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Contents

II Acts adopted under the EC Treaty/Euratom Treaty whose publication is not obligatory

ACTS ADOPTED BY BODIES CREATED BY INTERNATIONAL AGREEMENTS

- ★ **Regulation No 14 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of vehicles with regard to safety-belt anchorages, Isofix anchorages systems and Isofix top tether anchorages** 1
- ★ **Regulation No 66 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform technical prescriptions concerning the approval of large passenger vehicles with regard to the strength of their superstructure** 55

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Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other acts are printed in bold type and preceded by an asterisk.

II

(Acts adopted under the EC Treaty/Euratom Treaty whose publication is not obligatory)

ACTS ADOPTED BY BODIES CREATED BY INTERNATIONAL AGREEMENTS

Only the original UN/ECE texts have legal effect under international public law. The status and date of entry into force of this Regulation should be checked in the latest version of the UN/ECE status document TRANS/WP.29/343, available at:
<http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29fdocsts.html>.

Regulation No 14 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of vehicles with regard to safety-belt anchorages, Isofix anchorages systems and Isofix top tether anchorages

Addendum 13: Regulation No 14

Revision 4

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CONTENTS

REGULATION

1. Scope
2. Definitions
3. Application for approval
4. Approval
5. Specifications
6. Tests
7. Inspection during and after static tests for safety-belt anchorages
8. Modifications and extension of approval of the vehicle type
9. Conformity of production
10. Penalties for non-conformity of production
11. Operating instructions
12. Production definitely discontinued
13. Names and addresses of technical services conducting approval tests, and of administrative departments
14. Transitional provisions

ANNEXES

- Annex 1 — Communication concerning the approval (or extension, or refusal, or withdrawal, or production definitely discontinued) of a vehicle type with regard to safety-belt anchorages and Isofix anchorages systems and Isofix top tether anchorage if any pursuant to Regulation No 14
- Annex 2 — Arrangements of the approval mark
- Annex 3 — Location of effective belt anchorages
- Annex 4 — Procedure for determining the 'H' point and the actual torso angle for seating positions in motor vehicles
 - Appendix 1 — Description of the three-dimensional 'H' point machine
 - Appendix 2 — Three-dimensional reference system
 - Appendix 3 — Reference data concerning seating positions
- Annex 5 — Traction device
- Annex 6 — Minimum number of anchorage points and location of lower anchorages
 - Appendix 1 — Location of lower anchorages — angle requirements only
- Annex 7 — Dynamic test as an alternative to the safety-belt anchorages static strength test
- Annex 8 — Dummy specifications
- Annex 9 — Isofix anchorages systems and Isofix top tether anchorages

1. SCOPE

This Regulation applies to anchorages for safety-belts intended for adult occupants of forward-facing or rearward-facing seats in vehicles of categories M and N ⁽¹⁾.

It also applies to Isofix anchorages systems and Isofix top tether anchorages intended to Isofix child restraint systems installed in vehicles of category M₁ N₁ vehicles fitted with Isofix anchorages have also to comply with the provisions of this Regulation.

2. DEFINITIONS

For the purposes of this Regulation,

- 2.1. 'Approval of a vehicle' means the approval of a vehicle type equipped with anchorages for given types of safety-belts;
- 2.2. 'Vehicle type' means a category of power-driven vehicles, which do not differ in such essential respects as the dimensions, lines and materials of components of the vehicle structure or seat structure to which the safety-belts anchorages and the Isofix anchorages systems and Isofix top tether anchorages if any are attached and, if the anchorages strength is tested according to the dynamic test, the characteristics of any component of the restraint system, especially the load limiter function, having an influence on the forces applying to the safety-belt anchorages.
- 2.3. 'Belt anchorages' means the parts of the vehicle structure or the seat structure or any other part of the vehicle to which the safety-belt assemblies are to be secured;
- 2.4. 'Effective belt anchorage' means the point used to determine conventionally, as specified in paragraph 5.4., the angle of each part of the safety-belt in relation to the wearer, that is, the point to which a strap would need to be attached to provide the same lie as the intended lie of the belt when worn, and which may or may not be the actual belt anchorage depending on the configuration of the safety-belt hardware at its attachment to the belt anchorage.

⁽¹⁾ As defined in the Consolidated Resolution (R.E.3, Annex 7), document TRANS/WP29/78/Rev.1/Amend.2, as last amended by Amend.4.

- 2.4.1. *For example,*
- 2.4.1.1. where a strap guide is used on the vehicle structure or on the seat structure, the middle point of the guide at the place where the strap leaves the guide on the belt wearer's side, shall be considered as the effective belt anchorage; and,
- 2.4.1.2. where the belt runs directly from the wearer to a retractor attached to the vehicle structure or the seat structure without an intervening strap guide, the effective belt anchorage shall be considered as being the intersection of the axis of the reel for storing the strap with the plane passing through the centre line of the strap on the reel;
- 2.5. 'Floor' means the lower part of the vehicle body-work connecting the vehicle side walls. In this context it includes ribs, swages and possibly other reinforcements, even if they are below the floor, such as longitudinal and transverse members;
- 2.6. 'Seat' means a structure which may or may not be integral with the vehicle structure complete with trim, intended to seat one adult person. The term covers both an individual seat or part of a bench seat intended to seat one person;
- 2.6.1. 'Front passenger seat' means any seat where the 'foremost H point' of the seat in question is in or in front of the vertical transverse plane through the driver's R point;
- 2.7. 'Group of seats' means either a bench-type seat, or seats which are separate but side by side (i.e. with the foremost anchorages of one seat in line with or forward of the rearmost anchorages and in line with or behind the foremost anchorages of another seat) and accommodate one or more seated adult person;
- 2.8. 'Bench seat' means a structure complete with trim, intended to seat more than one adult person;
- 2.9. 'Folding seat' means an auxiliary seat intended for occasional use which is normally folded;
- 2.10. 'Seat type' means a category of seats which do not differ in such essential respects as:
- 2.10.1. the shape, dimensions and materials of the seat structure,
- 2.10.2. the types and dimensions of the adjustment systems and all locking systems,
- 2.10.3. the type and dimensions of the belt anchorages on the seat, of the seat anchorage and of the affected parts of the vehicle structure;
- 2.11. 'Seat anchorage' means the system by which the seat assembly is secured to the vehicle structure, including the affected parts of the vehicle structure;
- 2.12. 'Adjustment system' means the device by which the seat or its parts can be adjusted to a position suited to the morphology of the seated occupant; this device may, in particular, permit of:
- 2.12.1. longitudinal displacement;
- 2.12.2. vertical displacement;
- 2.12.3. angular displacement;
- 2.13. 'Displacement system' means a device enabling the seat or one of its parts to be displaced or rotated without a fixed intermediate position, to permit easy access to the space behind the seat concerned;
- 2.14. 'Locking system' means any device ensuring that the seat and its parts are maintained in any position of use and includes devices to lock both the seat back relative to the seat and the seat relative to the vehicle.

- 2.15. 'Reference zone' means the space between two vertical longitudinal planes, 400 mm apart and symmetrical with respect to the H point, and defined by rotation from vertical to horizontal of the headform apparatus, as described in Regulation No 21, annex 1. The apparatus shall be positioned as described in that annex to Regulation No 21 and set to the maximum length of 840 mm.
- 2.16. 'Thorax load limiter function' means any part of the safety-belt and/or the seat and/or the vehicle intended to limit the level of the restraint forces applying to the occupant's thorax in case of a collision.
- 2.17. 'Isofix' is a system for the connection of child restraint systems to vehicles which has two vehicle rigid anchorages, two corresponding rigid attachments on the child restraint system and a means to limit the pitch rotation of the child restraint system.
- 2.18. 'Isofix position' means a system which allows to install:
- (a) either an universal Isofix forward facing child restraint system as defined in Regulation No 44,
 - (b) or a semi-universal Isofix forward facing child restraint system as defined in Regulation No 44,
 - (c) or a semi-universal Isofix rearward facing child restraint system as defined in Regulation No 44,
 - (d) or a semi-universal Isofix lateral facing position child restraint system as defined in Regulation No 44,
 - (e) or a specific vehicle Isofix child restraint system as defined in Regulation No 44.
- 2.19. 'Isofix low anchorage' means one 6 mm diameter rigid round horizontal bar, extending from vehicle or seat structure to accept and restrain an Isofix child restraint system with Isofix attachments.
- 2.20. 'Isofix anchorages system' means a system made up of two Isofix low anchorages which is designed for attaching an Isofix child restraint system in conjunction with an anti-rotation device.
- 2.21. 'Isofix attachment' means one of the two connections, fulfilling the requirements of Regulation No 44, extending from the Isofix child restraint system structure, and compatible with an Isofix low anchorage.
- 2.22. 'Isofixchild restraint system' means a child restraint system, fulfilling the requirements of Regulation No 44, which has to be attached to an Isofix anchorages system.
- 2.23. 'Static force application device (SFAD)' means a test fixture that engages the vehicle Isofix anchorages systems and that is used to verify their strength and the ability of the vehicle or seat structure to limit the rotation in a static test. The test fixture is described in the figures 1 and 2 of Annex 9.
- 2.24. 'Anti-rotation device':
- (a) An anti-rotation device for an Isofix universal child restraint system consists of the Isofix top-tether.
 - (b) An anti-rotation device for an Isofix semi-universal child restraint system consists of either a top tether, the vehicle dashboard or a support leg intended to limit the rotation of the restraint during a frontal impact.

- (c) For Isofix, universal and semi-universal, child restraint systems the vehicle seat itself does not constitute an anti-rotation device.
- 2.25. 'Isofix top tether anchorage' means a feature, such as a bar, located in a defined zone, designed to accept an Isofix top tether strap connector and transfer its restraint force to the vehicle structure.
- 2.26. 'Isofix top tether connector' means a device intended to be attached to an Isofix top tether anchorage.
- 2.27. 'Isofix top tether hook' means an Isofix top tether connector typically used to attach an Isofix top tether strap to an Isofix top tether anchorage as defined in figure 3 of Annex 9 of this Regulation.
- 2.28. 'Isofix top tether strap' means a webbing strap (or equivalent) which extends from the top of an Isofix child restraint system to the Isofix top tether anchorage, and which is equipped with an adjustment device, a tension-relieving device, and an Isofix top tether connector.
- 2.29. 'A guidance device' is intended to help the person installing the Isofix child restraint system by physically guiding the Isofix attachments on the Isofix child restraint into correct alignment with the Isofix low anchorages to facilitate engagement.
- 2.30. 'Isofix marking fixture' means something that informs someone wishing to install an Isofix child restraint system of the Isofix positions in the vehicle and the position of each corresponding Isofix anchorages system.
- 2.31. 'A child restraint fixture' means a fixture according to one out of the seven Isofix size classes defined in paragraph 4 of annex 17 — appendix 2 of Regulation No 16 and particularly whose dimensions are given from figure 1 to figure 7 in the previous mentioned paragraph 4. Those child restraint fixtures (CRF) are used in Regulation No 16, to check what are the Isofix child restraint systems size classes which can be accommodated on the vehicle Isofix positions. Also one of the CRF, the so-called ISO/F2 (B) which is described in figure 2 of the previous mentioned paragraph 4, is used in this Regulation to check the location and the possibility of access to any Isofix anchorages system.
3. APPLICATION FOR APPROVAL
- 3.1. The application for approval of a vehicle type with regard to the belt anchorages, the Isofix anchorages systems and the Isofix top tether anchorages if any shall be submitted by the vehicle manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the undermentioned documents in triplicate and by the following particulars:
- 3.2.1. drawings of the general vehicle structure on an appropriate scale, showing the positions of the belt anchorages, of the effective belt anchorages (where appropriate), of the Isofix anchorages systems and of Isofix top tether anchorages if any and detailed drawings of the belt anchorages, of the Isofix anchorages systems if any, of the Isofix top tether anchorage if any, and of the points to which they are attached;
- 3.2.2. a specification of the materials used which may affect the strength of the belt anchorages, of the Isofix anchorages systems and Isofix top tether anchorages if any;
- 3.2.3. a technical description of the belt anchorages, of the Isofix anchorages systems and Isofix top tether anchorages if any;
- 3.2.4. in the case of belt anchorages, of the Isofix anchorages systems and of Isofix top tether anchorages if any affixed to the seat structure:

- 3.2.4.1. detailed description of the vehicle type with regard to the design of the seats, of the seat anchorages and of their adjustment and locking systems;
- 3.2.4.2. drawings, on an appropriate scale and in sufficient detail, of the seats, of their anchorage to the vehicle, and of their adjustment and locking systems.
- 3.2.5. evidence that the safety-belt or the restraint system used in the anchorages approval test complies with Regulation No 16, in the case where the car manufacturer chooses the alternative dynamic strength test.
- 3.3. At the option of the manufacturer, a vehicle representative of the vehicle type to be approved or the parts of the vehicle considered essential for the belt anchorages test, for the Isofix anchorages systems and for Isofix top tether anchorages test if any, by the technical service conducting approval tests shall be submitted to the service.
- 4. APPROVAL
- 4.1. If the vehicle submitted for approval pursuant to this Regulation meets the relevant requirements of this Regulation, approval of that vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each type approved. Its first two digits (at present 06, corresponding to the 06 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party may not assign the same number to another vehicle type as defined in paragraph 2.2. above.
- 4.3. Notice of approval or of extension or refusal or withdrawal of approval or production definitely discontinued of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement which apply this Regulation by means of a form conforming to the model in annex 1 to the Regulation.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
 - 4.4.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ⁽¹⁾;
 - 4.4.2. the number of this Regulation, to the right of the circle prescribed in paragraph 4.4.1.
 - 4.4.3. the letter 'e', to the right of the number of this Regulation in the case of type approval according to the dynamic test of Annex 7.

⁽¹⁾ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia and Montenegro, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 (vacant), 36 for Lithuania, 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa, 48 for New Zealand, 49 for Cyprus, 50 for Malta, 51 for the Republic of Korea, 52 for Malaysia and 53 for Thailand. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

- 4.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1 need not be repeated; in such a case the additional numbers and symbols of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.
- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 4.8. Annex 2 to this Regulation gives examples of arrangements of the approval mark.
5. SPECIFICATIONS
- 5.1. **Definitions** (see Annex 3)
- 5.1.1. The H point is a reference point as defined in paragraph 2.3 of Annex 4 of this Regulation, which must be determined in accordance with the procedure set out in that annex.
- 5.1.1.1. Point H' is a reference point corresponding to H as defined in paragraph 5.1.1 which shall be determined for every normal position in which the seat is used.
- 5.1.1.2. The R point is the seating reference point defined in paragraph 2.4 of Annex 4 of this Regulation.
- 5.1.2. The three-dimensional reference system is defined in appendix 2 of Annex 4 of this Regulation.
- 5.1.3. Points L_1 and L_2 are the lower effective belt anchorages.
- 5.1.4. Point C is a point situated 450 mm vertically above the R point. However, if the distance S as defined in paragraph 5.1.6. is not less than 280 mm and if the alternative formula $BR = 260 \text{ mm} + 0,8 S$ specified in paragraph 5.4.3.3. is chosen by the manufacturer, the vertical distance between C and R shall be 500 mm.
- 5.1.5. The angles α_1 and α_2 are respectively the angles between a horizontal plane and planes perpendicular to the median longitudinal plane of the vehicle and passing through the point H_1 and the points L_1 and L_2 .
- 5.1.6. S is the distance in millimetres of the effective upper belt anchorages from a reference plane P parallel to the longitudinal median plane of the vehicle defined as follows:
- 5.1.6.1. if the seating position is well-defined by the shape of the seat, the plane P shall be the median plane of this seat.
- 5.1.6.2. in the absence of a well-defined position:
- 5.1.6.2.1. the plane P for the driver's seat is a vertical plane parallel to the median longitudinal plane of the vehicle which passes through the centre of the steering-wheel in the plane of the steering-wheel rim when the steering-wheel, if adjustable, is in its central position.
- 5.1.6.2.2. the plane P for the front outboard passenger shall be symmetrical with that of the driver.
- 5.1.6.2.3. The plane P for the rear outboard seating position shall be that specified by the manufacturer on condition the following limits for distance A between the longitudinal median plane of the vehicle and plane P are respected:
- A is equal or more than 200 mm if the bench seat has been designed to accommodate two passengers only,
- A is equal or more than 300 mm if the bench seat has been designed to accommodate more than two passengers.

5.2. General specifications

5.2.1. Anchorages for safety-belts shall be so designed, made and situated as to:

5.2.1.1. enable the installation of a suitable safety-belt. The belt anchorages of the front outboard positions shall be suitable for safety-belts incorporating a retractor and pulley, taking into consideration in particular the strength characteristics of the belt anchorages, unless the manufacturer supplies the vehicle equipped with other types of safety-belts which incorporate retractors. If the anchorages are suitable only for particular types of safety-belts, these types shall be stated on the form mentioned in paragraph 4.3 above;

5.2.1.2. reduce to a minimum the risk of the belt's slipping when worn correctly;

5.2.1.3. reduce to a minimum the risk of strap damage due to contact with sharp rigid parts of the vehicle or seat structures;

5.2.1.4. enable the vehicle, in normal use, to comply with the provisions of this Regulation;

5.2.1.5. for anchorages which take up different positions to allow persons to enter the vehicle and to restrain the occupants, the specifications of this Regulation shall apply to the anchorages in the effective restraint position.

5.2.2. Any Isofix anchorages system and any Isofix top tether anchorage, installed or intended to be installed, for Isofix child restraint systems shall be so designed, made and situated as to:

5.2.2.1. Any Isofix anchorages system and any top tether anchorage shall enable the vehicle, in normal use, to comply with the provisions of this Regulation.

Any Isofix anchorages system and Isofix top tether anchorage which could be added on any vehicle shall also comply with the provisions of this Regulation. Consequently, such anchorages shall be described on the application document for type approval.

5.2.2.2. Isofix anchorages system and Isofix top tether anchorage resistance are designed for any Isofix child restraint systems of group of mass 0; 0+; 1 as defined in Regulation No 44.

5.2.3. *Isofix anchorage systems, design and positioning:*

5.2.3.1. Any Isofix anchorages system shall be 6 mm $\pm$ 0,1 mm diameter transverse horizontal rigid bar(s) which cover(s) two zones of 25 mm minimum effective length located on the same axis as defined in figure 4 annex 9.

5.2.3.2. Any Isofix anchorages system installed on a vehicle seating position shall be located not less than 120 mm behind the design H-point as determined in annex 4 to this Regulation, measured horizontally and up to the centre of the bar.

5.2.3.3. For any Isofix anchorages system installed in the vehicle, it shall be verified the possibility to attach the Isofix child restraint fixture 'ISO/F2' (B) described in Regulation No 16 (Annex 17, appendix 2, figure 2).

5.2.3.4. The bottom surface of the fixture 'ISO/F2' (B) as defined in Regulation No 16 (Annex 17, appendix 2, figure 2), shall have attitude angles within the following limits, angles measured relatively to the vehicle reference planes as defined in Annex 4 of appendix 2 to this Regulation:

(a) Pitch: 15° $\pm$ 10°,

(b) Roll: 0° $\pm$ 5°,

(c) Yaw: 0° $\pm$ 10°

5.2.3.5. Isofix anchorage systems shall be permanently in position or storable. In case of storable anchorages, the requirements relating to Isofix anchorages system shall be fulfilled in the deployed position.

5.2.3.6. Each Isofix low anchorage bar (when deployed for use) or each permanently installed guidance device shall be visible, without the compression of the seat cushion or seat back, when the bar or the guidance device is viewed, in a vertical longitudinal plane passing through the centre of the bar or of the guidance device, along a line making an upward angle of 30 degrees with a horizontal plane.

As an alternative to the above requirement, the vehicle shall be permanently marked adjacent to each bar or guidance device. This marking shall consist in one of the following, at the choice of the manufacturer.

5.2.3.6.1. As a minimum, the symbol of Annex 9, figure 12 consisting of a circle with a diameter of minimum 13 mm and containing a pictogram, meeting the following conditions:

(a) the pictogram shall contrast with the background of the circle;

(b) the pictogram shall be located close to each bar of the system;

5.2.3.6.2. The word 'ISOFIX' in capital letters of at least 6 mm height.

5.2.4. *Isofix top tether anchorages, design and positioning:*

At the request of the car manufacturer, methods described in paragraphs 5.2.4.1 and 5.2.4.2 can be used alternatively.

Method described in paragraph 5.2.4.1 can only be used if the Isofix position is located on a vehicle seat.

5.2.4.1. Subject to paragraphs 5.2.4.3 and 5.2.4.4, the portion of each Isofix top tether anchorage that is designed to bind with an Isofix top tether connector shall be located not further than 2 000 mm far from the shoulder reference point and within the shaded zone, as shown in figures 6 to 10 of annex 9, of the designated seating position for which it is installed, with the reference of a template described in SAE J 826 (July 1995) and shown in Annex 9, figure 5, according to the following conditions:

5.2.4.1.1. The 'H' point of the template is located at the unique design 'H' point of the full downward and full rearward position of the seat, except that the template is located laterally midway between the two Isofix lower anchorages;

5.2.4.1.2. The torso line of the template is at the same angle to the transverse vertical plane as the seat back in its most upright position; and

5.2.4.1.3. The template is positioned in the vertical longitudinal plane that contains the H-point of the template.

5.2.4.2. The Isofix top tether anchorage zone may be alternatively located with the aid of the fixture 'ISO/F2' (B), as defined in Regulation No 16 (Annex 17, appendix 2, figure 2), in an Isofix position equipped with Isofix low anchorages as shown in figure 11 of Annex 9.

The seating position shall be the seat's rearmost, downmost position with the seat back in its nominal position, or as recommended by the vehicle manufacturer.

In the side view, the Isofix top tether anchorage shall lie behind the 'ISO/F2' (B) fixture rear face.

The intersection between the 'ISO/F2' (B) fixture rear face and the horizontal line (Annex 9, figure 11, reference 3) containing the last rigid point of a hardness greater than 50 Shore A at the top of the seat back defines the reference point 4 (Annex 9, figure 11) on the centreline of the 'ISO/F2' (B) fixture. At this reference point, a maximum angle of 45° above the horizontal line defines the upper limit of the top tether anchorage zone.

In the top view, at the reference point 4 (Annex 9, figure 11), a maximum angle of 90° extending rearward and laterally and in the rear view, a maximum angle of 40° defines 2 volumes which limit the anchorage zone for the Isofix top tether.

The origin of the Isofix top tether strap (5) is located at the intersection of the 'ISO/F2' (B) fixture with a plane 550 mm distant above the 'ISO/F2' (B) fixture horizontal face (1) on the 'ISO/F2' (B) fixture centreline (6).

Further, the Isofix top tether anchorage shall be more than 200 mm but not more than 2 000 mm from the origin of the Isofix top tether strap on the rear face of the 'ISO/F2' (B) fixture, measured along the strap when it is drawn over the seat back to the Isofix top tether anchorage.

- 5.2.4.3. The portion of the Isofix top tether anchorage in a vehicle that is designed to bind with the Isofix top tether connector may be located outside the shaded zones referred to paragraphs 5.2.4.1 or 5.2.4.2 if a location within a zone is not appropriate and the vehicle is equipped with a routing device that:
- 5.2.4.3.1. ensures that the Isofix top tether strap functions as if the portion of the anchorage designed to bind with the Isofix top tether anchorage were located within the shaded zone; and
- 5.2.4.3.2. is at least 65 mm behind the torso line, in case of a non-rigid webbing-type routing device or a deployable routing device, or at least 100 mm behind the torso line, in the case of a fixed rigid routing device; and
- 5.2.4.3.3. when tested after being installed as it is intended to be used, the device is of sufficient strength to withstand, with the Isofix top tether anchorage the load referred to in paragraph 6.6 of this Regulation.
- 5.2.4.4. A tether anchorage may be recessed in the seat back, provided that it is not in the strap wrap-around area at the top of the vehicle seat back.
- 5.2.4.5. The Isofix top tether anchorage shall have dimensions to permit the attachment of an Isofix top tether hook as specified in figure 3.

Clearance shall be provided around each Isofix top tether anchorage to allow latching and unlatching to it. For each Isofix top tether anchorage under a cover, the cover shall be identified by for example one of the symbols or the mirror image of one of the symbols set out in figure 13 of Annex 9; the cover shall be removable without the use of tools.

5.3. **Minimum number of belt anchorages to be provided**

- 5.3.1. Any vehicle in categories M and N (except those vehicles of categories M₂ and M₃ which belong to Classes I or II, according to Regulation No 36, to Class A, according to Regulation No 52 and to Classes I or II and A, according to Regulation No 107) must be equipped with safety-belt anchorages which satisfy the requirements of this Regulation.
- 5.3.1.1. The anchorages of a harness belt system approved as a S-type belt (with or without retractor(s)) according to Regulation No 16 shall comply with the requirements of Regulation No 14, but the additional anchorage or anchorages provided for the fitting of a crotch strap (assembly) are exempted from the strength and location requirements of this Regulation.
- 5.3.2. The minimum number of safety-belt anchorages for each forward and rearward directed seating position shall be those specified in Annex 6.
- 5.3.3. However, for outboard seating positions, other than front, of vehicles of category N₁, shown in Annex 6 and marked with the symbol Ø, two lower anchorages are allowed, where there exists a passage between a seat and the nearest side-wall of the vehicle intended to permit access of passengers to other parts of the vehicle.

A space between a seat and the side-wall is considered as a passage if the distance between that side-wall, with all doors closed, and a vertical longitudinal plane passing through the centre line of the seat concerned, measured at the R point position and perpendicularly to the median longitudinal plane of the vehicle is more than 500 mm.

- 5.3.4. For the front centre seating positions shown in annex 6 and marked with the symbol *, two lower anchorages shall be considered adequate where the windscreen is located outside the reference zone defined in Annex 1 to Regulation No 21; if located inside the reference zone, three anchorages are required.

As regards belt anchorages, the windscreen is considered as part of the reference zone when it is capable of entering into static contact with the test apparatus according to the method described in Annex 1 to Regulation No 21.

- 5.3.5. In every seating position marked in Annex 6 with symbol $\frac{+}{-}$, three anchorages shall be provided. Two anchorages may be provided if one of the following conditions is fulfilled:

- 5.3.5.1. there is a seat or other parts of the vehicle conforming to Regulation No 80, appendix 1, paragraph 3.5. directly in front; or
- 5.3.5.2. no part of the vehicle is in the reference zone, or capable of being in the reference zone when the vehicle is in motion; or
- 5.3.5.3. parts of the vehicle within the said reference zone comply with the energy absorbing requirements set out in Regulation No 80, appendix 6.

- 5.3.6. For all folding seats, or seating intended solely for use when the vehicle is stationary as well as for all the seats of any vehicle which are not covered by paragraphs 5.3.1 to 5.3.4, no belt anchorages are required. However, if the vehicle is fitted with anchorages for such seats, these anchorages must comply with the provisions of this Regulation. In this case, two lower anchorages shall be sufficient.

- 5.3.7. In the case of the upper deck of a double-deck vehicle, the requirements for the centre front seating position shall apply also in the outboard front seating positions.

- 5.3.8. *Minimum number of Isofix positions to be provided*

- 5.3.8.1. Any vehicle of category M₁ must be equipped at least with two Isofix positions.

At least two of the Isofix positions shall be equipped both with an Isofix anchorages system and an Isofix top tether anchorage.

The type and number of Isofix fixtures, defined in Regulation No 16, which can be installed on each Isofix position are defined in Regulation No 16.

- 5.3.8.2. Notwithstanding paragraph 5.3.8.1 if a vehicle is only equipped with one seat row, no Isofix position is required.
- 5.3.8.3. Notwithstanding paragraph 5.3.8.1 at least one of the two Isofix positions systems shall be installed at the second seat row.
- 5.3.8.4. If an Isofix anchorages system is installed at a front seating position protected with a frontal airbag, a de-activation device for this airbag shall be fitted.
- 5.3.8.5. Notwithstanding paragraph 5.3.8.1 in case of integrated 'built in' child restraint system(s) the number of Isofix positions to be provided shall be at least two minus the number of the integrated 'built in' child restraint system(s) of mass groups 0, or 0+, or 1.

5.3.8.6. Notwithstanding the provision of the paragraph 5.3.8.1, convertible vehicles as defined in Annex 7, paragraph 8.1 of the Consolidated Resolution on the Construction of Vehicles (R.E.3) ⁽¹⁾ with more than one seat row shall be fitted with at least two Isofix low anchorages. In case where an Isofix top tether anchorage is provided on such vehicles, it shall comply with the suitable provisions of this Regulation.

5.3.9. In the case of seats capable of being turned to or placed in other orientations, for use when the vehicle is stationary, the requirements of paragraph 5.3.1 shall apply only to those orientations designated for normal use when the vehicle is travelling on a road, in accordance with this Regulation. A note to this effect shall be included in the information document.

5.4. **Location of belt anchorages** (see Annex 3, figure 1)

5.4.1. *General*

5.4.1.1. The belt anchorages for any one belt may be located either wholly in the vehicle structure or in the seat structure or any other part of the vehicle or dispersed between these locations.

5.4.1.2. Any one belt anchorage may be used for attaching the ends of two adjacent safety-belts, provided that the test requirements are met.

5.4.2. *Location of the effective lower belt anchorage*

5.4.2.1. Front seats, vehicle category M_1

In motor vehicles of category M_1 the angle α_1 (other than buckle side) shall be within the range of 30 to 80 degrees and the angle α_2 (buckle side) shall be within the range of 45 to 80 degrees. Both angle requirements shall be valid for all normal travelling positions of the front seats. Where at least one of the angles α_1 and α_2 is constant (e.g. anchorage fixed at the seat) in all normal positions of use, its value shall be $60 \pm 10^\circ$. In the case of adjustable seats with an adjusting device as described in paragraph 2.12 with a seatback angle of less than 20° (see Annex 3, figure 1), the angle α_1 may be below the minimum value (30°) stipulated above, provided it is not less than 20° in any normal position of use.

5.4.2.2. Rear seats, vehicle category M_1

In motor vehicles of category M_1 the angles α_1 and α_2 shall be within the range of 30 to 80 degrees for all rear seats. If rear seats are adjustable the above angles shall be valid for all normal travelling positions.

5.4.2.3. Front seats, vehicle categories other than M_1

In motor vehicles of categories other than M_1 the angles α_1 and α_2 must be between 30 and 80 degrees for all normal travelling positions of the front seats. Where in the case of front seats of vehicles having a maximum vehicle mass not exceeding 3,5 tonnes at least one of the angles α_1 and α_2 is constant in all normal positions of use, its value shall be $60 \pm 10^\circ$ (e.g. anchorage fixed at the seat).

5.4.2.4. Rear seats and special front or rear seats, vehicle categories other than M_1

In vehicles of categories other than M_1 , in the case of:

(a) bench seats,

(b) adjustable seats (front and rear) with an adjusting device as described in paragraph 2.12. with a seatback angle of less than 20° (see Annex 3, figure 1), and

⁽¹⁾ Document TRANS/WP29/78/Rev.1/Amend.2, as last amended by Amend.4.

