings are still aligned. f) Where the rear head restraints interfere with the CRS, they should be repositioned as necessary to avoid this. They may be removed if instructed to do so in the vehicle handbook.
4.4.3.	Q6 dummy positioning
	a) Ensure that the dummy's upper back is in contact with the vehicle seat back if seated on a booster cushion or the back of the CRS if seated in a booster seat. This is done by bending the dummy's back into an upright position and then rocking the dummy sideways while at the same time pushing the pelvis backwards. b) Ensure that the CRS is aligned with the new reference marks. c) Ensure that the dummy is sat on the centreline of the CRS and is not rotated about the vertical axis. d) Push the dummy's shoulders toward the seat back or CRS until either the shoulders contact the seat back or the booster seat back. e) Ensure that the dummy is sitting in an upright position and is aligned with the centreline marks on the head restraint (if applicable) or is parallel to the marks of the centreline. f) Ensure that the CRS position did not change relative to the marked position.
4.4.3.1.	Legs
	a) Position the femurs straight forward with a distance of 150mm ±5mm between the centres of the knees. If the CRS prevents this gap from being achieved, position the knees as close to the target values as possible. b) Where possible, allow the lower legs to rest naturally. The tibias shall be parallel to the vehicle centreline and the feet shall be separated by the same distance as the knees.
4.4.3.2.	Position of the front seat
	Follow the steps detailed in Section 4.2 to establish whether or not the vehicle is considered to be of limited rear space for the Q6. If this is not the case, proceed with the steps below.
4.4.3.3.	Belt routing
	a) Ensure that the lap belt is routed through the belt guidance of the booster seat. b) Remove the slack of the lap belt by pulling on the diagonal belt near the

<table>
<tr><td></td><td>buckle with a force of 150N.
c) Route the diagonal belt through the belt guidance of the booster for boosters with high back. Ensure that the belt is not twisted in the guidance of the booster.
d) The belt shall lie naturally across the chest and be allowed to sit as it falls. A load of 50N shall be applied to the diagonal section of the belt towards the D-loop to achieve a natural and flat belt position across the chest.
e) The use of any non permanent belt guides or clips on either the vehicle or CRS is prohibited.
f) There shall be no tape or stickers applied to the diagonal section of the adult belt.</td></tr>
<tr><td>4.4.3.4.</td><td>Arms</td></tr>
<tr><td></td><td>a) The upper arm shall be positioned parallel to the chest. The measurements shall be taken on the neoprene suit along the front surface of the arm (bicep) and along the IR-TRACC on the chest.
b) Position the lower arms parallel to the upper legs resting on the booster or armrest as close as possible to the side of the femur. The elbows shall be kept as close as possible to the torso.</td></tr>
<tr><td>4.3.3.5</td><td>Dummy Marking</td></tr>
<tr><td></td><td> 

The following measurements are to be carried out prior to test but after positioning procedures have been carried out.
<table>
<tr><th colspan="2">Q6</th></tr>
<tr><td>A</td><td>Top of head to roof (vertically)</td></tr>
<tr><td>B</td><td>Head CoG to door/window (horizontal)</td></tr>
<tr><td>C</td><td>Shoulder (pivot point) to door/window (horizontal)</td></tr>
<tr><td>D</td><td>Lower rib to door (horizontal)</td></tr>
<tr><td>E</td><td>Hip joint (femur mounting hole) to door (horizontal)</td></tr>
<tr><td>F</td><td>Hip joint (femur mounting hole) to floor (vertical)</td></tr>
<tr><td></td><td>Head angle (where fitted)</td></tr>
<tr><td></td><td>Pelvic angle (tilt sensor)</td></tr>
</table></td></tr>
</table>

4.5.	**Q10 Installation**
4.5.1.	Dummy preparation
	a) Attach a foam pad of 125mm x 90mm with a thickness of 20mm ±2mm to the rear of the dummy pelvis, outside the suit, using tape to hold it in place. The pad shall be centred on the midsagittal plane with the upper edge at the same height as the top of the pelvis flesh. b) This pad shall remain on the dummy for the test unless it can be removed without the need to move the dummy. c) The foam pad shall have the following properties: Density of 152-200kg/m^3 Compression deflection 25% of 89-118kPa
4.5.2.	Placing the booster cushion in the vehicle
	a) Place the CRS on the relevant seating position and mark the fore/aft position on the CRS on the side of the CRS and vehicle. Align the CRS with the markings on the vehicle seat cushion and check that there is no interaction between the CRS and side door when it is closed. If there is some interaction, the CRS may be moved inboard by up to 50mm. b) If an ISOFIX CRS is used no markings are needed, the CRS shall be aligned with the anchorages and engaged with the vehicle.
4.5.3.	Placing the Q10 dummy in the vehicle
	a) Place the dummy on the booster cushion and ensure that the suit has not moved in the gap between femur and hip by pulling the suit towards the knees. b) Align the dummy and CRS with the marked centreline. c) Buckle the seatbelt. If the buckle is not accessible because of interaction with the CRS, move the CRS and dummy outboards by the minimum distance (with a maximum of 50mm) required to get free access to the buckle. Remove the slack from the webbing but do not tighten the webbing. d) Try to realign the CRS with the marks on the seat cushion. If the CRS cannot easily be aligned with the original marks due to the shape of the vehicle seat or position of the seat belt buckle, then re-mark the new lateral position of CRS relative to vehicle seat. e) Ensure that the rear of the CRS is in contact with the seat back by pressing the CRS backwards against the seat and making sure that the fore/aft markings are still aligned. f) Where applicable, place the hip shields on the Q10 dummy. Ensure that the distance between the hip shields is no less than 154mm. If needed, a large gap should be used to establish the best fit.

4.5.4.	Q10 dummy positioning
	a) Ensure that the dummy's lower back is in contact with the vehicle seat back by bending the dummy's back into an upright position and then rocking the dummy sideways while at the same time pushing the pelvis backwards. b) Ensure that the booster cushion is aligned with the new reference marks. c) Ensure that the dummy is sat on the centreline of the CRS and is not rotated about the vertical axis. d) Push the dummy's shoulders toward the seat back until either the shoulders contact the seat back or the head is in contact with the head restraint. e) The top of the rear head restraint shall be positioned within ±20mm of the top of the dummy head or in the nearest notch above. If the head restraint cannot be raised sufficiently to be within 20mm, put it in the highest position. f) Ensure that the dummy is sitting in an upright position and is aligned with the centreline marks on the head restraint (if applicable) or is parallel to the marks of the centreline. g) Ensure that the CRS position did not change relative to the marked position.
4.5.4.1.	Legs
	a) Position the femurs straight forward with a distance of 130mm ±5mm between the centres of the knees. If the CRS prevents this gap from being achieved, position the knees as close to the target values as possible. b) Where possible, allow the lower legs to rest naturally. The tibias shall be parallel to the vehicle centreline and the feet shall be separated by the same distance as the knees. c) Record the pelvic angle using the tilt sensor in the test details.
4.5.4.2.	Position of the front seat
	Follow the steps detailed in Section 4.2 to establish whether or not the vehicle is considered to be of limited rear space for the Q10. If this is not the case, proceed with the steps below.
4.5.4.3.	Belt routing
	a) Follow the CRS installation instructions when routing the seat belt and ensure that the belt is routed correctly through any necessary belt guides. b) Remove the slack of the lap belt by pulling on the diagonal belt near the buckle with a force of 150N. c) Ensure that the belt is not twisted in the guidance of the booster cushion. d) The belt shall initially be positioned over the IR-TRACC (upper for Q10) if possible, a load of 50N shall be applied to the diagonal section of the belt in towards the D-loop to achieve a natural and flat position across the chest. The belt may have moved away from the initial position, there is no need for further adjustment.

<table>
<tr><td></td><td>e) The use of any non-permanent belt guides or clips on either the vehicle or CRS is prohibited.
f) There shall be no tape or stickers applied to the diagonal section of the adult belt.</td></tr>
<tr><td>4.5.4.4.</td><td>Arms</td></tr>
<tr><td></td><td>a) The upper arm shall be positioned parallel to the chest. The measurements shall be taken on the neoprene suit along the front surface of the arm (bicep) and between the two IR-TRACCs on the chest.
b) Position the lower arms parallel to the upper legs resting on the booster cushion or armrest as close as possible to the side of the femur. The elbows shall be kept as close as possible to the torso. Where possible, the tip of fingers should be in x-direction in line with the screws of the knee joint. Measure and record the upper arm angle.</td></tr>
<tr><td>4.5.4.5.</td><td>Dummy marking</td></tr>
<tr><td></td><td> 

The following measurements are to be carried out prior to test but after positioning procedures have been carried out.
<table>
<tr><th colspan="2">Q10</th></tr>
<tr><td>A</td><td>Top of head to roof (vertically)</td></tr>
<tr><td>B</td><td>Head CoG to door/window (horizontal)</td></tr>
<tr><td>C</td><td>Shoulder (pivot point) to door/window (horizontal)</td></tr>
<tr><td>D</td><td>Lower rib to door (horizontal)</td></tr>
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<tr><td></td><td>Head angle (where fitted)</td></tr>
<tr><td></td><td>Pelvic angle (tilt sensor)</td></tr>
</table></td></tr>
</table>

5.	**CRS FOR DYNAMIC TESTS**
	• In the Frontal ODB impact, a Q6 child dummy shall be installed on the 2nd row outboard passenger seat behind the driver. A Q10 child dummy shall be installed on the 2nd row outboard passenger seat behind the front passenger. • The Q6 dummy shall be seated in an appropriate forward facing CRS for a six year old child or a child with a stature of 125cm. This will be either the CRS recommended by the vehicle manufacturer, or if there is no recommendation, a suitable CRS from the CRS Installation List will be selected by the Designated Agency. Rearwards facing CRS will not be permitted for the Q6. • The Q10 dummy shall be seated on a booster cushion only. This will be the booster cushion recommended by the vehicle manufacturer. Where the vehicle manufacturer recommends a high back booster with detachable backrest it will be used without backrest. If there is no recommendation for a booster cushion, one will be chosen by the Designated Agency from a list of suitable options from the CRS Installation List. • Where a vehicle is equipped with an integrated CRS covering the Q6 and/or Q10 on the rear outboard 2nd row test positions, the integrated CRS will be used in the dynamic tests. Integrated CRS will be used even if they are optional equipment. • Where a vehicle is equipped with only one integrated CRS on either outboard position covering both or only one of two child ages, the integrated CRS will be used only where applicable.
5.1.	**Marking Q10 and Q6 Child Dummy Head Excursion**
5.1.1.	If applicable, position the rear seats in accordance with the adjustments detailed earlier for the tests.
5.1.2.	Install the H-point machine in accordance with the procedure detailed earlier for the Hybrid III 5th percentile occupant. Mark the H-point location on the vehicle.
5.1.3.	The vehicle should be clearly marked on both sides to define a scale of at least 400 - 600mm (with 50mm increments) forward of the H-point location of the Hybrid III 5th percentile. The intention is that these marks should be clearly visible on the high speed film. Markings shall be applied to the exterior top and waist level of the door as well as inside the car at waist level.
5.1.4.	The 450mm and 550mm excursion lines shall be clearly distinguished from the other markings in some way, for example using a different colour. These lines shall also be marked on the vehicle in locations that are clearly visible to the onboard cameras. Alternatively, it is acceptable for the lines across the vehicle to be superimposed during post film processing.

ANNEXURE IV
VULNERABLE ROAD USER PROTECTION TEST PROTOCOL

TABLE OF CONTENTS

1.	**PEDESTRIAN PROTECTION TEST - VEHICLE PREPARATION**
1.1.	**Unladen Kerb Weight**
1.1.1.	The capacity of the fuel tank will be specified in the manufacturer's booklet. This volume will be referred to throughout as the 'fuel tank capacity'.
1.1.2.	Syphon most of the fuel from the tank and then run the car until it has run out of fuel.
1.1.3.	Refill the fuel tank with fuel (or an equivalent mass of water or other ballast) to its fuel tank capacity.
1.1.4.	Check the oil level and top up to its maximum level if necessary. Similarly, top up the levels of all other fluids to their maximum levels if necessary.
1.1.5.	Ensure that the vehicle has its spare wheel on board or tyre repair kit (if permitted and is provided instead of spare wheel) referred in CMVR 138(3), along with any tools supplied with the vehicle. Nothing else should be in the vehicle.
1.1.6.	Ensure that all tyres are inflated according to the manufacturer's instructions for half load.
1.1.7.	Remove the front vehicle license plate and its holder/brackets if these are removable from the bumper.
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 weight' of the vehicle. Record this weight in the test details.
1.2.	**Additional Weights**
1.2.1.	Put the fore-aft adjustment of both front seats in their mid-positions. If there is no notch at the mid-position, use the first notch immediately rearward.
1.2.2.	Place a 75kg mass on the driver's seat and a 75kg mass on the front passenger's seat.
1.2.3.	Ensure that the front wheels are in the straight ahead position
1.2.4.	If the suspension is adjustable in any way, ensure that the vehicle is at the correct attitude for travelling at 40km/h. See Section 1.4.
1.3.	**Suspension Settling**
1.3.1.	Roll the vehicle forwards by a distance of at least 1 metre.
1.3.2.	Roll the vehicle backwards by a distance of at least 1 metre.
1.3.3.	Repeat steps 1.3.1 and 1.3.2 for three complete cycles. Note: This procedure may be inappropriate for cars which have to be set up as described in Section 1.2.4.
1.3.4.	Measure and record the ride heights of the vehicle at the point on the wheel arch in the same transverse plane as the wheel centres. Do this for all four wheels.
1.4.	**Normal Ride Attitude**
1.4.1.	After following the above procedures the vehicle is in its Normal Ride Attitude when the vehicle attitude is in running order positioned on the ground, with the tyres inflated to the recommended pressures, the front wheels in the straight-ahead

	position, with maximum capacity of all fluids necessary for operation of the vehicle, with all standard equipment as provided by the vehicle manufacturer, with a 75kg mass placed on the driver's seat a 75kg mass placed on the front passenger's seat, and with the suspension set for a driving speed of 40km/h in normal running conditions specified by the manufacturer (especially for vehicles with an active suspension or a device for automatic levelling).
1.4.2.	The manufacturer shall specify the Normal Ride Attitude with reference to the vertical (Z) position of any marks, holes, surfaces and identification signs on the vehicle body, above the ground. These marks shall be selected such as to be able to easily check the vehicle front and rear ride heights and vehicle attitude. If the reference marks are found to be within ±25mm of the design position in the vertical (Z) axis, then the design position shall be considered to be the normal ride height. If this condition is met, either the vehicle shall be adjusted to the design position, or all further measurements shall be adjusted, and tests performed, to simulate the vehicle being at the design position. Where this is not the case, the normal ride height as determined within Section 1.3 will be used.
1.4.3.	All ride heights measured are the Normal Ride Attitude ride heights.
2.	**ASSESSMENT OF VEHICLES WITH DEPLOYABLE SYSTEMS**
2.1.	**Prerequisites to Assessment**
2.1.1.	Prior to the testing and assessment of a vehicle equipped with a deployable system, the vehicle manufacturer must liaise with the Bharat NCAP secretariat and test laboratory. This should begin several weeks before the scheduled test date.
2.1.2.	In order for the systems to be assessed in the deployed position or for the system to be deployed during the tests, it will be necessary for the vehicle manufacturer to provide the Bharat NCAP Secretariat with the relevant detailed information highlighted in the following sections before any testing begins.
2.1.3.	The vehicle manufacturer is responsible for providing all necessary information, detailed in this protocol, to the Bharat NCAP Secretariat regarding detection of pedestrians and the deployment of the system. Based on the evidence provided, the Secretariat will decide whether or not the vehicle qualifies for assessment in either the deployed or undeployed position or if dynamic tests are required.
2.1.4.	General information is also required regarding the functionality of the system along with specific details of the sensing, trigger and deployment systems.
2.1.5.	The vehicle manufacturer must ensure that the test laboratory is given adequate information regarding the replacement of consumable components, system trigger requirements, details of any health hazards and sufficient spare parts to ensure that testing can be performed on schedule.
2.1.6.	Where there is no information, a lack of sufficient information or the system does not meet the Bharat NCAP requirements; the vehicle will be assessed without triggering of the active pedestrian protection elements.
2.1.6.1.	The moveable bonnet top is defined as all structures connected to the bonnet that move with the whole assembly when activated in a pedestrian impact. The rear edge of the bonnet is the most rearward point of the moveable bonnet top when it is closed.

2.2.	**Detection of Pedestrians**
2.2.1.	PDI2 is the default test tool to be used when demonstrating system triggering for the hardest to detect (HTD) pedestrian. Where PDI2 has been used, it will not be necessary for CAE data to be provided justifying the HTD as detailed in 2.2.2. However, head impact times and physical testing will still be required as in 2.2.3 along with the total response time (TRT) of the system. TRT = sensing time (ST) + deployment time (DT).
2.2.2.	Where the vehicle manufacturer believes that the PDI2 is not an appropriate test tool for replicating the HTD pedestrian, they must demonstrate with an alternative tool the sensor system's ability to detect a range of pedestrian statures that result in head contacts with the vehicle. The statures should be selected from a 6 year old child, 5th percentile female, 50th percentile male and 95th percentile male. A combination of physical testing and numerical simulations will be required to demonstrate the suitability of the sensing system for the range of pedestrian sizes.
2.2.2.1.	The numerical simulations will be required to identify the 'hardest to detect' (HTD) pedestrian and support the use of an alternative test tool. The simulations, which must also include the PDI2 responses, will concern the pedestrian statures that result in head contact with the bonnet, as studied and proven in Section 2.3. Head impact times for all statures must be provided regardless of where they contact the vehicle along with the total response time (TRT) of the system. TRT = sensing time (ST) + deployment time (DT).
2.2.2.2.	Minimum of two numerical simulations per appropriate stature (maximum 8 in total) will be required to identify the 'hardest to detect' pedestrian and support the choice of test tool. Pedestrian models should be selected from the different statures specified in Section 2.2.2.
2.2.2.3.	Where other numerical models are to be introduced, then the manufacturer must provide supporting evidence showing suitable biofidelity and kinematics of the chosen models.
2.2.2.4.	The pedestrian stance to be used in the model will be facing in a direction perpendicular to the vehicle centreline with the legs apart walking towards the vehicle centreline with the rearward leg being impacted by the bumper first. The heel to heel distances (P) to be used are: ○ 6YO P = 190 ± 10 mm ○ 5th P = 245 ± 10 mm ○ 50th P = 310 ± 10 mm ○ 95th P = 337 ± 10 mm The same simulation shall be used even if the curvature of the bumper results in the front leg being impacted first.
2.2.2.5.	The models used in the simulations will have the following H-point height above ground when measured in upright standing position with shoes: 95th male: 1040mm ±5% 50th male: 938mm ±5% 5th female: 820mm ±5% 6YO: 610mm ±5%

2.2.2.6.	The frictional value to be applied between the foot and the ground shall be between 0.3±0.1.
2.2.2.7.	The simulations shall be conducted at the system's lower deployment threshold (LT) impact speed specified by the vehicle manufacturer.
2.2.2.8.	The simulations will be conducted at two separate locations on the bumper. For each of the appropriate statures simulations will be performed on the vehicle centreline and at the outboard end of the bumper test zone defined in Section 3.8.2. An additional simulation may be required where the bumper test zone is relatively narrow when compared to the width of the moveable bonnet top.
2.2.2.9.	Outputs from the simulations shall clearly highlight what the critical pedestrian size is for that particular sensing system. Once the hardest to detect pedestrian is established the appropriate test tool that reflects the characteristics of that pedestrian can be identified for use in the physical tests. The minimum output parameters from the numerical simulations will be: ○ Bumper force ○ Effective mass ○ Energy ○ Bumper intrusion ○ Acceleration (when used as trigger)
2.2.2.10.	Effective mass will be calculated as follows. This calculation assumes that peak force on the vehicle occurs when the leg velocity reaches 0m/s: $M_e = \frac{\int_{t_1}^{t_2} F dt}{\Delta v}$ M_e = Effective mass (kg) F = Force (N) Δv = Change in Velocity (m/s) dt = Time increment (s) t_1 = Time of first contact (s) t_2 = Time of peak force (s)
2.2.2.11.	In the event that a system triggers before the peak force is imparted onto the bumper cross member, the following calculation should be used: $M_e = \frac{\int_{t_1}^{t_2} F dt}{\int_{t_1}^{t_2} a dt}$ M_e = Effective mass (kg) F = Force (N) a = Leg acceleration (m/s^2) dt = Time increment (s) t_1 = Time of first contact (s) t_2 = Time of system trigger (s)
2.2.2.12.	For the calculation of effective mass, only movement in the X direction is considered. The most significant structures that load the leg should be considered, such as the bumper cross member and any upper or lower cross beams. Less significant structures, such as grills and valances may be ignored. Viscous effects should be ignored.

2.2.2.13.	Of the outputs specified in Section 2.2.2.10, the most appropriate trigger parameter(s) for the specific type of sensing system shall be used to show an appropriate level of correlation between the chosen test tool and the numerical simulations. Trigger parameters must correspond with the system sensing time. The vehicle manufacturer may choose the impact location and vehicle components for inclusion onto the calculation of the output parameters.
2.2.3.	Physical testing will be used to assess the capability of the sensing system(s). As a surrogate for a pedestrian that is larger/heavier than a 50th percentile male, the legform detailed in Section 9 for legform to bumper tests shall be used. This is to ensure that the system deploys when impacting larger or 'upper limit' pedestrians.
2.2.3.1.	To ensure that the pedestrian impact sensor(s) are effective across the full bumper width, a minimum of three tests shall be performed at locations within the bumper test zone.
2.2.3.2.	Test matrix:

Test	Impactor	Impact point	Speed	Output
1	PDI2/HTD(1)	• Directly on localised sensor e.g. accelerometer ± 50mm. If the sensing system uses a combination of contact strip switches and localised accelerometers, the positions of the accelerometers should be used to define the impact locations. • For non-localised sensor systems, such as contact switches, test the vehicle at the centreline.	LT(2)+/-2km/h	• High speed film • Actuator trigger time • Initiation of deployment
2	PDI2/HTD	Bumper test zone end, left or right hand side, ±50mm.	LT +/-2km/h	
3	PDI2/HTD	Farthest from sensor(s) if not tested already, ±50mm.	LT +/-2km/h	
4(3)	Detailed in Section 9.1 or WG17 impactor to account for larger pedestrians	Directly on localised sensor e.g. accelerometer, ±50mm. For non-localised sensor systems test directly in line with the front longitudinal member to produce the highest acceleration levels on the impactor. This test may be performed using a representative surrogate with equivalent mass and stiffness to prevent damage to instrumentation.	40 +/-2km/h	

	Notes: 1. HTD = Other appropriate hardest to detect pedestrian/stature (as defined by section 2.2.2); 2. LT = Lower deployment Threshold. 3. The impactor for test 4 may be chosen by the vehicle manufacturer.
2.2.3.3.	Where a test is performed below the lower threshold speed but within the velocity tolerance or outside the bumper test zone and the system does not deploy, the test must be repeated at a speed no less than the lower threshold and not outside the bumper test zone.
2.2.3.4.	The outputs from all physical tests shall include, but is not limited to: • Good quality high speed film showing an overview of the test. • Documentation of the correct test location, e.g. using paint marks and post test photographs. • Documentation of test speed (vehicle or impactor as applicable), e.g. using known road markings or speed measurement systems etc. • Actuator trigger time (current clamp/ECU). • Evidence of system deployment initiation, i.e. film showing the first movement of the bonnet top or frangible break wires/contacts/squibs.
2.2.3.5.	The first physical test, or tests, must be performed with the pedestrian protection system fully functional from the sensing systems to the bonnet actuators/airbag squibs. At the same time, it is acceptable to include an additional means of highlighting deployment, such as flashes and/or squibs for that first test. Once a valid firing time and system deployment has been confirmed, the remaining tests may then be performed with the flashes/squibs connected in place of the bonnet actuators or airbag; thus negating the need for deployment. The entire system architecture should be present up to the bonnet actuators/airbag for all tests. Flashing hazard warning lights or other indications that are not connected to the actuator wiring system will not be accepted.
2.3.	**Timing of System Deployment**
2.3.1.	Grid points that are not affected by the active system will be tested statically.
2.3.2.	Where the manufacturer has demonstrated, by numerical simulations or alternative means (vehicle speed of 45km/h), that a system is fully deployed and remains in the intended position prior to the head impact time of the smallest appropriate stature pedestrian, as defined in Section 2.2.1, then all headform tests shall be performed with the bonnet in the fully deployed position. There will be no need to trigger any active elements during the sub system pedestrian tests. This does not apply to airbag systems.
2.3.3.	However, where the system is not fully deployed before the HIT for any certain stature, all grid points forwards of the corresponding wrap around distance will be tested dynamically. The plot of wrap around distance vs head impact time shall be provided for all vehicles, see Figure 24.
2.3.4.	For systems that do not remain in a permanently deployed position ~~then~~ dynamic pedestrian testing will be required for all test locations.

2.3.5.	The simulations shall be performed using the same CAE model/code and the same pedestrian stance detailed in Section 2.2.1, positioning the pedestrian on the vehicle centreline.
2.3.6.	The vehicle manufacturer must determine the wrap around distance for each test location and establish the relevant head impact time for that stature of pedestrian.
2.3.7.	Further details on performing dynamic tests are provided in Section 8.5.
2.4.	**Protection at Speeds below the Deployment Threshold**
2.4.1.	Exemption zones
2.4.1.1.	Bharat NCAP maintains that vehicles that offer protection without a deployable device, offer protection at lower speeds and some protection at higher speeds. Therefore, Bharat NCAP requires that vehicles equipped with deployable pedestrian protection systems also provide protection at impact speeds below the system deployment threshold on the part of the vehicle affected by the deployable pedestrian protection system.
2.4.1.2.	The area of the vehicle considered will be all grid points that have a distance measured in the lateral Y axis of 50mm or more inboard from the side reference lines and 50mm or less measured in the lateral Y axis outboard from the movable bonnet shut line. See Figure 1.
2.4.1.3.	The area will also extend rearward from the 1000mm wrap around distance (WAD) up to the rear of the movable bonnet top defined in 2.1.7. Child/small adult headforms will apply to grid points from wrap around distances 1000mm to 1700mm both WADs inclusive and adult headforms will apply to grid points rearward beyond from 1700mm up to the rear of the movable bonnet top. See Figure 1.
2.4.1.4.	Where parts of the movable bonnet are to be tested in the deployed position e.g. based on head contact time, and others are not, the area of consideration will include all grid points that are located between the rear of the movable bonnet top and 50mm forward or less from the most forward part of the bonnet that will be tested in the deployed position. See Figure 1.
2.4.1.5.	The vehicle manufacturer is required to provide the Designated Agency HIC15 or colour data showing that, at the lower deployment threshold speed, no grid point within the area mentioned above that is predicted green, yellow or orange at 40km/h shall produce HIC values above 1350 at the lower deployment threshold.
2.4.1.6.	For no less than 2/3rds of the total number of grid points within the prescribed area, HIC values must not exceed 1000.
2.4.1.7.	Data shall be provided for each grid point according to the following performance criteria: HIC15 < 1000 = Yellow 1000 < HIC15 < 1350 = Orange
2.4.1.8.	Up to three physical tests may be performed to verify the CAE data at just below the deployment threshold speed. These tests will be selected at random by the Designated Agency.

2.4.1.9.	Where any of the criteria in Section 2.4.1.5to 2.4.1.7 are not met then all pedestrian tests will be performed with the system in the undeployed position.

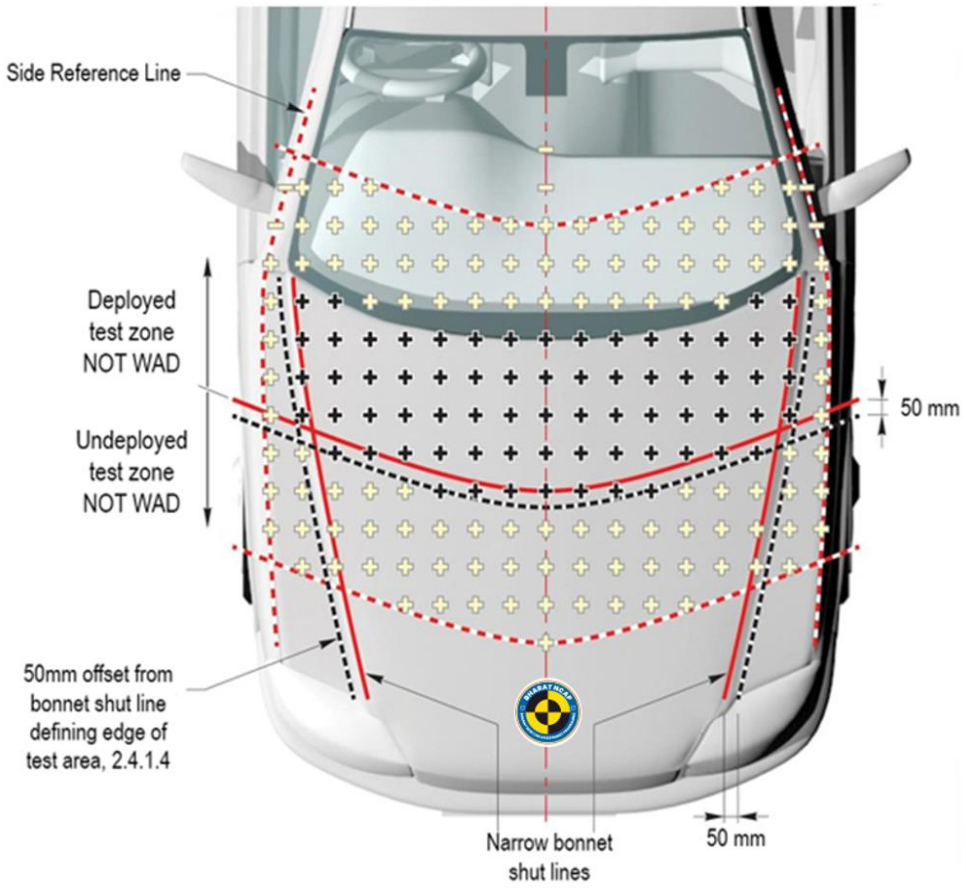


Figure 1: Area to meet low speed requirements

2.5.	**Protection at Higher Impact Speeds**
2.5.1.	Upper deployment threshold
2.5.1.1.	All deployable systems must initiate deployment at speeds of at least 50km/h. It is not necessary for a system to be fully deployed and reach the intended position before head impact at 50km/h
2.5.1.2.	A physical test using the impactor chosen in Section 2.2 is required at 50km/h to show that deployment has initiated. The outputs from the test are as those described in Section 2.2.3.5.
2.5.1.3.	The test shall be performed at either the vehicle centreline or, if localised sensors used, as far away from the sensor as a possible while remaining within the bumper test zone.

