C-NCAP Management Regulation

(2012 edition)

China Automotive Technology and Research Center

Foreword

Starting from 1979 when USA adopted NCAP system- New Car Assessment Programme, the safety of vehicle is gradually accepted by consumers. Various countries/districts have launched NCAP evaluation for more than 30years. On the basis of research and reference of other counties' experiences on NCAP, CATARC established its own CNCAP (China New Car Assessment Programme)in 2006, taking consideration of Chinese automotive standard, technology and economic development.

In NCAP system, test method is as same as the one used in regulation approval test, but with more and stricter test items. Taking example, qualification test in NCAP includes head injury, thorax compression and thigh axial force, as well as neck and leg damages parameters. Meanwhile, for making up the shortage of bio-mechanics, NCAP also tests the deformation of body, passenger compartment and steering system, to evaluate the possible causes of occupants' injury. Most importantly, NCAP has a set of mature safety assessment methods, converting the determination of "pass" and "fail" for the regular test into the perceivable and qualified star rating assessment. Due to the wide influence, strict standard, normative tests, justice, direct result release to customers and reflection on the actual safety situation the vehicle, NCAP attaches attention of all main auto manufacturers, who take it as key evaluation reference for vehicle R&D. manufacturers who obtain good rating in NCAP test, take the test result as the promotion way for market launch.

Experiences prove that NCAP does improve auto safety and road traffic safety. For six years of CNCAP implementation, the safety technology of local vehicles and assessment scoring are increasingly upgraded, more safety devices are installed on vehicles. Most manufacturers take CNCAP as the reference for product development and improvement. Following the further research and implementation of CNCAP, CATARC made supplement on C-NCAP Management Regulation (2012 edition) in 2006, added SID-IIs(D version) dummy in lateral impact test, introduced child safety concept, added the additional scores for vehicles which are easily installed with ISOFIX. So the new C-NCAP Management Regulation (2009 edition) was released and implemented in 2010. Later, CNCAP administration center discussed with expert panel on the international NCAP development trend, and updated C-NCAP Management Regulation (2012 edition).

Comparing with C-NCAP Management Regulation (2006 edition) and C-NCAP Management Regulation (2009 edition), C-NCAP Management Regulation (2012 edition) is improved both on scoring method and test items. The main differences of C-NCAP Management Regulation (2012 edition) and C-NCAP Management Regulation (2009 edition) are shown as below:

- Evaluation qualification on dummy in rear row, namely for the adult female dummy in the rear row in three impact tests, the scores is given according to the parameters of each dummy, with maximum score of 2 points.
- The test speed of frontal impact test against deformable barrier with 40% overlapping is changed from 56^{+1}_{-1}km/h into 64^{+1}_{-1}km/h.
- Adding the test on neck protection after low-speed collision (whiplash test), the score of 4 points is given.
- Adding the adding score of 1 point on automotive electronic stability control (ESC);

- The total score of 51 is changed into 62 points, and the star rating is amended accordingly.
- Improving the relevant content of Chapter 2 Operation management.
- Modifying the relevant paragraphs concerning with above amendment.

C-NCAP Management Regulation (2012 edition) will be carried out on July 1st of 2012.

Due to the different edition of management regulation, there are the discrepancy of test method and items, so the final evaluation results are not comparable. Therefore, all parties taking advantage of the CNCAP assessment results should clarify the edition and date of the test and results, to avoid any negative impact caused by wrong quotation of CNCAP results.

With the development of automotive safety technology, CNCAP pursues the new improvement program, enhances the communication with all aspects, to help making progress of safety technology.

President of CATARC

September 2011

Chapter I General Provisions

1. Objectives

1.1 Purposes

1.1.1 C-NCAP aims at establishing high standard, fair and impartial methods for assessing vehicle safety performance under impact, so as to promote the development of vehicle technologies in pursuit of a higher concept for safety. The intention of the programme is to provide consumers with safety information concerning the newly marketed vehicles, encourage the manufacturers to attach higher importance to safety standards, improve the safety performance and technical standards of the vehicles while giving publicity by means of the assessment process to the vehicles that excel in occupant protection.

1.1.2 Likewise, C-NCAP focuses on the procedures for measuring fuel consumption which is immediately related with the interests of the end-users, so as to motivate the improvement of automotive fuel economy and encourage manufacturers to make persistent efforts in upgrading the energy-saving techniques.

1.1.3 These assessment procedures are to be progressively enhanced based on the local evolutions of automotive technologies as well as the deep-going researches on the road traffic situations.

1.2 Notes

(1) No stylized test procedure can fully reflect the protection provided by a vehicle in the wide variety of accidents which occur on the roads. The methods provided by C-NCAP for assessing and rating the vehicles' safety performance in qualitative and quantitative terms can reflect the vehicle's safety performance to certain extent only.

It is, however, necessary to specify that

1) No stylized test procedure can fully reflect the protection provided by a vehicle in the wide variety of accidents which occur on the roads. The methods provided by C-NCAP for assessing and rating the vehicles' safety performance in qualitative and quantitative terms can reflect the vehicle's safety performance to certain extent only.

2) No anthropometrical dummies are available which can measure all potential risks of injury to humans or assess protection for different sizes of occupant in different seating positions.

3) Economic constraints prevent the tests from being repeated, so to take account of vehicle and test variations a number of actions have been taken:

a) The manufacturers of the vehicles are required to compare the results of the C-NCAP tests with those of their own tests that may have been conducted, and to report any anomalies that they have found together with the enterprises' own test results for comparison. Such data will not be taken as a basis for rating the vehicles and will be kept confidential.

b) The overall assessments are based on the combination of multiple results. Variations in any one of these will only have a limited effect on the overall rating.

4) The requirements of the national standards were set to provide the lowest level of protection only. For car occupants, these limits are too lenient to adequately identify the best practice in current car production and to provide a goal for further improvement. Therefore, by referencing to the NCAP data available overseas, more demanding limits have been set to identify aspects of a car's performance which offer significantly greater protection.

5) With the launching of C-NCAP and the in-depth investigation of road traffic accidents, we reserve our rights to make modifications to test items, test and scoring methods and assessment clauses, so that the C-NCAP assessment reflects the morphology of China's traffic accidents to the fullest possible degree and make contribution to reducing human injury and improving vehicle safety performance.

2. Management body

China Automotive Technology and Research Center (CATARC) is the management body of C-NCAP. A C-NCAP Management Center will be specially established to be in charge of the organizing and implementation affairs, including determining the annual plan and financial budget, selecting the vehicle model (including voluntary applications by enterprises) to be assessed, reviewing the assessment results, handling disputes and confusions and determining on other incidental issues. Under the C-NCAP Management Center there will be General Affairs Department, Test Assessment Department and Information and Media Department, which are responsible for the following respectively:

1) General Affairs Department: Determining annual implementation plan and financial budget; analyzing and determining vehicle models to be assessed; vehicle procurement; organizing release of information and results; communications and interactions with vehicle manufacturers; contacting consultant committees; conducting international cooperation activities; business promotion and follow-up development of C-NCAP.

2) Test Assessment Department: Arranging test schedules; supervising the testing; making assessments according to test results; test management and data evaluation.

3) Information and Media Department: Analyzing annual sales information of vehicle models; announcing C-NCAP assessment results; collecting relevant technical information at home and abroad; managing the C-NCAP website and dedicated magazine columns; contacting media partners.

In addition, a C-NCAP Consultant Committee will be established, which will be mainly responsible for putting forward suggestions and opinions concerning the protocols and operations of C-NCAP. The members of the Consultant Committee (including the Guest Monitors) will consist of: experts and scholars with relevant knowledge from institutions of higher learning, research institutes and academic organizations, governmental authorities and agencies, professional organization, consumer organizations and media representatives, etc.

3. C-NCAP tests

The C-NCAP tests consist of mandatory test and additional test. The mandatory test includes impact tests and whiplash test, while the additional test refers to fuel consumption test.

3.1 Impact tests

3.1.1 Frontal impact test against rigid barrier with 100% overlapping

The test shall be conducted such that the test vehicle frontally crashes against a fixed rigid barrier with 100% overlapping at an impact speed of 50^{+1}_{0}km/h (test speed not lower than 50km/h). The test vehicle approaches the barrier in a route that does not deviate sideways from the theoretical trail by 150mm in either transverse direction. Place a Hybrid III 50 percentile male dummy in the driver's seat and passenger seat respectively in the front row, to measure the injuries to the front seat occupants. Place a Hybrid III 5 percentile female dummy in the left-most seat of the second row, to measure the injuries of occupants in the second row of seats. Place a 3-year-old child dummy of P series in the right-most seat of the second row of seats, to check the performance of the restrain system for occupants and the protection to child occupants (See the C-NCAP Test Procedures specified in Chapter IV for details).

3.1.2 Frontal impact test against deformable barrier with 40% overlapping

The test shall be conducted such that the vehicle frontally crashes against a fixed deformable endoergic barrier at an impact speed of 64^{+1}_{0}km/h. The impact overlapping width between the offset impact vehicle and the deformable barrier should be within the range of 40% of the vehicle width ±20mm. Place a Hybrid III 50 percentile male dummy in the driver's seat and passenger seat in the front row to measure the injury to the occupants in the front seats. Place a Hybrid III 5 percentile female dummy on the left-most seat of the second row to measure the injuries of occupants in the second row of seats. (See the C-NCAP test procedures as specified in Chapter IV)

3.1.3 Side impact test against mobile deformable barrier

The trolley fitted with a deformable barrier face to impact with the driver's side of the test vehicle. The mobile barrier is to move in a direction perpendicular to the test vehicle, with the center line of the barrier aligned with the R point of the test vehicle, and the impact speed should be 50^{+1}_{0}km/h (test speed not lower than 50km/h). The longitudinal perpendicular plane of the mobile barrier should be within ±25mm from the transverse vertical plane that passes the R point of the front row seat on the test vehicle's impact side. Position a EuroSID II dummy on the driver's seat to measure the injury to the driver's position. (See the C-CNAP test procedures specified in Chapter IV)

3.2 Whiplash test

The driver seat and its restrain system of the test vehicle shall be such fitted on the sled as they originally on the test vehicle. The sled shall be launched at a speed of 15.65^{+1}_{0}km/h with a specified acceleration pulse to simulate the rear-end impact. Place a BioRID II dummy is placed in the seat to measure the injuries to occupant neck during the rear-end impact and to evaluate the protective performance of headrest to occupant neck. (See the C-CNAP test procedures specified in Chapter IV)

3.3 Fuel consumption test

Test vehicle shall be preconditioned inside a chamber at temperature of 24° C±3° C; afterwards, it shall be soaked for 18h ~ 24h. Prior to the test, the engine lube and coolant shall fall within ±2° C of the ambient temperature. Carry out the test as per GB/T 19233-2008 and GB 18352.3-2005. (For details, see the fuel consumption measurement procedures set out in Chapter V)

4. Rating of assessment results

A maximum score of 62 points in C-NCAP is available. The full score for each of the above tests will be 18 points, or a total of 54 points for all three of the tests. The full score for the whiplash test as described in paragraph 3.1 is 4 points. Safety belt reminder and ISOFIX device are entitled to 1.5 points and 0.5 point respectively in extra, and a bonus point of 1 point to side air curtain (and side airbag) and ESC respectively. The sum of the points for the three impact tests and the whiplash test plus the bonus points (rounded to one decimal place) will be recorded as the total score, which will be used to determine the star rating according to the following conditions. For 5-star and 4-star vehicles, other conditions (see paragraph 3 of Chapter III) have to be satisfied in addition to the total score.

Based on the total score, the test vehicle will be subject to star rating according to the following criteria:

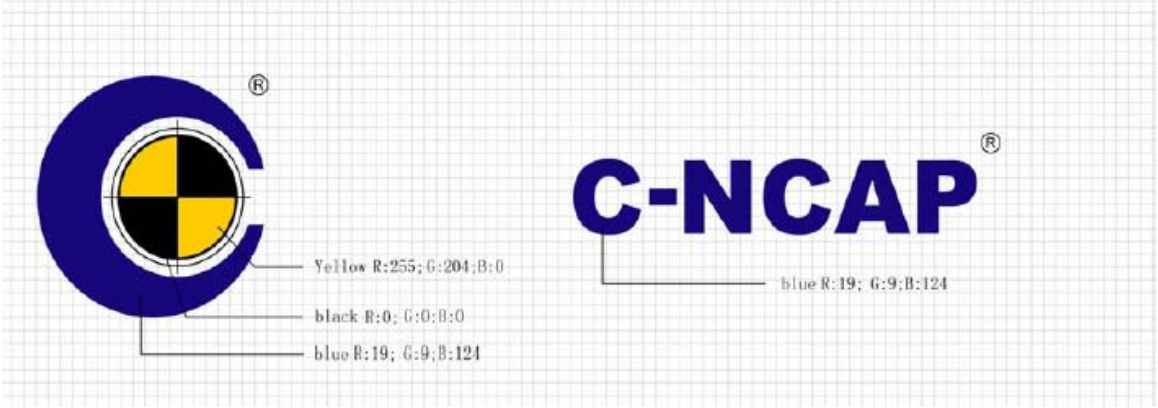
Total score	Star rating
≥60 points	5+ （★★★★★☆）
52 (inclusive) - 60 points	5 （★★★★★）
44(inclusive) - 52 points	4 （★★★★）
36(inclusive) - 44 points	3 （★★★）
28(inclusive) - 36 points	2 （★★）
＜28 points	1 （★）

5. Designated website and media

The website www.c-ncap.org and the magazine *World Auto* (monthly) will be C-NCAP Management Center's designated media for releasing C-NCAP information and test results. The website www.c-ncap.org will focus on introducing the C-NCAP organization, its work procedures, latest developments and comments on test results. It will also have a media service area for other forms of media to download information about test result comments. The *World Auto* carries information about C-NCAP operations and detailed reports on the assessment results in the form of dedicated columns and special issues, which are not to be quoted without permission.

6. C-NCAP's exclusive label

C-NCAP has applied and registered the following lettering and label for its exclusive use:



7. Note

C-NCAP is China's New Car Assessment Program developed by China Automotive Technology and Research Center (CATARC), which reserves all rights over C-CNAP. No institution is allowed to conduct C-NCAP based tests or assessments on vehicles for publicity or commercial purposes without permission by CATARC.

The assessment results, scores and star rating are only valid to the model and configuration of vehicle tested. All parties, which will use the results of C-NCAP assessement, shall guarantee their authenticity, integrity and veracity.

Chapter II Operation Management

1. Selection of vehicle types for assessment

1.1 Principle

1.1.1 The vehicles to be assessed should be passenger cars (i.e. Category M_1 vehicles) newly marketed within the recent two years.

1.1.2 The vehicles to be assessed should have relatively large sales volume among vehicles of its type, and its production should not be scheduled to stop in the near future.

1.1.3 Classification of vehicles for selection and result announcement purposes:

1) Small passenger vehicles: passenger cars shorter than 4m in length, including small MPVs;

2) Category A passenger cars: two-compartment passenger cars with a length no more than 4.5m, or three-compartment passenger cars with a displacement not greater than 1.6L;

3) Category B passenger cars: passenger cars longer than 4.5m with a displacement greater than 1.6L;

4) Multi-purpose vehicles: MPV with more than two rows of seats;

5) Sport utility vehicles: SUV

1.2 Identifying procedure

1.2.1 The C-NCAP Management Center conducts a statistical analysis on the vehicles newly marketed over the previous two years to preliminarily determine the scope of the candidate vehicle types for the current year's assessment. The candidate vehicle types may be identified in groups according to the annual plan.

1.2.2 The manufacturer will be informed of the candidate vehicle type and will be asked to provide information on that type and its dealers (the manufacturer to fill out the Feedback Sheet for Vehicles Undergoing C-NCAP Assessment, see Annex 1 to this Chapter).

1.2.3 Upon receipt of the manufacturer's feedback information, the C-NCAP Management Center will finalize the vehicle types to be assessed. If the manufacturer's feedback is not available, the determination will be made on the basis of the standard configuration of the basic model of that candidate. In the case where the vehicle to be assessed has several configurations and these configurations do not differ obviously in sales volume, the model with the simplest configuration will be selected for assessment.

1.2.4 As for any vehicle type not selected, the vehicle manufacturer may voluntarily apply for the C-NCAP assessment; provided, however, the vehicle type concerned shall be initially placed onto the market within

recent two years, and its sales volume shall not be less than 3000 units in principle.

1.3 **Procedures and requirements for a manufacturer to apply for the voluntary assessment**

1.3.1 Application

To voluntarily apply for subjecting a vehicle type to the C-NCAP assessment, the vehicle manufacturer shall submit the letter of application for C-NCAP assessment to the C-NCAP Management Center (See Annex 5).

1.3.2 Examination and approval of the application

After receiving the letter of application for C-NCAP assessment as submitted by the manufacturer, C-NCAP Management Center will conduct reviews against the application qualifications and principles; provided all the requirements are met, the Management Center will accept the application and issue the “Letter of CATARC for Approving Voluntary C-NCAP Assessment” to the manufacturer.

The manufacturer shall, within the specified time limit after receiving the letter mentioned above, deliver all the fees required for the vehicle purchasing and tests, and provid the seat necessary for the whiplash test.

As for the product for which the result is already released, manufacturer may apply for re-test once improvement has been made. C-NCAP Management Center will consider accepting/rejecting such application one year after the release of results of the previous test. All costs and expenses necessary for the re-test shall be calculated as in the case of manufacturer’s voluntary application for testing. After the re-test, no further application for the same vehicle type will be accepted.

1.3.3 Miscellaneous

The purchase of vehicles, test procedures, and the announcement of the results are the same as the case in which the assessment is funded by CATARC.

2 Vehicle purchasing

Having identified the vehicle type to be assessed, the C-NCAP Management Center will, without prior notification to the vehicle manufacturer concerned, purchase the vehicle of the type with the required configuration from a randomly selected dealer. Media is allowed to participate in purchasing the vehicle.

3 Test

3.1 Test performing notice

Having purchased the vehicle, a date for the test will be determined through consultation between the General Affairs Department and the Test Assessment Department. 12 to 15 days prior to the test, a C-NCAP Test Performing Notice (see Annex 2) will be delivered to the manufacturer stating the vehicle type to be tested, its configuration, the mode and duration of the test, etc.

3.2 Preparation of test

3.2.1 Within 5 days after receipt of the Test Performing Notice, the manufacturer shall provide the C-NCAP Management Center with a Table of Basic Parameters of the Test Vehicle (see Annex 3 of this

Chapter).

3.2.2 All pre-test preparation including the preparation of the vehicle, adjustment of the occupant compartment, calibration of the dummy, positioning and measuring of the dummy, and preparation of test equipment will be performed by professional test personnel arranged by the Test Assessment Department. Technicians of the manufacturer may, within the specified time limit, view the test preparations, and verify the necessary parameters; provided, however, no manipulation is allowed as to the equipment/apparatus, including vehicle, test dummies, etc.

3.2.3 All the preparation work prior to the whiplash test, including preparation of seat fixture, adjustment and measurement of seat, calibration of dummy, placement and measurement of dummy and preparation of test equipment, shall be perfomed by professional test personnel arranged by the Test Assessment Department. Vehicle manufacturer is required to provide necessary technical support, including the installation parameters of angles of seat slid rails, lead wire for the power supply interface of electric seat and its definition, lead wire for the triggering line of seat with active headrest and its definition, etc. Technicians of the manufacturer may, within the specified time limit, view the test preparations, and verify the necessary parameters; provided, however, no manipulation is allowed as to the equipment/apparatus, including vehicle, test dummies, etc.

3.2.4 All the preparations for the fuel consumption measurements shall be made by the test professionals as organized by the Test Assessment Department. If necessary, technicians of the manufacturer may verify the related parameters; provided, however, no vehicle manipulation is allowed.

3.3 Performing the tests

The tests will be performed by professional test personnel. Technical personnel of the manufacturer and representatives of the media may be present and witness the test starting from 1 hour prior to the test until 1 hour after completion of the test. Test data processing and scores assessment will be completed within one week after the test.

3.4 Reviewing the assessment results

C-NCAP Management Center will review and summarize the C-NCAP test results regularly, on which basis the information to be released will be determined.

4 Release of assessment results

4.1 The form of result releasing

The release will be in the form of the star rating finally credited to the vehicle, and the points of each C-NCAP test impact item and the whiplash test scored by the vehicle are announced at the same time.

4.1.1 Description of vehicle’s safety configuration

Apart from the star rating and the points that the vehicle scored in each test, the result released by C-NCAP will also include a description about the brand, model, basic parameters and the vehicle series covered by that vehicle type, together with a statement on the safety configuration of the vehicle under assessment, namely the configuration of safety belt and retractor, the safety airbag and curtain airbag as well as the availability of safety belt reminder and SOFIX device and active headrest for the booster seats.

4.1.2 Specimen of releasing the results and supplemental explanations

The specimen of releasing the results and the items therein are shown in Annex 6; if appropriate, the following supplemental explanations (not exhaustive) may be inserted:

a) The star rating provided by the test results shall only apply to the vehicle type of the same model and configurations as assessed therein.

b) Reasons shall be indicated in case the star rating as released according to the provisions concerning impact test scores and star rating evaluations shown in Paragraph 3, Chapter III is inferior to that corresponding to the actual score of the vehicle type concerned.

c) In case of a vehicle type assessed based on manufacturer's voluntary application, it shall be such indicated.

4.1.3 Any other measurement data obtained from the assessment tests shall be furnished to no entity other than the vehicle manufacturer concerned.

4.2 Frequency and method of result releasing

Release frequency: normally once every 3 months. In particular cases, the assessment result would be released at any time.
Releasing method:

1) Through C-NCAP designated website (www.c-ncap.org);

2) Through dedicated column or special issue of *World Auto*, or by media authorized by C-CNAP Management Center;

3) By C-NCAP assessment result release conferences, news report and live broadcasting.

Other media are allowed to carry assessment results downloaded from www.c-ncap.org website's media service area, but are required to register and receive authorization before they can make use of such information, and are to indicate the source of such information they release.

World Auto will release assessment results and related information in more details in its special issues and dedicated columns, and will allow other media to make in-depth reports by way of copy-right cooperation with *World Auto*.

5 Funds

5.1 CATARC will set aside annually dedicated budget funds to cover the costs for purchasing the vehicles, conducting the tests and overall management to ensure long-term operation of C-NCAP.

5.2 In the case of C-NCAP tests applied for by vehicle manufacturer, all the required funds (including the costs for purchasing the vehicle and for conducting the tests) will be provided by the manufacturer, and the purchasing of vehicles and conducting of the tests will follow the same procedure as the assessments conducted with CATARC funds. In assessments applied for by the manufacturer, the test vehicle will be purchased at the actual market price, and the total test cost will be RMB 520,000. For the purpose of whiplash test, the seat shall be provided by vehicle manufacturer.

6. Management of third-party personnel and related affairs during test

6.1 Management of test viewers

6.1.1 The actual testing schedule of the vehicle to be assessed will be informed to the manufacturer concerned in advance and will be announced on C-NCAP's designated website.

6.1.2 The manufacturer should submit to the C-NCAP Management Center the names of those to view the test three days prior to the date of test.

6.1.3 Manufacturer's personnel may view the preparations of impact tests at the specified time spans, and view the test process through the duration beginning half an hour before the test and ending half an hour after the test. Such personnel will be rejected to enter the impact test lab unless with the viewing permit issued to the manufacturer.

6.1.4 Media representatives wishing to view the tests should submit an application and a list of the attendants to the C-NCAP Management Center three days prior to the date of test, and can be present at the testing site only when permission is granted. Media representatives will be rejected to enter the impact test lab unless with the viewing permit issued to the media; in the lab, the shooting time span and zones shall be subject to C-NCAP Management Center.

6.1.5 Any other person who wishes to view the impact tests shall submit the application in advance to the C-NCAP Management Center; once approved, he could enter the test lab by presenting the viewing permit.

6.1.6 During the whiplash test, related technicians from vehicle manufacturer are only allowed to enter the test lab to provide necessary technical support at designated time period during the test preparation; and to witness the test only half an hour prior to and after the test. To enter the test lab, staff of vehicle manufacturer shall present the visit permit issued by C-NCAP Management Center.

6.1.7 Due to restrictions of test conditions and management, no viewing will be arranged in the course of fuel consumption measurements.

6.2 Management of manufacturer's personnel and test related affairs

6.2.1 Manufacturer's personnel may confirm the testing conditions according to the following:

(1) condition of the test vehicle before tests;

(2) positioning of the dummies and setting of the seats before tests.

6.2.2 When confirming the test conditions, the following items that may significantly affect the test result can be cross checked with the Test Assessment Department, and their results can be recorded separately in the data sheet designed by the Test Assessment Department:

(1) anchorage of the seat runners of the seat on which the dummy is positioned, the location of the seat, the location the dummy is positioned, the conditions of the safety belt and the layout of the measurement data lines;

(2) position of the steering system (upper or lower, front or rear);

(3) battery condition of the vehicle;

(4) the reaction of the airbag warning light when ignition is switched to position "On";

(5) other relevant matters to be confirmed as required by the impact test method;

(6) standard position of pedal and moment of activation of active headrest (applicable to whiplash test only).

6.2.3 Personnel from the manufacturer are not to get into physical contact with the vehicle, the dummy and the safety belts when making the confirmation, except when it is confirmed there is a special need and approved by the person in charge of the Test Assessment Department.

6.2.4 The checking by the manufacturer's personnel shall not exceed a limit of 60 minutes, which can be extended for a suitable length when there is a justifiable reason and when the permission is granted by the person in charge of the Test Assessment Department. In such case a summary of opinions can be proposed backed by appropriate reasons, and modifications to the test conditions can be made after permission by the Test Assessment Department is granted.

6.2.5 Views from the media are allowed to take photos or videos before and during the tests only after the permission by the person in charge of the Test Assessment Department is obtained.

6.2.6 For the purpose of the whiplash test, vehicle manufacturer is required to provide necessary technical support, e.g. adjustment of electric seat; however, no manipulation shall be unfolded to seat or test equipment unless with the consent of the superintendent of the Testing and Assessement Department.

7. Complaints over the results and their solution

In the case of dispute over the result of assessment on the part of the manufacturer, a complaint in the form of a Complaint Form (see Annex 4) can be submitted to the C-NCAP Management Center within 10 days after the announcement of the results. The C-NCAP Management Center should give a reply within one month after receipt of the Complaint Form. If the dispute still remains, the C-NCAP Management Center may arrange debates on the issue at the request of the manufacturer.

When improvements have been made to the product whose assessment result has been announced, the manufacturer may apply for re-testing. The costs for re-testing shall be as if it were a test voluntarily applied for by the manufacturer. There can only be one such re-testing. Significant discrepancies in the assessment arising from problems caused by failure in applying the required test procedures during the test are entitled to re-assessment, and such situation will be stated at the time of result release. Costs for re-assessment of this type will be borne by the C-NCAP Management Center.

8. Processing of test data, graphical information, and post-test vehicles

All the data and graphical information acquired from the C-NCAP formal assessment tests as well as the post-test vehicles shall be merely furnished to the vehicle manufacturer concerned, by charging certain fees. If interested, the vehicle manufacturer shall so request at C-NCAP Management Center within three months after the release of the results, by deliver the corresponding amount as per the “Handling Procedures for C-NCAP Test Data, Image Data and Post-test Vehicle”. In case the assessment is conduct on manufacturer’s voluntary application, the vehicle manufacturer may take back the test vehicle one month after the release of the results.

In case of no request for purchasing or taking back the vehicles four months after the release of the results, it shall be considered that C-NCAP Management Center is authorized to dispose them.

9. Use of C-NCAP assessment results and related signs

The results and related signs as released by C-NCAP may be freely used; provided, however, if they are to used for any commercial purpose, the user shall submit a prior statement to C-NCAP Management Center, explaining the sites and formats to use such signs. C-NCAP Management Center shall have right to put forward any requirements in restricting the use.

10. Technological exchange

The C-NCAP Management Center will hold at least one C-NCAP Workshop and Technological exchange activity annually. Such activities may also be held together with the assessment result release conference. Manufacturers and relevant institutions may carry out exchange and technological cooperation activities in various forms with the C-NCAP Management Center.

11. Communications and public propaganda activities

C-NCAP Management Center may, based on actual demands, attend car shows or organize public propaganda activities including exhibition tours. In addition, it is to unfold many types of exchanges with various stakeholders, so as to popularize automotive safety knowledge and enhance the safety consciousness of the public at large.

Chapter III Assessment Procedures

1. Test items

1.1 Frontal impact test against a rigid barrier with 100% overlapping

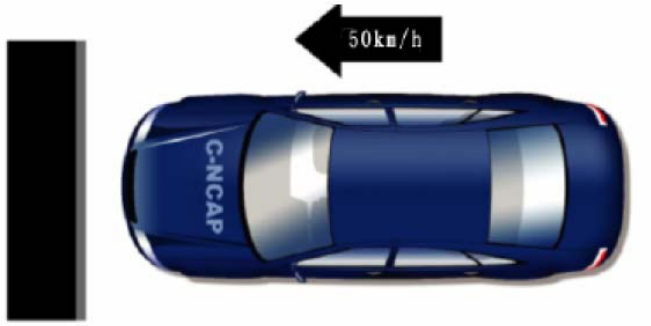


Figure 1 Frontal impact test against a rigid barrier with 100% overlapping

As shown in Figure 1, the test shall be carried out in accordance with the C-NCAP testing procedure. The test vehicle frontally crashes against a fixed rigid barrier with 100% overlapping, which shall be covered by 20 mm-thick plywood boards. The impact velocity is 50^{+1}_{0}km/h km/h (the test speed shall be no less than 50km/h). The test vehicle shall not deviate by 150 mm from the theoretic track in any transverse direction before crashing against the barrier. A Hybrid III 50 percentile male dummy shall be placed at driver and front passenger positions respectively, to measure the injury to front occupants. Place a Hybrid III 5 percentile female dummy on the most outboard seat to the left of the second row, and place a P-series dummy representing a 3-years-old child on the most outboard seat to the right of the same row, so as to measure the injuries suffered by the second-row passengers. In case the ISOFIX anchorages are only fitted to the outboard seat to the left of the second row, the positions of the child dummy and the female dummy may be interchanged.

1.2 Frontal impact test against a deformable barrier with 40% overlapping

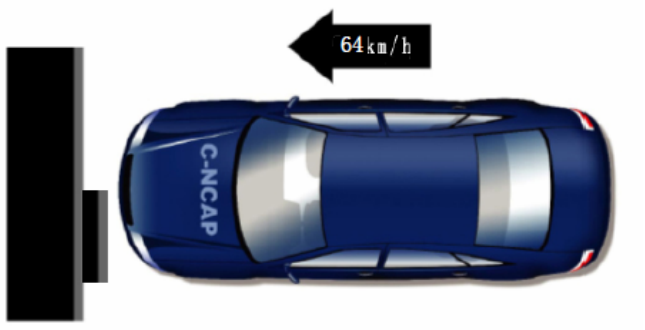


Figure 2 Frontal impact test against a deformable barrier with 40% overlapping

As shown in Figure 2, the test shall be performed in accordance with the C-NCAP testing procedure. The test

vehicle frontally crashes against a deformable barrier with 40% overlapping at the impact velocity of 64^{+1}_{-1} km/h. The overlapping of the vehicle subject to offset impact with the deformable barrier shall be within 40% of vehicle width ±20 mm. A Hybrid III 50 percentile male dummy shall be placed at driver and front passenger areas respectively, to measure the injury to front occupants. A Hybrid III 5 percentile female dummy shall be located in the leftmost seat of the second row, so as to measure the injuries suffered by the second-row passengers. During the test, the measurement of the deformation of A-pillar, steering-column and pedals is required.

1.3 Side impact test against a mobile deformable barrier

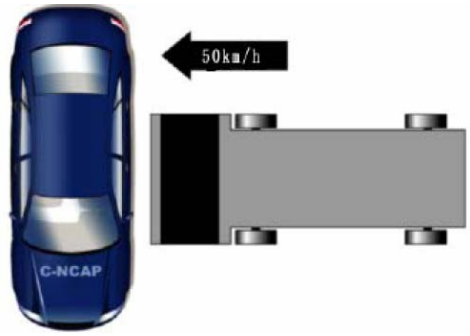


Figure 3 Side impact test against a mobile deformable barrier

As shown in Figure 3, the test shall be performed in accordance with the C-NCAP testing procedure. A deformable cell bond is to be attached to the front end of trolley. The mobile barrier shall move in the direction perpendicular to the test vehicle. The centerline of the barrier shall align with the R-point of the test vehicle. The impact velocity is 50^{+}_{0} km/h (the test speed shall be no less than 50km/h). The longitudinal vertical median plane of the mobile deformable barrier shall be coincident within ±25 mm with a transverse vertical plane passing through the R-point of the front seat adjacent to the struck side of the tested vehicle. A EuroSID II dummy shall be placed at the driver position; place a SID-IIs (version D) dummy on the impact side of the second row, so as to measure the injuries suffered by the second-row passengers.

1.4 Whiplash test

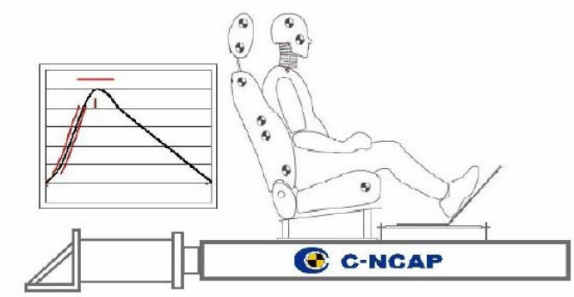


Figure 4 Whiplash test

As shown in Figure 4, the whiplash test is performed as per the test procedures specified by C-NCAP Management Center. By simulating the original vehicle structure, install the seat, together with the restraint

system, onto the movable sled. The sled is launched by the special acceleration pulse having the speed variation at $15.65^{+0.8}_{-0.8}$km/h, so as to simulate the rear impact process. Place a BioRID II dummy on the seat to measure the neck injuries during the rear impact.

To conduct the whiplash test to a vehicle under assessment which is purchased with the fund of C-NCAP Management Center, likewise the seat shall be dismantled from a vehicle (other than that used for the impact test) purchased from the vehicle dealer. For a vehicle which undergoes the C-NCAP assessment under the voluntary application of a manufacturer, the seat used for the whiplash test shall be furnished by the vehicle manufacturer; the technical staff of the Testing and Appraisal Dept. will, after the whiplash test, check the confomity with the seats onboard the vehicle under assessment.

2. Performance parameters and scoring method

2.1 Scoring

2.1.1 Frontal impact test against a rigid barrier with 100% overlapping

With regard to this test, a maximum score of 18 points is available. Max. score for the front-row dummy is 16 points, and the dummy body areas to be scored include head, neck, thorax, upper leg and lower leg, which can be awarded up to 5, 2, 5, 2 and 2 points respectively. The max. score for the second-row female dummy is 2 points; the dummy is divided into 3 regions for scoring, i.e. head, neck and thorax, with a full score of 0.8 point, 0.2 point and 1 point respectively.