(c) other rear seats

angles α_1 and α_2 may be between 20° and 80° in any normal position of use. Where in the case of front seats of vehicles having a maximum vehicle mass not exceeding 3,5 tonnes at least one of the angles α_1 and α_2 is constant in all normal positions of use, its value shall be $60 \pm 10^\circ$ (e.g. anchorage fixed at the seat).

In the case of seats, other than front seats, of vehicles in categories M_2 and M_3 , the angles α_1 and α_2 shall be between 45 and 90 degrees for all normal positions of use.

- 5.4.2.5. The distance between the two vertical planes parallel to the median longitudinal plane of the vehicle and each passing through a different one of the two effective lower belt anchorages L_1 and L_2 of the same safety-belt shall not be less than 350 mm. In the case of any central seating positions in rear rows of seats of vehicles of category M_1 and N_1 , the above-mentioned distance shall be not less than 240 mm, provided that it is not possible to exchange the centre rear seat with any of the other seats of the vehicle. The median longitudinal plane of the seat shall pass between points L_1 and L_2 and shall be at least 120 mm from these points.

5.4.3. *Location of the effective upper belt anchorages (see annex 3)*

- 5.4.3.1. If a strap guide or similar device is used which affects the location of the effective upper belt anchorage, this location shall be determined in a conventional way by considering the position of the anchorage when the longitudinal centre line of the strap passes through a point J_1 defined successively from the R point by the following three segments:

RZ: a segment of the torso line measured in an upward direction from R and 530 mm long;

ZX: a segment perpendicular to the median longitudinal plane of the vehicle, measured from point Z in the direction of the anchorage and 120 mm long;

X J_1 : a segment perpendicular to the plane defined by segments RZ and ZX, measured in a forward direction from point X and 60 mm long.

Point J_2 is determined by symmetry with point J_1 about the longitudinal vertical plane passing through the torso line described in paragraph 5.1.2 of the manikin positioned in the seat in question.

Where a two-door configuration is used to provide access to both the front and rear seats and the upper anchorage is fitted to the 'B' post, the system must be designed so as not to impede access to or egress from the vehicle.

- 5.4.3.2. The effective upper anchorage shall lie below the plane FN, which runs perpendicular to the longitudinal median plane of the seat and makes an angle of 65° with the torso line. The angle may be reduced to 60° in the case of rear seats. The plane FN shall be so placed as to intersect the torso line at a point D such that $DR = 315 \text{ mm} + 1,8 S$. However, when $S \leq 200 \text{ mm}$, then $DR = 675 \text{ mm}$.

- 5.4.3.3. The effective upper belt anchorage shall lie behind a plane FK running perpendicular to the longitudinal median plane of the seat and intersecting the torso line at an angle of 120° at a point B such that $BR = 260 \text{ mm} + S$. Where $S \geq 280 \text{ mm}$, the manufacturer may use $BR = 260 \text{ mm} + 0,8 S$ at his discretion.

- 5.4.3.4. The value of S shall not be less than 140 mm.

- 5.4.3.5. The effective upper belt anchorage shall be situated to the rear of a vertical plane perpendicular to the median longitudinal plane of the vehicle and passing through the R point as shown in annex 3.

- 5.4.3.6. The effective upper belt anchorage shall be situated above a horizontal plane passing through point C defined in paragraph 5.1.4.

5.4.3.7. In addition to the upper anchorage specified in paragraph 5.4.3.1 other effective upper anchorages may be provided if one of the following conditions is satisfied:

5.4.3.7.1. The additional anchorages comply with the requirements of paragraphs 5.4.3.1 to 5.4.3.6.

5.4.3.7.2. The additional anchorages can be used without the aid of tools, comply with the requirements of paragraphs 5.4.3.5 and 5.4.3.6 and are located in one of the areas determined by shifting the area shown in figure 1 of Annex 3 of this Regulation, 80 mm upwards or downwards in a vertical direction.

5.4.3.7.3. The anchorage(s) is/are intended for a harness belt, complies/comply with the requirements laid down in paragraph 5.4.3.6 if it lie(s) behind the transverse plane passing through the reference line and is/are located:

5.4.3.7.3.1. In the case of a single anchorage, within the area common to two dihedrals defined by the verticals passing through points J_1 and J_2 as defined in paragraph 5.4.3.1 and whose horizontal sections are shown in figure 2 of Annex 3 of this Regulation;

5.4.3.7.3.2. In the case of two anchorages, within whichever of the above defined dihedrals is suitable, provided that each anchorage is not more than 50 mm distant from the symmetrically-located, mirror-image position of the other anchorage about plane P, as defined in paragraph 5.1.6 of the seat in question.

5.5. **Dimensions of threaded anchorage holes**

5.5.1. An anchorage shall have a threaded hole of 7/16 inch (20 UNF 2B).

5.5.2. If the vehicle is fitted by the manufacturer with safety-belts which are attached to all anchorages prescribed for the seat in question, these anchorages need not meet the requirement set out in paragraph 5.5.1, provided that they comply with the other provisions of this Regulation. In addition, the requirement set out in paragraph 5.5.1 shall not apply to additional anchorages which meet the requirement set out in paragraph 5.4.3.7.3.

5.5.3. It shall be possible to remove the safety-belt without damaging the anchorage.

6. TESTS

6.1. **General tests for seat belt anchorages**

6.1.1. Subject to application of the provisions of paragraph 6.2, and at the request of the manufacturer;

6.1.1.1. the tests may be carried out either on a vehicle structure or on a completely finished vehicle;

6.1.1.2. The tests may be restricted to the anchorages relating to only one seat or one group of seats on the condition that:

(a) the anchorages concerned have the same structural characteristics as the anchorages relating to the other seats or group of seats; and

(b) where such anchorages are fitted totally or partially on the seat or group of seats, the structural characteristics of the seat or group of seats are the same as those for the other seats or groups of seats.

6.1.1.3. windows and doors may be fitted or not and closed or not;

6.1.1.4. any fitting normally provided and likely to contribute to the rigidity of the vehicle structure may be fitted.

- 6.1.2. The seats shall be fitted and placed in the position for driving or use chosen by the technical service responsible for conducting approval tests to give the most adverse conditions with respect to the strength of the system. The position of the seats shall be stated in the report. The seat-back shall, if its inclination is adjustable, be locked as specified by the manufacturer or, in the absence of any such specification, in a position corresponding to an effective seat-back angle as close as possible to 25° for vehicles of categories M₁ and N₁ and to 15° for vehicles of all other categories.

6.2. **Securing the vehicle for seat belt anchorages tests and for Isofix anchorages tests**

- 6.2.1. The method used to secure the vehicle during the test shall not be such as to strengthen the seat belt anchorages or the Isofix anchorages and their anchorage area or to lessen the normal deformation of the structure.
- 6.2.2. A securing device shall be regarded as satisfactory if it produces no effect on an area extending over the whole width of the structure and if the vehicle or the structure is blocked or fixed in front at a distance of not less than 500 mm from the anchorage to be tested and is held or fixed at the rear not less than 300 mm from that anchorage.
- 6.2.3. It is recommended that the structure should rest on supports arranged approximately in line with the axes of the wheels or, if that is not possible, in line with the points of attachment of the suspension.
- 6.2.4. If a securing method other than that prescribed in paragraphs 6.2.1 to 6.2.3 of this Regulation is used, evidence must be furnished that it is equivalent.

6.3. **General test requirements for seat belt anchorages**

- 6.3.1. All the belt anchorages of the same group of seats shall be tested simultaneously. However, if there is a risk that non-symmetrical loading of the seats and/or anchorages may lead to failures, an additional test may be carried out with non-symmetrical loading.

- 6.3.2. The tractive force shall be applied in a direction corresponding to the seating position at an angle of 10 degrees $\pm$ 5° above the horizontal in a plane parallel to the median longitudinal plane of the vehicle.

A preload of 10 per cent with a tolerance of $\pm$ 30 per cent of the target load shall be applied; the load shall be increased to 100 per cent of the relevant target load.

- 6.3.3. Full application of the load shall be achieved as rapidly as possible, and within a maximum load application time of 60 seconds.

However, the manufacturer may request the application of the load to be achieved within 4 seconds.

The belt anchorages must withstand the specified load for not less than 0,2 second.

- 6.3.4. Traction devices to be used in the tests described in paragraph 6.4 below are shown in annex 5. The devices shown in Annex 5, figure 1 are placed onto the seat cushion and then, when possible, pushed back into the seat back while the belt strap is pulled tight around it. The device shown in Annex 5, figure 2 is placed in position, the belt strap is fitted over the device and pulled tight. No preload beyond the minimum necessary for correct positioning of the test device shall be introduced to safety-belt anchorages during this operation.

The traction device of either 254 mm or 406 mm used at each seating position shall be such that its width is as close as possible to the distance between the lower anchorages.

The positioning of the traction device shall avoid any mutual influences during the pull test which adversely affects the load and load distribution.

- 6.3.5. The belt anchorages for seats for which upper belt anchorages are provided shall be tested under the following conditions:

6.3.5.1. Front outboard seats:

The belt anchorages shall be submitted to the test prescribed in paragraph 6.4.1 in which the loads are transmitted to them by means of a device reproducing the geometry of a three-point belt equipped with a retractor having a pulley or strap guide at the upper belt anchorage. In addition, if the number of anchorages is more than that prescribed in paragraph 5.3., these anchorages shall be subjected to the test specified in paragraph 6.4.5, in which the loads shall be transmitted to the anchorages by means of a device reproducing the geometry of the type of safety-belt intended to be attached to them.

- 6.3.5.1.1. In the case where the retractor is not attached to the required outboard lower belt anchorage or in the case where the retractor is attached to the upper belt anchorage, the lower belt anchorages shall also be submitted to the test prescribed in paragraph 6.4.3.

- 6.3.5.1.2. In the above case the tests prescribed in paragraphs 6.4.1 and 6.4.3 can be performed on two different structures if the manufacturer so requests.

6.3.5.2. Rear outboard seats and all centre seats:

The belt anchorages shall be subjected to the test prescribed in paragraph 6.4.2 in which the loads are transmitted to them by means of a device reproducing the geometry of a three-point safety-belt without a retractor, and to the test prescribed in paragraph 6.4.3, in which the loads are transmitted to the two lower belt anchorages by means of a device reproducing the geometry of a lap belt. The two tests can be performed on two different structures if the manufacturer so requests.

- 6.3.5.3. When a manufacturer supplies his vehicle with safety-belts, the corresponding belt anchorages may, at the request of the manufacturer, be submitted only to a test in which the loads are transmitted to them by means of a device reproducing the geometry of the type of belts to be attached to these anchorages.

- 6.3.6. If no upper belt anchorages are provided for the outboard seats and the centre seats, the lower belt anchorages shall be submitted to the test prescribed in paragraph 6.4.3, in which the loads are transmitted to these anchorages by means of a device reproducing the geometry of a lap belt.

- 6.3.7. If the vehicle is designed to accept other devices which do not enable the straps to be directly attached to belt anchorages without intervening sheaves, etc. or which require belt anchorages supplementary to those mentioned in paragraph 5.3, the safety-belt or an arrangement of wires, sheaves, etc. representing the equipment of the safety-belt, shall be attached by such a device to the belt anchorages in the vehicle and the belt anchorages shall be subjected to the tests prescribed in paragraph 6.4, as appropriate.

- 6.3.8. A test method other than those prescribed in paragraph 6.3 may be used, but evidence must be furnished that it is equivalent.

6.4. Particular test requirements for seat belt anchorages

- 6.4.1. *Test in configuration of a three-point belt incorporating a retractor having a pulley or strap guide at the upper belt anchorage*

- 6.4.1.1. A special pulley or guide for the wire or strap appropriate to transmit the load from the traction device, or the pulley or strap guide supplied by the manufacturer shall be fitted to the upper belt anchorage.

- 6.4.1.2. A test load of $1\,350 \text{ daN} \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 2) attached to the belt anchorages of the same belt, by means of a device reproducing the geometry of the upper torso strap of such a safety-belt. In the case of vehicles of categories other than M_1 and N_1 , the test load shall be $675 \pm 20 \text{ daN}$, except that for M_3 and N_3 vehicles the test load shall be $450 \pm 20 \text{ daN}$.
- 6.4.1.3. At the same time a tractive force of $1\,350 \text{ daN} \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 1) attached to the two lower belt anchorages. In the case of vehicles of categories other than M_1 and N_1 , the test load shall be $675 \pm 20 \text{ daN}$, except that for M_3 and N_3 vehicles the test load shall be $450 \pm 20 \text{ daN}$.
- 6.4.2. *Test in configuration of a three-point belt without retractor or with a retractor at the upper belt anchorage*
- 6.4.2.1. A test load of $1\,350 \text{ daN} \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 2) attached to the upper belt anchorage and to the opposite lower belt anchorage of the same belt using, if supplied by the manufacturer, a retractor fixed at the upper belt anchorage. In the case of vehicles of categories other than M_1 and N_1 , the test load shall be $675 \pm 20 \text{ daN}$, except that for M_3 and N_3 vehicles the test load shall be $450 \pm 20 \text{ daN}$.
- 6.4.2.2. At the same time a tractive force of $1\,350 \text{ daN} \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 1) attached to the lower belt anchorages. In the case of vehicles of categories other than M_1 and N_1 , the test load shall be $675 \pm 20 \text{ daN}$, except that for M_3 and N_3 vehicles the test load shall be $450 \pm 20 \text{ daN}$.
- 6.4.3. *Test in configuration of a lap belt*
- A test load of $2\,225 \text{ daN} \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 1) attached to the two lower belt anchorages. In the case of vehicles of categories other than M_1 and N_1 , the test load shall be $1\,110 \pm 20 \text{ daN}$, except that for M_3 and N_3 vehicles the test load shall be $740 \pm 20 \text{ daN}$.
- 6.4.4. *Test for belt anchorages located wholly within the seat structure or dispersed between the vehicle structure and the seat structure*
- 6.4.4.1. The test specified in paragraphs 6.4.1, 6.4.2 and 6.4.3 above shall be performed, as appropriate, at the same time superimposing for each seat and for each group of seats a force as stated below.
- 6.4.4.2. The loads indicated in paragraphs 6.4.1, 6.4.2 and 6.4.3 above shall be supplemented by a force equal to 20 times the mass of the complete seat. The inertia load shall be applied to the seat or to the relevant parts of the seat corresponding to the physical effect of the mass of the seat in question to the seat anchorages. The determination of the additional applied load or loads and the load distribution shall be made by the manufacturer and agreed by the Technical Service.
- In the case of vehicles in categories M_2 and N_2 , this force must be equal to 10 times the mass of the complete seat; for categories M_3 and N_3 it shall be equal to 6.6 times the mass of the complete seat.
- 6.4.5. *Test in configuration of a special-type belt*
- 6.4.5.1. A test load of $1\,350 \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 2) attached to the belt anchorages of such a safety-belt by means of a device reproducing the geometry of the upper torso strap or straps.
- 6.4.5.2. At the same time, a tractive force of $1\,350 \pm 20 \text{ daN}$ shall be applied to a traction device (see Annex 5, figure 3) attached to the two lower belt anchorages.

6.4.5.3. In the case of vehicles of categories other than M_1 and N_1 , this test load shall be 675 ± 20 daN, except that for M_3 and N_3 vehicles the test load shall be 450 ± 20 daN.

6.4.6. *Test in the case of rearward-facing seats*

6.4.6.1. The anchorage points shall be tested according to the forces prescribed in paragraphs 6.4.1, 6.4.2 or 6.4.3, as appropriate. In each case the test load shall correspond to the load prescribed for M_3 or N_3 vehicles.

6.4.6.2. The test load shall be directed forward in relation to the seating position in question, corresponding to the procedure prescribed in paragraph 6.3.

6.5. In the case of a group of seats as described in paragraph 1 of Annex 7, the dynamic test of Annex 7 can be performed, at the option of the car manufacturer, as an alternative to the static test prescribed in paragraphs 6.3 and 6.4.

6.6. **Static test requirements**

6.6.1. The strength of the Isofix anchorage systems shall be tested applying the forces, as prescribed in paragraph 6.6.4.3, to the static force application device (SFAD) with Isofix attachments well engaged.

In case of Isofix top tether anchorage an additional test shall be performed as prescribed in paragraph 6.6.4.4.

All the Isofix positions of a same seat row, which can be used simultaneously, shall be tested simultaneously.

6.6.2. The test may be carried out either on a completely finished vehicle or on sufficient parts of the vehicle so as to be representative of the strength and rigidity of the vehicle structure.

Windows and doors may be fitted or not and closed or not.

Any fitting normally provided and likely to contribute to the vehicle structure may be fitted.

The test may be restricted to the Isofix position relating to only one seat or group of seats on the condition that:

- (a) The Isofix position concerned has the same structural characteristics as the Isofix position relating to the other seats or group of seats and,
- (b) Where such Isofix positions are fitted totally or partially on the seat or group of seats, the structural characteristics of the seat or group of seats are the same as those for the other seats or groups of seats.

6.6.3. If the seats and head restraint are adjustable, they shall be tested in the position defined by the technical service within the limited range prescribed by the car manufacturer as provided in appendix 3 of Annex 17 of Regulation No 16.

6.6.4. *Forces, directions and excursion limits*

6.6.4.1. A force of $135 \text{ N} \pm 15 \text{ N}$ shall be applied to the centre of the lower front crossbar of the SFAD in order to adjust the fore-aft position of the SFAD rearward extension to remove any slack or tension between the SFAD and its support.

- 6.6.4.2. Forces shall be applied to the static force application device (SFAD) in forward and oblique directions according to table 1.

Table 1

Directions of test forces

Forward	$0^\circ \pm 5^\circ$	8 kN $\pm$ 0,25 kN
Oblique	$75^\circ \pm 5^\circ$ (to both sides of straight forward, or if any worst case side, or if both side are symmetric, only one side)	5 kN $\pm$ 0,25 kN

Each of these tests may be performed on different structures if the manufacturer so requests.

Forces in the forward direction shall be applied with an initial force application angle of $10^\circ \pm 5^\circ$ above the horizontal. Oblique forces shall be applied horizontally $0^\circ \pm 5^\circ$. A pre-load force of 500 N $\pm$ 25 N shall be applied at the prescribed loading point X indicated in figure 2 annex 9. Full application of the force shall be achieved within a period of 2 s or less. The force shall be maintained for a minimum period of 0,2 s.

All measurements shall be made according to ISO 6487 with CFC of 60 Hz or any equivalent method.

- 6.6.4.3. Tests of Isofix anchorages system only:

- 6.6.4.3.1. Forward direction force test:

Horizontal longitudinal excursion (after pre-load) of point X of SFAD during application of the 8 kN $\pm$ 0,25 kN force shall be limited to 125 mm and permanent deformation including partial rupture or breakage of any Isofix low anchorage or surrounding area shall not constitute failure if the required force is sustained for the specified time.

- 6.6.4.3.2. Oblique direction force test:

Excursion in the direction of the force (after pre-load) of point X of SFAD during application of the 5 kN $\pm$ 0,25 kN force shall be limited to 125 mm and permanent deformation including partial rupture or breakage of any Isofix low anchorage or surrounding area shall not constitute failure if the required force is sustained for the specified time.

- 6.6.4.4. Test of Isofix anchorages systems and Isofix top tether anchorage:

A tension pre-load of 50 N $\pm$ 5 N must be applied between the SFAD and the top-tether anchorage. Horizontal excursion (after pre-load) of point X during application of the 8 kN $\pm$ 0,25 kN force shall be limited to 125 mm and permanent deformation including partial rupture or breakage of any Isofix low anchorage and top tether anchorage, or surrounding area shall not constitute failure if the required force is sustained for the specified time.

Table 2

Excursions limits

Force direction	Maximum excursion of point X of SFAD
Forward	125 mm longitudinal
Oblique	125 mm force direction

6.6.5. *Additional forces*

6.6.5.1. *Seat inertia forces*

For the installation position where the load is transferred into a vehicle seat assembly, and not directly into the vehicle structure, a test shall be carried out to ensure that the strength of the vehicle seat anchorages to the vehicle structure is sufficient. In this test, a force equal to 20 times the mass of the relevant parts of the seat assembly shall be applied horizontally and longitudinally in a forward direction to the seat or the relevant part of the seat assembly corresponding to the physical effect of the mass of the seat in question to the seat anchorages. The determination of the additional applied load or loads and the load distribution shall be made by the manufacturer and agreed by the technical service.

At the request of the manufacturer, the additional load can be applied at the X point of SFAD during the static tests described above.

If the top tether anchorage is integrated to the vehicle seat, this test shall be performed with the Isofix top tether strap.

No breakage shall occur and excursion requirements given in the table 2 have to be fulfilled.

Note: This test does not have to be performed in case of any anchorage of the vehicle safety-belt system is integrated to the vehicle seat structure, and the vehicle seat is already tested and approved to meet the anchorage load tests required by this Regulation for adult passenger restraint.

7. INSPECTION DURING AND AFTER STATIC TESTS FOR SAFETY-BELT ANCHORAGES

7.1. All the anchorages shall be capable of withstanding the test prescribed in paragraphs 6.3. and 6.4. Permanent deformation, including partial rupture or breakage of any anchorage or surrounding area, shall not constitute failure if the required force is sustained for the specified time. During the test, the minimum spacings for the effective lower belt anchorages specified in paragraph 5.4.2.5 and the requirements of paragraph 5.4.3.6 for effective upper belt anchorages shall be respected.

7.1.1. For vehicles of category M₁ of a total permissible mass not exceeding 2,5 tonnes, if the upper safety-belt anchorage is attached to the seat structure, the effective upper safety-belt anchorage shall not be displaced during the test forward of a transverse plane passing through the R point and point C of the seat in question (see figure 1 of Annex 3 to this Regulation)

For vehicles other than mentioned above, the effective upper safety-belt anchorage shall not be displaced during the test forward of a transverse plane inclined 10° in forward direction and passing through the R point of the seat.

The maximum displacement of the effective upper anchorage point shall be measured during the test.

If the displacement of the effective upper anchorage point exceeds the above-mentioned limitation, the manufacturer shall demonstrate to the satisfaction of the technical service that there is no danger to the occupant. As an example, the test procedure according to Regulation No 94 or a sled test with corresponding pulse may be carried out to demonstrate a sufficient survival space.

7.2. In vehicles where such devices are used, the displacement and locking devices enabling the occupants of all seats to leave the vehicle must still be operable by hand after the tractive force was removed.

7.3. After testing any damage to the anchorages and structures supporting load during tests shall be noted.

7.4. By derogation, the upper anchorages fitted to one or more seats of vehicles of category M₃ and those of category M₂ with a maximum mass exceeding 3,5 tonnes, which meet the requirements of Regulation No 80, need not to comply with the requirements of paragraph 7.1 concerning compliance with paragraph 5.4.3.6.

8. MODIFICATIONS AND EXTENSION OF APPROVAL OF THE VEHICLE TYPE

8.1. Every modification of the vehicle type shall be notified to the administrative department which approved the vehicle type. The department may then either:

8.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the vehicle still complies with the requirements; or

8.1.2. require a further test report from the technical service responsible for conducting the tests.

8.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.3 above to the Parties to the Agreement which apply this Regulation.

8.3. The competent authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

9. CONFORMITY OF PRODUCTION

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

9.1. Every vehicle bearing an approval mark as prescribed under this Regulation shall conform to the vehicle type approved with regard to details affecting the characteristics of the safety-belt anchorages and the Isofix anchorages system and Isofix top tether anchorage.

9.2. In order to verify conformity as prescribed in paragraph 9.1 above, a sufficient number of serially-produced vehicles bearing the approval mark required by this Regulation shall be subjected to random checks.

9.3. As a general rule the checks as aforesaid shall be confined to the taking of measurements. However, if necessary, the vehicles shall be subjected to some of the tests described in paragraph 6 above, selected by the technical service conducting approval tests.

10. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

10.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirement laid down in paragraph 9.1 above is not complied with or if its safety-belt anchorages or the Isofix anchorages system and Isofix top tether anchorage failed to pass the checks prescribed in paragraph 9 above.

10.2. If a Contracting Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1 to this Regulation.

11. OPERATING INSTRUCTIONS

The national authorities may require the manufacturers of vehicles registered by them to state clearly in the instructions for operating the vehicle:

11.1. where the anchorages are; and

11.2. for what types of belts the anchorages are intended (see Annex 1, item 5).

12. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of safety-belt anchorages or a type of Isofix anchorages system and Isofix top tether anchorage approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement, which apply this Regulation by means of a communication form conforming to the model in Annex 1 to this Regulation.

13. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations secretariat the names and addresses of the technical services responsible for conducting approval tests and of the administrative departments which grant approval and to which forms certifying approval or extension, or refusal or extension or withdrawal of approval, issued in other countries, are to be sent.

14. TRANSITIONAL PROVISIONS

14.1. As from the official date of entry into force of the 06 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approvals under this Regulation as amended by the 06 series of amendments.

14.2. As from 2 years after the enter into force of the 06 series of amendments to this Regulation, Contracting Parties applying this Regulation shall grant ECE type approvals only if the requirements of this Regulation, as amended by the 06 series of amendments, are satisfied.

14.3. As from 7 years after the enter into force of the 06 series of amendments to this Regulation, Contracting Parties applying this Regulation may refuse to recognize approvals which were not granted in accordance with the 06 series of amendments to this Regulation.

14.4. For vehicles not affected by paragraph 7.1.1 above, approvals granted according to the 04 series of amendments to this Regulation shall remain valid.

14.5. For vehicles not affected by Supplement 4 to the 05 series of amendments to this Regulation the existing approvals shall remain valid, if they had been granted in compliance with the 05 series of amendments, up to its Supplement 3.

14.6. As from the official date of entry into force of Supplement 5 to the 05 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approvals under this Regulation as modified by Supplement 5 to the 05 series of amendments.

14.7. For vehicles not affected by Supplement 5 to the 05 series of amendments to this Regulation the existing approvals shall remain valid, if they had been granted in compliance with the 05 series of amendments, up to its Supplement 3.

14.8. As from 20 February 2005 for vehicles of category M₁, Contracting Parties applying this Regulation shall grant ECE approvals only if the requirements of this Regulation, as amended by Supplement 5 to the 05 series of amendments, are satisfied.

14.9. As from 20 February 2007 for vehicles of category M₁, Contracting Parties applying this Regulation may refuse to recognize approvals which were not granted in accordance with Supplement 5 to the 05 series of amendments to this Regulation.

14.10. As from 16 July 2006 for vehicles of category N, Contracting Parties applying this Regulation shall grant approval only if the vehicle type satisfies the requirements of this Regulation as amended by the Supplement 5 to the 05 series of amendments.

14.11. As from 16 July 2008 for vehicles of category N, Contracting Parties applying this Regulation may refuse to recognize approvals not granted in accordance with Supplement 5 to the 05 series of amendments to this Regulation.

ANNEX 1

COMMUNICATION

[maximum format: A4 (210 × 297 mm)]



issued by: Name of administration

.....

.....

.....

concerning: ⁽²⁾

APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to safety-belt anchorages and Isofix anchorages systems and Isofix top tether anchorage if any pursuant to Regulation No 14.

Approval No

Extension No

1. Trade name or mark of the power-driven vehicle:
2. Type of vehicle:
3. Manufacturer's name and address:
4. If applicable, name and address of manufacturer's representative:
5. Designation of the type of belts and retractors authorized for fitting to the anchorages with which the vehicle is equipped:

		Anchorage on (*)	
		vehicle structure	seat structure
Front	Right-hand seat	{ lower anchorages { outboard upper anchorage inboard	
	Middle seat	{ lower anchorages { right upper anchorage left	
	Left-hand seat	{ lower anchorages { outboard upper anchorage inboard	
Rear	Right-hand seat	{ lower anchorages { outboard upper anchorage inboard	
	Middle seat	{ lower anchorages { right upper anchorage left	
	Left-hand seat	{ lower anchorages { outboard upper anchorage inboard	
(*) Insert in the actual position the following letter(s): 'A' for a three-point belt, 'B' for lap belts, 'S' for special-type belts; in this case the type shall be stated under 'Remarks', 'Ar', 'Br' or 'Sr' for belts with retractors, 'Ae', 'Be' or 'Se' for belts with an energy absorption device, 'Are', 'Bre' or 'Sre' for belts with retractors and energy-absorption devices on at least one anchorage.			

Remarks:

6. Description of seats ⁽³⁾:
7. Description of the adjustment, displacement and locking systems either of the seat or of its parts ⁽³⁾:
.....
8. Description of seat anchorage ⁽³⁾:
9. Description of particular type of safety-belt required in the case of an anchorage located in the seat structure or incorporating an energy-dissipating device:
10. Vehicle submitted for approval on:
11. Technical service responsible for conducting approval tests:
12. Date of report issued by that service:
13. Number of report issued by that service:
14. Approval granted/extended/refused/withdrawn ⁽²⁾
15. Position of approval mark on vehicle:
16. Place:
17. Date:
18. Signature:
19. The following documents, filed with the administration service which has granted approval and available on request are annexed to this communication:
 - drawings, diagrams and plans of the belt anchorages, Isofix anchorages systems, of the top tether anchorages if any, and of the vehicle structure;
 - photographs of the belt anchorages, of the Isofix anchorages systems, of the top tether if any, and of the vehicle structure;
 - drawings, diagrams and plans of the seats, of their anchorage on the vehicle, of the adjustment and displacement systems of the seats and of their parts and of their locking devices ⁽³⁾;
 - photographs of the seats, of their anchorage, of the adjustment and displacement systems of the seats and of their parts, and of their locking devices ⁽³⁾.

⁽¹⁾ Distinguishing number of the country, which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

⁽²⁾ Strike out what does not apply.

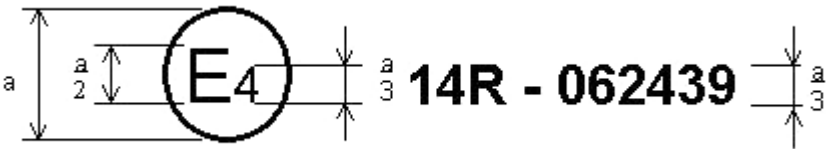
⁽³⁾ Only if the anchorage is affixed on the seat or if the seat supports the belt strap.

ANNEX 2

ARRANGEMENTS OF THE APPROVAL MARK

MODEL A

(see paragraph 4.4 of this Regulation)

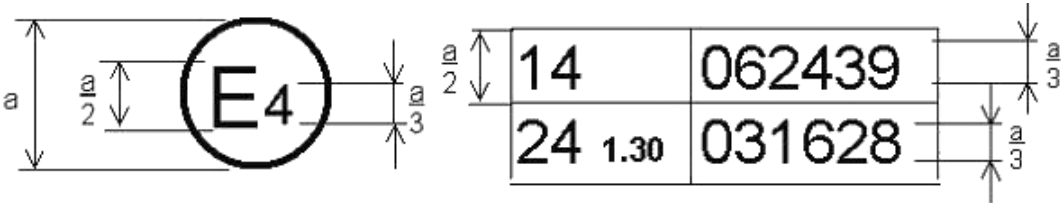


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to safety-belt anchor-ages, been approved in the Netherlands (E4), pursuant to Regulation No 14, under the number 062439. The first two digits of the approval number indicate that Regulation No 14 already included the 06 series of amendments when the approval was given.