2.6.	**Bonnet Deflection due to Body Loading**
2.6.1.	Given that deployable bonnets may have reduced support from their peripheral structures compared to passive systems, Bharat NCAP requires that head protection is not compromised by bonnet collapse.
2.6.1.1.	This is done by measuring and comparing the Z displacement at the position of head contact for both a deployed and undeployed bonnet at the time of first head contact. At the position of head impact the difference between deployed and undeployed bonnet can be no more than 75% of the generated deployment height at that point, see Figure 2.
2.6.1.2.	The evaluation shall be calculated with the use of CAE without the 'package' being present. The package meaning of engine and ancillaries. All body in white structures and bonnet supports must be present. However, all components that load the legs and pelvis must be included.
2.6.1.3.	At the point of head impact, it is essential that the bonnet deflection in the deployed state does not exceed the total available clearance between deployed bonnet and under bonnet hard point, i.e. (h2 + h3) - z2 > 0, see Figure 3.
2.6.1.4.	This would be established using numerical simulations at 40km/h with the appropriate sized pedestrian that loads the least supported part of the bonnet top for that particular size of vehicle. For example, on a small vehicle with a short bonnet it may be that the 50th percentile male contacts the vehicle rearward of the bonnet top. Therefore, a smaller pedestrian stature will be required.
2.6.1.5.	The stance described in Section 2.2.2.5 shall be used positioning the pedestrian's head on the vehicle centreline. *Note: Impacts at the centreline were chosen to simplify ~~to~~ the modelling needed and to avoid the possibility of glancing blows. It is also assumed there will be the least support to the bonnet at the centreline.*

2.6.1.6.

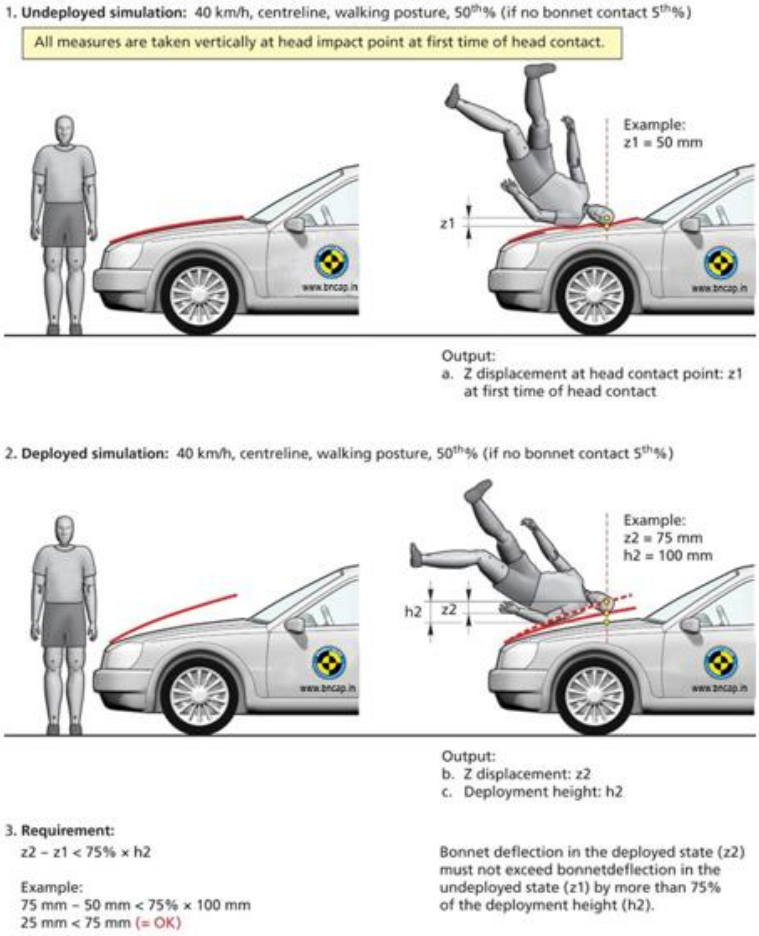


Figure 2: Bonnet deflection deployed and undeployed comparison

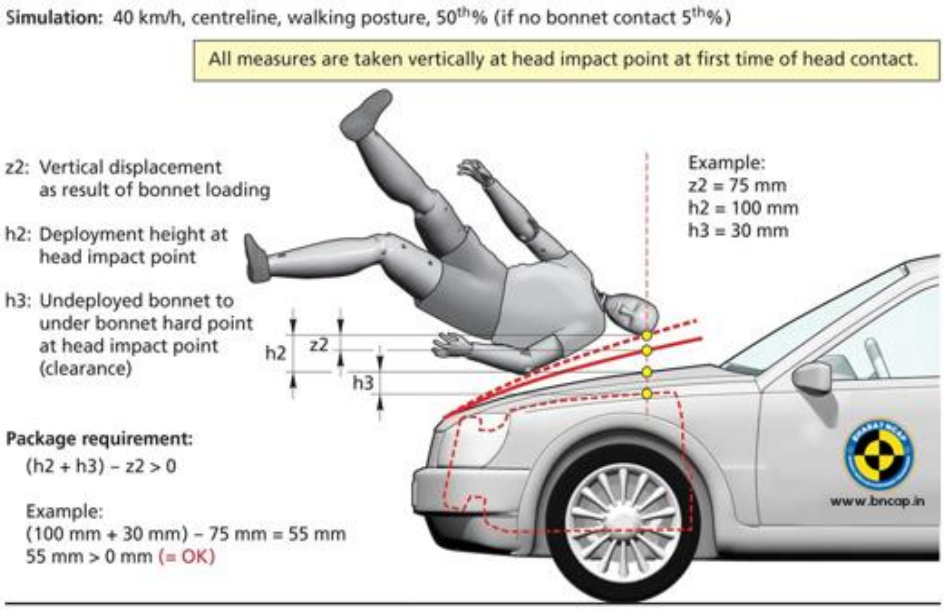
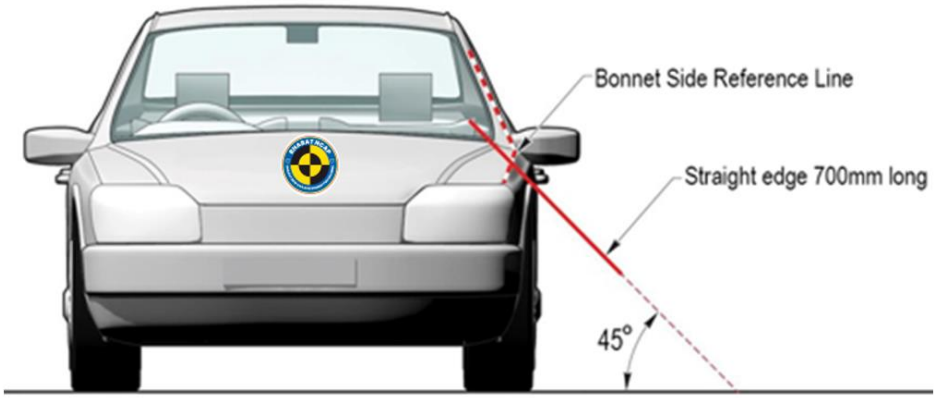
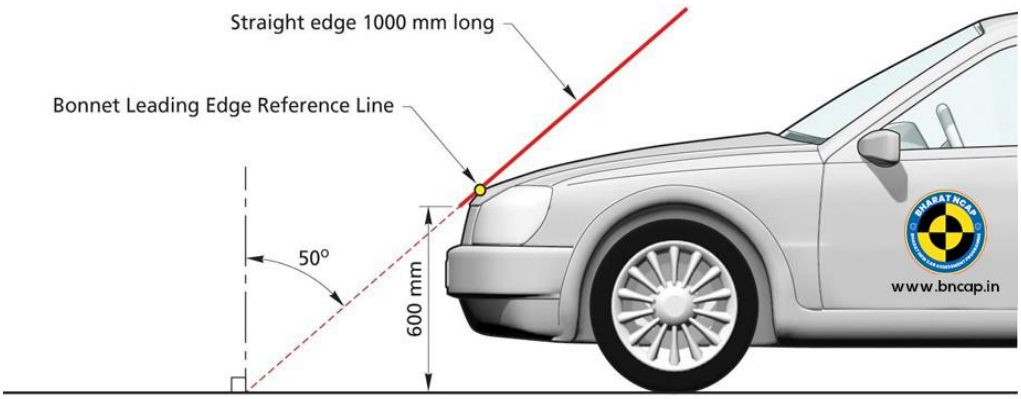
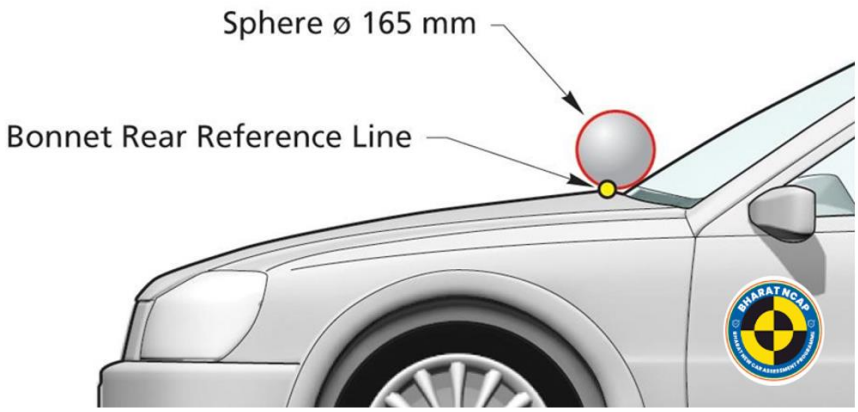


Figure 3: Bonnet deflection total clearance requirement

3.	**VEHICLE MARKING**
3.1.	**General**
3.1.1.	The vehicle shall be marked with a grid as described in the following sections. The marking procedures divide the front of the car into zones which are then assessed using appropriate impactors.
3.1.2.	Where no predicted data is to be provided by the vehicle manufacturer, the testable area shall be marked as described in the Section below
3.1.3.	All markings and measurements should be made with the vehicle in its Normal Ride Attitude.
3.1.4.	The vehicle manufacturer must provide Bharat NCAP with coordinates of all grid points derived from either CAE data or a physical mark out.
3.1.5.	A comparison of the grid origin C0,0 and two other points on the 2100WAD, line will be made between the laboratory mark out and the data provided by the vehicle manufacturer. For manufacturer predicted data to be accepted, grid points must be within 10mm of each other.
3.1.6.	Where the grid points of Bharat NCAP and the vehicle manufacturer are within 10mm of each other the laboratory mark-out shall be used.
3.1.7.	Where the two grids differ by more than 10mm the vehicle manufacturer shall be informed and both markings will be examined in greater detail to establish the cause of any differences. The Secretariat will then take a decision as to how to proceed with vehicle marking.
3.1.8.	The vehicle manufacturer must provide data for all headform grid locations. Testing will be carried out by Bharat NCAP at a number of locations to verify the accuracy of data provided by the vehicle manufacturer.
3.1.9.	For vehicles fitted with deployable systems, the headform impactor marking will be applied to the vehicle with the system in the undeployed state. This will be the case regardless of whether or not the bonnet is locking or non-locking or the vehicle uses an airbag.
3.1.10.	For vehicles fitted with deployable systems, the WAD775mm and WAD930mm will be marked on the vehicle with the system in the un-deployed state. If deployment occurs prior to the pedestrian contact with the WAD775mm, creating an increased hazard such as increased height, the Bharat NCAP secretariat will give consideration to marking out the WAD775 and WAD930mm in the deployed state. Note: Marking in the undeployed state was chosen to avoid the possibility of discontinuities in the test areas leading to anomalies or inconsistencies in the test results.
3.1.11.	Where the vehicle manufacturer provides data showing that a deployable system offers protection to the upper leg, the upper legform tests will be carried out by conducting dynamic tests. The WAD775mm and WAD930mm will be marked on the vehicle in the deployed position.
3.1.12.	In case of any gaps in the relevant markup areas of the vehicle front such as WAD 930 and the internal bumper reference line, e.g. in the grille area, approximate the outer contour of the vehicle using tape to span these gaps. Between the lower bumper reference line and the BLE, create a wrap around up to the BLE. All measurements and markings shall be placed on this tape. In case of any doubt on

	how to place the tape use the WAD marking procedure, i.e. the covering tape is placed like the tape measure during WAD marking.
3.2.	**Bonnet Side Reference Line**
	The Bonnet Side Reference Line is defined as the geometric trace of the highest points of contact between a straight edge 700mm long and the side of a bonnet, as defined in Section 3.3.1 and A-Pillar, when the straight edge, held parallel to the lateral vertical plane of the car and inclined inwards by 45° is traversed down the side of the bonnet top and A-Pillar, while remaining in contact with the surface of the body shell, any contact with door mirrors is ignored. See Figure 4. Where multiple or continuous contacts occur the most outboard contact shall form the bonnet side reference line.  Figure 4: Determination of the bonnet side reference lines
3.2.1.	Fix a straight edge that is 700mm long at 45° to the vertical. With this edge in a plane parallel to the lateral vertical plane of the car, position the straight edge at the front of the front wing and in contact with, the bonnet.
3.2.2.	Mark the uppermost point of contact of the straight edge and wing.
3.2.3.	Pull the straight edge away from the wing, move it towards the other end of the vehicle by not more than 100mm and then back into contact with the wing.
3.2.4.	Mark the uppermost point of contact of the straight edge and wing.
3.2.5.	Repeat Sections 3.2.3 to 3.2.4 moving the edge along the length of the wing, A-Pillar and Cant Rail if required (depending on the anticipated position of the 2100 Wrap Around Distance).
3.2.6.	Using a flexible rule, join the marks on the vehicle to form a line. This line may not be continuous but may ‘jump’ around the wing/wheel arch.
3.2.7.	Repeat for the other side of the vehicle.
3.2.8.	A partial modification of the side reference lines may be necessary subsequent to the determination of the corner reference points according to Section 3.6.2.

3.3.	**Bonnet Leading Edge Reference Line**
	The Bonnet Leading Edge Reference Line is defined as the geometric trace of the points of contact between a straight edge 1000mm long and the front surface of the bonnet, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 50° from the vertical and with the lower end 600mm above the ground, is traversed across and in contact with the bonnet leading edge, see Figure 5. For vehicles having the bonnet top surface inclined at 50°, so that the straight edge makes a continuous contact or multiple contacts rather than a point contact, determine the reference line with the straight edge inclined rearwards at an angle of 40° from the vertical. For vehicles of such shape that the bottom end of the straight edge makes first contact with the vehicle, then that contact is taken to be the bonnet leading edge reference line, at that lateral position. For vehicles of such shape that the top end of the straight edge makes first contact with the vehicle, then the geometric trace of 1000mm wrap around distance, will be used as the Bonnet Leading Edge reference line at that lateral position. The top edge of the bumper shall also be regarded as the bonnet leading edge, if it is contacted by the straight edge during this procedure.  Figure 5: Determination of the Bonnet Leading Edge Reference Line
3.3.1.	The bonnet leading edge is defined as the front upper outer structure including the bonnet and wings, the upper side members of the headlight surround and any other attachments.
3.3.2.	Fix a straight edge that is 1000mm long at an angle 50° to the vertical and with its lower end at a height of 600mm. If the top surface of the bonnet is inclined at 50°, such that the straight edge makes a continuous contact or multiple contacts rather than a point contact, determine the reference line with the straight edge inclined rearwards at an angle of 40°. With this edge in a plane parallel to the vertical longitudinal plane of the car, position the straight edge at one end of, and in contact with, the bonnet.
3.3.3.	Mark the point of contact of the straight edge and bonnet.
3.3.4.	If the bottom end of the straight edge makes first contact then mark this point of contact.

3.3.5.	If the top end of the straight edge makes first contact behind the 1000mm Wrap Around Distance, then use the geometric trace of the 1000mm Wrap Around Distance at that lateral position.
3.3.6.	Pull the straight edge away from the bonnet, move it towards the other end of the bonnet by not more than 100mm and then into contact with the bonnet.
3.3.7.	Mark the point of contact of the straight edge and bonnet.
3.3.8.	Repeat Sections 3.3.4 to 3.3.7 across the whole width of the bonnet. Using a flexible rule, join the marks on the bonnet to form a line. This line may not be continuous but may 'jump' around the grill and badge area etc. This line is the Bonnet Leading Edge Reference Line.
3.4.	**Bonnet Rear Reference Line**
	The Bonnet rear reference line is defined as the geometric trace of the most rearward point of contact between a 165mm sphere and the frontal upper surface, when the sphere is traversed across the frontal upper surface, while maintaining contact with the windscreen.
3.4.1.	Remove the wiper blades and arms.
3.4.2.	Place a 165mm sphere at the vehicle centreline on the frontal upper surface so that the rearmost point of contact of the sphere is always on the glass.
3.4.3.	Mark the most forward point of contact between the sphere and the vehicle's frontal upper surface. Repeat this at suitable increments moving outboard until the sphere contacts the side reference line on both sides of the vehicle. See Figure 6.  Figure 6: Determination of the bonnet rear reference line
3.4.4.	If the bonnet rear reference line is located at a wrap around distance of more than 2100mm, the bonnet rear reference line is defined by the geometric trace of the 2100mm wrap around distance.
3.4.5.	Where the bonnet rear reference line and side reference line do not intersect, the bonnet rear reference line is extended and/or modified using a semi-circular template, of radius 100mm. The template shall be made of a thin flexible sheet material that easily bends to a single curvature in any direction. The template shall,

	if possible, resist double or complex curvature where this could result in wrinkling. The recommended material is a foam backed thin plastic sheet to allow the template to 'grip' the surface of the vehicle.
3.4.6.	The template shall be marked up with four points 'A' through 'D', as shown in Figure 7, while the template is placed on a flat surface. The template shall then be placed on the vehicle with Corners 'A' and 'B' coincident with the side reference line. Ensuring these two corners remain coincident with the side reference line, the template shall be slid progressively rearwards until the arc of the template makes first contact with the bonnet rear reference line. Throughout the process, the template shall be curved to follow, as closely as possible, the outer contour of the vehicle's bonnet top, without wrinkling or folding of the template. If the contact between the template and bonnet rear reference line is tangential and the point of tangency lies outside the arc scribed by points 'C' and 'D', then the bonnet rear reference line is extended and/or modified to follow the circumferential arc of the template to meet the side reference line, as shown in Figure 7.
3.4.7.	If the template does not make simultaneous contact with the side reference line at points 'A' and 'B', and tangentially with the bonnet rear reference line, or the point at which the bonnet rear reference line and template touch lies within the arc scribed by points 'C' and 'D', then additional templates shall be used where the radii are increased progressively in increments of 20mm, until all the above criteria are met.
3.4.8.	Once defined, the modified bonnet rear reference line is assumed in all subsequent paragraphs and the original ends of the line are no longer used.
3.4.9.	Replace the wiper arms and blades.

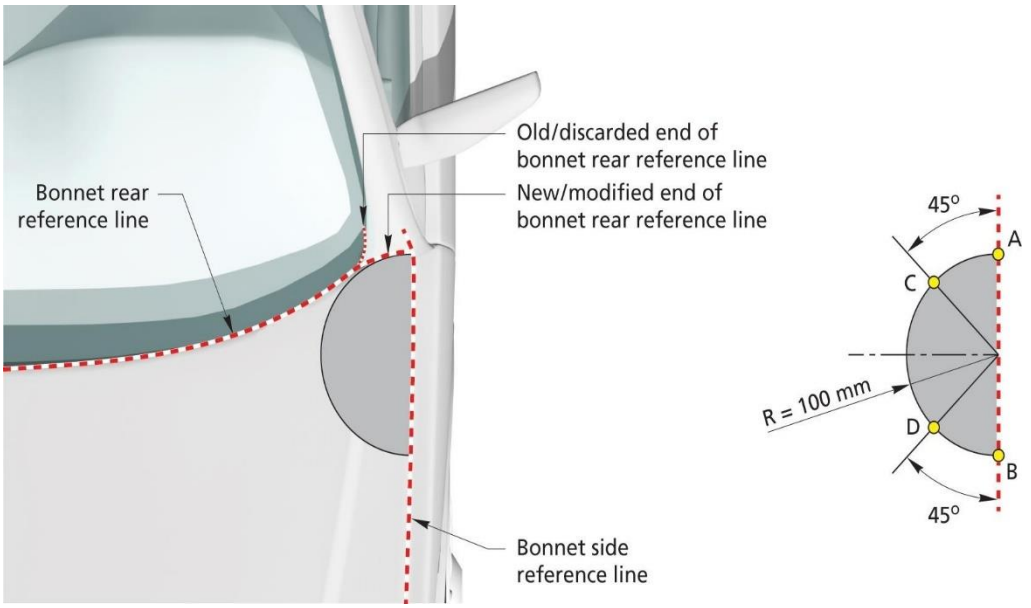
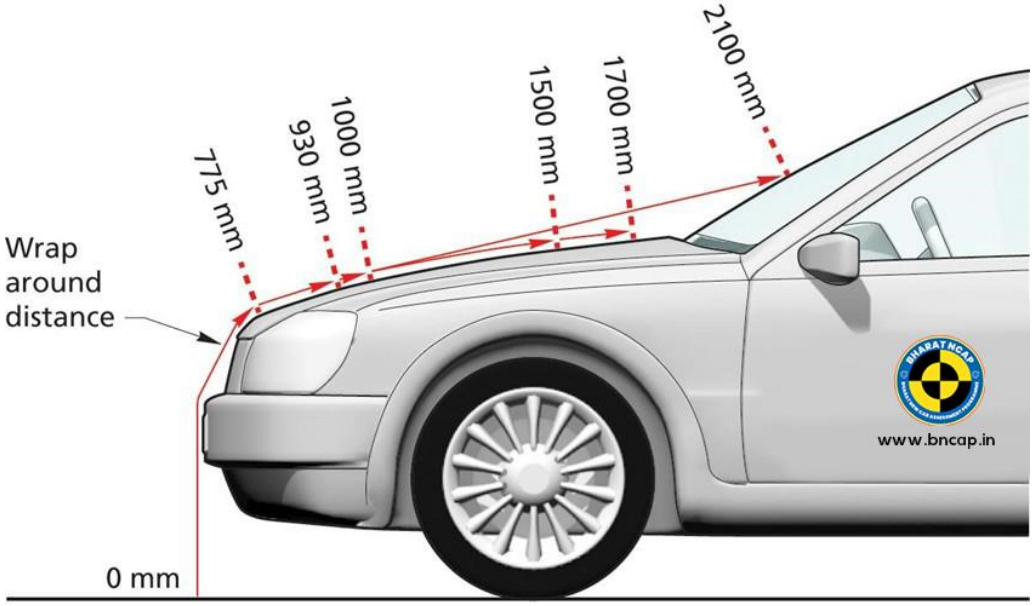
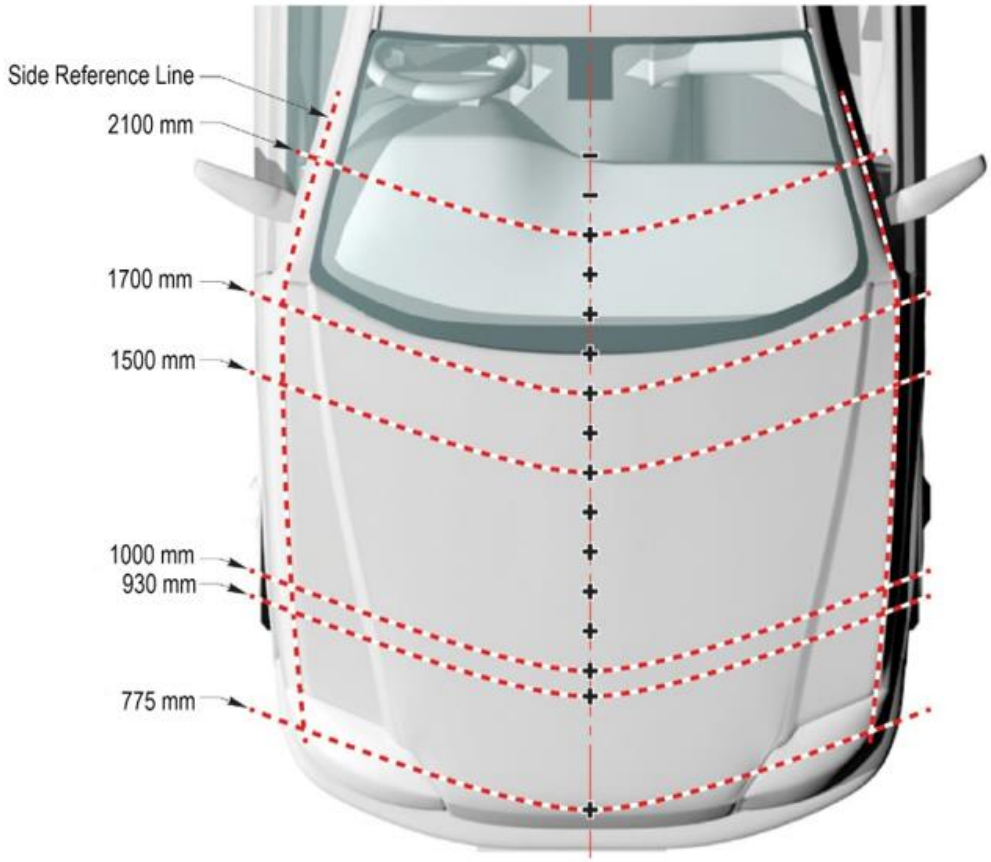
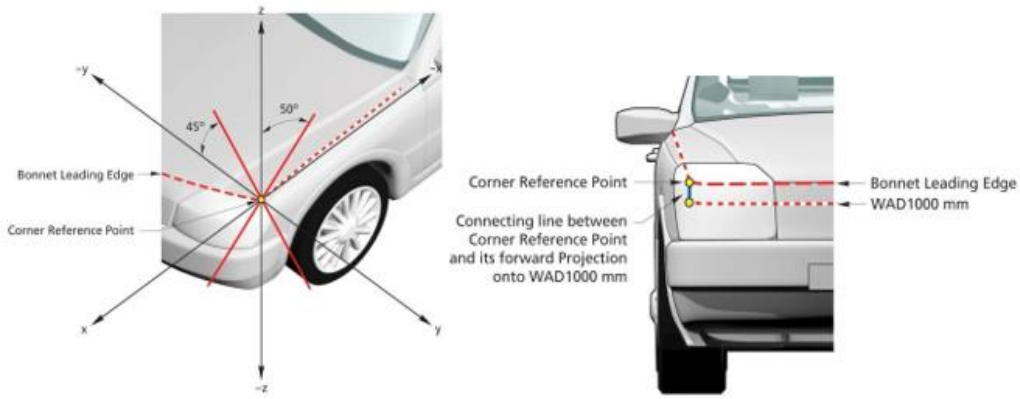
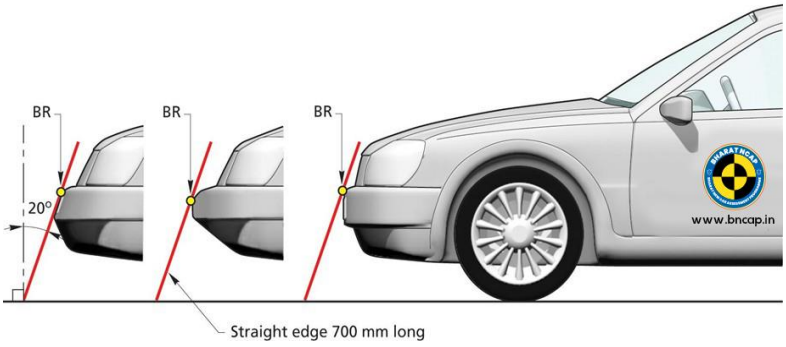
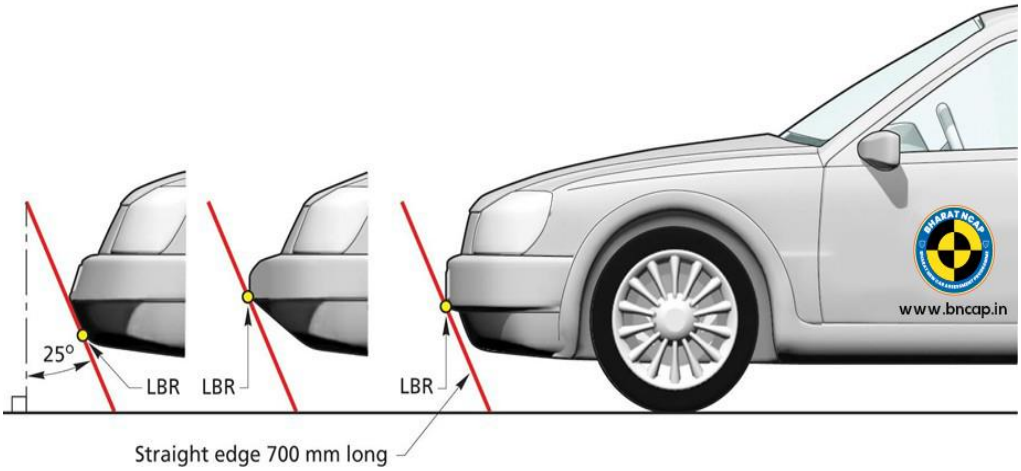


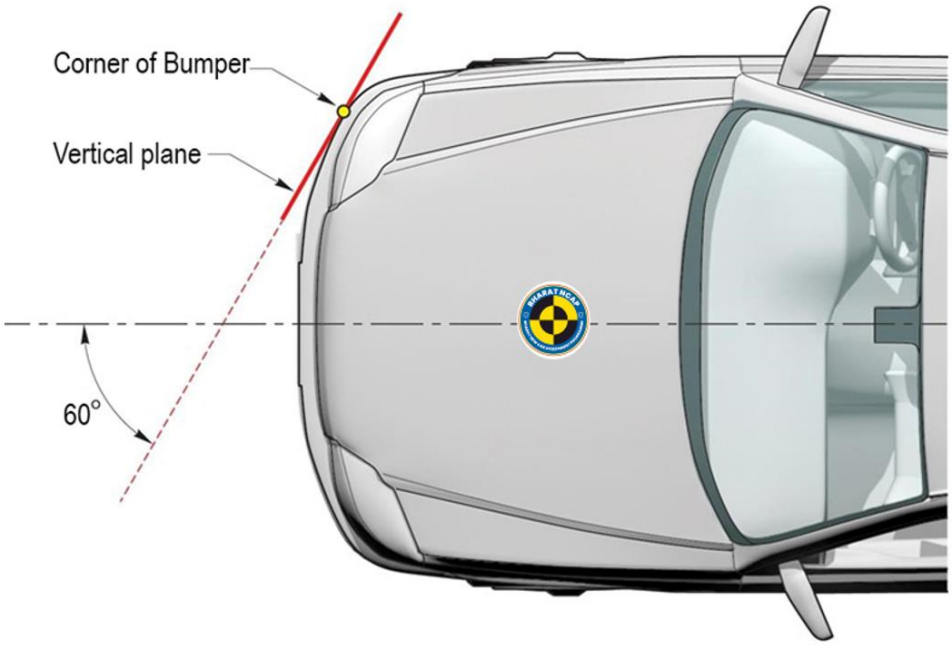
Figure 7: Bonnet rear reference line template and extension

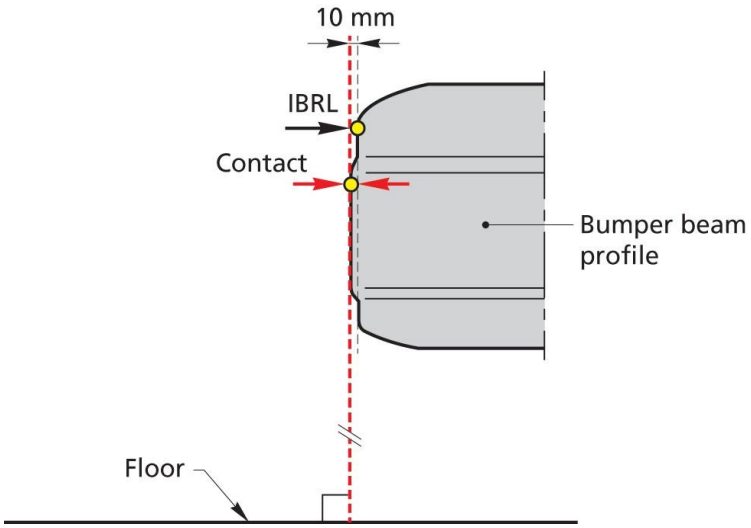
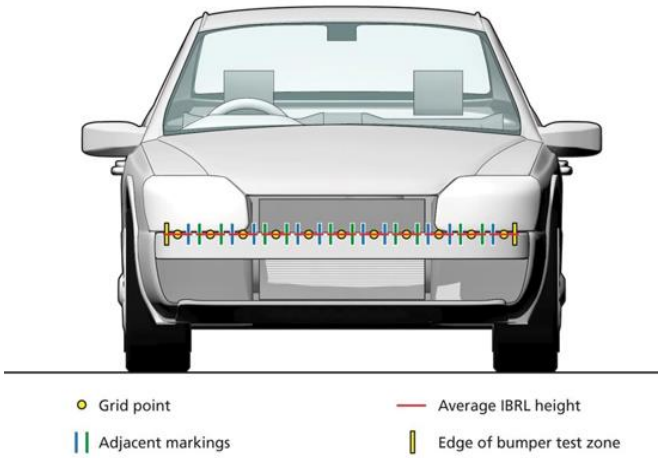
3.5.	**Marking Wrap Around Distances (WAD)**
	The headform test area is defined as the outer structure that includes the upper surface of all outer structures. It includes, but is not limited to, the bonnet, wings, windscreen scuttle, wiper arms/spindles, windscreen frame, A-pillars and roof. It is bounded by the geometric trace of the 1000mm wrap around line in the front, the Bonnet Side Reference Lines and the 2100mm wrap around distance (WAD).
3.5.1.	Begin at the vehicle centreline.
3.5.2.	Place the end of a flexible tape measure or graduated wire on the floor vertically below the front face of the bumper.
3.5.3.	Wrap the tape or wire over the bumper, bonnet windscreen and roof ensuring that it is maintained in a vertical longitudinal (X, Z) plane and that its end is still in contact with the ground. The tape should be held taut throughout the operation, vertically below the front face of the bumper, see Figure 8.  Figure 8: Marking wrap around lines
3.5.4.	Mark on the bumper/grille, bonnet top, windscreen, A-pillars and/or roof the wrap around distances of 775mm, 930mm, 1000mm, 1500mm, 1700mm and 2100mm. These are the geometric traces described on the outer surface of the vehicle by the end of flexible tape or wire 775mm, 930mm, 1000mm, 1500mm, 1700mm or 2100mm long, when it is held in a vertical fore/aft plane of the vehicle and traversed across the front of the bonnet and bumper.
3.5.5.	Where any of the WAD's lie below the outer contour of the vehicle, for example in the gap behind the bonnet, using the tape or wire approximate the outer contour of the vehicle horizontally rearward from the last point of contact and project the WAD vertically down onto the underlying structure.
3.5.6.	Reposition the end of the tape on the ground no further than 100mm laterally outboard starting at the vehicle centreline up to the Corner of Bumper. The tape should be stretched over the A-pillars where necessary.