The scoring for the frontal-row dummies shall be based on the injury criteria of the driver-side dummy. The scores of the passenger-side dummy may be validated only if they are less than the scores for corresponding areas of the driver-side dummy. The basic scoring principle for the adult dummies on the frontal row and the second row is: to set two limits for each parameter, a higher performance limit, threshold for maximum scores, and a lower performance limit, threshold for zero point; if a group involves the scoring of several body parts, the lowest point thereof shall be taken as the final score of the group concerned; the lowest score will be validated for a body region where multiple assessment criteria exist. The scores for each assessment shall be rounded to two decimal places.

2.1.1.1 Scoring of frontal-row dummy

2.1.1.1.1 Head

The maximum and minimum scores for head are 5 points and 0 point respectively. The score for the passenger-side dummy's head is obtained by measuring relevant parameters of the dummy, while the ultimate score for the driver-side dummy's head is obtained by subtracting the penalty for the deformation of the steering column from the score obtained herewith. The dummy head assessment parameters involve the head injury criterion (HIC_{36}) and the resultant acceleration of 3 ms. A maximum score of 5 points is available for each parameter. Higher and lower performance limits are to be used for calculation.

Higher performance limit: Head injury criterion (HIC_{36})	650

	Resultant acceleration of 3 ms	72 g
Lower performance limit:	Head injury criterion (HIC_{36})	1,000
	Resultant acceleration of 3 ms	88 g

The lower performance limit and the higher performance limit correspond to 0 point and 5 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

With regard to the driver-side dummy, the score for head will be subject to modification with 0 ~ -1, provided that excessive upward displacement of the steering column occurs.
The EEVC recommending limit is 80 mm. In calculating penalties, up to 90 percent of the EEVC limits (i.e., 72 mm), there is no penalty. Beyond 110 percent of the EEVC limits (i.e., 88 mm), there is a penalty of one point. The details are given below:

Upward displacement of steering column	Penalty
≤ 72 mm	0
≥ 88 mm	1

Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.1.1.2 Neck

The maximum and minimum scores for neck are 2 points and 0 point respectively. The score for neck is generated by measuring relevant parameters of the dummy. The assessment parameters include shear Fx, tension Fz and extension My, which can each be awarded up to 2 points.

Higher performance limit:
Shearing force Fx 1.9kN @ 0 ms, 1.2kN @ 25 ~ 35 ms, 1.1 kN @ 45 ms
Tension Fz 2.7kN @ 0 ms, 2.3kN @ 35 ms, 1.1 kN @ 60 ms
Extension bending moment My 42Nm

Lower performance limit:
Shearing force Fx 3.1kN @ 0 ms, 1.5kN @ 25 ~ 35 ms, 1.1 kN @ 45 ms
Tension Fz 3.3kN @ 0 ms, 2.9kN @ 35 ms, 1.1 kN @ 60 ms
Extension bending moment My 57Nm

Neck shearing force and tension are assessed from cumulative curve, with the limits being functions of time. By interpolation, a plot of points against time is computed. The score for each point may be calculated by linear interpolation, and the minimum point on this plot gives the score. Plots of the limits and rating boundaries are given in Figures 5, 6 and 7.

For extension bending moment, the score is calculated by linear interpolation and rounded to two decimal places.

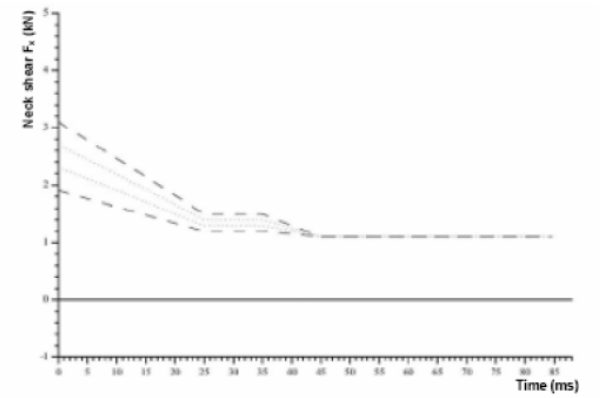


Figure 5 Neck shearing force Fx (positive direction)

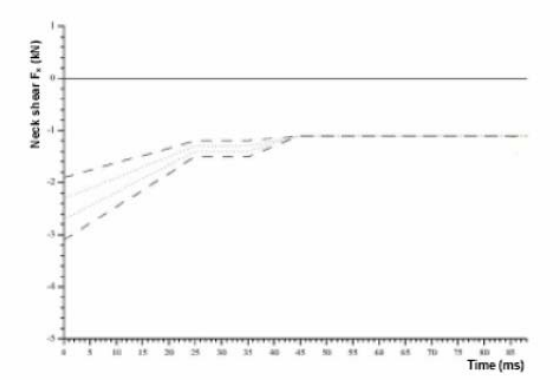


Figure 6 Neck shearing force Fx (negative direction)

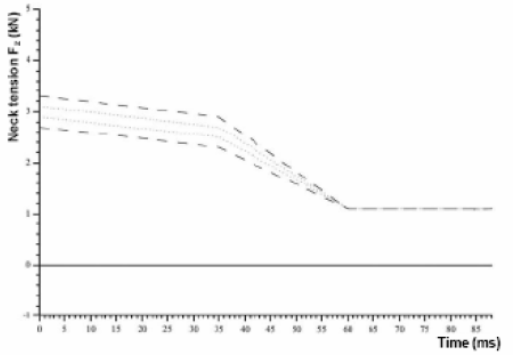


Figure 7 Neck tension Fz (positive direction)

2.1.1.1.3 Thorax

The maximum and minimum scores for this body area are 5 points and 0 point respectively.

The score for the passenger-side dummy's thorax is generated by measuring relevant parameters of the dummy, while the ultimate score for the driver-side dummy's thorax is obtained by subtracting the penalty for

the deformation of the steering column from the score obtained herewith. The dummy head assessment parameters include the compression and the resultant acceleration of 3 ms. A maximum score of 5 points is available for each parameter.

Higher performance limit:	Compressive deformation	22 mm
	Resultant acceleration of 3 ms	38 g
Lower performance limit:	Compressive deformation	50 mm
	Resultant acceleration of 3 ms	60 g

The lower performance limit and the higher performance limit correspond to 0 point and 5 points respectively. Where a measurement value falls between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

With regard to the driver-side dummy, the score for head will be subject to modification with 0 ~ -1, provided that excessive rearward displacement of the steering column occurs.

The EEVC recommending limit is 100 mm. In calculating penalties, up to 90 percent of the EEVC limits (i.e., 90 mm), there is no penalty. The details are given below: Beyond 110 percent of the EEVC limits (i.e., 110 mm), there is a penalty of one point.

The details are given below:

Rearward displacement of the steering column	Penalty
≤ 90 mm	0
≥ 110 mm	1

Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.1.1.4 Upper legs

The maximum and minimum scores for this body area are 2 points and 0 point respectively.

The score for femur is generated by measuring relevant parameters of the dummy. The femur assessment parameters include the femur compression force and the knee sliding compressive displacement. A maximum score of 2 points is available for each parameter.

Higher performance limit:	Femur compression force	3.8 kN
	Knee sliding compressive displacement	6 mm
Lower performance limit:	Femur compression force	9.07 kN @ 0 ms, 7.56 kN @ ≥10ms
	Knee sliding compressive displacement	15 mm

Femur compression force is assessed from a cumulative plot, with the limits being functions of time. By interpolation, a plot of points against time is computed. The score for each point may be calculated by linear interpolation, and the minimum point on this plot gives the score. Plots of the limits and score rating boundaries are given in Figure 8.

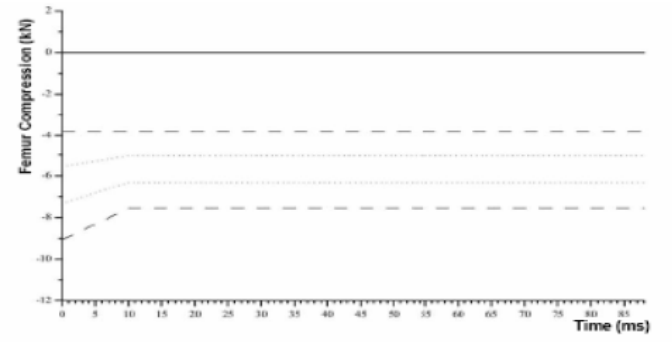


Figure 8 **Femur compression force**

2.1.1.1.5 Lower legs

The maximum and minimum scores for this body area are 2 points and 0 point respectively.

The score for lower legs is generated by measuring relevant parameters of the dummy. The lower leg assessment parameters include the femur compression and the knee slider compressive displacement, which can each be awarded up to 2 points.

Higher performance limit:	Tibia index (TI)	0.4
	Tibia compression	2kN
Lower performance limit:	Tibia index (TI)	1.3
	Tibia compression	8kN

The lower performance limit and the higher performance limit correspond to 0 point and 2 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.1.2 **Scoring of second-row female dummy**

To the maximum, the second-row female dummy may obtain 2 points, and to the minimum, 0 point. The scoring parts are head, neck and thorax of female dummy.

2.1.1.2.1 **Head injury criterion (HIC)**

To the maximum, this part may obtain 0.8 points, and to the minimum, 0 point.

If the head of the second-row female dummy involves no secondary impact during the forward motion, 0.8 point will be obtained directly for such criterion; in case of second impact (against, e.g., seat, pillar-B, etc.) during the forward motion, the score for dummy head shall be resulted from measuring appropriate dummy criterion; the assessment criterion shall be the head injury criterion (HIC_{15}); for this criterion, the max. score is 0.8 point, which is calculated by the higher and lower performance limits.

Higher performance limit:	head injury criterion (HIC15)	500

Lower performance limit:	head injury criterion (HIC15)	700

Lower performance limit and higher performance limit correspond to 0 point and 0.8 point, respectively; for a measured value falling between them, the appropriate score shall be obtained by linear interpolation, which numeral shall be rounded to the second digit after the decimal point.

The aforesaid second impact is defined as follows: the head presents the trace of contact with vehicle components, and, according to Clause 5 to SAE2052, the calculated head contact load exceeds 500 N (excluding any second impact of the female dummy itself, e.g., between head and knee, between chin and thorax, etc.).

2.1.1.2.2 Neck

For this part, the max. score is 0.2 point, and the min., 0 point. The neck score shall be obtained by measuring appropriate criteria of dummy neck. If the head of the second-row female dummy involves no secondary impact during the forward motion, the neck assessment criteria shall be the tension Fz, for which the max. score is 0.2 point; if a secondary impact is involved, the neck assessment criteria shall be the shear force Fx, tension Fz and extensional bending moment My, each of which may get 0.2 point to the minimum.

Higher performance limit:	Shear force Fx	1,200 N
	Tension Fz	1,700 N
	Extensional bending moment My	36 Nm
Lower performance limit:	Shear force Fx	1,950 N
	Tension Fz	2,620 N
	Extensional bending moment My	49 Nm

Lower performance limit and higher performance limit respectively correspond to 0 point and 0.2 point; for a measurement value falling within them, the score shall be calculated by means of linear interpolation, which shall be subsequently rounded off to 0.01.

For second impact, refer to Paragraph 2.1.1.2.1.

2.1.1.2.3 Thorax

The max. score for this part is 1 point, while the min. one is 0 point. The thorax score for the second-row female dummy is obtained by measuring related dummy criteria. The assessment criteria include compressive deformation.

Higher performance limit:	Compressive deformation	23 mm
Lower performance limit:	Compressive deformation	48 mm

Lower performance limit and higher performance limit respectively correspond to 0 point and 1 point; for a

measurement value falling within them, the score shall be calculated by means of linear interpolation, which shall be subsequently rounded off to 0.01.

2.1.1.3 **Overall rating for the fontal impact test against the rigid barrier with 100% overlapping**

Given in Table 1 is the overall rating principle for the fontal impact test against the rigid barrier with 100% overlapping:

Table 1 Overall rating principle for the fontal impact test against the rigid barrier with 100% overlapping

Area		Penalty item	Area score	Overall rating
Front-row dummy	Head	The score for the driver-side dummy's head is modified with 0~-1 for excessive upward displacement of the steering column.	0 ~ 5	0 ~ 18
	Neck	-	0 ~ 2	
	Thorax	The score for the driver-side dummy's thorax is modified with 0~-1 for excessive rearward displacement of the steering column.	0 ~ 5	
	Femur	-	0 ~ 2	
	Lower leg	-	0 ~ 2	
Second-row female dummy	Head	-	0 ~ 0.8	
	Neck	-	0~0.2	
	Thorax	-	0 ~ 1	
Overall penalty item		A minus one-point modifier will be applied for every door liable to open during the collision.	A maximum penalty of 4 points is available.	
		A minus one-point modifier will be applied for the safety belts located in the driver's side, the front passenger' side and the rear seat on which the dummy is placed, provided that they fail during the test.		
		A minus one-point modifier will be applied for the restraint system if, when removing the dummy from the restraint system, the dummy is locked and the application of a force of over 60N on the release system cannot set it free.		
		One point will be deducted in case of any failure with the anchorages for the second-row dummy or CRS (either secured with adult safety belt or ISOFIX anchorage)**		
		A minus one-point modifier will be applied for the doors fitted corresponding to each row of seats on both sides of the vehicle, which fail to be opened without the use of any tools after the test.		
		There is a penalty of two points if continuous leakage occurs in the fuel feeding system at an average rate of over 30g/min in the first 5 minutes after the impact.		

Note: *: "Failure of adult safety belt" means any situation below occurring with the safety belt and restraint system:

(1) Rupture of the strap;

(2) Rupture/disengagement of the buckle, adjusting device or connector;

(3) Malfunction of the retractor;

(4) Presenting the submarine effect.

**: "Failure of CRS anchorages" means any situation below:

(1) Any failure mentioned in (1) ~ (3) under item * above occurring with the adult safety belt intended for securing the CRS;

(2) Rupture/disengagement of the ISOFIX device intended for securing the CRS;

(3) Any contact of the head of the child dummy with any part inside the vehicle due to the fault of the adult safety belt or the ISOFIX device, which is used for securing the CRS, and the resultant acceleration of the head of dummy child exceeds 88 g in 3 ms.

2.1.2 **Fontal impact test against the deformable barrier with 40% overlapping**

During the test, a maximum score of 18 points is available. For the assessment of the front-row dummy, the body regions of the test dummy are classified into four groups each of which can be awarded up to four points. The max. score that can be obtained is 16 points. The grouped regions are:

Group 1: Head, neck
Group 2: Thorax
Group 3: Knee, femur, pelvis
Group 4: Lower leg, foot and ankle

For the assessment of the front-row dummy, the scoring shall be based on the injury criteria of the driver-side dummy. The scores of the passenger-side dummy may be validated only if they are less than the scores for corresponding areas of the driver-side dummy.

The max. score for the second-row female dummy is 2 points; the body parts of the female dummy are divided into 2 groups; for each group, the max,. score is 1 point; concretely, neck and head constitute the first group, and thorax, the second group. The basic scoring principle for the adult dummies in the frontal row and the second row is: to set two limits for each parameter, a higher performance limit, threshold for a maximum score of 4 points and a lower performance limit, threshold for zero point; the lowest point will be validated for a body region where multiple criteria exist. The scores for all individual parameters shall be rounded to two decimal places.

2.1.2.1 **Scoring of front-row dummy**

2.1.2.1.1. **Head and neck (Group 1)**

The sliding scale for this group is from 0 to 4 points.

2.1.2.1.1.1 Head

The score for the passenger-side dummy’s head is generated by measuring relevant parameters of the dummy, while the ultimate score for the driver-side dummy’s head is obtained by subtracting the penalty for the deformation of the steering column from the score obtained herewith. The dummy head assessment parameters involve the head injury criteria (HIC36) and the resultant acceleration of 3 ms. Each parameter can be awarded up to 4 points. The calculation is conducted by using the higher performance limit and the lower performance limit.

For the dummy’s head ratings, higher and lower performance limits and score calculation method, see Paragraph 2.1.1.1.1.

With regard to the driver-side dummy, the score for head will be subject to modification with 0 ~ -1, provided that excessive upward displacement of the steering column occurs. The EEVC recommending limit is 80 mm. In calculating penalties, up to 90 percent of the EEVC limits (i.e., 72 mm), there is no penalty. Beyond 110 percent of the EEVC limits (i.e., 88 mm), there is a penalty of one point. The details are given below:

Upward displacement of steering column	Penalty
≤ 72 mm	0
≥ 88 mm	1

Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.2.1.1.2 Neck

The score for neck is obtained by measuring relevant parameters of the dummy. The assessment parameters include shearing force Fx, tension Fz and extension bending moment My, which can each be awarded up to 4 points.

For the dummy's neck ratings, higher and lower performance limits and score calculation method, see Paragraph 2.1.1.1.2.

2.1.2.1.2 **Thorax (Group 2)**

The sliding scale for this group is from 0 to 4 points.

The score for the passenger-side dummy's thorax is generated by measuring relevant parameters of the dummy, while the ultimate score for the driver-side dummy's thorax is obtained by subtracting the penalty for the deformation of the steering column and A-pillar from the score obtained herewith. The dummy thorax assessment parameters include the compressive deformation and the resultant acceleration of 3 ms. Each parameter can be awarded up to 4 points.
For the dummy's thorax ratings, higher and lower performance limits and score calculation method, see Paragraph 2.1.1.1.3.

With regard to the driver-side dummy, the score for thorax will be subject to modification with 0 ~ -2 and 0 ~ -1 for the excessive rearward displacement of the A-pillar and the steering column. Where the rearward displacement of the A-pillar is not in excess of 100 mm, there is no penalty. In the case of the displacement being up to 200 mm, there is a penalty of 2 points. The EEVC recommending limit for the rearward displacement of the steering column is 100 mm. In calculating penalties, up to 90 percent of the EEVC limits (i.e., 90 mm), there is no penalty. Beyond 110 percent of the EEVC limits (i.e., 110 mm), there is a penalty of one point.

The details are given below:

Rearward displacement of A-pillar	Penalty

≤ 100 mm	0
≥ 200 mm	2

Rearward displacement of steering column	Penalty
≤ 90 mm	0
≥ 110 mm	1

Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.2.1.3 **Knee, femur, pelvis (Group 3)**

The sliding scale for this group is from 0 to 4 points.

The scores for these regions are obtained by measuring relevant parameters of the dummy. The assessment parameters include femur compression force and knee sliding compressive displacement, which can each be awarded up to 4 points.

For ratings, higher and lower performance limits, and score calculation method, see Paragraph 2.1.1.1.4.

2.1.2.1.4 **Lower leg, foot and ankle (Group 4)**

The sliding scale for this group is from 0 to 4 points.

The scores for these regions of the passenger-side dummy are generated by measuring relevant parameters of the dummy, while the ultimate scores for these regions of the driver-side dummy are obtained by subtracting the penalty for the deformation the pedals from the score obtained herewith. The assessment parameters include tibia index (TI) and tibia compression force, which can each be awarded up to 4 points.
For ratings, higher and lower performance limits and score calculation method, see Paragraph 2.1.1.1.5.

The scores for these regions of the driver-side dummy will be subject to modification with 0~ -1 for the excessive rearward and upward displacements of pedals. In the following are the details:

Pedal rearward displacement	Penalty
≤ 100 mm	0
≥ 200 mm	1

Pedal upward displacement	Penalty
≤ 72 mm	0
≥ 88 mm	1

Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

The penalty on the worst performing pedal shall be validated for all pedals of the vehicle.

Notes:

1. Pedal displacement is measured with no load applied to pedals.
2. If any of the pedals is so designed that it will be completely released from the mounting position during the impact, and it does fall from the mounting position but resulting in no perceptible resistance to the movement, no penalty will be taken into account.

2.1.2.2 **Scoring of second-row female dummy**

With regard to the female dummy on the second row of seats, the maximum score is 2 points while the minimum is 0 point. The female dummy is classified into two parts in terms of body region, i.e. head and neck (group 1) and thorax (group 2). The maximum score for each part is 1 point.

2.1.2.2.1 **Head and neck (Group 1)**

Max. score for this group is 1 point, and min. score, 0 point.

2.1.2.2.1.1 Head

If the head of second-row female dummy involves no second impact during its forward motion, 1 point may be obtained directly; in case of any second impact with frontal seat, pillar-B, etc. during its forward motion, the score of dummy head shall be obtained through measuring dummy's pertinent criterion; the assessment criterion is head injury criterion (HIC15); the max. score for this criterion is 1 point, which is calculated by means of higher performance limit and lower performance limit.
The lower performance limit and the higher performance limit correspond to 0 point and 1 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

For the scoring of dummy's head, higher and lower performance limits, score calculation, and judgment procedures for secondary impact, refer to related text of Paragraph 2.1.1.2.1.

2.1.2.2.1.2 Neck

Max. score for this part is 1 point, and min. score, 0 point.

Neck score is obtained by measuring related criteria of dummy neck. If the head of second-row female dummy involves no secondary impact during its forward motion, the neck assessment criteria shall be tension Fz, for which the max. score is 1 point; in case the head involves a second impact, the neck assessment criteria shall include shear force Fx, tension Fz and extensional bending moment My, each of which corresponds to 1 point to the maximum.

The lower performance limit and the higher performance limit correspond to 0 point and 1 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

For the scoring of dummy's neck, higher and lower performance limits, score calculation, and judgment

procedures for secondary impact, refer to related text of Paragraph 2.1.1.2.2.

2.1.2.2.2 Thorax (Group 2)

Max. score for this group is 1 point, and min. score, 0 point.

Thorax score of second-row female dummy shall be obtained by measuring related criteria of the dummy. The assessment criterion is represented by compressive deformation, for which 1 point may be obtained to the maximum.

The lower performance limit and the higher performance limit correspond to 0 point and 1 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

For the scoring of dummy thorax, higher and lower performance limit, and score calculation procedures, see related text in Paragraph 2.1.1.2.3.

2.1.2.3 Overall rating for the frontal impact test against the deformable barrier with 40% overlapping

Given in Table 2 is the overall rating principle for the frontal impact test against the deformable barrier with 40% overlapping

Table 2 Overall rating principle for the frontal impact test against the deformable barrier with 40% overlapping

Group no.		Area	Penalty item	Area score	Overall rating
Front-row dummy	Group 1	Head, neck	The score for the driver-side dummy's head will be subject to modification with 0~-1 for the excessive upward displacement of the steering column.	0 ~ 4	0 ~ 18
	Group 2	Thorax	The score for the driver-side dummy's thorax will be subject to modification with 0 ~ -2 and 0 ~ -1 for the excessive rearward displacement of the A-pillar and the excessive rearward displacement of the steering column respectively.	0 ~ 4	
	Group 3	Knee, femur, pelvis	-	0 ~ 4	
	Group 4	Lower leg and foot and ankle	The scores for these regions of the driver-side dummy will be subject to modification with 0~-1 for the excessive rearward and upward displacements of pedals.	0 ~ 4	
Second-row female dummy	Group 1	Head & neck	-	0 ~ 1	
	Group 2	Thorax	-	0 ~ 1	
Overall penalty item			A minus one-point modifier will be applied for every door liable to open	A maximum	

	during the impact.	penalty of 4 points is available.	
	A minus one-point modifier will be applied for the safety belts located in the driver's side, the front passenger' side and the rear seat on which the dummy is placed, provided that they fail during the test.		
	A minus one-point modifier will be applied for the restraint system if, when removing the dummy from the restraint system, the dummy is locked and the application of a force of over 60N on the release system cannot set it free.		
	A minus one-point modifier will be applied for the doors fitted corresponding to each row of seats on both sides of the vehicle, which fail to be opened without the use of any tools after the test.		
	There is a penalty of two points if continuous leakage occurs in the fuel feeding system at an average rate of over 30g/min in the first 5 minutes after the impact.		

2.1.3 Side impact test against the mobile deformable barrier

For the test, a maximum score of 18 points is available. For the front-row dummy, a max. score of 16 points may be obtained; the dummy body regions to be rated include head, thorax, abdomen and pelvis which can each be awarded up to 4 points. For the second-row female dummy, a max. score of 2 points may be obtained, and the scoring parts are dummy's head and pelvis, for each of which the max. score is 1 point.

For the adult dummies in the frontal row and the second row, the basic scoring principle for each dummy is: to set higher performance limit and lower performance limit, corresponding to the max. score and 0 point of each body part; the lowest point will be validated for a body region where multiple criteria exist. The scores for all individual parameters shall be rounded to two decimal places.

2.1.3.1 Scoring of front-row dummy

2.1.3.1.1 Head

The sliding scale for this body region is from 0 to 4 points.

The score for the dummy's head is generated by measuring relevant parameters of the dummy. The assessment parameters include the head injury criterion (HIC36) and the resultant acceleration of 3 ms which can each be awarded up to 4 points. Higher and lower performance limits are to be used for calculation.

For ratings, higher and lower performance limits and score calculation method, see Paragraph 2.1.1.1.1.

2.1.3.1.2 Thorax

The sliding scale for this body region is from 0 to 4 points.

The score for the dummy's thorax is generated by measuring relevant parameters of the dummy. The assessment parameters include compressive deformation and viscosity criterion (VC) which can each be awarded up to 4 points. Higher and lower performance limits are to be used for calculation.

Higher performance limit:	Compressive deformation	22 mm
	Viscosity criterion (VC)	0.32m/s
Lower performance limit:	Compressive deformation	42 mm
	Viscosity criterion (VC)	1.0m/s

The lower performance limit and the higher performance limit correspond to 0 point and 4 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

The score obtained for thorax performance will be subject to modification with 0 ~ -2 points in any of the following circumstances.

1. Backplate modifiers

Where the backplate load Fy is not greater than 1kN, there is no penalty. In the case it exceeds 4kN, a two-point penalty is applied to the dummy's thorax assessment. The details are as follows:

Backplate load Fy	Penalty
≤ 1.0 kN	0
≥ 4.0 kN	2

Between the two limits, the penalty is calculated by linear interpolation and rounded to two decimal places.

2. T12 modifiers

Where the T12 loads Fy and Mx are not greater than 1.5kN or 150Nm respectively, there is no penalty. If they exceed 2.0kN or 200Nm respectively, a two-point penalty is applied to the dummy's thorax assessment. The details are as follows:

Higher performance limit:			
	Fy 1.5kN	Mx	150Nm
Lower performance limit			
	Fy 2.0kN	Mx	200Nm

Between the two limits, the penalty is calculated by linear interpolation and rounded to two decimal places.

The penalty for the worse performing one of the two T12 parameters is used.

2.1.3.1.3 Abdomen

The sliding scale for this body region is from 0 to 4 points.

The score for the dummy's abdomen is generated by measuring relevant parameters of the dummy. The abdominal force is subject to assessment. A maximum score of 4 points is available for it. Higher and lower performance limits are to be used for calculation.

Higher performance limit:	Abdominal force	1.0kN
Lower performance limit:	Abdominal force	2.5kN

The lower performance limit and the higher performance limit correspond to 0 point and 4 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.3.1.4 Pelvis

The sliding scale for this body region is from 0 to 4 points.

The score for the dummy's pelvis is generated by measuring relevant parameters of the dummy. The pubic resultant force is subject to assessment. A maximum score of 4 points is available for it. Higher and lower performance limits are to be used for calculation.

Higher performance limit:	Pubis force	3.0kN
Lower performance limit:	Pubis force	6.0kN

The lower performance limit and the higher performance limit correspond to 0 point and 4 points respectively. Between the two limits, the score is calculated by linear interpolation and rounded to two decimal places.

2.1.3.2 Scoring of second-row female dummy

For the second-row female dummy, limits are set for the performance criteria of dummy's head and pelvis, with each body part corresponding to 1 point. Head assessment criterion is assumed by head injury criterion (HIC15), while pelvis assessment criterion, by resultant pelvis force.

2.1.3.2.1 Head

Max. score for this part is 1 point, and min. score, 0 point.

Score of dummy head is resulted from measuring dummy's related criterion; its assessment criterion is assumed by head injury criterion (HIC15), which corresponds to 1 point to the maximum, and is calculated by means of higher performance limit and lower performance limit.

For the concrete scoring, higher and lower performance limits, and score computation procedures, consult the pertinent text in Paragraph 2.1.1.2.1.1.

2.1.3.2.2 Pelvis

Max. score for this part is 1 point, and min. score, 0 point.

Score of dummy pelvis is resulted from measuring dummy's related criterion; its assessment criterion is assumed by resultant pelvis force (synthetic force of hip joint and iliac bone), which corresponds to 1 point to the maximum, and is calculated by means of higher performance limit and lower performance limit.

Higher performance limit:	Resultant pelvis force	3.5 kN
Lower performance limit:	Resultant pelvis force	5.5 kN

Lower performance limit and higher performance limit correspond to 0 point and 1 point, respectively; for a measurement value falling between them, the score shall be computed by means of linear interpolation, which shall be subsequently rounded off to 0.01.

2.1.3.3 Overall rating for the side impact test against the mobile deformable barrier

The overall rating principle for the side impact test against the mobile deformable barrier is set out in Table 3.

Table 3 Overall rating principle for the side impact test against the mobile deformable barrier

<table>
<tr><th colspan="2">Area</th><th>Penalty item</th><th>Area score</th><th>Overall rating</th></tr>
<tr><td rowspan="4">Front-row dummy</td><td>Head</td><td>-</td><td>0 ~ 4</td><td rowspan="8">0 ~ 18</td></tr>
<tr><td>Thorax</td><td>1) The score for thorax will be subject to modification with 0~-2 for the excessive backplate load Fy.</td><td>0 ~ 4</td></tr>
<tr><td>Abdomen</td><td>-</td><td>0 ~ 4</td></tr>
<tr><td>Pelvis</td><td>-</td><td>0 ~ 4</td></tr>
<tr><td rowspan="2">Second-row female dummy</td><td>Head</td><td>-</td><td>0 ~ 1</td></tr>
<tr><td>Pelvis</td><td>-</td><td>0 ~ 1</td></tr>
<tr><td colspan="2" rowspan="3">Overall penalty item</td><td>A minus one-point modifier will be applied for every door liable to open during the impact.</td><td rowspan="3">A maximum penalty of 4 points is available.</td></tr>
<tr><td>A minus one-point modifier will be applied for the failure during the test of the safety belt of the driver side and the second-row dummy, respectively.</td></tr>
<tr><td>There is a penalty of two points if the continuous leakage occurs in the fuel feeding system at an average rate of over 30g/min in the first 5 minutes after the impact.</td></tr>
</table>

2.1.4 Neck protection test in low-speed impact (whiplash test)

For reference only

In the total score of C-NCAP, this test item may contribute 4 points to the maximum.

The final score (0 ~ 4 points) shall be converted from the score of whiplash test. Max. score for the whiplash test is 8 points, and the scoring is based on the injury criteria measured through transducers installed on the dummy; dummy measuring data comprise two sets: one set represents the neck injury criterion calculated from head acceleration and thorax acceleration, and the max. score is 2 points; the other set is represented by neck load and torque, for which the max. score is 6 points.
The scoring is based on dummy injury criteria; for each injury criterion, both higher and lower performance limit are established, corresponding to the max. score and 0 point respectively; for a value falling between them, the score shall be calculated by means of linear interpolation, and the score of each test item shall be rounded off to 0.01. For this test, penalty of 2 points, 2 points and 4 points shall apply respectively in case of non-conformity below: max. dynamic opening of seatback, head interference space of head restraint, and seat track dynamic displacement.

2.1.4.1 Neck injury criterion (NIC)

For this group, the max. score is 2 points, and the min. score, 0 point. Scoring shall be resulted from the measurement of dummy head acceleration and thorax T1 acceleration. Through calculation, the neck injury criterion (NIC) can be obtained.

Higher performance limit: $8m2/s^2$

Lower performance limit: $30m2/s^2$

Lower performance limit and higher performance limit correspond to 0 point and 2 points, respectively; for a value falling between them, the score shall be calculated by means of linear interpolation, and the score of each test item shall be rounded off to 0.01.

2.1.4.2 Neck load and torque

Max. score for this group is 6 points, and min. score, 0 point. The scoring is based on the measurement of related criteria of dummy neck, including upper neck shear force Fx+, upper neck tension Fz+, upper neck torque My, lower neck shear force Fx+, lower neck tension Fz+, and lower neck torque My. The sum of points for all the criteria represents the final score of this body part.

Higher performance
limit:
Upper neck shear force Fx+ 340 N
Upper neck tension Fz+ 475 N
Upper neck torque My 12 Nm
Lower neck shear force Fx+ 340 N
Lower neck tension Fz+ 257 N
Lower neck torque My 12 Nm

Lower performance
limit:
Upper neck shear force Fx+ 730 N
Upper neck tension Fz+ 1,130 N
Upper neck torque My 40 Nm
Lower neck shear force Fx+ 730 N
Lower neck tension Fz+ 1,480 N
Lower neck torque My 40 Nm

Lower performance limit and lower performance limit correspond to 0 point and 1 point, respectively; for a value falling between them, the score shall be calculated by means of linear interpolation, and the score of each test item shall be rounded off to 0.01.

2.1.4.3 Penalty items for whiplash test

2.1.4.3.1 Seatback dynamic opening

For this item, the max. penalty score is 2 points. Based on image analysis, the max. variation of seatback opening is obtained during the impact; the limit for this item is 32º. No penalty score applies for a value below such limit (i.e., 0 point is obtained); 2 points shall be deducted if such limit is exceeded (i.e., -2 points are obtained).

2.1.4.3.2 Head interference space of head restraint

For this item, the max. penalty score is 2 points. In the course of seat adjustment and measurement, 2 points shall be deducted if HRMD measurement is interfered by the head restraint (i.e., -2 points are obtained).

2.1.4.3.3 Seat track dynamic displacement

For this item, the max. penalty score is 4 points. Based on the high-speed video data, 4 points shall be deducted if the maximum dynamic displacement of track in relation to fixed part exceeds 20mm in the course of dynamic impact (i.e., -4 points are obtained).

2.1.4.4 Conversion of bonus score from whiplash test

If the whiplash test score is 7 points or higher, a bonus score of 4 points shall be credited to C-NCAP whiplash test;

If the whiplash test score is no more than 4 points, a bonus score of 0 point shall be credited to C-NCAP whiplash test;

As shown in Figure 9, if the score of whiplash test falls within 4 and 7 points, then the bonus point for C-NCAP whiplash test shall be calculated by means of linear interpolation, which shall be subsequently rounded off to

0.01.