MODEL B

(see paragraph 4.5 of this Regulation)



a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E4) pursuant to Regulations Nos 14 and 24 (*). (In the case of the latter Regulation the corrected absorption co-efficient is 1,30 m⁻¹.) The approval numbers indicate that on the dates on which these approvals were granted, Regulation No 14 included the 06 series of amendments and Regulation No 24 was in its 03 series of amendments.

(*) The second number is given merely as an example.

ANNEX 3

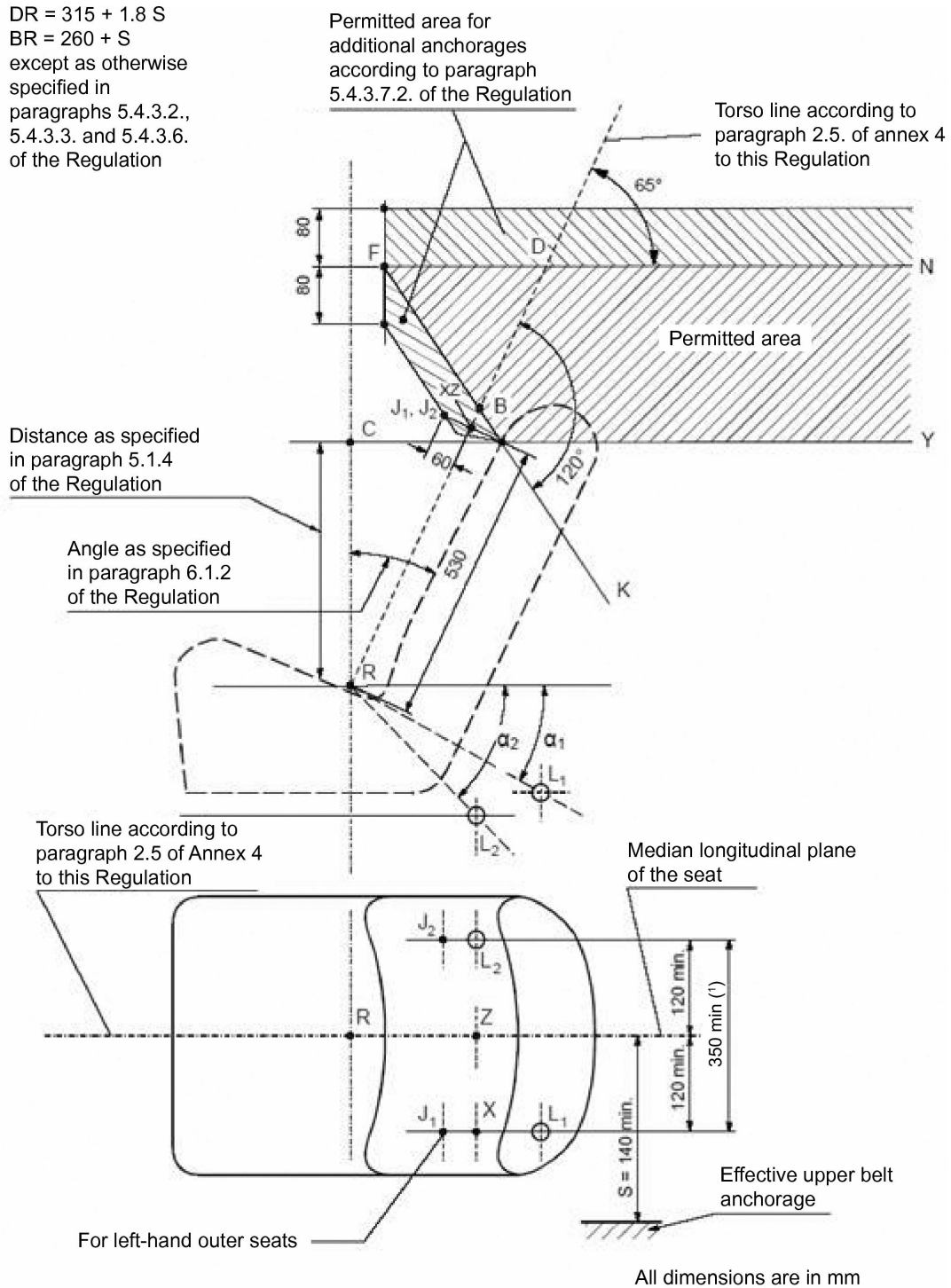
LOCATION OF EFFECTIVE BELT ANCHORAGES

Figure 1

Areas of location of effective belt anchorages

(The drawing shows one example, where the upper anchorage is fixed to the vehicle body side panel)

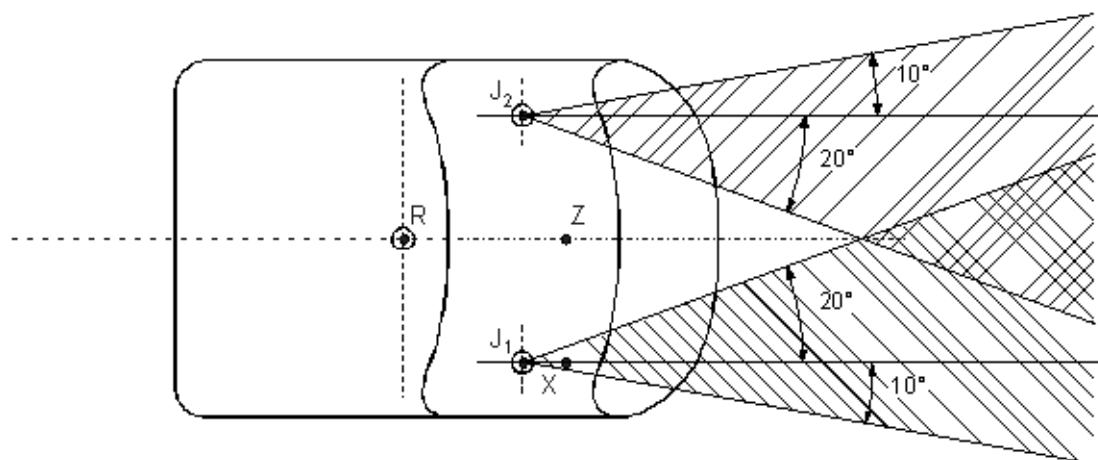
$DR = 315 + 1.8 S$
 $BR = 260 + S$
 except as otherwise
 specified in
 paragraphs 5.4.3.2.,
 5.4.3.3. and 5.4.3.6.
 of the Regulation



(¹) 240 mm minimum for the central rear seating positions of M₁ and N₁ categories of vehicles.

Figure 2

Effective upper anchorages conforming to paragraph 5.4.3.7.3 of the Regulation



ANNEX 4

PROCEDURE FOR DETERMINING THE 'H' POINT AND THE ACTUAL TORSO ANGLE FOR SEATING POSITIONS IN MOTOR VEHICLES**1. PURPOSE**

The procedure described in this annex is used to establish the 'H' point location and the actual torso angle for one or several seating positions in a motor vehicle and to verify the relationship of measured data to design specifications given by the vehicle manufacturer ⁽¹⁾.

2. DEFINITIONS

For the purposes of this annex:

- 2.1. 'Reference data' means one or several of the following characteristics of a seating position:
 - 2.1.1. the 'H' point and the 'R' point and their relationship,
 - 2.1.2. the actual torso angle and the design torso angle and their relationship.
- 2.2. 'Three-dimensional "H" point machine' (3-D H machine) means the device used for the determination of 'H' points and actual torso angles. This device is described in appendix 1 to this annex;
- 2.3. "'H" point' means the pivot centre of the torso and the thigh of the 3-D H machine installed in the vehicle seat in accordance with paragraph 4 below. The 'H' point is located in the centre of the centreline of the device which is between the 'H' point sight buttons on either side of the 3-D H machine. The 'H' point corresponds theoretically to the 'R' point (for tolerances see paragraph 3.2.2 below). Once determined in accordance with the procedure described in paragraph 4, the 'H' point is considered fixed in relation to the seat-cushion structure and to move with it when the seat is adjusted;
- 2.4. "'R" point' or 'seating reference point' means a design point defined by the vehicle manufacturer for each seating position and established with respect to the three-dimensional reference system;
- 2.5. 'Torso-line' means the centreline of the probe of the 3-D H machine with the probe in the fully rearward position;
- 2.6. 'Actual torso angle' means the angle measured between a vertical line through the 'H' point and the torso line using the back angle quadrant on the 3-D H machine. The actual torso angle corresponds theoretically to the design torso angle (for tolerances see paragraph 3.2.2 below);
- 2.7. 'Design torso angle' means the angle measures between a vertical line through the 'R' point and the torso line in a position which corresponds to the design position of the seat-back established by the vehicle manufacturer;
- 2.8. 'Centreplane of occupant' (C/LO) means the median plane of the 3-D H machine positioned in each designated seating position; it is represented by the co-ordinate of the 'H' point on the 'Y' axis. For individual seats, the centreplane of the seat coincides with the centreplane of the occupant. For other seats, the centreplane of the occupant is specified by the manufacturer;
- 2.9. 'Three-dimensional reference system' means a system as described in appendix 2 to this annex;
- 2.10. 'Fiducial marks' are physical points (holes, surfaces, marks or indentations) on the vehicle body as defined by the manufacturer;
- 2.11. 'Vehicle measuring attitude' means the position of the vehicle as defined by the co-ordinates of fiducial marks in the three-dimensional reference system.

⁽¹⁾ In any seating position other than front seats where the 'H' point cannot be determined using the 'Three-dimensional "H" point machine' or procedures, the 'R' point indicated by the manufacturer may be taken as a reference at the discretion of the competent authority.

3. REQUIREMENTS

3.1. Data presentation

For each seating position where reference data are required in order to demonstrate compliance with the provisions of the present Regulation, all or an appropriate selection of the following data shall be presented in the form indicated in appendix 3 to this annex:

- 3.1.1. the co-ordinates of the 'R' point relative to the three-dimensional reference system;
- 3.1.2. the design torso angle;
- 3.1.3. all indications necessary to adjust the seat (if it is adjustable) to the measuring position set out in paragraph 4.3. below.

3.2. Relationship between measured data and design specifications

- 3.2.1. The co-ordinates of the 'H' point and the value of the actual torso angle obtained by the procedure set out in paragraph 4. below shall be compared, respectively, with the co-ordinates of the 'R' point and the value of the design torso angle indicated by the vehicle manufacturer.
- 3.2.2. The relative positions of the 'R' point and the 'H' point and the relationship between the design torso angle and the actual torso angle shall be considered satisfactory for the seating position in question if the 'H' point, as defined by its co-ordinates, lies within a square of 50 mm side length with horizontal and vertical sides whose diagonals intersect at the 'R' point, and if the actual torso angle is within 5° of the design torso angle.
- 3.2.3. If these conditions are met, the 'R' point and the design torso angle, shall be used to demonstrate compliance with the provisions of this Regulation.
- 3.2.4. If the 'H' point or the actual torso angle does not satisfy the requirements of paragraph 3.2.2 above, the 'H' point and the actual torso angle shall be determined twice more (three times in all). If the results of two of these three operations satisfy the requirements, the conditions of paragraph 3.2.3 above shall apply.
- 3.2.5. If the results of at least two of the three operations described in paragraph 3.2.4 above do not satisfy the requirements of paragraph 3.2.2 above, or if the verification cannot take place because the vehicle manufacturer has failed to supply information regarding the position of the 'R' point or regarding the design torso angle, the centroid of the three measured points or the average of the three measured angles shall be used and be regarded as applicable in all cases where the 'R' point or the design torso angle is referred to in this Regulation.

4. PROCEDURE FOR 'H' POINT AND ACTUAL TORSO ANGLE DETERMINATION

- 4.1. The vehicle shall be preconditioned at the manufacturer's discretion, at a temperature of 20 ± 10 °C to ensure that the seat material reached room temperature. If the seat to be checked has never been sat upon, a 70 to 80 kg person or device shall sit on the seat twice for one minute to flex the cushion and back. At the manufacturer's request, all seat assemblies shall remain unloaded for a minimum period of 30 min prior to installation of the 3-D H machine.
- 4.2. The vehicle shall be at the measuring attitude defined in paragraph 2.11 above.
- 4.3. The seat, if it is adjustable, shall be adjusted first to the rearmost normal driving or riding position, as indicated by the vehicle manufacturer, taking into consideration only the longitudinal adjustment of the seat, excluding seat travel used for purposes other than normal driving or riding positions. Where other modes of seat adjustment exist (vertical, angular, seat-back, etc.) these will then be adjusted to the position specified by the vehicle manufacturer. For suspension seats, the vertical position shall be rigidly fixed corresponding to a normal driving position as specified by the manufacturer.
- 4.4. The area of the seating position contacted by the 3-D H machine shall be covered by a muslin cotton, of sufficient size and appropriate texture, described as a plain cotton fabric having 18,9 threads per cm² and weighing 0,228 kg/m² or knitted or non-woven fabric having equivalent characteristics. If test is run on a seat outside the vehicle, the floor on which the seat is placed shall have the same essential characteristics ⁽¹⁾ as the floor of the vehicle in which the seat is intended to be used.

⁽¹⁾ Tilt angle, height difference with a seat mounting, surface texture, etc.

- 4.5. Place the seat and back assembly of the 3-D H machine so that the centreplane of the occupant (C/LO) coincides with the centreplane of the 3-D H machine. At the manufacturer's request, the 3-D H machine may be moved inboard with respect to the C/LO if the 3-D H machine is located so far outboard that the seat edge will not permit levelling of the 3-D H machine.
- 4.6. 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.
- 4.7. Adjust the feet and leg positions of the 3-D H machine as follows:
- 4.7.1. Designated seating position: driver and outside front passenger
- 4.7.1.1. 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 3-D H machine as the right foot is to the right. The spirit level verifying the transverse orientation of the 3-D H 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.
- 4.7.1.2. If the left leg cannot be kept parallel to the right leg and the left foot cannot be supported by the structure, move the left foot until it is supported. The alignment of the sight buttons shall be maintained.
- 4.7.2. Designated seating position: outboard rear
- For rear seats or auxiliary seats, the legs are located as specified by the manufacturer. If the feet then rest on parts of the floor, which are at different levels, the foot which first comes into contact with the front seat shall serve as a reference and the other foot shall be so arranged that the spirit level giving the transverse orientation of the seat of the device indicates the horizontal.
- 4.7.3. Other designated seating positions
- The general procedure indicated in paragraph 4.7.1 above shall be followed except that the feet shall be placed as specified by the vehicle manufacturer.
- 4.8. Apply lower leg and thigh weights and level the 3-D H machine.
- 4.9. Tilt the back pan forward against the forward stop and draw the 3-D H machine away from the seat-back using the T-bar. Reposition the 3-D H machine on the seat by one of the following methods:
- 4.9.1. If the 3-D H machine tends to slide rearward, use the following procedure. Allow the 3-D H 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.
- 4.9.2. If the 3-D H machine does not tend to slide rearward, use the following procedure. Slide the 3-D H machine rearwards by applying a horizontal rearward load to the T-bar until the seat pan contacts the seat-back (see figure 2 of appendix 1 to this annex).
- 4.10. Apply a 100 ± 10 N load to the back and pan assembly of the 3-D H 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 (see figure 2 of appendix 1 to this annex). Then carefully return the back pan to the seat-back. Care must be exercised throughout the remainder of the procedure to prevent the 3-D H machine from sliding forward.
- 4.11. Install the right and left buttock weights and then, alternately, the eight torso weights. Maintain the 3-D H machine level.
- 4.12. Tilt the back pan forward to release the tension on the seat-back. Rock the 3-D H machine from side to side through 10° arc (5° to each side of the vertical centreplane) for three complete cycles to release any accumulated friction between the 3-D H machine and the seat.

During the rocking action, the T-bar of the 3-D H 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 3-D H machine are not to be restrained or held during this step. If the feet change position, they should be allowed to remain in that attitude for the moment.

Carefully return the back pan to the seat-back and check the two spirit levels for zero position. If any movement of the feet has occurred during the rocking operation of the 3-D H 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.

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 3-D H machine's seat pan on the seat.

- 4.13. Holding the T-bar to prevent the 3-D H machine from sliding forward on the seat cushion, proceed as follows:
- (a) return the back pan to the seat-back;
 - (b) 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 3-D H machine. If another level adjustment of the 3-D H machine is necessary, rotate the back pan forward, re-level, and repeat the procedure from paragraph 4.12.
- 4.14. Take all measurements:
- 4.14.1. The co-ordinates of the 'H' point are measured with respect to the three-dimensional reference system.
 - 4.14.2. The actual torso angle is read at the back angle quadrant of the 3-D H machine with the probe in its fully rearward position.
- 4.15. If a re-run of the installation of the 3-D H machine is desired, the seat assembly should remain unloaded for a minimum period of 30 min prior to the re-run. The 3-D H machine should not be left loaded on the seat assembly longer than the time required to perform the test.
- 4.16. If the seats in the same row can be regarded as similar (bench seat, identical seats, etc.) only one 'H' point and one 'actual torso angle' shall be determined for each row of seats, the 3-D H machine described in appendix 1 to this annex being seated in a place regarded as representative for the row. This place shall be:
- 4.16.1. in the case of the front row, the driver's seat;
 - 4.16.2. in the case of the rear row or rows, an outer seat.
-

*Appendix 1***DESCRIPTION OF THE THREE DIMENSIONAL 'H' POINT MACHINE (*)****(3-D H machine)****1. BACK AND SEAT PANS**

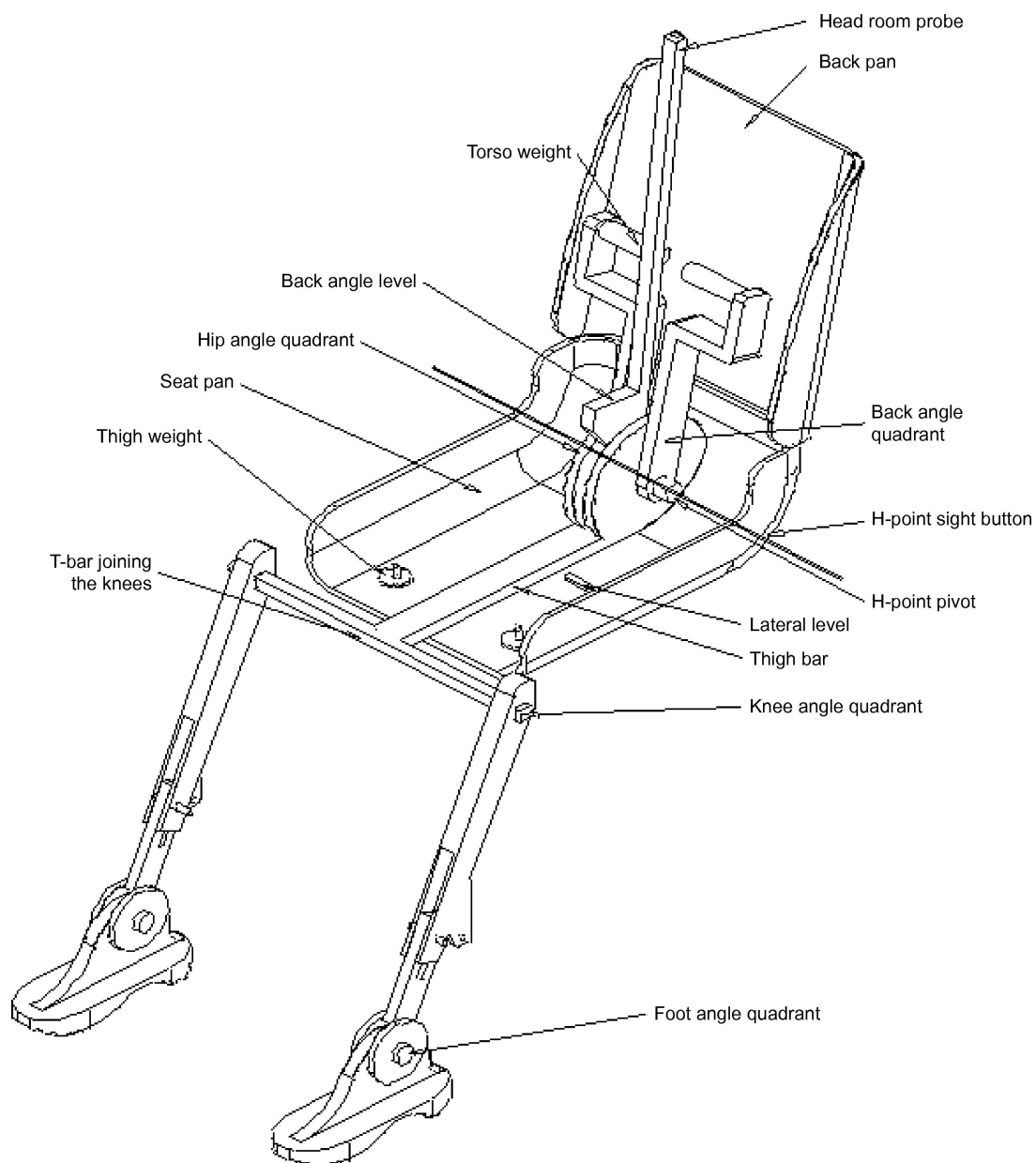
The back and seat pans are constructed of reinforced plastic and metal; they simulate the human torso and thigh and are mechanically hinged at the 'H' point. A quadrant is fastened to the probe hinged at the 'H' point to measure the actual torso angle. An adjustable thigh bar, attached to the seat pan, establishes the thigh centreline and serves as a baseline for the hip angle quadrant.

2. BODY AND LEG ELEMENTS

Lower leg segments are connected to the seat pan assembly at the T-bar joining the knees, which is a lateral extension of the adjustable thigh bar. Quadrants are incorporated in the lower leg segments to measure knee angles. Shoe and foot assemblies are calibrated to measure the foot angle. Two spirit levels orient the device in space. Body element weights are placed at the corresponding centres of gravity to provide seat penetration equivalent to a 76 kg male. All joints of the 3-D H machine should be checked for free movement without encountering noticeable friction.

(*) For details of the construction of the 3-D H machine refer to Society of Automobile Engineers (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, United States of America.
The machine corresponds to that described in ISO Standard 6549:1980.

Figure 1

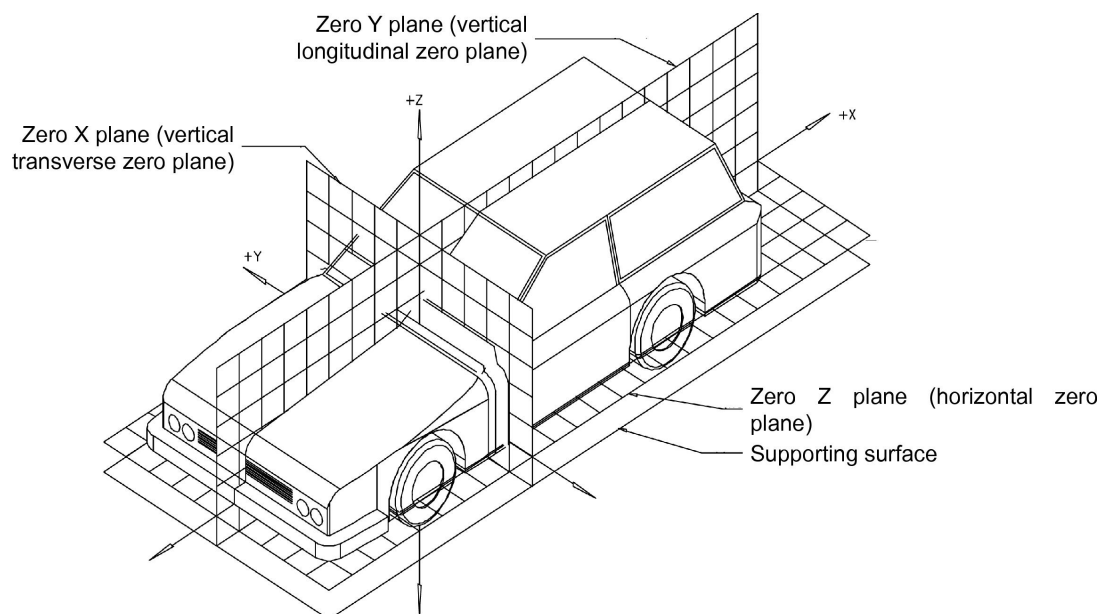
3-D H machine elements designation

Appendix 2

THREE-DIMENSIONAL REFERENCE SYSTEM

1. The three-dimensional reference system is defined by three orthogonal planes established by the vehicle manufacturer (see figure) (*).
2. The vehicle measuring attitude is established by positioning the vehicle on the supporting surface such that the co-ordinates of the fiducial marks correspond to the values indicated by the manufacturer.
3. The co-ordinates of the 'R' point and the 'H' point are established in relation to the fiducial marks defined by the vehicle manufacturer.

Figure

Three-dimensional reference system

(*) The reference system corresponds to standard ISO 4130:1978.

Appendix 3

REFERENCE DATA CONCERNING SEATING POSITIONS

1. Coding of reference data

Reference data are listed consecutively for each seating position. Seating positions are identified by a two-digit code. The first digit is an Arabic numeral and designates the row of seats, counting from the front to the rear of the vehicle. The second digit is a capital letter, which designates the location of the seating position in a row, as viewed in the direction of forward motion of the vehicle; the following letters shall be used:

L = left

C = centre

R = right

2. Description of vehicle measuring attitude

2.1. Co-ordinates of fiducial marks

X

Y

Z

3. List of reference data

3.1. Seating position:.....

3.1.1. Co-ordinates of 'R' point

X

Y

Z

3.1.2. Design torso angle:.....

3.1.3. Specifications for seat adjustment (*)

horizontal:

vertical:

angular:

torso angle:

Note: List reference data for further seating positions under 3.2, 3.3, etc.

(*) Strike out what does not apply.

ANNEX 5

TRACTION DEVICE

Figure 1

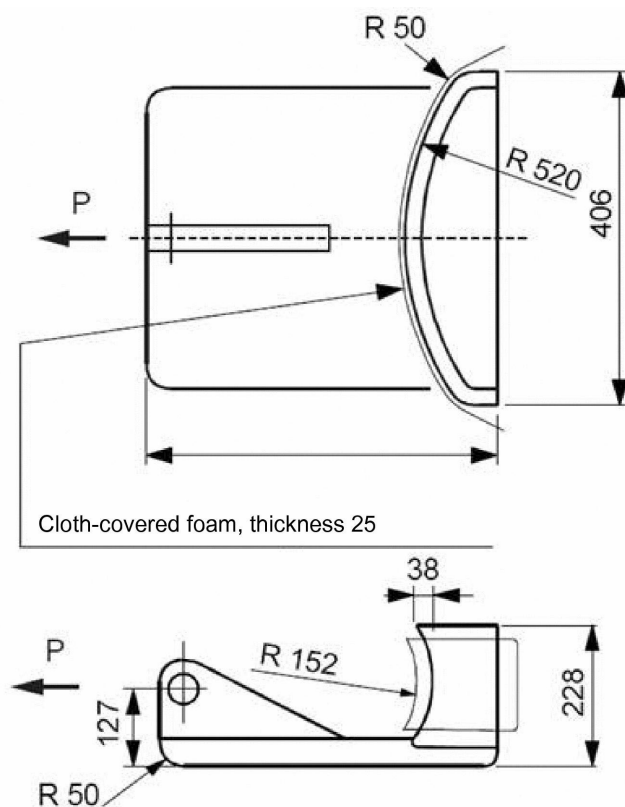


Figure 1a

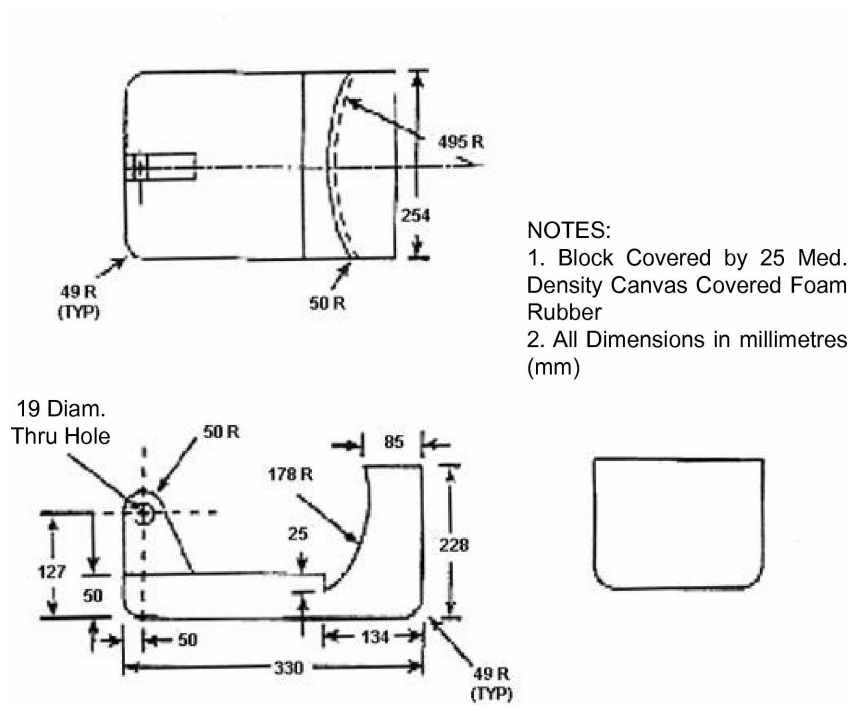
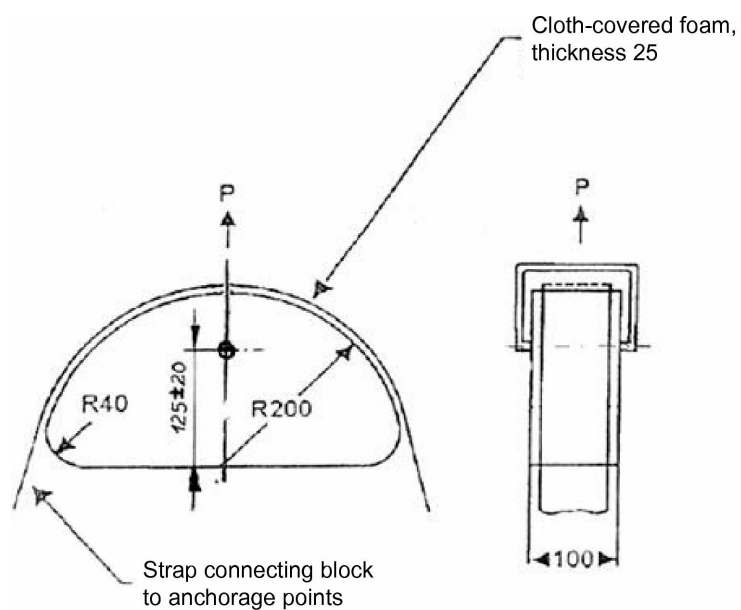


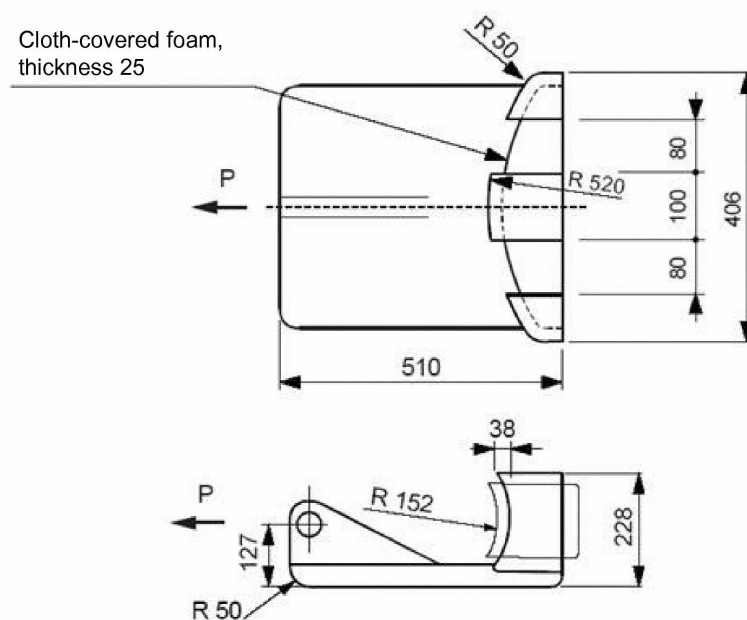
Figure 2



All dimensions are in millimetres

For the fixing of the strap the shoulder belt traction device may be modified by adding of two land edges and/or some bolts to avoid any drop off of the strap during the pull test.