3.5.7.	Repeat steps 3.5.2 to 3.5.6 until the width of the vehicle has been marked up to the Side Reference Lines.
3.5.8.	Join the points marked on the bonnet to form lines at wrap around distances of 775mm, 930mm, 1000mm, 1500mm, 1700mm and 2100mm. Points located from WADs 1000mm to 1500mm, both WADs inclusive, will be assessed using the child/small adult headform. Points from 1700mm to 2100 mm WAD inclusive will be assessed with the adult headform, see Figure 9.
3.5.9.	Where the bonnet rear reference line is between 1500mm and 1700mm WAD, points forward of and directly on the bonnet rear reference line will be assessed using the child/small adult impactor. Where the BRRL is rearward of 1700mm WAD, the child/small adult headform shall be used up to and including 1700mm. Points rearward of the bonnet rear reference line between 1500mm and 1700mm WAD will be assessed using the adult impactor.  Figure 9: Headform test area
3.6.	**Corner Reference Point**
	The Corner Reference Point is defined as the intersection of the Bonnet Leading Edge reference line (Section 3.3) and the Bonnet Side reference line (Section 3.2), see Figure 10. Where multiple or continuous contacts occur the most outboard contact shall form the corner reference point.

3.6.1.	The corner reference point shall be transferred forwards onto the WAD775mm at the same distance from the vehicle centreline.
3.6.2.	In case of the corner reference point being located rearwards of the WAD 1000 mm, a line connecting the corner reference point and its forward projection onto the WAD 1000 mm at the same distance from the vehicle centerline shall replace the section of the side reference line which is located forwards of the corner reference point.  Figure 10: Determination of the corner reference point
3.7.	**Bumper Reference Lines**
3.7.1.	Upper Bumper Reference Line For vehicles with an identifiable bumper structure the upper Bumper Reference Line is defined as the geometric trace of the uppermost points of contact between a straight edge and the bumper, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 20 degrees, is traversed across the front of the car whilst maintaining contact with the upper edge of the bumper. For a vehicle with no identifiable bumper structure it is defined as the geometric trace of the uppermost points of contact between a straight edge 700 mm long and the bumper, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined rearwards by 20 degrees, is traversed across the front of the car, whilst maintaining contact with the ground and the surface of the bumper. See Figure 11.  Figure 11: Determination of upper bumper reference line

3.7.1.1.	With a 700mm straight edge fixed at 20° to the vertical and in a plane parallel to the vertical longitudinal plane of the car, position the straight edge at one end of, and in contact with, the bumper and the ground. The straight edge may be shortened to avoid contact with structures above the bumper, the straight edge may also be lengthened to reach the bumper.
3.7.1.2.	Mark the uppermost point of contact of the straight edge and bumper.
3.7.1.3.	Pull the straight edge away from the bumper, move it towards the other end of the bumper by not more than 100mm and then into contact with the bumper.
3.7.1.4.	Mark the uppermost point of contact of the straight edge and bumper.
3.7.1.5.	Repeat Sections 3.7.1.3 along the whole of the length of the bumper.
3.7.1.6.	Using a flexible rule, join the marks on the bumper to form a line. This line may not be continuous but may 'jump' around the licence plate area etc. This line is the Upper Bumper Reference Line (UBRL).
3.7.2.	Lower Bumper Reference Line The Lower Bumper Reference Line (LBRL) also needs to be marked on the vehicle. This line identifies the lower limit to significant points of pedestrian contact with the bumper. It is defined as the geometric trace of the lowermost points of contact between a straight edge 700mm long and the bumper, when the straight edge, held parallel to the vertical longitudinal plane of the car and inclined forwards by 25º. It is traversed across the front of the car, while maintaining contact with the ground and with the surface of the bumper; see Figure 12.
3.7.3.	Proceed as per Sections 3.7.1.2 to 3.7.1.6 this line is the Lower Bumper Reference Line.  Figure 12: Determination of the Lower Bumper Reference Line

3.8.	**Bumper Corners, Bumper Test Zone and Internal Bumper Reference Line**
3.8.1.	Bumper Corners The Corner of Bumper is the point of contact of the vehicle with a vertical plane which makes an angle of 60° with the vertical longitudinal plane of the car and is tangential to the outer surface of the bumper, see Figure 13. Where multiple or continuous contacts occur the most outboard contact shall form the bumper corner.  Figure 13: Determination of bumper corner
3.8.1.1.	Fix a 700mm straight edge at 60° to the longitudinal direction of the car. With this edge horizontal move it into contact with the most forward part of the bumper.
3.8.1.2.	Mark the point of contact between the straight edge and the bumper. This is the Bumper Corner.
3.8.1.3.	If the bumper is angled at 60°, so that the straight edge makes a continuous contact or multiple contacts rather than a point contact, the outermost point of contact shall be the Bumper Corner.
3.8.1.4.	Repeat for the other side of the vehicle.
3.8.2.	Bumper test zone Mark a line across the bumper face at a vertical height of 520mm above ground reference level.
3.8.2.1.	Remove the plastic bumper cover and any associated components such as padding and energy absorbers.
3.8.2.2.	Identify the outermost ends of the bumper beam/lower rails/cross beam structures.
3.8.2.3.	The bumper test zone is defined as either the area limited by the bumper corners or the outermost ends of the bumper beam/lower rails/cross beam structures, whichever is larger.
3.8.2.4.	Record the distance from the vehicle centreline to the end of the bumper test zone.

3.8.3.	To mark the internal bumper reference line (IBRL):
3.8.3.1.	Measure the height of the bumper from a vertical plane contacting the beam up to 10mm into the profile to get the internal bumper reference line height at 100mm intervals outboard of the vehicle centreline. See Figure 14: Marking IBRL height.  **Figure 14: Marking IBRL height**
3.8.3.2.	For every upper legform grid point outboard of the bumper beam, use the average bumper beam height allocated to the outermost grid point on the bumper beam as defined in 3.8.3.3.
3.8.3.3.	Divide the area between each 100mm mark into three areas of equal width. If the bumper beam extends by 33.3mm or more outboard of the outermost 100mm grid point, mark the distance of 33.3mm on the bumper beam. Take the average height of each 100mm mark and the adjacent two marks. The height at each 100mm interval is the average height of the 100mm mark and adjacent divisions, see Figure 15. If the end of the bumper beam is less than 33.3mm outboard of the outermost grid point, the average height is taken from the height of the grid point and the inboard adjacent mark only.  **Figure 15: IBRL height at 100mm intervals**

3.8.3.4.	Replace the bumper components and mark both outermost ends of the bumper beam/lower rails/cross beam structures.
3.8.3.5.	Transfer the averaged height of the beam calculated at each 100mm interval on the bumper beam onto the external bumper face.
3.8.3.6.	The internal bumper reference line is then constructed using the heights marked on the bumper face in 3.8.3.5up to a maximum height above ground reference level of 520mm. Where there are locations above 520mm, the internal reference line will be limited to no more than 520mm above ground reference level for those locations.
3.9.	**Marking Headform Impact Area Grid Points**
3.9.1.	Mark the longitudinal centreline of the vehicle on the bumper/grille, bonnet top, windscreen and roof.
3.9.2.	Mark Wrap Around Distances (not lines) on the centreline only at 100mm intervals. Start from Wrap Around Distance 1000mm and end at Wrap Around Distance 2100mm. For vehicles with a V-shaped front end it may also be necessary to mark additional Wrap Around Distances of 2200mm, 2300mm, etc. See Figure 16.
3.9.3.	Starting at one of the wrap around distance marks at the centreline, mark grid points every 100mm in both lateral directions up to the side reference lines. The 100mm distances are measured horizontally in a lateral vertical plane through the respective centreline mark and projected vertically onto the vehicle surface. Where a vehicle has the WAD 1000 mark on the vehicle centreline forward of the Bonnet Leading Edge Reference Line and having the forward angle being more than 60° to the ground reference level the distances are projected horizontally onto the vehicle surface. The forward angle is defined as the angle to the ground reference level, of a straight line connecting the WAD 1000 mark on the centreline with the intersection point of the Bonnet Leading Edge Reference Line and the centreline. The angle designated by the manufacturer may be deemed as the forward angle if it deviates within ±2° from the actual measurement. If due to the horizontal projection two grid points have a distance of less than 50 mm to each other, the horizontal projected grid point will be deleted. The distance shall be measured with a tautly held flexible tape.
3.9.4.	Repeat step 3.9.3 for every wrap around distance on the vehicle centreline until the entire headform impact area is marked with grid points. Depending on the shape of the vehicle, (e.g. V-shaped vehicle front end) it may be necessary to also use the wrap around distance points at 2200mm, 2300mm, etc. See Figure 16.
3.9.5.	For A-pillars only, mark an additional grid point at the intersection of the lateral vertical plane and the side reference line for each wrap around distance.

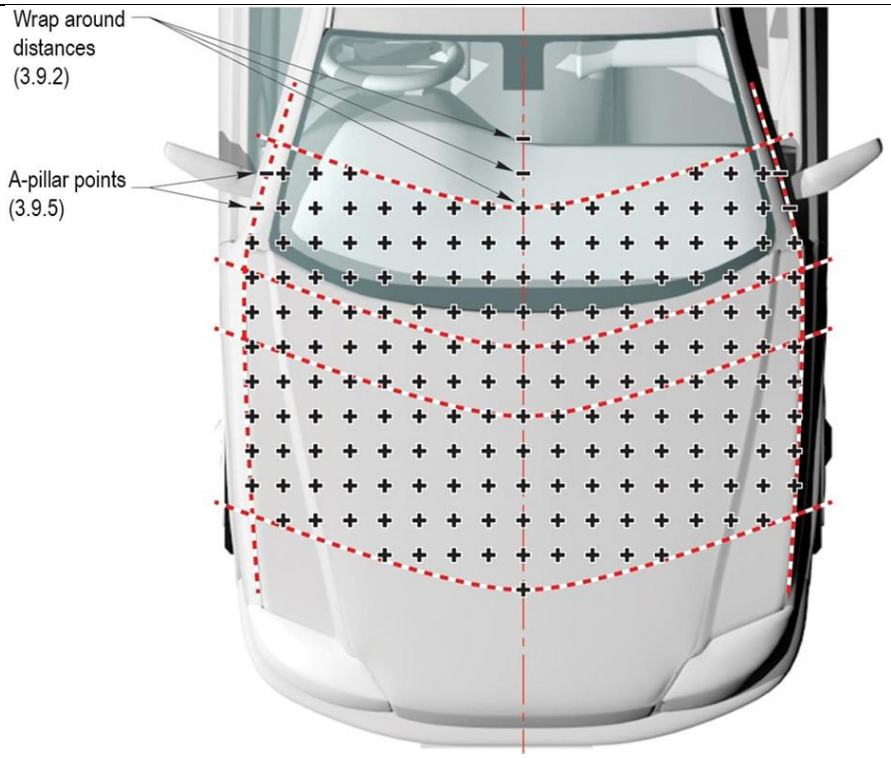


Figure 16: Grid points

3.9.6.	Where any of the grid points lie underneath the outer contour of the vehicle, for example in the gap behind the bonnet, approximate the outer contour of the vehicle horizontally rearward from the last point of contact by using an adhesive tape. Mark the grid point on the tape to replace the underlying grid point. See Figure 17.
3.9.7.	Where a wiper obstructs the placement of the tape, the wiper shall be ignored during tape placement unless the grid point falls on the wiper itself.

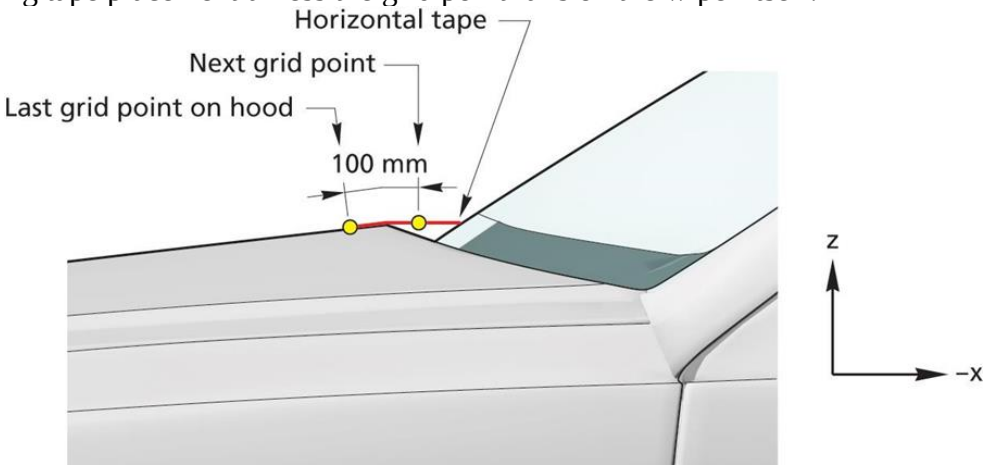


Figure 17: Grid points beneath outer contour (example at vehicle centreline)

3.9.8.	Remove those grid points that have a distance, measured in the lateral Y axis, of less than 50mm to the side reference lines, excluding those points which are on A-pillar side reference line. See Figure 18

3.9.9.	The remaining grid points are used for the assessment of the vehicle. For impact testing, these grid points are the aiming points.
3.9.10.	Where the vehicle is equipped with an active system, the aiming points will always be considered in the undeployed state.

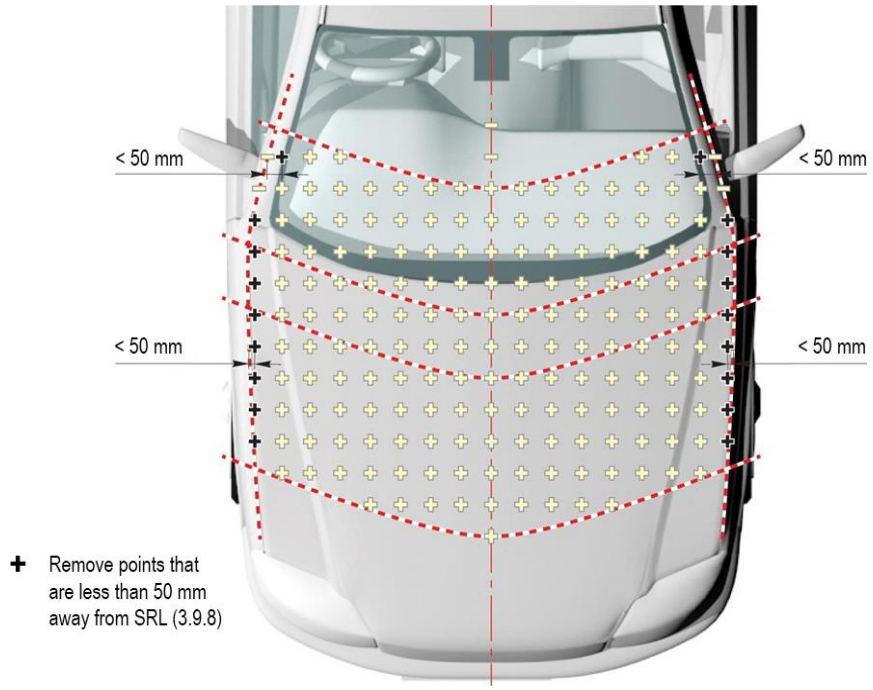


Figure 18: Deleting grid points

3.10.	**Identification of the Headform Grid Points**
3.10.1.	All child/small adult headform grid points will contain the prefix ‘C’. All adult headform points will contain the prefix ‘A’.
3.10.2.	The grid point will be identified by means of a row and column system. The origin will be at the grid point on the vehicle centreline and the 1000mm WAD. This point is C0,0.
3.10.3.	The rows at the origin will be row 0, and the subsequent rows will be marked in increasing increments of 1 up to the rearmost row
3.10.4.	The column on the centreline will be column 0, the adjacent column on the right of the vehicle, as shown below, will be column +1, with the other columns increasing by 1 toward the SRL, i.e. +2, +3, ….+8. The column on the left of the vehicle will be column -1 with the other columns decreasing by 1 toward the SRL, i.e. -2, -3, ..-8.
3.10.5.	Every point will be identified firstly by the relevant headform impactor (A or C), then by the row, then by the column. See Figure 19.

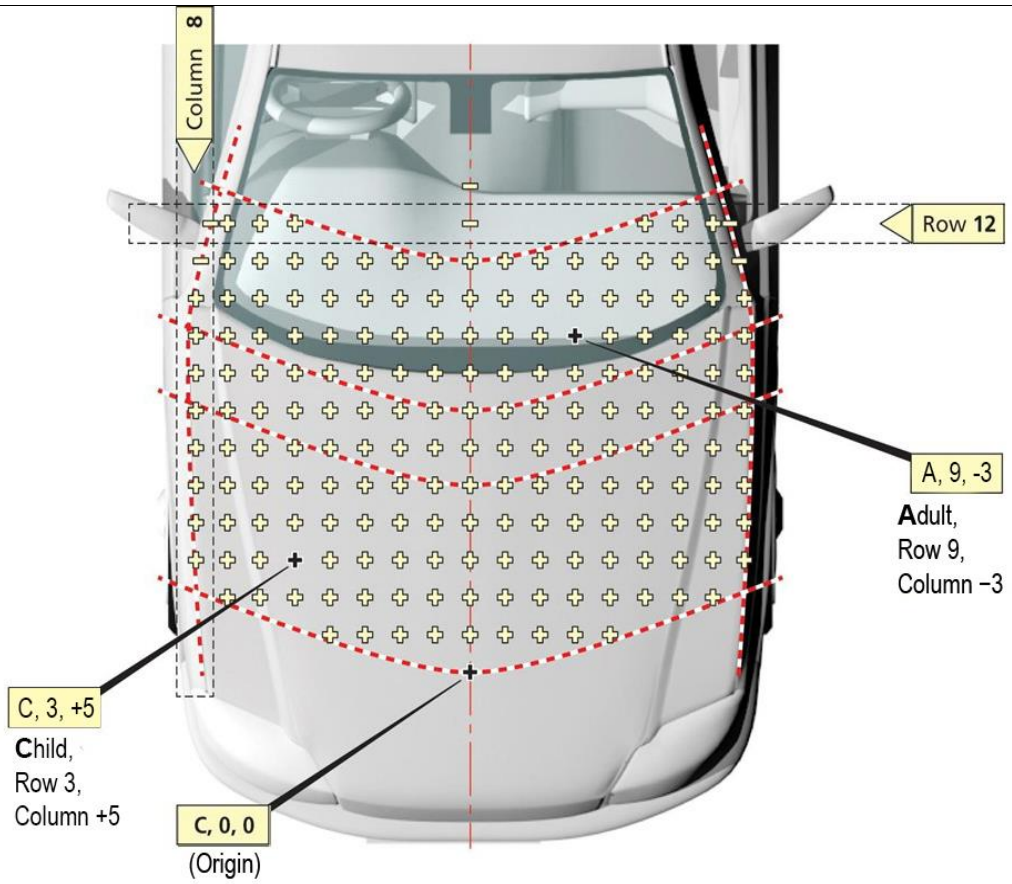


Figure 19 Labelling of the headform grid points

3.11.	**Marking Upper Legform to WAD775mm Grid Points**
3.11.1.	Starting at the intersection of the vehicle centreline and WAD775mm, mark grid points every 100mm in both lateral directions along the WAD775 up to the corner reference points, which have been projected fore/aft onto the WAD775mm. The 100mm distances are measured horizontally in a lateral vertical plane and projected onto the WAD775mm. See Figure 20.
3.11.2.	Grid points less than 50mm from the corner reference point shall be deleted.
3.12.	**Marking Legform Grid Points**
3.12.1.	Starting at the intersection of the vehicle centreline and upper bumper reference line, mark grid points every 100mm in both lateral directions up to the edge of the bumper test zone. The 100mm distances are measured horizontally in a lateral vertical plane and projected onto the upper bumper reference line. See Figure 20.
3.12.2.	Where the edge of the bumper test zone is more than 50mm outboard of the outermost grid point, an additional point will be added 50mm outboard of the last grid point. The distances are measured horizontally in a lateral vertical plane.
3.13.	**Labelling the Upper Legform and Legform Grid Points**
3.13.1.	All upper legform grid points will contain the prefix ‘U’. All legform points will contain the prefix ‘L’.
3.13.2.	The grid points will be marked sequentially from the origin at the grid points on the vehicle centreline. For the upper legform, the origin will be marked U0. For the legform the origin will be marked L0.

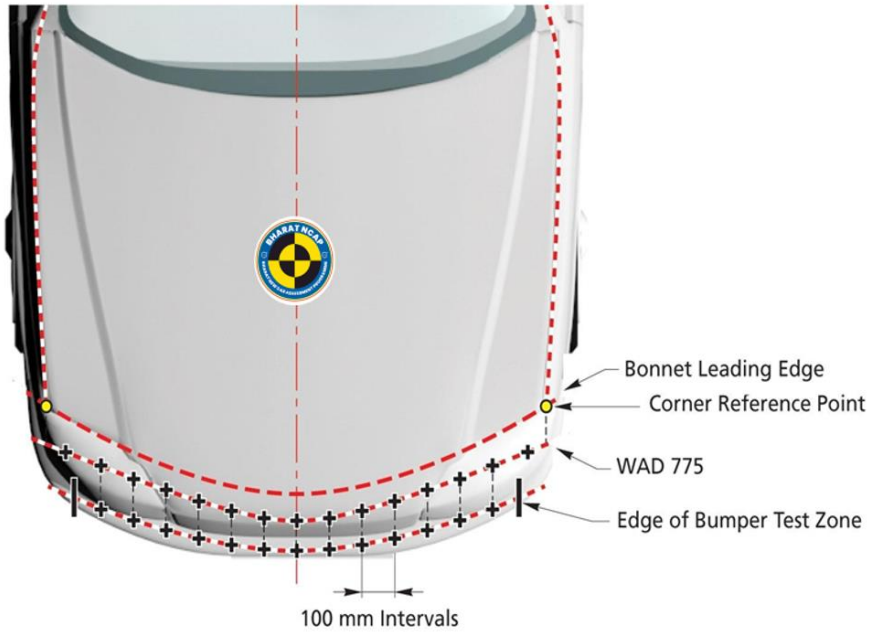


Figure 20: Division of the WAD775 and upper bumper reference lines

3.13.3.	The adjacent points on the right of the vehicle will be +1, with the other points increasing by 1 with outboard movement, i.e. +2, +3 etc. The points on the left of the vehicle -1 with the other columns decreasing by 1 i.e. -2, -3 etc.
3.13.4.	Every point will be labelled firstly by the relevant impactor (U or L), then by the individual number. See Figure 21.