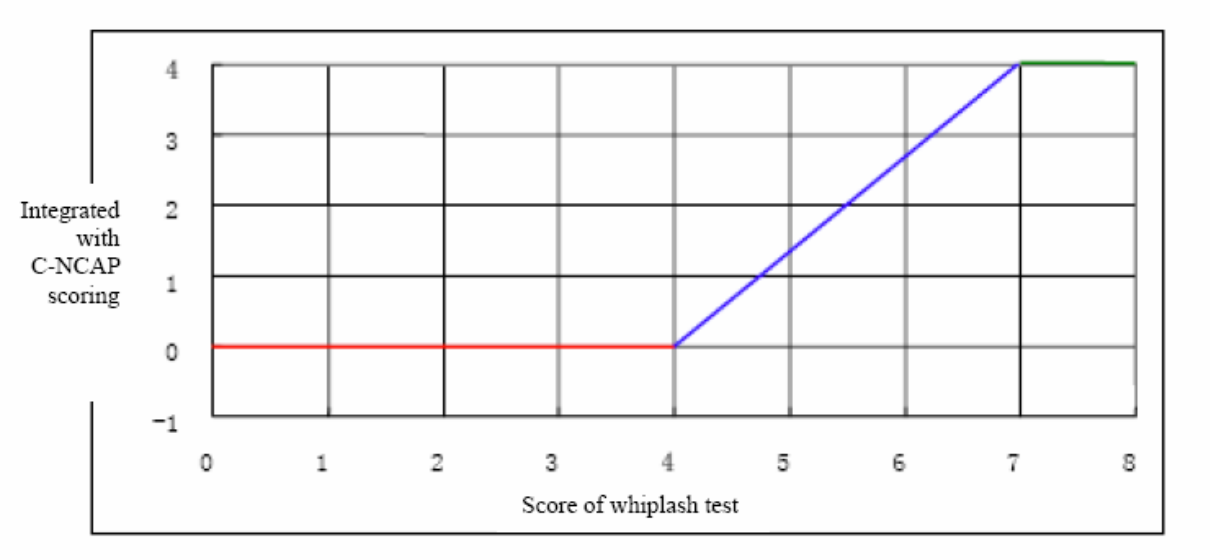


Figure 9 Conversion measure for whiplash test score

2.1.4.5 Overall scoring of whiplash test

Table 4 presents the overall scoring principles for the whiplash test:

Table 4 Overall scoring principles for whiplash test

Criteria	Higher performance limit	Lower performance limit	Score	Score of whiplash test	Bonus score converted for C-NCAP
NIC	$8m^2/s^2$	$30m^2/s^2$	0 ~ 2	0 ~ 8	0 ~ 4
Upper neck Fx+	340 N	730 N	0 ~ 6		
Upper neck Fz+	475 N	1,130 N			
Upper neck My	12 N·m	40 N·m			
Lower neck Fx+	340 N	730 N			
Lower neck Fz+	257 N	1,480 N			
Lower neck My	12 N·m	40 N·m			
Seatback dynamic opening	32°		-2 or 0		
Head interference space of head restraint	Y/N		-2 or 0		
Seat track dynamic displacement	20mm		-4 or 0		

2.2 Bonus items

A bonus of 4 points is available.

2.2.1 Safety belt reminder

A maximum bonus of 1.5 point is available to the vehicle equipped with the safety belt reminder.

In the position of the driver: The safety belt reminder located in the driver area shall be incorporated with audible signals. Where the driver does not wear the safety belt, the reminder shall be actuated in case one of the following circumstances is met:

1. The vehicle has already traveled forward for 60s;
2. The vehicle has already traveled 500m forward;
3. The forward speed of the vehicle has already exceeded 25km/h.

A bonus of 0.5 point may be granted if the driver safety belt reminder meets the above requirements. Otherwise, there is no bonus.

In the position of front passenger: A bonus of 1 point shall be granted for the passenger safety belt reminder (no particular requirement for the type of signals), if fitted, provided that the function of monitoring the use of the seat in that area is available (i.e., the safety belt reminder located in that area shall be automatically ineffective if the seat is not used.) as well; a bonus of 0.5 point shall be granted provided only the safety belt reminder is fitted, but without the function of monitoring the use of the seat.

2.2.2 Side airbag and air curtain

A bonus of 1 point may be granted for the vehicle fitted with side airbags and air curtains that can normally deploy during the side impact test against the mobile deformable barrier.

2.2.3 ISOFIX anchorages

A bonus of 0.5 point may be granted for the vehicle fitted with ISOFIX anchorages (at least 2 groups are available, and to the minimum one group is used for the second row of seats) which don't fail in the frontal rigid barrier impact test with 100% overlapping as mentioned in "Note" of Table 1.

2.2.4 Electronic stability control (ESC) system

For a vehicle fitted with electronic stability control (ESC) system, if vehicle maker may furnish a test report demonstrating that the system complies with GTR No.8 "Electronic Stability Control Systems" or FMVSS 126 " Electronic Stability Control Systems Testing" or ECE R13H Annex 9 "Electronic Stability Control Systems", then one bonus point may be obtained.

Such test report shall include the following to the minimum:

(a) ESC functional requirements in compliance with standard;

(b) Test data of slow increase of the turning angle of steering wheel;
(c) Sinusoidal stagnation test data and curve;
(d) Photographs of test vehicle fitted with test equipment and test site;
(e) ESC parameters of test vehicle, such as wheelbase, wheel track, tyre model, maximum design gross mess, mass center position, suspension structure form and main structure parameters; and
(f) Document explaining the parametric consistency between test vehicle for C-NCAP and that for ESC test.

3.Scoring and star rating

The scores generated from the three impact tests (i.e., frontal 100% overlapped impact test against rigid barrier, frontal 40% overlapped impact test against deformable barrier, and lateral impact test against deformable mobile barrier), the whiplash test, and various bonus items are added together as a total score (as given in the enclosed Appendix), rounded to one decimal place. The maximum score of the C-NCAP assessment is 62. To achieve corresponding star ratings, the total test score should satisfy the following overall rating principle. With regard to five-star vehicles and four-star vehicles, other requirements should also be met.

First of all, the star rating for the test vehicle shall be conducted based on the total scores in accordance with the star rating criteria as follows.

Total score	Star rating
⩾ 60 points	5+ (★★★★★☆)
⩾ 52 but < 60 points	5 (★★★★★)
⩾ 44 but < 52 points	4 (★★★★)
⩾ 36 but < 44 points	3 (★★★)
⩾ 28 but < 36 points	2 (★★)
< 28 points	1 (★)

Secondly, the following conditions should be also satisfied by five-star vehicles and four-star vehicles.

With regard to a five-star vehicle, for the three impact tests (i.e., frontal 100% overlapped impact test against rigid barrier, frontal 40% overlapped impact test against deformable barrier, and lateral impact test against deformable mobile barrier), no particular area of the front-row dummy may be awarded zero point. Otherwise, it will be downgraded as a four-star vehicle. For the frontal impact test against the rigid barrier with 100% overlapping and the frontal impact test against the deformable barrier with 40% overlapping, particular areas include head, neck and thorax. For the side impact test against the mobile deformable barrier, particular areas include head, thorax, abdomen and pelvis.

In respect of a four-star vehicle, the score generated from each of the three tests (i.e., frontal 100% overlapped impact test against rigid barrier, frontal 40% overlapped impact test against deformable barrier, and lateral impact test against deformable mobile barrier) shall be not lower than 10 points. Otherwise, it will be downgraded as a three-star vehicle.

Chapter IV Test Procedures

1. Frontal rigid barrier impact test procedure

1.1 Vehicle preparation

1.1.1 Checking and confirming vehicle(s) upon arrival

When the vehicle to be tested arrives at the laboratory, first measure and record the mass of the vehicle and its front and rear axle loads. Check and confirm the appearance, confirguation and basic parameters of the vehicle (See Annex 3).

1.1.2 Measurement of vehicle kerb mass

1.1.2.1 Drain the fuel from the tank and then run the engine until it has run out of fuel.

1.1.2.2 Calculate the mass of fuel contained in the fuel tank at its rated capacity, using a density for petrol of 0.74g/ml or 0.84g/ml for diesel. The fuel tank shall be filled with water to mass equal to 90 percent of the mass of a fuel.

1.1.2.3 Check and adjust tyre pressure according to the manufacturer's instructions for half load. Check and top up the levels of all other fluids (e.g., engine oil, transmission fluid, brake fluid, washing fluid, antifreeze, etc.) to their maximum levels. Confirm the spare tyre and driver tool are on-board. Nothing else should be in the vehicle.

1.1.2.4 Measure and record the height of the intersection point between the transverse plan passing through the centers of the 4 wheels and the upper edge of the wheel guard plate.

1.1.2.5 Measure and record the mass of the vehicle and its front and rear axle loads. The mass of the vehicle is the kerb mass of the complete vehicle.

1.1.3 Vehicle preparation and installation of test equipments

1.1.3.1 Drain the engine oil, transmission fluid, brake fluid, washing fluid, antifreeze, power assisted fluid, etc. In this case, the mass of the liquids shall be offsets. Drain the fluids in the air conditioning system.

1.1.3.2 Remove the luggage area carpeting, driver tool and spare tyres from the vehicle (ensure that it will not affect the crash performance of the vehicle).

1.1.3.3 Fix the on-board data acquisition equipment. Also install one-way accelerometers at the base of the 'B' pillars on the left and right sides of the vehicle.

1.1.3.4 Measure the mass of the vehicle and its front and rear axle loads. Compare them with those

determined in paragraph 1.1.2.5. The load of each axle shall not differ by more than 5 percent, each variation not exceeding 20 kg, and the mass of the vehicle by more than 25kg. Any component(s) not liable to affect the crash performance of the vehicle may be added or removed and the mass of the water in the fuel tank may be adjusted to help achieve the desired weights. Record the final mass of the vehicle and its final front and rear axle loads.

1.1.3.5 Upon completion of the procedure described in paragraph 1.6.2, measure and record the mass of the vehicle and its front and rear axle loads. The mass of the vehicle determined herein is the test mass (including dummy and all instrumentation). Measure and record the height of the intersection point between the transverse plan passing through the centers of the 4 wheels and the upper edge of the wheel guard plate.

1.1.4 Affixing C-NCAP logo and vehicle markings

C-NCAP logo, the unique marking for test vehicle - test code and lab information shall be attached to the vehicle.

1.2. Measurement of vehicle deformation

For vehicle deformation measurement, a mobile 3D coordinates measuring machine shall be used. The machine requires a coordinate system to be set up relative to a particular plane, with its axes being in the same directions of those of the vehicle coordinate system. During the testing, some structure at the rear of the vehicle can be used as a reference point for measurement. The vehicle deformation is to be measured with such reference point being 0 point. During the measurement, the vehicle shall be in a state as described in paragraph 1.1.3.4.

1.2.1 Measurement before test

1.2.1.1 The steering wheel, if adjustable, shall be placed in the midway between the limits of its range(s) of adjustment in any direction.

1.2.1.2 The ignition switch shall be placed at the “off” position and the battery shall be disconnected.

1.2.1.3 Remove the components equipped at the centre of the steering wheel or, if fitted, the airbag to expose the end of the steering column. When doing this, carefully make the connection lines to the airbag which will need to be remade on re-assembly. The removal of the airbag or the components equipped at the center of the steering wheel shall follow the instruction recommended by vehicle manufacturer.

1.2.1.4 Mark the centre of the top of the steering-column.

1.2.1.5 Set up the coordinate system of vehicle bodywork, by applying either of the following procedures.

1.2.5.1 Provided, for the non-deformation locations at the rear end of the vehicle (left, right, and middle), manufacturer could furnish the coordinate values of 8 characteristic points (spatially scattered to the max. practicable extent, and convenient for measurement) under the designed bodywork coordinate system for the

vehicle, record them, based on which the designed bodywork coordinate system is subsequently set up through the use of software.

1.2.5.2 Provided manufacturer could not furnish the 8 characteristic points described in Paragraph 1.2.1.5.1, set up the bodywork coordinate system as follows: Adjust the vehicle until the horizontal level is attained; mark the position of at least 8 datum points (spatially scattered to the max. practicable extent) on the rear end of the vehicle (left, right and middle), which are not expected to deform in the test. Among them, one point serves as the original point of the coordinate, and two points are taken to establish the x or y axis, which is in parallel with the corresponding axis of the bodywork coordinate system. Where such two points are not available on the vehicle body, then two points that are basically in parallel with the corresponding axis of the vehicle coordinate system are to be given by the manufacturer. Establish a 'z' plane on the plane ground on which the vehicle stays, and horizontally moves it through the original point of the coordinate. Record the coordinate values of 8 characteristic points.

1.2.1.6 Measure and record the coordinate located in the marked centre of the top of the steering-column.

1.2.1.7 Mark, measure and record the B-pillars on the driver and passenger sides:

I. at a distance of 100 mm above the sill;

II. at a distance of 100 mm beneath the lowest level of the side window frames on both sides.

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

1.2.1.8 Refix the component in the centre of the steering wheel, and check all bolts are securely fastened.

1.2.1.9 Connect the battery, check whether the circuit is functional or not. Ensure that airbags are in a normal working condition.

1.2.2 Measurement after test

1.2.2.1 Remove the dummies from the passenger compartment.

1.2.2.2 Remove the centre of the steering wheel.

1.2.2.3 Measure the 8 characteristic points (datum points) prior to the test.
1.2.2.4 Set up the bodywork coordinate system. With the software, input the pre-test coordinate values of any 6 points among the 8 characteristic points (datum points), so as to set up, via the software, the bodywork coordinate system based on the coordinate values of these 6 points. In the newly-established coordinate system, compare the coordinate values of such 6 points with their pre-test counterparts; in case of low consistency, randomly select 6 out of the 8 characteristic points (datum points) to re-establish the bodywork coordinate system, and conduct comparison again. In case the consistency is low either, correct the measurement values in accordance with the procedures shown in Paragraph 1.2.3.

1.2.2.5 Measure and record the coordinate located in the marked centre of the top of the steering-column.

1.2.3 Modification

1.2.3.1 After the test, measure and record the marks on the driver and passenger-side B-pillar.

1.2.3.2 Compare the changes in positions of related B-pillar points above the z axis before and after the test.

1.2.3.3 Find the angle θ that best satisfies the following equation: $z=-xl\ sin\theta + zl\ cos\theta$ for the B-pillar sill point (where z = pre-impact vertical measurement, and *xl*, *zl* = post-impact longitudinal and vertical measurement).

1.2.3.4 Transform the post impact longitudinal and vertical measurements (x, z) using the following equations:

$$\begin{bmatrix} x \\ z \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x1 \\ z1 \end{bmatrix}$$

Note: *x*, *z* = the corrected coordinate values, *xl*, *zl* = the actual values measured after the impact.

1.2.4 Results

The following measurement results may be obtained based on the pre-impact measurements and post impact measurements (or the post impact measurements modified)

1.2.4.1 The longitudinal and vertical displacements of the steering-column.

1.3. Passenger compartment adjustments

1.3.1 Front seat adjustments

1.3.1.1 Front seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest backward locking position. Check and confirm the seat sliding system is in a completely locked position.

1.3.1.2 Front seats independently adjustable for height shall be placed at the height position defined by the manufacturer or the lowest position.

1.3.1.3 Seat cushions adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

1.3.1.4 If adjustable, the seat-backs shall be adjusted so that the resulting inclination of the torso of HPM machine is as close as possible to that recommended by the manufacturer for normal use or to 25 degrees towards the rear from the vertical.

1.3.1.5 Where adjustable, the seat bracket shall be placed at the position defined by the manufacturer or the

completely retracted position.

1.3.1.6 Head restraints adjustable for height shall be in their uppermost position.

1.3.1.7 Head restraints adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

1.3.1.8 Arm-rests shall be in the lowered position, unless this is prevented by the position of the dummies in the vehicles.

1.3.1.9 Other adjustment mechanisms shall be set to the manufacturer’s design position.

1.3.2 Rear seat adjustments

1.3.2.1 Rear seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest rearward locking position. Check and confirm the seat sliding system is in a completely locked position.

1.3.2.2 For a second-row seat allowing vertical adjustment, seat height shall be set to the manufacturer’s design position.

1.3.2.3 For a second-row seat with adjustable seatback, the seat back shall be adjusted to the manufacturer’s design position or the position inclining backwards by 25° from the vertical plane.

1.3.2.4 Lumbar support, if any, for second-row seat shall be adjusted to the manufacturer’s design position or the fully retracted position.

1.3.2.5 Head restraints of rear seats placed with female dummy shall be adjusted to the lowest lock position. For a second-row seat fitted with child seat, the head restraint shall be adjusted to a proper position suitable for the installation; if interfering with the installation of the anticipated child seat, such head restrain may be removed.

1.3.2.6 Rear seats adjustable for orientation shall be adjusted to forward facing.

1.3.2.7 Other adjustment mechanisms shall be set to the manufacturer’s design position.

1.3.3 Steering wheel adjustments

1.3.3.1 The steering wheel adjustable horizontally for direction shall be placed in midway between the limits of its range(s) of adjustment.

1.3.3.2 The steering wheel adjustable longitudinally for direction shall be placed in midway between the limits of its range(s) of adjustment.

1.3.3.3 The steering wheel shall be left free, with its spokes in the position which according to the

manufacturer corresponds to straight-ahead travel of the vehicle.

1.3.4 Adjustment of safety belt anchorages

Where adjustable, safety belt anchorages shall be placed in the position defined by the manufacturer or the middle position, or close to the fixed upper midway.

1.3.5 Gear-change lever

The gear-change lever shall be in the neutral position.

1.3.6 Glazing

The movable glazing of the vehicle shall be in the closed position, meanwhile, the position of the operating handle corresponds to the closed position of the glazing.

1.3.7 Pedals

The pedals shall be in their normal position of rest.

1.3.8 Sun-visor

The sun-visors shall be in the stowed position.

1.3.9 Rear-view mirror

The interior rear-view mirror shall be in the normal position of use.

1.3.10 Doors

The doors shall be closed but not locked.

1.3.11 Convertible roof

If an convertible or removable roof is fitted, it shall be in place and in the closed position.

1.3.12 Parking brake

Parking brakes shall be in their normal position of rest.

1.4. Dummy preparation and calibration

During the test, two HybridIII 50% male dummies, one HybridIII 5% female dummies, and one P-series dummy representing a 3-years-old child are to be used. Each dummy will be clothed with formfitting cotton

stretch garments with short sleeves and pants; each dummy representing an adult shall be with shoes. Moreover, neck sheath shall be fitted for adult dummy.

1.4.1 Dummy test condition

1.4.1.1 The dummy shall be tested at the temperature of between 20℃ and 22℃ and the humidity of between 10％ and 70％.

1.4.1.2 The dummy shall be placed in temperatures specified in paragraph 1.4.1.1 for at least 5 hours prior to the calibration of the dummy, the adjustment of dummy joints and the impact test.

1.4.2 Adjustment of dummy joints

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

1.4.2.2 All constant friction joints shall be subject to adjustment. When a force being 1g～2 g is applied, the dummy limbs can continue to move.

1.4.3 Calibration of dummies

1.4.3.1 HybridIII 50% male dummies shall be calibrated in accordance with the provisions of CFR 572 Subpart E and Annex 10 to ECE R94; HybridIII 5% female dummies in accordance with the provisions of CFR 572 Subpart O; the dummy representing a child shall be calibrated in accordance with the user’s manual as furnished by the dummy manufacturer.

1.4.3.2 The dummies should be re-calibrated after every two impact tests. The knee sliding displacement shall be calibrated to 10mm after every two impact tests and re-calibrated after every eight impact tests.

1.4.3.3 If an injury criterion reaches or exceeds its normally accepted limit as specified in paragraph 2.1.1 of Chapter Four, then that part of the dummy shall be re-calibrated.

1.4.3.4 If any part of a dummy is broken in a test then the part shall be replaced.

1.4.3.5 All data concerning the calibration of dummies shall be maintained for future check.

1.5. Preparations of child restraint system

The test could be conducted on the child restraint required or recommended in product instruction, but the manufacturer must apply after receiving the test notice and provide the sample within 3 days prior to the test. If the manufacturer doesn’t apply or provide the child restraint applied for in time, the test will be conducted with the type of CRS as designated by the C-NCAP Management Center.

1.6. Instrumentation

All instrumentation shall be calibrated prior to the test. All instrumentation shall be re-calibrated after one year, regardless of their use frequency. Accelerometers shall be subject to normal calibration with vibration sensor calibrators, to ensure the accuracy of test results. The Channel Amplitude Class (CAC) for each transducer shall be chosen to cover the Minimum Amplitude listed in Table 5. 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.

Table 5 Test requirements

Instrumentation	Location		Minimum amplitude	Channels measured
Driver HybridIII50% male dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck Forces and moments	Fx	9kN	3
		My	280Nm	
		Fz	13kN	
	Thorax: Deformation and accelerations	D_{thorax}	90 mm	4
		Ax, Ay, Az	150g	
	Upper leg: Compression forces (L/R)	Fz	13kN	2
	Knees: Sliding displacements (L/R)	D_{knee}	19 mm	2
	Upper tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	

	Lower tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
Front passenger HybridIII50% male dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck: forces and moments	Fx	9kN	3
		My	290Nm	
		Fz	14kN	
	Thorax: Deformation and accelerations	D_{thorax}	90 mm	4
		Ax, Ay, Az	150g	
	Upper leg: Compression forces (L/R)	Fz	13kN	2
	Knees: Sliding displacements (L/R)	D_{knee}	19 mm	2
	Upper tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
	Lower tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
Second-row HybridIII5% female dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck: forces and moments	Fx	9 kN	4
		Fy	9 kN	
		Fz	14 kN	
		My	290 Nm	
	Thorax: Deformation	D_{thorax}	90 mm	1
Dummy representing a child seated in the second row	Head: Accelerations	Ax, Ay, Az	150g	3
	Thorax: Accelerations	Ax, Ay, Az	150g	3
Safety belt tension sensor	Driver-side shoulder belt and waist belt	F_{belt}	16 kN	2
	Front passenger-side shoulder belt and waist belt	F_{belt}	16 kN	2
	Shoulder belt and waist belt for the second-row female	F_{belt}	16 kN	2
Accelerometer	B-pillar on the left side of the vehicle	Ax	250g	1
	B-pillar on the right side of the vehicle	Ax	250g	1
Total				74

1.7. Dummy placement and measurement

Two HybridIII 50% male dummies shall be placed on driver’ s seat and the front outboard passenger seat, respectively, and a HybridIII 5% female dummy on the outboard seat to the left of the second row. A child restraint system is secured onto the outboard seat to the right of the second row, on which a P-series dummy representing a 3-years-old child is placed; the child restraint system is fixed by safety belt or ISOFIX device.

In case the ISOFIX device is only fitted to the outboard seat to the left of the second row, the positions of the child dummy and the female dummy may be interchanged. The instrumentation shall be mounted in the vehicle such that they are not likely to affect the movement of the dummies. Prior to the test, the dummy and instrumentation shall be stabilized in the temperatures as close as possible to the range of 20 C ~ 22 C.

1.7.1 The procedure for the determination of the “H” point and the actual torso angle

1.7.1.1 The vehicle shall be preconditioned in the temperatures of 20 C ~ 22 C, to ensure the seat materials are at ambient temperature. If the seat is new and has never been sat upon, a 75±10kg person or device shall sit on the seat for 1 min twice to flex the cushions and back. All seat assemblies shall remain unloaded for at least 30min before the installation of the HPM machine (SAEJ826).

1. 7.1.2 The area of the seating position contacted by the HPM machine shall be covered by a muslin cotton of adequate size and proper material, or plain cotton with 18.9 yarns/cm^2 and density of 0.228kg/m2, or knitted or nonwoven fabric with the same characteristics.

1. 7.1.3 Place the seat and back assembly of the HPM machine so that the centreplane of the seats coincides with the centreplane of the HPM machine.

1. 7.1.4 Attach the foot and lower leg assemblies to the seat pan assembly, either individually or by using the T-bar and lower leg assembly. A line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centreplane of the seat. Dimensional adjustment bars for lower leg and upper leg shall be adjusted to the 10% sight mark.

1. 7.1.5 Adjust the feet and leg positions of the HPM machine as follows:

1.7.1.5.1 Driver and outside front passenger Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located approximately the same distance to the left of the centreplane of the HPM machine as the right foot is to the right. The spirit level verifying the transverse orientation of the HPM machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear. The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centreplane of the seat.

1.7.1.5.2 Rear outboard passenger behind front passengers For the second-row seats, assembly of feet and legs shall be adjusted by following the procedures for the driver and the front-row outboard passenger. If, in such context, the frontal-row seat components comes into contact with or interferes with the HPM machine, the frontal-row seats shall be moved forwards for the time being to eliminate such effect.

1.7.1.6 Apply lower leg and thigh weights and level the HPM machine.

1.7.1.7 Tilt the back pan forward against the forward stop and draw the HPM machine away from the seat-back using the T-bar. Reposition the HPM machine on the seat by one of the following methods:

1.7.1.7.1 If the HPM machine tends to slide rearward, use the following procedure. Allow the HPM machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required (i.e., until the seat pan contacts the seat-back). If necessary, reposition the lower leg.

1.7.1.7.2 If the HPM machine does not tend to slide rearward, use the following procedure. Slide the HPM machine rearwards by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back.

1.7.1.8 Apply a 100 ± 10 N load to the back and pan assembly of the HPM machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing by the above intersection to a point just above the thigh bar housing. Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the HPM machine from sliding forward.

1.7.1.9 Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the HPM machine level.

1.7.1.10 Tilt the back pan forward to release the tension on the seatback. Rock the HPM machine from side to side through a 10° arc (5° to each side of the vertical centreplane) for three complete cycles to release any accumulated friction between the HPM machine and the seat.

1.7.1.10.1 During the rocking action, the T-bar of the HPM machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar must therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the HPM machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction. The feet of the HPM machine are not to be restrained during this step.

1.7.1.10.2 Carefully return the back pan to the seat-back and check the two spirits levels for zero position. If any movement of the feet has occurred during the rocking operation of the HPM machine, they must be repositioned as follows: Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; and no forward or lateral loads are to be applied. When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

1.7.1.10.3 Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the back pan sufficient to level the HPM machine’s seat pan on the seat.

1.7.1.11 Holding the T-bar to prevent the HPM machine from sliding forward on the seat cushion, proceed as follows:

Return the back pan to the seat-back; alternately apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care shall be exercised to ensure that no exterior downward or lateral loads are applied to the HPM machine.

1.7.1.12 Measurement and record

1.7.1.12.1 Measure the position of the H-point relative to the fixed part of the vehicle structure.

1.7.1.12.2 The actual torso angle is read at the back angle quadrant of the HPM machine with the probe in its fully rearward position.

1.7.2 Dummy installation

Two HybridIII 50% male dummies shall be placed on the driver’s seat and the outside front passenger seat, respectively; a HybridIII 5% female dummy on the outboard seat to the left of the second row; and a child restraint system, together with a P-series dummy representing a 3-years-old child, on the outboard seat to the right of the second row. The dummy should not be left to sit directly on the seat for more than 4 hours prior to the test. If the dummy is in the vehicle for a time longer than 4 hours but less than 12 hours, then the dummy should be sat on plywood boards placed over the seat, to eliminate excessive compression of the seat.

1.7.2.1 Installation of adult dummies

1.7.2.1.1 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.

1.7.2.1.2 Buckle up the safety belt across the dummy.

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

1.7.2.1.4 Maintaining the small rearwards force to the lower torso, apply a small rearwards force to the upper torso to return the upper torso to the seat back.

1.7.2.2 Installation of child dummy and child restraint system

1.7.2.2.1 Installation of child restraint system on the second row of seats

1.7.2.2.1.1 Installation of child restraint system to be secured by adult safety belt The installation shall be completed in accordance with the user’s manual of CRS.

1.7.2.2.1.2 Installation of child restraint system to be secured by ISOFIX device The installation shall be completed in accordance with the user’s manual of CRS. If the installation way of CRS is not indicated in the user’s manual, the following principle shall be followed up: in case of the vehicle with top tether anchorage, CRS shall be installed via ISOFIX anchorage and top tether anchorage; in case of the vehicle without top tether anchorage, CRS shall be installed via ISOFIX anchorage and support leg, and the specific installation method is shown in the instruction of CRS.

1.7.2.2.2 Placement of the child dummy onto child restraint system

1.7.2.2.2.1 Place the dummy on the child restraint.

1.7.2.2.2.2 Place a hinged wooden board or a similar bendable device 2.5 cm thick and 6 cm wide and of length relevant to the dummy size being tested, which is equal to the shoulder height (seating) detracted with the hip centre height (the height of knee joint plus the half of thigh, seating). The board should follow as closely as possible the curvature of the chair and its lower end should be at the height of the dummy’s hip joint.

1.7.2.2.2.3 Adjust the belt in accordance with the manufacturer’s instructions, but to a tension of 250 ± 25 N above the adjuster force, with a deflection angle of the strap at the adjuster of 45 ± 5 , or alternatively, the angle prescribed by the manufacturer.

1.7.2.2.2.4 At the end of adjustment, release the belt, and get out of the board.

1.7.2.2.2.5 Then re-buckle the belt, push the dummy child till it comes to a contact with the CRS back, and adjust CSR to guarantee the strap slackage distributing evenly. Adjust dummy so that its head maintains upright and two legs retain parallel. Raise the dummy’s legs, then let them fall down slightly and reside stably at a certain position. Place the hands onto femurs, which shall be secured with adhesive tape.

1.7.3 Hybrid III 50% male 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 suspended accidentally, the dummy positioning and measurement 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.

1.7.3.1 Head
The transverse instrumentation platform of the head shall be horizontal within 2.5 degrees. To level the head of the test dummy in vehicles with upright seats with non-adjustable backs, the following sequences must be followed. First adjust the position of the "H" point within the limits set forth in Paragraph 1.7.3.5 to level the transverse instrumentation platform of the head of the test dummy. If the transverse instrumentation platform of the head is still not level, then adjust the pelvic angle of the test dummy within the limits provided in Paragraph 1.7.3.6. If the transverse instrumentation platform of the head is still not level, then adjust the neck bracket of the test dummy the minimum amount necessary to ensure that the transverse instrumentation platform of the head is horizontal within 2.5 degrees.

1.7.3.2 Arms
The driver’s upper arms shall be adjacent to the torso with the centrelines as close to a vertical plane as possible. The passenger’s upper arms shall be in contact with the seat back and the sides of the torso.

1.7.3.3 Hands

The palms of the driver test dummy shall be in contact with the outer part of the steering wheel rim at the rim’s horizontal centreline. The thumbs shall be over the steering wheel rim and shall be lightly taped to the steering wheel rim so that if the hand of the test dummy is pushed upward by a force of not less than 9 N and not more than 22 N, the tape shall release the hand from the steering wheel rim. The palms of the passenger test dummy shall be in contact with outside of thigh. The little finger shall be in contact with the seat cushion.

1.7.3.4 Torso

In vehicles equipped with bench seats, the upper torso of the driver and passenger test dummies shall rest against the seat back. The midsagittal plane of the driver dummy shall be vertical and parallel to the vehicle’s longitudinal centreline, and pass through the centre of the steering wheel rim. The midsagittal plane of the passenger dummy shall be vertical and parallel to the vehicle’s longitudinal centreline and the same distance from the vehicle’s longitudinal centreline as the midsagittal plane of the driver dummy. In vehicles equipped with bucket seats, the upper torso of the driver and passenger test dummies shall rest against the seat back. The midsagittal plane of the driver and the passenger dummy shall be vertical and shall coincide with the longitudinal centreline of the bucket seat.

1.7.3.5 "H" point

The "H" point of the driver and passenger test dummies shall coincide within 13 mm in the vertical dimension and 13 mm in the horizontal dimension of a point 6 mm below the position of the "H" point determined by using the procedures specified in Paragraph 1.7.1. 1.7.3.6 Pelvic angle The pelvic angle measured from the horizontal on the flat surface of the gauge shall be 22.5° ±2.5° .

1.7.3.7 Legs

The upper legs of the driver and passenger test dummies shall rest against the seat cushion to the extent permitted by placement of the feet. The initial distance between the outboard knee clevis flange surfaces shall be 270 mm±10 mm. To the extent practicable, the left leg of the driver dummy and both legs of the passenger dummy shall be in vertical longitudinal planes.

1.7.3.8 Feet

The right foot of the driver test dummy shall rest on the undepressed accelerator with the rearmost point of the heel on the floor surface in the plane of the pedal. If the foot cannot be placed on the accelerator pedal, it shall be positioned perpendicular to the tibia and placed as far forward as possible in the direction of the centreline of the pedal with the rearmost point of the heel resting on the floor surface. The heel of the left foot shall be placed as far forward as possible and shall rest on the floor pan. The left foot shall be positioned as flat as possible on the toe board. The longitudinal centreline of the left foot shall be placed as parallel as possible to the longitudinal centreline of the vehicle.

The heels of both feet of the passenger test dummy shall be placed as far forward as possible and shall rest on the floor pan. Both feet shall be positioned as flat as possible on the toe board. The longitudinal centreline of the feet shall be placed as parallel as possible to the longitudinal centreline of the vehicle.

1.7.4 HybridIII 5% female 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, the dummy positioning and measurement 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.

1.7.4.1 Torso

In vehicles equipped with bench seats on the second row, the midsagittal plane of the HybridIII 5% female dummy shall coincide with the longitudinal centreline of the bench seat; in vehicles equipped with single seats on the second row, the midsagittal plane of the HybridIII 5% female dummy shall coincide with the longitudinal centreline of the single seat; the thigh of the dummy shall rest against the seat cushion to the extent permitted, and angle of leg and thigh is adjusted within 120° ± 5° , the horizontal distance to the longitudinal center of the front of dummy keens o is 160 mm-170 mm, Push the dummy keens backward, to make hip and seat back closely contact or make the back of the legs contact with the front of cushion with torso resting against the seatback.

1.7.4.2 Head

The installation plane of the head sensor shall be horizontal, with the deviation angle to be ideally controlled within + 0.5 . For the vehicles with adjustable seatbacks of the second row, keep the position of thighs, and place the plane horizontal via adjusting backrest angle forward (or backward); for the vehicles with unadjustable seatbacks of the second row, adjust the angle with regulating the lower neck bracket. If the requirement is unable to achieve, place the plane as horizontal as possible, and make record.

1.7.4.3 Pelvic angle

The pelvic angle of the HybridIII 5% female dummy measured from the horizontal on the flat surface of the gauge shall be 20° ±2.5° . If failed, adjust the angle as close as possibleto 20° , and guarantee the head sensor installation surface to adjust according to paragraph 1.7.4.2 and make record. If the longitudinal plane angle of the sensor installation and the pelvic angle couldn’t be fulfilled simultaneously, it should preferentially guarantee the longitudinal plane angle is 0° ±0.5° .

1.7.4.4 Legs and feet

Keep head, torso and thigh unmoved, adjust angle of legs, to place feet on the floorpan and keep the longitudinal centerline of two feet paralleled with longitudinal centerline of the vehicle as possible; if the feet are unable to reach the floorpan, keep the feet paralleled with the floorpan at the nearest position.

1.7.4.5 Arms

The HybridIII 5% female dummy’s upper arms shall be in contact with the seat back and the sides of the torso.

1.7.4.6 Hands

The palms of the HybridIII 5% female dummy shall be in contact with outside of thigh. The little finger shall be in contact with the seat cushion.

1.7.4.7 “H” point

“H” point of the rear-row HybridIII 5% female dummy shall fall within a zone 13 mm from a target point in both vertical and longitudinal directions. Such target point shall reside 6 mm underneath the H-point as established according to the procedures of Paragraph 1.7.1. If the position of H-point exceeds the prescribed scope, the dummy shall be adjusted properly according to Paragraph 1.7.4, such that the H-point of the dummy could fall within the prescribed scope.