Figure 3



All dimensions are in millimetres

ANNEX 6

MINIMUM NUMBER OF ANCHORAGE POINTS AND LOCATION OF LOWER ANCHORAGES

Vehicle category	Forward facing seating positions				Rear facing
	Outboard		Centre		
	Front	Other	Front	Other	
M ₁	3	3	3	3	2
M ₂ ≤ 3,5 tonnes	3	3	3	3	2
M ₃ & M ₂ > 3,5 tonnes	3 ⊕	3 or 2 ‡	3 or 2 ‡	3 or 2 ‡	2
N ₁	3	3 or 2 ∅	3 or 2 *	2	2
N ₂ & N ₃	3	2	3 or 2 *	2	2

Key to symbols:

- 2 : two lower anchorages, which allow the installation of a safety-belt type B, or of safety-belts types Br, Br3, Br4m or Br4Nm, where required by the Consolidated Resolution on the Construction of Vehicles (R.E.3), Annex 13, appendix 1.
- 3 : two lower anchorages and one upper anchorage which allow the installation of a three-point safety-belt type A, or of safety-belts types Ar, Ar4m or Ar4Nm, where required by the Consolidated Resolution on the Construction of Vehicles (R.E.3), Annex 13, appendix 1.
- ∅ : refers to paragraph 5.3.3. (Two anchorages permitted if a seat is inboard of a passageway).
- * : refers to paragraph 5.3.4. (Two anchorages permitted if the windscreen is outside reference zone).
- † : refers to paragraph 5.3.5. (Two anchorages permitted if nothing is in the reference zone).
- ⊕ : refers to paragraph 5.3.7. (Special provision for the upper deck of a vehicle).

Appendix 1

LOCATION OF LOWER ANCHORAGES — ANGLE REQUIREMENTS ONLY

Seat		M ₁	Other than M ₁
Front (*)	buckle side (α_2)	45° — 80°	30° — 80°
	other than buckle side (α_1)	30° — 80°	30° — 80°
	angle constant	50° — 70°	50° — 70°
	bench — buckle side (α_2)	45° — 80°	20° — 80°
	bench — other than buckle side (α_1)	30° — 80°	20° — 80°
	adjustable seat with seat back angle < 20°	45° — 80° (α_2) (*) 20° — 80° (α_1) (*)	20° — 80°
Rear ‡		30° — 80°	20° — 80° Ψ
Folding	No belt anchorage required. If anchorage fitted: see angle requirements Front and Rear.		

Notes:

‡ : outboard and centre.

(*) : if angle is not constant see paragraph 5.4.2.1.

Ψ : 45° — 90° in the case of seats on M₂ and M₃ vehicles.

ANNEX 7

**DYNAMIC TEST AS AN ALTERNATIVE TO THE SAFETY-BELT ANCHORAGES
STATIC STRENGTH TEST****1. SCOPE**

This annex describes a dynamic sled test that can be performed as an alternative to the safety-belt anchorages static strength test prescribed in paragraphs 6.3 and 6.4 of this Regulation.

This alternative can apply at the request of the car manufacturer in the case of a group of seats where all the seating positions are equipped with 3-point safety-belts to which thorax load limiter functions are associated and when the group of seats additionally comprises a seating position for which the upper safety-belt anchorage is located on the seat structure.

2. PRESCRIPTIONS

- 2.1. In the dynamic test prescribed in paragraph 3. of this annex, there shall be no rupture of any anchorage or surrounding area. A programmed rupture necessary for the functioning of the load limiter device is however permitted.

The minimum spacings for the effective lower anchorages specified in paragraph 5.4.2.5 of this Regulation, and the requirements for the effective upper anchorages specified in paragraph 5.4.3.6 of this Regulation and, when applicable, completed by the following paragraph 2.1.1, shall be respected.

- 2.1.1. For vehicles of category M₁ of a total permissible mass not exceeding 2,5 tonnes, the upper safety-belt anchorage, if attached to the seat structure, shall not be displaced forward of a transverse plane passing through the R point and point C of the seat in question (see figure 1 of Annex 3 to this Regulation).

For vehicles other than mentioned above, the upper safety-belt anchorage shall not be displaced forward of a transverse plane inclined 10° in forward direction and passing through the R point of the seat.

- 2.2. In vehicles where such devices are used, the displacement and locking devices enabling the occupants of all seats to leave the vehicle must still be operable by hand after the test.
- 2.3. The vehicle owner's manual shall include indications that each safety-belt shall only be replaced by an approved safety-belt for the considered seating position in the vehicle, and shall in particular identify those seating positions which may only be fitted with an appropriate safety-belt equipped with a load limiter.

3. DYNAMIC TEST CONDITIONS**3.1. General conditions**

The general conditions described in paragraph 6.1 of this Regulation apply to the test described in this annex.

3.2. Installation and preparation**3.2.1. Sled**

The sled must be so constructed that no permanent deformation appears after the test. It must be so guided that, during the impact phase, the deviation does not exceed 5° in the vertical plane and 2° in the horizontal plane.

3.2.2. Securing of the vehicle structure

The part of the vehicle structure considered essential for the vehicle rigidity regarding the seat anchorages and the safety-belt anchorages shall be secured on the sled, according to the disposals described in paragraph 6.2 of this Regulation.

3.2.3. *Restraint systems*

- 3.2.3.1. The restraint systems (the complete seats, the safety-belt assemblies and the load limiter devices) shall be mounted on the vehicle structure according to the series production vehicle specifications.

The vehicle environment facing the tested seat (dashboard, seat, etc., depending on the tested seat) can be mounted on the test sled. If there were a frontal airbag, it has to be deactivated.

- 3.2.3.2. At the request of the car manufacturer and in agreement with the technical service in charge of the tests, some components of the restraint systems other than the complete seats, the safety-belt assemblies and the load limiter devices, may not be mounted on the test sled or may be replaced by components having equivalent or lower stiffness and whose dimensions are comprised in the vehicle interior fittings dimensions, provided that the tested configuration is at least as unfavourable as the series configuration regarding the forces applying to the seat and safety-belt anchorages.

- 3.2.3.3. The seats shall be adjusted as required in paragraph 6.1.2 of this Regulation, in the position for use chosen by the technical service in charge of the tests as the one giving the most adverse conditions regarding the anchorages strength and compatible with the installation of the dummies in the vehicle.

3.2.4. *Dummies*

A dummy whose dimensions and mass are defined in Annex 8 shall be positioned on each seat and restrained by the safety-belt provided in the vehicle.

No dummy instrumentation is required.

3.3. **Test**

- 3.3.1. The sled shall be so propelled that, during the test, its speed variation is 50 km/h. The sled deceleration shall be within the corridor specified in Annex 8 of Regulation No 16.

- 3.3.2. If applicable, the activation of additional restraining devices (preloading devices, etc., except airbags) is triggered according to the car manufacturer's indications.

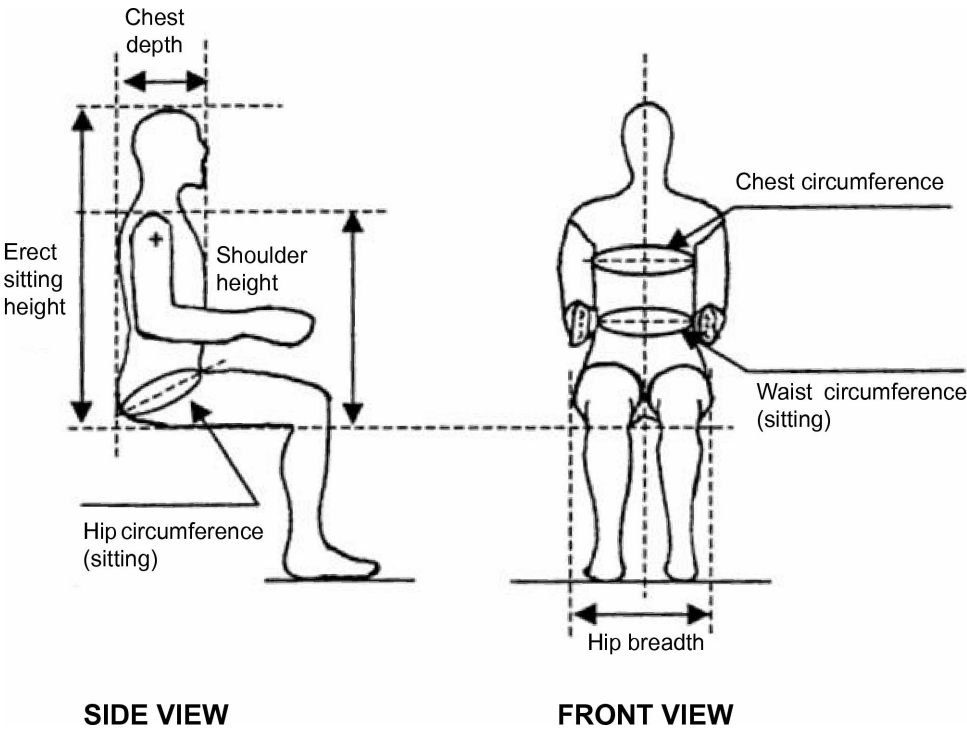
- 3.3.3. It shall be checked that the safety-belt anchorages' displacement does not exceed the limits specified in paragraphs 2.1 and 2.1.1 of this annex.
-

ANNEX 8

DUMMY SPECIFICATIONS (*)

Mass	97,5 ± 5 kg
Erect sitting height	965 mm
Hip breadth (sitting)	415 mm
Hip circumference (sitting)	1 200 mm
Waist circumference (sitting)	1 080 mm
Chest depth	265 mm
Chest circumference	1 130 mm
Shoulder height	680 mm
Tolerance on all length dimensions	± 5 per cent

Remark: a sketch explaining the dimensions is given in the figure below.



(*) Devices described in the Australian Design Rule (ADR) 4/03 and Federal Motor Vehicle Safety Standard (FMVSS) No 208 are considered equivalent.

ANNEX 9

ISOFIX ANCHORAGES SYSTEMS AND ISOFIX TOP TETHER ANCHORAGES

Figure 1

Static force application device (SFAD), isometric views

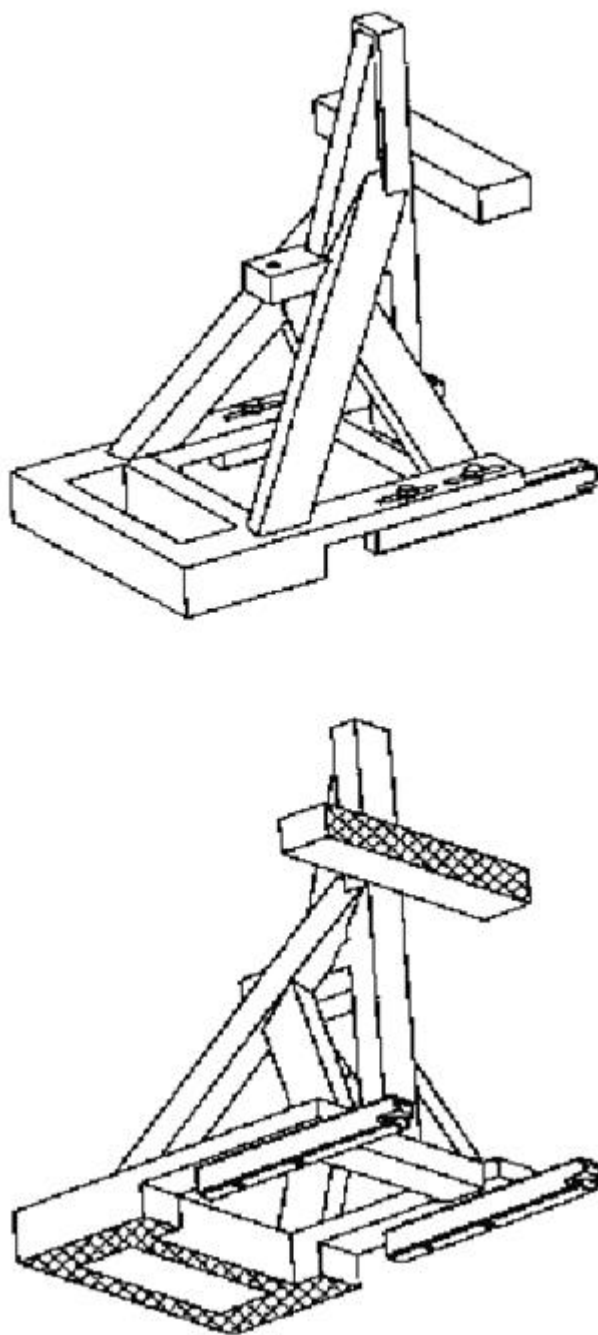
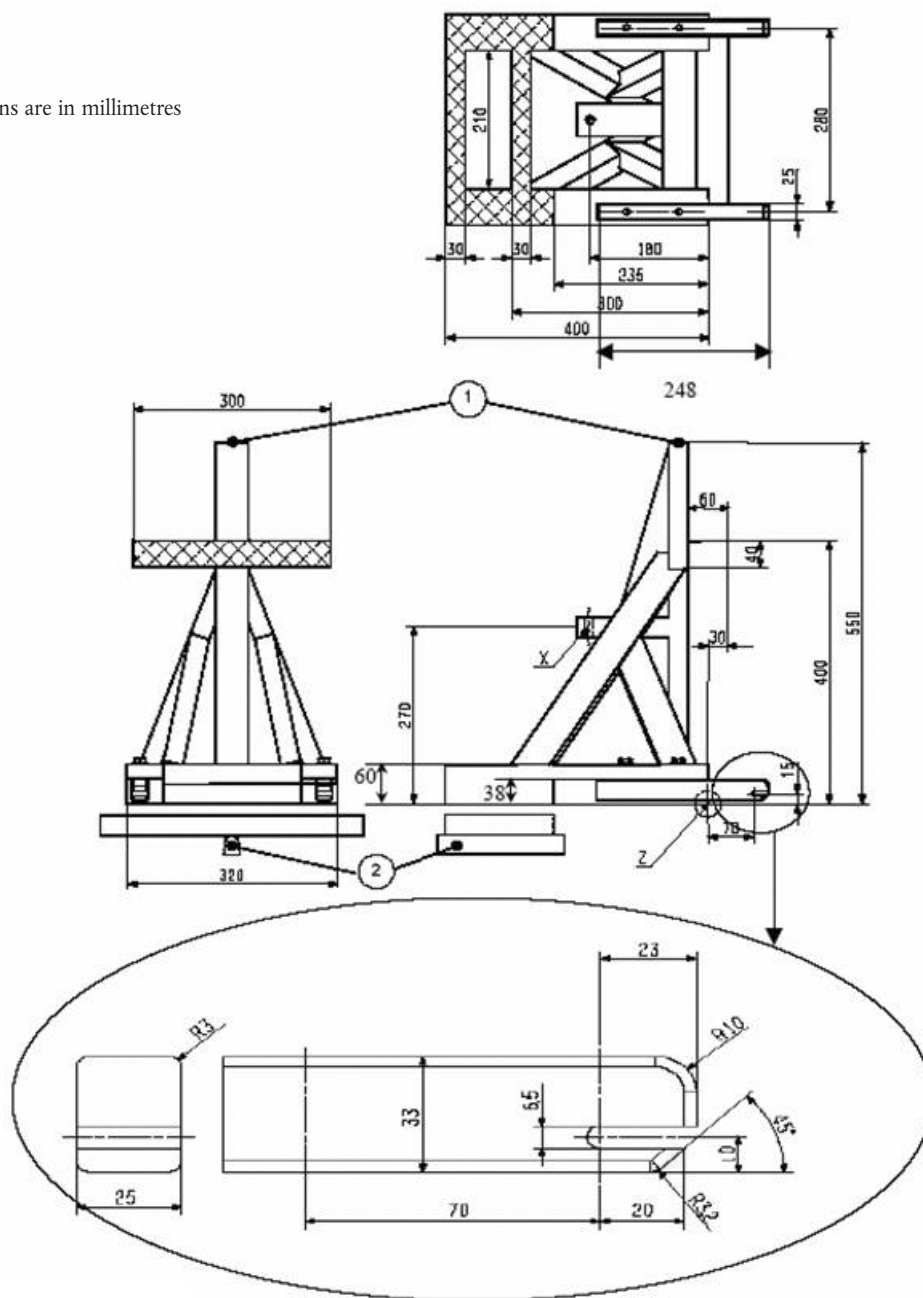


Figure 2

Static force application device (SFAD), dimensions

Dimensions are in millimetres



Key

- 1 Top tether attachment point
- 2 Pivot attachment for stiffness testing as described below.

Stiffness of SFAD: When attached to rigid anchorage bar(s) with the front cross member of the SFAD supported by a rigid bar that is held at the centre by a longitudinal pivot 25 mm below the SFAD base (to allow bending and twisting of the SFAD base) the movement of point X shall not be greater than 2 mm in any direction when forces are applied in accordance with table No 1 of paragraph 6.6.4 of this Regulation. Any deformation of the Isofix anchorages system shall be excluded from the measurements

Figure 3

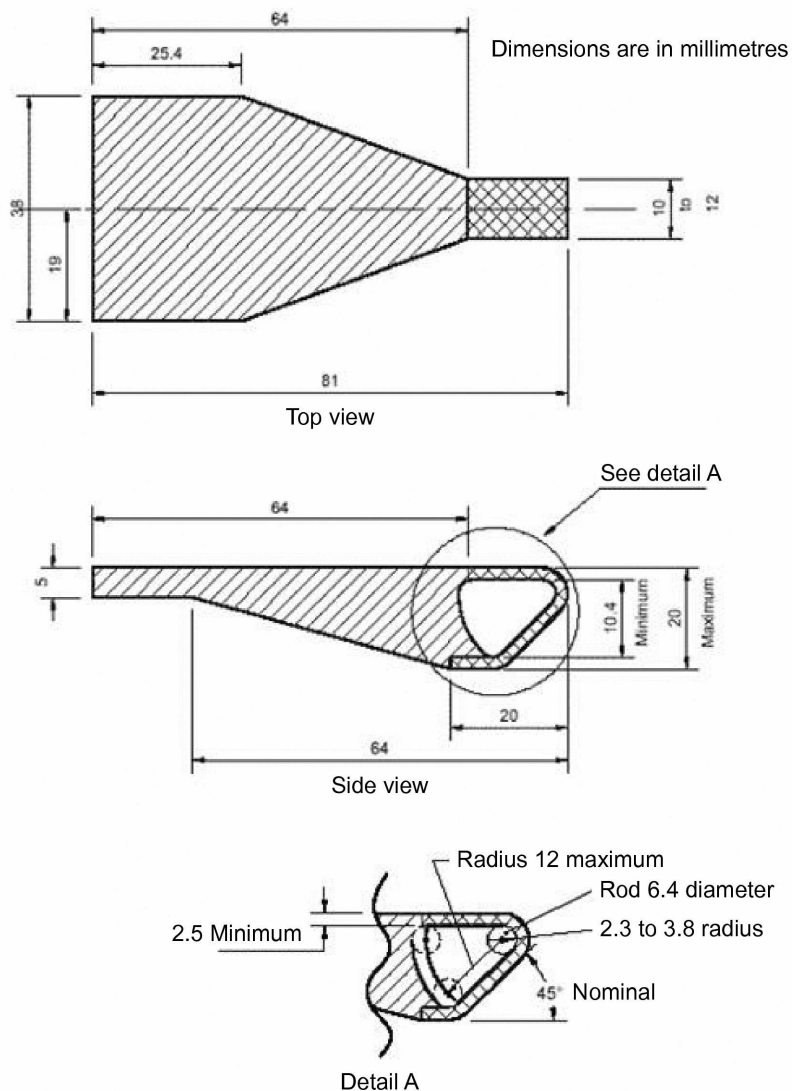
Isofix Top tether connector (hook type) dimensions

Figure 4

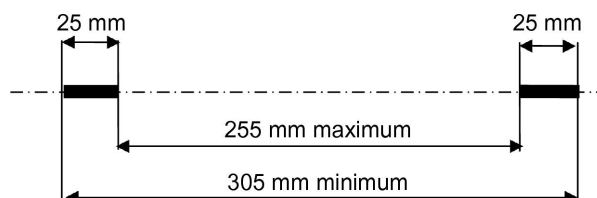
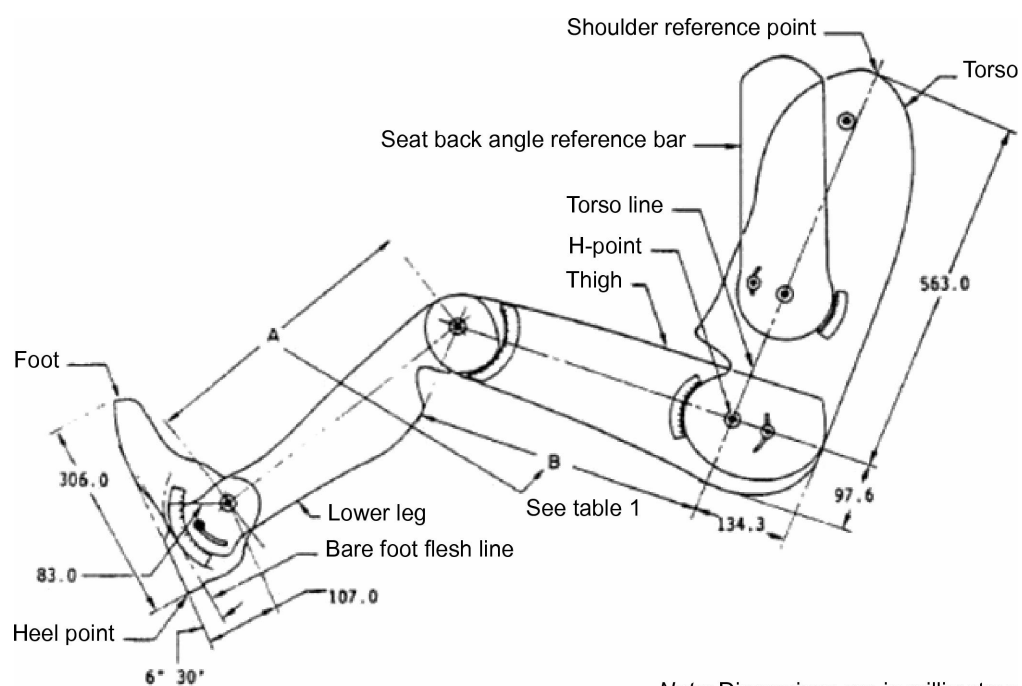
Distance between both low anchorage zones

Figure 5

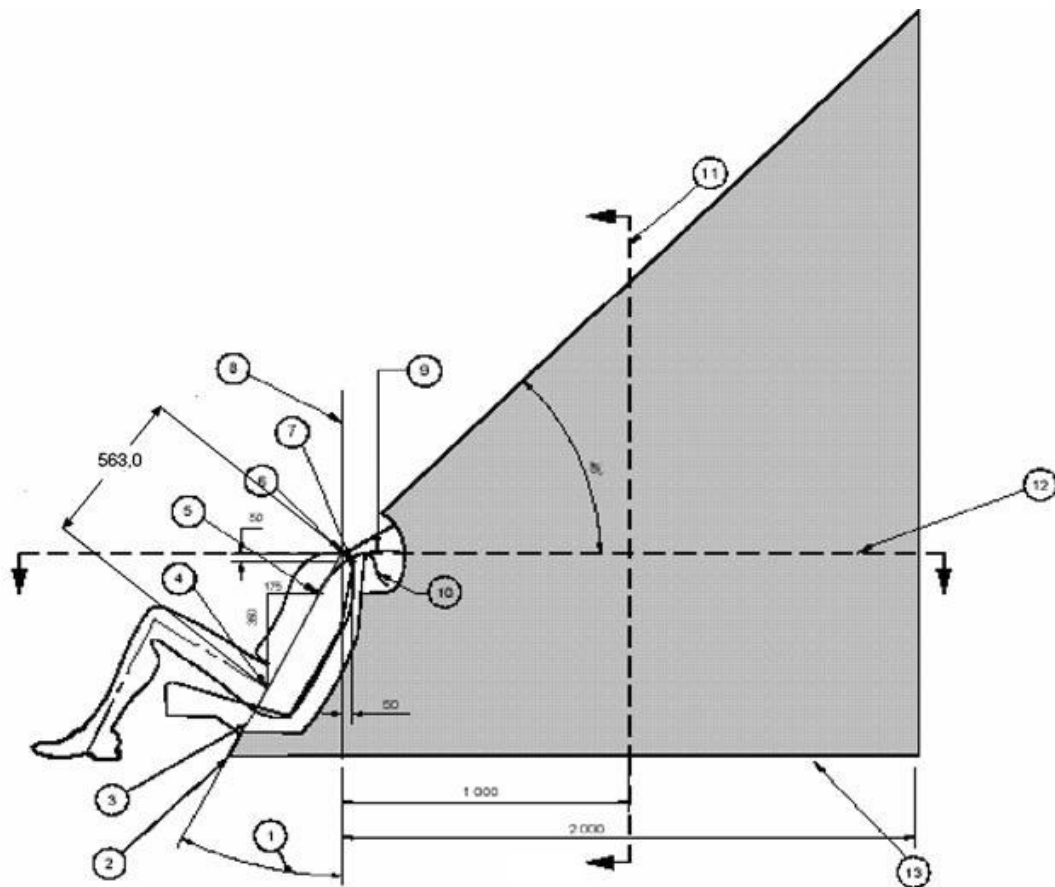
Two dimensions template

Note: Dimensions are in millimetres

Figure 6

Isofix Top tether anchorage location, Isofix zone — Side view

Dimensions are in millimetres

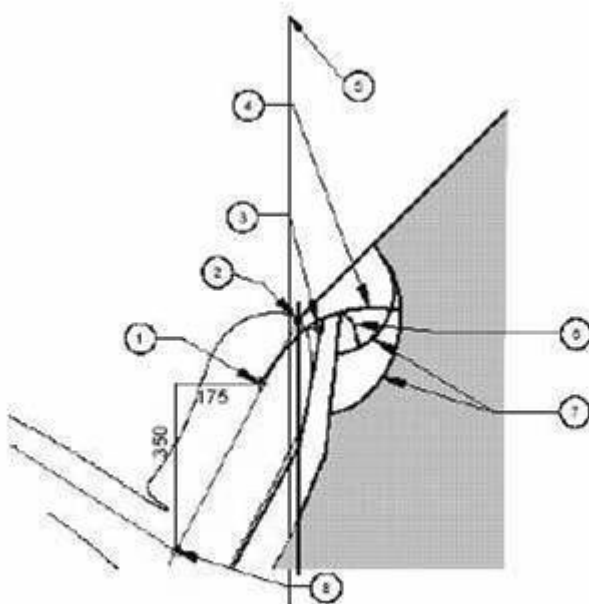


- 1 Back angle
 - 2 Intersection of torso line reference plane and floor pan
 - 3 Torso line reference plane
 - 4 H-point
 - 5 'V' point
 - 6 'R' point
 - 7 'W' point
 - 8 Vertical longitudinal plane
 - 9 Strap wrap-around length from 'V' point: 250 mm
 - 10 Strap wrap-around length from 'W' point: 200 mm
 - 11 'M' plane cross-section
 - 12 'R' plane cross-section
 - 13 Line represents the vehicle specific floor pan surface within the prescribed zone
- NOTE 1 Portion of top tether anchorage that is designed to bind with the top tether hook to be located within shaded zone
- NOTE 2 'R' Point: Shoulder reference point
- NOTE 3 'V' Point: V-reference point, 350 mm vertically above and 175 mm horizontally back from H-point
- NOTE 4 'W' Point: W-reference point, 50 mm vertically below and 50 mm horizontally back from 'R' point
- NOTE 5 'M' Plane: M-reference plane, 1 000 mm horizontally back from 'R' point
- NOTE 6 The forwardmost surfaces of the zone are generated by sweeping the two wraparound lines throughout their extended range in the front part of the zone. The wraparound lines represent the minimum adjusted length of typical top tether straps extending from either the top of the CRS (W-point), or lower on the back of the CRS (V-point).