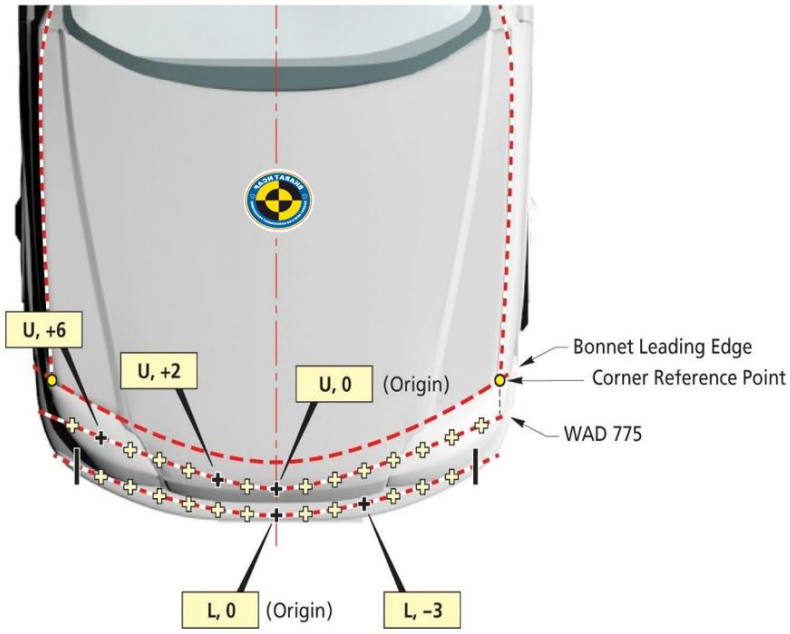
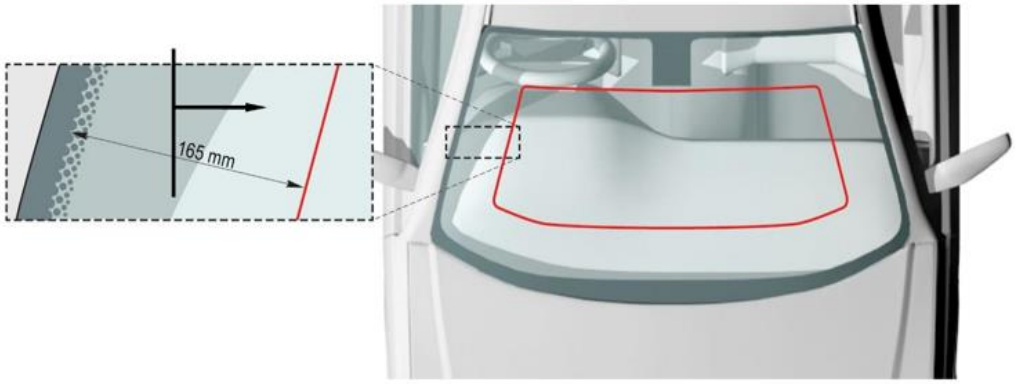
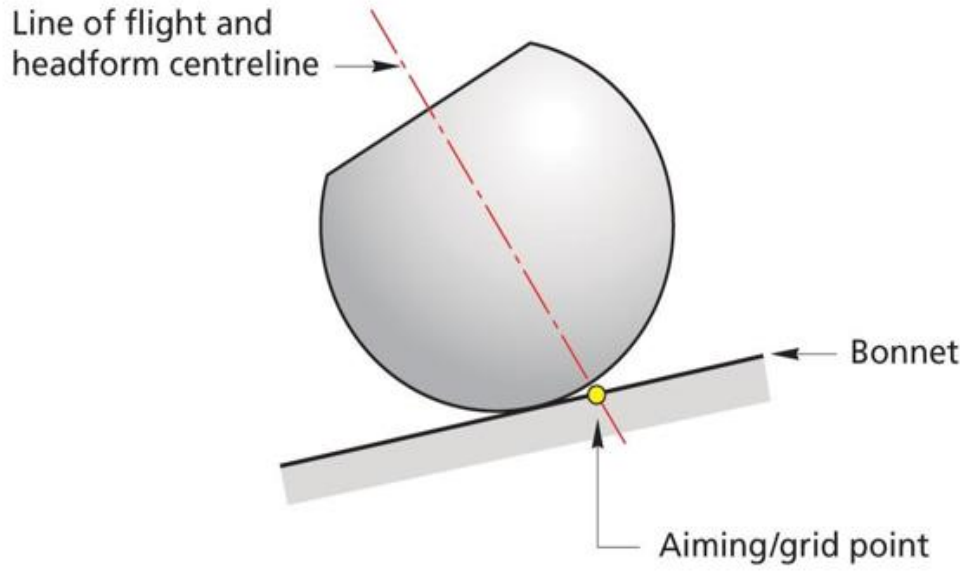


Figure 21: Labelling the Upper Legform and Legform grid points

4.	**Headform DATA**
4.1.	**Manufacturer Supplied Data**
4.1.1.	The vehicle manufacturer is required to provide the Bharat NCAP Secretariat with HIC15 or colour data detailing the protection offered by the vehicle at all headform grid locations.
4.1.2.	All data must be supplied by the manufacturer before any vehicle marking or testing begins, preferably with delivery of the test vehicle(s).
4.1.3.	For the headform area, data shall be provided for each grid point according to the following performance criteria: $HIC_{15} < 650$ = Green $650 \leq HIC_{15} < 1000$ = Yellow $1000 \leq HIC_{15} < 1350$ = Orange $1350 \leq HIC_{15} < 1700$ = Brown $1700 \leq HIC_{15}$ = Red

4.1.4.	Some grid points shall have a default red or green rating awarded to them. These shall be clearly identified as defaulted in the predicted data. The only areas to be defaulted are as follows: • A-pillars = Default red (unless data is provided to suggest otherwise) • Windscreen glazing = Default green (except for areas defined in Section 4.1.5 to 4.1.7)
4.1.5.	5 Any grid points that are within 165mm of the solid strip around the periphery of the windscreen mounting frame cannot be defaulted green. The 165mm shall be measured along the outer contour of the windscreen . See Figure 22.
4.1.6.	Where there are any structures mounted directly behind the windscreen, such as sensor systems, the overlying grid points shall not be defaulted green.
4.1.7.	Grid points on the windscreen that are within 100mm of ANY underlying structures in the windscreen base area, measured from the grid point in the impact direction of the relevant headform, cannot be defaulted green.
4.1.8.	Where the vehicle manufacturer can provide evidence that shows an A-pillar is not red, those grid points will be considered in the same way as other points.
4.1.9.	Grid points on the side reference line that are rearward of the bonnet rear reference line will be deemed as grid points on the A-pillars
4.1.10.	Defaulted locations are not included in the random selection of verification tests, see Section 5, and the correction factor calculation
4.1.11.	Before test points are selected, defaulted locations will be confirmed by the laboratory.  Figure 22: Windscreen periphery measurement
4.2.	**Unpredictable Grid Locations**
4.2.1.	Where certain structures are such that the protection offered by particular grid points is unpredictable, those grid points may be coloured blue in the predicted data.
4.2.2.	Those areas of the vehicle that may contain blue grid points are limited to the following structures: • Plastic scuttle • Windscreen wiper arms and windscreen base • Headlamp glazing • Break-away structures

4.2.3.	Where blue points are identified, the vehicle manufacturer must provide test results and/or CAE modelling as justification to show the unpredictable performance of the location(s).
4.2.4.	Blue points, either singly or grouped together in pairs, will form a blue zone.
4.2.5.	Where there are two grid points in a zone they must be adjacent (longitudinally, laterally and diagonally) to each other. A maximum of eight zones may be blue over the entire headform impact area.
4.2.6.	The laboratory will choose one blue point to assess each zone. Symmetry may be applied.
4.2.7.	The test results of blue points will be applied to the grid point(s) in each zone. The colour of each tested blue point will be changed from blue to the colour corresponding to the HIC15 measured.
4.2.8.	Blue point tests will not be used in the random selection of verification tests, see Section 5, and the correction factor calculation.
4.3.	**Absence of Manufacturer Data**
4.3.1.	Where predicted data is NOT provided by the vehicle manufacturer, the vehicle sponsor may chose for ALL grid points to be tested by the Testing laboratory.
4.3.2.	Alternatively, test points may be selected on a worst case performance basis.
4.3.2.1.	The bonnet marking and point selection for all impactors will follow that outlined in the Section below
4.3.2.2.	The impactors will be used which are specified in Section below
4.3.2.3.	The latest performance criteria (HIC650-1700) will be applied.
5.	**HEADFORM VERIFICATION TESTS**
5.1.	**Verification Tests**
5.1.1.	The vehicle sponsor will fund 10 verification tests in the headform area.
5.1.2.	The vehicle manufacturer has the option of sponsoring up to 10 additional headform verification tests. These are in addition to any blue points and those funded by the sponsor. Where this is the case, the vehicle manufacturer must inform Bharat NCAP of the number of tests when predicted data is provided.
5.1.3.	The location of all verification tests will be selected at the same time and at random by the Bharat NCAP Secretariat regardless of the test sponsor.
5.1.4.	Only those grid points on defaulted grid positions or those coloured blue will be excluded from the randomly selected points. All other grid points are eligible for selection.
5.1.5.	There is no restriction as to the location of the randomly selected tests. Tests to adjacent impact locations are acceptable provided that permanent vehicle damage would not influence other test results.
5.1.6.	Where damage from already tested grid points affects other verification tests, the Secretariat shall be informed and will take a decision on how to proceed further.

5.1.7.	The results of all verification tests shall be used in the calculation of a correction factor.
5.2.	**Headform Tests**
5.2.1.	The selected grid point shall be treated as the aiming point for the headform impactor, with deployable system in the undeployed position.
5.2.2.	The centreline of the headform impactor shall be directly in the line of flight toward the aiming point. See Figure 23.
5.2.3.	The effect of gravity shall be considered when positioning the propulsion system for test. Under the influence of gravity the headform will deviate from the trajectory it has initially when leaving the propulsion system.
5.2.4.	Establish the correct trajectory for the headform, taking gravity into account. The determination of where to position the firing mechanism will require the following information: • Headform diameter • Distance that the headform must travel after leaving the propulsion system • Required angle of impact to horizontal • Angle of the bonnet top at the point of impact • Required impact velocity
5.2.5.	Using the above information calculate the distance from the aiming point to ensure that the required correct trajectory is established. The angle to which the propulsion system should be set and the velocity that the propulsion system must give to achieve the required velocity at impact and the required angle of incidence at impact must also be calculated.  **Figure 23: Aiming point**

6.	**DETERMINATION OF UPPER LEGFORM AND LOWER LEGFORM IMPACT POINTS**
6.1.	**Legform to Bumper Tests**
6.1.1.	The legform to bumper tests will be conducted if the lower bumper reference line at the chosen grid point is less than 425mm above the ground when the test vehicle is at its Normal Ride Attitude. For vehicles where part or all of the Lower Bumper Reference Line is above 425mm, select the bumper impact points as in Section 6.1.2 and afterwards refer to Section 6.2.
6.1.2.	The vehicle manufacturer must identify any asymmetrical grid points before the start location is selected and any nominations are made.
6.1.3.	The Bharat NCAP Secretariat will select one of the locations L0 or L1 for testing; additional tests will then be performed to every second grid point outboard of this point.
6.1.4.	Symmetry is applied across the vehicle. Tests can be conducted on both sides of the vehicle. For each pair of symmetrical grid points the laboratory chooses the point to be actually tested.
6.1.5.	Grid points that have not been tested will be awarded the worst result from one of the adjacent points.
6.1.6.	Where the vehicle manufacturer believes that the performance of a non selected point will not be reflected correctly or symmetry does not apply, they may choose to sponsor additional tests to any of these points. Nominations must be made for both possible starting points and before the first point to test is chosen as detailed in Section 6.1.2.
6.2.	**Upper Legform to Bumper Tests**
6.2.1.	These tests are conducted, instead of the legform to bumper tests, if the Lower Bumper Reference Line at the position(s) defined in Section 6.1, is greater than 500mm vertically above the ground at the vehicle's normal ride attitude.
6.2.2.	Where the Lower Bumper Reference Line at the position(s) defined in Section 6.1, is between 425mm and 500mm vertically above the ground at the vehicle's normal ride attitude, the vehicle manufacturer may choose to use either the Legform to bumper test or the Upper Legform to bumper test.
6.2.3.	The upper legform to bumper tests must be carried out at the same lateral position as the points selected in Section 6.1, with the intersection of the longitudinal and lateral planes, at the centre of the impactor, aimed mid way between the Upper Bumper Reference Line and the Lower Bumper Reference Line.
6.3.	**Upper Legform to WAD775mm Tests**
6.3.1.	A test is not required if the calculated impact energy would be less than 160J.
6.3.2.	The vehicle manufacturer must identify any asymmetrical grid points before the start location is selected and any nominations are made.

6.3.3.	The Bharat NCAP Secretariat will select one of the locations U0 or U1 for testing; additional tests will then be performed to every second grid point outboard of this point.
6.3.4.	Symmetry is applied across the vehicle. Tests can be conducted made on both sides of the vehicle. For each pair of symmetrical grid points, the laboratory chooses the point to be actually tested.
6.3.5.	Grid points that have not been tested will be awarded the worst result from one of the adjacent points
6.3.6.	Where a point is to be awarded a symmetrical or adjacent result, there must be no more than a 10% difference in the calculated impact energy between the two points. Where the energy differs by more than 10%, a test is required.
6.3.7.	Where the vehicle manufacturer believes that the performance of a non-selected point will not be reflected correctly or symmetry does not apply, they may choose to sponsor additional tests to any of these points. Nominations must be made for both possible starting points and before the first point to test is chosen as detailed in Section 6.1.2.
7.	**RECORDING THE IMPACT POINT LOCATIONS**
7.1.	**General**
7.1.1.	A three dimensional measuring system with an accuracy of ±0.5mm shall be used to record the grid origin and the points chosen for test. For all impact locations, record the position of the selected impact points.
7.1.2.	Care should be taken at all times not to move the vehicle while the impact points are being recorded or transferred.
7.2.	**Measuring Impact Points**
7.2.1.	Ensure that the vehicle is at its test weight and fully test prepared as defined in Section 1.
7.2.2.	Measure the ride heights at all four wheels using the marks defined in Section 1.3.4. Record the ride heights in the test details.
7.2.3.	During digitising, care should be taken not to move the vehicle by, for example, leaning on it.
7.2.4.	The co-ordinates of all impact locations should be digitised with the 3D arm.
7.2.5.	A hard copy of the impact points co-ordinates should be obtained for reference.
7.2.6.	After digitisation, the bonnet top and bumper featuring all the impact points shall be removed and replacements fitted. See Section 8.3 for fitting procedures.
7.2.7.	The original bonnet and bumper shall be kept for reference and will be replaced on the vehicle once testing is complete.

7.3.	**Transferring Impact Points to Replacement Vehicle Parts**
7.3.1.	Replacement parts will need to be fitted to the vehicle for the series of tests. It is not practical to have to mark out each of the parts completely for a single test. Therefore, the original marked-out bonnet will be retained as a reference and individual impact locations transferred to replacement components.
7.3.2.	With the new component(s) fitted, measure the ride heights at all four wheels.
7.3.3.	These ride heights must be altered until they match the original recorded ride heights measured in Section 1.3. If the ride heights are too high then they can be reduced by adding weights. If the ride heights are too low then they can be increased by removing weight from the vehicle and/or inserting blocks under the body of the vehicle. The additional weights and/or blocks shall be removed before testing.
7.3.4.	Set up the 3D measuring system.
7.3.5.	Using the co-ordinates recorded in Section 7.2 for the original impact points, locate and mark the desired impact point on the new component.
8.	**PERFORMING OF PEDESTRIAN IMPACT TESTS**
8.1.	**General**
8.1.1.	Safety of personnel shall be a priority at all times
8.1.2.	Ensure that all equipment used is in full working order, has been checked for safety and is in calibration where appropriate
8.2.	**Propulsion System**
8.2.1.	An air, spring or hydraulic gun will be used to propel the various body form impactors.
8.2.2.	For the legform and the headform tests the impactors are required to be in free flight at the time of impact.
8.3.	**Fitting Replacement Parts to Vehicles**
8.3.1.	Careful note shall be taken before any testing is performed as to how any parts liable to need replacement are fitted to the vehicle structure.
8.3.2.	Fitting of parts shall not increase or decrease the strength of the structure of the vehicle.
8.3.3.	If significant repair work is required, this will be done at a manufacturer-approved dealer.
8.4.	**Photographic Record**
8.4.1.	A photographic record shall be kept of each test.
8.4.2.	Before any testing has been conducted but after the vehicle is fully test prepared including all markings, the vehicle shall be photographed according to the following schedule. Note that these shall be the only pre-test photographs taken

8.4.3.	List of still photographs Amount of vehicle visible — View Point Full vehicle — Left side Full vehicle — Right side Front third of vehicle — Left side Front third of vehicle — Right side Full vehicle — Front Left half of vehicle — Front Right half of vehicle — Front Front third of vehicle — Top Front third, right half of vehicle — Top Front third, left half of vehicle — Top Legform test points — Front Upper legform test points — Front Child head zone test points — Top Adult head zone test points — Top
8.4.4.	Post-test photographs are detailed for each test type in the individual test procedures.
8.5.	**Testing Active Systems**
8.5.1.	Static pedestrian tests
8.5.1.1.	Static pedestrian tests will be performed in the normal way and according to the usual tolerances.
8.5.2.	Dynamic pedestrian tests
8.5.2.1.	Where dynamic tests are required, only a lateral impact tolerance of +/-10mm will be required. The headform shall be aimed at the grid point, the subsequent impact location on the vehicle will then be determined by the timing of the system deployment relative to the propulsion of the headform.
8.5.2.2.	The vehicle manufacturer will be required to provide Bharat NCAP with data from numerical simulations performed with the bonnet in the undeployed position. Simulations are to be conducted with a vehicle speed of 40km/h with all pedestrian statures that result in head contact to bonnet. Pedestrian models should be selected from the following statures, a 6-year-old, 5^{th} percentile female, 50^{th} percentile male and 95^{th} percentile male. The pedestrian position and stance to be used in the model is defined in Section 2.6.1.5.
8.5.2.3.	From the simulations both head contact time and the wrap around distance should be recorded.
8.5.2.4.	A graph shall be plotted with a best fit straight line as shown in Figure 24. When a test point is selected, as the wrap distance will be known, the equivalent head contact time can be obtained from the graph that will be used in the dynamic test set up.

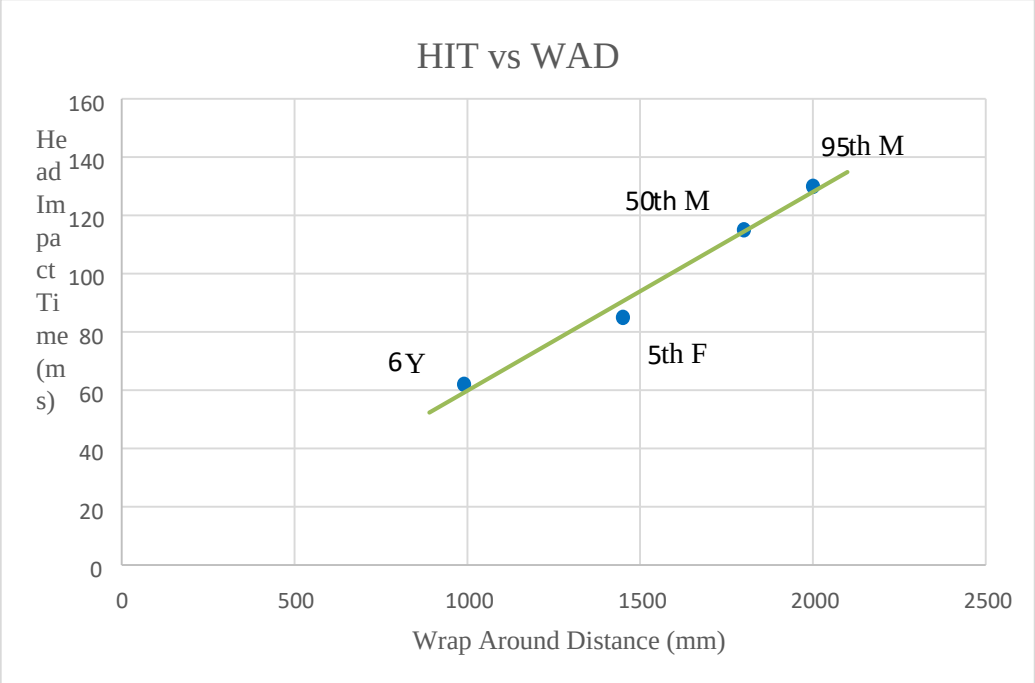
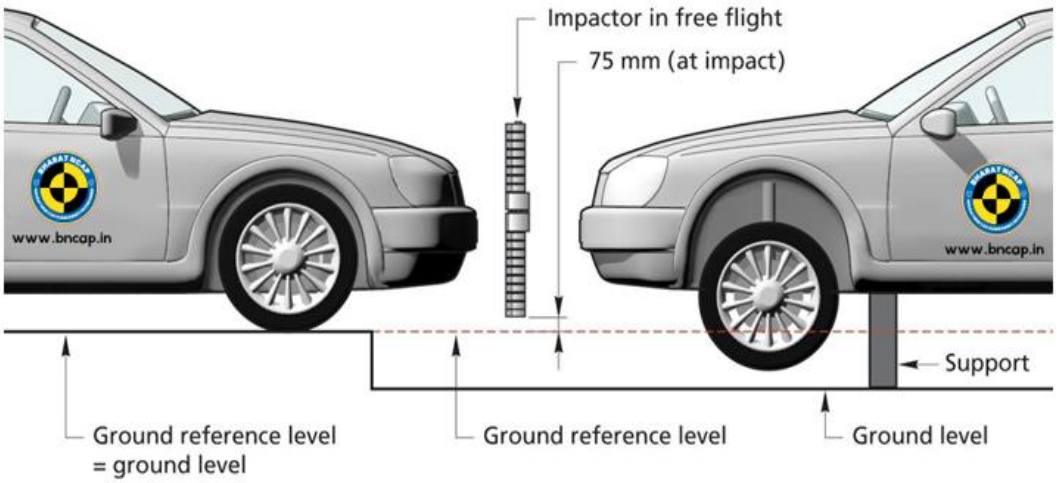
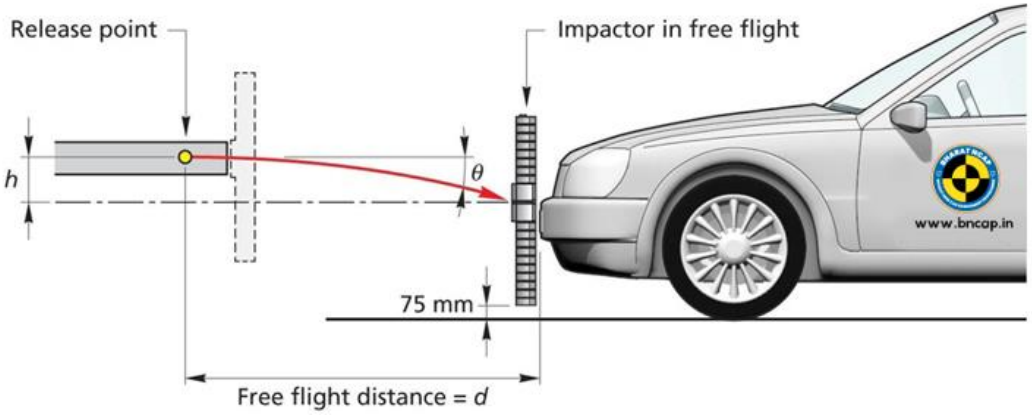


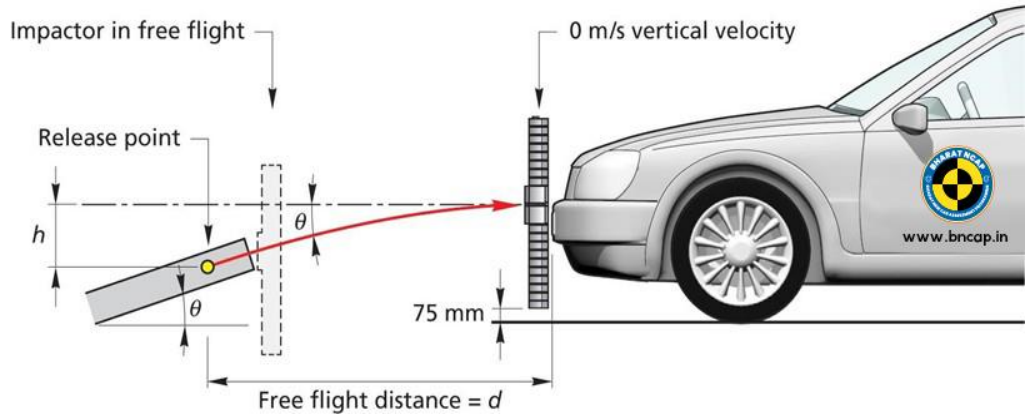
Figure 24: WAD vs HIT

8.5.2.5.	The vehicle manufacturer must provide the test laboratory with all the necessary details of how to trigger the system, monitor trigger signals and replace spare parts.
8.5.3.	Upper leg testing
8.5.3.1.	If deployment occurs prior to pedestrian contact with the WAD775mm, creating an increased hazard such as increased height, the Bharat NCAP secretariat will give consideration to marking out the WAD775mm in the deployed state.
8.5.3.2.	Unless there is concern about additional hazards being created by the system deploying prior to or during pedestrian contact with the WAD775mm, all upper legform testing will be carried out with the system in the un-deployed state.
8.5.3.3.	Where the vehicle manufacturer provides data showing that a deployable system offers protection to the upper leg, the upper legform tests will be carried out by conducting dynamic tests.
9.	**LEGFORM TESTS**
9.1.	**Description of Legform and its Instrumentation**
9.1.1.	The legform impactor used shall conform to that specified in UNECE/TRANS/WP.29/GRSP/2013/26, Annex 4

<table>
<tr><td>9.1.2.</td><td>Instrumentation:
* Optional
<table>
<tr><th>Location</th><th>Measurement</th><th>CFC (Hz)</th><th>CAC</th><th>No of channels</th></tr>
<tr><td>Tibia Bending</td><td>Tibia-1
Tibia-2
Tibia-3
Tibia-4</td><td>180</td><td>400Nm</td><td>4</td></tr>
<tr><td>Knee Elongation</td><td>Medial collateral ligament
Anterior cruciate ligament
Posterior cruciate ligament</td><td>180</td><td>300mm</td><td>3</td></tr>
<tr><td>Tibia*</td><td>Acceleration</td><td>180</td><td>500g</td><td>1</td></tr>
</table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>9.2.</td><td>Certification</td></tr>
<tr><td>9.2.1.</td><td>The certification procedures are detailed in UNECE/TRANS/WP.29/GRSP/2013/26 Annex 6, Chapter 1.4.</td></tr>
<tr><td>9.2.2.</td><td>The legform shall be re-certified before each vehicle assessment.</td></tr>
<tr><td>9.2.3.</td><td>The legform shall be re-certified after a maximum of 10 impacts.</td></tr>
<tr><td>9.2.4.</td><td>The legform shall be re-certified at least once every 12 months regardless of the number of impacts it has undergone.</td></tr>
<tr><td>9.2.5.</td><td>If the legform exceeds any of its CACs then it shall be re-certified.</td></tr>
<tr><td>9.2.6.</td><td>The legform shall be re-certified according to the procedures prescribed in UNECE/TRANS/WP.29/GRSP/2013/26 Annex 6, Chapter 1.2 at least once a year.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>9.3.</td><td>Test Procedure – Pre Test</td></tr>
<tr><td>9.3.1.</td><td>Ensure that the vehicle is fully test prepared as described in Section 1.</td></tr>
<tr><td>9.3.2.</td><td>Ensure that the legform, the vehicle, the propulsion system and the data acquisition equipment have been soaked in a temperature in the range of 16^{o}C to 24^{o}C for at least 4 hours prior to testing.</td></tr>
<tr><td>9.3.3.</td><td>Align the vehicle so that the propulsion system can aim at the impact position and the propulsion system can fire the legform in a direction that is parallel to the vehicle centreline.</td></tr>
<tr><td>9.3.4.</td><td>Roll the vehicle forwards to give the desired free flight distance.</td></tr>
<tr><td>9.3.5.</td><td>At the time of first contact the bottom of the legform shall be 75mm above Ground Reference Level ±10mm. The measurement must be taken from the bottom of the legform without any protective covers.</td></tr>
</table>

9.3.6.	Insert blocks under the wheels of the vehicle such that vehicle height is raised as required by the gravity correction method used to ensure the above tolerance; and the tolerance for direction of impact are both satisfied. Alternatively, ensure that the vehicle is positioned above a trench in the floor. See Figure 25.  Figure 25: Legform to Bumper tests
9.3.7.	If required, ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle, friction in the vehicle's suspension system may be a source of variance.
9.3.8.	To ensure that the legform impacts with its bottom at the correct height above the ground a correction to take into account the action of gravity when the legform is in free flight is required. This can take the form of raising the legform a distance h, and firing it horizontally so that the action due to gravity results in the bottom of the impactor being at 75mm above ground level at the point of first contact with the vehicle. This can be achieved using the method in Section 9.4. However, this method will only remain within the tolerance specified in 9.5.9 if its free flight distance is about 400mm or less. For test houses that use a free flight distance of more than 400mm, the legform shall be fired using a ballistic correction procedure as described in Section 9.5.
9.4.	**Compensation for Gravity (horizontal firing)**
9.4.1.	Measure the distance d (in metres) between the point of first contact and the point from where the legform will leave the propulsion system and begin free flight (release point).

9.4.2.	The distance that the legform will fall due to gravity can be calculated from the formula: $$\text{Fall due to Gravity } h = \frac{gd^2}{2v^2}$$ Assuming values for g, acceleration due to gravity = 9.81ms^{-2} and v, exit velocity of the legform from the propulsion system (at the release point) = 11.1ms^{-1} gives: Fall due to Gravity $h = 0.03981\ d^2$
9.4.3.	Raise the propulsion system by this calculated amount, h. The angle θ must remain within the tolerance specified in Section 9.5.9. See Figure 26.
9.4.4.	 Figure 26: Droop Compensation
9.5.	**Ballistic Compensation**
	There are two procedures which can be used for ballistic compensation, it is at the discretion of the test agency as to the most appropriate method, see Figure 27. The terms used for the calculations are: At the release point: u = initial velocity ϕ = firing angle At the point of first contact: v = impactor velocity (11.1m/s) θ = direction of impact (0º) d = free flight distance h = height increase
9.5.1.	The first case is where ϕ is fixed, and θ = 0º, v = 11.1m/s. The vehicle must be positioned in relation to the fixed propulsion system, therefore u, d, and h are the subjects.

9.5.2.	Using the following equations find u, d, and h: $$u = \frac{v}{\cos(\phi)}$$ $$d = \frac{v^2}{g}\tan(\phi)$$ $$h = \frac{v^2}{2g}\tan^2(\phi)$$
9.5.3.	Position the vehicle to be the correct distance away from, and height above the release point. Proceed to Section 9.5.8.
9.5.4.	The second case is where d is fixed, and θ = 0º v = 11.1m/s. The propulsion system is positioned and aimed in relation to the vehicle, therefore u, h and ϕ are the subjects.
9.5.5.	Using the following equations find u, h and ϕ: $$u = v\left(1 + \frac{g^2 d^2}{v^4}\right)^{\frac{1}{2}}$$ $$h = \frac{gd^2}{2v^2}$$ $$\phi = \tan^{-1}\left(\frac{gd}{v^2}\right)$$
9.5.6.	Position the propulsion system to be the correct distance away from, height above and correctly aimed at the vehicle.
9.5.7.	The angle ϕ shall be set so that the impactor is at the top of the ballistic at the point of first contact.  Figure 27: Ballistic Correction Procedure

9.5.8.	Set the speed control on the propulsion system to give 11.1m/s ±0.2m/s at the point of first contact. The velocity measuring device should be able to measure to an accuracy of at least ±0.02 m/s. The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the point of first contact.
9.5.9.	The direction of impact at the point of first contact shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The axis of the legform shall be vertical at the time of first contact. The tolerance to these directions is ±2º.
9.5.10.	At the time of first contact the impactor shall have the intended orientation about its vertical axis, for correct operation of the knee joint, with a tolerance of ±2º.
9.5.11.	The bending moments shall be ±10.0Nm within the 30ms immediately prior to impact.
9.5.12.	At the time of first contact the centerline of the legform impactor shall be within ±10mm of the selected impact point.
9.5.13.	During contact between the legform impactor and the vehicle, the impactor shall not contact the ground or any object not part of the vehicle.
9.5.14.	Fire the propulsion system.
9.6.	**Test Procedure – Post Test**
9.6.1.	Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.
9.6.2.	Additional photographs may be required for an individual test
9.6.3.	Check that no CAC has been exceeded before conducting the next test, if this has occurred then the impactor must be re-certified before the next test.
9.6.4.	Replace any damaged part of the vehicle that will affect the results of the next test with new parts according to Section 8.3.
9.6.5.	Repeat procedure given from Sections 9.3 to 9.6 for the next impact location.

10.	**UPPER LEGFORM TO BUMPER TESTS**
10.1.	**Description of Upper Legform and its Instrumentation**
10.1.1.	The upper legform impactor used shall conform to that specified in Regulation (EC) 78/2009 of the European Parliament and of the Council (14th January 2009) and annexed in R (EC) 631/2009 (22nd July 2009).

Table 3: Instrumentation

Location	Measurement	CFC (Hz)	CAC	No of channels
Upper femur	Force	180	10kN	
Lower femur	Force	180	10kN	
Centre of femur	Bending moment	180	1000Nm	
50mm above centre of femur	Bending moment	180	1000Nm	
50mm below centre of femur	Bending moment	180	1000Nm	

10.2.	**Certification**
10.2.1.	The certification procedures are detailed in Regulation (EC) 631/2009 (22nd July 2009).
10.2.2.	The upper legform shall be certified before the test programme.
10.2.3.	The foam sheet(4) from which the pieces of foam shall be taken shall be certified before the test programme.
	(4) - The foam shall be 25mm thick Confor™ foam type CF-45 or equivalent
10.2.4.	The upper legform shall be re-certified after a maximum of 20 impacts.
10.2.5.	The upper legform shall be re-certified at least once every 12 months regardless of the number of impacts it has undergone.
10.2.6.	If the upper legform exceeds any of its CACs then it shall be re-certified before it is used for any test.
10.3.	**Test procedure - Pre-test**
10.3.1.	Ensure that the vehicle is fully test prepared as described in Section 1.
10.3.2.	Ensure the vehicle is at the normal ride attitude as recorded during marking up of the vehicle.
10.3.3.	Ensure that the upper legform, the vehicle, the propulsion system and the data acquisition equipment have been soaked in a temperature in the range of 16ºC to 24ºC for at least 2 hours prior to testing
10.3.4.	The total mass of the upper legform impactor including those propulsion and guidance components which are effectively part of the impactor during the impact shall be 9.5kg ±0.1kg.