1.7.5 Dummy measurement

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

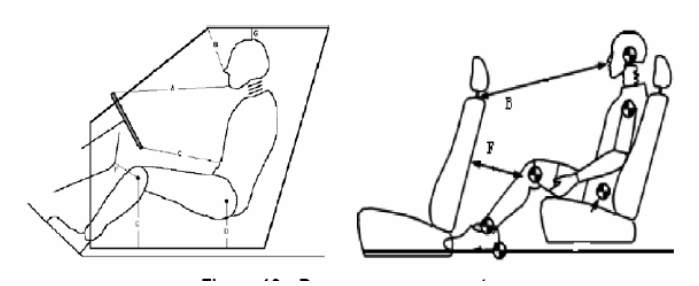


Figure 10 Dummy measurement

Table 6 Measurements of relative positions of dummies

HybridIII50%driver-side male dummy		HybridIII50%front passenger side male dummy		Second-row HybridIII50% female dummy	
A	Chin to upper rim of steering wheel	A	Chin to dashboard	A	-
B	Nose to top edge of windshield glazing	B	Nose to top edge of windshield glazing	B	Nose to upper center of frontal seatback
C	Abdomen to lower rim of steering wheel	C	Abdomen to dashboard	C	-
D	H-point to door sill	D	H-point to door sill	D	-
E	Knee bolt to top edge of door sill	E	Knee bolt to top edge of door sill	E	-
F	Knee bolt to edge of dashboard	F	Knee bolt to edge of dashboard	F	Knee joint to frontal seat back
G	Head to roof surface	G	Head to roof surface	G	Head to roof surface
H	Neck angle θ	H	Neck angle θ	H	Neck angle θ
I	H-point to vehicle structure	I	H-point to vehicle structure	I	H-point to vehicle structure
J	Actual seat back angleα	J	Actual seat back angle α	J	Actual seat back angle α

1.8. Photographs taken before and after test

The minimum resolution for photographs shall be 640×480. Given in Table 7 are the minimum quantity and contents of photographs taken before and after the test. “0” represents that photographs should be taken.

Table 7 Test photographs

Sr. No.	View	Pre-test	Post-test
1	Front view of car	0	0
2	Car LHS	0	0
3	Car RHS	0	0
4	Car LHS at 45 degrees to front	0	0
5	Car RHS at 45 degrees to rear	0	0
6	Rear view of car	0	0
7	Front view of front windshield glazing	0	0
8	To show area immediately in front of driver	0	0
9	To show area immediately in front of passenger	0	0
10	Side view of driver area	0	0
11	Side view of passenger area	0	0
12	To show driver knees	0	0
13	To show passenger knees	0	0
14	To show driver contacts		0
15	To show passenger contacts		0
16	To show the location of driver's seat	0	0
17	To show the location of passenger seats	0	0
18	Driver and car interior (with doors open)	0	0
19	Passengers and car interior (with doors open)	0	0
20	To show car with its left doors open	0	0
21	To show car with its right doors open	0	0
22	To show the front bottom of car	0	0
23	To show the rear bottom of car	0	0
24	To show area immediately on the left side of rear passengers	0	0
25	To show area immediately on the right side of rear passengers	0	0
26	To show area at 45 degrees to front on the right side of the second-row child passenger	0	0
27	To show area at 45 degrees to front on the left side of the second-row female passenger	0	0
28	To show area in front of the second-row female passenger	0	0
29	To show area in front of the second-row child passenger	0	0

1.9. Camera location

The minimum resolution for camera shall be 512×384. Also, the non-stroboscopic high speed film lighting system is to be used.

Table 8 Camera location and requirements

Camera no.	Camera type	Camera location	Shot content
1	1000fps	Front visual field of windshield glazing	Front view of motions of driver and passenger dummies
2	1000fps	Frontal end to B-pillar on the left side of car	Motion of driver dummy
3	1000fps	B-pillar to C-pillar on the right side of car	Motion of rear passenger dummy
4	1000fps	Entire visual field from barrier to left side of car	Overall motion process of the left part of car
5	1000fps	Frontal end to B-pillar on the right side of car	Motion state of passenger dummy
6	1000fps	Barrier to full visual field from the right side of car	Overall motion process of the right part of car
7	30fps	At 45 degrees to front on the left side of car	Deformation of the left side of car
8	30fps	At 45 degrees to rear on the left side of car	Deformation of the left side of car
9	30fps	Test track	Vehicle motion process
10	30fps	At 45 degrees to front on the right side of car	Deformation of the right side of car
11	1,000fps	Interior of rear-row passenger compartment (onboard camera)	Motion attitude of rear-row female dummy

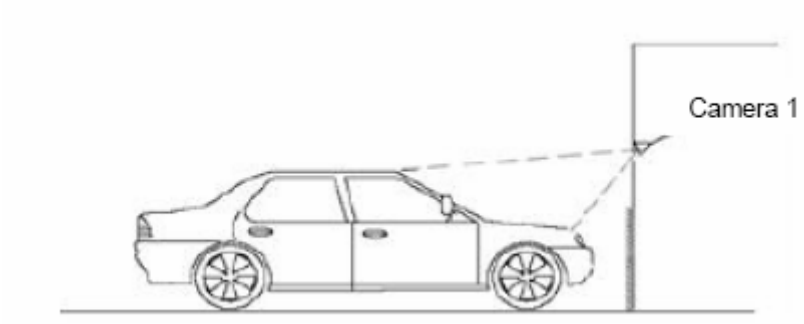


Figure 11 Camera locations for 100% frontal impact test against a rigid barrier

1.10. Test facility

1.10.1 Testing ground

The test area shall be large enough to accommodate the run-up track, the barrier and the technical equipment necessary for the test. The track, for at least 5 meters before the barrier, shall be horizontal, flat,

dry and smooth.

1.10.2 Traction system

The acceleration of the vehicle shall be not greater than 0.3g, to ensure the location of the dummy before the impact. The vehicle shall be accelerated in such a way: it moves at acceleration in the first half of the run-up track and at a constant speed in the last half. The speed shall be controlled such that it is accurate to ± 0.2km/h. The test speed is between 50km/h and 51km/h. Record the actual test speed.

1.10.3 Lighting system

The non-stroboscopic lighting system for the high speed camera shall be actuated 5min before the test, to ensure the temperature of the impact zone is not unreasonably high.

1.10.4 Position of rigid barrier relative to vehicle

The centerline of the vehicle shall not deviate by ±150 mm from the centerline of the surface of the rigid barrier.

1.10.5 Rigid barrier

The rigid wall shall consist of a block of reinforced concrete not less than 3 meters wide and not less than 1.5 meters high. The thickness of the rigid wall shall be such that it weighs at least 7×104kg. The front face shall be vertical, perpendicular to the axis of the run-up-tack, and shall be covered by 20-mm thick plywood board (see Figure 12). If necessary, the barrier shall be secured to the ground with additional arresting devices, to prevent any displacement of the barrier. The barrier shall be located such that the impact angle is zero degree.

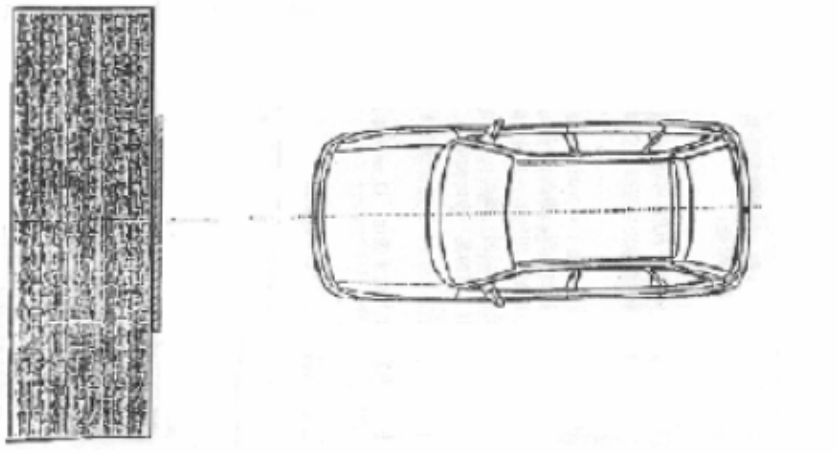


Figure 12 Testing of rigid barrier

1.11. Items to be checked and confirmed before test

1.11.1 Battery

Check that whether the vehicle battery is connected, reaches rated voltage as well as is fastened securely. The battery shall be replaceable.

1.11.2 Ignition switch

The ignition switch shall be placed at “on” position.

1.11.3 Airbag warning light

The airbag switch, where fitted, shall be placed at “on” position, and the airbag light on the dashboard shall illuminate as normal.

1.11.4 Dummy painting

Colored paints shall be applied to the parts of the driver and front passenger dummies such as head, nose, chin, knee and lower leg, etc., to identify and tell them apart. Neck shall be painted red; nose purple; chin blue; left knee red; right knee blue; left lower leg purple, green and blue from top to bottom; right lower leg green, red and purple from top to bottom. All painted areas shall be large enough to enable the dummy’s contacts with the vehicle to be visible. The frontal side of head of female dummy shall be painted in red, the side facing the vehicle door, in green, and the other side, in yellow; in addition, her nose shall be painted in brown, and chin, in blue. For the child dummy, the frontal, left and right sides shall be painted in blue, brown and green, respectively; in addition, left and right knees shall be painted in yellow and brown, respectively.

1.11.5 Checking the on-board data acquisition unit

Ensure that the battery of the on-board data acquisition unit is in a normal working condition prior to the test, and measure the trigger switch at a normal working condition.

1.11.6 Checking doors and latches

Ensure that all doors are completely closed, but not locked prior to the test.

1.12. Items to be checked and confirmed after test

1.12.1 Safety belt
With regard to the safety belts for driver, front passenger and rear passenger dummies, check whether they fail or not during the test.

1.12.2 Doors
Check whether doors are locked or not. After the test, check whether the side doors corresponding to each row of seats can be opened without any tools.

1.12.3 Fuel feeding system

After the impact test, check whether the feeding system leaks or not. Where constant leakage occurs in the fuel feeding system, measure the amount of fuel leaked in the first 5min after the impact test. Calculate the average leaking rate.

1.12.4 Opening force of safety belt buckle

Measure and record the forces applied to open the safety belt buckles for driver, front passenger and rear passenger dummies.

1.13. Calculation of injury criteria

Table 9 lists all the measurement locations and parameters of the dummies as well as the channel frequency class (CFC) at which they are to be filtered. Record all these channel data. Head impacts occurring after the dummy head rebounds from an initial contact are not considered when calculating injury criteria of head and neck.

Table 9 Measurement locations and channel frequency class (CFC) of dummies

	Location	Parameter	CFC	Injury
Hybrid III 50% male dummy	Head	Accelerations, Ax, Ay, Az	1,000	Peak resultant acceleration HIC_{36} Resultant 3ms exceeding
	Neck	Forces, Fx, Fz	1,000	Tension (Fz) continuous exceeding
		Moments, My	600	Shear (Fx) continuous exceeding Peak extension (My) i
	Thorax	Deflection, D_{thorax}	180	Peak deflection
		Accelerations, Ax, Ay, Az		Peak resultant acceleration Resultant 3 ms exceeding
	Femurs (L / R)	Forces, Fz	600	Compressive axial force (-Fz) Continuous exceeding
	Knees (L / R)	Displacements, D_{knee}	180	Peak displacement
	Upper tibia (L / R)	Forces, Fz	600	Peak tibia compression
		Moments, Mx, My		Tibia Index
	Lower tibia (L / R)	Forces, Fz	600	Peak tibia compression
		Moments, Mx, My		Tibia Index
Hybrid III 50% female dummy	Head	Accelerations, Ax, Ay, Az	1,000	HIC_{15}
	Neck	Forces, Fx, Fy, Fz	1,000	Peak neck force
		Moments, My	600	Peak extension (My) i
	Thorax	Deflection, D_{thorax}	600	Peak deflection

1.13.1 Hybrid III 50% male dummy

1.13.1.1 Head

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

$$HIC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where Ax, Ay, Az represent accelerations in three dimensions, expressed in g, and $t2 - t1 \leqslant 36$ ms. Calculate resultant accelerations for a cumulative time period of 3 ms.

1.13.1.2 Neck

Calculate the neck extension bending moment from:

$$(My)i = My - Fx \cdot d$$

Where My and Fx are bending moment and shear force respectively measured at the transducer and d is the distance from the transducer to the interface (d=0.01778) (SAEJ1733). Determine the ‘continuous exceeding’ of both the neck tension (Fz) and neck shear (Fx) forces.

1.13.1.3 Thorax

Determine the peak thorax deformation and calculate resultant accelerations for a cumulative time period of 3 ms.

1.13.1.4 Upper leg

Determine the axial compressive force on a continuous basis.

1.13.1.5 Knee sliding displacement

Determine the peak knee sliding displacement.

1.13.1.6 Lower leg

Calculate TI:

$$M_R = \sqrt{(M_X)^2 + (M_Y)^2}$$

$$TI = \left|M_R/(M_C)_R\right| + \left|F_Z/(F_C)_Z\right|$$

Where:

M_x – the bending moment about the x axis;

M_y – the bending moment about the y axis;

$(M_C)_R$ - the critical value of the bending moment = 225 Nm;

F_Z - the axial compressive force in vertical direction (z);
$(F_C)_Z$ - the critical value of the compressive force = 35.9 kN;
The peak value of TI and the peak axial compressive force.

1.13.2 HybridIII 5% female dummy

1.13.2.1 Head

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

$$HIC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where: Ax, Ay, Az — Acceleration values in three directions, expressed in g, $t_2 - t_1 \leqslant 15$ ms.

1.13.2.2 Neck

Calculate the extensional bending moment of neck:

$$(My)\ I = My - Fx \cdot d$$

Where, My and Fx are the measured values of transducer, and d is the distance from the center of transducer to head-neck intersection plane (SAE J1733) d＝0.01778. Determine the peak extensional bending moment Fz and shear force Fx of neck.

1.13.2.3 Thorax

1.13.2 Determine the peak compressive deformation of thorax.

2. Frontal impact test against deformable barrier with 40% overlapping

2.1. Vehicle preparation

2.1.1 Checking and confirming vehicle(s) upon arrival

When the test vehicle arrives at the laboratory, first measure and record the mass of the vehicle and its front and rear axle loads. Check and confirm the appearance, configuration and basic parameters of the vehicle (Annex 3 to Chapter II).
2.1.2 Measurement of vehicle curb mass

2.1.2.1 Drain the fuel from the tank and then run the engine until it has run out of fuel.

2.1.2.2 Calculate the mass of fuel contained in the fuel tank at its rated capacity, using a density for petrol of 0.74g/ml or 0.84g/ml for diesel. The fuel tank shall be filled with water to mass equal to 90 percent of the mass of a fuel.

2.1.2.3 Check and adjust tyre pressure according to the manufacturer’s instructions for half load. Check and top up the levels of all other fluids (e.g., engine oil, transmission fluid, brake fluid, washing fluid, antifreeze, etc.) to their maximum levels. Confirm the spare tyre and driver tool are on-board. Nothing else should be in the vehicle.

2.1.2.4 Measure and record the height of the intersection point between the transverse plan passing through the centers of the 4 wheels and the upper edge of the wheel guard plate.

2.1.2.5 Measure and record the mass of the vehicle and its front and rear axle loads. The mass of the vehicle is the curb mass of the complete vehicle.

2.1.3 Vehicle preparation and installation of test equipments

2.1.3.1 Drain the engine oil, transmission fluid, brake fluid, washing fluid, antifreeze, power assisted fluid, etc. In this case, the mass of the liquids shall be offset. Drain the fluids in the air conditioning system.

2.1.3.2 Remove the carpet in the luggage compartment, driver tool and spare tyres from the vehicle (make sure that it will not affect the crash performance of the vehicle).

2.1.3.3 Fix the on-board data acquisition equipment. Also install one-way accelerometers at the sills beneath the B-pillars on the left and right sides of the vehicle.

2.1.3.4 Measure the mass of the vehicle and its front and rear axle loads. Compare them with those determined in Paragraph 2.1.2.5. The load of each axle shall not differ from them by more than 5 percent, each variation not exceeding 20 kg, and the mass of the vehicle by more than 25kg. Any component not liable to affect the crash performance of the vehicle may be added or removed and the mass of the water in the fuel tank may be adjusted to help achieve the desired weights. Record the final mass of the vehicle and its final front and rear axle loads.

2.1.3.5 Upon completion of the test described in Paragraph 2.6.2, measure and record the mass of the vehicle and its front and rear axle loads. The mass of the vehicle determined herein is the test mass (including dummy and all instrumentation). Measure and record the height of the intersection point between the transverse plan passing through the centers of the four wheels and the upper edge of the wheel guard.

2.1.4 Affixing C-NCAP logo and vehicle markings

C-NCAP logo, the unique marking for test vehicle - test code and lab information shall be attached to the vehicle.

2.2 Measurement of vehicle deformation

For vehicle deformation measurement, a 3D measuring system (the software shall presentthe coordinate conversion function: an appropriate coordinate system could be automatically generated based on the inputs of the coordinate values of several points) can be used. The system requires a coordinate system to be set up relative to a particular plane, with its axes being in the same directions of those of the vehicle coordinate system.

During the testing, some structure at the rear of the vehicle can be used as a reference for measurement. During the measurement, the vehicle shall be in a state like it is after the completion of the test described in Paragraph 2.1.3.4.

2.2.1 Measurement before test

2.2.1.1 Mark the centre of the clutch, brake, accelerator and parking brake pedals. If adjustable, the pedals will be placed at the middle position or at the position recommended by the manufacturer.

2.2.1.2 The steering wheel, if adjustable, shall be placed in the midway between the limits of its range(s) of adjustment in any direction..

2.2.1.3 The ignition switch shall be placed at “off” position and the battery shall be disconnected.

2.2.1.4 Remove the components equipped at the centre of the steering wheel or, if fitted, the airbag to expose the end of the steering column. When doing this, carefully make the connection lines to the airbag which will need to be remade on re-assembly. The removal of the airbag or the components equipped at the center of the steering wheel shall follow the instruction recommended by vehicle manufacturer.

2.2.1.5 Mark the centre of the top of the steering-column.

2.2.1.6 Set up the coordinate system of vehicle bodywork, by applying either of the following procedures:

2.2.1.6.1 Provided, for the non-deformation locations at the rear end of the vehicle (left, right, and iddle), manufacturer could furnish the coordinate values of 8 characteristic points (spatially scattered to the max. practicable extent, and convenient for measurement) under the designed bodywork coordinate system for the vehicle, record them, based on which the designed bodywork coordinate system is subsequently set up through the use of software.
2.2.1.6.2 Provided manufacturer could not furnish the 8 characteristic points described in Paragraph 2.2.1.6.1, set up the bodywork coordinate system as follows: Adjust the vehicle until the horizontal level is attained; mark the position of at least 8 datum points (spatially scattered to the max. practicable extent) on the rear end of the vehicle (left, right and middle), which are not expected to deform in the test. Among them, one point serves as the original point of the coordinate, and two points are taken to establish the x or y axis, which is in parallel with the corresponding axis of the bodywork coordinate system. Where such two points are not available on the vehicle body, then two points that are basically in parallel with the corresponding axis of the vehicle coordinate system are to be given by the manufacturer.

Establish a ‘z’ plane on the ground on which the vehicle stays, and horizontally moves it through the original point of the coordinate. Record the coordinate values of 8 characteristic points.

2.2.1.7 Measure and record the centre of the clutch, service brake, accelerator and, if fitted, parking brake pedals as well as the coordinate located in the marked centre of the top of the steering-column.

2.2.1.8 Measure and record the B-pillars on the passenger side:

I. at a distance of 100 mm above the sill;

II. at a distance of 100 mm beneath the lowest level of the side window frames on two sides.

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

2.2.1.9 Measure and record the A and B-pillars on the driver side:

I. at a distance of 100 mm above the sill;

II. at a distance of 100 mm beneath the lowest level of the side window frames on two sides.

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

2.2.1.10 Refix the component in the centre of the steering wheel, and check all bolts are securely fastened.

2.2.1.11 Connect the battery, check whether the circuit is functional or not. Ensure that airbags are in a normal working condition.

2.2.2 Measurement after test

2.2.2.1 Measure the distance between each pedal to a fixed point of the vehicle before the dummy is removed. Where it is not possible to make such measurement, then first remove the dummy, provided that the post-impact positions of pedals are not to be changed as far as possible during the test. The distance shall be re-measured after the dummy is removed.

In the case of any change in the positions of pedals, use the distance measured and reposition the pedals.

2.2.2.2 Remove the central parts of the steering wheel.

2.2.2.3 Measure the 8 characteristic points (datum points) prior to the test.

2.2.2.4 Set up the bodywork coordinate system. With the software, input the pre-test coordinate values of any 6 points among the 8 characteristic points (datum points), so as to set up, via the software, the bodywork coordinate system based on the coordinate values of these 6 points. In the newly-established coordinate system, compare the coordinate values of such 6 points with their pre-test counterparts; in case of low

consistency, randomly select 6 out of the 8 characteristic points (datum points) to re-establish the bodywork coordinate system, and conduct comparison again. In case the consistency is low either, correct the measurement values in accordance with the procedures shown in Paragraph 2.2.3.

2.2.2.5 Measure and record the centre of the clutch, service brake, accelerator, and, if fitted, parking brake pedals, as well as the coordinate located in the marked centre of the top of the steering-column. If a pedal is disengaged, then such pedal is not subject to measurement.

2.2.2.6 Measure and record the mark on A-pillar.

2.2.3 Correction

2.2.3.1 After the test, measure and record the marks on the driver and passenger-side B-pillar.

2.2.3.2 Compare the changes in positions of related B-pillar points above the z axis before and after the test.

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

2.2.3.4 Transform the post impact longitudinal and vertical measurements (x, z) using the following equations:

$$\begin{bmatrix} X \\ Z \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x1 \\ z1 \end{bmatrix}$$

Note: *x*, *z* = the corrected coordinate values, *xl*, *zl* = the actual values measured after the impact.

2.2.4 Results

The following measurement results may be obtained based on the pre-impact measurements and post impact measurements (or the post impact measurements modified).

2.2.4.1 The longitudinal and vertical displacements of steering-column.

2.2.4.2 The longitudinal and vertical displacements of all pedals.

2.2.4.3 The longitudinal displacement of A-pillar at its horizontal level.

2.3. Passenger compartment adjustments

2.3.1 Front seat adjustments

2.3.1.1 Front seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest backward locking position. Check and confirm the seat sliding system is in a completely locked position.

2.3.1.2 Front seats independently adjustable for height shall be placed at the height position defined by the manufacturer or the lowest position.

2.3.1.3 Seat cushions adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

2.3.1.4 If adjustable, the seat-backs shall be adjusted so that the resulting inclination of the torso of 3DH machine is as close as possible to that recommended by the manufacturer for normal use or, in the absence of any particular recommendation by the manufacturer, to 25 degrees towards the rear from the vertical.

2.3.1.5 Where adjustable, the seat bracket shall be placed at the position defined by the manufacturer or the completely retracted position.

2.3.1.6 Head restraints adjustable for height shall be in their uppermost position.

2.3.1.7 Head restraints adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

2.3.1.8 Arm-rests shall be in the lowered position, unless this is prevented by the position of the dummies in the vehicles.

2.3.1.9 Other adjustment mechanisms shall be set to the manufacturer’ s design position.

2.3.2 Rear seat adjustments
2.3.2.1 Rear seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest rearward locking position. Check and confirm the seat sliding system is in a completely locked position.

2.3.2.2 For a second-row seat allowing vertical adjustment, seat height shall be set to the manufacturer’ s design position or the lowest position.

2.3.2.3 For a second-row seat with adjustable seatback, the seat back shall be adjusted to the manufacturer’ s design angle or the position inclining backwards by 25° from the vertical plane.

2.3.2.4 Lumbar support, if any, for second-row seat shall be adjusted to the manufacturer’s design position or the fully retracted position.

2.3.2.5 Head restraints of rear seats shall be adjusted to the lowest locking position.

2.3.2.6 If the tilt angle is adjustable, head restraint shall be adjusted to the foremost position.

2.3.2.7 Rear seats adjustable for orientation shall be adjusted to forward facing.

2.3.2.8 Other adjustment mechanisms shall be set to the manufacturer’s design position.

2.3.3 Steering wheel adjustments

2.3.3.1 The steering wheel adjustable horizontally for direction shall be placed in midway between the limits of its range(s) of adjustment.

2.3.3.2 The steering wheel adjustable vertically for direction shall be placed in midway betweenthe limits of its range(s) of adjustment.

2.3.3.3 The steering wheel shall be left free, with its spokes in the position which according to the manufacturer corresponds to straight-ahead travel of the vehicle.

2.3.4 Adjustment of safety belt anchorages

Where adjustable, safety belt anchorages shall be placed in the position defined by the manufacturer or the middle position, or close to the fixed upper midway.

2.3.5 Gear-change lever

The gear-change lever shall be in the neutral position.

2.3.6 Glazing
The movable glazing of the vehicle shall be in the closed position, meanwhile the position of the operating handle corresponds to the closed position of the glazing.
2.3.7 Pedals

The pedals shall be in their normal position of rest.

2.3.8 Sun-visor

The sun-visors shall be in the stowed position.

2.3.9 Rear-view mirror

The interior rear-view mirror shall be in the normal position of use.

2.3.10 Doors

The doors shall be closed but not locked.

2.3.11 Opening roof

If an opening or removable roof is fitted, it shall be in place and in the closed position.

2.3.12 Parking brake

Parking brakes shall be in their normal position of rest.

2.4. Dummy preparation and calibration

During the test, two HybridIII50% male dummies and one HybridIII 5% female dummies are to be used. Each dummy will be clothed with formfitting cotton stretch garments with short sleeves and pants and fitted with shoes. Neck shields shall be fitted to HybridIII50% male dummies if a frontal protection airbag is present. Moreover, each dummy shall be fitted with the neck protection sheath.

2.4.1 Dummy test condition

2.4.1.1 The dummy shall be tested at the temperature of 20 C ~ 22 C and the humidity of 10% ~ 70%.

2.4.1.2 The dummy shall be placed in temperatures specified in Paragraph 2.4.1.1 for at least 5 hours prior to the calibration of the dummy, the adjustment of dummy joints and the impact test.

2.4.2 Adjustment of dummy joints

2.4.2.1 The dummy joints should be adjusted as close as possible to the time of the test and, in any case, not more than 24 hours before the test.
2.4.2.2 All constant friction joints shall be subject to adjustment. When a force being 1g ~ 2 g is applied, the dummy limbs can continue to move.

2.4.3 Calibration of dummies

2.4.3.1 HybridIII 50% male dummies shall be calibrated in accordance with the provisions of CFR 572 Subpart E and Annex 10 to ECE R94; HybridIII 5% female dummies in accordancewith the provisions of CFR 572 Subpart O.

2.4.3.2 The dummies should be re-calibrated after every two impact tests. The knee sliding displacement shall be calibrated to 10 mm after every two impact tests and re-calibrated after every eight impact tests.

2.4.3.3 If an injury criterion reaches or exceeds its normally accepted limit as specified in Paragraph 2.1.2 of Chapter IV, then that part of the dummy shall be re-calibrated.

2.4.3.4 If any part of a dummy is broken in a test then the part shall be replaced.

2.4.3.5 All data concerning the calibration of dummies shall be maintained for future check.

2.5. Instrumentation

All instrumentation shall be calibrated prior to the test. All instrumentation shall be re-calibrated after one year, regardless of their use frequency. Accelerometers shall be subject to normal calibration with vibration sensor calibrators, to ensure the accuracy of test results. The Channel Amplitude Class (CAC) for each transducer shall be chosen to cover the Minimum Amplitude listed in Table 9. 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.

Table 10 Test requirements

Instrumentation	Location		Minimum amplitude	Channels measured
Driver HybridIII 50% male dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck: Forces and moments	Fx	9kN	3
		My	280Nm	
		Fz	13kN	
	Thorax: Deformation and accelerations	D_{thorax}	90 mm	4
		Ax, Ay, Az	150g	
	Upper leg: Compression forces (L/R)	Fz	13kN	2
	Knees: Sliding displacements (L/R)	D_{knee}	19 mm	2
	Upper tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
	Lower tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
Front passenger HybridIII 50%male dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck: forces and moments	Fx	9kN	3
		My	290Nm	
		Fz	14kN	
	Thorax: Deformation and accelerations	D_{thorax}	90 mm	4
		Ax, Ay, Az	150g	
	Upper leg: Compression forces (L/R)	Fz	13kN	2
	Knees: Sliding displacements (L/R)	D_{knee}	19 mm	2
	Upper tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
	Lower tibia: Forces and moments (L/R)	Fz	12kN	6
		Mx, My	400Nm	
Second-row Hybrid III 5% female dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Neck: forces and moments	Fx	9 kN	4
		Fy	9 kN	
		Fz	14 kN	
		My	290 Nm	
	Thorax: Deformation	D_{thorax}	90 mm	1
Safety belt tension sensor	Driver-side shoulder belt and waist belt	F_{belt}	16 kN	2
	Front passenger-side shoulder belt and waist belt	F_{belt}	16 kN	2
	Shoulder belt and waist belt of second-row female dummy	F_{belt}	16 kN	2
Accelerometer	B-pillar on the left side of the vehicle	Ax	250g	1
	B-pillar on the right side of the vehicle	Ax	250g	1
Total				68

2.6. Dummy placement and measurement

For reference only

A HybridIII 50% male dummy shall be placed on driver’s seat and front outboard passenger seat respectively, and a HybridIII 5% female dummy on the rear outboard seat behind front passengers. During the test, the restraint system shall be used. The instrumentation shall be mounted in the vehicle such that they are not likely to affect the movement of the dummies. Prior to the test, the dummy and instrumentation shall be stabilized in the temperatures as close as possible to the range of 20 C ~ 22 C.

2.6.1 The procedure for the determination of the “H” point and the actual torso angle

2.6.1.1 The vehicle shall be preconditioned in the temperatures of 20 C ~ 22 C, to ensure the seat materials are at ambient temperature. If the seat is new and has never been sat upon, a 75 ± 10kg person or device shall sit on the seat for 1 minute twice to flex the cushions and back. All seat assemblies shall remain unloaded for at least 30min before the installation of the HPM machine (SAEJ826).

2.6.1.2 The area of the seating position contacted by the HPM machine shall be covered by a muslin cotton of adequate size and proper material, or plain cotton with 18.9 yarns/cm^2 and density of 0.228kg/m^2, or knitted or nonwoven fabric with the same characteristics.

2.6.1.3 Place the seat and back assembly of the HPM machine so that the centreplane of the seats coincides with the centreplane of the HPM machine.

2.6.1.4 Attach the foot and lower leg assemblies to the seat pan assembly, either individually or by using the T-bar and lower leg assembly. A line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centreplane of the seat.

Dimensional adjustment bars for lower and upper legs shall be adjusted to the 10% sight marks.

2.6.1.5 Adjust the feet and leg positions of the HPM machine as follows:

2.6.1.5.1 Driver and front outboard passenger

Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located approximately the same distance to the left of the centreplane of the HPM machine as the right foot is to the right. The spirit level verifying the transverse orientation of the HPM machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear. The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centreplane of the seat.

2.6.1.5.2 Rear outboard passenger

For the second row, the assembly of feet and legs shall be adjusted by following the adjustment procedures for the driver and the frontal-row outboard passenger. If, in such context, the frontal-row seat components come into contact or interfere with the HPM machine, the frontal row shall be moved forwards for the time

being, so as to eliminate the interferences.

2.6.1.6 Apply lower leg and thigh weights and level the HPM machine.

2.6.1.7 Tilt the back pan forward against the forward stop and draw the HPM machine away from the seat-back using the T-bar. Reposition the HPM machine on the seat by one of the following methods:

2.6.1.7.1 If the HPM machine tends to slide rearward, use the following procedure. Allow the HPM machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required (i.e., until the seat pan contacts the seat-back). If necessary, reposition the lower leg.

2.6.1.7.2 If the HPM machine does not tend to slide rearward, use the following procedure. Slide the HPM machine rearwards by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back.

2.6.1.8 Apply a 100 ± 10 N load to the back and pan assembly of the HPM machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing by the above intersection to a point just above the thigh bar housing. Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the HPM machine from sliding forward.

2.6.1.9 Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the HPM machine level.

2.6.1.10 Tilt the back pan forward to release the tension on the seatback. Rock the HPM machine from side to side through a 10° arc (5° to each side of the vertical centreplane) for three complete cycles to release any accumulated friction between the HPM machine and theseat.

2.6.1.10.1 During the rocking action, the T-bar of the HPM machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar must therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the 3-D H machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction. The feet of the HPM machine are not to be restrained during this step.

2.6.1.10.2 Carefully return the back pan to the seat-back and check the two spirits levels for zero position. If any movement of the feet has occurred during the rocking operation of the HPM machine, they must be repositioned as follows: Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; and no forward or lateral loads are to be applied.

When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

2.6.1.10.3 Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the

back pan sufficient to level the HPM machine’s seat pan on the seat.

2.6.1.11 Holding the T-bar to prevent the HPM machine from sliding forward on the seat cushion, proceed as follows:

Return the back pan to the seat-back; alternately apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care shall be exercised to ensure that no exterior downward or lateral loads are applied to the HPM machine.

2.6.1.12 Measurement and record

2.6.1.12.1 Measure the position of the H-point relative to the fixed part of the vehicle structure.

2.6.1.12.2 The actual torso angle is read at the back angle quadrant of the HPM machine with the probe in its fully rearward position.

2.6.2 Dummy installation

A HybridIII 50% male dummy shall be placed on the driver’s seat and the outside front passenger seat respectively, and a HybridIII 5% female dummy on the outside rear seat behind front passengers. The dummy should not be left to sit directly on the seat for more than 2 hours prior to the test. If the dummy is in the vehicle for a time longer than 2 hours but less than 12 hours, then the dummy should be sat on plywood boards placed over the seat, to eliminate excessive compression of the seat.

2.6.2.1 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.

2.6.2.2 Buckle up the safety belt across the dummy.

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

2.6.2.4 Maintaining the small rearwards force to the lower torso, apply a small rearwards force to the upper torso to return the upper torso to the seat back.

2.6.3 HybridIII 50% male 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, the dummy positioning and measurement 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.

2.6.3.1 Head

The transverse instrumentation platform of the head shall be horizontal within 2.5 degrees. To level the head of the test dummy in vehicles with upright seats with non-adjustable backs, the following sequences must be followed. First adjust the position of the "H" point within the limits set forth in Paragraph 2.6.3.5 to level the transverse instrumentation platform of the head of the test dummy. If the transverse instrumentation platform of the head is still not level, then adjust the pelvic angle of the test dummy within the limits provided in Paragraph 2.6.3.6. If the transverse instrumentation platform of the head is still not level, then adjust the neck bracket of the test dummy the minimum amount necessary to ensure that the transverse instrumentation platform of the head is horizontal within 2.5 degrees.