Figure 7

Isofix Top tether anchorage location, Isofix zone — Enlarged side view of wrap-around area

Dimensions are in millimetres



- 1 'V' point
- 2 'R' point
- 3 'W' point
- 4 Strap wrap-around length from 'V' point: 250 mm
- 5 Vertical longitudinal plane
- 6 Strap wrap-around length from 'W' point: 200 mm
- 7 Arcs created by wrap-around lengths
- 8 H-point

NOTE 1 Portion of top tether anchorage that is designed to bind with the top tether hook to be located within shaded zone

NOTE 2 'R' point: Shoulder reference point

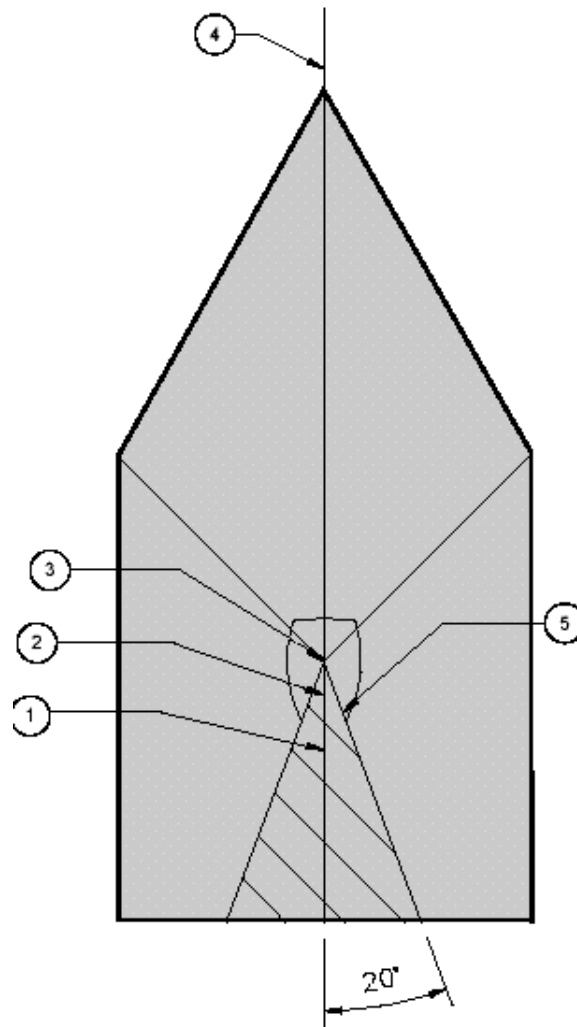
NOTE 3 'V' Point: V-reference point, 350 mm vertically above and 175 mm horizontally back from H-point

NOTE 4 'W' Point: W-reference point, 50 mm vertically below and 50 mm horizontally back from 'R' point

NOTE 5 'M' Plane: M-reference plane, 1 000 mm horizontally back from 'R' point

NOTE 6 The forwardmost surfaces of the zone are generated by sweeping the two wraparound lines throughout their extended range in the front part of the zone. The wraparound lines represent the minimum adjusted length of typical top tether straps extending from either the top of the CRS (W-point), or lower on the back of the CRS (V-point).

Figure 9

Isofix Top tether anchorage location, Isofix zone — Front view

1 'V' point

2 'W' point

3 'R' point

4 Median plane

5 Area view along torso reference plane

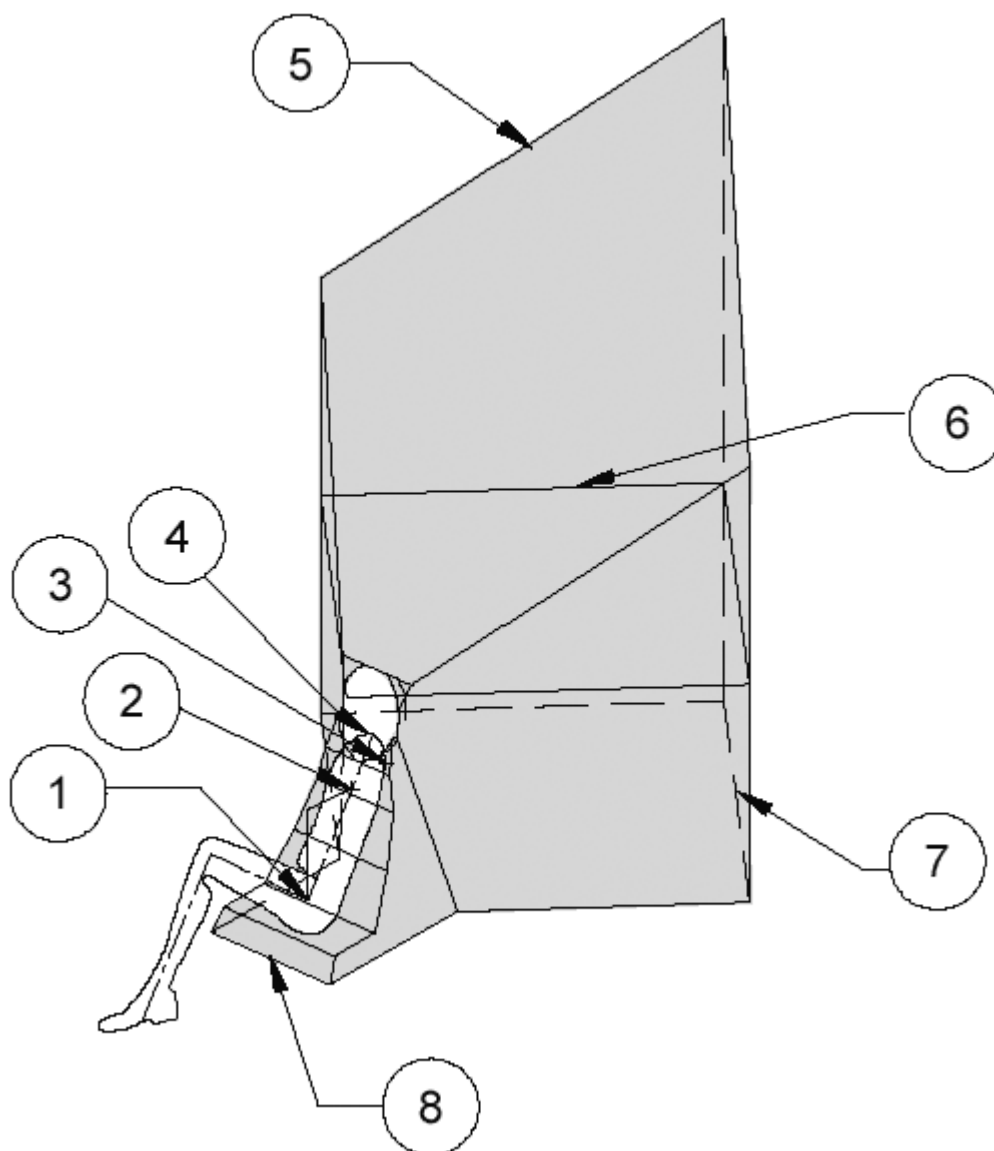
NOTE 1 Portion of top tether anchorage that is designed to bind with the top tether hook to be located within shaded zone

NOTE 2 'R' point: Shoulder reference point

NOTE 3 'V' Point: V-reference point, 350 mm vertically above and 175 mm horizontally back from H-point

NOTE 4 'W' Point: W-reference point, 50 mm vertically below and 50 mm horizontally back from 'R' point

Figure 10

Isofix Top tether anchorage location, Isofix zone — Three-dimensional schematic view

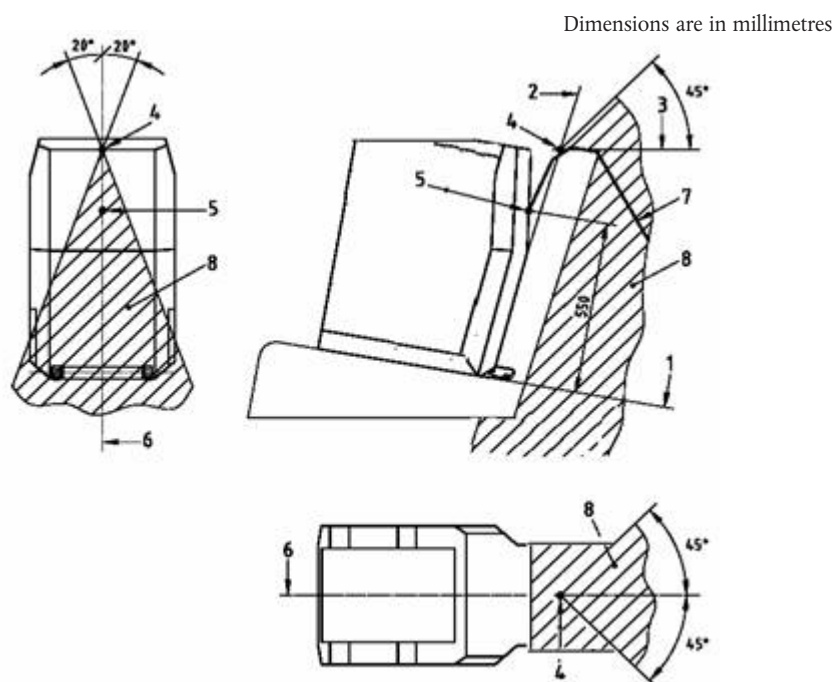
- 1 H-point
- 2 'V' point
- 3 'W' point
- 4 'R' point
- 5 45° plane
- 6 'R' plane cross-section
- 7 Floor pan surface
- 8 Front edge of zone

NOTE 1 Portion of top tether anchorage that is designed to bind with the top tether hook to be located within shaded zone

NOTE 2 'R' point: Shoulder reference point

Figure 11

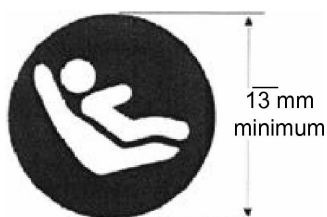
Alternative method of locating the top tether anchorage using the 'ISO/F2' (B) fixture, Isofix zone — side, top and rear views



- 1 'ISO/F2' (B) fixture horizontal face
- 2 'ISO/F2' (B) fixture rear face
- 3 Horizontal line tangent to top of seat back (last rigid point of a hardness greater than 50 Shore A)
- 4 Intersection between 2 and 3
- 5 Tether reference point
- 6 'ISO/F2' (B) fixture centreline
- 7 Top tether strap
- 8 Limits of anchorage zone

Figure 12

Isofix low anchorage symbol

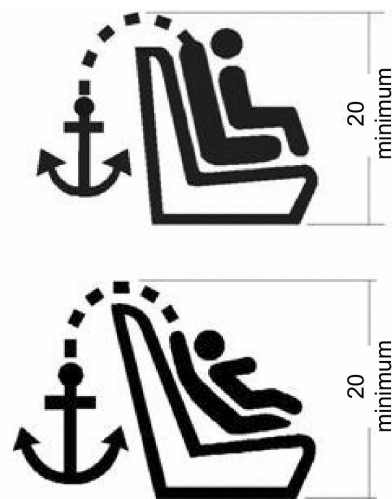


Notes:

1. Drawing not to scale.
2. Symbol may be shown in mirror image.
3. Colour of the symbol at choice of manufacturer.

Figure 13

Symbol used to identify the location of a top tether anchorage that is under a cover



Notes:

1. Dimensions in mm
2. Drawing not to scale
3. The symbol shall be clearly visible either by means of contrast colours or by adequate relief if it is moulded or embossed.

Only the original UN/ECE texts have legal effect under international public law. The status and date of entry into force of this Regulation should be checked in the latest version of the UN/ECE status document TRANS/WP.29/343, available at:
<http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29docsts.html>.

Regulation No 66 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform technical prescriptions concerning the approval of large passenger vehicles with regard to the strength of their superstructure

Addendum 65: Regulation No 66

Revision 1

Incorporating all valid text up to:

Supplement 1 to the original version of the Regulation — Date of entry into force: 3 September 1997

01 series of amendments — Date of entry into force: 9 November 2005

CONTENTS

REGULATION

1. Scope
2. Terms and Definitions
3. Application for approval
4. Approval
5. General specifications and requirements
6. Modification and extension of approval of a vehicle type
7. Conformity of production
8. Penalties for non-conformity of production
9. Production definitely discontinued
10. Transitional provisions
11. Names and addresses of technical services responsible for conducting approval tests, and of administrative departments

ANNEXES

- Annex 1 — Communication concerning vehicle type with regard to the strength of its superstructure, pursuant to Regulation No 66
- Annex 2 — Arrangement of the approval mark
- Annex 3 — Determination of the centre of gravity of the vehicle
- Annex 4 — Viewpoints on the structural description of the superstructure
- Annex 5 — Rollover test as the basic approval method
- Annex 6 — Rollover test using body sections as an equivalent approval method
- Annex 7 — Quasi-static loading test of body sections as an equivalent approval method
- Appendix 1 — Determination of the vertical movement of the centre of gravity during rollover
- Annex 8 — Quasi-static calculation based on testing of components as an equivalent approval method
- Appendix 1 — Characteristics of plastic hinges
- Annex 9 — Computer simulation of rollover test on complete vehicle as an equivalent approval method

1. SCOPE

This Regulation applies to single-deck rigid or articulated vehicles designed and constructed for the carriage of more than 22 passengers, whether seated or standing, in addition to the driver and crew.

2. TERMS AND DEFINITIONS

For the purposes of this Regulation, the following terms and definitions are used:

2.1. Units of measurement

The units of measurement shall be:

Dimensions and linear distances	metres (m) or millimetres (mm)
Mass or load	kilograms (kg)
Force (and weight)	Newtons (N)
Moment	Newton-metres (Nm)
Energy	Joules (J)
Gravitational constant	9,81 (m/s ²)

2.2. 'Vehicle' means a bus or coach designed and equipped for transportation of passengers. The vehicle is an individual representative of a vehicle type.

2.3. 'Vehicle type' means a category of vehicles produced with the same design technical specification, main dimensions and constructional arrangement. The vehicle type shall be defined by the vehicle manufacturer.

2.4. 'Family of vehicle types' means those vehicle types, proposed in future as well as existing now, which are covered by the approval of the worst case, in respect of this Regulation.

2.5. 'Worst case' means the vehicle type, among a group of vehicle types, least likely to withstand the requirements of this Regulation in respect of the strength of superstructure. The three parameters which define the worst case are: structural strength, reference energy and the residual space.

2.6. 'Approval of a vehicle type' means the whole official process in which the vehicle type is checked and tested to prove that it meets all the requirements specified in this Regulation.

2.7. 'Extension of approval' means the official process in which a modified vehicle type is approved on the basis of an earlier approved vehicle type, by comparison of structure, potential energy and residual space criteria.

2.8. 'Articulated vehicle' means a vehicle which consists of two or more rigid sections which articulate to one another, the passenger compartments of each section intercommunicate so that passengers can move freely between them; the rigid sections are permanently connected so that they can only be separated by an operation involving facilities which are normally only found in a workshop.

2.9. 'Passenger compartment' means the space intended for passengers' use excluding any space occupied by fixed appliances such as bars, kitchenettes or toilets.

2.10. 'Driver's compartment' means the space intended for the driver's exclusive use and containing the driver's seat, the steering wheel, controls, instruments and other devices necessary for driving the vehicle.

2.11. 'Occupant restraint' means any device which connects a passenger, driver or crew member to his seat, during a rollover.

- 2.12. 'Vertical longitudinal central plane' (VLCP) means the vertical plane which passes through the mid-points of the front axle track and the rear axle track.
- 2.13. 'Residual space' means a space to be preserved in the passengers', crew and driver's compartment(s) to provide better survival possibility for passengers, driver and crew in case of a rollover accident.
- 2.14. 'Unladen kerb mass' (M_k) means the mass of the vehicle in running order, unoccupied and unladen but with the addition of 75 kg for the mass of the driver, the mass of fuel corresponding to 90 per cent of the capacity of the fuel tank specified by the manufacturer, and the masses of coolant, lubricant, tools and spare wheel, if any.
- 2.15. 'Total occupant mass' (M_m) means the combined mass of any passengers, crew who occupy seats fitted with occupant restraints.
- 2.16. 'Total effective vehicle mass' (M_t) means the unladen kerb mass of the vehicle (M_k) combined with the portion ($k = 0,5$), of the total occupant mass (M_m), considered to be rigidly attached to the vehicle.
- 2.17. 'Individual occupant mass' (M_{mi}) means the mass of an individual occupant. The value of this mass is 68 kg.
- 2.18. 'Reference energy' (E_R) means the potential energy of the vehicle type to be approved, measured in relation to the horizontal lower level of the ditch, at the starting, unstable position of the rollover process.
- 2.19. 'Rollover test on a complete vehicle' means a test on a complete, full-scale vehicle to prove the required strength of the superstructure.
- 2.20. 'Tilting bench' means a technical device, an arrangement of tilting platform, ditch and concrete ground surface, used in the rollover testing of a complete vehicle or body sections.
- 2.21. 'Tilting platform' means a rigid plane which can be rotated around a horizontal axis in order to tilt a complete vehicle or body section.
- 2.22. 'Body work' means the complete structure of the vehicle in running order, including all the structural elements which form the passenger compartment, driver's compartment, baggage compartment and spaces for the mechanical units and components.
- 2.23. 'Superstructure' means the load-bearing components of the bodywork as defined by the manufacturer, containing those coherent parts and elements which contribute to the strength and energy absorbing capability of the bodywork, and preserve the residual space in the rollover test.
- 2.24. 'Bay' means a structural section of the superstructure forming a closed loop between two planes which are perpendicular to the vertical longitudinal central plane of the vehicle. A bay contains one window (or door) pillar on each side of the vehicle as well as side wall elements, a section of the roof structure and a section of the floor and underfloor structure.
- 2.25. 'Body section' means a structural unit, which represents one part of the superstructure for the purposes of an approval test. A body section contains at least two bays connected by representative connecting elements (side, roof, and underfloor, structures).
- 2.26. 'Original body section' means a body section composed of two or more bays of exactly the same form and relative position, as they appear in the actual vehicle. All connecting elements between the bays are also arranged exactly as they appear in the actual vehicle.

- 2.27. 'Artificial body section' means a body section built up from two or more bays but not in the same position, nor at the same distance from each other as in the actual vehicle. The connecting elements between these bays need not be identical with the real body work structure but shall be structurally equivalent.
- 2.28. 'Rigid part' means a structural part or element which does not have significant deformation and energy absorption during the rollover test.
- 2.29. 'Plastic zone' (PZ) means a special geometrically limited part of the superstructure in which, as the result of dynamic, impact forces:
- large scale plastic deformations are concentrated,
 - essential distortion of the original shape (cross section, length, or other geometry) occurs,
 - loss of stability occurs, as a result of local buckling,
 - kinetic energy is absorbed due to deformation.
- 2.30. 'Plastic hinge' (PH) means a simple plastic zone formed on a rod-like element (single tube, window column, etc).
- 2.31. 'Cantrail' means the longitudinal structural part of the bodywork above the side windows including the curved transition to the roof structures. In the rollover test the cantrail hits the ground first.
- 2.32. 'Wastrail' means the longitudinal structural part of the bodywork below the side windows. In the roll-over test the wastrail may be the second area to contact the ground after initial deformation of the vehicle cross-section.
3. APPLICATION FOR APPROVAL
- 3.1. The application for approval of a vehicle type with regard to the strength of its superstructure shall be submitted by the vehicle manufacturer or by his duly accredited representative to the Administrative Department.
- 3.2. It shall be accompanied by three copies of each of the undermentioned documents and by the following particulars:
- 3.2.1. The main identifying data and parameters of the vehicle type, or group of vehicle types;
- 3.2.1.1. General layout drawings of the vehicle type, its bodywork and its interior arrangement with the main dimensions. Seats which have passenger restraints shall be clearly marked and their positions in the vehicle shall be accurately dimensioned;
- 3.2.1.2. The unladen kerb mass of the vehicle, and the associated axle loads;
- 3.2.1.3. The exact position of the unladen vehicle's centre of gravity together with the measuring report. To determine the centre of gravity position the measuring and calculation methods described in Annex 3 shall be used;
- 3.2.1.4. The total effective vehicle mass, and the associated axle loads;
- 3.2.1.5. The exact position of the centre of gravity of the total effective mass of the vehicle, together with the measuring report. To determine the centre of gravity position, the measuring and calculation methods described in Annex 3 shall be used.

- 3.2.2. All the data and information which are needed to evaluate the worst case criteria in a group of vehicle types:

- 3.2.2.1. The value of reference energy (E_R) which is the product of the vehicle mass (M), the gravity constant (g) and the height (h_1) of centre of gravity with the vehicle in its unstable equilibrium position when starting the rollover test (see figure 3)

$$E_R = M \cdot g \cdot h_1 = M \cdot g \left[0,8 + \sqrt{h_0^2 + (B \pm t)^2} \right]$$

where:

M = M_k , the unladen kerb mass of the vehicle type if there are no occupant restraints, or,

M_t , total effective vehicle mass when occupant restraints are fitted, and

$M_t = M_k + k \times M_m$, where $k = 0,5$,

h_0 = the height (in metres) of the vehicle centre of gravity for the value of mass (M) chosen,

t = perpendicular distance (in metres) of the vehicle centre of gravity from its longitudinal vertical central plane,

B = perpendicular distance (in metres) of the vehicle's longitudinal vertical central plane to the axis of rotation in the rollover test,

g = gravitational constant,

h_1 = the height (in metres) of the vehicle centre of gravity in its starting, unstable position related to the horizontal lower plane of the ditch;

- 3.2.2.2. Drawings and detailed description of the superstructure of the vehicle type or group of vehicle types according to Annex 4;

- 3.2.2.3. Detailed drawings of the residual space according to paragraph 5.2 for every vehicle type to be approved.

- 3.2.3. Further detailed documentation, parameters, data depending on the approval test method chosen by the manufacturer, as detailed in Annex 5, Annex 6, Annex 7, Annex 8 and Annex 9.

- 3.2.4. In case of an articulated vehicle, all of this information shall be given separately for each section of the vehicle type, except for paragraph 3.2.1.1 which is related to the complete vehicle.

- 3.3. On request of the technical service a complete vehicle (or one vehicle from each vehicle type, if approval is requested for a group of vehicle types) shall be presented to check its unladen kerb mass, axle loads, position of the centre of gravity and all other data and information which are relevant to the strength of superstructure.

- 3.4. According to the approval test method chosen by the manufacturer, appropriate test pieces shall be submitted to the technical service upon its request. The arrangement and number of these test pieces shall be agreed with the technical service. In case of test pieces which have been tested earlier, the test reports shall be submitted.

4. APPROVAL

- 4.1. If the vehicle type or group of vehicle types submitted for approval to this Regulation meets the requirements of paragraph 5 below, approval of that vehicle type shall be granted.

- 4.2. An approval number shall be assigned to each vehicle type approved. Its first two digits (at present 01 corresponding to the 01 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another vehicle type.
- 4.3. Notice of approval or of refusal or extension of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement which apply this Regulation, by means of a communication form (see Annex 1) and of drawings and diagrams supplied by the applicant for approval, in a format agreed between the manufacturer and the technical service. Paper documentation shall be foldable to A4 (210 mm x 297 mm) format.
- 4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every vehicle conforming to a vehicle type approved under this Regulation an international approval mark consisting of:
- 4.4.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ⁽¹⁾;
- 4.4.2. the number of this Regulation, followed by the letter 'R', a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.
- 4.5. The approval mark shall be clearly legible and be indelible.
- 4.6. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 4.7. Annex 2 to this Regulation gives an example of the approval mark.

5. GENERAL SPECIFICATIONS AND REQUIREMENTS

5.1. Requirements

The superstructure of the vehicle shall have the sufficient strength to ensure that the residual space during and after the rollover test on complete vehicle is unharmed. That means:

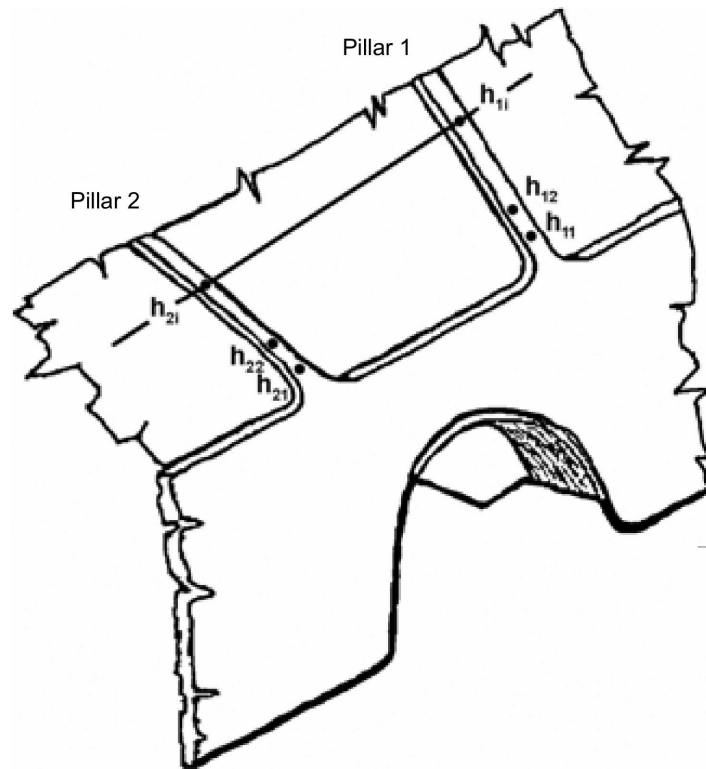
- 5.1.1. no part of the vehicle which is outside the residual space at the start of the test (e.g. pillars, safety rings, luggage racks) shall intrude into the residual space during the test. Any structural parts, which are originally in the residual space (e.g. vertical handholds, partitions, kitchenettes, toilets) shall be ignored when evaluating the intrusion into the residual space.

⁽¹⁾ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Serbia and Montenegro, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 for Ireland, 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32 for Latvia, 33 (vacant), 34 for Bulgaria, 35 (vacant), 36 for Lithuania, 37 for Turkey, 38 (vacant), 39 for Azerbaijan, 40 for The former Yugoslav Republic of Macedonia, 41 (vacant), 42 for the European Community (Approvals are granted by its Member States using their respective ECE symbol), 43 for Japan, 44 (vacant), 45 for Australia, 46 for Ukraine, 47 for South Africa, 48 for New Zealand, 49 for Cyprus, 50 for Malta and 51 for the Republic of Korea. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

- 5.1.2. no part of the residual space shall project outside the contour of the deformed structure. The contour of the deformed structure shall be determined sequentially, between every adjacent window and/or door pillar. Between two deformed pillars the contour shall be a theoretical surface, determined by straight lines, connecting the inside contour points of the pillars which were the same height above the floor level before the rollover test (see Figure 1).

Figure 1

Specification of the contour of the deformed structure



5.2. Residual space

The envelope of the vehicle's residual space is defined by creating a vertical transverse plane within the vehicle which has the periphery described in Figures 2(a) and 2(c), and moving this plane through the length of the vehicle (see Figure 2(b)) in the following manner:

- 5.2.1. the S_R point is located on the seat-back of each outer forward or rearward facing seat (or assumed seat position), 500 mm above the floor under the seat, 150 mm from the inside surface of the side wall. No account shall be taken of wheel arches and other variations of the floor height. These dimensions shall also be applied in the case of inward facing seats in their centre planes;
- 5.2.2. if the two sides of the vehicle are not symmetrical in respect of floor arrangement and, therefore, the height of the S_R points are different, the step between the two floor lines of the residual space shall be taken as the longitudinal vertical centre plane of the vehicle (see Figure 2(c));
- 5.2.3. the rearmost position of the residual space is a vertical plane 200 mm behind the S_R point of the rearmost outer seat, or the inner face of the rear wall of the vehicle if this is less than 200 mm behind that S_R point;

The foremost position of the residual space is a vertical plane 600 mm in front of the S_R point of the foremost seat (whether passenger, crew, or driver) in the vehicle set at its fully forward adjustment;

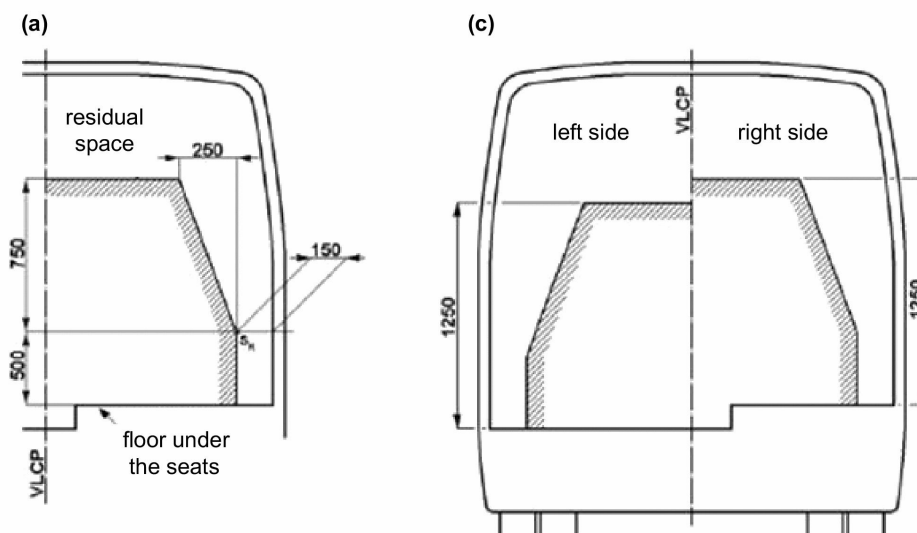
If the rearmost and foremost seats on the two sides of the vehicle are not in the same transverse planes, the length of the residual space on each side will be different;

- 5.2.4. The residual space is continuous in the passenger, crew and driver compartment(s) between its rearmost and foremost plane and is defined by moving the defined vertical transverse plane through the length of the vehicle along straight lines through the S_R points on both sides of the vehicle. Behind the rearmost and in front of the foremost seat's S_R point the straight lines are horizontal;
- 5.2.5. The manufacturer may define a bigger residual space than is required for a given seat arrangement, to simulate a worst case in a group of vehicle types to allow for future design development.

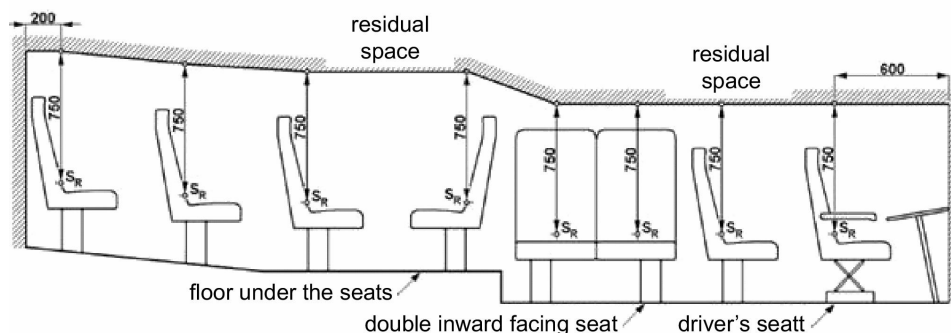
Figure 2

Specification of residual space

(a) and (c) lateral arrangements



b) longitudinal arrangement



5.3. Specification of rollover test on a complete vehicle as the basic approval method

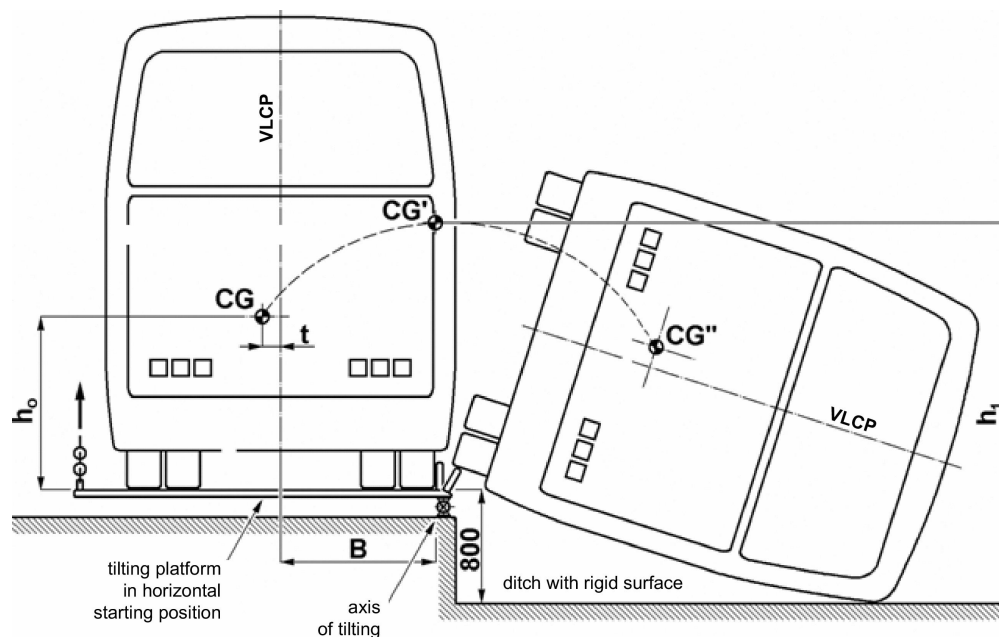
The rollover test is a lateral tilting test (see Figure 3), specified as follows:

- 5.3.1. The complete vehicle is standing on the tilting platform, with blocked suspension and is tilted slowly to its unstable equilibrium position. If the vehicle type is not fitted with occupant restraints it will be tested at unladen kerb mass. If the vehicle type is fitted with occupant restraints it will be tested at total effective vehicle mass;

- 5.3.2. The rollover test starts in this unstable vehicle position with zero angular velocity and the axis of rotation runs through the wheel-ground contact points. At this moment the vehicle is characterised by the reference energy E_R (see paragraph 3.2.2.1 and Figure 3);
- 5.3.3. The vehicle tips over into a ditch, having a horizontal, dry and smooth concrete ground surface with a nominal depth of 800 mm;
- 5.3.4. The detailed technical specification of the rollover test on a complete vehicle as the basic approval test is given in Annex 5.