	The upper legform impactor mass may be adjusted from this value by up to ±1kg, provided the required impact velocity is also changed using the formula: $$V = \sqrt{\frac{1170}{M}}$$ Where: V = impact velocity (m/s) M = mass (kg), measured to an accuracy of better than ±1%
10.3.5.	The total mass of the front member and other components in front of the load transducer assemblies, together with those parts of the load transducer assemblies in front of the active elements, but excluding the foam and skin, shall be 1.95 ± 0.05kg.
10.3.6.	Fit new pieces of foam, from the certified sheet of foam, to the upper legform.
10.3.7.	Align the vehicle so that the propulsion system can aim at the impact position as defined in Section 6.1 and the propulsion system can propel and guide the upper legform in a direction that is parallel to the vehicle centreline ±2º. At the time of first contact the impactor centreline shall be midway between the Upper Bumper Reference Line and the Lower Bumper Reference Line with ±10 mm tolerance and laterally with the selected impact location with a tolerance of ±10 mm.
10.3.8.	The impact velocity of the upper legform impactor when striking the bumper shall be 11.1m/s ±0.2m/s. The velocity measuring device should be able to measure to an accuracy of at least ±0.02 m/s. The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the point of first contact.
10.3.9.	Roll the vehicle forwards to give the desired distance, so that the impactor strikes the vehicle after it has been accelerated to the test speed and so that any end stops on the guidance system do not interfere with its interaction with the vehicle.
10.3.10.	The direction of impact shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The axis of the upper legform shall be vertical at the time of first contact. The tolerance to these directions is ±2º.
10.3.11.	Fire the Propulsion.
10.4.	**Test Procedure – Post test**
10.4.1.	Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.
10.4.2.	Additional photographs may be required for an individual test
10.4.3.	Check that no CAC has been exceeded before conducting the next test, if this has occurred then the impactor must be re-certified before the next test.
10.4.4.	Replace any damaged part of the vehicle which would affect the results of the next test with new parts according to Section 8.3.
10.4.5.	Repeat procedure given in sections 10.3 and 10.4 for the next impact location.

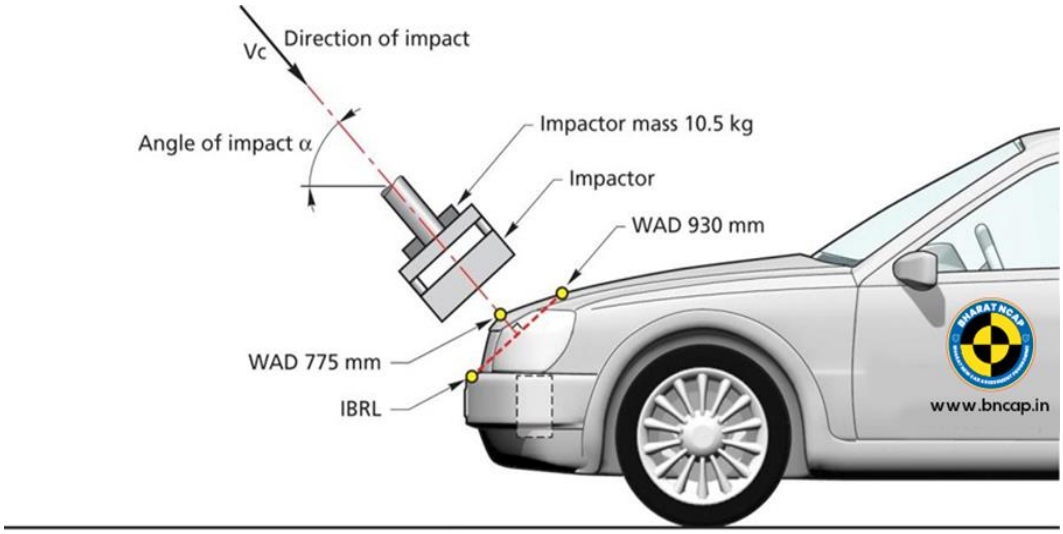
11.	**UPPER LEGFORM TO WAD775mm TESTS**
11.1.	**Description of Upper Legform and its Instrumentation**
11.1.1.	The upper legform used shall conform to that specified in Regulation (EC) 78/2009 of the European Parliament and of the Council (14th January 2009) and annexed in R (EC) 631/2009 (22nd July 2009).

Table 4 : Instrumentation and measurements

Location	Measurement	CFC (Hz)	CAC	No of channels
Upper femur	Force	180	10kN	1
Lower femur	Force	180	10kN	1
Centre of femur	Bending moment	180	1000Nm	1
50mm above centre of femur	Bending moment	180	1000Nm	1
50mm below centre of femur	Bending moment	180	1000Nm	1

11.2.	**Certification**
11.2.1.	The certification procedures are detailed in Regulation (EC) 631/2009 (22nd July 2009).
11.2.2.	The upper legform shall be certified before the test programme.
11.2.3.	The foam sheet[5] from which the pieces of foam shall be taken shall be certified before the test programme.
	(5) The foam shall be re-certified after a maximum of 20 impacts.
11.2.4.	The upper legform shall be re-certified after a maximum of 20 impacts.
11.2.5.	The upper legform shall be re-certified at least once every 12 months regardless of the number of impacts it has undergone.
11.2.6.	If the upper legform exceeds any of its CACs then it shall be re-certified before it is used for any test.
11.3.	**Determination of Impact Angle, Impact Energy and Impact Velocity**
11.3.1.	Ensure that the vehicle has its spare wheel on board or tyre repair kit (if permitted and is provided instead of spare wheel) referred in CMVR 138(3) along with any tools supplied with the vehicle. Nothing else should be in the vehicle**.**

11.3.2.	The nominal impactor energy to be used in the test shall be calculated using the following formula: $$En = 0.5 \times m_n \times v_c^2$$ Where: $$m_n = 7.4kg$$ $$v_c = v_o \cos(1.2\alpha)$$ $$v_o = 11.11 \frac{m}{s}$$
11.3.3.	The test velocity vt shall then be adjusted to meet the nominal energy by using the following formula: $$vt = \sqrt{\frac{2En}{10.5kg}}$$
11.4.	**Test Procedure – Pre Test**
11.4.1.	Ensure that the vehicle is fully test prepared as described in Section 1
11.4.2.	Ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle.
11.4.3.	Ensure that the upper legform, the vehicle, the propulsion system and the data acquisition equipment have been soaked in a temperature in the range of 16ºC to 24ºC for at least 2 hours prior to testing.
11.4.4.	Fit a new piece of foam to the upper legform impactor from the certified sheet of foam.
11.4.5.	Apply weights to the back of the upper legform impactor to bring the total mass to 10.5kg. Larger weights should first be applied and various smaller weights should then be added to achieve the correct weight. The upper legform impactor mass should be measured to an accuracy of better than ±1%.
11.4.6.	Where α <0º, then α=0º. The impact will be in the same Y-Z plane as each grid point. The tolerances to these directions are ±2°.
11.4.7.	The upper legform impactor shall be aligned such that the centerline of the propulsion system and the longitudinal axis of the upper legform impactor are in the fore and aft vertical plane of the section of the vehicle to be tested. The tolerances to these directions are ±2°. At the time of first contact the impactor centreline shall be coincident with the WAD775mm with a ±10mm tolerance, and laterally with the selected impact location with a tolerance of ±10mm.
11.4.8.	Adjust the propulsion system to give the correct velocity and angle of incidence at the point of impact with the tolerance on the impact velocity being ±2%. The effect of gravity shall be considered when the impact velocity is obtained from measurements taken before the first point of contact. The tolerance on impact direction ±2°.
11.4.9.	Roll the vehicle forwards to give the desired distance, so that the impactor strikes the vehicle after it has been accelerated to the test speed and so that any end stops on the guidance system do not interfere with its interaction with the vehicle. See Figure 28.

11.4.10.	Fire the Propulsion system  **Figure 28: Upper Legform to WAD775mm Test**
11.5.	**Test Procedure – Post Test**
11.5.1.	Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.
11.5.2.	Additional photographs may be required for an individual test at the Project Managers discretion.
11.5.3.	Check that no CAC has been exceeded before conducting the next test, if this has occurred then the impactor must be re-certified before the next test.
11.5.4.	Replace any damaged part of the vehicle which would affect the results of the next test with new parts according to Section 8.3.
11.5.5.	Repeat procedure given in sections 11.4 and 11.5 for the next impact location.
12.	**HEADFORM TESTING**
12.1.	**Description of Headforms and Their Instrumentation**
12.1.1.	The headforms used shall conform to that specified in Regulation (EC) 78/2009 of the European Parliament and of the Council (14th January 2009) and annexed in Regulation (EC) 631/2009 (22nd July 2009).
12.1.2.	The child/small adult impactor to be used is defined in Part V (Test impactors), no. 3 of the Annex of Regulation (EC) 631/2009. The adult impactor to be used is defined in Part V (Test impactors), no. 4 but excluding no. 4.1.1 of the Annex of Regulation (EC) 631/2009.

Instrumentation:

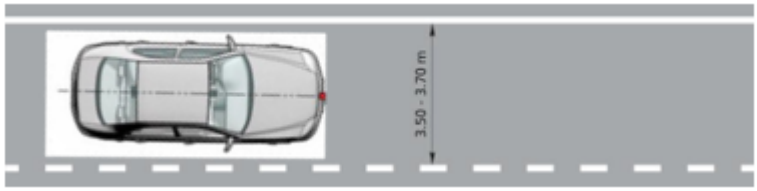
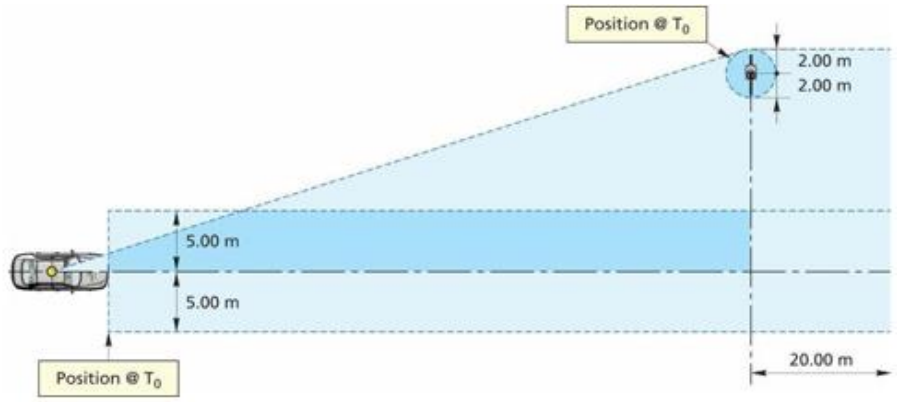
Location	Measurement	CFC (Hz)	CAC	No of channels
Center of gravity of headform	Fore/Aft acceleration*(6)	1000	500g	1
Center of gravity of headform	Vertical acceleration	1000	500g	1
Center of gravity of headform	Lateral acceleration	1000	500g	1

(6) – Relative to the direction of motion of the headform

12.2.	**Certification - Dynamic**
12.2.1.	The certification procedures are detailed in Regulation (EC) 631/2009
12.2.2.	The headforms[7] shall be certified before the test programme.
12.2.3.	The headforms[7] shall be certified after a maximum of 20 impacts.
12.2.4.	The headforms[7] shall be certified at least once every 12 months regardless of the number of impacts they have undergone.
12.2.5.	If the headforms[7] exceed any of their CACs then they shall be re-certified before they are used for any test.
	(7) – Headforms consist of headskins, aluminum sphere and instrumentation
12.3.	**Test Procedure – Pre Test**
12.3.1.	Ensure that the vehicle is fully test prepared as described in Section 1.
12.3.2.	Ensure the vehicle is at the same ride heights as those recorded during marking up of the vehicle.
12.3.3.	Ensure that the headforms, the vehicle, the propulsion system and the data acquisition equipment have been soaked in a temperature in the range of 16ºC to 24ºC for at least 2 hours prior to testing.
12.3.4.	Fit the required headform to the propulsion system. A child/small adult headform impactor shall be used for tests to the forward section of the bonnet top, A-pillars, windscreen, roof (labelled C in Section 3.10), with the test locations lying between boundaries described by wrap around distances of 1000mm and 1500mm. An adult headform impactor shall be used for tests to the rearward section of the bonnet top (labelled A in Section 3.10), with the test locations lying between boundaries described by wrap around distances of 1700 mm and 2100 mm. Where test locations lie between 1500 mm and 1700 mm the structure being tested will determine the headform to be used, see Section 3.5.9.
12.3.5.	The position of the ‘test location’ describes the location of the grid point and will always determine which impactor shall be used; this will also be the case where the grid point is not coincidental with the point of first contact. For example, between 1500 mm and 1700 mm a grid point on the windscreen base will be impacted by the adult headform even if the point of first contact is with the rear edge of the bonnet.

12.3.6.	Roll the vehicle forwards to give the desired free flight distance.
12.3.7.	Adjust the propulsion system so that it can fire the headform at the grid point with the correct angle of incidence and is aimed at the impact point.
12.3.8.	The direction of impact shall be in the fore and aft vertical plane of the section of the vehicle to be tested. The tolerance for this direction is ±2°. The direction of impact of tests to the bonnet top shall be downward and rearward, as if the vehicle were on the ground.
12.3.9.	The angle of impact for tests with the child/small adult headform impactor shall be 50° ±2° to the Ground Reference Level. For all headform grid points on or forward of the bonnet leading edge reference line, defined in Section 3.3, the angle of impact shall be 20° ±2° to ground reference level.
12.3.10.	For tests with the adult headform impactor the angle of impact shall always be 65° ±2° to the Ground Reference Level. For tests with the adult headform impactor to heavy vehicles, as defined in the Heavy Vehicle Test and Assessment Protocol, the angle of impact shall always be 50° ±2° to the Ground Reference Level.
12.3.11.	The effect of gravity shall be taken into account when the impact angle is obtained from measurements taken before the time of first contact.
12.3.12.	The centreline of the headform impactor shall be within a ±10mm tolerance to the selected grid point.
12.3.13.	Set the speed control on the propulsion system to give a velocity of 11.1 ±0.2m/s at the point of first contact. The velocity measuring device should be able to measure to an accuracy of at least ±0.02m/s. The effect of gravity shall be taken into account when the impact velocity is obtained from measurements taken before the point of first contact.
12.3.14.	Fire the propulsion system.
12.4.	**Test Procedure – Post Test**
12.4.1.	Take at least two still photographs of the resultant dent, one from the side and one from the front. Each photograph shall have some means of identifying the vehicle and test location. The preferred method shall be to use unique run numbers for each test.
12.4.2.	Additional photographs may be required for an individual test at the Project Manager's discretion.
12.4.3.	Check that no CAC has been exceeded before conducting the next test, if this has occurred then the impactor must be re-certified before the next test.
12.4.4.	Replace any damaged part of the vehicle which would affect the results of the next test with new parts according to Section 8.3.
12.4.5.	Repeat procedure given in sections 12.3 and 12.4 for the next impact location.

2.	**AEB CAR-TO-PEDESTRIAN**	
2.1.	**CHILD CROSSING**	
2.1.1.	The test vehicle shall be fitted with AEB System complying to requirements given in AIS-185 for AEB Car-to-Pedestrian	
2.1.2.	To verify compliance, the vehicle manufacturer may sponsor a test according to AIS-185 or shall submit a Test Report issued by Test Agencies conducted per AIS-185	
2.2.	**ADULT CROSSING**	
2.2.1.	The test model shall be fitted with AEB System complying to requirements given in AIS-185 for AEB Car-to-Pedestrian	
2.2.2.	The test shall be conducted with an adult pedestrian target as defined in ISO 19206.	
2.2.3.	To verify compliance, the vehicle manufacturer may sponsor a test according to AIS-185 or shall submit a Test Report issued by Test Agencies conducted per AIS-185	
2.2.4.	The child pedestrian target shall be replaced by an adult pedestrian target when conducting the test for this assessment.	
3.	**AEB CAR-TO-MOTORCYCLIST (CMRm)**	
3.1.	**Definitions**	
	Throughout this protocol the following terms are used.	
3.1.1.	Car-to-Motorcyclist Rear Moving (CMRm) – a collision in which a vehicle travels forwards towards motorcycle going at a constant lower speed and the frontal structure of the vehicle strikes the rear structure of the motorcycle.	
3.1.2.	Vehicle Under Test (VUT) – the vehicle being tested according to this protocol with a pre-crash collision mitigation or avoidance system on board.	
3.1.3.	Motorcyclist Target (MT) The motorcyclist target as defined in ISO 19206:3 2021 shall be used for the assessments	
3.2.	Reference System as defined in AIS 185 shall be used in this assessment	
3.2.1.	Speed of the VUT during the entire test	$\mathbf{V}_{VUT}$
	- V_{impact}, speed when VUT impacts MT	V_{impact}
	- V_{rel_impact}, relative speed when VUT impacts MT	$\mathbf{V}_{rel\_impact}$
3.2.2.	TEST CONDITIONS	
3.2.2.1.	Test Track, Ambient conditions and Data Filtering shall be as mentioned in AIS 185	
3.2.2.2.	Lane Markings	
	Some tests described in this document require the use of two different types of lane markings. These lane markings must conform to one of the lane markings as	

	defined AIS 191 Part 1/ IRC:35-2015 to mark a lane with a width of 3.5 m to 3.7 m when measured from the inside edge of the lane marking: i. dashed line with a width between 0.10 and 0.25 m (0.10 and 0.15 m for centerlines); ii. solid line with a width between 0.10 and 0.25m. The lane markings should be sufficiently long to ensure that there is atleast 20m of marking remaining ahead of the vehicle after the test is complete.  Figure 1: Layout of the lane markings (Dimensions reference inside edge of lane marking)
3.2.2.3.	Surroundings
3.2.2.3.1.	Conduct testing such that there are no other vehicles, highway furniture, obstructions (except where detailed in the test scenario), other objects or persons protruding above the test surface that may give rise to abnormal sensor measurements within: • 5 m on either side of the VUT test path during the full duration of the test and within a longitudinal distance of 20 m ahead of the VUT when the test ends; • a circle of 2 m radius around the MT; and • the visual axis between the geometric centre of the VUT and the circle surrounding the MT  Figure 2: Free space requirements (nearside scenario only)
3.2.2.4.	VUT Preparation shall be as defined in AIS-185 and shall be conducted at the 'Maximum Mass'.

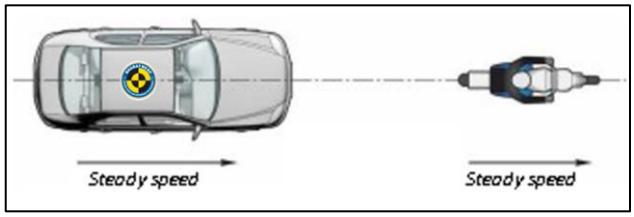
<table>
<tr><td>3.2.2.4.1.</td><td>The vehicle mass condition of ’Maximum Mass’ as defined in AIS-185 shall be followed. This maximum mass shall include the mass of onboard equipment’s, driver and any secondary person if present for noting the results.</td></tr>
<tr><td>3.2.2.4.1.1</td><td>The front/rear axle load distribution needs to be within 5% of the front/rear axle load distribution as specified by the vehicle manufacturer for maximum mass condition.</td></tr>
<tr><td>3.2.2.5.</td><td>VUT Pre-test Conditioning for tyres and brakes shall as per the procedure specified in AIS-185</td></tr>
<tr><td>3.2.2.6.</td><td>Test Scenarios</td></tr>
<tr><td>3.2.2.7.</td><td>The VUT and the MT will travel in the same direction, with the VUT impacting the rear of the motorcycle as shown in figure below
 

Figure 3: CMRm test scenario</td></tr>
<tr><td>3.2.2.8.</td><td>The test speeds for the VUT and the MT shall be as per the table below</td></tr>
<tr><td>3.2.2.8.1.</td><td>Table 1: The scenario of AEB Motorcyclist
<table>
<tr><th></th><th colspan="2">CMRm</th></tr>
<tr><td>VUT speed [km/h]</td><td>40</td><td>60</td></tr>
<tr><td>VUT direction</td><td colspan="2">Forward</td></tr>
<tr><td>Target speed [km/h]</td><td>30</td><td>45</td></tr>
<tr><td>Impact location [%]</td><td colspan="2">50</td></tr>
<tr><td>Lighting condition</td><td colspan="2">Day</td></tr>
</table></td></tr>
<tr><td>3.2.2.9.</td><td>Test Conduct</td></tr>
<tr><td>3.2.2.9.1.</td><td>Before every test run, drive the VUT around a circle of maximum diameter 30 m at a speed less than 10 km/h for one clockwise lap followed by one anticlockwise lap, and then manoeuvre the VUT into position on the test path. If requested by the vehicle manufacturer, an initialisation run may be included before every test run. Bring the VUT to a halt and push the brake pedal through the full extent of travel and release.</td></tr>
<tr><td>3.2.2.9.2.</td><td>For vehicles with an automatic transmission, select D. For vehicles with a manual transmission, select the highest gear where the RPM will be at least 1500 at the test speed. If fitted, a speed limiting device or cruise control function may be used to maintain the VUT speed unless the vehicle manufacturer shows that there are interferences between these devices and the AEB system in the VUT.
Apply only minor steering inputs as necessary to maintain the VUT tracking along the test path.</td></tr>
</table>

3.2.2.9.3.	Perform the first test a minimum of 90 seconds and a maximum of 10 minutes after completing the tyre conditioning, and subsequent tests after the same time period. If the time between consecutive tests exceeds 10 minutes, repeat the tyre conditioning procedures and recommence testing.	
3.2.2.9.4.	Between tests, manoeuvre the VUT at a maximum speed of 50 km/h and avoid riding the brake pedal, harsh acceleration, braking, or turning unless strictly necessary to maintain a safe testing environment.	
3.2.2.10.	Test Execution	
3.2.2.10.1.	The test shall start when the TTC is 4s and is valid when below boundary conditions are met	
	Speed of VUT	Test speed ± 1.0 km/h
	Speed of MT	Test speed ± 1.0 km/h
	Lateral deviation from test path	0± 0.1 m
3.2.2.10.2.	The end of a test is considered when one of the following occurs: i. V_{VUT} = 0 km/h; ii. $V_{VUT} < V_{MT}$; or iii. contact between VUT and MT	
3.2.2.10.3.	Braking is applied, such that it results in a maximum brake level of -4 m/s2 to 0.25 m/s2, when applied in a non-threat situation. The particular brake profile to be applied (pedal application rate applied in 200 ms (maximum 400 mm/s) and pedal force) shall be specified by the manufacturer. When the brake profile provided by the manufacturer results in a higher brake level than allowed, the iteration steps as described in Appendix A – Annexure II will be applied to scale the brake level from 4 m/s2 to 0.25 m/s2.	
3.2.2.10.4.	When no brake profile is provided, the default brake profile as described in Appendix A – Annexure II will be applied.	

Appendix - A

A.1	Test Environment
	Guidelines for the test Environment: • No additional objects/buildings in the observation area • Proving ground surface completely covered with tarmac or concrete • Ground conditions: flat, dry street • No metallic or other strong radar-reflecting parts in-ground or surrounding area

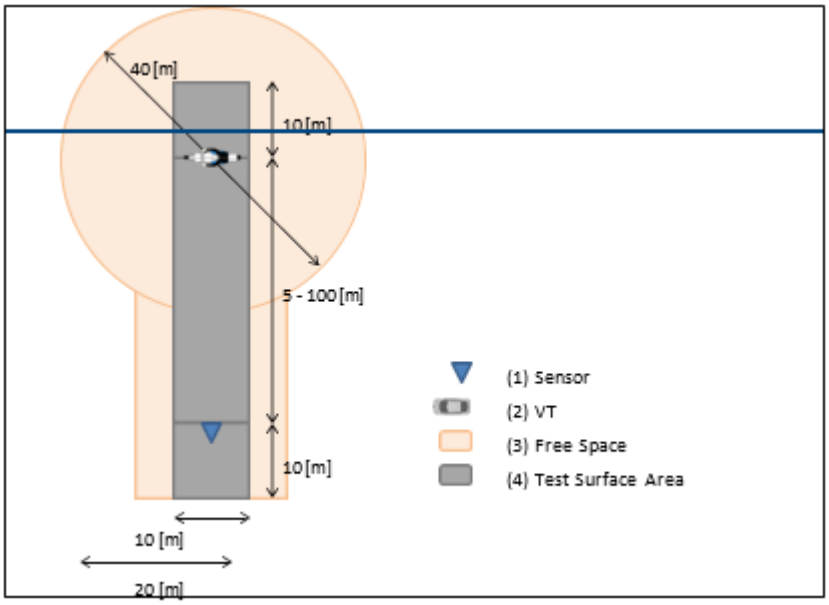


Figure A-1: Test environment

ANNEXURE V

POST CRASH SAFETY TEST PROTOCOL

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1.	**RESUCE SHEET**
1.1.	Vehicle Manufacturer shall design a Rescue Sheet providing information related to Occupant Extrication and Rescue as specified in ISO 17840.
1.2.	As far as possible, the rescue sheet shall have an inbuilt QR code which when accessed shall lead to additional / detailed information which may be available on the official website of the vehicle manufacturer.
1.3.	The vehicle manufacturer will be permitted to make corrections before publication, as long as all material issued by the vehicle manufacturer is updated as well.
1.4.	Rescue Sheet provided by the vehicle manufacturer will be uploaded on the Bharat NCAP website.
2.	**MULTI COLLISION BRAKE**
2.1.	**Introduction**
2.1.1.	The vehicle manufacturer must mention in the vehicle handbook that the vehicle is equipped with an MCB system and it should explain how it works.
2.1.2.	Definitions
2.1.3.	Multi Collision Brake (MCB):
	System fitted to a vehicle that applies the brakes to prevent or mitigate a subsequent impact when a vehicle has been involved in a collision of sufficient severity. In response to a primary collision with or without airbag deployment, information is sent to the braking system to decelerate the vehicle with the intention to bring the vehicle to a standstill. It must not be possible to deactivate the MCB by the driver. After a crash and the vehicle coming to a standstill it is allowed for the MCB to release in order to help first responders move the vehicle.
2.1.4.	MCB trigger signal
	Signal sent from the crash detection function to the braking system during a primary collision.
2.1.5.	The test procedure for the Multi Collision Brake technology consists of a destruction-free demonstration of braking caused by the MCB trigger signal
2.1.6.	Destruction-free MCB test
2.1.6.1.	• The vehicle shall be driven in a straight line, on a dry surface, at a speed of 15km/h ±1km/h. • The MCB trigger signal is simulated on the vehicle network using test and development equipment of the vehicle manufacturer. • If declared necessary by the vehicle manufacturer, the acceleration pedal shall be disengaged immediately prior to simulation of the MCB trigger signal. • The brake pedal must not be engaged by the driver or other means during the entirety of the test. (Video of footwell area and vehicle CAN needed). • The test shall be performed by the vehicle manufacturer with series production vehicles.

	• The vehicle must exceed a minimum deceleration of 3m/s^2 with brake lights illuminated.
2.1.7.	Additional Requirements and Provisions
2.1.7.1.	A vehicle manufacturer -specific name for the MCB technology can be used in the manual.
2.1.7.2.	Additionally, the vehicle manufacturer has to demonstrate the functioning of the feature in a Frontal ODB crash test.
2.1.7.3.	The vehicle manufacturer must demonstrate the MCB function in the official Frontal ODB crash test. The impact can be such that would result in a post-crash movement of the vehicle under testing to verify if the MCB would not have been triggered.
2.1.7.4.	The vehicle CAN data will be recorded for the ODB crash test.
2.1.7.5.	Video recording of the test at a ¾ angle from the rear on driver side to show the brakes lights are Illuminated is required.
2.1.7.6.	It must not be possible to deactivate the MCB system.
3.	**SOS Call / E-call**
3.1.	The vehicle manufacturer can provide an automatic or manual SOS / E-call system
3.2.	Such a system shall allow the occupants inside the vehicle to request for help after a crash or in any emergency situation by either pressing a dedicated button or an automatic system that can initiate a voice call (and optionally a data message with location) to emergency service providers identified by the vehicle manufacturer or predefined contacts fed by the user in the system.
3.3.	The vehicle manufacturer shall publish guidelines on the functionality of SOS / E-call feature in his user manual.
3.4.	As an alternative, the vehicle manufacturer shall submit an in-house test report or a test report issued by test agencies towards the functionality of the system shall be as per UN ECE R144.
3.5.	The SOS call / E-call shall be free of charge for the user.
4.	**AUTOMATIC ACTIVATION OF HAZARD LIGHTS**
4.1.	After all of the official Bharat NCAP crash tests, the hazard warning lights must illuminate automatically.
4.2.	The assessment shall be applicable to the hazard lights present near the vehicle front (headlamp, bumper, bonnet, etc.) and on the vehicle tailgate / boot door.
4.3.	It shall not be applicable to the hazard lights located on ORVM's or vehicle fenders.
4.4.	All of the vehicle hazard lamps shall be covered by the high-speed cameras such that they can be observed in the test videos.

5.	**ENERGY MANAGEMENT**
5.1	**Protection against Electrical shock**
5.1.1.	Requirements specified in AIS 098 and AIS 201 for Protection against electrical shock will be verified during the official Frontal ODB and FWRB test respectively.
5.1.2.	Requirements specified in AIS 099 for Protection against electrical shock will be verified during the official Side MDB and Oblique Side Pole Test.
5.1.3.	Requirements specified in AIS 101 for Protection against electrical shock will be verified during the official Rear Impact Test (MRB50)
5.2	**HV energy disabling method / Mechanical Service Disconnect**
5.2.1.	BharatNCAP encourages an easy and fast disabling method for the HV connection. The vehicle shall be equipped with a Mechanical Service Disconnect switch / provision such that no specific tools or PPE shall be required to disable the HV system via the switch.
5.2.2.	The vehicle manufacturer shall provide one or more of such mechanical disconnect switch / provision.
5.2.3.	If 02 deactivation switches / provisions are provided, the manufacturer shall not provide both of these in the same zone / area of the vehicle (For Eg: 2 manual deactivations in the frontal / rear compartment would not be accepted)
5.3	**Assessment of Fuel Leakage requirements**
5.3.1.	Requirements specified in AIS 098 and AIS 201 for Fuel Leakage will be verified during the official Frontal ODB and FWRB test respectively.
5.3.2.	Requirements specified in AIS 099 for Fuel Leakage will be verified during the official Side MDB and Oblique Side Pole Test.
5.3.3.	Requirements specified in AIS 101 for Fuel Leakage will be verified during the official Rear Impact Test (MRB50)
6.	**OCCUPANT EXTRICATION**
6.1.	**Automatically Activated Door Locking (AADL) System**
6.1.1.	If the vehicle model is equipped with AADL system, the system shall meet the requirements specified in AIS 098, AIS 099 and AIS 201.
6.1.2.	If the variant selected for the official test is equipped with AADL, during the test AADL will be kept in active mode with all vehicle doors locked before the test and no complete or partial deactivation of the system will be allowed.
6.2.	**Door opening forces**
6.2.1.	The post impact door opening forces are measured after the two frontal impact tests for all doors and the unstruck side doors after the side impact tests. Only the side doors (not the tailgate for example) will be checked.