2.6.3.2 Arms

The driver’s upper arms shall be adjacent to the torso with the centrelines as close to a vertical plane as possible. The passenger’s upper arms shall be in contact with the seat back and the sides of the torso.

2.6.3.3 Hands

The palms of the driver test dummy shall be in contact with the outer part of the steering wheel rim at the rim’s horizontal centreline. The thumbs shall be over the steering wheel rim and shall be lightly taped to the steering wheel rim so that if the hand of the test dummy is pushed upward by a force of not less than 9 N and not more than 22 N, the tape shall release the hand from the steering wheel rim. The palms of the passenger test dummy shall be in contact with outside of thigh. The little finger shall be in contact with the seat cushion.

2.6.3.4 Torso

In vehicles equipped with bench seats, the upper torso of the driver and passenger test dummies shall rest against the seat back. The midsagittal plane of the driver dummy shall be vertical and parallel to the vehicle’s longitudinal centreline, and pass through the centre of the steering wheel rim. The midsagittal plane of the passenger dummy shall be vertical and parallel to the vehicle’s longitudinal centreline and the same distance from the vehicle’s longitudinal centreline as the midsagittal plane of the driver dummy. In vehicles equipped with bucket seats, the upper torso of the driver and passenger test dummies shall rest against the seat back. The midsagittal plane of the driver and the passenger dummy shall be vertical and shall coincide with the longitudinal centreline of the bucket seat.

2.6.3.5 "H" point

The "H" point of the driver and passenger test dummies shall coincide within 13 mm in the vertical dimension and 13 mm in the horizontal dimension of a point 6 mm below the position of the "H" point determined by using the procedures specified in Paragraph 2.6.1.

2.6.3.6 Pelvic angle

The pelvic angle measured from the horizontal on the flat surface of the gauge shall be 22.5° ±2.5° .

2.6.3.7 Legs

The upper legs of the driver and passenger test dummies shall rest against the seat cushion to the extent permitted by placement of the feet. For the driver, the outboard knee clevis flange surfaces shall fall within the vertical plane, with the left leg residing, to the maximum extent practicable, within the longitudinal vertical plane. For the passenger, the outboard knee clevis flange surfaces shall fall within the vertical plane, with the interval between both surfaces at 270 mm±10 mm, and, to the maximum extent practicable, both legs shall fall within the longitudinal vertical planes respectively.

2.6.3.8 Feet

The right foot of the driver test dummy shall rest on the undepressed accelerator with the rearmost point of the heel on the floor surface in the plane of the pedal. If the foot cannot be placed on the accelerator pedal, it shall be positioned perpendicular to the tibia and placed as far forward as possible in the direction of the centreline of the pedal with the rearmost point of the heel resting on the floor surface. The heel of the left foot shall be placed as far forward as possible and shall rest on the floor pan. The left foot shall be positioned as flat as possible on the toe board. The longitudinal centreline of the left foot shall be placed as parallel as possible to the longitudinal centreline of the vehicle.

The heels of both feet of the passenger test dummy shall be placed as far forward as possible and shall rest on the floor pan. Both feet shall be positioned as flat as possible on the toe board. The longitudinal centreline of the feet shall be placed as parallel as possible to the longitudinal centreline of the vehicle.

2.6.4 HybridIII 5% female 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, the dummy positioning and measurement 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.
2.6.4.1 Torso

In vehicles equipped with bench seats on the second row, the midsagittal plane of the HybridIII 5% female dummy shall coincide with the longitudinal centreline of the bench seat; in vehicles equipped with single seats on the second row, the midsagittal plane of the HybridIII 5% female dummy shall coincide with the longitudinal centreline of the single seat; the thigh of the dummy shall rest against the seat cushion to the extent permitted, and angle of leg and thigh is adjusted within 120° ± 5° , the horizontal distance to the longitudinal center of the front of dummy keens o is 160 mm-170 mm, Push the dummy keens backward, to make hip and seat back closely contact or make the back of the legs contact with the front of cushion with torso resting against the seatback.

2.6.4.2 Head

The installation plane of the head sensor shall be horizontal, with the deviation angle to be ideally controlled within + 0.5 . For the vehicles with adjustable seatbacks of the second row, keep the position of thighs, and place the plane horizontal via adjusting backrest angle forward (or backward); for the vehicles with

unadjustable seatbacks of the second row, adjust the angle with regulating the lower neck bracket. If the requirement is unable to achieve, place the plane as horizontal as possible, and make record.

2.6.4.3 Pelvic angle

The pelvic angle of the HybridIII 5% female dummy measured from the horizontal on the flat surface of the gauge shall be 20° ±2.5° . If failed, adjust the angle as close as possible to 20° , and guarantee the head sensor installation surface to adjust according to paragraph 2.6.4.2 and make record. If the longitudinal plane angle of the sensor installation and the pelvic angle couldn’t be fulfilled simultaneously, it should preferentially guarantee the longitudinal plane angle is 0° ±0.5° .

2.6.4.4 Legs and feet

Keep head, torso and thigh unmoved, adjust angle of legs, to place feet on the floorpan and keep the longitudinal centerline of two feet paralleled with longitudinal centerline of the vehicle as possible; if the feet are unable to reach the floorpan, keep the feet paralleled with the floorpan at the nearest position.

2.6.4.5 Arms

The HybridIII 5% female dummy’s upper arms shall be in contact with the seat back and the sides of the torso.

2.6.4.6 Hands

The palms of the HybridIII 5% female dummy shall be in contact with outside of thigh. The little finger shall be in contact with the seat cushion.

2.6.4.7 “H” point

“H” point of the rear-row HybridIII 5% female dummy shall fall within a zone 13 mm from a target point in both vertical and longitudinal directions. Such target point shall reside 6 mm underneath the H-point as established according to the procedures of Paragraph 2.6.1. If the position of H-point exceeds the prescribed scope, the dummy shall be adjusted properly according to Paragraph 2.6.4, such that the H-point of the dummy could fall within the prescribed scope.

2.6.5 Dummy measurement

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

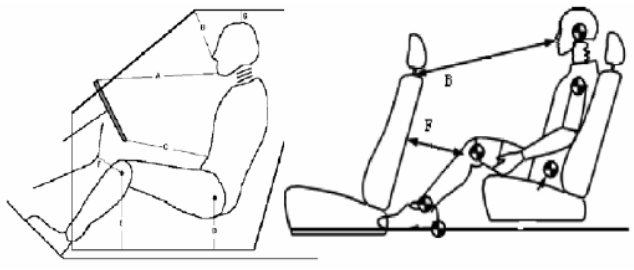


Figure 13 Dummy measurement

Table 11 Dummy measurement

HybridIII50% driver-side male dummy		HybridIII50% front passenger side male dummy		HybridIII5% dummy representing a female passenger behind the driver	
A	Chin to upper rim of steering wheel	A	Chin to dashboard	A	-
B	Nose to top edge of windshield glazing	B	Nose to top edge of windshield glazing	B	Nose to upper center of frontal seatback
C	Abdomen to lower rim of steering wheel	C	Abdomen to dashboard	C	-
D	H-point to door sill	D	H-point to door sill	D	-
E	Knee bolt to top edge of door sill	E	Knee bolt to top edge of door sill	E	-
F	Knee bolt to edge of dashboard	F	Knee bolt to edge of dashboard	F	Knee joint to frontal seat back
G	Head to roof surface	G	Head to roof surface	G	Head to roof surface
H	Neck angle θ	H	Neck angle θ	H	Neck angle θ
I	H-point to vehicle structure	I	H-point to vehicle structure	I	H-point to vehicle structure
J	Actual seat back angle α	J	Actual seat back angle α	J	Actual seat back angle α

2.7. Photographs taken before and after test

The minimum resolution for photographs shall be 640×480. Given in Table 12 are the minimum quantity and contents of photographs taken before and after the test. “O” represents that photographs should be taken.

Table 12 Test photographs

Sr. No.	View	Pre-test	Post-test
1	Front view of car	0	0
2	Car LHS	0	0
3	Car RHS	0	0
4	Car LHS at 45 degrees to front	0	0
5	Car RHS at 45 degrees to front	0	0
6	Rear view of car	0	0
7	Front view of front windshield glazing	0	0
8	To show area immediately in front of driver	0	0
9	To show area immediately in front of passenger	0	0
10	Side view of driver area	0	0
11	Side view of passenger area	0	0
12	To show driver knees	0	0
13	To show passenger knees	0	0
14	To show driver contacts		0
15	To show passenger contacts		0
16	To show the location of driver's seat	0	0
17	To show the location of passenger seats	0	0
18	Driver and car interior (with doors open)	0	0
19	Passengers and car interior (with doors open)	0	0
20	To show car with its left doors open	0	0
21	To show car with its right doors open	0	0
22	To show the front bottom of car	0	0
23	To show the rear bottom of car	0	0
24	To show area immediately on the left side of rear passengers	0	0
25	To show area immediately on the right side of rear passengers	0	0
26	To show area in front of second-row female dummy		
27	To show area at 45 degrees to front on the right side of rear passengers	0	0
28	To show driver-side pedal area	0	0
29	To show A-pillar area on the left side of car	0	0
30	To show A-pillar area on the right side of car	0	0
31	Front view of deformable barrier	0	0
32	To show area on the left of deformable barrier	0	0
33	To show area on the right of deformable barrier	0	0
34	Deformable barrier RHS at 45° to front	0	0
35	To the position of deformable barrier relative to car		

2.8. Camera location

The minimum resolution for camera shall be 512×384. Also, the non-stroboscopic high speed film lighting system is to be used.

Table 13 Camera location and requirements

Camera no.	Camera type	Camera location	Shot content
1	1,000fps	Front visual field of windshield glazing	Front view of motions of driver and passenger dummies
2	1,000fps	Frontal end to B-pillar on the left side of car	Motion of driver dummy
3	1,000fps	B-pillar to C-pillar on the right side of car	Motion of rear passenger dummy
4	1,000fps	Entire visual field from barrier to left side of car	Overall motion process of the left part of car
5	1,000fps	Frontal end to B-pillar on the right side of car	Motion of passenger dummy
6	1,000fps	Entire visual field from barrier to right side of car	Overall view of motion of the right side of car
7	30fps	At 45 degrees to front on the left side of car	Deformation of the left side of car
8	30fps	At 45 degrees to rear on the left side of car	Deformation of the left side of car
9	30fps	Test track	Vehicle motion process
10	30fps	At 45 degrees to front on the right side of car	Deformation of the right side of car
11	1,000fps	Interior of rear-row passenger compartment (onboard camera)	Motion attitude of rear-row female dummy

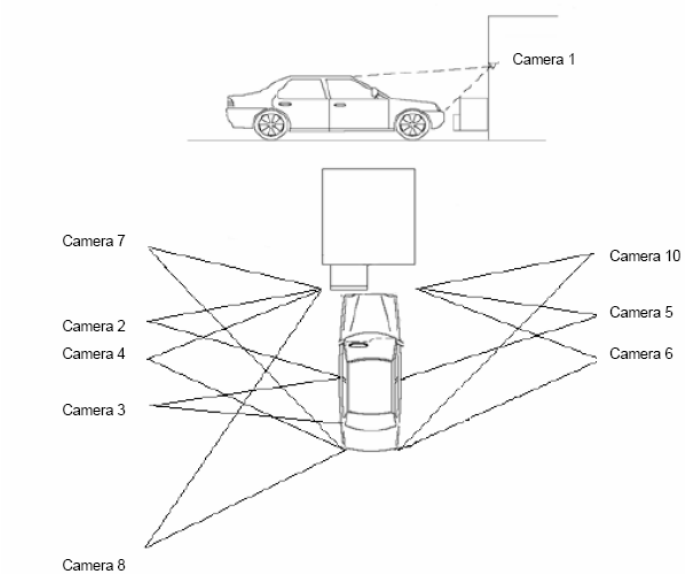


Figure 14 Camera location for frontal impact test against deformable barrier with 40% overlapping

2.9. Test facilities

2.9.1 Testing ground

The test area shall be large enough to accommodate the run-up-track, the barrier and the technical equipment necessary for the test. The track, for at least 5 meters before the barrier, shall be horizontal, flat,

dry and smooth.

2.9.2 Traction system

The acceleration of the vehicle shall be not greater than 0.3g, to ensure the location of the dummy before the impact. The vehicle shall be accelerated in such a way: it moves at acceleration in the first half of the run-up track and at a constant speed in the last half. The speed shall be controlled such that it is accurate to ± 0.2km/h. The test speed is between 56km/h and 57km/h. Record the actual test speed.

2.9.3 Lighting system

The non-stroboscopic lighting system for the high speed camera shall be actuated 5min before the test, to ensure the temperature of the impact zone is not unreasonably high.

2.9.4 Deformable barrier positioning

2.9.4.1 Measurement of vehicle width

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

2.9.4.2 Vehicle overlapping

Determine the central bisection line of the vehicle. Calculate 10% of the vehicle width and mark a line on the bonnet and front bumper which is 10% of the vehicle width to the central bisection line. The area between this line and the widest point on the driver’ s side of the car will be the overlapping area with the deformable barrier.

2.9.4.3 Vehicle to deformable barrier positioning
T
he overlapping of the vehicle with the deformable barrier face shall be 40%±20 mm.

2.9.5 Mounting deformable barrier

2.9.5.1 The deformable barrier shall be rigidly fixed to the edge of a block of reinforced concrete weighing at least 7×104 kg or to some structure attached thereto. The attachment of the barrier ace shall be such that the vehicle shall not come into contact with any structure at any height above 75 mm from the top surface of the barrier (excluding the upper flange) during any stage of the impact. The front face of the surface to which the deformable face is attached shall be flat and continuous over the height and width of the face and shall be vertical and perpendicular to the axis of the run-up track, with the tolerance being ± 1 degree. The attachment surface shall not be displaced by more than 10 mm during any stage of the test. If necessary, additional anchorage or arresting devices shall be used to prevent displacement of the concrete block. The edge of the deformable barrier shall be aligned with the edge of the attachment surface appropriate for the

side of the vehicle to be tested.

2.9.5.2 The deformable barrier shall be attached by means of ten bolts, five in the top mounting flange and five in the bottom. These bolts shall be of at least 8 mm diameter. Steel clamping strips shall be used for both the top and bottom mounting flanges (see Figures 15 and 16). These strips shall be 60 mm high, 1000 mm wide and 3 mm thick. The edges of the clamping strips should be rounded off to prevent tearing of the barrier against the strip during impact. The edge of the strip should be located no more than 5 mm above the base of the upper barrier mounting flange, or 5 mm below the top of the lower barrier mounting flange. Five clearance holes of 9.5 mm diameter shall be drilled in both strips to correspond with those in the mounting flange on the barrier. The mounting strip and barrier flange holes may be widened from 9.5 mm up to a maximum of 25 mm in order to accommodate differences in back-plate arrangements and/or load cell wall hole configurations. None of the fixtures shall fail in the impact test. In the case where the deformable barrier is mounted on a load cell wall (LCW) it should be noted that the above dimensional requirements for mountings are intended as a minimum. Where a LCW is present, the mounting strips may be extended to accommodate higher mounting holes for the bolts. If the strips are required to be extended, then thicker gauge steel should be used accordingly, such that the barrier does not pull away from the wall, bend or tear during the impact. If an alternative method of mounting the barrier is used, it should be at least as secure as that specified in the above Paragraphs.

2.9.6 Deformable barrier specifications

2.9.6.1 Component and material specifications

The dimensions of the deformable barrier are illustrated in Figure 15. The dimensions of the individual components of the barrier are listed separately below.

2.9.6.1.1 Main body of the cell bond

Dimensions:
Height: 650 mm (in direction of cells)
Width: 1000 mm
Depth: 450 mm (in direction of cell axes)
Tolerance of above dimensions is ± 2.5 mm
Material: Aluminum 3003
Cell Thickness: 0.076 mm ± 15%

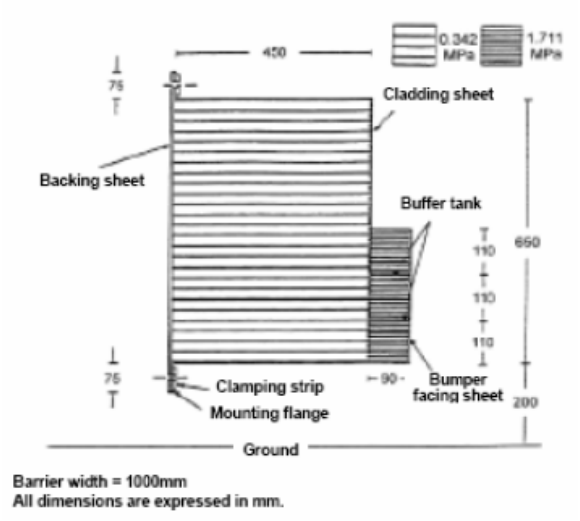


Figure 15 Deformable barrier for frontal impact test against deformable barrier with 40%

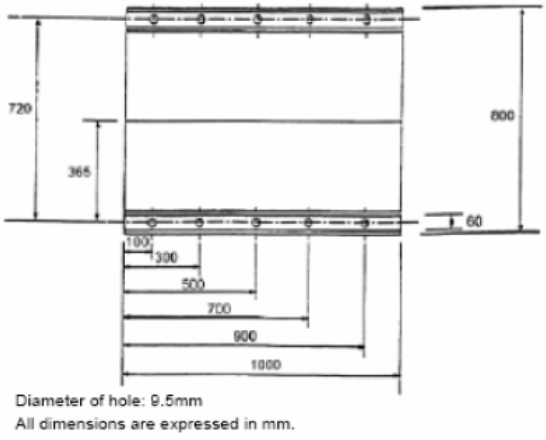


Figure 16 Positions of holes for barrier mounting

Cell Size: 19.1 mm ± 20%
Density: 28.6kg/m3 ± 20%
Crush strength: 0.342MPa -10% ~ 0%

2.9.6.1.2 Bumper element

Dimensions:
Height: 330 mm (in direction of cells)
Width: 1000 mm
Depth: 90 mm (in direction of cell axes)
Tolerance of all above dimensions is ± 2.5 mm
Cell Thickness: 0.076 mm ± 15%
Cell Size: 6.4 mm ± 20%
Density: 82.6kg/m3 ± 20%
Crush strength: 1.711Mpa -10% ~ 0%
Diameter of hole: 9.5 mm

All dimensions are expressed in mm.

2.9.6.1.3 Backplate

Dimensions:
Height: 800 mm±2.5 mm
Width: 1000 mm±2.5 mm
Thickness: 2.0 mm±0.1 mm

2.9.6.1.4 Cladding sheet

Dimensions:
Length: 1700 mm±2.5 mm
Width: 1000 mm±2.5 mm
Thickness: 0.81 mm±0.07 mm
Material: Aluminum 5251/5052

2.9.6.1.5 Bumper facing sheet

Dimensions:
Height: 330 mm±2.5 mm
Width: 1000 mm±2.5 mm
Thickness: 0.81 mm±0.07 mm
Material: Aluminum 5251/5052

2.9.6.1.6 Adhesives

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

2.9.6.2 Cell bond calibration

In the following is a briefing test procedure for calibration of the material for the deformable barrier used in frontal impact test against deformable barrier with 40%. The crush strengths applied to the material shall be 0.342MPa and 1.711MPa, respectively.

2.9.6.2.1 Sampling locations

To ensure uniformity of crush strength across the whole of the barrier face, 8 samples shall be taken from 4 locations evenly spaced across the honeycomb block. The location of the samples depends on the size of the honeycomb block. First, four samples, each measuring 300 mm×300 mm×50 mm thick shall be cut from the block of barrier face material. Please refer to Figure 17 for an illustration of how to locate these sections within the honeycomb block. Each of these larger samples shall be cut into samples for certification testing (150 mm ×150 mm×50 mm). Calibration shall be based on the testing of two samples from each of these four

locations. The other two should be made available to the applicant, upon request.

2.9.6.2.2 Sample size

Samples with the following size shall be used for testing:

Length: 150 mm±6 mm
Width: 150 mm±6 mm
Height: 50 mm±2 mm

The walls of incomplete cells around the edge of the sample shall be trimmed as follows:

In the 'W' direction, the fringes shall be no greater than 1.8 mm (see Figure 17);

In the 'L' direction, half the length of one bonded cell wall (in the cell direction) shall be left at either end of the specimen (see Figure 18).

2.9.6.2.3 Area measurement

The length of the sample shall be measured in three locations, 12.7 mm from each end and in the middle, and recorded as L1, L2 and L3 (Figure 17). In the same manner, the width shall be measured and recorded as W1, W2 and W3 (Figure 17). These measurements shall be taken on the centreline of the thickness. The crush area shall then be calculated as:

$$A = [(L1+L2+L3)/3] \times [(W1+W2+W3)/3]$$

2.9.6.2.4 Crush rate and distance

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

2.9.6.2.5 Data collection

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

2.9.6.2.6 Crush strength determination

Ignore all data prior to 6.4 mm of crush and after 16.5 mm of crush. Divide the remaining data into three sections or displacement intervals (n=1, 2, 3) (see Figure 15), where:

- 6.4 mm ~ 9.7 mm, inclusive

- 9.7 mm ~ 13.2 mm, exclusive
- 13.2 mm ~ 16.5 mm, inclusive

Calculate the average value for each section:

$$F(n)=（F(n)1 + F(n)2 + \ldots + F(n)m）/m \; m = 1, 2, 3$$

Where m is the number of data points in each of the displacement intervals. Calculate the crush strength as follows:

$$S(n) = F(n)/A \; n = 1, 2, 3$$

2.9.6.2.7 Sample crush strength specification

For a cell bond sample to pass this calibration, the following condition shall be satisfied:

0.308 Mpa $\leqslant$ S(n) $\leqslant$ 0.342 Mpa, for 0.342 Mpa material

1.540 Mpa $\leqslant$ S(n) $\leqslant$ 1.711 Mpa, for 1.711 Mpa material, n = 1, 2, 3.

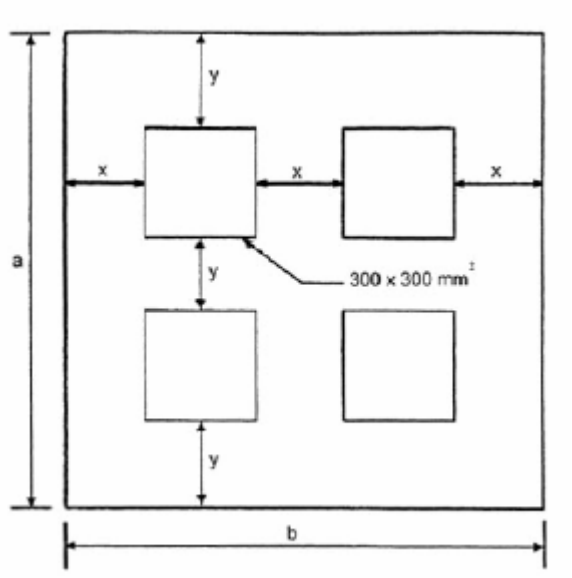
2.9.6.2.8 Block crush strength specification

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

2.9.6.3 Adhesive bonding procedure

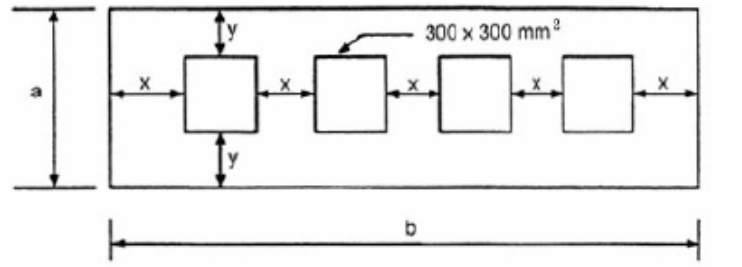
2.9.6.3.1 Immediately before bonding, aluminum sheet surfaces to be bonded shall be thoroughly cleaned using a suitable solvent. This is to be carried out at least twice or as required to eliminate grease or dirt deposits. The cleaned surfaces shall then be abraded using 120 grit abrasive paper. Metallic/Silicon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

2.9.6.3.2 The adhesive shall be applied to one surface only, using a ribbed rubber roller. In cases where cell bond is to be bonded to Aluminum sheet, the adhesive should be applied to the Aluminum sheet only. A maximum of 0.5kg/m2 shall be applied evenly over the surface, giving a maximum film thickness of 0.5 mm.



If a ≥ 900 mm:

x = 1/3 (b – 600 mm) and y = 1/3 (a – 600 mm) (for a ≤ b)



If a < 900 mm:

x = 1/5 (b – 1200 mm) and y = 1/2 (a – 300 mm) (for a ≤ b)

Figure 17 Locations of samples for calibration

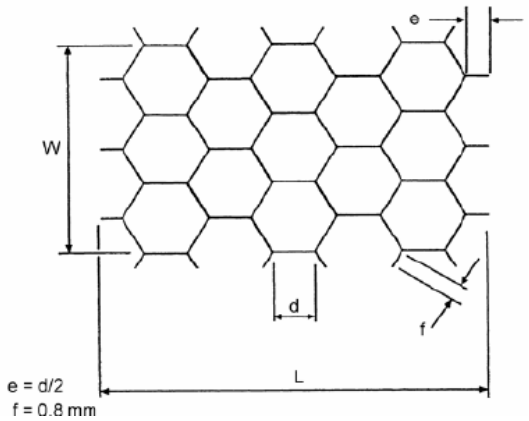


Figure 18 Cell bond axes and measured dimensions

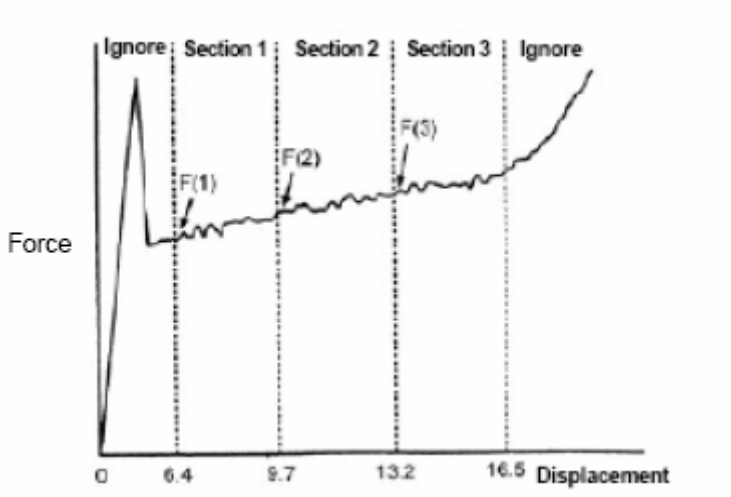


Figure 19 Compressive force and displacement

2.9.6.4 Construction

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

2.9.6.4.2 The bumper element shall be adhesively bonded to the front of the cladding sheet such that the cell axes are perpendicular to the sheet. The bottom of the bumper element shall be flush with the bottom surface of the cladding sheet. The bumper facing sheet shall be adhesively bonded to the front of the bumper element.

2.9.6.4.3 The bumper element shall then be divided into three equal sections by means of two horizontal slots. These slots shall be cut through the entire depth of the bumper section and extend the whole width of the bumper. The slots shall be cut using a saw; their width shall be the width of the blade used and shall not exceed 4.0 mm.

2.9.6.4.4 Clearance holes for mounting the barrier are to be drilled in the mounting flanges (shown in Figure 16). The holes shall be of 9.5 mm diameter. Five holes shall be drilled in the top flange at a distance of 40 mm from the top edge of the flange and five in the bottom flange, 40 mm from the bottom edge of that flange. The holes shall be at 100 mm, 300 mm, 500 mm, 700 mm, 900 mm from either edge of the barrier. All holes shall be drilled to ±1 mm of the nominal distances. These hole locations are a recommendation only. Alternative positions may be used which offer at least the mounting strength and security as that provided by the above mounting specifications.

2.10 Items to be checked and confirmed before test

2.10.1 Battery

Check that whether the vehicle battery is connected, reaches rated voltage as well as is fastened securely. The battery shall be replaceable.

2.10.2 Ignition switch

The ignition switch shall be placed at “on” position.

2.10.3 Airbag warning light

The airbag switch, where fitted, shall be placed at “on” position, and the airbag light on the dashboard shall illuminate as normal,

2.10.4 Dummy painting

Colored paints shall be applied to the parts of the frontal-row dummies such as head, nose, chin, knee and lower leg, etc., to identify and tell them apart. Neck shall be painted red; nose purple; chin blue; left knee red; right knee blue; left lower leg purple, green and blue from top to bottom; right lower leg green, red and purple from top to bottom. All painted areas shall be large enough to enable the dummy’s contacts with the vehicle to be visible. The frontal side of head of the rear-row female dummy shall be painted in red, the side facing the door, in green, and the other side, in yellow; in addition, nose shall be painted in brown, and chin, in blue.

2.10.5 Checking the on-board data acquisition unit

Ensure that the battery of the on-board data acquisition unit is in a normal working condition prior to the test, and measure the trigger switch at a normal working condition.

2.10.6 Checking doors and latches

Ensure that all doors are completely closed, but not locked prior to the test.

2.11 Items to be checked and confirmed after test

2.11.1 Safety belt

With regard to the safety belts for driver, front passenger and rear passenger dummies, check whether they fail or not during the test.

2.11.2 Doors

Check whether doors are locked or not. After the test, check whether the side doors corresponding to each row of seats can be opened without any tools.

2.11.3 Fuel feeding system

After the impact test, check whether the feeding system leaks or not. Where constant leakage occurs in the

fuel feeding system, measure the amount of fuel leaked in the first 5min after the impact test. Calculate the average leaking rate.

2.11.4 Opening force of safety belt buckle

Measure and record the forces applied to open the safety belt buckles for driver, front passenger and rear passenger dummies.

2.12 Calculation of dummy injury criteria

Table 14 lists all the measurement locations and parameters of the dummies as well as the channel frequency class (CFC) at which they are to be filtered. Record all these channel data. Head impacts occurring after the dummy head rebounds from an initial contact are not considered when calculating injury criteria of head and neck.

Table 14 Measurement locations and channel frequency class (CFC) of dummies

	Location	Parameter	CFC	Calculation of injury parameters
HybridIII 50% male dummy	Head	Accelerations, Ax, Ay, Az	1,000	HIC_{36} Resultant 3ms exceeding
	Neck	Forces, Fx, Fz	1,000	Tension (Fz) continuous exceeding
		Moments, My	600	Shear (Fx) continuous exceeding Peak extension (My)i
	Thorax	Deflection, D_{thorax}	180	Peak deflection
		Accelerations, Ax, Ay, Az		Peak resultant acceleration Resultant 3 ms exceeding
	Femurs (L / R)	Forces, Fz	600	Continuous exceeding of compressive axial force (-Fz)
	Knees (L / R)	Displacements, D_{knee}	180	Peak displacement
	Upper tibia (L / R)	Forces, Fz	600	Peak tibia compression
		Moments, Mx, My		Tibia Index
	Lower tibia (L / R)	Forces, Fz	600	Peak tibia compression Tibia Index
HybridIII 50% female dummy	Head	Accelerations, Ax, Ay, Az	1,000	HIC_{15}
	Neck	Forces, Fx, Fy, Fz	1,000	Peak force of neck
		Moments, My	600	Peak extension (My)i
	Thorax	Deflection, D_{thorax}	180	Peak deflection

2.12.1 HybridIII 50% male dummy

2.12.1.1 Head

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

$$HIC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where Ax, Ay, Az represent accelerations in three dimensions, expressed in g, and t2 − t1≤ 36 ms. Calculate resultant accelerations for a cumulative time period of 3 ms.

2.12.1.2 Neck

Calculate the neck extension bending moment from:

$$(My)i = My - Fx \cdot d$$

Where My and Fx are bending moment and shear force respectively measured at the transducer and d is the distance from the transducer to the interface (d=0.01778) (SAEJ1733). Determine the ‘continuous exceeding’ of both the neck tension (Fz) and neck shear (Fx) forces.

2.12.1.3 Thorax

Determine the peak value of the thorax deformation and calculate resultant accelerations for a cumulative time period of 3 ms.

2.12.1.4 Upper leg

Determine the axial compressive force on a continuous basis.

2.12.1.5 Knee sliding displacement

Determine the peak knee slider displacement.

2.12.1.6 Lower leg

Calculate TI:

$$M_R = \sqrt{(M_X)^2 + (M_Y)^2}$$

$$TI = \left|M_R / (M_C)_R\right| + \left|F_Z / (F_C)_Z\right|$$

Where:

Mx – the bending moment about the x axis;
My – the bending moment about the y axis;
(MC)R - the critical value of the bending moment = 225 Nm;
FZ - the axial compressive force in vertical direction (z);
(FC)Z - the critical value of the compressive force = 35.9 kN;
The peak value of TI and the peak axial compressive force.

2.13.2 HybridIII 5% female dummy

2.13.2.1 Head

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

$$HIC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where Ax, Ay, Az represent accelerations in three dimensions, expressed in g, and t2 – t1≤ 15 ms.

2.13.2.2 Neck

Calculate the neck extension bending moment from:

$$(My)i = My - Fx \cdot d$$

Where My and Fx are values respectively measured at the transducer and d is the distance from the center of transducer to the head-neck interface (SAE J1733) (d =0.01778). Determine the peak value of extensional bending moment (Fz) and shear force (Fx) of the neck.

2.13.2.3 Thorax

Determine the peak value of compressive deformation of thorax.

3. Side impact test procedure

3.1. Vehicle preparation

3.1.1 Checking and confirming vehicle(s) upon arrival

When the vehicle to be tested arrives at the laboratory, first measure and record the mass of the vehicle and its front and rear axle loads. Check and confirm the appearance, configuration and basic parameters of the vehicle (Annex 3).

3.1.2 Measurement of kerb mass

3.1.2.1 Drain the fuel from the tank and then run the engine until it has run out of fuel.

3.1.2.2 Calculate the mass of the fuel contain in the tank at its rated capacity, using a density for petrol of 0.74g/ml or 0.84g/ml for diesel. The fuel tank shall be filled with water to mass equal to 90 percent of the mass of a fuel.

3.1.2.3 Check and adjust tyre pressure according to the manufacturer’s instructions for half load. Check and top up the levels of all other fluids (e.g., engine oil, transmission fluid, brake fluid, washing fluid, antifreeze, etc.) to their maximum levels. Confirm the spare tyre and driver tool are on-board. Nothing else should be in the vehicle.

3.1.2.4 Measure and record the mass of the vehicle and its front and rear axle loads. The mass of the vehicle is the curb mass of the complete vehicle.

3.1.2.5 Measure and record the ride-heights of the vehicle for all four wheels at the point on the wheel arch in the same transverse plane as the wheel centers.

3.1.3 Measurement of reference mass

3.1.3.1 Adjust the front row seats at both sides to the middle position of travel or in the nearest backward locking position.

3.1.3.2 Place an ES-2 test dummy (80kg) in the front driver’s seating position or an equivalent weight.

3.1.3.3 Place weight in the luggage apartment, till the vehicle mass is the kerb mass plus 100kg. The weights shall be evenly distributed in the apartment. If inconvenient, they should be placed in the middle position of the apartment.