Figure 3

Specification of the rollover test on a complete vehicle showing the path of the centre of gravity through the starting, unstable equilibrium, position



5.4. Specifications of equivalent approval tests

Instead of the rollover test on a complete vehicle, at the discretion of the manufacturer, one of the following equivalent approval test methods can be chosen:

- 5.4.1. Rollover test on body sections which are representative of the complete vehicle, in accordance with the specifications of Annex 6;
- 5.4.2. Quasi-static loading tests of body sections in accordance with the specifications of Annex 7;
- 5.4.3. Quasi-static calculations based on the results of component tests in accordance with the specifications of Annex 8;
- 5.4.4. Computer simulation — via dynamic calculations — of the basic rollover test on a complete vehicle in accordance with the specifications of Annex 9;
- 5.4.5. The basic principle is that the equivalent approval test method must be carried out in such a way that it represents the basic rollover test specified in Annex 5. If the equivalent approval test method chosen by the manufacturer cannot take account of some special feature or construction of the vehicle (e.g. air-conditioning installation on the roof, changing height of the waist rail, changing roof height) the complete vehicle may be required by the technical service to undergo the rollover test specified in Annex 5.

5.5. **Testing of articulated buses**

In the case of an articulated vehicle, each rigid section of the vehicle shall comply with the general requirement specified in paragraph 5.1. Each rigid section of an articulated vehicle may be tested separately or in combination as described in Annex 5, paragraph 2.3, or in Annex 3, paragraph 2.6.7.

5.6. **Direction of rollover test**

The rollover test shall be carried out on that side of the vehicle which is more dangerous with respect to the residual space. The decision is made by the technical service on the basis of the manufacturer's proposal, considering at least the following:

- 5.6.1. the lateral eccentricity of the centre of gravity and its effect on the reference energy in the unstable, starting position of the vehicle, see paragraph 3.2.2.1;
- 5.6.2. the asymmetry of the residual space, see paragraph 5.2.2;
- 5.6.3. the different, asymmetrical constructional features of the two sides of the vehicle, and the support given by partitions or inner boxes (e.g. wardrobe, toilet, kitchenette). The side with the lesser support shall be chosen as the direction of the rollover test.

6. MODIFICATION AND EXTENSION OF APPROVAL OF A VEHICLE TYPE

- 6.1. Every modification of the approved vehicle type shall be advised to the Administrative Department which granted the type approval. The Administrative Department may then either,

- 6.1.1. agree that the modifications made are unlikely to have an appreciable effect and that in any case the modified vehicle type still complies with the requirements of this Regulation and constitutes part of a family of vehicle types together with the approved vehicle type; or

- 6.1.2. require a further test report from the technical service responsible for conducting the tests to prove that the new vehicle type complies with the requirements of this Regulation and constitutes part of a group of vehicle types together with the approved vehicle type; or

- 6.1.3. refuse the extension of approval and require a new approval procedure to be carried out.

- 6.2. The decisions of the Administrative Department and the technical service shall be based on the three-fold criteria of the worst case:

- 6.2.1. the structural criterion means whether the superstructure is changed or not (see Annex 4). If no change, or the new superstructure is stronger, this is favourable;

- 6.2.2. the energy criterion means whether the reference energy is changed or not. If the new vehicle type has the same or smaller reference energy than the approved one, this is favourable;

- 6.2.3. residual space criterion is based on the envelope surface of the residual space. If the residual space of the new vehicle type is everywhere within the approved case residual space, this is favourable.

- 6.3. If all three criteria described in paragraph 6.2 are changed favourably, the extension of the approval shall be granted without further investigation.

If all of three answers are unfavourable, a new approval procedure is required.

If the answers are mixed, further investigations (tests, calculation, structural analysis, for example) will be required. These investigations shall be determined by the technical service cooperating with the manufacturer.

- 6.4. Confirmation or refusal of approval, specifying the alterations, shall be notified by the procedure specified in paragraph 4.3. above to the Parties to the Agreement which apply this Regulation.

- 6.5. The Administrative Department issuing the extension of approval shall assign a series number to each communication form drawn up for such an extension.

7. CONFORMITY OF PRODUCTION

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

- 7.2. Every vehicle approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set out in paragraph 5 above. Only those elements which are nominated by the manufacturer as part of the superstructure shall be checked.

- 7.3. The normal frequency of inspections authorised by the Administrative Department shall be once every two years. If non-conformity is discovered in the course of one of these visits, the Administrative Department may increase the visit frequency to re-establish the conformity of production as rapidly as possible.

8. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

- 8.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 7 above are not complied with.

- 8.2. If a party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation 'APPROVAL WITHDRAWN'.

9. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of vehicle approved in accordance with this Regulation, he shall so inform the Administrative Department which granted the approval. Upon receiving the relevant communication, that Administrative Department shall inform the other Parties to the Agreement applying this Regulation by means of a copy of the approval form bearing at the end, in large letters, the signed and dated annotation 'PRODUCTION DISCONTINUED'.

10. TRANSITIONAL PROVISIONS

- 10.1. As from the official date of entry into force of the 01 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approval under this Regulation as amended by the 01 series of amendments.

- 10.2. As from 60 months after the date of entry into force, Contracting Parties applying this Regulation shall grant ECE approvals for new vehicle types as defined in this Regulation only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 01 series of amendments.

- 10.3. Contracting Parties applying this Regulation shall not refuse to grant extensions of approval to the preceding series of amendments to this Regulation.

- 10.4. ECE approvals granted under this Regulation, in its original form, earlier than 60 months after the date of entry into force and all extensions of such approvals, shall remain valid indefinitely, subject to paragraph 10.6 below. When the vehicle type approved to the preceding series of amendments meets the requirements of this Regulation as amended by the 01 series of amendments, the Contracting Party which granted the approval shall notify the other Contracting Parties applying this Regulation thereof.
- 10.5. No Contracting Party applying this Regulation shall refuse national type approval of a vehicle type approved to the 01 series of amendments to this Regulation.
- 10.6. Starting 144 months after the entry into force of the 01 series of amendments to this Regulation, Contracting Parties applying this Regulation may refuse first national registration (first entry into service) of a vehicle which does not meet the requirements of the 01 series of amendments to this Regulation.
11. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the Agreement which apply this Regulation shall communicate to the United Nations secretariat the names and addresses of the technical services responsible for conducting approval tests and of the Administrative Departments which grant approval. Forms issued in other countries to certify approval or extension or refusal or withdrawal of approval, are to be sent to the Administrative Departments of all Parties to this Agreement.

ANNEX 1

COMMUNICATION

[Maximum format: A4 (210 × 297 mm)]



issued by: Name of the administration:

.....

.....

.....

concerning: ⁽²⁾

APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to the strength of its superstructure pursuant to Regulation No 66.

Approval No

Extension No

1. Trade name or mark of the vehicle type:
2. Vehicle type:
3. Vehicle category/class:
4. Manufacturer's name and address:
5. If applicable, name and address of the manufacturer's representative:
6. Brief summary of description of the superstructure in respect of paragraph 3.2.2.2. of this Regulation and Annex 4:
7. Reference number of detailed drawing showing the residual space used in the approval procedure:
8. Unladen kerb mass (kg): and associated axle loads (kg):
9. Maximum number of seats permitted to be fitted with occupant restraints:
10. The position of the centre of gravity of the unladen vehicle in the longitudinal, transverse and vertical planes:
- 10.1. for unladen kerb mass:
- 10.2. for total effective mass:
11. If the vehicle is fitted with occupant restraints then additionally, the total effective vehicle mass (kg): and the associated axle loads (kg):
12. The value of reference energy (E_R) as specified in paragraph 3.2.2.1. of this Regulation:
13. Vehicle submitted for approval on:
14. Method of test or calculation employed for approval:
15. Direction of the rollover test used or assumed during the approval procedure:
16. Technical service responsible for conducting approval tests:
17. Date of test report issued by that service:
18. Number of report issued by that service:
19. Approval granted/refused/extended/withdrawn:
20. Reason(s) for extension (if applicable):

21. Position of approval mark on the vehicle:

List of documents containing data specified, in paragraph 3.2. of the Regulation, and in the annex referring to the approval test method which was used.

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.....
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.....

The listed documents are held by the Administrative Department and are available on request.

Place:

Date:

Signature:

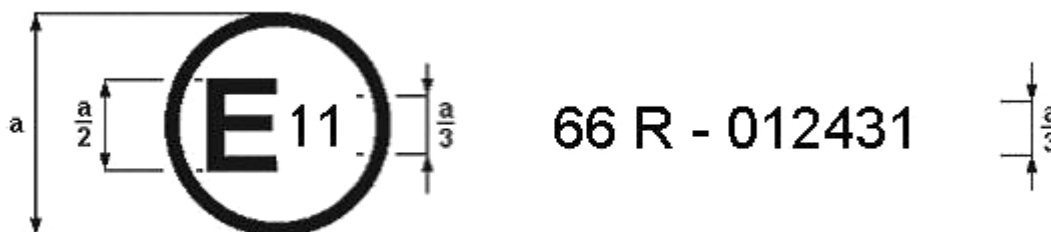
(¹) Distinguishing number of the country, which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

(²) Strike out what does not apply.

ANNEX 2

ARRANGEMENT OF THE APPROVAL MARK

(See paragraph 4.4 of this Regulation)

 $a = 8 \text{ mm min.}$

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the strength of the superstructure, been approved in the United Kingdom (E11) pursuant to Regulation No. 66 under approval number 012431. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of the 01 series of amendments to Regulation No. 66.

ANNEX 3

DETERMINATION OF THE CENTRE OF GRAVITY OF THE VEHICLE**1. GENERAL PRINCIPLES**

- 1.1. The reference and the total energy to be absorbed in the rollover test depend directly on the position of the vehicle's centre of gravity position. Therefore, its determination should be as accurate as practicable. The method of measurement of dimensions, angles and load values, and the accuracy of measurement shall be recorded for assessment by the technical service. The following accuracy of measuring apparatus is required:

- for measurements less than 2 000 mm, accuracy of ± 1 mm
- for measurements greater than 2 000 mm, accuracy of $\pm 0,05$ per cent
- for measured angles, accuracy of ± 1 per cent
- for measured load values, accuracy of $\pm 0,2$ per cent

The wheel-base(s) and the distance between the centres of the footprint of the wheel(s) at each axle (the track of each axle) shall be determined from the manufacturer's drawings.

- 1.2. Blocked suspension is specified as the condition for determining centre of gravity and for carrying out the actual rollover test. The suspension shall be blocked in the normal operating position as defined by the manufacturer.
- 1.3. The position of the centre of gravity is defined by three parameters:
- 1.3.1. longitudinal distance (l_1) from the centre line of front axle;
 - 1.3.2. transverse distance (t) from the vertical longitudinal central plane of the vehicle;
 - 1.3.3. vertical height (h_0) above the flat horizontal ground level when the tyres are inflated as specified for the vehicle.
- 1.4. A method for determining l_1 , t , h_0 , using load cells is described here. Alternative methods using lifting equipment and/or tilt tables for example may be proposed by the manufacturer to the technical service who will decide whether the method is acceptable based on its degree of accuracy.
- 1.5. The centre of gravity position of the unladen vehicle (unladen kerb mass M_k) shall be determined by measurements.
- 1.6. The centre of gravity position of the vehicle with total effective mass (M_t) may be determined:
- 1.6.1. by measuring the vehicle in total effective mass condition; or
 - 1.6.2. by using the measured centre of gravity position in the unladen kerb mass condition and considering the effect of the total occupant mass.

2. MEASUREMENTS

- 2.1. The position of the vehicle's centre of gravity shall be determined in the unladen kerb mass condition or the total effective vehicle mass condition as defined in paragraphs 1.5. and 1.6. For the determination of the position of the centre of gravity in the total effective vehicle mass condition, the individual occupant mass (factored by the constant, $k = 0,5$) shall be positioned and rigidly held 200 mm above and 100 mm forward of the R point (which is defined in Regulation No 21, Annex 5) of the seat.
- 2.2. The longitudinal (l_1) and transverse (t) coordinates of centre of gravity shall be determined on a common horizontal ground (see Figure A3.1) where each wheel or twinned wheel of the vehicle is standing on an individual load cell. Each steered wheel shall be set to its straight-ahead position.
- 2.3. The individual load-cell readings shall be noted simultaneously and shall be used to calculate the total vehicle mass and centre of gravity position.

- 2.4. The longitudinal position of the centre of gravity relative to the centre of the contact point of the front wheels (see Figure A3.1) is given by:

$$l_1 = \frac{(P_3 + P_4) \cdot L_1 + (P_5 + P_6) \cdot L_2}{(P_{\text{total}})}$$

where:

P_1 = reaction load on the load cell under the left-hand wheel of the first axle

P_2 = reaction load on the load cell under the right-hand wheel of the first axle

P_3 = reaction load on the load cell under the left-hand wheel(s) of the second axle

P_4 = reaction load on the load cell under the right-hand wheel(s) of the second axle

P_5 = reaction load on the load cell under the left-hand wheel(s) of the third axle

P_6 = reaction load on the load cell under the right-hand wheel(s) of the third axle

$P_{\text{total}} = (P_1 + P_2 + P_3 + P_4 + P_5 + P_6) = M_k$ unladen kerb mass; or,

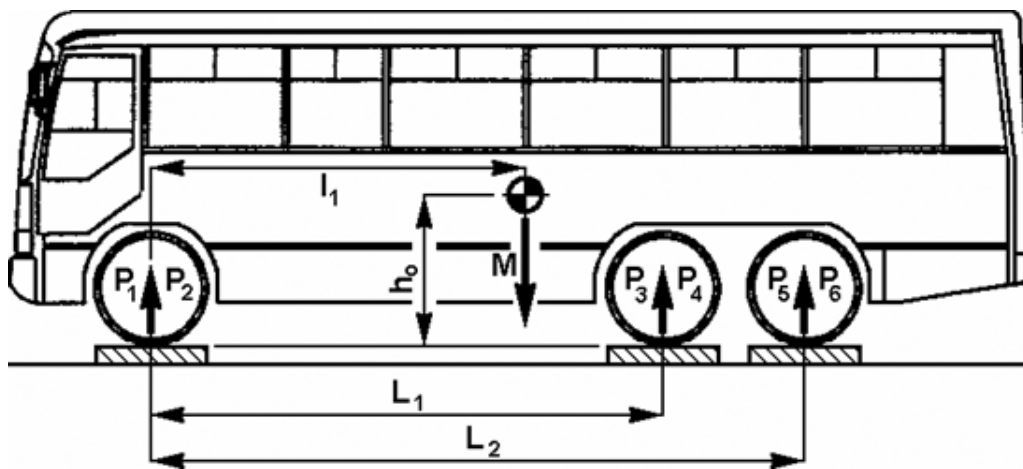
= M_t total effective vehicle mass, as appropriate

L_1 = the distance from centre of wheel on 1st axle to centre of wheel on second axle

L_2 = the distance from centre of wheel on 1st axle to centre of wheel on third axle, if fitted.

Figure A3.1

Longitudinal position of the centre of gravity



- 2.5. The transverse position (t) of the vehicle's centre of gravity relative to its longitudinal vertical centre plane (see figure A3.2) is given by:

$$t = \left((P_1 - P_2) \frac{T_1}{2} + (P_3 - P_4) \frac{T_2}{2} + (P_5 - P_6) \frac{T_3}{2} \right) \cdot \frac{1}{P_{\text{total}}}$$

where:

T_1 = distance between the centres of the footprint of the wheel(s) at each end of the first axle

T_2 = distance between the centres of the footprint of the wheel(s) at each end of the second axle

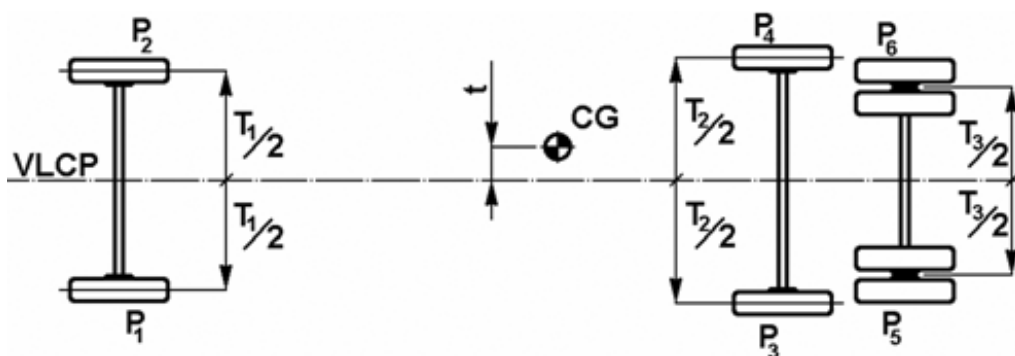
T_3 = distance between the centres of the footprint of the wheel(s) at each end of the third axle.

This equation assumes that a straight line can be drawn through the centre points of T_1 , T_2 , T_3 . If this is not the case then a specialised formula will be required.

If the value of (t) is negative, then the centre of gravity of the vehicle is situated to the right of the centreline of the vehicle.

Figure A3.2

Transverse position of centre of gravity



- 2.6. The height of the centre of gravity (h_0) shall be determined by tilting the vehicle longitudinally and using individual load-cells at the wheels of two axles.
- 2.6.1. Two load-cells shall be positioned on a common horizontal plane, to receive the front wheels. The horizontal plane shall be at sufficient height above the surrounding surfaces that the vehicle can be tilted forward to the required angle (see paragraph 2.6.2 below) without its nose touching that surface.
- 2.6.2. A second pair of load-cells shall be placed in a common horizontal plane on top of support structures, ready to receive the wheels of the second axle of the vehicle. The support structures shall be sufficiently tall to generate a significant angle of inclination α ($> 20^\circ$) for the vehicle. The greater the angle, the more accurate will be the calculation — see figure A3.3. The vehicle is repositioned on the four load-cells, with the front wheels chocked to prevent the vehicle rolling forward. Each steered wheel shall be set to its straight-ahead steer position.
- 2.6.3. The individual load-cell readings shall be noted simultaneously and shall be used to check the total vehicle mass and centre of gravity position.
- 2.6.4. The inclination of the tilting test shell be determined by the equation (see figure A3.3):

$$\alpha = \arcsin\left(\frac{H}{L_1}\right)$$

where:

H = height difference between the footprints of the wheels of the first and second axles

L_1 = the distance from centre of wheel's first and second axles.

- 2.6.5. The unladen kerb mass of the vehicle shall be checked as follows:

$$F_{\text{total}} = F_1 + F_2 + F_3 + F_4 = P_{\text{total}} = M_k$$

where:

F_1 = reaction load on the load cell under the left hand wheel of the first axle

F_2 = reaction load on the load cell under the right hand wheel of the first axle

F_3 = reaction load on the load cell under the left hand wheel of the second axle

F_4 = reaction load on the load cell under the right hand wheel of the second axle

If this equation is not fulfilled the measurement shall be repeated and/or the manufacturer shall be asked to modify the value of the unladen kerb mass in the technical description of the vehicle.

2.6.6. The height (h_0) of the vehicle centre of gravity is given by:

$$h_0 = r + \left(\frac{1}{\tan \alpha} \right) \left(l_1 - L_1 \frac{F_3 + F_4}{P_{\text{total}}} \right)$$

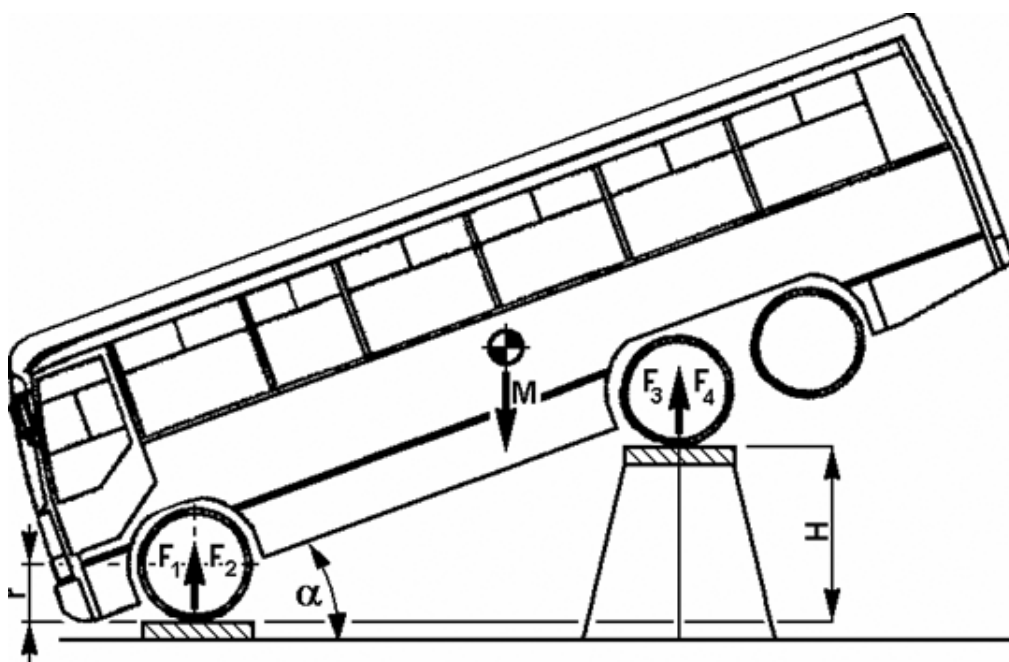
where:

r = height of wheel centre (on first axle) above the load cell top surface.

2.6.7. If the articulated vehicle is tested in separate sections, the centre of gravity position shall be established separately for each section.

Figure A3.3

Determination of height of centre of gravity



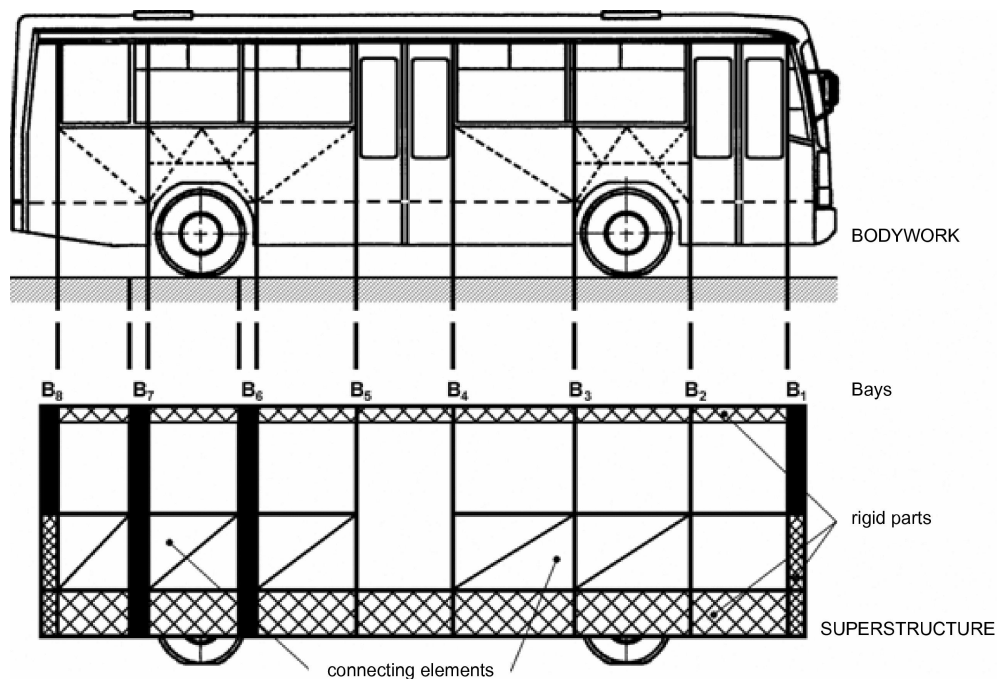
ANNEX 4

VIEWPOINTS ON THE STRUCTURAL DESCRIPTION OF THE SUPERSTRUCTURE

1. GENERAL PRINCIPLES
 - 1.1. The manufacturer shall define unambiguously the superstructure of the bodywork (see figure A4.1, for example) and shall state:
 - 1.1.1. which bays contribute to the strength and energy absorption of the superstructure;
 - 1.1.2. which connecting elements between the bays contribute to the torsional stiffness of the superstructure;
 - 1.1.3. the mass distribution among the nominated bays;
 - 1.1.4. which elements of the superstructure are assumed as rigid parts.

Figure A4.1

Derivation of the superstructure from the bodywork

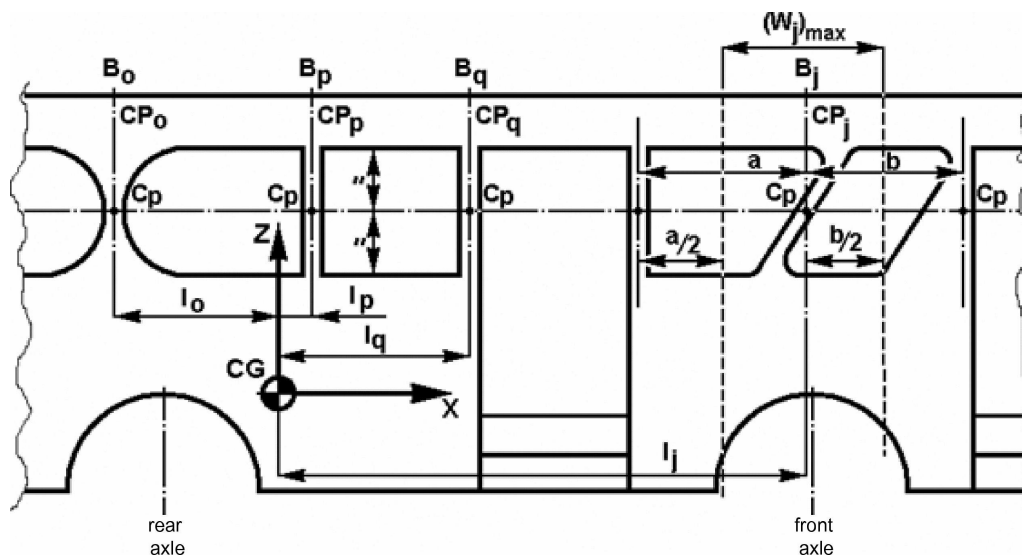


- 1.2. The manufacturer shall supply the following information about the elements of the superstructure:
 - 1.2.1. drawings, with all the significant geometrical measurements necessary to produce the elements and to evaluate any change or alteration of the element;
 - 1.2.2. the material of the elements referred to national, or international standards;
 - 1.2.3. the joint technology between the structural elements (riveted, bolted, glued, welded, type of welding, etc.).
- 1.3. Every superstructure shall have at least two bays: one in front of the centre of gravity and one behind the centre of gravity.
- 1.4. No information is required about any elements of the bodywork, which are not parts of the superstructure.

2. BAYS
- 2.1. A bay is defined as a structural section of the superstructure forming a closed loop between two planes which are perpendicular to the vertical longitudinal centre plane (VLCP) of the vehicle. A bay contains one window (or door) pillar on each side of the vehicle as well as side wall elements, a section of the roof structure and a section of the floor and underfloor structure. Every bay has a transverse centre plane (CP) perpendicular to the VLCP of the vehicle and passing through the centre points (C_p) of the window-pillars (see figure A4.2).
- 2.2. The C_p is defined as a point at half window height and halfway across the pillar width. If the C_p of the left-side and right-side pillars of a bay are not in the same transverse plane, the CP of the bay is set halfway between the transverse planes of the two C_p 's.
- 2.3. The length of a bay is measured in the direction of the longitudinal axis of the vehicle, and is determined by the distance between two planes perpendicular to the VLCP of the vehicle. There are two limits which define the length of a bay: the window (door) arrangement, and the shape and construction of the window (door) pillars.)