6.2.2.	The unlatching/unlocking of the side doors will already have been checked as part of the automatic door locking section
6.2.3.	Using a gauge attached to the door handle pull the door handle until a maximum force of 750N is registered. The opening force should be applied perpendicular to the door, in a horizontal plane, unless this is not possible. If the door opens before the 750N level is reached note down the opening force. If the door does still not open upon reaching 750N then use tools to open the door.
6.2.4.	When dealing with a sliding door the opening force of [750N]* shall be applied in a direction following the vehicle centreline – door should be pulled in this direction once the door unlatching forces have been carried out (as mentioned previously the unlatching/unlocking check of the side doors will already have been checked as part of the automatic locking doors section.)
6.2.5.	An open hinged door is defined as a door that is opened to an angle of at least 45° relative to the door hinge axis, allowing enough room for occupant extraction.
6.2.6.	An open sliding door is defined as a door that, when opened, presents a minimum opening of at least 500mm compared to the closed position of the door, that would allow the extrication of an occupant. To summarise there are 2 stages to the door opening forces procedure: Load gauge up to 750N and then tools.
	*Force shown is monitored for sliding doors at present, value may be adjusted depending on test experience.
6.3.	**Additional requirements for Electric door handles or handles retracting into door panel and having no possibility for physical grip**
6.3.1.	The door handle should be in the retracted / vehicle in motion position for the test.
6.3.2.	The vehicle manufacturer should inform both the designated agency and the test laboratory if any special action is needed, for example if the engine must be running for the retracting door handles to operate as normal in the test.
6.3.3.	For a retracting door handle it is permitted to apply special actions at the handle to have access to it. For example, pushing in one corner to pivot it and then hold the handle (if no tools are needed at all). This needs to be discussed with the designated agency prior to tests and it must be explained in the Rescue Sheet and also in the vehicle handbook.
6.3.4.	For the official crash tests, with the exception of the struck side doors in the side impacts, the handles of all side doors must be in the extended/ready to open position immediately after the test. It is assumed that by design the door handles will extend outwards ready for use when the SRS system deploys any airbag/detects a severe impact or the door handle remains in its retracted position but can be grabbed nevertheless by the first responder without any tool. The test laboratory personnel will note down the status of each door handle post impact.
6.3.5.	Penalty will be applied where any of the side door handles cannot be used as normal or accessed without tools after the test.

6.3.6.	It is not acceptable to direct the user/owner/rescuer of the vehicle to a cable release for the door in the luggage area for example or to have to connect a slave battery to the vehicle in order to extend the door handles. A vehicle equipped with electric door handles will not be given any special treatment compared to a vehicle with conventional door handles.
6.3.7.	**Tailgate opening**
6.3.7.1.	Tailgate definition: A door which gives rear direct access to the occupants or to any energy disabling equipment as described in the rescue sheet.
6.3.7.2.	After each of the official tests, the tailgate will be checked to ensure it can be opened without the use of tools. These checks will be performed on all types of tailgate handle, electric, manual or otherwise. If the door doesn't open during post crash assessment, penalty shall be applied.
6.3.7.3.	Modifications to the tailgate by the crash test laboratory must not influence the function of the tailgate mechanism. For example, a wire or string connected to the latch mechanism.
6.3.7.4.	The assessment of the tailgate shall be done directly after the crash test or latest together with the door opening test procedure.
6.3.7.5.	Other tailgates or boot doors that are not used as a direct access to the occupants shall not be assessed.
6.4.	**Seat belt buckle unlatching**
6.4.1.	Any position where the seat belt is used for any of the official crash test shall be checked post-test, once all of the door opening forces have been measured. This applies to both adult and child occupants where the vehicle seatbelt is used to restrain them and/or a CRS in the test.
6.4.2.	Unbuckling procedure
6.4.3.	• The load shall be applied directly to the centre point in the direction of the opening movement of the buckle release button. The operator shall hold the buckle with one hand ensuring the application of the force measurement in the correct orientation with the other hand to measure in the axis of the buckle opening movement. The metal probe of the measurement device should only contact the button of the belt buckle and not the surrounding material of the buckle body. The application of force shall be conducted slowly and constantly. • It is permitted to slightly move the adult dummy, child dummy or CRS in order to access the buckle. • No further steps will be taken to open the buckle or tools allowed to cut the belt, unbolt the buckle from the car etc. The test laboratory shall record the load at which each buckle releases.
6.4.4.	The test laboratory should note the load at which each buckle releases.

ANNEXURE VI
ASSESSMENT PROTOCFOL FOR SAFE DRIVING TEST

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1.	**OCCUPANT DETECTION FOR SBR SYSTEM**
1.1.	All designated seating positions in the vehicle's rear rows will be assessed.
1.2.	A maximum of 5.0 points can be awarded for Occupant Detection in the Rear Rows
1.3.	The score will be calculated using below formula. $\frac{\text{Number of seating positions with Occupant Detection}}{\text{Number of seating positions in the row}} \times 5$
1.4.	The maximum score shall be normalized to 5 points for 3-row vehicles
1.5.	Example 1 • If a 5-Seater (2 Front + 3 Rear) vehicle has occupant detection on rear outboard seats only, then vehicle score will be calculated as below: • Score : (2/3) x 5 = 3.333 points • (i.e. Rear occupant detection on 2 seats out of 3 seating positions) Example 2 • If a 5-Seater (2 Front + 3 Rear) vehicle has occupant detection at all designated seating positions in the rear row, then vehicle score will be calculated as below: • Score: (3/3) x 5 = 5.000 points Example 3 • If a 7-Seater (2 Front + 3-pos in 2nd row + 2-pos in 3rd Row) vehicle has occupant detection at all designated seating positions in the 2nd row only, then vehicle score will be calculated as below: • Score: (3/5) x 5 = 3.000 points
2.	**DRIVER DROWSINESS and ATTENTION WARNING (DDAW)**
2.1.	For vehicles complying with the requirements as mentioned in AIS-184, a score of 5.0 points is awarded.
3.	**FORWARD COLLISION WARNING (FCW)**
3.1.	The score available for the assessment is 5.0 points. There shall be no partial or linear scoring for the assessment.
3.2.	The vehicle shall meet the collision warning requirements (Cl 6.1.1) as specified in AIS 185

<table>
<tr><td>4.</td><td>LANE DEPARTURE WARNING</td></tr>
<tr><td>4.1.</td><td>For vehicles complying with the requirements for Lane Departure Warning as mentioned in AIS-191, a score of 5.0 points is awarded.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>5.</td><td>BLIND SPOT DETECTION OR VISUALIZATION</td></tr>
<tr><td>5.1</td><td>Score</td></tr>
<tr><td>5.1.1</td><td>The vehicle can score 5 points for Blind Spot Detection System if conditions given in Table 1 below are met.</td></tr>
<tr><td>5.1.2</td><td>The vehicle can score 5 points for Blind Spot Visualization System if conditions given in Table 2 below are met</td></tr>
<tr><td></td><td>Table 1: Blind spot detection test scoring point
<table>
<tr><th>Side</th><th>Lateral distance TV to SV (meter)</th><th>Status</th></tr>
<tr><td rowspan="2">Driver</td><td>2 to 3</td><td>Detect (total of 3 runs)</td></tr>
<tr><td>6.0</td><td>Not detect (1 run)</td></tr>
<tr><td rowspan="2">Passenger</td><td>2 to 3</td><td>Detect (total of 3 runs)</td></tr>
<tr><td>6.0</td><td>Not detect (1 run)</td></tr>
</table>
Table 2: Blind spot visualization test scoring point.
<table>
<tr><th>Side</th><th>Lateral distance TV to SV (meter)</th><th>Status</th></tr>
<tr><td>Driver</td><td>2 to 3</td><td>Clearly visible</td></tr>
<tr><td>Passenger</td><td>2 to 3</td><td>Clearly visible</td></tr>
</table></td></tr>
<tr><td>5.2.4</td><td>No partial score will be awarded for the assessment.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>6.</td><td>REAR CROSS TRAFFIC ALERT (RCTA)</td></tr>
<tr><td>6.1.</td><td>The vehicle will be awarded 5 points if he requirements mentioned in Cl 6.2 below are met. No partial score shall be awarded for the assessments.</td></tr>
<tr><td>6.2.</td><td>When tested as per the test procedure given for RCTA in Annexure-I, the vehicle shall issue an audio or visual alarm on detection of the specified targets. Such a detection shall be before the VUT crosses the straight ahead movement path of the targets (i.e. the direction perpendicular to the VUT’s reversing direction)</td></tr>
</table>

7.	**TRAFFIC SIGN RECOGNITION**
7.1.	5 points shall be awarded to the test vehicle, when clause 8.3 to 8.7 of the Testing Procedure for Traffic Sign Recognition are met.
7.2.	There shall be no partial scoring for the assessment.
8.	**HILL HOLD CONTROL**
8.1.	The vehicle manufacturer shall produce a test report from the test agency for the Hill Hold Assist function.
8.2.	05 points shall be awarded on the submission of the report.
9.	**SCORING**
9.1.	The maximum score awarded in the vertical is 25 points.
9.2.	Each technology, except the Occupant Detection for SBR system, can either score 5 points or 0 points. There is no partial scoring to these technologies. The score for Occupant Detection for SBR systems will be rounded to 3 decimal places.
9.3.	Out of all technologies provided by the vehicle manufacturer, a maximum of 5 technologies will be awarded a score.
9.4.	If more than 05 technologies are assessed, the score for each technology shall be displayed in the fact sheet.
9.5.	The score achieved by the vehicle is weighted by a factor of 10 to calculate the weighted score for the vehicle.
9.6.	This weighted score is used to calculate the final rating of the vehicle
9.7.	The weighted score shall be rounded to 2 decimal places for final assessments.
9.8.	For Eg. If a vehicle manufacturer provides 3 technologies and scores 15 points, then: Weighted Score = $\frac{15}{25} \times 10 = 6.00$ points

ANNEXURE VII
ASSESSMENT PROTOCOL FOR ACCIDENT AVOIDANCE

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<table>
<tr><td>1.</td><td>ELECTRONIC STABILITY CONTROL (ESC)</td></tr>
<tr><td>1.1.</td><td>ESC system shall meet the requirements of AIS-133.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.</td><td>AUTONOMOUS EMERGENCY BRAKING CAR-TO-CAR</td></tr>
<tr><td>2.1.</td><td>Car-to-Car Rear Stationary</td></tr>
<tr><td>2.1.1</td><td>For vehicles complying with the requirements as mentioned in AIS-185, a score of 5 points is awarded.</td></tr>
<tr><td>2.1.2</td><td>No partial score is awarded for the assessment.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.2.</td><td>Car-to-Car Rear Moving</td></tr>
<tr><td>2.2.1</td><td>For vehicles complying with the requirements as mentioned in AIS-185, a score of 5 points is awarded.</td></tr>
<tr><td>2.2.2</td><td>No partial score is awarded for the assessment.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.3.</td><td>Car-to-Car Rear Braking</td></tr>
<tr><td>2.3.1.</td><td>Maximum score of 10 points shall be awarded to the 04 tests conducted under this assessment.</td></tr>
<tr><td>2.3.2.</td><td>For all of the AEB function tests, the assessment criteria used is the relative impact speed Vrel_impact between the VUT and the GVT.</td></tr>
<tr><td></td><td>The Vrel_impact shall be measured at the first instant of contact between the VUT and the GVT.</td></tr>
<tr><td>2.3.3</td><td>The relative impact speed of the VUT shall be rounded off upto 1 decimal place</td></tr>
<tr><td>2.3.4.</td><td>Where there is no full avoidance a linear interpolation is applied to calculate the score</td></tr>
<tr><td>2.3.5.</td><td>The points available for the different relative impact speed for CCRb are detailed in the table below.</td></tr>
<tr><td></td><td>
<table>
<tr><th>Relative impact speed (V_{rel_impact})</th><th>Points awarded</th></tr>
<tr><td>$0 \leq Vrel\_impact < 5.0$</td><td>2.500</td></tr>
<tr><td>$5.1 \leq Vrel\_impact < 15.0$</td><td>2.000</td></tr>
<tr><td>$15.1 \leq Vrel\_impact < 30.0$</td><td>1.500</td></tr>
<tr><td>$30.1 \leq Vrel\_impact < 40.0$</td><td>1.000</td></tr>
<tr><td>$40.1 \leq Vrel\_impact$</td><td>0.000</td></tr>
</table>
</td></tr>
</table>

3.	**SCORING**
3.1.	The maximum score awarded in the vertical is 25 points.
3.2.	The score achieved by the vehicle is weighted by a factor of 10 to calculate the weighted score for the vehicle.
3.3.	This weighted score is used to calculate the final rating of the vehicle
3.4.	The weighted score shall be rounded to 2 decimal places for final assessments.
3.5.	For Eg. If a vehicle scores 15.50 points from all of the assessments, the final weighted score for the vehicle shall be: Weighted Score = $\frac{15.50}{25} \times 10 = 6.20$ points

ANNEXURE VIII
ASSESSMENT PROTOCOL FOR CRASH PROTECTION

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ASSESSMENT PROTOCOL – ADULT OCCUPANT PROTECTION

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1.	**ASSESSMENT PROTOCOL – ADULT OCCUPANT PROTECTION**
1.1.	**Method of assessment**
1.1.1.	**Points Calculation**
	A sliding scale system of points scoring has been used to calculate points for each measured criterion. This involves two limits for each parameter, a more demanding limit (higher performance), below which a maximum score is obtained and a less demanding limit (lower performance), beyond which no points are scored. Where a value falls between the two limits, the score is calculated by linear interpolation.
1.1.1.1.	Capping
	Capping limits are maintained for criteria related to critical body regions. 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.
1.2.	**HYBRID-III -50TH PERCENTILE**
1.2.1.	**Criteria and Limit Values**
	The basic assessment criteria used for frontal impact, 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. For the frontal offset deformable barrier impact, the lowest scoring body region of driver or passenger is used to determine the score. Capping is applied on the critical body regions: head, neck and chest.
1.2.1.1.	Head
1.2.1.1.1.	Drivers with Steering Wheel Airbags and Passengers
	If a steering wheel airbag is fitted the following criteria are used to assess the protection of the head for the driver. These criteria are always used for the passenger. Note: HIC15 levels above 1000 have been recorded with airbags, where there is no hard contact and no established risk of internal head injury. A hard contact is assumed if the peak resultant head acceleration exceeds 80g or if there is other evidence of hard contact. If there is no hard contact a score of 4 points is awarded. If there is hard contact, the following limits are used: *Higher performance limit* HIC_{15} 500 Resultant Acc. 3 msec exceedence 72g

	Lower performance and capping limit HIC_{15} 700 (20% risk of injury ≥ AIS3 [1,2]) Resultant Acc. 3 msec exceedence 80g
1.2.1.1.2.	Drivers with No Steering Wheel Airbag
	If no steering wheel airbag is fitted, and the following requirements are met in the frontal impact test: HIC_{15} <700 Resultant Acc. 3 msec exceedance <80g, *Higher performance limit* Resultant peak Acc. 80g Resultant Acc. 3 msec exceedence 65g *Lower performance and capping limit* HIC_{15} 700 Resultant peak Acc. 120g Resultant Acc. 3 msec exceedence 80g
1.2.1.2.	Neck
	Higher performance limit Shear 1.9kN @ 0 msec, 1.2kN @ 25 - 35msec, 1.1kN @ 45msec Tension 2.7kN @ 0 msec, 2.3kN @ 35msec, Extension 42Nm *Lower performance and capping limit* 1.1kN @ 60msec Shear 3.1kN @ 0msec, 1.5kN @ 25 - 35msec, 1.1kN @ 45msec* Tension 3.3kN @ 0msec, 2.9kN @ 35msec, Extension 57Nm* (Significant risk of injury [4]), 1.1kN @ 60msec*
1.2.1.3.	Chest
	Higher performance limit Compression 22mm (5% risk of injury □ AIS3 [5]) Viscous Criterion 0.5m/sec (5% risk of injury □ AIS4) *Lower performance and capping limit* Compression 42mm Viscous criterion 1.0 m/sec (25% risk of injury □ AIS4)
1.2.1.4.	Knee, Femur and Pelvis
	Higher performance limit Femur Compression 3.8kN (5% risk of pelvis injury) Knee slider compressive displacement 6mm

	Lower performance and capping limit Femur Compression 9.07kN @ 0msec, 7.56kN @ 10msec (Femur fracture limit) Knee slider compressive displacement 15mm (Cruciate ligament failure limit)
1.2.1.5.	Lower Leg
	Higher performance limit Tibia index 0.4 Tibia Compression 2kN *Lower performance and capping limit* Tibia index 1.3 Tibia Compression 8kN (10% risk of fracture [4,8])
1.2.1.6.	Foot/Ankle
	Higher performance limit Pedal rearward displacement 100 mm *Lower performance and capping limit* Pedal rearward displacement 200 mm 1. *Pedal displacement is measured for all pedals with no load applied to them.* 2. *If any of the pedals are designed to completely release from their mountings during the impact, no account is taken of the pedal displacement provided that release occurred in the test and that the pedal retains no significant resistance to movement.* 3. *If a mechanism is present to move the pedal forwards in an impact, the resulting position of the pedal is used in the assessment.* 4. *The passenger's foot/ankle protection is not currently assessed.*
1.3.	**HYBRID III – 5TH PERCENTILE**
1.3.1.	**Criteria and Limit Values**
	• The basic assessment criteria used for the full width frontal impact test, 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. • High and Low performance limit and their according scores are applicable to the Front Passenger dummy used in the Frontal Full Width test. • For the Rear Passenger dummy, it is required that the dummy meets only the capping limits for the body regions.

1.3.1.1.	Head
	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. *Higher performance limit* HIC15 500 Resultant Acc. 3 msec exceedence 72g *Lower performance and capping limit* HIC15 700 Resultant Acc. 3 msec exceedence 80g
1.3.1.2.	Neck
	Higher performance limit Shear 1.2 kN Tension 1.7 kN Extension 36 Nm *Lower performance* Shear 1.95 kN Tension 2.62 kN Extension 49 Nm *Capping limit* Shear 2.7 kN Tension 2.9 kN Extension 57 Nm
1.3.1.3.	Chest
	Higher performance limit Compression 18mm Viscous Criterion 0.5m/sec *Lower performance and Capping limit* Compression 34mm Viscous Criterion 1.0m/sec
1.3.1.4.	Knee, Femur and Pelvis
	The knee, femur, pelvis region is assessed by the femur compression: *Higher performance limit* Femur compression 2.6 kN

	Lower performance limit Femur Compression 6.2 kN *Capping Limit* Femur Compression 7.0 kN The knee slider displacement are measured for monitoring purpose only.
1.3.1.5.	Lower Leg
	The Lower Legs are measured for monitoring purpose only.
1.4.	**WORLDSID - 50th PERCENTILE**
1.4.1.	**Criteria and Limit Values**
	• The basic assessment criteria used for both side barrier and pole impacts, with the upper and lower performance limits along with the capping limits for each parameter, are summarised below. • For the Side Impact test, a maximum of four points are available for each body region. Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. There is no limit to the number of modifiers that can be applied. • For Side Pole tests, four points are awarded on meeting the capping limit requirements of the head region. Additional one point per region is awarded for meeting the capping limit requirements of shoulder force, chest, abdomen and pelvis. No linear scaling of scores shall apply to the Pole Side Impact test. • For both side MDB and pole impacts, capping is applied on the head, chest, abdomen and pelvis. Where no head protection systems are present, the pole test will not be allowed and the points for that test are set to zero. • Meeting the Head capping limit is mandatory for scoring in the Pole Test. If the vehicle does not meet the head capping limit, the Adult Occupant Protection score for that test will be considered as 'zero'. • Note: The requirement is for the fitment of a 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 head airbags, the manufacturer is requested to provide evidence that the system is effective, at least in principle, before a test can be allowed.
1.4.1.1.	**Head**
1.4.1.1.1.	**Side Impact**
	Higher performance limit HIC15 500 Resultant Acc. 3 msec exceedence 72g

	Lower performance and capping limit HIC15 700 (20% risk of injury AIS3) Resultant Acc. 3 msec exceedence 80g
1.4.1.1.2.	**Side Pole**
	Capping limits HIC15 <700 Peak Resultant Acc <80g No direct head contact with the pole
1.4.1.2.	**Shoulder Force (Oblique Side Pole)**
	The peak lateral shoulder force shall not exceed 3.0 kN
1.4.1.3.	**Chest (Side MDB and Oblique Side Pole)**
	The assessment is based on the worst performing individual rib lateral compression. MDB Higher performance limit Lateral Compression 28mm (5% risk of AIS3, 67YO) MDB Lower performance and capping limit Lateral Compression 50mm (30% risk of AIS3, 45YO) Pole Capping limit Lateral Compression 55mm (50% risk of AIS3, 45YO)
1.4.1.4.	**Abdomen (Side MDB and Side Pole)**
	Higher performance limit Lateral Compression 47mm (33% risk of AIS3, 67YO) *Lower performance and capping limit* Lateral Compression 65mm
1.4.1.5.	**Pelvis (Side MDB and Side Pole)**
	Higher performance limit Pubic Symphysis Force 1.7kN (5% risk of AIS3, 67YO) *Lower performance and capping limit* Pubic Symphysis Force 2.8kN (20% risk of AIS3, 45YO *Pole Capping limit* Pubic Symphysis Force 3.36 kN

<table>
<tr><td>1.5</td><td>STATIC WHIPLASH TEST - ASSESSMENT PROTOCOL</td></tr>
<tr><td></td><td></td></tr>
<tr><td>1.5.1</td><td>Front Row - Head Restraint</td></tr>
<tr><td></td><td>The vehicle manufacturer shall offer a Head Restraint compliant to IS 15546 Revision 1 / ECE R17.10</td></tr>
<tr><td>1.5.2</td><td>Rear Row - Head Restraint</td></tr>
<tr><td></td><td>The vehicle manufacturer shall offer a Head Restraint compliant to IS 15546 Revision 1 / ECE R17.10</td></tr>
<tr><td>1.5.3</td><td>2 points shall be awarded for Head Restraints installed for the designated seating positions in the Front Row.</td></tr>
<tr><td>1.5.4</td><td>3 points shall be awarded for Head Restraints installed for the designated seating positions in the Rear Rows.</td></tr>
<tr><td>1.5.5</td><td>Example of the scoring scheme is as shown below:
Here, in this table, HR – Availability of Head Restraint at the seating position.</td></tr>
<tr><td></td><td>Table 1: Scoring scheme
<table>
<tr><th></th><th colspan="2">Front Row</th><th colspan="3">2nd Row</th><th colspan="3">3rd Row</th></tr>
<tr><th></th><th>Pos 1</th><th>Pos 3</th><th>Pos 4</th><th>Pos 5</th><th>Pos 6</th><th>Pos 7</th><th>Pos 8</th><th>Pos 9</th></tr>
<tr><td rowspan="2">5-seater vehicle-1</td><td>HR</td><td>HR</td><td>HR</td><td>HR</td><td>HR</td><td colspan="3" rowspan="2">NA</td></tr>
<tr><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td></tr>
<tr><td rowspan="2">5-seater vehicle-2</td><td>HR</td><td>HR</td><td>HR</td><td>--</td><td>HR</td><td colspan="3" rowspan="2">NA</td></tr>
<tr><td>1.0</td><td>1.0</td><td>1.0</td><td>0.0</td><td>1.0</td></tr>
<tr><td rowspan="2">7-seater vehicle-1</td><td>HR</td><td>HR</td><td>HR</td><td>HR</td><td>HR</td><td>HR</td><td>NA</td><td>HR</td></tr>
<tr><td>1.0</td><td>1.0</td><td>0.6</td><td>0.6</td><td>0.6</td><td>0.6</td><td>NA</td><td>0.6</td></tr>
</table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>1.6</td><td>REAR IMPACT TEST - ASSESSMENT PROTOCOL</td></tr>
<tr><td>1.6.1</td><td>The vehicle shall meet all the requirements specified in AIS 101 (Rev. 1) as amended from time to time.</td></tr>
<tr><td>1.6.2.</td><td>Additionally, the vehicle shall meet the following conditions:
a) None of the doors shall open during impact
b) The vehicle doors shall remain unlocked after the test
It shall be possible to open atleast one of the vehicle front doors within a force value of 750N and without use of any tools.</td></tr>
<tr><td>1.6.3.</td><td>The vehicle shall be awarded 5 points if the requirements of Cl 1.6.1 and 1.6.2 both are met.</td></tr>
</table>

ASSESSMENT PROTOCOL – CHILD OCCUPANT PROTECTION

1	**VEHICLE HANDBOOK INFORMATION**
	Consumers should be able to rely on the information given in the vehicle handbook to determine which CRS suits them and their children best. The information provided should clearly state what is, and moreover, what is not possible in terms of installing child restraint systems on the different seating positions in the vehicle. The vehicle handbook needs to detail, in tabular format, the CRS categories (Universal, ISOFIX and i-Size as defined in UN Regulation 16) that are suitable or not suitable for installation for each passenger seating position. Where any of the applicable tables in the section below are not present, the CRS installation and vehicle based assessments will not be performed and 0 points shall be awarded in these areas. It is acceptable for the table to be annexed in the vehicle handbook or provided on a permanent website provided that clear references are provided in the vehicle handbook.
1.1	**Universal (Belted) CRS Table**
	The Universal CRS table should clearly detail on which seating positions a Universal CRS can be installed (and not installed) using the vehicle's seatbelt. This is to be done for every Universal CRS weight group, using the following key of letters to be used in the table: U: Suitable for "Universal" category restraints approved for use in this mass group. U(*) or U(R) will also be permitted provided that there is an accompanying key. UF: Suitable for forward-facing "Universal" category restraints approved for use in this mass group. L: Suitable for particular child restraints given on attached list. These restraints may be of the "Specific vehicle", "Restricted" or "Semi-universal" categories. B: Built-in restraint approved for this mass group. X: Seat position not suitable for children in this mass group.
1.2	**ISOFIX CRS Table**
	The ISOFIX CRS table should clearly detail which seating positions can be used (and not used) for installing an ISOFIX CRS. This is to be done for every ISOFIX CRS size class and/or type of fixture using the following key of letters to be used in the table: IUF: Suitable for ISOFIX forward child restraints systems of Universal category approved for use in the mass group IL: Suitable for particular ISOFIX child restraint systems (CRS) given in the attached list. These ISOFIX CRS are those of the "specific vehicle", "restricted" or "semi-universal" categories. IL-SU will also be permitted provided that there is an accompanying key. X: ISOFIX position not suitable for ISOFIX child restraint systems in this mass group and/or this size class.
1.3	**i-Size CRS Table**
	The i-Size CRS table should clearly detail which seating positions can be used for installing an i-Size CRS using the following key of letters to be used in the table: i-U / i-UF: Suitable for i-Size "universal" CRS forward and/or rearward facing. X : Seating position not suitable for i-Size "universal" CRS.

<table>
<tr><td>1.4</td><td>Airbag Disabling</td></tr>
<tr><td>1.4.1</td><td>Where a passenger frontal airbag is fitted (both front and rear seats if applicable) all CRS tables in the vehicle handbook must clearly indicate that when these passenger airbags are active the seat is NOT suitable for any rearward facing CRS. This is to be done with the use of two separate columns in the relevant tables, Universal, ISOFIX and i-size where appropriate. One column shall indicate the CRS installation options with the airbag ON and the second column with the airbag OFF. Below is a representative table for the same.</td></tr>
<tr><td></td><td>
<table>
<tr><td></td><td colspan="2">Front passenger seat</td><td>Rear Outboard seats</td><td>Centre rear seat</td></tr>
<tr><td></td><td>Airbag activated</td><td>Airbag deactivated</td><td></td><td></td></tr>
<tr><td>Group 0</td><td>X</td><td>U</td><td>U</td><td>U</td></tr>
<tr><td>Group 0+</td><td>X</td><td>U</td><td>U</td><td>U</td></tr>
<tr><td>Group I</td><td>X</td><td>U</td><td>U</td><td>U</td></tr>
<tr><td>Group II</td><td>U</td><td>U</td><td>U</td><td>U</td></tr>
<tr><td>Group III</td><td>U</td><td>U</td><td>U</td><td>U</td></tr>
</table>
</td></tr>
<tr><td>1.4.2</td><td>Where a vehicle is equipped with a low risk deployment frontal airbag and it may not be necessary to deactivate the airbag, then such details must be informed in the handbook indicating that this airbag can remain active when installing a RWF CRS. A clear explanation as to why it is safe for the airbag to remain enabled must also be provided in the handbook. The vehicle manufacturer must provide convincing data to the Designated Agency to show that the frontal airbag can indeed be considered as low risk.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>2.</td><td>CRS Installation Scoring</td></tr>
<tr><td>2.1.</td><td>Each eligible CRS-seating position combination from the Installation Matrix will be assessed. 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 Integrated CRS-seating combination meets the relevant requirements. Where the requirements of Sections above are not met, the CRS-Seating position combination is considered as a fail.</td></tr>
<tr><td>2.2.</td><td>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.</td></tr>
<tr><td>2.3.</td><td>The installation score CRSi = $\sum \frac{T_i - F_i}{T_i}$</td></tr>
</table>

	Ti = Total number of eligible positions in the vehicle for the CRSi.
	Fi = Number of failed installations,
	and where i = 1, ..., M; the total number of CRS on the extended Installation List.
2.4.	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'.
2.5.	Separate points will be given for fitment of the CRS as follows:
2.6.	Installation listed CRS: **10 points**
	Vehicle Manufacturer (VM) Recommended CRS: **2 points**
2.7.	The CRS score is calculated by taking the average of the CRSi 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.
2.8.	The VM Recommended CRS score is calculated by taking the average of the CRSi 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.
2.9.	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.
2.10.	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
2.11.	If there is no recommendation for CRS, the maximum available score for CRS fitment will be **10 points**.
2.12.	The resulting point scores per CRS is expressed as numbers, with 3 decimal points. The total score for CRS installation is the sum of the points for fitment all CRS's.

Table 1. list of CRS installations

Sr. No.	CRS Description	Applicable Mass Group
1	Joie gemm	Group 0+
2	Joie gemm with i-base encore	Group 0+
3	Joie I -steadi	Group 0+, I
4	Cybex Solution B3 i-Fix	Group I, II, III
5	Maxi Cosi Titan-S	Group I, II, III
6	Chicco Unico Evo I-Size	Group I, II, III
7	Britax EVOLVAFIX	Group I, II, III
8	VM Recommended CRS (Q1.5, Q3)	Group 0+, I
9	VM Recommended CRS (Q6, Q10)	Group II, III

2.13. Legend:

Pass	CRS can be installed correctly
Fail	CRS fails installation requirements, 0 points awarded
Exempt	Vehicle handbook or exempt the CRS from being installed on that seating position
N/A	This combination of CRS and seating position is not applicable

Table 2: Example of CRS installation scoring

	CRS	1st Row	2nd Row			3rd Row	Scoring			
		Right	Right	Centre	Left		Pass	Fail	Exempt	Score
Reference List	Joie gemm	Exempt	Pass	Exempt	Pass	NA	2	0	2	100.0%
	Joie gemm with i-base encore	Exempt	Pass	Exempt	Pass	NA	2	0	2	100.0%
	Joie I -steadi	Exempt	Pass	Exempt	Pass	NA	2	0	2	100.0%
	Cybex Solution B3 i-Fix	Pass	Fail	Exempt	Fail	NA	1	2	0	33.3%
	Maxi Cosi Titan-S	Pass	Fail	Exempt	Fail	NA	1	2	0	33.3%
	Chicco Unico Evo I-Size	Fail	Pass	Exempt	Pass	NA	2	1	0	66.7%
	Britax EVOLVAFIX	Fail	Pass	Exempt	Pass	NA	2	1	0	66.7%
OEM	OEM Specified (Q1.5,Q3)	Exempt	Pass	Exempt	Pass	NA	2	0	2	100.0%
	OEM Specified (Q6,Q10)	Exempt	Pass	Exempt	Pass	NA	2	0	2	100.0%

Summary	
Reference List	7.104
OEM Specified	2.000
TOTAL CRS INSTALLATION SCORE	9.104

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

3. DYNAMIC ASSESSMENT

The starting point for the dynamic assessment of child occupant protection is the dummy response data recorded in two different test configurations: frontal impact in offset and side impact. 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 the defined modifiers.