3.1.3.4 Place an SID II -s test dummy (45kg) or an equivalent weight on the impacted side seat of the second row.

3.1.3.5 Measure the mass of the vehicle and its front and rear axle loads, namely reference mass and reference axle load.

3.1.3.6 Measure and record the height of the intersection point between the transverse plan passing through the centers of the 4 wheels and the upper edge of the wheel guard plate.

3.1.4 Vehicle preparation and test device installation

3.1.4.1 Remove the luggage area carpeting, any tools supplied with the vehicle and spare tyres from the vehicle (ensure that it will not affect the crash performance of the vehicle).
3.1.4.2 Fix the on-board data acquisition equipment. Also install one-way accelerometers at the lower B-pillar sill on the right side of the vehicle (y axis). A three-way accelerometers shall be mounted at the centre of weight of the mobile deformable barrier.

3.1.4.3 Place an ES-2 test dummy (80kg) in the front driver’s seating position or an equivalent weight (with the seat in the middle position).

3.1.4.4 Place an SID II -s test dummy (45kg) or an equivalent weight on the impacted side seat of the second row.

3.1.4.5 Measure the mass of the vehicle and its front and rear axle loads. Compare them with those determined in Paragraph 3.1.3.5. The total vehicle mass shall be within 1% of the reference mass. Each axle load shall be within the smaller of 5% or 20kg of its respective axle reference load. Any component not liable to affect the crash performance of the vehicle may be added or removed and the mass of the water in the fuel tank may be adjusted to help achieve the desired weights.

3.1.4.6 Measure and record the height of the intersection point between the transverse plan passing through the centers of the 4 wheels and the upper edge of the wheel guard plate.

3.1.5 Affixing C-NCAP logo and vehicle markings

C-NCAP logo, the unique marking for test vehicle - test code and lab information shall be attached to the vehicle.

3.2 Measurement of “R” point

The “R” point is measured with a mobile 3D measuring system. The 3D measuring system requires a coordinate system to be set up relative to a particular plane, with its axes being in the same directions of those of the vehicle coordinate system.

3.2.1 Place the HPM machine in accordance with Paragraph 3.6.1 (SAE J826).

3.2.2 Find two points on the vehicle to establish the x or y axis, which coincides with the vehicle coordinate system. Where such two points are not available on the vehicle, then the T-bar of the HPM machine serves as y axis.

3.2.3 Select one point an original point as the zero point of the coordinate system. This point may be defined by the manufacturer.

3.2.4 Establish a coordinate system, which is horizontally moved through the original point.

3.2.5 Measure and record the R-point coordinate. If the values measured are not within the range defined by the manufacturer, then re-measurement and recording will be required after the HPM machine is re-adjusted in accordance with Paragraph 3.6.1.

3.2.6 With the vehicle doors closed, find two points on the vehicle such that the x-coordinate value is consistent with the x-coordinate value of the R point, with the tolerance being ±0.2 mm. Draw a line through the two points, which is the central position of impact area.

3.3. Passenger compartment adjustments

3.3.1 Adjustment of the driver's seat

3.3.1.1 Front seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest backward locking position. Check and confirm the seat sliding system is in a completely locked position.

3.3.1.2 Front seats independently adjustable for height shall be placed at the position defined by the manufacturer or the middle position.

3.3.1.3 Seat cushions adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

3.3.1.4 If adjustable, the seat-backs shall be adjusted so that the resulting inclination of the torso of HPM machine reaches the design angle stated by the manufacturer or is adjusted to 25 degrees towards the rear from the vertical.

3.3.1.5 Where adjustable, the seat bracket shall be placed at the position defined by the manufacturer or the completely retracted position.

3.3.1.6 Head restraints adjustable for height shall be adjusted such that their surface is on the same height level of the centre of weight of the dummy head or in their uppermost position.

3.3.1.7 Head restraints adjustable for inclination shall be adjusted to the position defined by the manufacturer or the middle position.

3.3.1.8 Arm-rests shall be in the lowered position, unless this is prevented by the position of the dummies in the vehicles.

3.3.1.9 Other adjustment mechanisms shall be set to the manufacturer's design position.

3.3.2 Front passenger seat adjustments

Front passenger seats shall be placed in the same position, to the max. practicable extent, as driver's seat.

3.3.3 Adjustment of the second row of seats

3.3.3.1 The second row of seats adjustable longitudinally shall be placed in the middle position of travel or in the nearest backward locking position. Check and confirm the seat sliding system is in a completely locked position.

3.3.3.2 For second-row seat allowing vertical adjustment, seat height shall be adjusted to the manufacturer's design position or the middle position.

3.3.3.3 If adjustable, the seat-backs shall be adjusted to the design angle stated by the manufacturer or to 25 towards the rear from the vertical.

3.3.3.4 Lumbar support, if any, for second-row seat shall be adjusted to the position defined by the manufacturer or the completely retracted position.

3.3.3.5 Head-restraint of second-row seat shall be adjusted to the lowest locking position.

3.3.3.6 Head restraints adjustable for inclination shall be adjusted to their foremost positions.

3.3.3.7 If adjustable, seat orientation shall be adjusted to the forward-facing.

3.3.3.8 Other adjustment mechanisms shall be set to the manufacturer’s design position.

3.3.4 Steering wheel adjustments

3.3.4.1 The steering wheel adjustable horizontally for direction shall be placed in midway between the limits of its range(s) of adjustment.

3.3.4.2 The steering wheel adjustable vertically for direction shall be placed in midway between the limits of its range(s) of adjustment.

3.3.4.3 The steering wheel shall be left free, with its spokes in the position which according to the manufacturer corresponds to straight-ahead travel of the vehicle.

3.3.5 Adjustment of safety belt anchorages

Where adjustable, safety belt anchorages shall be placed in the position defined by the manufacturer or the middle position, or close to the fixed upper midway.

3.3.6 Gear-change lever

The gear-change lever shall be in the neutral position.

3.3.7 Glazing

The movable glazing of the vehicle shall be closed.

3.3.8 Pedals

The pedals shall be in their normal position of rest.

3.3.9 Sun-visor

The sun-visors shall be in the stowed position.

3.3.10 Rear-view mirror

The interior rear-view mirror shall be in the normal position of use.

3.3.11 Doors

The doors shall be closed but not locked.

3.3.12 Opening roof

If an opening or removable roof is fitted, it shall be in place and in the closed position.

3.3.13 Parking brake

Parking brakes shall be in their normal position of rest.

3.4 Dummy preparation and calibration

During the test, use and place an ES-2 test dummy at the area occupied by driver, and place a SID-IIs side impact test dummy on the outboard side to the left of the second row of seats. Both dummies shall be clothed with standard rubber garments and suitable pants and fitted with shoes.

3.4.1 Dummy test condition

3.4.1.1 The dummy shall be tested at the temperature of 18 C ~ 26 C and the humidity of 10% ~70%.

3.4.1.2 The dummy shall be placed in temperatures specified in Paragraph 3.4.1.1 for at least 5 hours prior to the calibration of the dummy, the adjustment of dummy joints and the impact test.

3.4.2 Adjustment of dummy joints

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

3.4.2.2 All constant friction joints shall be subject to adjustment. When a force being 1g ~ 2 g is applied, the dummy limb can continue to fall.

3.4.3 Calibration of dummies

3.4.3.1 The ES-2 test dummy shall be subject to calibration in accordance with the provisions of Annex F to GB 20071-2006 “Protection of Passengers in the Event of Lateral Collision”, and the SID-IIs side impact test dummy subject to Section V of CFR 572.

3.4.3.2 The dummies should be re-calibrated after every two impact tests.

3.4.3.3 If an injury criterion for the side impact test reaches or exceeds its normally accepted limit as specified in Paragraph 2.1.3 of Chapter IV, then that part of the dummy shall be re-calibrated.

3.4.3.4 If any part of a dummy is broken in a test then the part shall be replaced.

3.4.3.5 All data concerning the calibration of dummies shall be maintained for future check.

3.5 Instrumentation

All instrumentation shall be calibrated prior to the test. All instrumentation shall be re-calibrated after one year, regardless of the number of tests for which it has been used. Accelerometers shall be subject to normal calibration with vibration sensor calibrators, to ensure the accuracy of test results. The Channel Amplitude Class (CAC) for each transducer shall be chosen to cover the Minimum Amplitude listed in Table 15. 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.

Table 15 Test requirements

Instrumentation	Location		Minimum amplitude	Channels measured
ES-2 side impact test dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Shoulder: Forces	Fx, Fy, Fz	8kN	3
	Thorax T1: Accelerations	Ax, Ay, Az	250g	3
	Thorax T12: Accelerations	Ax, Ay, Az	250g	3
	Thorax rib: Deflection and accelerations (upper, middle, lower)	D_{rib}	75 mm	6
		Ay	700g	
	Abdomen: Forces (front, middle, rear)	Fy	5kN	3
	Backplate: Forces and moments	Fx, Fy	3kN	4
		My, Mz	160Nm	
	Thorax T12: Forces and moments	Fx, Fy	5kN	4
		My, Mz	300Nm	
	Buttocks: Accelerations	Ax, Ay, Az	250g	3
	Pubis: Forces	Fy	20kN	1
	Femurs: Forces and moments (L/R)	Fx, Fy, Fz	22kN	12
		Mx, My, Mz	340Nm	
SID-IIs side impact dummy	Head: Accelerations	Ax, Ay, Az	250g	3
	Thorax T12: Accelerations	Ax, Ay, Az	250g	3
	Hip joint and iliac bone: resultant force	Fy	8kN	2
Accelerometer	B-pillar on the right side of the vehicle	Ay	250g	1
	Centre of mass of deformable barrier	Ax, Ay, Az	250g	3
Total				57

3.6. Dummy placement and measurement

An ES-2 test dummy shall be placed on driver’s side. During the test, the restraint system shall be used. The instrumentation shall be mounted in the vehicle such that they are not likely to affect the fall of the dummy. Prior to the test, the dummy and instrumentation shall be stabilized in the temperatures as close as possible to the range of 18 C ~ 26 C.

3.6.1 The procedure for the determination of the “H” point and the actual torso angle

3.6.1.1 The vehicle shall be preconditioned in the temperatures between 18 C and 26 C, to ensure the seat materials are at ambient temperature. If the seat is new and has never been sat upon, a 75 ± 10kg person or device shall sit on the seat for 1 minute twice to flex the cushions and back. All seat assemblies shall remain unloaded for at least 30min before the installation of the HPM machine (SAEJ826).

3.6.1.2 The area of the seating position contacted by the HPM machine shall be covered by a muslin cotton or knitted or nonwoven fabric.

3.6.1.3 Place the seat and back assembly of the HPM machine so that the centreplane of the seats coincides with the centreplane of the HPM machine.

3.6.1.4 Attach the foot and lower leg assemblies to the seat pan assembly, either individually or by using the T-bar and lower leg assembly. A line through the "H" point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centreplane of the seat. Dimensional adjustment bars for lower leg and upper leg shall be adjusted to the 10% sight mark.

3.6.1.5 Adjust the feet and leg positions of the HPM machine as follows:

3.6.1.5.1 Driver
Both feet and leg assemblies shall be moved forward in such a way that the feet take up natural positions on the floor, between the operating pedals if necessary. Where possible the left foot shall be located approximately the same distance to the left of the centreplane of the HPM machine as the right foot is to the right. The spirit level verifying the transverse orientation of the HPM machine is brought to the horizontal by readjustment of the seat pan if necessary, or by adjusting the leg and foot assemblies towards the rear. The line passing through the "H" point sight buttons shall be maintained perpendicular to the longitudinal centreplane of the seat.

3.6.1.5.2 Passengers seated on the second row

For the second-row seats, assembly of feet and legs shall be adjusted by following the procedures for the driver and the front-row outboard passenger. If, in such context, the frontal-row seat components comes into contact or interferes with the HPM machine, the frontal-row seats shall be moved forwards for the time being to eliminate such effect.

3.6.1.6 Apply lower leg and thigh weights and level the HPM machine.

3.6.1.7 Tilt the back pan forward against the forward stop and draw the HPM machine away from the seat-back using the T-bar. Reposition the HPM machine on the seat by one of the following methods.

3.6.1.7.1 If the HPM machine tends to slide rearward, use the following procedure. Allow the HPM machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required (i.e., until the seat pan contacts the seat-back). If necessary, reposition the lower leg.

3.6.1.7.2 If the HPM machine does not tend to slide rearward, use the following procedure. Slide the HPM machine rearwards by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back.

3.6.1.8 Apply a 100 ± 10 N load to the back and pan assembly of the HPM machine at the intersection of the hip angle quadrant and the T-bar housing. The direction of load application shall be maintained along a line passing by the above intersection to a point just above the thigh bar housing. Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the HPMmachine from sliding forward.

3.6.1.9 Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the HPM machine level.

3.6.1.10 Tilt the back pan forward to release the tension on the seatback. Rock the HPM machine from side to side through a 10° arc (5° to each side of the vertical centreplane) for three complete cycles to release any accumulated friction between the HPM machine and the seat.

3.6.1.10.1 During the rocking action, the T-bar of the HPM machine may tend to diverge from the specified horizontal and vertical alignment. The T-bar must therefore be restrained by applying an appropriate lateral load during the rocking motions. Care shall be exercised in holding the T-bar and rocking the HPM machine to ensure that no inadvertent exterior loads are applied in a vertical or fore and aft direction. The feet of the HPM machine are not to be restrained during this step.

3.6.1.10.2 Carefully return the back pan to the seat-back and check the two spirits levels for zero position. If any movement of the feet has occurred during the rocking operation of the HPM machine, they must be repositioned as follows: Alternately, lift each foot off the floor the minimum necessary amount until no additional foot movement is obtained. During this lifting, the feet are to be free to rotate; and no forward or lateral loads are to be applied. When each foot is placed back in the down position, the heel is to be in contact with the structure designed for this.

3.6.1.10.3 Check the lateral spirit level for zero position; if necessary, apply a lateral load to the top of the back pan sufficient to level the HPM machine’s seat pan on the seat.

3.6.1.11 Holding the T-bar to prevent the HPM machine from sliding forward on the seat cushion, proceed as follows:

Return the back pan to the seat-back; alternately apply and release a horizontal rearward load, not to exceed 25 N, to the back angle bar at a height approximately at the centre of the torso weights until the hip angle quadrant indicates that a stable position has been reached after load release. Care shall be exercised to ensure that no exterior downward or lateral loads are applied to the HPM machine.

3.6.1.12 Measurement and recording

3.6.1.12.1 Measure the position of the H-point relative to the fixed part of the vehicle structure.

3.6.1.12.2 The actual torso angle is read at the back angle quadrant of the HPM machine with the probe in its fully rearward position.

3.6.2 Dummy installation

An ES-2 and a SID-IIs test dummy shall be placed on the driver’s side and the outboard side to the left row of seats, respectively. The dummies should not be left on the seat for more than 2 hours prior to the test. If the dummy is in the vehicle for a time longer than 2 hours but less than 12 hours, then the dummies should be sat on plywood boards placed over the seat, to eliminate excessive compression of the seat.

3.6.2.1 Place the dummy in the driver’s seat. Buckle up the safety belt.

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

3.6.2.3 Maintaining the small rearwards force to the lower torso, apply a small rearwards force to the upper torso to return the upper torso to the seat back. The shoulder of the dummy shall be in the rearmost position. The midsagittal plane of the dummy shall coincide with the longitudinal centreline of the seat.

3.6.3 ES-2 test 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, the dummy positioning and measurement 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.

3.6.3.1 "H" point

The H-point of the ES-2 dummy is situated 21 mm forward of that of the H-point determined according to Paragraph 3.6.1. The pelvis of the dummy is placed such that the lateral line through the H-point of the dummy is perpendicular to the middle perpendicular plane of seat. The line through the H-point of the dummy shall be horizontal, with the tolerance being not greater than $\pm 2^{o}$. The M3 holes in the H-point back plate on both sides of the pelvis of the ES-2 dummy are indicated as “Hm”, which shall be in a circle with a radius of 10 mm round the H-point as determined in Paragraph 3.6.1.

3.6.3.2 Legs and feet

Without inducing pelvis and torso movement, place the dummy’s right foot on the undepressed accelerator pedal with the heel resting as far forward as possible on the floorpan. Set the left foot perpendicular to the lower leg with the heel resting on the floorpan in the same lateral as the right heel. Set the knees of the dummy such that their outside surfaces are 150 $\pm$ 10 mm from the plane of symmetry of the dummy. If

possible within these constraints place the thighs of the dummy in contact with the seat cushion.

3.6.3.3 Upper arms

The angle between the upper arms and the torso reference line of the dummy shall be 40º ±5º.

3.6.4 Positioning of SID-IIs side impact test dummy

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, the dummy positioning and measurement 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.

3.6.4.1 Torso

For a vehicle on which the second row is fitted with bench seat, the symmetrical plane of SID-IIs dummy shall coincide with the longitudinal vertical center plane of the seat concerned. For a vehicle on which the second row is fitted with single seats, the symmetrical plane of dummy shall coincide with the longitudinal vertical center plane of the single seat concerned. Upper legs of dummy shall preferably stay contact with the seat cushion; adjust the assembly of lower and upper legs to 120° ± 5°; for the frontal part of dummy knees, the transverse spacing between centers shall be 160 mm ~ 170 mm; and both upper and lower legs shall fall within a same vertical plane. Push dummy knees backwards such that no gap exists between hip and seatback or the rear part of dummy’s lower legs stay contact with the frontal side of seat cushion; moreover, the upper torso of dummy shall preferably come into contact with the seat back .

3.6.4.2 Head

The installation plane of the head sensor shall be horizontal, with the deviation angle to be ideally controlled within + 0.5 . For the vehicles with adjustable seatbacks of the second row, keep the position of thighs, and place the plane horizontal via adjusting backrest angle forward (or backward); for the vehicles with unadjustable seatbacks of the second row, adjust the angle with regulating the lower neck bracket. If the requirement is unable to achieve, place the plane as horizontal as possible, and make record.

3.6.4.3 Pelvic angle

The pelvic angle of the SID-IIs 5% female dummy measured from the horizontal on the flat surface of the gauge shall be 20° ±2.5°. If failed, adjust the angle as close as possible to 20°, and adjust the head sensor installation surface to level according to Paragraph 3.6.4.2 and make record. If the installation plane angle of the sensor and the pelvic angle couldn’t be fulfilled simultaneously, it should preferentially guarantee the longitudinal plane angle to be 0° ±0.5°.

3.6.4.4 Legs and feet

Keep head, torso and thigh unmoved, adjust angle of legs, to place feet on the floorpan and keep the

longitudinal centerline of two feet paralleled with longitudinal centerline of the vehicle as possible; if the feet are unable to reach the floorpan, keep the feet paralleled with the floorpan at the nearest position.

3.6.4.5 Upper arms

The angle between the upper arms and the torso reference line of the dummy shall be 40° ±5°.

3.6.4.6 "H" point

"H" point of the rear-row SID-IIs 5% female dummy shall fall within a zone 13 mm from a target point in both vertical and longitudinal directions. Such target point shall reside 6 mm underneath the H-point as established according to the procedures of Paragraph 3.6.1. If the position of H-point exceeds the prescribed scope, the dummy shall be adjusted properly according to Paragraph 3.6.4, such that the H-point of the dummy could fall within the prescribed scope.

3.6.5 Measurement of dummy position

The following measurements are to be recorded prior to the test after the dummy settling and positioning procedures have been carried out. As shown in Figure 20, the items to be measured are set out in Table 16.

Table 16 Dummy measurement

ES-2 side impact test dummy		SID-IIs side impact test dummy	
A	Head to roof surface	A	Head to roof surface
B	Nose to top edge of windshield glazing	B	Nose to rear end of frontal-row seat head restraint
C	Nose to centre of steering wheel	C	-
D	Thorax to centre of steering wheel (horizontal)	D	-
E	H-point to door frame (horizontal)	E	H-point to door frame (horizontal)
F	H-point to door sill (vertical)	F	H-point to door sill (vertical)
G	Knee to floor surface	G	Knee to floor surface
H	Head to side windshield glazing	H	Head to side windshield glazing
J	Shoulder to side windshield glazing	J	Shoulder to side windshield glazing
K	Elbow to door	K	Elbow to door
L	Buttocks to door	L	Buttocks to door
M	Knee to door	M	Knee to door

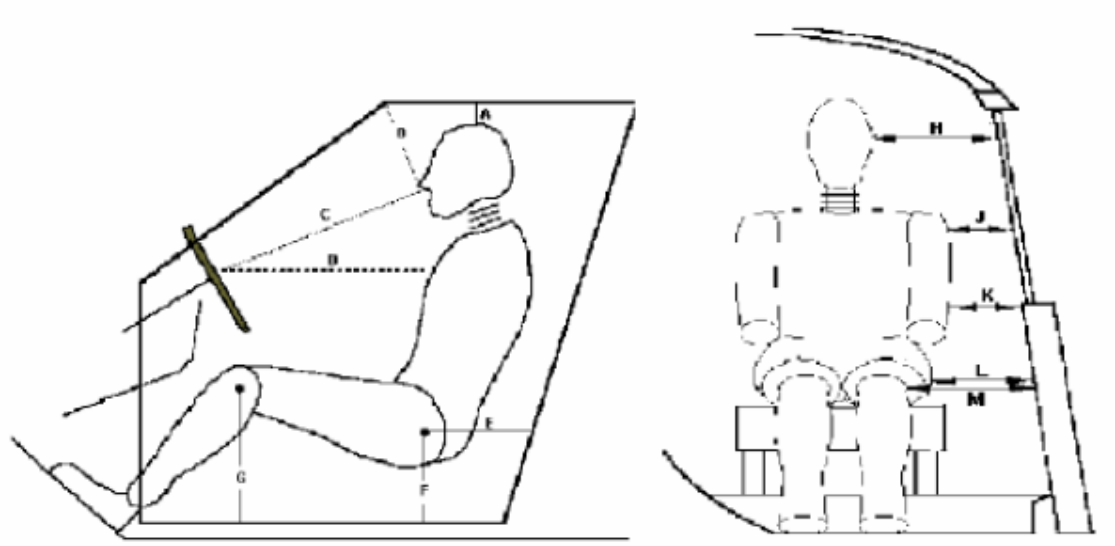


Figure 20 Diagram of the positions of the dummy for measurement

3.7 Photographs taken before and after test

The minimum resolution for photographs shall be 640×480. Given in Table 17 are the minimum quantity and contents of photographs taken before and after the test. "O" represents that photographs should be taken.

Table 17 Test photographs

Sr. No.	View	Pre-test	Post-test
1	Front view of car	0	0
2	Car LHS	0	0
3	Car RHS	0	0
4	Car LHS at 45 degrees to front	0	0
5	Car RHS at 45 degrees to rear	0	0
6	Rear view of car	0	0
7	Front view of front windshield glazing	0	0

8	To show area immediately in front of driver	0	0
9	To show area on the left side of driver	0	0
10	To show area on the right side of driver	0	0
11	To show passenger knees	0	0
12	To show driver contacts		0
13	To show the location of driver's seat	0	0
14	Driver and car interior	0	0
15	To show car with its left doors open	0	0
16	To show car with its right doors open	0	0
17	To show the front bottom of car	0	0
18	To show the rear bottom of car	0	0
19	Front view of mobile deformable barrier	0	0
20	To show the left side of mobile deformable barrier	0	0
21	To show the right side of mobile deformable barrier	0	0
22	To show area at 45 degrees to front on the right side of mobile deformable barrier	0	0
23	To show the position of mobile deformable barrier to car		0

3.8 Camera location

The minimum resolution for camera shall be 512×384. Also, the non-stroboscopic high speed film lighting system is to be used. Camera locations and requirements are given in Figure 21 and Table 18, respectively.

Table 18 Camera locations and requirements

Camera no.	Camera type	Camera location	Shot content
1	1000fps	Front visual field of windshield glazing	Front view of motions of driver dummy
2	1000fps	At 45 degrees to front on the right side of dummy	View of motions of driver dummy
3	1000fps	Entire front visual field of car	View of motions of car
4	1000fps	Partial front view of car	View of motions of car and mobile deformable barrier
5	1000fps	Rear view of car	View of motions of car and mobile deformable barrier
6	30fps	At 45 degrees to front on the left side of car	Overall motion process of car
7	1000fps	At 45 degrees to rear on the left side of car	Overall motion process of car
8	30fps	At 45 degrees to front on the right side of car	Overall motion process of car

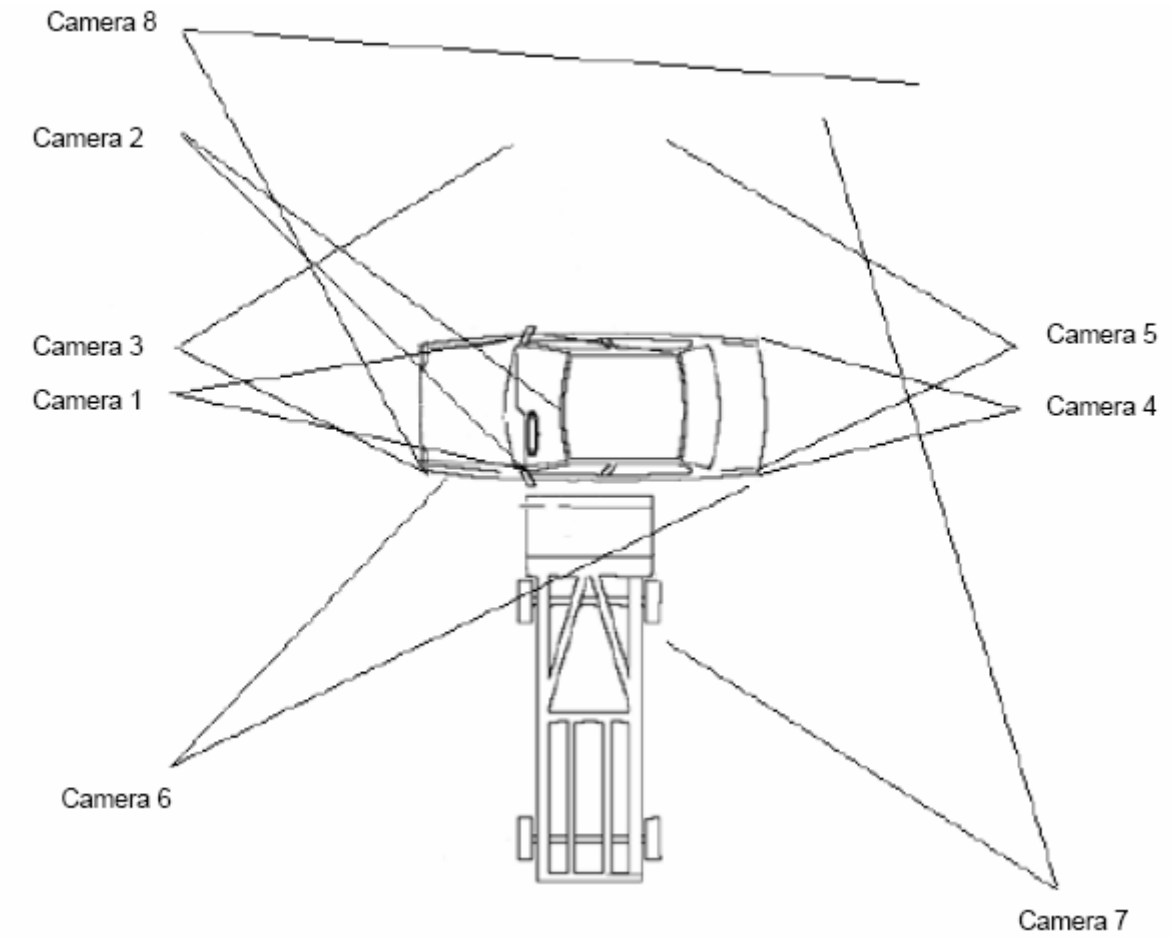


Figure 21 Camera locations for side impact test against mobile deformable barrier

3.9 Test facilities

For reference only

3.9.1 Testing ground

The test area shall be large enough to accommodate the test track, the mobile deformable barrier propulsion system and the technical equipment necessary for the test and to permit after-impact displacement of the vehicle. The part in which vehicle impact and displacement occur shall be horizontal, flat, dry and uncontaminated.

3.9.2 Test speed

The test speed for the mobile deformable barrier shall be 50km/h ~ 51km/h, and shall be stabilized at least 1m before the impact. It shall be accurate to ±0.2km/h. Record the actual impact speed of the mobile deformable barrier.

3.9.3 Lighting system

The non-stroboscopic lighting system for the high speed camera shall be actuated 5min before the test, to ensure the temperature of the impact zone is not unreasonably high.

3.9.4 Mobile deformable barrier to vehicle positioning

The longitudinal vertical median plane of the mobile deformable barrier shall be coincident within ±25 mm with a transverse vertical plane passing through the R-point of the front seat adjacent to the struck side of the tested vehicle. The horizontal median plane limited by the external lateral vertical planes of the front face shall be at the moment of impact within two planes determined before the test and situated 25 mm above and below the previously defined plane.

3.9.5 Mobile deformable barrier

The mobile deformable barrier shall have the characteristics described in Annex C to GB20071-2006 "Protection of Passengers in the Event of Lateral Collision". The testing requirements are set out in Annex C. The mobile deformable barrier shall be fitted with a braking device, to avoid its second impact with the test vehicle. C-NCAP marking shall be attached to the both sides of the mobile deformable barrier. Measure and record the mass of the mobile deformable barrier and each axle load.

3.10 Items to be checked and confirmed before test

3.10.1 Battery

Check that whether the vehicle battery is connected, reaches rated voltage as well as is fastened securely. The battery shall be replaceable.

3.10.2 Ignition switch

The ignition switch shall be placed at "on" position.

3.10.3 Airbag warning light

The airbag switch, where fitted, shall be placed at “on” position, and the airbag light on the dashboard shall illuminate as normal,.

3.10.4 Dummy painting

Colored paints shall be applied to the parts of the driver and front passenger dummies such as head, upper arms, upper ribs, middle ribs, lower ribs, abdomen, buttocks, etc., to identify and tell them apart. Neck shall be painted red; upper arms blue; ribs purple for their upper part, red for their middle part and green for their lower part; abdomen yellow; buttocks blue. All painted areas shall be large enough to enable the dummy’s contacts with the vehicle to be visible.

3.10.5 Checking the on-board data acquisition unit

Ensure that the battery of the on-board data acquisition unit is in normal working condition prior to the test, and measure the trigger switch at normal working condition.

3.10.6 Checking doors and latches

Ensure that all doors are completely closed, but not locked prior to the test.

3.11 Items to be checked and confirmed after test

3.11.1 Safety belt

Check whether the driver-side safety belt is liable to fail or not during the test.

3.11.2 Doors

A check shall be made to see whether door opening occurs or not during the impact.

3.11.3 Fuel system

After the impact test, check whether the feeding system leaks or not. Where constant leakage occurs in the fuel feeding system, measure the amount of fuel leaked in the first 5min after the impact test. Calculate the average leaking rate.

3.12 Calculation of injury criteria

Table 19 lists all locations of the ES-2 test dummy and parameters to be measured as well as the channel frequency class (CFC) at which they are to be filtered. Record all these channel data. Head impacts occurring after the dummy head rebounds from an initial contact are not considered when calculating injury criteria of head and neck. Some of the following parameters measured are to be recorded only but not for assessment.

The specific parameters for evaluation are prescribed in Paragraph 2.1.3 of Chapter IV.

Table 19 ES-2 and SID-IIs dummy test locations and parameters to be measured

Location	Parameter	CFC	Calculation of injury parameters
Head	Ax, Ay, Az	1000	HPC Resultant 3ms exceeding
Shoulder	Fx, Fy, Fz	600	Peak force Resultant force
Thorax ribs: Deflection and accelerations (upper, middle, lower)	Drib	180	Peak deflection VC Peak rib acceleration
	Ay		
Thorax T1: Accelerations	Ax, Ay, Az	180	T1 and T12 peak lateral acceleration
Thorax T12: Accelerations	Ay	180	
Abdomen: Forces (front, middle, rear)	Fy	600	Peak value of the sum of three forces
Hip joint and iliac bone: resultant force	Fy	600	Peak value of the sum of two forces
Backplate: Forces and moments	Fx, Fy	600	Peak forces and moments Resultant forces of Fx and Fy
	My, Mz	600	
T12: Forces and moments	Fx, Fy	600	Peak forces and moments
	Mx, My	600	
Buttocks: Accelerations	Ax, Ay, Az	180	Peak lateral acceleration
Pelvis: resultant force	Fy	600	Peak force
Upper legs: Forces and moments (L & R)	Fx, Fy, Fz	600	Peak forces and moments
	Mx, My, Mz	600	

3.12.1 ES-2 dummy

3.12.1.1 Head

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

$$HPC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where Ax, Ay, Az represent accelerations in three dimensions, expressed in g; for ES-2, t2−t1 ≤ 36 ms, and calculate resultant accelerations for a cumulative time period of 3ms; for SID-IIs, t2−t1 ≤ 15 ms.

3.12.1.2 Thorax ribs

Select the maximum value from the deformation of three ribs Drib.

Calculate the VC value of thorax ribs from:

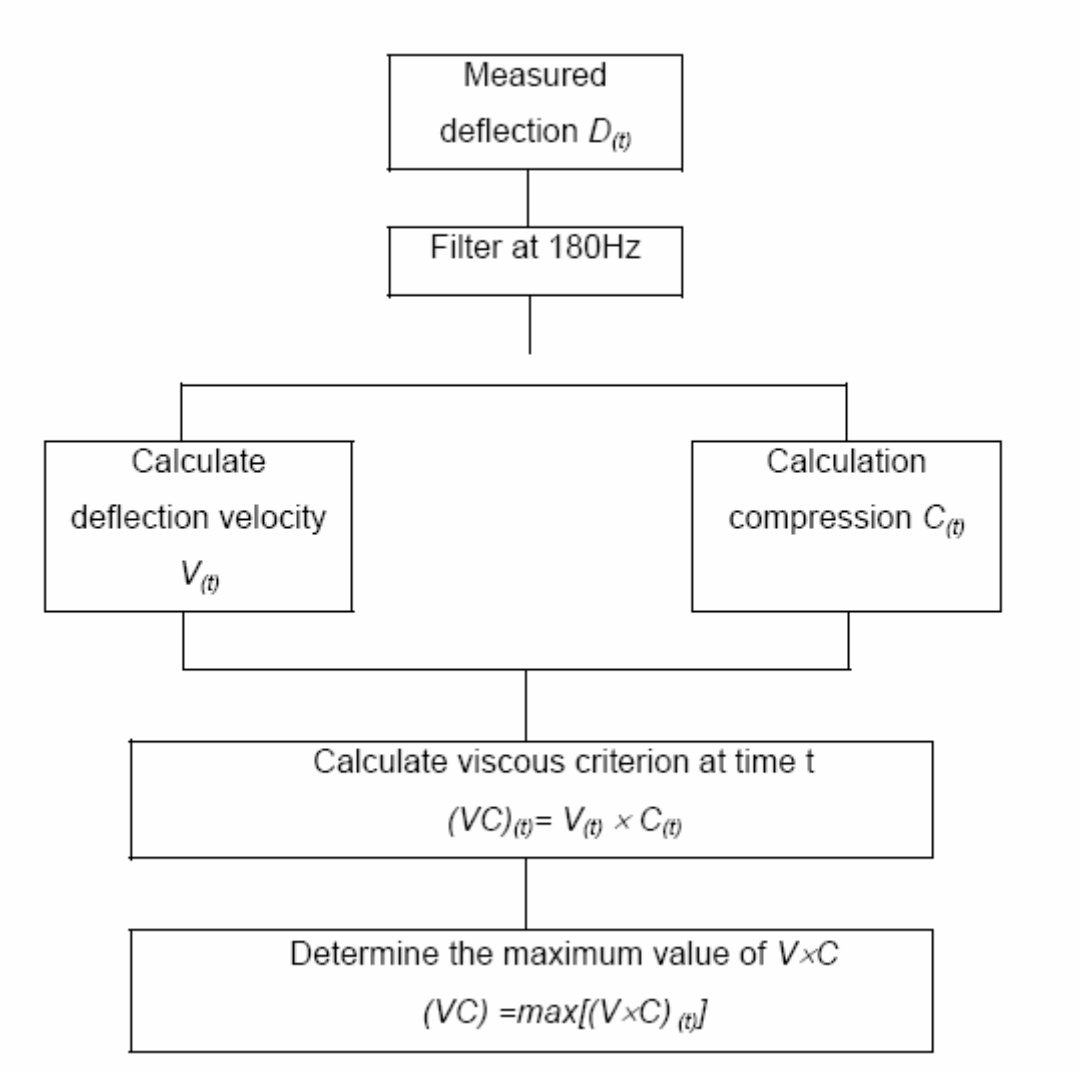
$$C_{(t)} = \frac{D_{(t)}}{0.14}$$

The rib deformation rate at the time t is obtained based on the deformation which is filtered.