Figure A4.2

Definition of length of bays



- 2.3.1. The maximum length of a bay is defined by the length of the two neighbouring window (door) frames

$$(W_j)_{\max} = \frac{1}{2}(a + b)$$

where:

a = the length of the window (door) frame behind the j^{th} pillar, and

b = the length of the window (door) frame in front of the j^{th} pillar

If the pillars on opposite sides of the bay are not in one transverse plane, or the window frames on each side of the vehicle have different lengths (see figure A4.3), the overall length, W_j of the bay is defined by:

$$(W_j)_{\max} = \frac{1}{2}(a_{\min} + b_{\min} - 2L)$$

where:

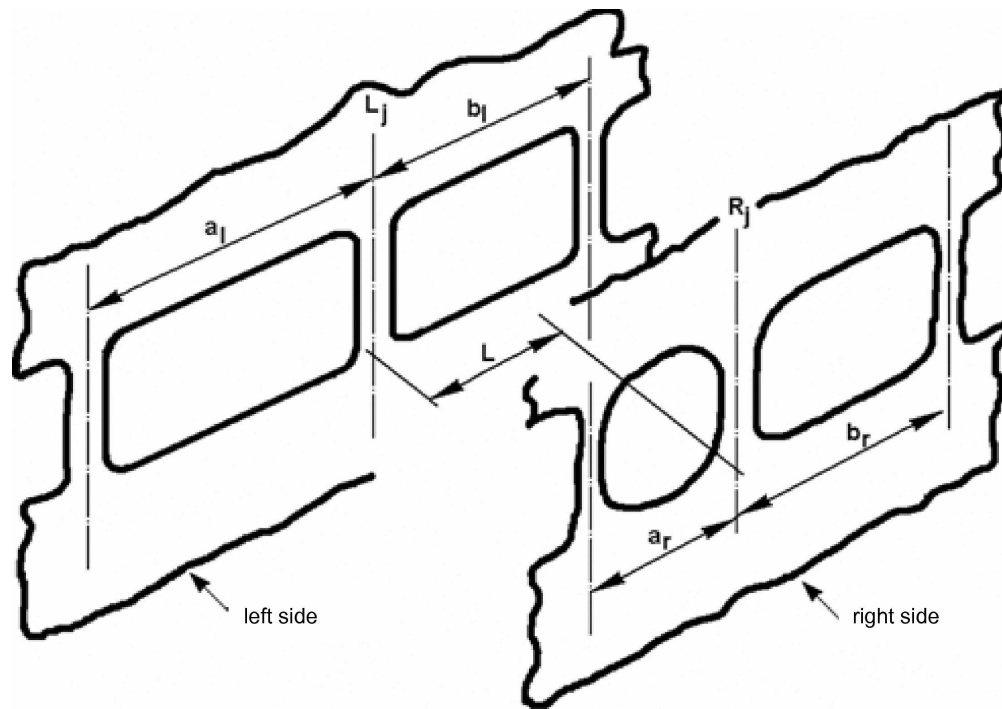
$a_{\min}$ = the smaller value of $a_{\text{right side}}$ or $a_{\text{left side}}$

$b_{\min}$ = the smaller value of $b_{\text{right side}}$ or $b_{\text{left side}}$

L = the longitudinal offset between the centrelines of the pillars on the left and right sides of the vehicle.

Figure A4.3

Definition of bay length when pillars on each side of the bay are not in one transverse plane



2.3.2. The minimum length of a bay shall include the whole window pillar (including its inclination, corner radii, etc.). If the inclination and corner radii exceed half the length of the adjacent window then the next pillar shall be included in the bay.

2.4. The distance between two bays shall be defined as the distance between their CP's.

2.5. The distance of a bay from the centre of gravity of the vehicle shall be defined as the perpendicular distance from its CP to the vehicle centre of gravity.

3. CONNECTING STRUCTURES BETWEEN THE BAYS

3.1. the connecting structures between bays shall be clearly defined in the superstructure. These structural elements fall into two distinct categories:

3.1.1. The connecting structures which form part of the superstructure. These elements shall be identified by the manufacturer, in this design submission: they include:

3.1.1.1. side-wall structure, roof structure, floor structure, which connect several bays;

3.1.1.2. structural elements which reinforce one or more bays; for example, boxes under seats, wheel arches, seat structures connecting side-wall to floor, kitchen, wardrobe and toilet structures.

3.1.2. The additional elements which do not contribute to the structural strength of the vehicle but which may intrude into the residual space, for example: ventilation ducts, hand luggage boxes, heating ducts.

4. MASS DISTRIBUTION

4.1. The manufacturer shall clearly define the portion of the mass of the vehicle attributed to each of the bays of the superstructure. This mass distribution shall express the energy absorbing capability and load bearing capacity of each bay. The following requirements shall be met when defining the distribution of mass:

4.1.1. the sum of the masses attributed to each bay shall be related to the mass M of the complete vehicle:

$$\sum_{j=1}^n (m_j) \geq M$$

where:

m_j = the mass attributed to the j^{th} bay

n = the number of bays in the superstructure

M = M_k , unladen kerb mass; or,

M_v , total effective vehicle mass, as appropriate

4.1.2. the centre of gravity of the distributed masses shall be in the same position as the centre of gravity of the vehicle:

$$\sum_{j=1}^n (m_j l_j) = 0$$

where:

l_j = the distance of the j^{th} bay from the centre of gravity of the vehicle (see paragraph 2.3),
 l_j is positive, if the bay is in front of the centre of gravity and negative if it is behind it.

4.2. The mass ' m_j ' of each bay of the superstructure shall be defined by the manufacturer, as follows:

4.2.1. the masses of the components of the ' j^{th} ' bay shall be related to its mass ' m_j ' by:

$$\sum_{k=1}^s m_{jk} \geq m_j$$

where:

m_{jk} = the mass of each component of the bay

s = the number of individual masses on the bay;

4.2.2. the centre of gravity of the component masses of a bay shall have the same transverse position inside the bay as the bay's centre of gravity (see figure A4.4):

$$\sum_{k=1}^s m_{jk} y_k = \sum_{k=1}^s m_{jk} z_k = 0$$

where:

y_k = the distance of the k^{th} mass component of the bay from the axis 'Z' (see figure A4.4).

y_k will have a positive value on one side of the axis and a negative value on the other side.

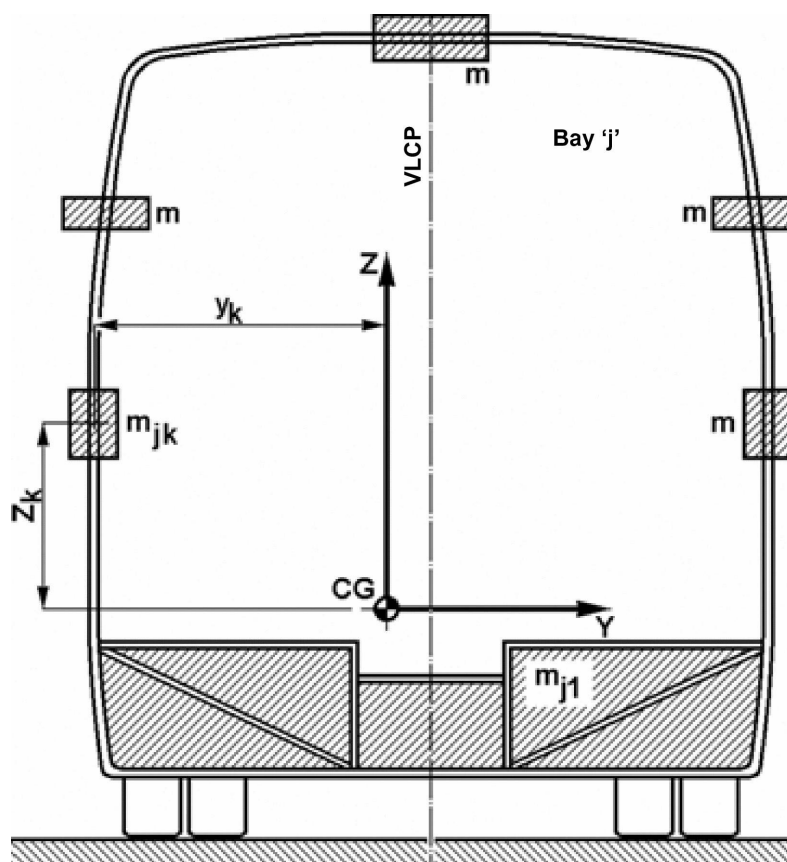
z_k = the distance of the k^{th} mass component of the bay from the axis 'Y',

z_k will have a positive value on one side of the axis and a negative value on the other side.

4.3. In the case where occupant restraints are part of the vehicle specification, the occupant mass attributed to a bay shall be attached to that part of the superstructure which is designed to absorb seat and occupant loadings.

Figure A4.4

Distribution of mass in the cross section of a bay



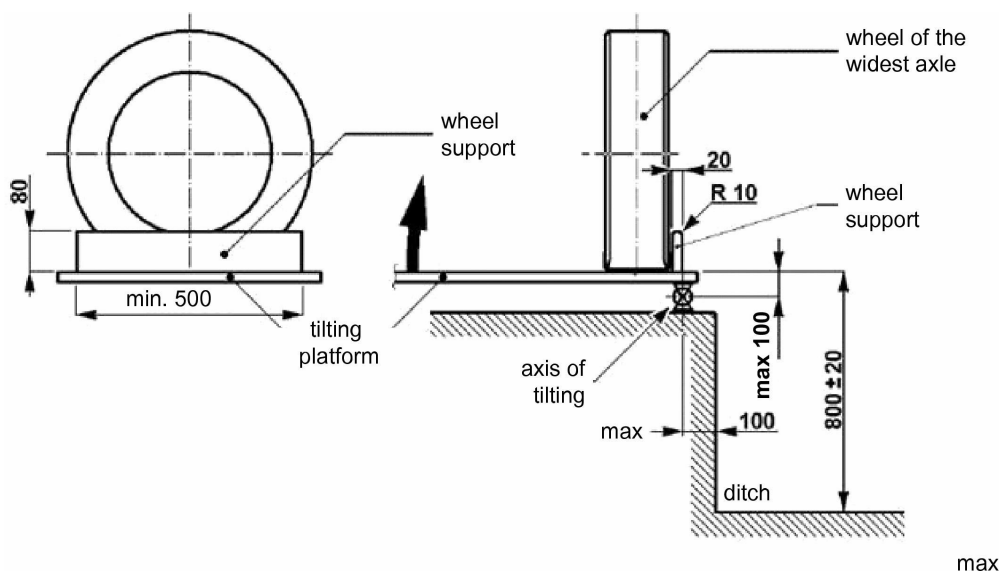
ANNEX 5

ROLLOVER TEST AS THE BASIC APPROVAL METHOD

1. THE TILTING BENCH
 - 1.1. The tilting platform shall be sufficiently rigid and the rotation sufficiently controlled to ensure simultaneous lifting of the axles of the vehicle with a difference of less than 1° in the platform's tilt angles measured below the axles.
 - 1.2. The height difference between the horizontal lower plane of the ditch (see figure A5.1) and the plane of the tilting platform on which the bus is standing, shall be 800 ± 20 mm.
 - 1.3. The tilting platform, related to the ditch, shall be placed as follows (see figure A5.1):
 - 1.3.1. the axis of its rotation is max 100 mm from the vertical wall of the ditch;
 - 1.3.2. the axis of the rotation is max 100 mm below the plane of the horizontal tilting platform.

Figure A5.1

Geometry of the tilting bench

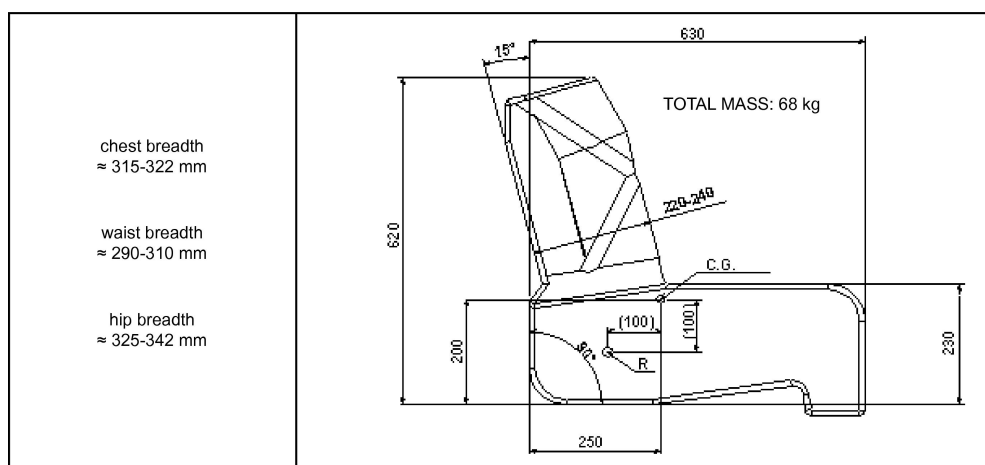


- 1.4. Wheel supports shall be applied at the wheels being close to the axis of rotation against sliding of the vehicle sideways when tilting it. The main characteristics of the wheel supports (see figure A5.1) shall be:
 - 1.4.1. dimensions of the wheel support:

height:	shall not be greater than two-thirds of the distance between the surface on which the vehicle stands before it is tilted and part of the rim of the wheel which is nearest to the surface
width:	20 mm
edge radius:	10 mm
length:	500 mm minimum;
 - 1.4.2. the wheel supports at the widest axle shall be placed on the tilting platform so that the side of the tyre is at maximum 100 mm from the axis of rotation;

- 1.4.3. the wheel supports at the other axles shall be adjusted so that the vertical longitudinal centre plane (VLCP) of the vehicle shall be parallel to the axis of rotation.
- 1.5. The tilting platform shall be constructed to prevent the vehicle moving along its longitudinal axis.
- 1.6. The impact area of the ditch shall have a horizontal, uniform, dry and smooth concrete surface.
- 2. PREPARATION OF TEST VEHICLE
 - 2.1. The vehicle to be tested need not be in a fully finished, 'ready for operation' condition. Generally, any alteration from the fully finished condition is acceptable if the basic features and behaviour of the superstructure are not influenced by it. The test vehicle shall be the same as its fully finished version in respect of the following:
 - 2.1.1. the position of the centre of gravity, the total value of vehicle mass (unladen kerb mass, or total effective vehicle mass where restraints are fitted) and the distribution and location of masses, as declared by the manufacturer.
 - 2.1.2. all of those elements which — according to the manufacturer — contribute to the strength of the superstructure shall be installed in their original position (see Annex 4 to this Regulation).
 - 2.1.3. elements, which do not contribute to the strength of the superstructure and are too valuable to risk damage (e.g. drive chain, dashboard instrumentation, driver's seat, kitchen equipment, toilet equipment, etc.) can be replaced by additional elements equivalent in mass and method of installation. These additional elements must not have a reinforcing effect on the strength of superstructure.
 - 2.1.4. fuel, battery acid and other combustible, explosive or corrosive materials may be substituted with other materials provided that the conditions of paragraph 2.1.1 are met.
 - 2.1.5. In the case where occupant restraint devices are part of the vehicle type, a mass shall be attached to each seat fitted with an occupant restraint following one of these two methods, at the choice of the manufacturer:
 - 2.1.5.1. First method: That mass shall be:
 - 2.1.5.1.1. 50 per cent of the individual occupant mass (M_{mi}) of 68 kg.
 - 2.1.5.1.2. placed to have its centre of gravity 100 mm above and 100 mm forward of the R point of the seat as defined in Regulation No 21, Annex 5.
 - 2.1.5.1.3. fixed rigidly and securely so that it does not break away during the test.
 - 2.1.5.2. Second method: That mass shall be:
 - 2.1.5.2.1. an anthropomorphic ballast with a mass of 68 kg and shall be restrained with a 2 point safety-belt. The ballast must allow guiding and positioning for safety-belts.
 - 2.1.5.2.2. placed to have its centre of gravity and dimensioning according to figure A5.2.
 - 2.1.5.2.3. fixed rigidly and securely so that it does not break away during the test.

Figure A5.2

Dimensions for the anthropomorphic ballast

2.2. The test vehicle shall be prepared as follows:

2.2.1. Tyres shall be inflated to the pressure prescribed by the manufacturer.

2.2.2. The suspension system of the vehicle shall be blocked, i.e. the axles, the springs and the suspension elements of the vehicle shall be fixed in relation to the bodywork.

The floor height above the horizontal tilting platform shall be according to the manufacturer's specification for the vehicle, dependent on whether it is loaded to unladen kerb mass or total vehicle mass.

2.2.3. Every door and opening window of the vehicle shall be closed but not locked.

2.3. The rigid sections of an articulated vehicle may be tested separately or in combination.

2.3.1. For testing the articulated sections as a combination, the sections of the vehicle shall be fixed to each other in such a way that,

2.3.1.1. there is no relative movement between them during the roll-over process.

2.3.1.2. there is no significant change in mass distribution and centre of gravity positions.

2.3.1.3. there is no significant change in the strength and deformation capability of the superstructure.

2.3.2. For testing the articulated sections separately, the single-axle sections shall be attached to an artificial support which keeps them in fixed relation to the tilting platform during its movement from the horizontal to the point of roll-over. This support shall meet the following requirements:

2.3.2.1. it shall be fixed to the structure in such a way that it does not cause either reinforcement or extra additional load to the superstructure.

2.3.2.2. it shall be constructed so that it does not suffer any deformation which could change the direction of the roll-over of the vehicle.

2.3.2.3. its mass shall be equal to the mass of those elements, parts of the articulated joint, which nominally belong to the section being tested, but which are not placed on it (e.g. turntable and its floor, handholds, rubber sealing curtains, etc.).

- 2.3.2.4. its centre of gravity shall have the same height as the common centre of gravity of those parts which are listed in paragraph 2.3.2.3.
- 2.3.2.5. it shall have an axis of rotation parallel to the longitudinal axis of the multi-axle section of the vehicle, and passing through the points of contact of the tyres of that section.
3. TEST PROCEDURE, TEST PROCESS
- 3.1. The rollover test is a very rapid, dynamic process having distinguishable stages, should be taken into consideration when a rollover test, its instrumentation and measurement are planned.
- 3.2. The vehicle shall be tilted without rocking and without dynamic effects until it reaches unstable equilibrium and commences its rollover. The angular velocity of the tilt platform shall not exceed 5 degrees/sec. (0,087 radians/sec).
- 3.3. For inside observation high-speed photography, video, deformable templates, electrical contact sensors or other suitable means shall be used to determine that the requirements of paragraph 5.1. of this Regulation has been met. This shall be verified at any places of the passenger, driver's and crew compartment where the residual space seems to be endangered, the exact positions being at the discretion of the technical service. At least two positions, nominally at the front and rear of the passenger compartment shall be used.
- 3.4. Outside observation and recording of the rollover and deformation process is recommended, which means the following:
- 3.4.1. two high-speed cameras — one at the front and another at the rear. They should be located far enough from the front and rear wall of the vehicle to produce a measurable picture, avoiding wide-angle distortion in the shaded area, as shown in figure A5.3a.
- 3.4.2. the position of the centre of gravity and the contour of the superstructure (see figure A5.3b), is marked by stripes and bands to ensure correct measurements on the pictures.

Figure A5.3a

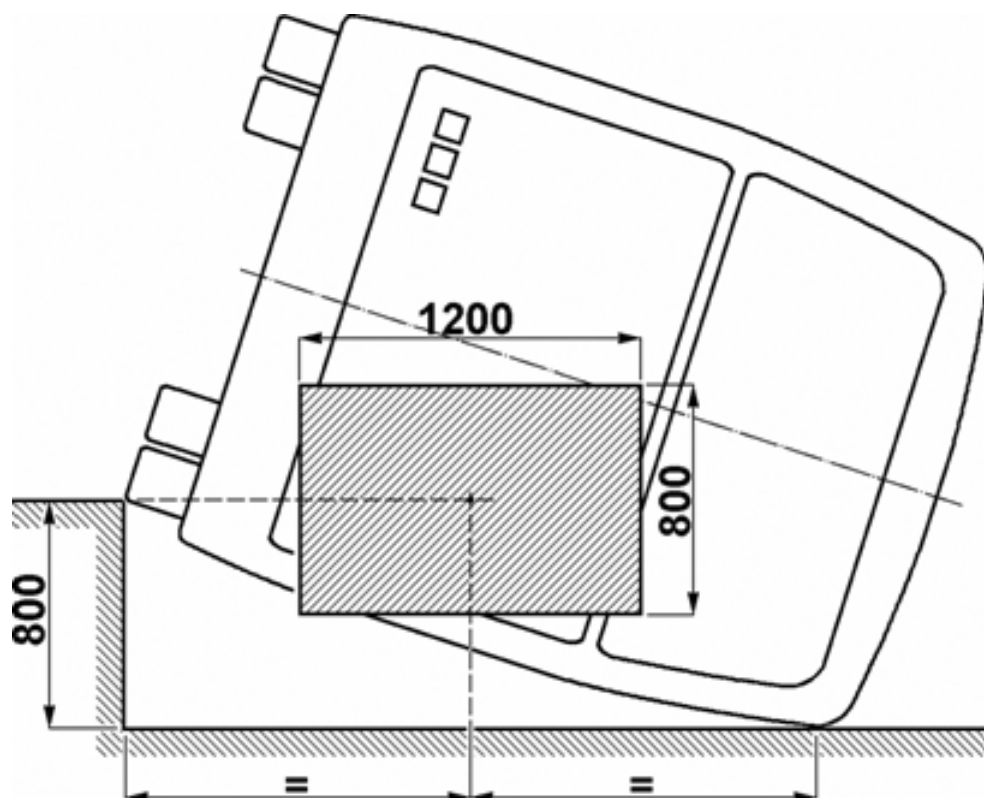
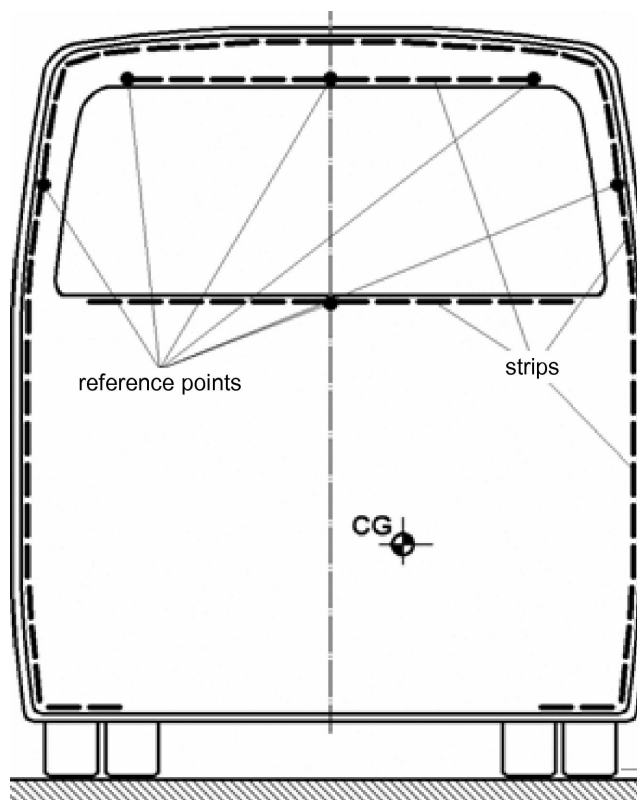
Recommended field of view of outside camera

Figure A5.3b

Recommended marking of the centre of gravity position and the contour of the vehicle

4. DOCUMENTATION OF THE ROLLOVER TEST

4.1. Detailed description of the tested vehicle shall be given by the manufacturer in which:

- 4.1.1. all the deviations between the fully finished vehicle type in running order and the tested vehicle are listed.
- 4.1.2. the equivalent substitution (in respect of mass, mass distribution and installation) shall be proved in every case, when structural parts, units are substituted by other units or masses.
- 4.1.3. there is a clear statement of the position of centre of gravity in the tested vehicle which may be based on measurements carried out on the test vehicle when it is ready for test, or a combination of measurement (carried out on the fully finished vehicle type) and calculation based on the mass substitutions.

4.2. The test report shall contain all the data (pictures, records, drawings, measured values, etc.) which show:

- 4.2.1. that test was carried out according to this annex;
 - 4.2.2. that the requirements given in paragraphs 5.1.1 and 5.1.2 of this Regulation are met (or not);
 - 4.2.3. the individual evaluation of inside observations;
 - 4.2.4. all the data and information needed for the identification of the vehicle type, the test vehicle, the test itself, and the personnel responsible for the test and its evaluation.
- 4.3. It is recommended to document in the test report the centre of gravity's highest and lowest position related to the ground level of the ditch.

ANNEX 6

ROLLOVER TEST USING BODY SECTIONS AS AN EQUIVALENT APPROVAL METHOD**1. ADDITIONAL DATA AND INFORMATION**

If the manufacturer chooses this method of testing, the following information shall be given to the technical service in addition to the data, information and drawings listed in paragraph 3 of this Regulation:

- 1.1. drawings of the body sections to be tested;
- 1.2. verification of the validity of the distribution of masses given in Annex 4, paragraph 4, upon successful completion of the body section rollover tests;
- 1.3. the measured masses of the body sections to be tested, and verification that their centre of gravity positions are the same as that of the vehicle with unladen kerb mass if not fitted with occupant restraints, or with total effective vehicle mass if occupant restraints are fitted. (Presentation of measuring reports)

2. THE TILTING BENCH

The tilting bench shall meet the requirements given in Annex 5, paragraph 1.

3. PREPARATION OF BODY SECTIONS

- 3.1. The number of the body sections to be tested shall be determined by the following rules:
 - 3.1.1. all the different bay configurations which are part of the superstructure shall be tested in at least one body section;
 - 3.1.2. every body section shall have at least two bays;
 - 3.1.3. in an artificial body section (see paragraph 2.27 of this Regulation) the ratio of the mass of any one bay to any other bay shall not exceed 2;
 - 3.1.4. the residual space of the whole vehicle shall be well represented in the body sections, including any peculiar combinations arising from the vehicles bodywork configuration;
 - 3.1.5. the whole roof structure shall be well represented in the body sections if there are local specialities, like changing height, air condition installation, gas tanks, luggage carrier, etc.
- 3.2. The bays of the body section shall be exactly the same structurally as they are represented in the superstructure, as regards shape, geometry, material, joints.
- 3.3. The connecting structures between the bays shall represent the manufacturer's description of the superstructure (see Annex 4, paragraph 3) and the following rules shall be considered:
 - 3.3.1. in the case of an original body section taken directly from the actual vehicle layout, the basic and the additional connecting structures (see Annex 4 paragraph 3.1) shall be the same as that of the vehicle superstructure;
 - 3.3.2. in the case of an artificial body section, the connecting structures shall be equivalent in terms of strength, stiffness and behaviour to that of the vehicle superstructure;
 - 3.3.3. those rigid elements which are not part of the superstructure but which can encroach on the residual space during deformation, shall be installed into the body sections;
 - 3.3.4. the mass of the connecting structures shall be included in the mass distribution, in terms of attribution to a particular bay and distribution within that bay.

- 3.4. The body sections shall be equipped with artificial supports, to provide the same centre of gravity positions and axis of rotation for them on the tilting platform as that of the complete vehicle. The supports shall meet the following requirements:
 - 3.4.1. they shall be fixed to the body section in such a way that they do not provide either reinforcement or extra additional load on the body section;
 - 3.4.2. they shall be sufficiently strong and rigid to resist any deformation which could change the direction of the body section motion during the tilting and rollover process;
 - 3.4.3. their mass shall be included in the mass distribution and centre of gravity position of the body section.
- 3.5. The distribution of mass in the body section shall be arranged with the following considerations:
 - 3.5.1. the whole body section (bays, connecting structures, additional structural elements, supports) shall be considered when checking the validity of equations 5 and 6, in Annex 4, paragraph 4.2;
 - 3.5.2. any masses attached to the bays (see paragraph 4.2.2 and figure 4 of Annex 4) shall be placed and fixed to the body section in such a way that they do not cause reinforcement or additional load or limitation of the deformation.
 - 3.5.3. In the case where occupant restraints are part of the vehicle type, the occupant masses shall be considered as described in Annex 4 and Annex 5.

4. TEST PROCEDURE

The test procedure shall be the same as described in paragraph 3. of Annex 5 for a complete vehicle.

5. EVALUATION OF THE TESTS

- 5.1. The vehicle type shall be approved if all the body sections pass the rollover test and equations 2 and 3 in paragraph 4 of Annex 4 are fulfilled.
- 5.2. If one of the body sections fails the test, the vehicle type shall not be approved.
- 5.3. If a body section passes the rollover test, each of the bays which form that body section are considered to have passed the rollover test, and the result can be quoted used in future applications for approval, provided that the ratio of their masses remains the same in the subsequent superstructure.
- 5.4. If a body section fails the rollover test, all the bays within that body section shall be considered to have failed the test even if the residual space is invaded in only one of the bays.

6. DOCUMENTATION OF BODY SECTION ROLLOVER TESTS

The test report shall contain all the data necessary to demonstrate:

- 6.1. The construction of the tested body sections (dimensions, materials, masses, centre of gravity position, construction methods);
- 6.2. that the tests were carried out according to this annex;
- 6.3. whether, or not, the requirements — given in paragraph 5.1 of this Regulation — are met;
- 6.4. the individual evaluation of the body sections and their bays;
- 6.5. the identity of the vehicle type, its superstructure, the tested body sections, the tests themselves and the personnel responsible for the tests and their evaluation.

ANNEX 7

QUASI- STATIC LOADING TEST OF BODY SECTIONS AS AN EQUIVALENT APPROVAL METHOD**1. ADDITIONAL DATA AND INFORMATION**

This method of testing uses body sections as test units, each one built up from at least two bays of the vehicle under appraisal, connected together with representative structural elements. If the manufacturer chooses this method of testing, the following additional information shall be supplied to the technical service, in addition to the data, and drawings listed in paragraph 3.2 of this Regulation:

- 1.1. drawings of the body sections to be tested.
- 1.2. energy values to be absorbed by the individual bays of the superstructure, as well as the energy values belonging to the body sections to be tested.
- 1.3. verification of the energy requirement, see paragraph 4.2 below, upon completion of successful quasi-static loading tests of body sections.

2. PREPARATION OF BODY SECTIONS

- 2.1. The manufacturer shall consider the requirements given in Annex 6, paragraphs 3.1, 3.2, and 3.3, when designing and producing the body sections for test.
- 2.2. The body sections shall be equipped with the residual space profile, at positions where it is considered that the pillars or other structural elements are likely to intrude as a result of the expected deformation.

3. TEST PROCEDURE

- 3.1. Each body section to be tested shall be firmly and securely attached to the test bench through a rigid underframe structure in such a way that:
 - 3.1.1. local plastic deformation shall not occur around the attachment points;
 - 3.1.2. the location and method of attachment shall not inhibit the formation and working of expected plastic zones and hinges.
- 3.2. For application of the load to the body section, the following rules shall be considered:
 - 3.2.1. the load shall be evenly distributed on the cantrail, through a rigid beam, which is longer than the cantrail to simulate the ground in a rollover test, and which follows the geometry of the cantrail.
 - 3.2.2. the direction of the applied load (see figure A7.1) shall be related to the longitudinal vertical centre plane of the vehicle and its inclination (α) shall be determined as follows:

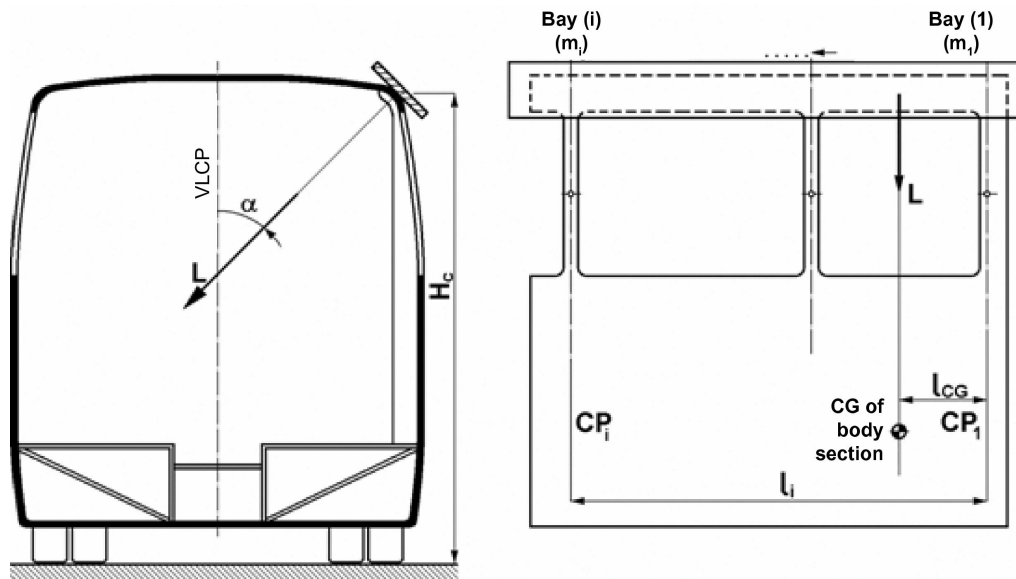
$$\alpha = 90^{\circ} - \arcsin\left(\frac{800}{H_c}\right)$$

where:

H_c = the cantrail height (in mm) of the vehicle measured from the horizontal plane on which it is standing.