From the information collected in the two test scenarios, individual test scores are computed for both the Q6 and Q10 dummy. Where a vehicle is available with optional 2nd seat row on any variant, the dynamic assessment will be based on a vehicle fitted with the optional seats.

3.1. Points Calculation

A sliding scale system of points scoring is used to calculate points for each measured criterion where a higher and lower performance limit exists. Where a value falls between the two limits, the score is calculated by linear interpolation. If only a lower performance limit is available for a criterion, this limit is used as a “Pass”/ “Fail” criteria.

	Capping limits are applied to both child dummies and exceeding a capping limit generally indicates unacceptable high risk of injury. Where a dummy measurement has exceeded a capping limit, the score of that entire dummy will be 0 points in the impact in which the limit was exceeded.
3.2.	**Criteria and Limit Values**
	The basic assessment criteria used for frontal impact, 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. Injury parameter assessments detailed in the tables below will not be evaluated during the rebound phase.
3.2.1.	Precondition
	If the restraint system is unable to keep the child dummy restrained that dummy will be penalised for its dynamic performance in the impact in which the issue occurred.
3.2.1.1.	Restraint
	• During the forwards movement of the dummy only, the diagonal belt slips off the shoulder. Where this occurs zero points will be awarded to the dummy. Slipping of the shoulder is when the belt moves below the shoulder joint down the upper arm. • During the forwards movement of the dummy only, the diagonal belt moves into the gap between the clavicle and upper arm with folding of the belt webbing. Where this occurs a penalty of -4 points will be applied to the overall dummy score of the impact in which it occurs. • During the forwards movement of the dummy only, at any time throughout the impact either the pelvis of the dummy submarines beneath the lap section of the belt or the lap section does not prevent the dummy from moving upwards during rebound and is no longer restraining the pelvis. The same shall be monitored during the dynamic tests.
3.2.1.2.	Ejection
	Dummy ejection will be evaluated at any time throughout both the front and side impacts. The dummy pelvis does not remain in the booster seat or on the booster cushion and is not correctly restrained by the lap section of the seatbelt. The CRS does not remain within the same seating position or in no longer correctly restrained by the adult belt. It must not be displaced onto the floor or any other part of the rear seat/occupant compartment.
3.2.1.3.	Failure of restraint system components
	Failure of the restraint system components will be evaluated at any time throughout both the front and side impacts. There is any breakage or fracturing of load-bearing parts of the belt system including

	buckles, webbing and anchorage points. There is any breakage or fracturing of any seat belt lock-offs, tethers, straps, ISOFIX anchorages, backrest to booster cushion connections or any other attachments which are specifically used to anchor the CRS to the vehicle fail.
3.2.2.	Frontal Impact
3.2.2.1.	Head contact
	If there is hard contact seen on the high speed film, the head score is based on the Resultant 3ms acceleration and HIC15 values.
3.1.1.	Side Impact
3.1.1.1.	Head contact
	If there is hard contact seen on the high speed film, the head score is based on the Resultant 3ms acceleration and HIC15 values.
3.1.1.2.	Side Impact Criteria
	The contribution of the Dynamic Score to the Child Occupant Protection Score is calculated by summing the body scores for the relevant body regions for the Q6 and Q10 in both front and side impact (24 in total).

Table 3: Frontal impact criteria, limits and available points per body region for Q6, Q10

	Criteria	Performance Limits			Available points
		Higher	Lower	Capping	
Head Score	HIC15	500	700	800	4 Points
	Resultant 3ms acceleration	60g	80 g	80 g	
	Head excursion (Monitoring) Q6 Q10	 450mm	 550mm 550mm	 NA NA	
Upper Neck	Tension Fz	1.7kN	2.62kN	(monitoring)	2 Points
	Extension My (with head to interior contact) Q6 Q10	 NA NA	 36Nm 49Nm	 NA NA	

Chest (T4)	Resultant Force Q6 Q10	NA 41g	NA 55g	NA 55g	NA 2 Points
	Deflection Q6 Q10	30 mm (monitoring)	42 mm (monitoring)	NA (monitoring)	2 Points NA
Pelvis	ASIS load	NA	NA	NA	
TOTAL					8 points /dummy

Table 4. Side impact criteria, limits and available points per body region for Q6, Q10

	Criteria	Performance Limits			Available points
		Higher	Lower	Capping	
Head Score	HIC15 (with hard contact)	500	700	800	2 Points
	Resultant 3ms acceleration	60 g	80 g	80 g	
Upper Neck	Resultant Force Q6 Q10		 2.4kN 2.2kN	 NA (monitoring)	1 Point
Chest (T4)	Resultant 3ms acceleration		67 g	NA (monitoring)	1 Point
TOTAL					4 points/dummy

4.	**VEHICLE BASED ASSESSMENTS**
4.1.	**ISOFIX Seating Positions**
4.1.1	If both the rear outboard seats are compliant as per the conditions a) to g) set below, 4 points will be awarded to the vehicle.
	a) The ISOFIX/i-size system present in the vehicle shall be approved according to UN Regulation 14 or AIS-182
	b) It is required that the vehicle manufacturer shall submit a test report for these seating positions complying to the specified regulations.
	c) The ISOFIX/i-size seating positions must meet the applicable label marking requirements according to the UN Regulation 14/UN Regulation 145/AIS-182
	d) The location of each i-Size anchorage must be marked. The location of each top tether anchorage must be marked and include both text and a pictogram.
	e) All markings and labels must be of conspicuous design.
	f) All markings and labels must be permanently visible.
	g) All markings and labels must be permanently attached to the vehicles.

	h) In addition, these seating positions must be marked with 'IL' or 'IUF' in the ISOFIX CRS table detailed in the vehicle handbook
4.1.2	Where the vehicle is provided with an additional ISOFIX/i-size compliant seating position other than the 2nd row outboard seating position that meets the above requirements and can correctly accommodate an i-Size CRS, additional 2 point shall be awarded.
4.2.	**Three Simultaneous Use Seating Positions**
	a) 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. A combination of three CRS will be used to assess this, which may be proposed by the vehicle manufacturer. 1 point shall be awarded to the Child Protection score
	b) If the vehicle manufacturer recommends the front passenger seat for a Rearward Facing CRS, presence of a Passenger Airbag Disabling provision as a standard fitment is mandatory. If such a system is not present, the front passenger seat will not be considered for assessment of a rear ward facing CRS irrespective of the manufacturer recommendations.
	c) 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.
4.3.	**Two or more Largest ISOFIX Positions**
	a) For vehicles with rear seats, two or more passenger seats should be suitable for simultaneous use with the largest size of rearward facing (Class C) ISOFIX CRS, Fixture (CRF) ISO/R3. The vehicle shall be awarded 1 point for meeting the requirement for fitment of the CRF.
	b) When checking a CRF behind the driver seat, the driver seat may be adjusted longitudinally forward but not further than the mid position between its 95th 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. The full range of seat height adjustment can be used. All adjustments of any passenger seats are permissible to install the fixture.
	c) For vehicles without rear seats, one or more passenger seats shall be suitable for simultaneous use with the largest size of rearward facing (Class C) ISOFIX CRS, Fixture (CRF) ISO/R3
	d) The vehicle handbook must inform the user that the vehicle is capable of accommodating the ISO/R3 fixture.

4.4.	**Passenger Airbag Disabling**	
	For manual airbag deactivation, 2 points will be awarded when requirements for manual switches in sections 4.4.1, 4.4.2 and 4.4.3 are met. For automatic airbag deactivation, 4 points will be awarded when the below requirements in sections 4.4.1, 4.4.2 and 4.4.4 are met. The passenger airbag disabling method must be a standard fitment across the vehicle model to be eligible for assessment in this section.	
4.4.1.	If the passenger airbag can be de-activated, the following requirements shall be met	
	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.	
4.4.2.	Airbag status indicator requirements:	
	a) Easily visible information and warnings must be provided for the driver and front seat passenger, showing the status of the airbag	
	b) 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.	
	c) The AIRBAG ON pictogram must be based upon that of the sun visor label (ECE R94 or AIS-098) as shown:	
	d) The AIRBAG OFF pictogram must be based upon that detailed in ECE R121 as shown	
	e) 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.	
	f) If the information to indicate that the airbag is enabled is provided by an illuminated signal, the signal is required to be illuminated for a period of atleast 60 seconds after the ignition is switched on.	
	g) Information to indicate that the airbag is disabled must be permanently displayed, when the ignition is on.	
	h) 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.	

4.4.3	Manual airbag deactivation requirements:
	a) 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.
	b) 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 and OFF along with the corresponding pictogram.
	c) 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.
	d) Where a hardware switch is used, it must be accessible and clearly visible when installing CRS.
	e) 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.
	f) It must not be possible for a rearward facing child; restrained on the front passenger seat; to operate the switch at any time.
	g) 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.
	h) 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.
4.4.4	Automatic airbag deactivation requirements:
	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
	a) The system must ensure that the airbag is OFF for ANY rearward facing CRS and obviate any risk associated with airbag deployment
	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.

5.	**TWO SEATERS AND VEHICLES WITH LIMITED REAR SPACE**

	This Section details how protection for children is assessed by BNCAP in vehicles equipped with two seats and in vehicles where space is limited in the rear
5.1.	**Vehicles with only Two Seats**
5.1.1.	CRS installation assessment
5.1.1.1.	The "Installation CRS List" and any car manufacturer recommended seats will be installed on the passenger seats. Where the passenger seat is able to meet the requirements specified above for applicable CRS the vehicle will be awarded 12 points.
5.1.1.2.	All groups (0-III) are represented by the CRS Installation List and the car must pass the installation for all these CRS.
5.1.1.3.	When the manufacturer exempts the front passenger seat, 0 points will be awarded for the CRS installation assessment.
5.1.2.	Dynamic assessment
5.1.2.1.	For two seater sports cars there will be no dynamic assessment, thus leading to 0 points for dynamic assessment.
5.1.3.	Vehicle based assessments
5.1.3.1.	The following vehicle based assessments will be applied to two seater vehicles
5.1.3.2.	ISOFIX Usability
	When the passenger seat is in compliance with the requirements, 4 points shall be awarded to the Child Protection score.
5.1.3.3.	Largest ISOFIX Positions
	When the passenger seat can accommodate a largest ISOFIX, 1 point shall be awarded to the Child Protection score.
5.1.3.4.	Passenger Airbag Warning Marking and Disabling
5.1.4.	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.
	For automatic airbag deactivation, 4 points will be awarded. For manual switches, 2 points will be awarded.
5.2.	**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 BNCAP 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.

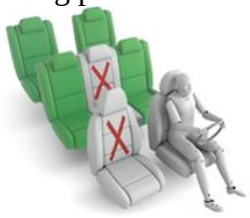
5.2.1.	CRS installation assessment
5.2.1.1.	The CRS Installation List seats and any car manufacturer recommended seats will be installed on the passenger and rear seats, using the front seat settings as specified in the vehicle handbook. Where the passenger seat is able to meet the requirements for CRS Installation tests, the vehicle will be awarded 12 points.
5.2.2.	Dynamic assessment
5.2.2.1.	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 BNCAP 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.
5.2.2.2.	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, BNCAP will indicate that it was not possible to install the CRS with and adult in the normal BNCAP front seat test position. A maximum of 24 points can be achieved.
6.	**Scoring and Visualisation**
6.1.	**Scoring**
6.1.1.	The maximum number of points available for child protection (including limited rear space and two seaters) is 49. The maximum points available in each assessment area is as follows: Dynamic Assessment: With rear seats 24, Without rear seats 24 Installation of Child Restraints: With rear seats 12, Without rear seats 12 Vehicle Based Assessments: With rear seats 12, Without rear seats 09 The child protection score will be the sum of all three areas. The tables below summarise the maximum possible score in each (sub)category.
6.1.2.	Normal and Limited Rear Space Vehicles

Category	Total points 48
Dynamic Assessment	**24**
Frontal Impact	16
Side Impact	8
Vehicle Based Assessments	**12**
02 ISOFIX / i-Size seating positions	4
Additional ISOFIX / i-Size seating positions	2
Two or more ISO/R3 Positions	1
Passenger Airbag Warning Marking and Disabling	4 or 2
Three Simultaneous use of CRS	1
Installation of Child Restraints	**12**
Installation List	10
Recommended seats	2

6.1.3. Two Seater Vehicles

Category	Total points 45
Dynamic Assessment	**24**
Frontal Impact	16
Side Impact	8
Vehicle Based Assessments	**9**
01 ISOFIX / i-Size seating positions	4
01 ISO/R3 Positions	1
Passenger Airbag Warning Marking and Disabling	4 or 2
Installation of Child Restraints	**12**
Installation List	10
Recommended seats	2

<table>
<tr><td>6.2.</td><td>Visualization</td></tr>
<tr><td>6.2.1.</td><td>Dynamic protection</td></tr>
<tr><td></td><td>The dynamic protection provided to children for each body region is 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 mentioned in the below table.</td></tr>
<tr><td></td><td>
<table>
<tr><td colspan="2">Number of points available for body region:</td><td>4 points</td><td>2 points</td><td>1 point</td></tr>
<tr><td>Green</td><td>‘Good’</td><td>4.000</td><td>2.000</td><td>1.000</td></tr>
<tr><td>Yellow</td><td>‘Adequate’</td><td>2.670 – 3.999</td><td>1.335 – 1.999</td><td>0.667 – 0.999</td></tr>
<tr><td>Orange</td><td>‘Marginal’</td><td>1.330 – 2.669</td><td>0.667 – 1.334</td><td>0.333 – 0.664</td></tr>
<tr><td>Brown</td><td>‘Weak’</td><td>0.001 – 1.329</td><td>0.333 – 0.666</td><td>0.001 – 0.332</td></tr>
<tr><td>Red</td><td>‘Poor’</td><td>0.000</td><td>0.000</td><td>0.000</td></tr>
</table>
</td></tr>
<tr><td>6.2.2.</td><td>Installation CRS</td></tr>
<tr><td></td><td>The results of the CRS installation check will be shown in terms of “Pass”, Fail”, “Exempt” or “N/A” in tabular format.</td></tr>
<tr><td>6.2.3.</td><td>Visualization of installation CRS.</td></tr>
<tr><td></td><td>The website will present the installation results of each CRS in a map of the vehicle. Four possible outcomes will be presented to indicate the following:
● Install without problem
The CRS could be installed on that seating position safely, easily and without any issues.
● Installation failure
The CRS could not be installed on that seating position. Issues arose that prevented the CRS from being installed correctly and safely.

X Installation prohibited - Where X is in handbook –
It is prohibited to install a CRS on this seating position. The vehicle handbook indicated X for that particular seating position.
  </td></tr>
</table>

3.	**SCORING FOR THE CRASH PROTECTION VERTICAL**
3.1.	The maximum score awarded in the vertical is 114 points.
3.2.	The score achieved by the vehicle in the individual tests is rounded to 3 decimal places.
3.3.	The scores achieved by the vehicle in the Adult Occupant Protection and Child Occupant Protection are added together and rounded to 2 decimal places.
3.4.	This score achieved by the vehicle is weighted by a factor of 55 to calculate the weighted score for the vehicle in the crash protection vertical.
3.5.	The weighted score is rounded to 2 decimal places for consideration in the final score.
3.6.	For Eg. If a vehicle manufacturer scores 89.63 points from all assessments of the vertical, then: Weighted Score = $\frac{89.63}{114} \times 55$ = 43.24 points

ANNEXURE IX

ASSESSMENT PROTOCOL FOR VULNERABLE ROAD USER PROTECTION

TABLE OF CONTENTS

A.	**ASSESSMENT PROTOCOL – PEDESTRIAN PROTECTION**
A.1	**Introduction**
	The following protocol deals with the assessments made in the area of Pedestrian Protection, in particular in the adult and child headform, the upper leg form, lower leg form impacts and AEB VRU
A.1.1	METHOD OF ASSESSMENT
	The assessment of pedestrian protection is made with the use of headform, upper legform, lower legform impact and AEB test data. In the legform areas, the bumper and front of the bonnet of the car will be marked with a grid and are assessed using the two legform impactors. Bharat NCAP will test "worst case" grid points and manufacturers may nominate additional tests to be performed and the results will be included in the overall assessment. In the headform impact area, a grid will be marked on the outer surface of the vehicle. The vehicle manufacturer is required to provide the Bharat NCAP Secretariat with data detailing the protection offered by the vehicle at all grid locations. The data shall be provided to the Designated Agency before any test preparation begins. The predicted level of protection offered by the vehicle is verified by Bharat NCAP by means of testing of a sample of randomly selected gridpoints and the overall prediction is corrected accordingly. For AEB testing, the vehicle manufacturer may sponsor a test according to AIS 185 or shall submit a valid Test Report issued by Testing agencies in accordance to AIS-185.
A.2	**Points Calculation**
	For the legform impact areas, a sliding scale system of points scoring has been used to calculate points for each measured criterion. This involves two limits for each parameter, a more demanding limit (higher performance), below which a maximum score is obtained and a less demanding limit (lower performance), beyond which no points are scored. Where a value falls between the two limits, the score is calculated by linear interpolation. No capping is applied to any of the measurements. The maximum score for each grid point is one point for bumper and bonnet leading edge tests. The total score will then be scaled to a maximum of six points for each impactor. For the headform impact area, the protection predicted by the vehicle manufacturer will be compared to the outcome of the randomly selected test locations. The results at those test locations will be used to generate a correction factor, which will then be applied to the predicted score. Only data that results in a correction factor of between 0.750 and 1.250 are accepted. Where this is not the case, the cause will be investigated and the Secretariat will subsequently take a decision as to how to proceed. Where the data are accepted, the headform score will be based on the predicted data score with correction applied.

1.	**PEDESTRIAN IMPACT ASSESSMENT**
1.1.	**Criteria and Limit Value**
	The assessment criteria used for the pedestrian impact tests, with the upper and lower performance limits for each parameter, are summarised below. Where multiple criteria exist for an individual test, the lowest scoring parameter is used to determine the performance of that test, unless indicated otherwise.
1.1.1.	Headform
	The manufacturer must provide predicted data for all grid points. This data shall be expressed as a colour according to the corresponding colour boundaries for the predicted HIC15 performance given below. Alternatively, HIC15 values may be provided. Green HIC15 < 650 Yellow 650 ≤ HIC15 < 1000 Orange 1000 ≤ HIC15 < 1350 Brown 1350 ≤ HIC15 < 1700 Red 1700 ≤ HIC15 The manufacturer is allowed to colour a limited number of grid points in blue where the performance is unpredictable. These grid points will always be tested. The procedure is detailed in the Pedestrian Protection Test protocol.
1.1.2.	Upper Legform
	Higher performance limit Bending Moment 285Nm Sum of forces 5.0kN *Lower performance limit* Bending Moment 350Nm Sum of forces 6.0kN
1.1.3.	Legform
	Higher performance limit Tibia Bending Moment 282Nm MCL Elongation 19mm ACL/PCL Elongation 10mm *Lower performance limit* Tibia Bending Moment 340Nm MCL Elongation 22mm ACL/PCL Elongation 10mm

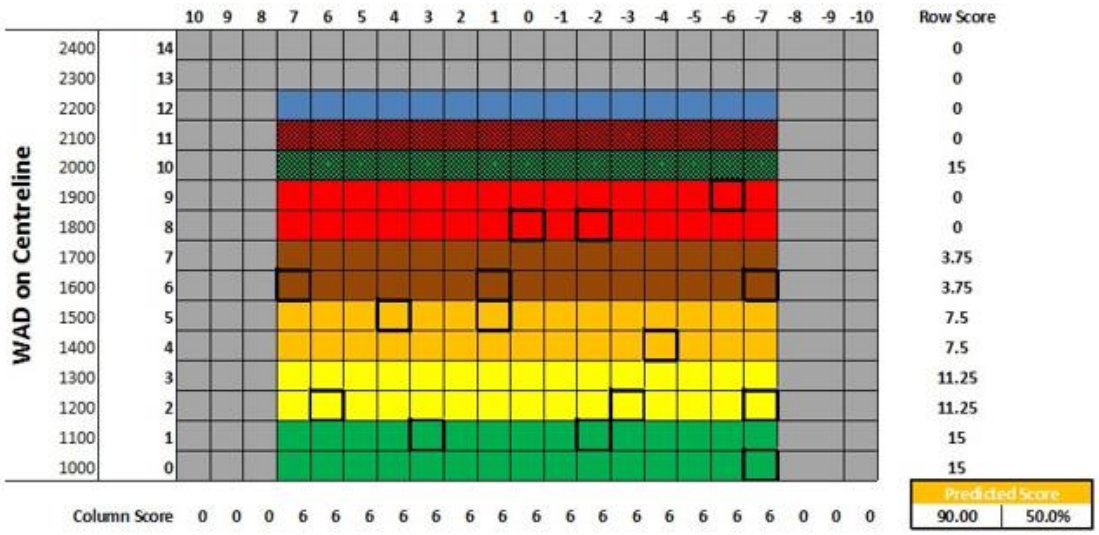
1.2.	**Modifiers**
	There are no modifiers applied.
1.3.	**Scoring and Visualisation**
1.3.1.	Scoring
	A maximum of 24 points is available for the headform test zone. The total score for all grid points is calculated as a percentage of the maximum achievable score, which is then multiplied by 24 points. The bonnet leading edge and bumper test zone will be awarded a maximum of 6 points each. A total of 36 points are available in the pedestrian protection assessment.
1.3.1.1.	Headform
	Each of the grid points can be awarded up to one point, resulting in a maximum total amount of points equal to the number of grid points. For each predicted colour the following points are awarded to the grid point: $HIC_{15} < 650$ — 1.00 point $650 \leq HIC_{15} < 1000$ — 0.75 points $1000 \leq HIC_{15} < 1350$ — 0.50 points $1350 \leq HIC_{15} < 1700$ — 0.25 points $1700 \leq HIC_{15}$ — 0.00 points
1.3.2.	Headform Correction factor
	The data provided by the manufacturers are scaled using a correction factor, which is calculated based on a number of verification tests performed. The verification points are randomly selected grid points, distributed in line with the predicted colour distribution. The actual tested total score of the verification test points is divided by the predicted total score of these verification test points. This is called the correction factor, which can be lower or higher than 1. $Correction\ Factor = \frac{Actual\ tested\ score}{Predicted\ score}$ The correction factor is multiplied to all the grid points (excluding defaulted and blue points). The final score for the vehicle can never exceed 100% regardless of the correction factor.
1.3.2.1.	HIC tolerance
	As test results can be variable between labs and in-house tests and/or simulations a 10% tolerance to the HIC value of the verification test is applied. The tolerance is applied in both directions, meaning that when a tested point scores better than predicted, but within the tolerance, the predicted result is applied. The tolerance is only applies to verify whether the predicted colour of the tested verification point is correct. When, including tolerance, the colour is not in line with the prediction, the true colour of the test point is determined by comparing the actual measured HIC

value with the colour band in section 1.3.1.1 without applying a tolerance to the HIC value.

Prediction	HIC_{15} range	Accepted HIC_{15} range
Green	$HIC_{15} < 650$	$HIC_{15} < 722.22$
Yellow	$650 \leq HIC_{15} < 1000$	$590.91 \leq HIC_{15} < 1111.11$
Orange	$1000 \leq HIC_{15} < 1350$	$909.09 \leq HIC_{15} < 1500.00$
Brown	$1350 \leq HIC_{15} < 1700$	$1227.27 \leq HIC_{15} < 1888.89$
Red	$1700 \leq HIC15$	$1545.45 \leq HIC15$

1.3.2.2. Example

Headform testing:
Manufacturer X has provided the following prediction to Bharat NCAP with a total score of 90 points (excluding blue) out of the possible 195:



The prediction consists of the following:

15 Default Green	x 1.00 =	15.00
30 Green	x 1.00 =	30.00
30 Yellow	x 0.75 =	22.50
30 Orange	x 0.50 =	15.00
30 Brown	x 0.25 =	7.50
30 Red	x 0.00 =	0.00
15 Default Red	x 0.00 =	0.00
15 Blue		
195 grid points		**90.00 points**

15 verification points were chosen for testing:

Verification												Score
1-10	GRID-point	R2|C-7	R2|C-3	R1|C-2	R4|C-4	R5|C1	R5|C4	R8|C-2	R6|C-7	R2|C6	R1|C3	
	Prediction											6
	Test result (HIC)	750	600	500	1200	1492	850	2000	1400	1112	660	
	Test result (pts)	0.75	0.75	1	0.5	0.5	0.75	0	0.25	0.5	1	6
11-20	GRID-point	R8|C0	R6|C7	R0|C-7	R9|C-6	R6|C1						
	Prediction											1.50
	Test result (HIC)	2000	1822	700	1544	1450						
	Test result (pts)	0	0.25	1	0.25	0.25						1.75
											Correction factor	1.033

$$Correction\ Factor = \frac{Actual\ tested\ score}{Predicted\ score} = \frac{6.00 + 1.75}{6.00 + 1.50} = 1.033$$

8 Blue zones were tested containing 15 blue points:

Blue points									Score
Blue	Blue Zone	1	2	3	4	5	6	7	8	
	GRID-point	12,7 | 12,6	12,5 | 12,4	12,3 | 12,2	12,1 | 12,0	12,-1 | 12,-2	12,-3 | 12,-4	12,-5 | 12,-6	12,-7	
	Test result (HIC)	1000	650	1700	1500	1700	1699	1350	1349	
	Test result (pts)	0.5	0.75	0	0.25	0	0.25	0.25	0.5	4.5

The final score will be:

150 Predicted	75.00 x 1.033 = 77.475
15 Default Green	15.000
15 Default Red	0.000
15 Blue	4.500
195 grid points	**96.975 points**

The score in terms of percentage of the maximum achievable score is 96.975/195 = 49.730%
The final headform score is 49.730% x 24 = **11.935 points**

1.3.2.3. Upper Legform

Each of the grid points can be awarded up to one point resulting in a maximum total of points equal to the number of grid points. A linear sliding scale is applied between the relevant 10 limits of each parameter. The upper legform performance for each grid point is based upon the worst performing parameter.

The total score for the upper legform area will be calculated out of six by scaling the sum of grid points score by the relevant number of grid points.

Example:
For a vehicle that has 9 grid points and tests are performed to points U0, U-2 and U-4 with the following results:

Test result U0	**Score**	**Total**
Femur upper bending moment = 281.40Nm	1.000	
Femur middle bending moment = 342.60Nm	0.114 =>	**0.114**
Femur lower bending moment = 324.10Nm	0.398	
Femur sum of forces = 5.26kN	0.740	
Test result U-2	**Score**	**Total**
Femur upper bending moment = 395.81Nm	0.000	**0.000**
Femur middle bending moment = 467.69Nm	0.000	
Femur lower bending moment = 435.69Nm	0.000	
Femur sum of forces = 6.80kN	0.000	
Test result U-4	**Score**	**Total**
Femur upper bending moment = 152.00Nm	1.000	**1.000**
Femur middle bending moment = 208.00Nm	1.000	
Femur lower bending moment = 245.00Nm	1.000	
Femur sum of forces = 4.89kN	1.000	

Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Given that U-1 and U-3 have not been tested, both will be awarded the result from the adjacent point U-2. Symmetry will also be applied to all grid points on the opposite side of the vehicle (U+1 to U+4).

U+4	U+3	U+2	U+1	U0	U-1	U-2	U-3	U-4
1.000	0.0	0.0	0.0	0.114	0.0	0.0	0.0	1.000

The score for each individual grid point is then summed up, this produces a score in terms of the maximum achievable percentage of 2.114/9 = 23.488%
The final upper legform score is 23.488% x 6 = **1.409 points**

1.3.2.4. Legform

Each of the grid points can be awarded up to one point resulting in a maximum total of points equal to the number of grid points. A linear sliding scale is applied between the relevant limits of each parameter. The one point per grid point is divided into two independent assessment areas of equal weight:

1. Tibia injury assessment based on the worst performing of tibia moments T1, T2, T3, T4 (0.500 point).
2. Knee injury assessment based upon MCL elongation, as long as ACL/PCL elongation is smaller than the threshold (0.500 point).

The total score for the legform area will be calculated out of six by scaling down the sum of grid points scores by the relevant number of grid points.

Example:
For a vehicle that has 11 grid points and tests are performed to points L1, L+3 and L+5 with the following results:

Test result L+1	**Score**	**Total**
Tibia bending moment = 280.00Nm	0.500	0.500
ACL or PCL elongation = 10.00mm MCL elongation = 15.00mm	Fail 0.500	} 0.000
		= 0.500
Test result L+3	**Score**	**Total**
Tibia bending moment = 320.00Nm	0.172	0.172
ACL or PCL elongation = 9.50mm MCL elongation = 20.50mm	Pass 0.250	} 0.250
		= 0.422
Test result L+5	**Score**	**Total**
Tibia bending moment = 340.00Nm	0.000	0.000
ACL or PCL elongation = 10.00mm	Fail	0.000
MCL elongation = 19.00mm	0.000	
		= 0.000

Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Given that L0, L+2 and L+4 have not been tested, L0 will be awarded the score from L+1, L+2 will be awarded the score from L+3 and L+4 will be awarded the score from L+5. Symmetry will also be applied to the other side of the vehicle.