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

Where: D(t) is the deformation at the time t.

δ t represents the interval for measurement of deflection (s), and is not greater than 125×10^{-4}s.



3.12.1.3 Abdomen

Calculate the sum of the three forces applied to abdomen, and take whichever is largest.

3.12.1.4 Pubis force

Take the peak pubis force.

3.12.2 SID-IIs dummy

3.12.2.1 Head

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

$$HIC = (t_2 - t_1)\left[\frac{\int_{t1}^{t2} A_R \cdot dt}{(t_2 - t_1)}\right]^{2.5}$$

Where: Ax, Ay and Az—Post-filtering accelerations in three directions, expressed in g, and t2 − t1 ⩽ 15 ms.

3.12.2.2 Resultant pelvis force

Calculate the synthetic force of hip joint and iliac bone.

4 Whiplash test procedures

4.1 Sample preparations

4.1.1 To conduct the whiplash test on a vehicle under assessment which is purchased with the fund of C-NCAP Management Center, the seat shall be dismantled from the purchased vehicle with the assistance of the pertinent staff of the manufacturer
concerned.

4.1.2 For a vehicle type which undergoes the C-NCAP assessment under the voluntary application of a manufacturer, the seat used for the whiplash test shall be furnished by the vehicle manufacturer; the technical staff of the Testing and Appraisal Dept. will, after the whiplash test, evaluate the consistency with the seats onboard the vehicle under assessment.

4.1.3 After samples reach the lab, it is to check and verify sample appearance, model and basic parameters, in addition to taking photos.

4.1.4 Test fixtures for seats shall be fabricated according to seat installation parameters and sample size, so as to ensure that seats could be firmly fixed to the sled and the seat status onboard the physical vehicle could be simulated.

4.2 Pre-test measurements

For the purpose of all measurements stated below, vehicles shall be conditioned to the standard state as per appropriate provisions of the C-NCAP Management Regulation (for details, see Clause 1.1, Chapter 4).

4.2.1 Prior to the start of C-NCAP test, measure, via a 3-D coordinate measuring machine, and record the relative height of the heel rest point.

4.2.2 Determination of heel rest point

4.2.2.1 Determine and mark the geometric center point on the upper surface of accelerator pedal.

4.2.2.2 Heel rest point is defined as the intersection between a line tangential to such center point and the floor surface within the longitudinal plane.

4.3 Setting of test conditions

4.3.1 Seat preparations and mounting

4.3.1.1 Seat together with its fixtures shall be correctly fastened to the test sled platform. In the case of a brand-new seat which is never sat on, it shall be sat on twice by a person weighing 75 kg ± 10 kg or by an equivalent device, with each run lasting 1 minute. Prior to the placement of the HPM machine (SAEJ826), all seat assemblies shall remain unladen for 30 minutes to the minimum.

4.3.2 Mounting of toe board

4.3.2.1 For the test, a standard substitute for toe board is employed, of which the floor section is horizontal, the foot-resting section inclines by 45°, and the surface is covered by carpet.

4.3.2.2 Mount a standard toe board, and, according to the relative height of heel rest point in physical vehicle, adjust the height of the standard toe board.

4.3.3 Mounting of safety belt

4.3.3.1 Mount safety belt. During test, the dummy shall put up safety belt, so as to be prevented from being thrown away upon impact.

4.3.3.2 Safety belt anchorages, buckle, guide mechanism, etc. fitted to the test seat may be used.

4.3.4 Determination of triggering moment of active elements

4.3.4.1 Based on the data furnished by manufacturer, determine whether to install active elements (e.g., triggering-type proactive head restraint).

4.3.4.2 For each element requiring activation, vehicle manufacturer shall indicate the accurate triggering moment.

4.4 Test waveforms

In the range of 0 ms ~ 150 ms, acceleration waveform shall be controlled in precision, so as to meet the test requirements. Speed variation of accelerating sled shall be controlled within ΔV = 15.65 km/h ± 0.8 km/h, with the retention time of waveform within ΔT = 91 ms ± 3 ms (see Figure 22).

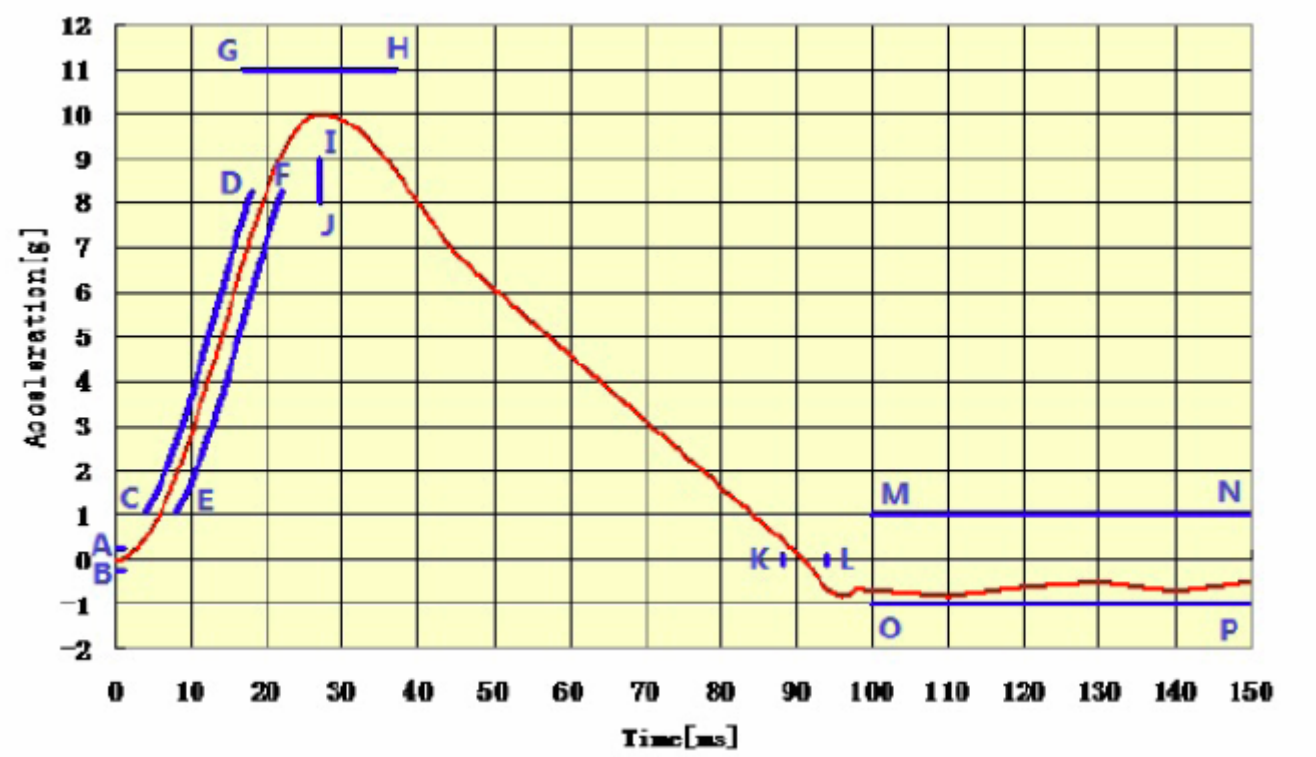


Figure 22 Acceleration waveform of whiplash test

Table 20 Parameters of test waveform channel

	Time (ms)	Acceleration (g)	Upper limit of rising margin		Lower limit of rising margin	
A	0	0.25	Time (ms)	Acceleration (g)	Time (ms)	Acceleration (g)
B	0	-0.25	(C)4	1.0531	(E)8	1.0531
C	4	1.0531	5	1.3751	9	1.3751
D	18	8.2705	6	1.7443	10	1.7443
E	8	1.0531	7	2.1608	11	2.1608
F	22	8.2705	8	2.6230	12	2.6230
G	17	11.00	9	3.1276	13	3.1276
H	37	11.00	10	3.6691	14	3.6691
I	27	8.00	11	4.2406	15	4.2406
J	27	9.00	12	4.8336	16	4.8336
K	88	0.00	13	5.4384	17	5.4384
L	94	0.00	14	6.0446	18	6.0446
M	100	1.00	15	6.6414	19	6.6414
N	150	1.00	16	7.2181	20	7.2181
O	100	-1.00	17	7.7645	21	7.7645
P	150	-1.00	(D)18	8.2705	(F)22	8.2705

4.5 Test environment

Test chamber shall present a temperature of 22.5 C ± 3 C and relative humidity of 10% ~ 70%.

4.6 Seat adjustments

4.6.1 Initialization of seat adjustments

4.6.1.1 Seat track adjusted to the most rearward locking position.

4.6.1.2 Seat height adjusted to the lowest position.

4.6.1.3 Seat tilt adjusted to the position closest to the horizontal.

4.6.1.4 Cushion height adjusted to the lowest position.

4.6.1.5 Cushion tilt adjusted to the position closest to the horizontal.

4.6.1.6 Lumbar support adjusted to the most downward and most rearward position.

4.6.1.7 If seatback is separately adjustable, its upper half shall be adjusted to the rearward position.

4.6.1.8 Cushion extension, if adjustable, shall be adjusted to the most rearward or least extended position.

4.6.1.9 Side bolsters, if adjustable, shall be adjusted to the widest or fully extended position.

4.6.1.10 Arm rests adjusted to the stowed position.

4.6.2 If longitudinal adjustable, test seat shall be adjusted to the mid position.

4.6.2.1 In the case of incrementally adjustable seat, if no locking position exists within the center ± 2 mm, it shall be adjusted rearwards to a locking position closest to the midpoint.

4.6.2.2 In the case of continuously adjustable seat, it shall be adjusted to the middle position (± 2 mm).

4.6.3 In the case of being vertically separately adjustable, test seat shall be adjusted to the middle position.

4.6.3.1 In the case of an incrementally adjustable seat by a single control, rear end of seat shall be adjusted to the middle position; if the middle position (± 2 mm) is other than a locking position, it shall be adjusted downwards to a locking position closest to the midpoint.

4.6.3.2 In the case of a continuously adjustable seat by a single control, rear end of seat shall be adjusted to the middle position (± 2 mm) in height.

4.6.3.3 In the case of a by-stage, incrementally adjustable seat by dual controls, both frontal and rear ends of seat shall be adjusted to the middle position (± 2 mm); if the middle position is other than a locking position, it shall be adjusted downwards to a locking position closest to the midpoint.

4.6.3.4 In the case of a by-stage, continuously adjustable seat by dual controls, both frontal and rear ends of seat shall be adjusted to the middle position (± 2 mm) in height.

4.6.4 If separately adjustable in vertical direction, test seat cushion shall be adjusted to the middle position.

4.6.4.1 Measuring cushion reference angle: Adjust the cushion to its lowest height. On its frontal and rear ends, mark two points spaced by 400 mm. measure the angle of the line connecting both points, which is deemed as the cushion reference angle.

4.6.4.2 In the case of a by-stage adjustable seat by a single control, the rear mark point of cushion shall be adjusted to the middle position in height; if the middle position (± 2 mm) is other than a locking position, it shall be adjusted downwards to a locking position closest to the midpoint.

4.6.4.3 In the case of a continuously adjustable seat by a single control, the rear mark point of cushion shall be adjusted to the middle position (± 2 mm) in height.

4.6.4.4 In the case of a by-stage, incrementally adjustable seat by dual controls, the rear mark point of cushion shall be adjusted to the middle position (± 2 mm) in height; if the middle position is other than a locking position, it shall be adjusted downwards to a locking position closest to the midpoint; the frontal mark point of cushion shall be adjusted such that the cushion angle runs consistent (± 0.5°) with the cushion reference angle measured in Paragraph 4.6.4.1; if no locking position exists within the range of ± 0.5°, it shall be adjusted downwards to a closest locking position.

4.6.4.5 In the case of a by-stage, continuously adjustable seat by dual controls, rear end of cushion shall be adjusted to the middle position (± 2 mm) in height, and the frontal mark point of cushion shall be adjusted such that the cushion angle runs consistent (± 0.5°) with the cushion reference angle measured in Paragraph 4.6.4.1.

4.6.5 Adjustment of seatback angle

4.6.5.1 If the test seatback angle is by-stage adjustable, and the angle of the upper half is separately adjustable, then the angle of the upper half shall be adjusted to the middle position (± 0.5°) within the adjustable range.

4.6.5.2 Adjust the seatback angle (including angular adjustment for the lower half of by-stage adjustable seatback) in such manner that the torso angle of the HPM machine reaches 25° ± 1°.

4.6.5.3 As for some incrementally adjustable seatbacks, if the seat cannot be adjusted to the prescribed range, then it shall be adjusted forwards to a position closest to the target value.

4.6.6 Adjustment of head restraint

4.6.6.1 Height adjustment of head restraint

4.6.6.1.1 If adjustable, the height of head restraint of test seat shall be adjusted to the middle position, i.e., the midway between the lowest position and the highest locking position.

4.6.6.1.2 If there is no locking position in the middle section, head restraint shall be uplifted by 10 mm from the middle position. Head restraint shall be adjusted to the locking position within this travel stroke, if any.

4.6.6.1.3 If there is no locking position within such travel stroke of 10 mm, the head restraint shall be adjusted downwards to the nearest locking position.

4.6.6.2 Tilt adjustment of head restraint

4.6.6.2.1 Foremost position of head restraint is defined as the locking position presenting the min. backset (i.e., the gap between the back surface of head to the frontal surface of head restraint) as measured by HRMD (head restraint measuring device). After HRMD is properly installed, adjust the head restraint forwards; if the head restraint already comes into contact with HRMD before the extreme position of head restraint is reached, then it is unnecessary to adjust the head restraint forwards any more. Also, adjust the head restraint backwards to the nearest locking position, which is taken as the foremost position.

4.6.6.2.2 Rearmost position of head restraint is defined as the position presenting the largest backset as measured by HRMD.

4.6.6.2.3 Adjust the tilt of head restraint such that the backset measured by HRMD falls at the midway between the foremost and rearmost positions. If there is no locking position at the midway, head restraint shall be adjusted to the locking position within the range 10 mm forwards. If there is still no locking position, head restraint shall be adjusted backwards to the nearest locking position.

4.6.7 For other adjustable mechanisms of test seat, the initial settings of Paragraph 4.6.1 shall be retained.

4.7 Determination procedures for H-point and backset

4.7.1 In the case of a brand-new seat which is never sat on, it shall be sat on twice by a person weighing 75 kg $\pm$ 10 kg, with each run lasting 1 minute, so as to flex both seat cushion and seatback.

4.7.2 Prior to the mounting of H-point machine, seat shall be soaked in the standard test environment for more than 3 h, and remain unloaded for 30 minutes to the minimum.

4.7.3 Cover the seating area in contact with HPM machine by a fine cotton with adequate dimension and proper material.

4.7.4 Put up seat pan and back pan assembly of HPM machine, such that the center planes could coincide for

both seat and HPM machine.

4.7.5 Install foot and lower leg assemblies, and adjust the length of lower leg to the 50 percentile position, that of upper leg, to the 10 percentile position, and knee spacing, to 250 mm.

4.7.6 Adjust the angle between foot and tibia to 90° ; place heel onto the floor, which shall extend to the forward direction as far as possible. Toe board shall be placed at a sufficiently far position, so as to avoid any potential interference of foot during the installation of HPM machine.

4.7.7 Install lower leg and upper leg weights, and level the HPM machine.

4.7.8 Cause the back pan incline forwards and leave the seatback; push the HPM machine backwards, until the seat pan comes into contact with the seatback. At the intersection between the hip angulometer and T-bar, exert a 100 N force horizontally backward; then restore the back pan onto the seatback.

4.7.9 Install hip weights. Then, alternatively install 6 torso weights to the left and right sides (including 2 big weights furnished by HRMD). The 2 big weights furnished by HRMD shall be installed at last, which shall be pushed to respective side and pressed down. In the entire course of weight installation, slightly press the T-bar to prevent the HPM from sliding forwards.

4.7.10 Incline the back pan up to the vertical position, and, within the range of 10° (5° from the plumb centerplane to left and right side each), rock the HPM machine to left and right for three runs. Please note that, during rocking, the T-bar of HPM machine would deviate from the prescribed horizontal and vertical reference positions; therefore, during the rocking it is a must to exert a proper lateral force onto the T-bar. When swaying the HPM machine by holding the T-bar, attentions shall be paid to prevent any vertical or longitudinal force from being applied inadvertently. Upon above manipulations, both feet of the HPM machine shall be free of any restriction, so that the motion of the HPM machine would not be limited.

4.7.11 Hold the T-bar (to prevent the HPM machine from sliding forwards on the seat cushion) and restore the back pan onto the seatback. To assure the stable torso position, apply backwards a force not exceeding 10 N at the CoG (center-of-gravity) position of the torso of the back pan module. Special attentions shall be drawn to that no downward or lateral force would be exerted onto the HPM machine.

4.7.12 Check whether the H-point machine is leveled, whether it is oriented due forwards, and whether the position falls on the seat centerline.

4.7.13 Alternatively lift left and right feet from the floor, until both feet cannot move forwards any more.

4.7.14 Move the toe board such that the toe could contact the 45° board plane within 230 mm and 270 mm.

4.7.15 If, after foot adjustment, the HPM machine cannot remain leveled, a proper force shall be exerted on the seat pan such that it could be horizontally anchored onto the seat.

4.7.16 Properly install the head restraint measuring device from up to down. During the installation, no

external force shall be exerted which would otherwise impact the HPM machine position.

4.7.17 Adjust the head of HRMD to the leveled position.

4.7.18 Measure and record the torso angle of HPM machine.

4.7.19 Measure and record the H-point mark position on the HPM machine. For the H-point coordinates at both sides, the error of XHPM value and ZHPM value shall fall within ± 2.5 mm.

4.7.20 Move backwards the backset probe of HRMD, until it comes into contact with the head restraint. Such point is marked as the first contact point.

4.7.21 Measure and record the horizontal distance from the aforesaid first contact point to the rearmost point of head (bolt point of backset probe). Such distance is taken as the dummy reference backset ‘Bref’.

4.7.22 Repeat the above measurements twice, assuring that the error of measurement in the three runs (XHPM, ZHPM, and Bref) falls within ± 5 mm. Failing that, additional measurement run shall be conducted, until the measurements (XHPM, ZHPM and Bref) of three consecutive runs meet the error requirement (i.e., within ± 5 mm), and the average of the last three measurement runs shall be taken as the basis for the dummy positioning.

4.8 Head interference space of head restraint

4.8.1 If, during the adjustment process stated in Paragraph 4.7.17, the HRMD headform cannot be adjusted to horizontal due to the too forward position of head restraint, the following adjustments are necessary.

4.8.2 If the tilt of head restraint is adjustable, then head restraint shall be adjusted backwards, until the leveling of HRMD would not be interfered any longer; head restraint shall be adjusted to the locking position.

4.8.3 If, after such adjustment of the tilt of head restraint, HRMD leveling is still impacted, or if the tilt of head restraint is non-adjustable, seatback shall be adjusted backwards, until head restraint would not interfere with the HRMD leveling any more.

4.8.4 Continue proceeding with the adjustments and measurements stated in Paragraphs 4.7.17 ~ 4.7.22.

4.8.5 The average torso angle of HPM machine in the three measurement plus 1.5° shall be taken as the pelvis target value for the positioning of BioRID dummy.

4.9 Dummy preparations and certification

4.9.1 Model of dummy

For the test, BioRID II dummy shall be employed.

4.9.2 Clothing of dummy

The dummy shall be dressed with two pairs of close-fitting, knee-length, spandex/lycra pants and two close-fitting, short-sleeved spandex shirts. The under layer of clothes shall be worn with the shiny/smooth side of the fabric facing out and the over-clothes with the shiny/smooth side against the underclothes (i.e. dull side facing out). The dummies feet shall be shod with size 45 Oxford-style, hard-soled shoes.

4.9.3 Test environment of dummy

4.9.3.1 Dummy shall be tested at the temperature of 22.5℃ ± 3℃ and a relative humidity of 10% ~ 70%.

4.9.3.2 Prior to test, dummy and seat shall be soaked in the standard test environment for 3h to the minimum.

4.9.4 Joint adjustments of dummy

4.9.4.1 Preferably joint adjustment of dummy shall be conducted in the very day of test. If prior adjustment is needed, it shall be conducted 24 h prior to the start of test.

4.9.4.2 All dummy joints presenting stable friction shall be adjusted prior to the test. Dummy joints shall be adjusted in such a manner that dummy limbs may remain continual motion under the effect of 1 g ~ 2 g.

4.9.5 Certification of dummy

4.9.5.1 Spine curvature check

4.9.5.1.1 With the pelvis adapter plate placed on a level surface, measure, under the static conditions, related distances and angles, and determine whether appropriate provisions are satisfied.

4.9.5.1.2 Curvature check shall be conducted once every 5 test runs.

4.9.5.2 Certification of impact

4.9.5.2.1 The dynamic response of BioRID II dummy is checked by attaching the spine, torso and head to a mini-sled that is impacted by a 33.4 kg pendulum at a velocity of 4.76 m/s ± 0.1m/s.

4.9.5.2.2 Dynamic impact certification of dummy shall be conducted once every 5 test runs.

4.9.5.3 Any part of dummy damaged during test shall be replaced.

4.9.5.4 All data for dummy certification shall be recorded and archived.

4.10 Test instrumentation and dummy transducers

4.10.1 Prior to the start of test, all instrumentations shall be already calibrated. Irrespective of the frequency of

use, all instrumentations and transducers shall be calibrated once each year.

4.10.2 Test data gathering and measuring equipment shall have a minimum sampling frequency of 10 kHz.

4.10.3 During test, test data gathering and measuring equipment shall record the data of -10 ms ~ 300 ms to the minimum. ‘0 ms’ means the launching moment of the accelerating sled.

4.10.4 To ensure test accuracy, the channel amplitude class (CAC) of each transducer shall be set according to Table 21. If, during test, transducer measurement reaches the CAC, then the transducer concerned shall be re-calibrated.

4.10.5 For dummy head and head restraint, foil contact switch shall be used to measure the switch signals, and determine the contact and detachment states between head and head restraint.

Table 21 Channel test requirements for dummy transducers

Test location		CAC (channel amplitude class)	CFC (channel filtering class)
CoG acceleration of head (g)	Ax	100	60
	Ay	100	60
	Az	100	60
Upper neck load (N)	Fx+	1,400	1,000
	Fz+	4,500	1,000
Upper neck moment (Nm)	My	115	600
Lower neck load (N)	Fx+	5,000	1,000
	Fz+	5,000	1,000
Lower neck moment (Nm)	My	200	600
Thorax T1 acceleration (left/right) (g)	Ax	100	60
	Ax	100	60
Total number of measuring channels		11	

4.11 Installation of dummy

4.11.1 It shall ensure that, prior to the installation of BioRID II dummy, the seat shall remain unladen for 15 minutes.

4.11.2 Place dummy on the seat.

4.11.3 Properly put up dummy safety belt, assuring that safety belt remains sufficiently slack to adjust dummy position where necessary.

4.11.4 Align dummy’s midsagittal plane with the centerline of the seat.

4.11.5 Adjust dummy to be vertical, and the instrumentation platform in the head shall be laterally level.

4.11.6 Adjust the pelvis angle top 26.5° (± 2.5°). If, since head restraint interferes with the head space (Paragraph 4.8), seatback angle is adjusted backwards, then pelvis angle shall be adjusted to the actually measured torso angle plus 1.5° (Paragraph 4.8.5).

4.11.7 The dummy H-point shall be adjusted to a zone ± 10 mm (in vertical direction) and ± 5 mm (in longitudinal direction) from a target point. Such target point shall reside 20 mm forward of the average value of the H-point as established in Paragraph 4.7.22.

4.11.8 Adjust the spacing of the lower legs so that the centerline of the knees and ankles is 200 mm±10 mm apart and ensures that the lateral planes of knees are vertical.

4.11.9 Cause the heel of dummy’s shoe on the floor surface. The tip of the shoe shall rest on the 45 toe pan between 230 mm and 270 mm from the intersection.

4.11.10 Adjust dummy’s arms as close to the torso sides as possible, in addition to contacting the seatback. The elbows shall be bent so that the palms face the dummy’s thighs and the small fingers of both hands are in contact with the seat cushion.

4.11.11 Adjust the instrumentation plan of the head to the level ± 0.5, and adjust the dummy backset.

4.11.11.1 Mark the rearmost point of dummy’s head, 95 mm from the top of the skullcap backwards along the midsagittal plane.

4.11.11.2 Measure the horizontal distance between the rearmost point on the dummy’s head and the first contact point marked on head restraint (Paragraph 4.7.20), which is adjusted to the average Bref (as determined in Paragraph 4.7.22) plus 15 mm (±2 mm).

Table 22 Requirements for dummy settings and tolerances

Position	Target	Tolerance
H-point (X-axis)	20 mm forward X_{HPM}	± 5 mm
H-point (Z-axis)	Z_{HPM}	± 10 mm
Pelvis angle	26.5°	± 2.5°
Head plane angle	0° (level)	± 0.5°
Backset	B_{ref} + 15 mm	± 2 mm

4.12 Test photos

Table 23 lists some photographs necessarily to be taken prior to and after the test (“○” means mandatory)

Table 23 Test photographs

No.	Shooting angle of picture	View-finding scope	Pre-test	Post-test
1	Front view of dummy	Dummy and seat	○	○
2	Dummy at 45° to front	Dummy and seat	○	○
3	Side view of dummy	Dummy and seat	○	○
4	Dummy at 45° to rear	Dummy and seat	○	○
5	Front view of dummy	From dummy head to thorax	○	○
6	Dummy at 45° to front	From dummy head to thorax	○	○
7	Side view of dummy	From dummy head to thorax	○	○
8	Dummy at 45° to rear	From dummy head to thorax	○	○
9	Close view of head restraint position		○	○
10	Particulars of damage, if any, to dummy, seat, etc.		×	○

4.13 High speed video

4.13.1 The test requires two cameras which record at 1,000 fps.

4.13.2 One high-speed camera shall record the overall test conditions of seat and dummy. Recording shall start at t = 0 and end at t = 300 ms.

4.13.3 The other camera shall record the entire motion process of dummy head and seat head restraint during the test. Recording shall start at t = 0 and end at t = 300 ms.

4.14 Lighting system

Prior to the start of test, activate the no-flash lighting system intended for the high-speed cameras, and ensure that, upon test, the lighting system could remain normal functioning and the temperature of the environment surrounding the seat and dummy would not be too high.

4.15 Assessment criteria calculation

4.15.1 Calculation of dummy injury criteria

4.15.1.1 For each dummy transducer, the channel filtering class (CFC) shall be set as per Table 20.

4.15.1.2 By means of the switching signals as measured by the dummy-head restraint contact switch,

determine the time of the first contact between head and head restraint, recorded as T−HRC(Start), and the time of detachment of the head from head restraint after the contact, recorded as T−HRC(End).

4.15.1.3 NIC

Neck injury criterion (NIC) is based on the relative horizontal acceleration and velocity of the occipital joint relative to T1.

$$NIC(t) = 0.2A_x^{rel}(t) + [V_x^{rel}(t)]^2$$

$$NIC_{max} = \underset{T-HRC_{(End)}}{Max}\,[NIC(t)]$$

Relative acceleration:

$$A_x^{rel}(t) = A_x^{T1}(t) - A_x^{Heads}(t)$$

Where: $A_x^{T1}(t) = \frac{A_x^{T1Left}(t) + A_x^{T1Right}(t)}{2}$ (in which all A_x^{T1Left}, $A_x^{T1Right}$ and A_x^{Head} are expressed in the unit of m/s^2)

Relative velocity:

$$V_x^{rel}(t) = \int_0^t A_x^{rel}(\tau)d\tau$$

4.15.1.4 Neck shear force

For the neck shear force, only the rearward motion portion of the head relative to torso shall be assessed, i.e., Fx is a positive value.

$$Fx_{max} = \underset{T-HRC_{(End)}}{Max}\,[Fx(t)]$$

4.15.1.5 Neck tension

For the neck tension, only the tensile portion shall be assessed, i.e., Fz is a positive force.

$$Fz_{max} = \underset{T-HRC_{(End)}}{Max}\,[Fz(t)]$$

4.15.1.6 Neck torque

Neck torque assesses two directions, namely, extension and flexion.

4.15.1.6.1 Upper neck torque

$$My^{OC}{}_{max} = \underset{T-HRC_{(End)}}{Max}\left|My^{OC}(t)\right|$$

$$My^{OC}(t) = My^{upper}(t) - D \cdot Fx^{upper}(t)$$

Where: D = 0.01778 m

4.15.1.6.2 Lower neck torque

$$My_{max} = \underset{T-HNC_{(final)}}{Max} |My(t)|$$

4.15.2 Analysis of test film

4.15.2.1 Seatback opening

By taking the seatback angle at T = 0 as reference, track the variation curve of seatback angle (defined as the maximum rearward change of the seatback angle during the impact).

Chapter V Additional Test – Fuel Consumption Measurement Procedures

1. Inspections of vehicle

1.1 Fill out the vehicle check list (see Table 24):

1.2 If applicable, check the OBD information;

1.3 If necessary, confirm the curb mass of the vehicle.

2. Test preparations

2.1 Affixing C-NCAP logo and vehicle markings

Each test vehicle shall be affixed with the C-NCAP logo and the sole vehicle marking –test serial number.

2.2 Replacement of fuel

2.2.1 Check of fuel

The lab test fuel shall be used; prior to the measurements of fuel consumption, check and record the density and temperature of the test fuel.

2.2.2 Replacement of fuel

(1) Empty the fuel tank;

(2) Refill in the lab test fuel up to 40% of the nominal tank volume (with fuel temperature less than 30 C);

(3) Cap the fuel tank lid.

2.3 Pre-conditioning

2.3.1 Ambient conditions

Room temperature: 24℃±3℃; humidity: (5.5 ~ 12.2) g of water/kg of air.

2.3.2 Warm-up of chassis dynamometer

Provided that the measurement of the preceding vehicle has ended for more than 50 minutes, it is necessary to warm up the chassis dynamometer (at the constant speed of 80 km/h for 30 minutes).

2.3.3 Check of vehicle

(1) Secure the test vehicle, and adjust the tire inflation pressure to the value indicated by the manufacturer;

Note: The vehicle shall be secured onto the chassis dynamometer as horizontally as possible, so as to minimize any extra force applied onto the surface of wheels and drum except for the gravity.

(2) Where necessary, confirm the position of overdrive switch;

(3) Check that all the onboard accessories have been shut off (air-conditioner, fan, ABS, TRC, radio, etc.);

(4) Check the drive mode (all-wheel-drive/two-wheel-drive mode);

(5) Mount the cooling fan in front of the vehicle, 0.3 m apart;

(6) Connect the CVS sampling tube with the tail pipe of the vehicle.

Table 24 Vehicle check list (Upon receiving/returning the vehicle)

VIN		Engine model		Upon receiving		Upon returning	
Transmission	AT/MT	Tyre model		Inspected by: (/)		Inspected by: (/)	
No.	Items	Key points		Result	Remarks	Result	Remarks
1	Odometer	Write down odometer reading		Y □ N □		Y □ N □	
2	Battery	Check if connections remain in good conditions		Y □ N □		Y □ N □	
3	Radiator	Check if coolant remains in good conditions		Y □ N □		Y □ N □	
4	Engine oil	Engine	Check the fluid level with oil dipper rod	Y □ N □		Y □ N □	
		Clutch/AT	If appropriate, check whether it remains in the good conditions	Y □ N □		Y □ N □	
		Brake/P/S	If appropriate, check whether it remains in the good conditions	Y □ N □		Y □ N □	
5	Exhaust pipe	Start up the engine, to check if any noticeable leakage exists with the exhaust system		Y □ N □		Y □ N □	
6	Harness, and engine compartment pipelines	Rupture, disturbance (visual inspection)		Y □ N □		Y □ N □	
7	Safety belt	Tension, wearing, damage		Y □ N □		Y □ N □	
8	Fuel system	Leakage		Y □ N □		Y □ N □	
9	Tyre and wheel	Size, wearing degree		Y □ N □		Y □ N □	
10	Idling	Abnormal sound/vibration, start-up performance, engine speed		Y □ N □		Y □ N □	
11	Safety operation at gear 'N'	Engine doesn't start up unless at the gear 'P/N'		Y □ N □		Y □ N □	
12	Instruments	Working status, warning indicators /MIL (check diagnostic codes, if necessary)		Y □ N □		Y □ N □	
13	Clutch, brake	Check pedal actions		Y □ N □		Y □ N □	
14	Towing hook for a frontal-wheel-drive vehicle	Place it in the compartment		Y □ N □		Y □ N □	
15	Wrap of driving wheel	Remove and place it into the compartment		Y □ N □		Y □ N □	
16	4-wheel-drive vehicle	If 2-wheel-drive mode is used for the test, furnish the effective switching program (2WD<—>4WD)		Y □ N □		Y □ N □	
		Cut off the drive axle, and place it into the compartment		Y □ N □		Y □ N □	
17	Outer surface of bodywork	Scratch, dirt		Y □ N □		Y □ N □	
18	On-board accessories	Except for necessary ones, any article shall be taken out of the compartment		Y □ N □		Y □ N □	
19	ECU	Harness remains in good connections		Y □ N □		Y □ N □	
20	Indication of fuel gauge	Check the remaining fuel quantity in fuel tank		Y □ N □		Y □ N □	

2.3.4 Setting of resistance

With the console of the chassis dynamometer, select and confirm the equivalent inertia weight and load used for the measurements in accordance with Table 25.

Table 25 Power and load absorbed by dynamometer

Reference mass (RM) of vehicle	Equivalent inertia weight	Power and load absorbed by dynamometer at 80km/h		Coefficients	
				a	b
kg	kg	kW	N	N	N/(km/h)^2
RM≤480	455	3.8	171	3.8	0.0261
480<RM≤540	510	4.1	185	4.2	0.0282
540<RM≤595	570	4.3	194	4.4	0.0296
595<RM≤650	625	4.5	203	4.6	0.0309
650<RM≤710	680	4.7	212	4.8	0.0323
710<RM≤765	740	4.9	221	5.0	0.0337
765<RM≤850	800	5.1	230	5.2	0.0351
850<RM≤965	910	5.6	252	5.7	0.0385
965<RM≤1080	1020	6.0	270	6.1	0.0412
1080<RM≤1190	1130	6.3	284	6.4	0.0433
1190<RM≤1305	1250	6.7	302	6.8	0.0460
1305<RM≤1420	1360	7.0	315	7.1	0.0481
1420<RM≤1530	1470	7.3	329	7.4	0.0502
1530<RM≤1640	1590	7.5	338	7.6	0.0515
1640<RM≤1760	1700	7.8	351	7.9	0.0536
1760<RM≤1870	1810	8.1	365	8.2	0.0557
1870<RM≤1980	1930	8.4	378	8.5	0.0577
1980<RM≤2100	2040	8.6	387	8.7	0.0591
2100<RM≤2210	2150	8.8	396	8.9	0.0605
2210<RM≤2380	2270	9.0	405	9.1	0.0619
2380<RM≤2610	2270	9.4	423	9.5	0.0646
2610<RM	2270	9.8	441	9.9	0.0674

Notes: ① RM = curb mass + 100kg (the curb mass is cited from the design parameters as provided by manufacturer);

② Except for vehicles of Category M1, the power values presented in the table above shall be multiplied by a coefficient '1.3' for any vehicle with the RM > 1,700 kg or for a full-time four-wheel-drive vehicle.

2.3.5 Pre-conditioning

(1) Turn on the cooling fan;

(2) A gasoline vehicle shall be preconditioned over the cycle shown in Figure 23;

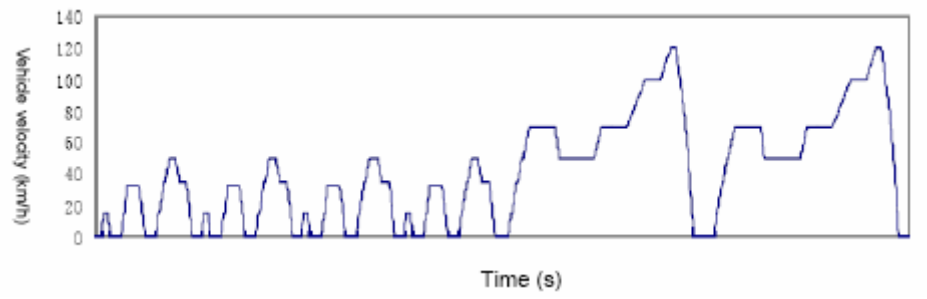


Figure 23 Cycle curve for preconditioning of a gasoline vehicle

(3) A diesel vehicle shall be preconditioned over the cycle shown in Figure 24.

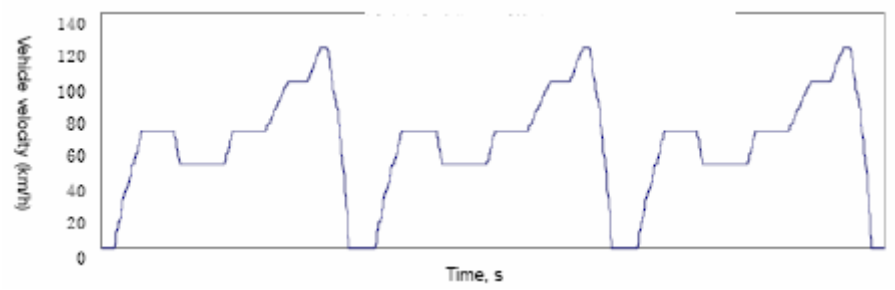


Figure 24 Cycle curve for preconditioning of a diesel vehicle

2.3.6 Soaking

(1) At the end of the pre-conditioning, it is forbidden to re-start up the engine;

(2) In case any vehicle relocation is necessary after the engine off, manual efforts are needed to push the vehicle;

(3) The soaking duration shall be 18 ~ 24 hours. After the start of soaking, record the initial time, the odometer reading, and the temperature of the soaking zone.

3. Test

3.1 Warm-up of equipment

(1) Provided that the measurement of the preceding vehicle has ended for more than 50 minutes, it is necessary to warm up the chassis dynamometer (at the constant speed of 80 km/h for 30 minutes);

(2) Prior to the test, analyzers shall be warmed up for at least 1 hour, and the HC a NOX analysis units shall put into normal operation (with gas circulated therein) for at least 30 minutes.

3.2 Inspections of vehicle

(1) Confirm that the soaking duration falls within 18 ~ 24 hours;

(2) Check and record the room temperature, engine oil temperature, and engine coolant temperature; both engine oil temperature and engine coolant temperature must fall within ±2 C of the soaking chamber temperature; otherwise, continue the soaking until the above requirements are met.

3.3 Vehicle preparations

(1) Secure the test vehicle, check and adjust the tire inflation pressure to the prescribed value;

Note: The vehicle shall be secured onto the chassis dynamometer as horizontally as possible, so as to minimize any extra force applied onto the surface of wheels and drum except for the gravity.

(2) Where necessary, confirm the position of overdrive switch;

(3) Check that all the onboard accessories have been shut off (air-conditioner, fan, ABS, TRC, radio, etc.);

(4) Check the drive mode (all-wheel-drive/two-wheel-drive mode);

(5) In case of automated transmission, check that the gear-shift lever rests at the "P (parking)" position;

(6) Confirm the engine hood has been closed.

3.4 Preparations of equipment

(1) Confirm that the room temperature falls within 24 C±3 C and the absolute humidity within 5.5 g/kg ~ 12.2g/kg;

(2) Check the setting of equivalent inertia weight and load on the chassis dynamometer;

(3) Confirm the volume of CVS;

(4) Mount the cooling fan in front of the vehicle, 0.3 m apart;

(5) Connect the CVS sampling tube with the tail pipe of the vehicle;

(6) Confirm both zero and range gases are normal, with the precision no less than 2%.

3.5 Test

(1) The test cycle is shown in Figure 25;

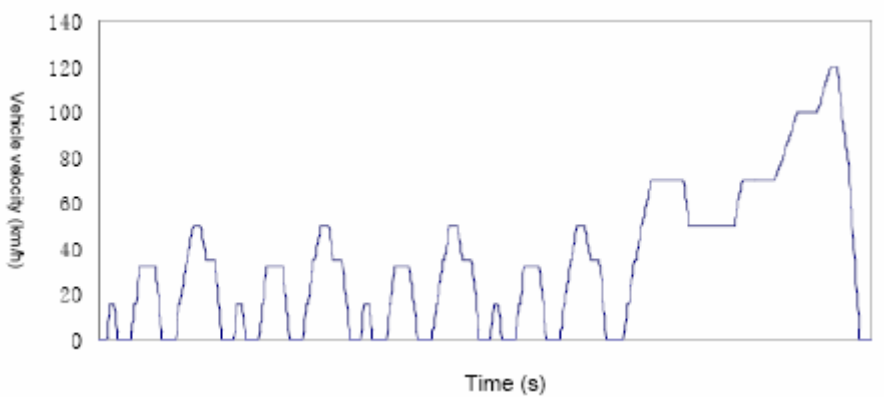


Figure 25 Test cycle

(2) Lasting for 1,180 seconds in total, the test, comprising two parts (urban cycle and suburban cycle), shall be uninterruptedly conducted until its end;

(3) Upon ignition of the engine, it is forbidden to press down the acceleration pedal;

(4) The driver shall control the acceleration and brake pedals as stably as possible, so as to maintain the travel to follow the curve tolerance;

(5) In case an overdrive gear (to be manipulated by the driver) is fitted, it may be used for the suburban cycle (i.e., forbidden to use for the urban cycle);

(6) In case of automated transmission, the gear shall be shifted to ‘D’ upon 6 s after the ignition of the engine; afterwards, no gear-shifting operation is allowed throughout the test, except for particular cases;

(7) In case of a manual transmission comprising more than 5 gear ratios, the user’s manual or the manufacturer’s suggestions may be consulted;

(8) In case of combined transmission, the procedures for automated transmission shall apply;

(9) During the test, diluted mode data may be gathered;

(10) The analysis of the sampling bags shall be completed within 20 minutes after the engine off;

(11) Check whether the MI (malfunction indicator) goes off and whether the OBD system presents any fault code.

3.6 Data processing

Data shall be processed with reference to the provisions of GB/T 19233-2008.

4. Vehicle parameters to be verified for the additional test

4.1 Basic information of vehicle necessary for the test

(1) Any particular requirement for transmission manipulation during test

(2) Requirements for using the overdrive switch of automatic transmission

(3) Elimination of speed limit arising from ABS warning, e.g., on-off of TRC

(4) Drive type and tyre inflation pressure of driven wheels

(5) Other matters to be explained

4.2 Parameters necessary for issuing the test report

See Annex 9.

Annex 1

Feedback Sheet for Vehicles Undergoing C-NCAP Assessment

Vehicle manufacturer			
Vehicle type (as shown in the Announcement)		Trademark	
Time to market of the latest remoulded type		Total sales volume / sales volume of the type with the same configuration as the sample vehicle	
Series for sales (marketed series)			
Basic parameters and configuration of vehicle	Overall dimension	L×W×H (mm)	
	Mass	Complete vehicle gross mass (kg)	
		Complete vehicle curb mass (kg)	
	Bodywork type		
	Engine	Model	
		Manufacturer	
		Displacement/power (ml/kW)	
		Number of cylinders	
		Fuel type	
	Transmission	Auto or manual	
		Number of gears and gear ratios	
	Drive pattern	Front-wheel/rear-wheel/all-wheel drive	
	Braking system	Operating mode (mechanical, hydraulic and pneumatic)	
		Wheel braking mode (disc or drum)	
	Restraint system	Safety belt (mounting position, number)	
		Verify whether the second row is to be equipped with safety belts or not	Yes□ No□
		Quantity and position of ISOFIX	
		Safety belt reminder (position, number)	
		Frontal airbag (mounting position, number)	

		Side airbag (air curtain) (mounting position, number)		
	Driver's seat	Seat model		
		Manufacturer		
Production information or vehicle type modification plan	Is it to discontinue production within one year? If yes, when?			Yes□ No□
	Is it in the process of vehicle modification?			Yes□ No□
	Which type of modification?			Body□ Construction□ Safety configuration□ Others □
	If yes, when is it to be put in the market?			
Information about franchised stores	Give information concerning franchised stores in Beijing, Tianjin or other regions: (An additional sheet may be used if the space is not enough) Where no vehicle of such type is available in franchised stores, is the selection of sample vehicles from production line permitted? Yes□ No□			
Communication	Contact person		Tel./cell phone	
	Zip code		Fax.	
	Address			
Authorized representative's signature or common seal	(d/m/y)			
Note: The information presented above shall apply to the vehicle type with the configuration attaining the largest sales volume; pertaining proofing documents shall be furnished altogether. Where the manufacturer wishes to have other vehicle type(s) assessed, which has reached certain sales volume, any information as described above may also be given and such vehicle type(s) is to be listed as candidate vehicle type(s).				

Annex 2

C-NCAP Test Performing Notice

<table>
<tr><td>Vehicle manufacturer</td><td colspan="5"></td></tr>
<tr><td>Vehicle type</td><td colspan="5"></td></tr>
<tr><td>Configuration</td><td colspan="5"></td></tr>
<tr><td rowspan="5">Test items and date</td><td colspan="2">Fuel consumption measurement</td><td colspan="3">(d/m/y) ~ (d/m/y)</td></tr>
<tr><td colspan="2">Full frontal impact</td><td colspan="3">(d/m/y)</td></tr>
<tr><td colspan="2">Offset frontal impact</td><td colspan="3">(d/m/y)</td></tr>
<tr><td colspan="2">Side impact</td><td colspan="3">(d/m/y)</td></tr>
<tr><td colspan="2">Whiplash test</td><td colspan="3">(d/m/y) ~ (d/m/y)</td></tr>
<tr><td>Matters needing attention</td><td colspan="5"></td></tr>
<tr><td>Contact person</td><td></td><td>Telephone</td><td></td><td>Fax.</td><td></td></tr>
<tr><td>Common seal</td><td colspan="5">(d/m/y)</td></tr>
</table>

Annex 3

C-NCAP Basic Parameters of the Test Vehicle

Completed on:_____ (d/m/y)

Trademark, name and model of vehicle			Vehicle type		
Manufacturer					
Vehicle identification number (VIN) Engine number Date of manufacture					
Complete vehicle curb mass and axle load (kg)					
Complete vehicle gross mass and axle load (kg)					
Engine model and manufacturer					
Engine arrangement mode		Front (horizontal, longitudinal), middle, rear			
Half-laden tyre pressure (kPa)					
Tyre model and manufacture					
Rated voltage of battery (V)			Engine displacement (ml)		
Transmission model			Transmission arrangement mode		
Rated capacity of fuel tank			Fuel type		
Vehicle L×W×H (mm)			Number of doors		
Number of seats in complete vehicle			Number of seats in the front row		
Model and type of steering column		Model: Adjustable (yes/no) Crushable (yes/no)			
Steering wheel	Design position or middle position in forward and backward directions				
	Design position or middle position in upper and lower directions				
Safety belt and anchorage		Model and manufacturer	Pretensioner	Force limiter	Design position of upper anchorage

For reference only

Safety belt	Driver		Yes/No	Yes/No	
	Front passenger		Yes/No	Yes/No	
	Left rear passenger		Yes/No	Yes/No	
	Middle rear passenger		Yes/No	Yes/No	
	Right rear passenger		Yes/No	Yes/No	

Safety belt reminder	Fitted or not	Mounting position	Visual or audible
	Yes□ No□	Front: Driver □	Visual□ Audible□
		Passenger □	Visual□ Audible□ Monitor system: Yes□ No□

Model and manufacturer of front-passenger frontal airbag	Driver	
	Occupant	
	Other position	
Model and manufacturer of side airbag (either side)	Front	
	Rear	
	Other position	

Seat design parameters		Design R-point coordinate	Longitudinal adjustable design position	Vertical adjustable design position	Seat back angle adjustable design position
Front seat	Driver				
	Occupant				
Rear seat					
Seat parameters for frontal impact		H-point coordinate of seat at test position	Longitudinal adjustable position	Vertical adjustable position	Seat back angle adjustable position
Front seat	Driver		Middle		
	Occupant		Middle		
Rear seat					
Seat parameters for side impact		H-point coordinate of seat at test position	Longitudinal adjustable position	Vertical adjustable position	Seat back angle adjustable position
Front seat	Driver		Middle		

To furnish the coordinates of 8 characteristic points within the vehicle body design coordinate system; also, it shall assure that these 8 points will not undergo any deformation after the test.

1	2	3	4	5	6	7	8

<table>
<tr><td>Whether doors could be locked up automatically</td><td colspan="8">Yes□ No□</td></tr>
<tr><td>If yes, whether the lock-up could be eliminated automatically</td><td colspan="8">Yes□ No□</td></tr>
<tr><td rowspan="2">Fitted with child restraint system anchorage or not (ISOFIX)</td><td colspan="3">Yes□ No□</td><td>ISOFIX number</td><td></td><td>ISOFIX position</td><td colspan="2"></td></tr>
<tr><td colspan="3">Type, manufacturer and model of CRS applicable to this vehicle type</td><td colspan="5"></td></tr>
<tr><td rowspan="11">Installation parameters for driver's seat</td><td colspan="7">Coordinates of seat set-bolt hole</td><td rowspan="2">Seat track inclination</td></tr>
<tr><td colspan="2"></td><td>Front left</td><td>Front right</td><td>Rear left</td><td>Rear right</td></tr>
<tr><td rowspan="3">Coordinates</td><td>X</td><td></td><td></td><td></td><td></td><td rowspan="8"></td></tr>
<tr><td>Y</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Z</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Intersection angle between normal direction and coordinate axis</td><td>Axis-X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Axis-Y</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Axis-Z</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Driver's seat parameters of whiplash test</td><td colspan="2">H-point coordinates of seat at test position</td><td>Height of head restraint adjustable?</td><td>Head restraint longitudinally adjustable?</td><td colspan="2">Type of head restraint</td><td>Triggering moment</td></tr>
<tr><td colspan="2" rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td colspan="2">□ Non-proactive head restraint</td><td>--</td></tr>
<tr><td colspan="2">□ Retroaction type pro-active head restraint</td><td>--</td></tr>
<tr><td colspan="2">□ Triggering type pro-active head restraint</td><td>--</td></tr>
</table>

Annex 4

Sheet of Complaint on C-NCAP Assessment

Manufacturer (affix common seal)	(d/m/y)
Vehicle type	
Testing time	
Complained test items	
Complaint grounds	
Retesting time applied	
The authority's opinions (affix common seal)	(d/m/y)

Annex 5

Application Form for C-NCAP Assessment

Vehicle manufacturer				
Vehicle type			Trademark	
Series put for sales				
Time to market				
Vehicle configuration	Overall dimension	L×W×H (mm)		
	Mass	Complete vehicle gross mass (kg)		
		Complete vehicle curb mass (kg)		
	Bodywork type			
	Engine	Model		
		Manufacturer		
		Displacement		
		Power		
		Number of cylinders		
		Fuel type		
		OBD system		
	Transmission	Automated or manual		
		Number of gears and gear ratios		
	Drive pattern	Frontal-wheel/rear-wheel/all-wheel drive		
	Driving wheel	Tyre model		
		Tyre inflation pressure		
	Braking system	Operating mode (mechanical, hydraulic and pneumatic)		
		Wheel braking mode (disc or drum)		
	Restraint system	Safety belt (mounting position, number)		
		Safety belt warning device (position, number)		
		Airbag (mounting position, number)		
	Driver's seat	Seat model		
		Manufacturer		
Test items applied	Fuel consumption measurement			□
	Full frontal impact			□

	Offset frontal impact	□
	Side impact	□
	Whiplash test	□
Information about franchised stores		
Communication	Contact person	
	Tel.	
	Fax.	
	Zip code	
	Address	
Statement	In the case of no dispute over the testing for assessment, the evaluation results are to be released on website(s) and magazine(s).	
Common seal	(d/m/y)	

Annex 6

Specimen of Releasing of C-NCAP Assessment Results

[Vehicle type] C-NCAP Markings

(Photograph of vehicle)				
	Vehicle type		Time to market	
	Vehicle total length		Engine displacement	
	Curb mass		Test mass	
	Frontal airbag		Side airbag	
	Pretensioner		Air curtain	
	Force limiter		Driver-side safety belt reminder	
	ISOFIX device		Passenger-side safety belt reminder	

Assessment of overall star rating

Full frontal impact test score		40% offset impact test score	
Side impact test score		Score of whiplash test	
		Extra test score	
Overall star rating			

※Full frontal impact test score: [ ] points [ ]%

(Photograph of full frontal impact test)		Frontal-row passengers					Rear-row passengers		Minus points for single test item
		Head	Neck	Thorax	Upper leg	Lower leg	Head-neck	Thorax	
	Full score	5	2	5	2	2	1	1	--
	Test score								

※40% offset impact test score: [ ] points [ ]%

(Photograph of 40% offset impact test)		Frontal-row passengers				Rear-row passengers		Minus points for single test item
		Head-neck	Thorax	Upper leg	Lower leg	Head-neck	Thorax	
	Full score	4	4	4	4	1	1	--
	Test score							

※Side impact test score: [ ] points [ ]%

Photograph of side impact test		Frontal-row passengers				Rear-row passengers		Minus points for single test item
		Head	Thorax	Abdomen	Pelvis	Head	Pelvis	
	Full score	4	4	4	4	1	1	--
	Test score							

※Neck protection test score in low-speed rear impact (whiplash test): [ ] points [ ]%

Photograph of whiplash test		NIC	Neck load	Penalty score	Score of whiplash test	Converted bonus score of C-NCAP
	Full score	2	6	--	8	4
	Test score					

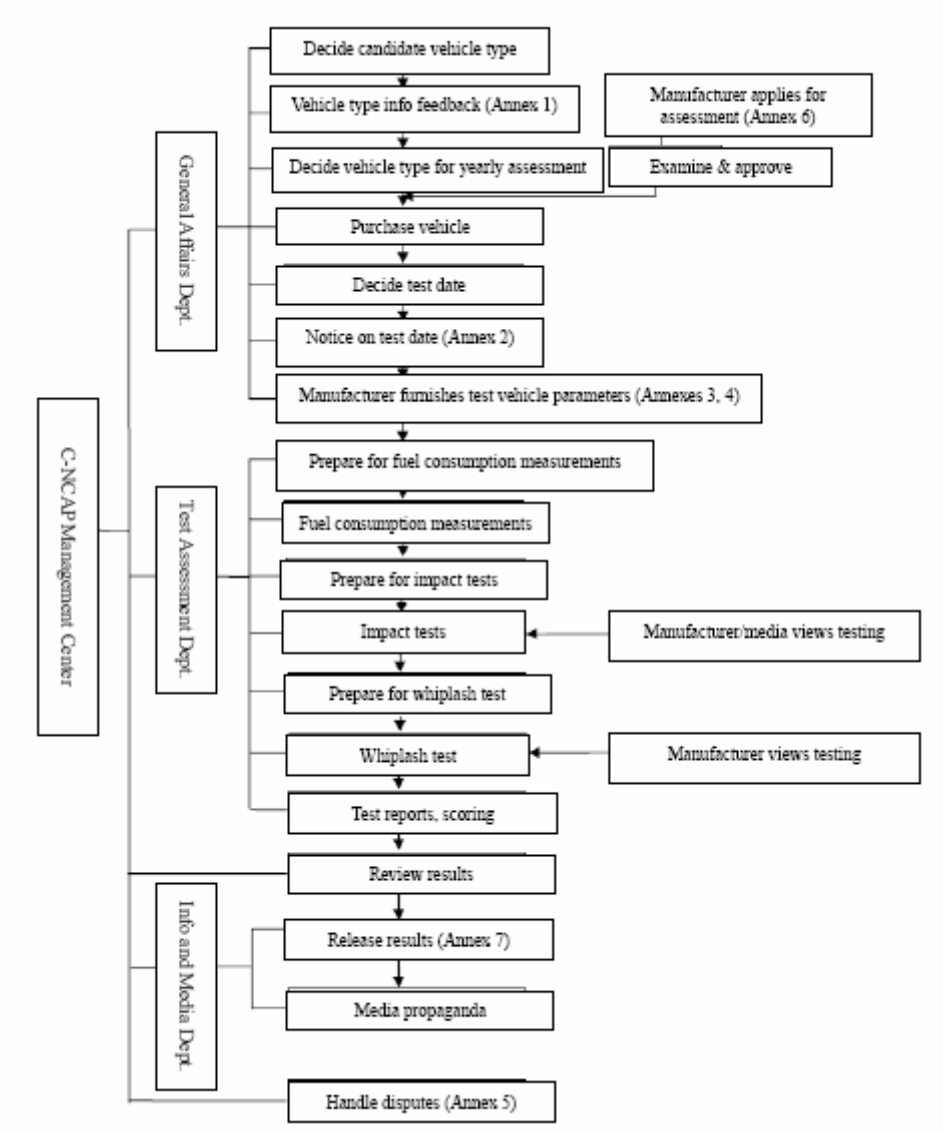
※Bonus score awarded for safety configurations: [ ] points

[Written description]

For reference only

Annex 7

C-NCAP Work Flow Diagram



Annex 8

ESC test parameter table

Parameter	Test vehicle for report	CNCAP test vel
Vehicle name		
Vehicle model		
Vehicle category		
VIN of sample vehicle		
Chassis model and manufacturer		
Engine model and manufacturer		
Kerb mass and axle load of the whole vehicle (kg)		
Maximum gross mass and axle load of the whole vehicle (kg)		
Axles		
Axle base (mm)		
Wheel track (mm)		
The maximum design speed (km/h)		
Tyre model		
Tyre pressure (kPa)		
Suspension type (front/rear)		
Mass center height (empty load/full load) (mm)		
Engine rated power (kW)		
Engine maximum torque (Nm)		
Transmission shift and ratio		
Axle ratio		
Service braking booster pattern		
Brake force adjustment pattern		
Service brake system type		
Brake master cylinder model and manufacturer		
Braking caliper model		
Braking disc model		
Braking shoe model		
Braking liner model		
Steering system type		
Steering booster model and manufacturer		
ESC system controller model and manufacturer		
Braking pressure adjuster model and manufacturer		
Engine ECU model and manufacturer		
Steering wheel angle sensor model and manufacturer		
Inertia variant model and manufacturer		
Wheel speed sensor model and manufacturer		

Annex 9

Information sheet of manufacturer's sample (for gasoline vehicle)

Parameters	Vehicle category			Trademark			
	Sample grade			Model & specifications			
	Manufacturer			Manufacture date			
	Chassis	VIN		Engine		Model	
		Model				Serial number	
		Manufacturer				Manufacturer	
	Complete vehicle curb mass (kg)					Displacement (L)	
	Gross vehicle weight (kg)					Engine type	
	Max. attainable velocity (km/h)					Cylinder/valve quantity	
	Designed number of occupants					Rated output (kW)/speed (r/min)	
	Drive pattern/transmission type					Layout of combustion chamber	
	Tyre inflation pressure of driving wheel (kPa)					Idling speed (r/min)	
	Tyre size					Volumetric compression ratio	
	Tyre manufacturer					Air intake/cooling mode	
	Tyre structure					Cylinder arrangement pattern	
	Sectional width of tyre					Bore/stroke/cylinder center line spacing	
	Fuel type & grade					Engine fueling mode	
	OBD system available?			Fuel pipe material			
	Final drive ratio			Fuel tank	Volume (L)/material		
	Gear ratios	Gear 1	Gear 2	ECU		Model/appearance No.	
		Gear 3	Gear 4				
		Gear 5	Gear 6			Manufacturer	
	Booster	Model/appearance No.		Intercooler		Model/appearance No.	
		Manufacturer				Manufacturer	
	Catalyst	Model/appearance No.		Quantity of catalytic units/content of precious metals (g/ft^3)			
		Manufacturer		Ratio of precious metals (Pt: Pd: Rh)			
		Quantity		Carrier structure/material			
		Volume (L)		Pore density (mesh/in^2)			

		Type		Mounting interval from exhaust opening (mm)		
	OS	Model/appearance No.		PCV	Model/appearance No.	
		Manufacturer			Manufacturer	
	Canister	Model/appearance No.			Control mode	
		Manufacturer			Throttle size	
	Secondary air injection	Model/appearance No.		EGR	Model/appearance No.	
		Manufacturer			Manufacturer	
		Type		Declared fuel consumption (L/100km)		
Other particular notes						

For reference only

Information sheet of manufacturer's sample (for diesel vehicle)

Parameters							
	Vehicle category				Trademark		
	Sample grade				Model & specifications		
	Manufacturer				Manufacture date		
	Chassis	VIN		Engine	Model		
		Model			Serial number		
		Manufacturer			Manufacturer		
	Complete vehicle curb mass (kg)				Engine type		
	Gross vehicle weight (kg)				Displacement (L)		
	Max. attainable velocity (km/h)				Cylinder/valve quantity		
	Fuel type & specifications				Rated output (kW)/speed (r/min)		
	Fuelling pattern				Max. torque (N.m)/speed (r/min)		
	Designed number of occupants				Air intake/cooling mode		
	Drive pattern/transmission type				Structure of combustion chamber		
	Tyre inflation pressure of driving wheel (kPa)				Injection type		□Direct□Other
	Tyre size				Idling speed (r/min)		
	Tyre manufacturer				Max. unladen speed (r/min)		
	Tyre structure				Volumetric compression ratio		
	Sectional width of tyre				Cylinder arrangement pattern		
	OBD system available?				Bore/stroke/cylinder center line spacing		
	Final drive ratio				Firing order		
	Gear ratios	Gear 1		Gear 2		ECU	Model/appearance No.
		Gear 3		Gear 4			Manufacturer
		Gear 5		Gear 6		EGR	Model/appearance No.
							Manufacturer
	Injector pump	Model/appearance No.				Fuel injector	Model/appearance No.
		Manufacturer					Manufacturer

	Booster	Model/appearance No.		Intercooler	Model/appearance No.	
		Manufacturer			Manufacturer	
	Speed governor	Model/appearance No.			Max. temperature at outlet	
		Manufacturer		Secondary air injection system	Model/appearance No.	
	PM trap	Model/appearance No.			Manufacturer	
		Manufacturer			Type (pulse/air pump)	
		Type		Quantity of catalytic units/content of precious metals (g/ft^3)		
	Catalyst	Model/appearance No.		Ratio of precious metals (Pt: Pd: Rh)		
		Manufacturer		Carrier structure/material		
		Quantity		Pore density ($mesh/in^2$)		
		Volume (L)		Mounting interval from exhaust opening (mm)		
		Type		Declared fuel consumption (L/100km)		
Other particular notes						

Annex 10

C-NCAP Recording Sheet of Measurements and Scoring for Impact Tests

Item			Head	Neck	Thorax	Femur		Lower leg		Overall penalty	Score
1. Frontal impact test against the rigid barrier with 100% overlapping	Frontal-row dummies	Test data	Driver-side HIC_{36}	Driver-side positive shearing force Fx@0, 25, 45ms (kN)	Driver-side compressive deformation (mm)	Driver-side femur compression force @0, 10ms (kN)	Left leg	Driver-side TI value	Left leg		
							Right leg		Right leg		
				Driver-side negative shearing force Fx@0, 25, 45ms (kN)							
			Driver-side 3ms (g)	Driver-side positive tension Fz@0, 35, 60ms (kN)	Driver-side 3ms (g)	Driver-side knee displacement (mm)	Left leg	Driver-side tibia compression force (kN)	Left leg		
							Right leg		Right leg		
				Driver-side extension bending moment My(I)(Nm)							
			Upward displacement of steering column (mm)	Passenger-side positive shearing force Fx@0, 25, 45ms (kN)	Rearward displacement of steering column (mm)	Passenger- side femur compression force @0, 10ms (kN)	Left leg	Passenger- side TI value	Left leg		
							Right leg		Right leg		
				Passenger-side negative shearing force Fx@0, 25, 45ms (kN)							
			Passenger side HIC_{36}	Passenger-side positive tension Fz@0, 35, 60ms (kN)	Passenger- side compressive deformation (mm)	Passenger- side knee displacement (mm)	Left leg	Passenger- side tibia compression force (kN)	Left leg		
							Right leg		Right leg		
			Passenger side 3ms (g)	Passenger-side extension bending moment My(I)(Nm)	Passenger- side 3ms (g)						
		Score									

For reference only

Item			Head		Neck		Thorax	Femur	Lower leg	Overall penalty	Score
1. Frontal impact test against the rigid barrier with 100% overlapping	Rear-row female dummy	Test data	Head-Neck				Thorax				
			No secondary impact of head		With secondary impact of head						
			Head		Head HIC_{15}		Compressive deformation (mm)				
			Neck Fz		Neck Fz						
			--	--	Neck Fx						
					Neck My						
		Score									

For reference only

Item			Head, neck		Thorax		Knee, femur		Lower leg		Overall penalty	Score
2. Frontal impact test against the deformable barrier with 40% overlapping	Frontal-row dummies	Test data	Driver-side HIC_{36}		Driver-side Compressive deformation (mm)		Driver-side femur compression force @0, 10ms(kN)	Left leg	Driver-side TI value	Left leg		
			Driver-side 3ms (g)									
			Upward displacement of steering column (mm)									
			Driver-side positive shearing force Fx@0, 25, 45ms (kN)					Right leg		Right leg		
			Driver-side negative shearing force Fx@0, 25, 45ms (kN)		Driver-side 3ms (g)		Driver-side knee displacement (mm)	Left leg	Driver-side Tibia compression force (kN)	Left leg		
			Driver-side positive tension Fz@0, 35, 60ms (kN)					Right leg		Right leg		
			Driver-side extension bending moment My(l)(Nm)		Rearward displacement of steering column (mm)		Passenger- side femur compression force @0, 10ms(kN)	Left leg	Max. pedal rearward displacement (mm)			
					A-pillar rearward displacement (mm)				Max. pedal upward displacement (mm)			
			Passenger-side HIC_{36}		Passenger-side negative shear: Fx@0, 25, 45ms(kN)				Passenger-side TI value	Left leg		
			Passenger-side 3ms (g)									
			Passenger-side positive shearing force					Right leg		Right leg		

			Fx@0, 25,45ms (kN)									
			Passenger-side negative shearing force Fx@0, 25, 45ms (kN)		Passenger-side 3ms (g)		Passenger- side knee displacement (mm)	Left leg	Passenger-side tibia compression force (kN)	Left leg		
			Passenger-side positive tension Fz@0, 35, 60ms (kN)					Right leg		Right leg		
			Passenger-side extension bending moment My(I)(Nm)									
		Score										

For reference only

Item			Head, neck		Thorax	Knee, femur	Lower leg	Overall penalty	Score
2. Frontal impact test against the deformable barrier with 40% overlapping	Rear-row female dummy	Test data	No secondary impact of head	With secondary impact of head	Compressive deformation				
			Head	Head HIC_{15}					
			Neck Fz	Neck Fz					
				Neck Fx					
				Neck My					
		Score							

Item			Head	Thorax	Abdomen	Pelvis	Overall penalty	Score
3.Side impact test against mobile deformable barrier	Front-row dummies	Measurement value	HIC_{36}	Compressive deformation (mm)	Abdominal force (kN)	Pubis force (kN)		
			3ms (g)	VC (m/s)				
				Back pan load Fy (kN)				
				T12-Fy (kN)				
				T12-Mx (Nm)				
		Score						
	Rear-row female dummy	Measurement value	HIC_{15}			Resultant pelvis force (hip joint and iliac bone)		
		Score						

4. Whiplash test	Item	Neck injury criterion (NIC)		Neck loads and torques		Penalty item	Whiplash test score	Converted score of C-NCAP
	Measurement value	NIC		Upper shear force of neck Fx (N)		Seatback opening (°)		
				Upper tension of neck Fz (N)				
				Upper torque of neck My (N)		Head interference space of head restraint		
				Lower shear force of neck Fx (N)				
				Lower tension of neck Fz (N)		Track failure		
				Lower torque of neck My (N)				
	Score							
5. Bonus items	Driver-side safety belt reminder							
	Front passenger-side safety belt reminder							
	Side airbag and air curtain							
	ISOFIX device							
	ESC							
Total score								
Star rating								