L+5	L+4	L+3	L+2	L+1	L0	L-1	L-2	L-3	L-4	L-5
0.0	0.0	0.422	0.422	0.500	0.500	0.500	0.422	0.422	0.0	0.0

The score for each individual grid point is then summed up, this produces a score in terms of the maximum achievable percentage of 3.188/11 = 28.981% The final upper legform score is 28.981% x 6 = **1.739 points**

1.3.3.	Visualisation of results
1.3.3.1.	Headform results
	The protection provided by each grid location is illustrated by a coloured area, on an outline of the front of the car. Where no grid is used in the assessment and the fallback scenario is adopted, the same 5 colour boundaries and HIC650 – HIC 1700 values will be applied. The headform performance boundaries are detailed below. Green $HIC_{15} < 650$ Yellow $650 \leq HIC_{15} < 1000$ Orange $1000 \leq HIC_{15} < 1350$ Brown $1350 \leq HIC_{15} < 1700$ Red $1700 \leq HIC15$
1.3.3.2.	Legform and upper legform results
	The protection provided by each grid location is illustrated by a coloured point on an outline of the front of the car. The colour used is based on the points awarded for that test site (rounded to three decimal places), as follows: Green grid point score = 1.000 Yellow 0.750 <= grid point score < 1.000 Orange 0.500 <= grid point score < 0.750 Brown 0.250 <= grid point score < 0.500 Red 0.000 <= grid point score < 0.250
2.	**ASSESSMENT OF AEB CAR-TO-PEDESTRIAN**
2.1	**Assessment with Child Target**
	For vehicles complying to the requirements as mentioned in AIS-185, a maximum score of 5 points are awarded.
	No partial score is awarded for the assessment.
2.2	**Assessment with Adult Target**
	For vehicles complying to the requirements as mentioned in AIS-185 for Car-to-Pedestrian impacts when tested using an adult pedestrian target, a maximum score of 5 points are awarded.
	No partial score is awarded for the assessment.

<table>
<tr><td>3.</td><td>ASSESSMENT OF AEB CAR-TO-MOTOTRCYCLIST</td></tr>
<tr><td></td><td>Autonomous Emergency Braking (AEB)
• For the AEB system tests, the test is concluded if one of the following occurs:
a) V_{VUT} = 0 km/h;
b) $V_{VUT} < V_{MT}$; or
c) contact between VUT
• Where there is no full avoidance, a linear interpolation is applied to calculate the score for the test speed.
• The impact speed shall be rounded off to 1 decimal place.
• The points available for the different impact speeds are detailed in the table below:
<table><tr><th>Impact Speed (kmph)</th><th>Points</th></tr><tr><td>$0 \leq V_{impact} < 5.0$</td><td>5.000</td></tr><tr><td>$5.1 \leq V_{impact} < 15.0$</td><td>3.500</td></tr><tr><td>$15.1 \leq V_{impact} < 30.0$</td><td>2.000</td></tr><tr><td>$30.1 \leq V_{impact}$</td><td>0.000</td></tr></table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>4.</td><td>SCORING</td></tr>
<tr><td></td><td></td></tr>
<tr><td>4.1.</td><td>The maximum score awarded in the vertical is 56 points.</td></tr>
<tr><td>4.2.</td><td>The score achieved by the vehicle is weighted by a factor of 20 to calculate the weighted score for the vehicle.</td></tr>
<tr><td>4.3.</td><td>The score achieved by the vehicle in the individual tests is rounded to 3 decimal places.</td></tr>
<tr><td>4.4.</td><td>The sum of the scores from the individual tests is then weighted to calculate the weighted score.</td></tr>
<tr><td>4.5.</td><td>The weighted score is rounded to 2 decimal places for consideration in the final score.</td></tr>
<tr><td>4.6.</td><td>For Eg.
If a vehicle manufacturer scores 29.63 points from all assessments of the vertical, then:

Weighted Score = $\frac{29.63}{56} \times 20 = 10.58$ points</td></tr>
</table>

ANNEXURE X
ASSESSMENT PROTOCOL FOR POST CRASH SAFETY

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1.	**RESCUE SHEET**
1.1	The vehicle shall be awarded 07 points for providing a Rescue sheet that is compliant to the requirements specified in ISO 17840.
2.	**MULTI COLLISION BRAKING (MCB)**
2.1.	The vehicle shall be awarded 2 points for meeting the requirements (Sr. No. 2.3 and 2.4) below
2.2.	The vehicle MCB shall be assessed as per the Non-Destructive test procedure and also in the ODB test
2.3.	For the Non Destructive Test, The MCB test is passed if the vehicle exceeds a minimum deceleration of $3m/s^2$ with brakes lights on.
2.4.	For the official ODB test, the data from the vehicle CAN shall be recorded to verify that the MCB trigger signal is sent on the vehicle network during the crash.
3.	**SOS CALL / E-CALL**
3.1.	The vehicle that meets the requirements from the test to the verification of vehicle manufacturer's supplied dossier / owner's manual shall be awarded 2 points.
3.2.	The call transmission from the test vehicle to the predefined contacts or Service Provider or Emergency Services as applicable shall be verified for at least 02 official crash tests. The tests shall be discussed by the vehicle manufacturer with Test Agency and the Designated Agency. However the Designated agency's decision on the tests for verification of SOS Call / E-Call shall be final.
3.3.	The call can be initiated either automatically or manually via a switch in the vehicle.
3.4.	The call shall not disconnect until done so after the due verification by the Designated Agency after the specific crash test.
3.5.	Additionally, o The vehicle shall be equipped with an SOS Call activation mechanism accessible to the driver and front passenger. o The SOS button shall be clearly marked, illuminated, and operable by a single press. o It shall be designed to minimize accidental activation (e.g., recessed or protected design). o The system shall confirm activation via audible and/or visual feedback. o The system shall have a backup power source capable of maintaining functionality for at least 30 minutes after loss of vehicle power supply. o All of these details shall be maintained in the vehicle manual
3.6.	Alternately, the vehicle manufacturer can demonstrate compliance to ECE R144 as an equivalent test method.
3.7.	There shall be no partial score for the assessment.

<table>
<tr><td>4.</td><td>AUTOMATIC ACTIVATION OF HAZARD LIGHTS</td></tr>
<tr><td>4.1.</td><td>A score of 1 point shall be awarded to this assessment. There shall be no partial scoring.</td></tr>
<tr><td>4.2.</td><td>The Hazard Lights shall glow as per the requirement of section 4.3 and 4.4 in each of the crash test.</td></tr>
<tr><td>4.3.</td><td>There is no capping limit on the duration for which the hazard lights shall glow after the crash test.</td></tr>
<tr><td>4.4.</td><td>The hazard warning lights must operate in all tests to qualify for rewards, no partial rewards are given.</td></tr>
<tr><td>4.5.</td><td>In the Bharat NCAP official crash tests, the following is required:</td></tr>
<tr><td></td><td><table>
<tr><td>ODB and Frontal FW tests</td><td>At least rear hazard lights illuminating
(Rear RH or Rear LH or Both)</td></tr>
<tr><td>MDB and Side Pole tests</td><td>At least non-struck side hazard lights illuminating
(Non-struck front or Non-struck rear or Both)</td></tr>
<tr><td>Rear Impact Test</td><td>At least front hazard lights illuminating
(Front RH or Front LH or Both)</td></tr>
</table></td></tr>
<tr><td>4.6.</td><td>If the hazard lights do not glow in any of the crash test as specified in Sr. No. 4.4 above, no points shall be awarded for the assessment.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>5.</td><td>ENERGY MANAGEMENT</td></tr>
<tr><td></td><td>A maximum score of 03 points are awarded to a vehicle under this assessment section.</td></tr>
<tr><td>5.1.</td><td>For Electric / Hybrid vehicles</td></tr>
<tr><td>5.1.1</td><td>For vehicles meeting the AIS regulatory requirements regarding ‘Protection against electrical shock’ in accordance to the latest applicable versions of AIS 098, 099, 101 and 201 shall be awarded 1 point.</td></tr>
<tr><td>5.1.2</td><td>It is a pre-requisite for the vehicles to qualify the requirements as per Sr. No 5.1.1 above to be eligible for further scoring.</td></tr>
<tr><td>5.1.3</td><td>For vehicles equipped with an accessible provision for a MSD (Manual Service Disconnect) shall be awarded 1 point.</td></tr>
<tr><td>5.1.3</td><td>The MSD's design shall be such that it allows for manual disconnection of the high-voltage circuit without tools, ensuring first responders can isolate the high-voltage circuit for a safe working environment.</td></tr>
<tr><td>5.1.4</td><td>Any additional MSD provided by the vehicle manufacturer that ensures a tool-free manual disconnection of the high-voltage circuit a shall be verified and accordingly awarded 01 additional point for successful disconnection of the high voltage circuit.</td></tr>
</table>

5.2.	**For IC Engine vehicles,**
5.2.1.	There shall be no more than slight leakage of liquid from the fuel-feed installation shall occur on collision.
5.2.2.	If there is continuous leakage in the fuel installation after the collision, the rate of leakage shall not exceed 30 g/min; if the liquid from the fuel installation mixes with liquids from the other systems, and if the several liquids cannot be easily separated and identified, the continuous leakage shall be evaluated from all the fluids collected. This shall be measured over a 5-minute time duration immediately after the impact.
5.2.3.	The IC Engine vehicle will be awarded 3 points on meeting the requirements specified in Sr No 5.2.1 and 5.2.2.
5.2.4.	There shall be no partial scoring for the assessment.
5.2.5.	Not meeting the fuel leakage requirements in any of the crash test will lead to no points being awarded for this assessment.
6.	**OCCUPANT EXTRICATION**
6.1.	A maximum of 05 points are awarded to a vehicle under this assessment section.
6.2.	The requirements of door opening as defined in 6.5 below and seat belt buckle opening forces as defined in Cl 6.6 below are applicable to frontal (ODB and Full Width) and side impact (MDB and Oblique Pole) tests.
6.3.	1.25 points are awarded for each of the crash test if the vehicle meets the requirements for door opening and seat belt buckle opening both.
6.4.	Not meeting either the door or seat belt buckle opening requirements in a test will lead to award of '0' points for that particular test only.
6.5.	**Door Opening Forces**
6.5.1.	No points are awarded to the test if the measured door opening force exceeds 750N or if tools are required to open a door.
6.5.2.	It shall pe possible to open atleast 1-door per row in case of any frontal or side impact test. Failing to meet this requirement shall disqualify the vehicle from scoring any points for door and seat belt buckle opening forces for that test.
6.5.3.	No point is awarded to a test if any of the door remains locked after impact in that test.
6.6.	**Seat belt buckle unlatching (defined force to open a seat belt buckle)**
6.6.1.	The seat belt buckle shall completely open under a load of no more than 60N for frontal impact tests applied directly to the centre point and in the direction of the opening movement of the buckle release button, for all the belted occupants.
6.6.2.	The seat belt buckle shall completely open under a load of no more than 100N for side impacts applied directly to the centre point and in the direction of the opening movement of the buckle release button, for all the belted occupants.

7.	**SCORING FOR THE VERTICAL**
7.1.	The maximum score awarded in the vertical is 20 points.
7.2.	The score achieved by the vehicle is weighted by a factor of 5 to calculate the weighted score for the vehicle.
7.3.	The score achieved by the vehicle in the individual tests is rounded to 3 decimal places.
7.4.	The sum of the scores from the individual tests is then weighted to calculate the weighted score.
7.5.	This weighted score is rounded to 2 decimal places for consideration in the final score.
7.6.	For Eg. If a vehicle manufacturer scores 12.632 points from all assessments of the vertical, then: Weighted Score = $\frac{12.63}{20} \times 5 = 3.16$ points

ANNEXURE XI
MODIFIERS FOR BNCAP

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1.	**MODIFIERS FOR ADULT OCCUPANT PROTECTION DUMMIES**
1.1.	**Modifiers for Hybrid-III-50th Percentile**
1.1.1.	**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.
1.1.1.1.	Head
1.1.1.1.1.	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.
1.1.1.1.2.	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.

1.1.1.1.3.	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, that is intended to provide protection to the head as well as the thorax, abdomen or pelvis deploys incorrectly, the penalty will be applied to two body regions, -1 to the head and -1 to the chest. • The modifier(s) will be applied to the scores of the impacts for which the airbag was intended to offer protection, regardless of the impact in which it deployed incorrectly. For example, the penalty will be applied to the side and pole impact scores if a side protection airbag deploys incorrectly during the frontal crash. Or, if a knee airbag deploys incorrectly in the full width impact, the modifier will be applied to the pelvic region of both the offset and full width tests. Where any frontal protection airbag deploys incorrectly, Bharat NCAP will not accept knee mapping data for that occupant.
1.1.1.2.	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
1.1.1.3.	Chest
1.1.1.3.1.	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 two points. Between these limits, the penalty is generated by linear interpolation.

1.1.1.3.2.	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.
1.1.1.3.3.	Asymmetry of reinforcements
	• In the Frontal ODB Impact Test, in case of asymmetry (reinforcements, layers, and spot welds density) Test Agencies will apply modifiers for both structural instability and the footwell area. • Functional asymmetry such as the asymmetry arising due to engine mounts, steering column opening, transmission, etc. shall not be considered for applying this modifier. • In case of asymmetry, the manufacturer is required to show evidence of a passenger side ODB64 test conducted using Adult dummies placed at the same seating position as defined for the RH ODB64 test. To have the modifiers removed, the vehicle manufacturer is required to submit the below data from the test: a) Adult dummy data with the Injury result same as in the RH ODB test b) Test Videos, Pre and Post Test Photos same as in the RH ODB test c) Post Test Vehicle structural photos d) Vehicle Structural Sensor Data (RH and LH B-pillar) • When this modifier is applied, knee mapping data will not be accepted
1.1.1.3.4.	Steering Wheel Contact
	Where there is obvious direct loading of the chest from the steering wheel, a one point penalty is applied.
1.1.1.3.5.	Shoulder belt load (Driver and Front Passenger)
	Where the shoulder belt load filtered at CFC60 exceeds 6.0kN a two point penalty is applied.

1.1.1.4.	Knee, Femur and Pelvis
1.1.1.4.1.	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 contact at other points, within this greater area, would be more aggressive penalties are applied. • The area considered extends vertically 50mm above and below the maximum height of the actual knee impact location [8]. Vertically upwards, consideration is given to the region up to 50mm above the maximum height of knee contact in the test. If the steering column has risen during the test it may be repositioned to its lowest setting if possible. Horizontally, for the outboard leg, it extends from the centre of the steering column to the end of the facia. • For the inboard leg, it extends from the centre of the steering column the same distance inboard, unless knee contact would be prevented by some structure such as a centre console. Over the whole area, an additional penetration depth of 20mm is considered, beyond that identified as the maximum knee penetration in the test. The region considered for each knee is generated independently. Where, over these areas and this depth, femur loads greater that 3.8kN and/or knee slider displacements greater than 6mm would be expected, a one point penalty is applied to the relevant leg.
1.1.1.4.2.	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 one point penalty is applied to the relevant leg. • Where a manufacturer is able to show, by means of acceptable test data, that the Variable Contact and/or Concentrated Loading modifiers should not be applied, the penalties may be removed. • If the Concentrated load modifier is not applied to either of the driver's knees, the left and right knee zones (defined above) will both be split into two further areas, a 'column' area and the rest of the facia. The column area for each knee will extend 60mm from the centreline of the steering column and the remainder of the facia will form the other area for each knee. As a result, the one point penalty for Variable Contact will be divided into two with one half

	of a point being applied to the column area and one half of a point to the remainder of the facia for each knee.
1.1.1.5.	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 <3.8 kN in the full vehicle test. - Knee Slider <6 mm 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
1.1.1.6.	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.
1.1.1.7.	Foot and Ankle
	• Footwell Rupture The score is reduced if there is significant rupture of the footwell area. This is usually due to separation of spot welded seams. A one point penalty is applied for footwell rupture. The footwell rupture may either pose a direct threat to the driver's feet or be sufficiently extensive to threaten the stability of footwell response. When this modifier is applied, Bharat NCAP will not accept knee mapping data. • Pedal Blocking Where the rearward displacement of a 'blocked' pedal exceeds 175mm relative to the pre-test measurement, a one point penalty is applied to the driver's foot and ankle assessment. A pedal is blocked when the forward movement of the intruded pedal under a load of 200N is <25mm. Between 50mm and 175mm of rearward displacement the penalty is calculated using a sliding scale between 0 to 1 points.

1.1.2.	**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 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 and Pelvis, Variable Contact* • *Knee, Femur and Pelvis, Concentrated loading* The assessments airbag stability, head bottoming-out (where present) and the knee impact areas are the same as for driver. For the outboard knee, the lateral range of the knee impact area extends from the centre line of the passenger seat to the outboard end of the facia. For the inboard knee, the area extends the same distance inboard of the seat centre line, unless knee contact is prevented by the presence of some structure such as the centre console. The passenger knee zones and penalties will not be divided into two areas even if the concentrated load modifier is not applied.
1.1.3.	**Scoring and Visualisation**
1.1.3.1	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 ‘Good’ 4.000 points Yellow ‘Adequate’ 2.670 - 3.999 points Orange ‘Marginal’ 1.330 - 2.669 points Brown ‘Weak’ 0.001 - 1.329 points Red ‘Poor’ 0.000 points
1.1.3.2	For frontal ODB impact, the body regions are grouped together, with the score calculated as per the sliding scale for the grouped body region being that of the worst performing region or limb. The grouped regions are: Head and Neck (4 points), Chest (4 points), Knee, Femur, Pelvis (i.e. left and right femur and knee slider) (4 points) and Leg and Foot (i.e. left and right lower leg and foot and ankle) (4 points).

1.1.3.3	The contribution of the frontal ODB impact test to the Adult Occupant Protection Score is calculated by summing the body scores for the relevant body regions, taking the lower of the driver and passenger scores for each region (16 points total).
1.1.3.4	For the Frontal Full Width test, the body scores for the relevant body regions are grouped as per regions: Head (4 points), Neck (4 points), Chest (4 points) and Knee, Femur and Pelvis (i.e. left and right femur) (4 points). This score from each body region is then summed with the applicable modifiers evaluated and applied. The final score for the dummy is the half of this summed score. Thus, the maximum points that the dummy can score from the test is 8 points.
1.2.	**MODIFIERS FOR HYBRID III – 5TH PERCENTILE**
1.2.1.	**Modifiers**
1.2.1.1	The score generated from 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.
1.2.1.2	Modifier penalties for Driver and Front Passenger shall be applied before the scores are scaled as per the respective dummy.
1.2.2.	**Front Passenger**
1.2.2.1.	Head
1.2.2.1.1.	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 or bottoming-out of the airbag by the dummy head, the modifier is also applied. *Note: Head bottoming-out is defined as follows: There is a definite rapid increase in the slope of one or more of the head acceleration traces, at a time when the dummy head is deep within the airbag. The acceleration spike associated with the bottoming out should last for more than 3ms.The acceleration spike associated with the bottoming out should generate a peak value more than 5 g above the likely level to have been reached if the spike had not occurred. This level will be established by smooth extrapolation of the curve between the start and end of the bottoming out spike.*

1.2.2.1.2.	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
1.2.2.1.3.	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, that is intended to provide protection to the head as well as the thorax, abdomen or pelvis deploys incorrectly, the penalty will be applied to two body regions, -1 to the head and -1 to the chest. • The modifier(s) will be applied to the scores of the impacts for which the airbag was intended to offer protection, regardless of the impact in which it deployed incorrectly. For example, the penalty will be applied to the side and pole impact scores if a side protection airbag deploys incorrectly during the frontal crash. Where any frontal protection airbag deploys incorrectly, Bharat NCAP will not accept knee mapping data for that occupant.
1.2.2.2.	Chest
	Shoulder belt load
	Where the shoulder belt load measured, exceeds 6kN a two point penalty is applied.
1.2.2.3.	Knee, Femur and Pelvis
	Submarining
	The score for the Knee, Femur and Pelvis is reduced by 4 points when submarining occurs. The modifier is applied when a 1kN drop in any of the two iliac forces measured is seen within 1 ms and when the submarining is confirmed on the high speed film.

1.2.3.	**Rear Passenger**
1.2.3.1.	Exceeding forward excursion line (Monitoring)
	The forward movement of the head of the Rear Passenger is monitored for movement that exceeds the 450mm or 550mm forward excursion line as defined in the full width test protocol. The movement is monitored and no score is modified based on the extent of the forward movement of the head..
1.2.3.2.	Chest
1.2.3.3.	Shoulder belt load
	Where the shoulder belt load measured, exceeds 6kN a two point penalty is applied.
1.2.3.4.	Knee, Femur and Pelvis (Monitoring)
	Submarining
	The modifier is applied when a 1kN drop in any of the two iliac forces measured is seen within 1 ms and when the submarining is confirmed on the high speed film. The modifier is only monitored and no score is modified if submarining is observed for the Rear Passenger.
1.2.4.	Scoring and Visualisation
1.2.4.1	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 ‘Good’ 4.000 points Yellow ‘Adequate’ 2.670 - 3.999 points Orange ‘Marginal’ 1.330 - 2.669 points Brown ‘Weak’ 0.001 - 1.329 points Red ‘Poor’ 0.000 points
1.2.4.2	For the front passenger dummy in the full width frontal impact, the body regions are grouped together, with the score calculated as per the applicable sliding scale for the grouped body region. The grouped regions are: Head (4 points), Neck (4 points), Chest (4 points) and Knee, Femur and Pelvis (i.e. left and right femur) (4 points). The final score is the sum of all these body region scores. The score after the application of the modifiers is scaled to one-fourth of the achieved score, i.e the maximum score for the dummy will be out of 4 points.
1.2.4.3	For the rear passenger dummy, each of the dummy body region, i.e. Head, Neck, Chest and the group of Knee, Femur and Pelvis on meeting the specified capping limits is awarded 1 point each such that the maximum score for the dummy is 4 points.

<table>
<tr><td>1.3.</td><td>MODIFIERS FOR WORLDSID – 50TH PERCENTILE</td></tr>
<tr><td>1.3.1.</td><td>Side MDB Impact Test</td></tr>
<tr><td>1.3.1.1.</td><td>Incorrect Airbag Deployment</td></tr>
<tr><td></td><td>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 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 penalties are applicable to both the Side MDB and Side Pole impacts.

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 or pole 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.</td></tr>
<tr><td>1.3.1.2.</td><td>Shoulder</td></tr>
<tr><td></td><td>Where the shoulder lateral force (Y direction) component is 3.0kN or above, no points will be awarded for the chest assessment.</td></tr>
<tr><td>1.3.1.3.</td><td>Chest and Abdomen</td></tr>
<tr><td></td><td>Where the viscous criterion (V*C) is 1.0m/s or above for the chest, abdomen or both, no points will be awarded for the relevant body region assessment</td></tr>
<tr><td>1.3.1.4.</td><td>Scoring and Visualisation</td></tr>
<tr><td></td><td>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 mentioned in the below table.</td></tr>
<tr><td></td><td>
<table>
<tr><td>Green</td><td>‘Good’</td><td>4.000</td><td>Points</td></tr>
<tr><td>Yellow</td><td>‘Adequate’</td><td>2.670 – 3.999</td><td>Points</td></tr>
<tr><td>Orange</td><td>‘Marginal’</td><td>1.330 – 2.669</td><td>Points</td></tr>
<tr><td>Brown</td><td>‘Weak’</td><td>0.001 – 1.329</td><td>Points</td></tr>
<tr><td>Red</td><td>‘Poor’</td><td>0.000</td><td>Points</td></tr>
</table>
</td></tr>
</table>

	• For the side barrier and pole impacts, individual body regions as applicable are used to compute the scores. Results are shown separately for side barrier and pole impact. • The contribution of the side impact tests to the Adult Occupant Protection Score is calculated by summing the body scores calculated as per the applicable sliding scale for the relevant body regions. The total score in side barrier 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.
1.3.2	**Oblique Pole Side Impact test**
1.3.2.1	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 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 two penalties would also be applicable to both the side and pole impact. 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 or pole 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.
1.3.2.2	Side Head Protection Device (Monitoring Only)
	Vehicles equipped with head protection side airbags, curtain, seat mounted or any other, will have the inflated energy absorbing areas evaluated by means of a geometric assessment. The airbags must provide protection for a range of occupant sizes in both the front and the rear on both sides of the vehicle. The area shall only be monitored and no penalty is applicable.
1.3.2.3.	Coverage areas
	To ensure adequate head protection is offered, the head protection device coverage is assessed in the geometric area, or the Head Protection Device (HPD) assessment zone, where the occupant head would most likely impact side structures. If the vehicle is equipped with movable rear seats the seat shall be set to the most rearward position. If there is a third row of fixed seats, these will be included in the assessment unless they are per manufacturers' recommendation not suitable for adult occupation (handbook).

1.3.2.4.	Application
	Where the airbags differ between the left and right hand sides of the vehicle, the airbags on both sides of the vehicle will be evaluated and the assessment will be based upon worst performing side. All areas of the airbag, both front and rear, will be evaluated and the assessment will be based upon the worst performing part of any of the airbags.
1.3.2.5.	Scoring and Visualization
1.3.2.5.1.	The dummy is awarded 4 points on meeting the capping requirements for the head region.
1.3.2.5.2.	1 point per region is then awarded to individual body regions of Shoulder (Force), Chest, Abdomen and Pelvis on meeting the specified capping limits for the dummy.
1.3.2.5.3.	A maximum score of 8 points is awarded to the dummy in the Oblique Pole Side Impact test

ANNEXURE XII

CONCEPTS BEHIND THE ASSESSMENTS

CONTENTS

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 and 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 50^{th} 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 biofiedelic 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 and 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**
3.1.	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:
3.1.1	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.
3.1.2	the latch has moved away from the fully latched condition.
3.1.3	if any hinge has released either from the door or bodyshell or due to internal hinge failure.
3.1.4	if there is a loss of structure between the hinges and latches.
3.1.5	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.
3.1.6	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.
3.1.7	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.

ANNEXURE XIII
SPECIMEN EQUIPMENT TEST MATRIX

1. Offset Deformable Barrier Frontal Impact/ Full Width Rigid Barrier Impact

Sr. No.	Parameter	Sub Parameter	Data to be filled by vehicle manufacturer	Variants	
				1	2
1	Engine - Fuel Type and capacity				
2	High Voltage (HV) Battery Capacity and Location on vehicle				
3	Engine Compartment packaging	(Clearance from fr. cross beam to engine and engine to firewall)			
4	Electric Motor Location and Orientation (For EVs)				
5	Vehicle structure (Front end to B pillar)	Same/Different			
6	Unladen Mass				
7	Tire Size				
8	Type of Wheel Rim				
9	Ride height	Front			
		Rear			
10	Vehicle Seating Capacity				
11	Seat Belt	Driver PT			
		Driver LL			
		Front Passenger PT			
		Front Passenger LL			
		Rear Outboard PT			
		Rear Outboard LL			
12	Seat Belt anchorage position (Fixed / Adjustable with number of adjustments)	Driver			
		Front Passenger			
		Rear Outboard			
13	Airbag	Driver	DAB - Volume and No. of Stages		
			SAB - Volume and No. of Stages		
			CAB - Volume and No. of Stages		
			Knee - Volume and No. of Stages		
		Passenger	DAB - Volume and No. of Stages		
			SAB - Volume and No. of Stages		
			CAB - Volume and No. of Stages		
			Knee - Volume and No. of Stages		
14	Seats (Manual/Powered/Both)				
15	Driver	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
	Front Passenger	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			

16	Rear Seat (2nd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
17	Rear Seat (3rd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
18	Interior fittings				
19	Vehicle Start / Stop	Key Barrel / Electric Button			
20	Sun Roof	Front			
		Rear			
21	Fuel tank capacity				
22	CNG Tank capacity (For CNG vehicles)				
23	CNG Tank Location (For CNG vehicles)				
24	HV Battery capacity for Hybrid vehicles				
25	HV Battery Location for Hybrid vehicles				
26	Fuel Line Routing	(RH / LH) of the vehicle			
27	CNG connectors for CNG vehicles	(RH / LH) of the vehicle			
28	HV Connectors for Hybrid vehicles	(RH / LH) of the vehicle			
29	Drive train	4x4, 4x2			
30	Propeller shaft components				
31	BIW Asymmetry (Reinforcements, Floor, etc.)				

2. Side Impact (MDB) Test/ Pole Side Impact Test

Sr. No.	Parameter	Sub Parameter	Data to be filled by vehicle manufacturer	Variants	
				1	2
1	Vehicle Type - Hatchback/Notchback				
2	Vehicle structure / BIW	Same/Different across all variants			
3	High Voltage (HV) Battery Capacity and Location on vehicle				
4	Unladen Mass				
5	Tyre Size and Wheel Rim Type				
6	Side Sill Height from the ground				
7	Door Trim design and Trim material	RH side			
		LH side			
8	Door Construction	RH side			
		LH side			
9	Driver seat (RH) side	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
10	Passenger seat (LH) side	Position			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
11	Rear Seat (2nd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
12	Rear Seat (3rd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Structure			
		Longitudinal adjustment			
		Angular adjustment			
		Height Adjuster			
		Head Restraint (Fixed / Adjustable)			
13	R point	Driver (RH) side			
		Passenger (LH) side			
14	Airbag - RH side	Curtain Airbag			
		Knee Airbag			
		Seat Airbag			
15	Airbag - LH side	Curtain Airbag			
		Knee Airbag			

		Seat Airbag			
16	Fuel Tank Location with drawing				
17	CNG Tank capacity and Location (For CNG vehicles)				
18	HV Battery Location for Hybrid vehicles				
19	Seats (Manual/Powered/Both)				
20	Seat Belt Pretensioner (PT)	Driver			
		Passenger			
		Rear Outboard			
21	Sunroof (Normal, Panoramic, Moonroof and etc. with details)	Front			
		Rear			
22	Fuel Line Routing (RH / LH) of the vehicle				
23	CNG connectors for CNG vehicles	(RH / LH) of the vehicle			
24	HV Connectors for Hybrid vehicles	(RH / LH) of the vehicle			
25	BIW Asymmetry (Reinforcements, Floor, etc.)				

3. Rear Impact Test (Dynamic and Static)

Sr. No.	Parameter	Sub Parameter	Data to be filled by vehicle manufacturer	Variants	
				1	2
1	Engine - Fuel Type and capacity				
2	High Voltage (HV) Battery Capacity and Location on vehicle				
3	Electric Motor Location and Orientation (For EVs)				
4	Vehicle structure (Rear end to B pillar)	Same/Different			
5	Unladen Mass				
6	Tire Size				
	Type of Wheel Rim				
7	Spare tire size and wheel rim type				
8	Spare tire location				
9	Ride height	Front			
		Rear			
10	Vehicle Seating Capacity				
11	Seats (Manual/Powered/Both)				
	Driver	Position			
		Head Restraint (Fixed / Adjustable)			
	Front Passenger	Position			
		Head Restraint (Fixed / Adjustable)			
12	Rear Seat (2nd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Head Restraint (Fixed / Adjustable)			
13	Rear Seat (3rd row) To be filled separately for Captain, Fixed Bench and Split Bench seats)	Seat Facing			
		Head Restraint (Fixed / Adjustable)			
		Rear			
14	Fuel tank capacity				
15	Fuel tank location with drawing				
16	CNG Tank capacity (For CNG vehicles)				
17	CNG Tank Location (For CNG vehicles)				
18	HV Battery capacity for Hybrid vehicles				
19	HV Battery Location for Hybrid vehicles				
20	Fuel Line Routing	(RH / LH) of the vehicle			
21	CNG connectors for CNG vehicles	(RH / LH) of the vehicle			
22	HV Connectors for Hybrid vehicles	(RH / LH) of the vehicle			
23	Drive train	4x4, 4x2			
24	Propeller shaft components				
25	BIW Asymmetry (Reinforcements, Floor, etc.)				