Figure A7.1

Application of load to the body section



- 3.2.3. the load shall be applied to the beam at the centre of gravity of the body section derived from the masses of its bays and the structural elements connecting them. Using the symbols of Figure A.7.1, the position of the body section can be determined by the following formula:

$$l_{CG} = \frac{\sum_{i=1}^s m_i l_i}{\sum_{i=1}^s m_i}$$

where:

s = the number of the bays in the body section

m_i = the mass of the i^{th} bay

l_i = the distance of the centre of gravity of the i^{th} bay from a selected pivot point (the central plane of Bay(1) in figure A7.1)

l_{CG} = the distance of the centre of gravity of the body section from the same selected pivot point.

- 3.2.4. the load shall be increased gradually, taking measurements of the associated deformation at discrete intervals until the ultimate deformation (d_u) when the residual space is invaded by one of the elements of the body section.

- 3.3. When plotting the load-deflection curve:

- 3.3.1. the frequency of measurement shall be such as to produce a continuous curve (see figure A.7.2);

- 3.3.2. the values of load and deformation shall be measured simultaneously;

- 3.3.3. the deformation of the loaded cantrail shall be measured in the plane and direction of the applied load;

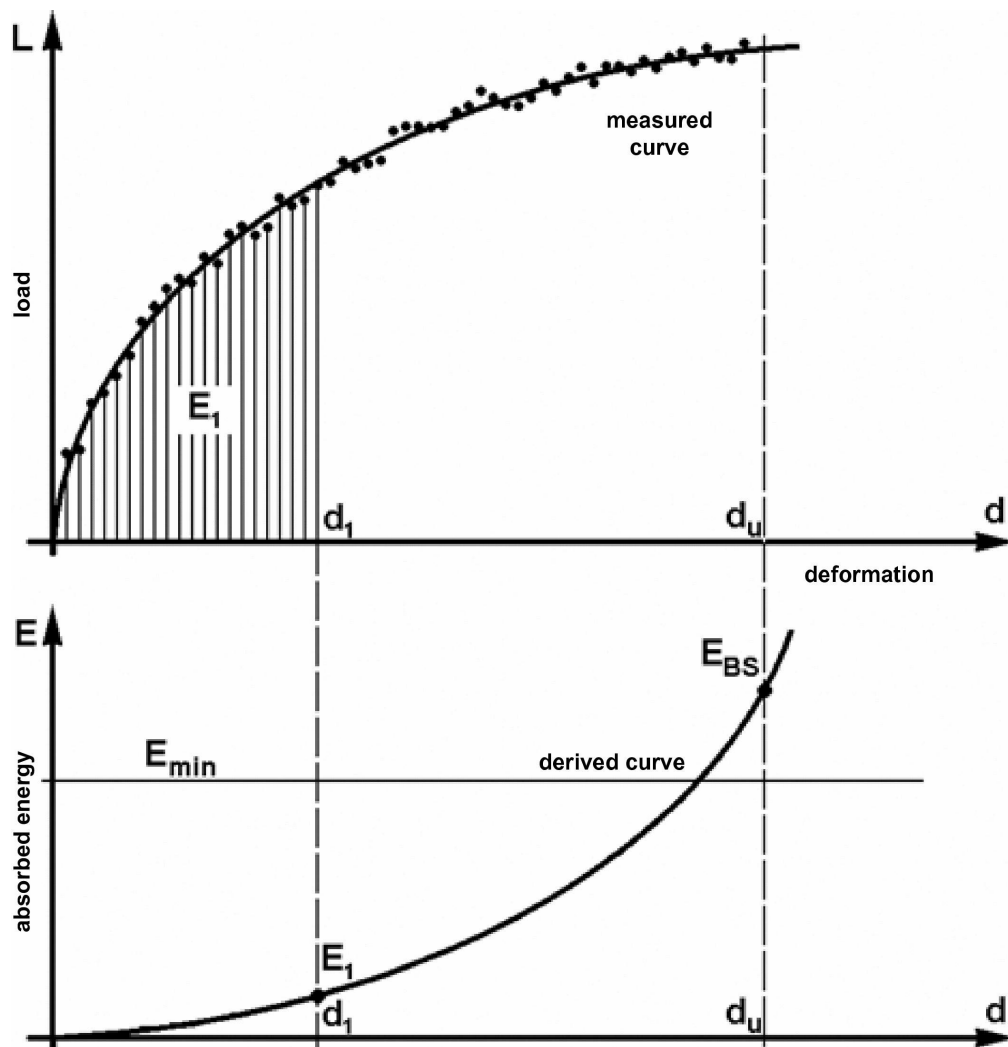
- 3.3.4. both load and deformation shall be measured to an accuracy of ± 1 per cent.

4. EVALUATION OF TEST RESULTS

- 4.1. From the plotted load-deformation curve the actual energy absorbed by the body section (E_{BS}) shall be expressed as the area below the curve (see figure A.7.2).

Figure A7.2

Absorbed energy for the body section, derived from the measured load-deformation curve



4.2. The minimum energy required to be absorbed by the body section (E_{min}) shall be determined as follows:

4.2.1. the total energy (E_T) to be absorbed by the superstructure is:

$$E_T = 0.75 M g \Delta h$$

where:

M = M_k , unladen kerb mass of the vehicle if there are no occupant restraints; or, M_v , total effective vehicle mass when occupant restraints are fitted,

g = gravitational constant,

Δh = the vertical movement (in metres) of the vehicle centre of gravity during a rollover test, as determined in appendix 1 to this annex.

4.2.2. the total energy ' E_T ' shall be distributed among the bays of the superstructure in the proportions of their masses:

$$E_i = E_T \frac{m_i}{M}$$

where:

E_i = the absorbed energy by the i^{th} bay

m_i = mass of the i^{th} bay, as determined in annex 4, paragraph 4.1

- 4.2.3. the minimum energy required to be absorbed by the body section (E_{min}) is the sum of the energy of the bays comprising the body section:

$$E_{min} = \sum_{i=1}^s E_i$$

- 4.3. The body section passes the loading test, if:

$$E_{BS} \geq E_{min}$$

In this case, all the bays which form that body section are considered to have passed the quasi-static loading test and these results can be quoted in future requests for approval provided that the component bays are not expected to carry a greater mass in the subsequent superstructure.

- 4.4. The body section fails the loading test if:

$$E_{BS} < E_{min}$$

In this case all the bays which form that body section are considered to have failed the test even if the residual space is invaded in only one of the bays.

- 4.5. The vehicle type shall be approved if all the required body sections pass the loading test.

5. DOCUMENTATION OF BODY SECTION QUASI-STATIC LOADING TESTS

The test report shall follow the form and content of Annex 6, paragraph 6.

Appendix 1

DETERMINATION OF THE VERTICAL MOVEMENT OF THE CENTRE OF GRAVITY DURING ROLLOVER

The vertical movement (Δh) of centre of gravity related to the rollover test may be determined by the graphical method shown below.

1. Using scaled drawings of the cross-section of the vehicle, the initial height (h_1) of the centre of gravity (position 1) above the lower plane of the ditch is determined for the vehicle standing at its point of unstable equilibrium on the tilting platform (see Figure A7.A1.1).
2. Using the assumption that the vehicle cross-section rotates around the edge of the wheel supports, (point A in Figure A7.A1.1) the vehicle cross-section is drawn with its cantrail just touching the lower plane of the ditch (see Figure A7.A1.2). In this position the height (h_2) of the centre of gravity (position 2) relative to the lower plane of the ditch is determined.

Figure A7.A1.1

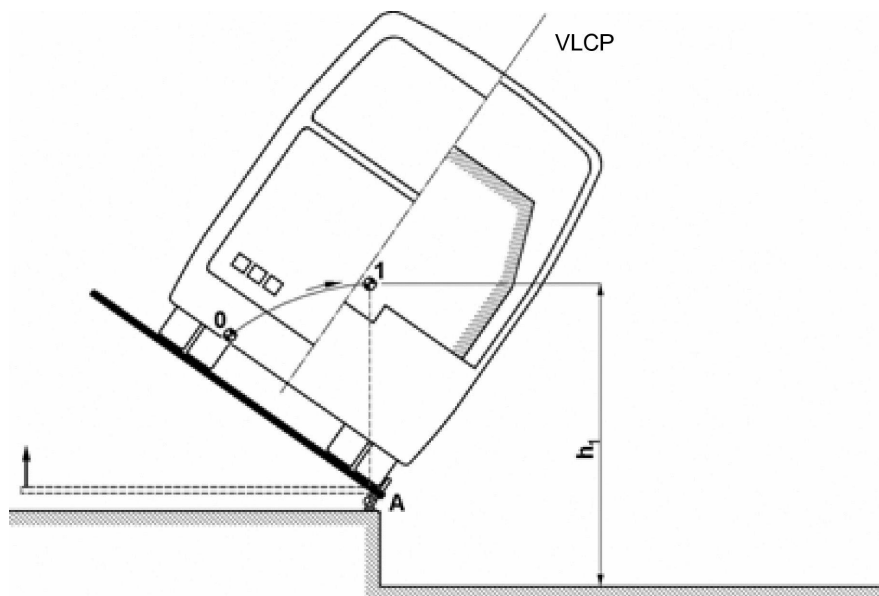
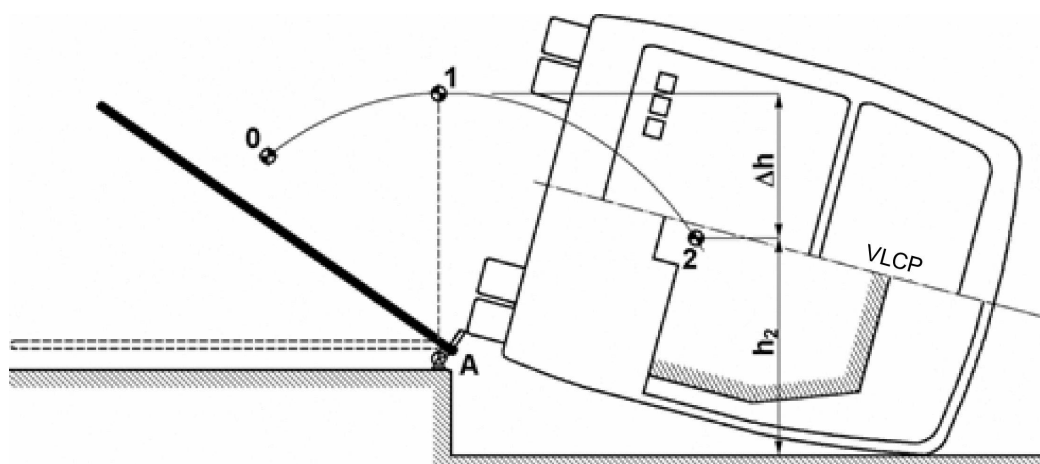


Figure A7.A1.2

Determination of the vertical movement of the vehicle centre of gravity

3. The vertical movement of the centre of gravity (Δh) is,

$$\Delta h = h_1 - h_2$$

4. If more than one body section is tested and each body section has a different final deformed shape, the vertical movement of centre of gravity (Δh_i) shall be determined for each body section and the combined mean value (Δh) is taken as,

$$\Delta h = \frac{1}{k} \sum_{i=1}^k \Delta h_i$$

where:

Δh_i = the vertical movement of the centre of gravity of the i^{th} body section,

k = the number of body sections tested.

ANNEX 8

QUASI-STATIC CALCULATION BASED ON TESTING OF COMPONENTS AS AN EQUIVALENT APPROVAL METHOD

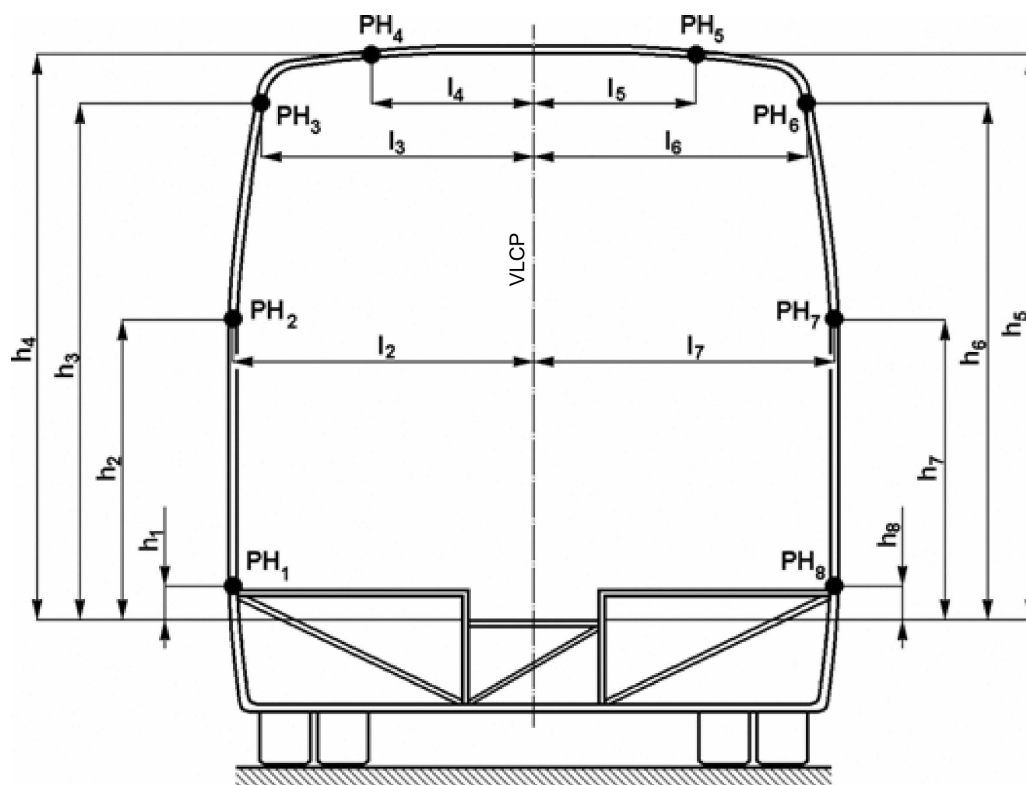
1. ADDITIONAL DATA AND INFORMATION

If the manufacturer chooses this test method, the following information shall be given to the technical service, in addition to the data and drawings listed in paragraph 3.2. of this Regulation:

- 1.1. The location of plastic zones (PZ) and plastic hinges (PH) in the superstructure;
 - 1.1.1. all the individual PZ's and PH's shall be uniquely identified on the drawing of the superstructure in their geometrically defined locations (see figure A.8.1.);
 - 1.1.2. structural elements between the PZ's and PH's can be treated as rigid or elastic parts in the calculation, and their length shall be determined by their actual dimensions in the vehicle.
- 1.2. The technical parameters of PZ's and PH's;
 - 1.2.1. the cross-sectional geometry of the structural elements in which the PZ's and PH's are located;
 - 1.2.2. the type and direction of loading applied to each PZ and PH;
 - 1.2.3. the load-deformation curve of each PZ and PH as described in appendix 1 of this annex. The manufacturer may use either the static, or the dynamic characteristics of the PZ's and PH's for the calculation but shall not mix static and dynamic characteristics in one calculation.

Figure A8.1

Geometrical parameters of plastic hinges on a bay



1.3. A statement of the total energy (E_T) to be absorbed by the superstructure, using the formula stated in paragraph 3.1. below.

1.4. A brief technical description of the algorithm and computer program which are used for the calculation.

2. REQUIREMENTS FOR THE QUASI-STATIC CALCULATION

2.1. For the calculation, the complete superstructure shall be mathematically modelled as a load-bearing and deformable structure, taking account of the following:

2.1.1. the superstructure shall be modelled as a single loaded unit containing deformable PZ's and PH's, connected by appropriate structural elements;

2.1.2. the superstructure shall have the actual dimensions of the bodywork. The inner contour of the side-wall pillars and roof structure shall be used when checking the residual space;

2.1.3. the PH's shall utilise the actual dimensions of the pillars and structural elements on which they are located (see Appendix 1 of this annex).

2.2. The applied loads in the calculation shall meet the following requirements:

2.2.1. the active load shall be applied in the transverse plane containing the centre of gravity of the superstructure (vehicle) which is perpendicular to the vertical longitudinal centre plane (VLCP) of the vehicle. The active load shall be applied on the cantrail of the superstructure through an absolutely rigid load application plane, which extends in both directions beyond the cantrail and any adjacent structure.

2.2.2. At the beginning of the simulation the load application plane shall touch the cantrail at its most distant part from the vertical longitudinal central plane. The contact points between the load application plane and the superstructure shall be defined to ensure an exact load transfer.

2.2.3. the active load shall have an inclination α related to the vertical longitudinal centre plane of the vehicle (see figure A.8.2).

$$\alpha = 90^\circ - \arcsin\left(\frac{800}{H_c}\right)$$

where:

H_c = the cantrail height (in mm) of the vehicle measured from the horizontal plane on which it is standing.

The direction of action of the active load shall not be changed during the calculation.

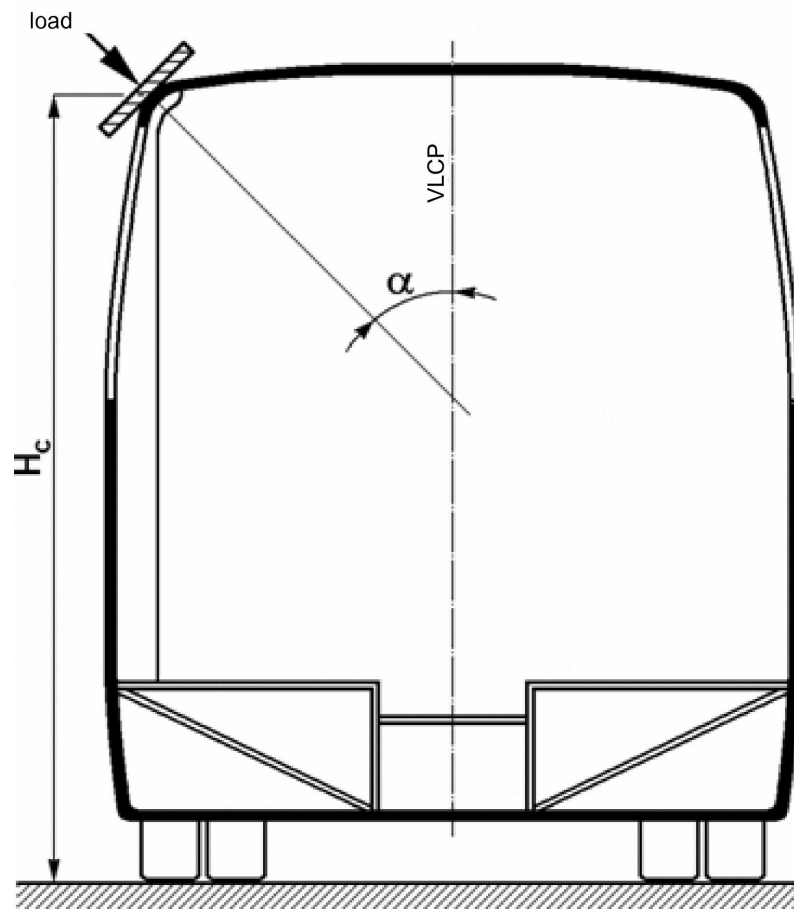
2.2.4. the active load shall be increased by small incremental steps and the whole structural deformation shall be calculated at every loading step. The number of loading steps shall exceed 100 and the steps shall be quasi-equal.

2.2.5. during the deformation process the load application plane may, in addition to parallel translation, be allowed to rotate around the axis of intersection of the load application plane with the transverse plane containing the centre of gravity, in order to follow the asymmetric deformation of the superstructure.

2.2.6. the passive (supporting) forces shall be applied on the rigid underfloor structure causing no influence on the structural deformation.

Figure A8.2

Load application to the superstructure



- 2.3. The algorithm of the calculation and the computer program shall meet the following requirements:
 - 2.3.1. the program shall take account of non-linearities in the PH characteristics and large scale structural deformations;
 - 2.3.2. the program shall accommodate the working range of PH's and PZ's and shall stop the calculation if the deformation of PH's exceeds the validated working range (see Appendix 1 of this annex);
 - 2.3.3. the program shall be able to calculate the total energy absorbed by the superstructure at every incremental load step;
 - 2.3.4. at every incremental load step, the program shall be able to demonstrate the deformed shape of the bays forming the superstructure, and the position of every rigid part which may intrude into the residual space. The program shall identify the incremental load step at which the residual space is first invaded by any of the rigid structural parts;
 - 2.3.5. the program shall be able to detect and identify the incremental load step at which overall collapse of the superstructure begins; when the superstructure becomes unstable and deformation continues without an increase of the load.

3. EVALUATION OF THE CALCULATION

- 3.1. The total energy (E_T) to be absorbed by the superstructure shall be determined as follows:

$$E_T = 0,75M \cdot g \cdot \Delta h$$

where:

M = M_k the unladen kerb mass of the vehicle, if there are no restraints, or

M_t the total effective vehicle mass when occupant restraints are fitted

G = the gravitational constant

Δh = the vertical movement (in metres) of the vehicle centre of gravity during a rollover test, as determined in Appendix 1 of Annex 7.

3.2. The absorbed energy (E_a) of the superstructure is calculated at the incremental load step at which the residual space is first touched by any of the rigid structural parts.

3.3. The vehicle type shall be approved if $E_a \geq E_T$

4. DOCUMENTATION OF QUASI-STATIC CALCULATION

The calculation report shall contain the following information:

4.1. detailed mechanical description of the superstructure containing the location of PZ's and PH's and defining the rigid and elastic parts;

4.2. data obtained from the tests and the resultant graphs;

4.3. a statement of whether or not the requirement of paragraph 5.1 of this Regulation are met;

4.4. identification of the vehicle type and the personnel responsible for the tests, the calculations, and the evaluation.

Appendix 1

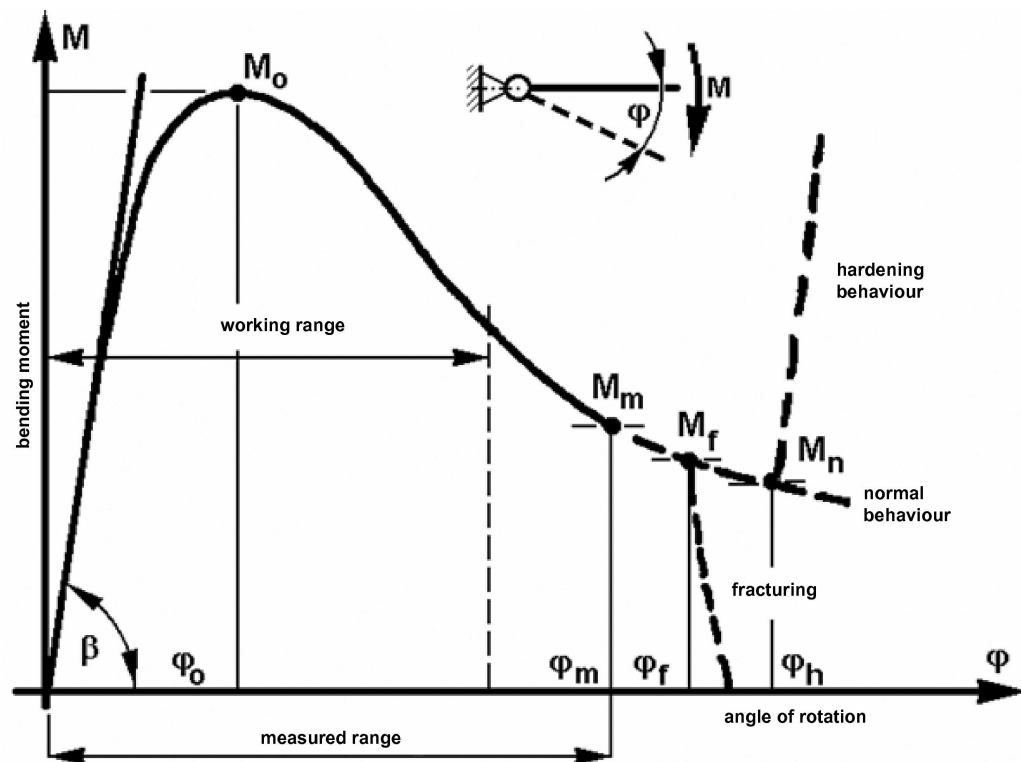
CHARACTERISTICS OF PLASTIC HINGES

1. CHARACTERISTIC CURVES

The general form of a Plastic Zone (PZ) characteristic curve is a non-linear load-deformation relationship measured on structural parts of the vehicle in laboratory tests. Plastic Hinge characteristic curves are a bending moment (M) — rotational angle (ϕ) relationship. The general form of a PH characteristic curve is shown in Figure A.8.A.1.1.

Figure A8.A1.1

Characteristic curve for a plastic hinge



2. ASPECTS OF DEFORMATION RANGES

2.1. The 'measured range' of the PH characteristic curve is the range of deformation over which measurements have been made. The measured range may contain the fracture, and/or the rapid hardening range. Only values of the PH characteristics which appear in the measured range shall be used in the calculation.

2.2. The 'working range' of the PH characteristic curve is the range covered by the calculation.

The working range shall not exceed the measured range, and may contain the fracture, but not the rapid-hardening range.

2.3. The PH characteristics to be used in the calculation shall contain the M - ϕ curve in the measured range.

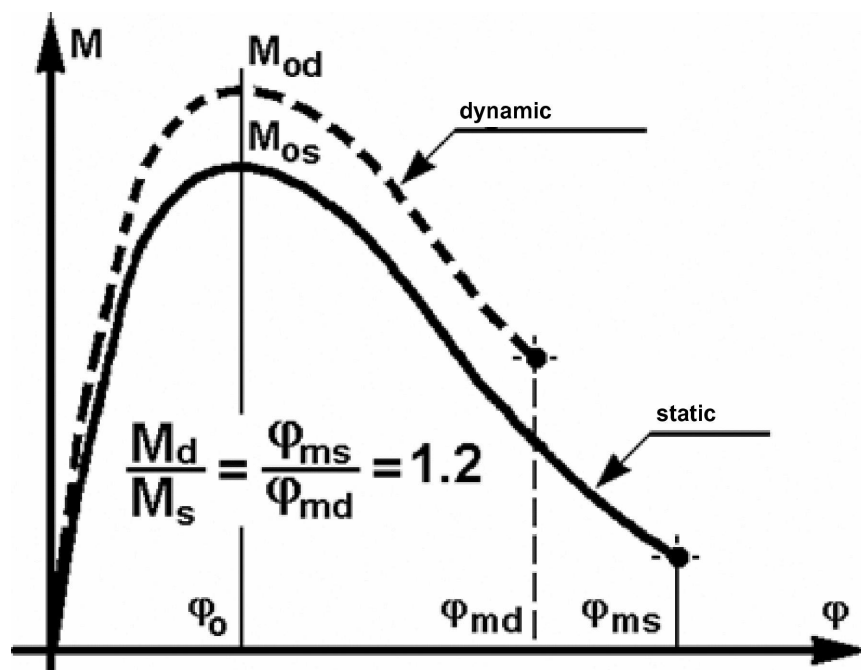
3. DYNAMIC CHARACTERISTICS

There are two kinds of PH and PZ characteristics: quasi-static and dynamic. The dynamic characteristics of a PH may be determined in two ways:

- 3.1. by dynamic impact testing of the component.
- 3.2. by using a dynamic factor K_d to transform the quasi-static PH characteristics. This transformation means that the values of the quasi-static bending moment may be increased by K_d . For steel structural elements $K_d = 1,2$ may be used without laboratory test.

Figure A8.A1.2

Derivation of plastic hinge dynamic characteristics from the static curve



ANNEX 9

COMPUTER SIMULATION OF ROLLOVER TEST ON COMPLETE VEHICLE AS AN EQUIVALENT APPROVAL METHOD**1. ADDITIONAL DATA AND INFORMATION**

The superstructure may be shown to meet the requirements specified in paragraphs 5.1.1 and 5.1.2 of this Regulation by a computer simulation method approved by the technical service.

if the manufacturer chooses this testing method, the following information shall be supplied to the technical service in addition to the data, and drawings listed in paragraph 3.2 of this Regulation:

- 1.1. A description of the applied simulation and calculation method which has been utilised, and clear precise identification of the analysis software, including at least, its producer, its commercial name, the version used and contact details of the developer.
- 1.2. The material models and the input data utilized.
- 1.3. The values for defined masses, centre of gravity and the moments of inertia used in the mathematical model.

2. THE MATHEMATICAL MODEL

The model shall be capable of describing the real physical behavior of the rollover process, in accordance with Annex 5. The mathematical model shall be constructed, and assumptions prescribed, in such a way that the calculation gives conservative results. The model shall be built up with the following considerations:

- 2.1. the technical service may require tests to be carried out on the actual vehicle structure to prove the validity of the mathematical model and to verify the assumptions made in the model.
- 2.2. the total mass and the centre of gravity position used in the mathematical model shall be identical to those of the vehicle to be approved.
- 2.3. the mass distribution in the mathematical model shall correspond to the vehicle to be approved. Moments of inertia used in the mathematical model shall be calculated on the basis of this mass distribution.

3. REQUIREMENTS FOR THE ALGORITHM AND SIMULATION PROGRAM, AND FOR COMPUTING EQUIPMENT

- 3.1. The position of the vehicle in unstable equilibrium at point of rollover, and the position at first contact with the ground shall be specified. The simulation program may start at the unstable equilibrium position, but shall start, at the latest, at the point of first contact with the ground.
- 3.2. The initial conditions at the point of first contact with the ground shall be defined using the change of potential energy from the unstable equilibrium position.
- 3.3. The simulation program shall run, at least, until the maximum deformation is reached.
- 3.4. The simulation program shall produce a stable solution, in which the result is independent of the incremental time step.
- 3.5. The simulation program shall be able to calculate the energy components for the energy balance at every incremental time step.
- 3.6. Non-physical energy components introduced by the process of mathematical modelling (for example, 'hourglass' and internal damping) shall not exceed 5 per cent of the total energy at any time.

3.7. The friction coefficient used at the ground contact shall be validated with physical test results, or the calculation shall prove that the friction coefficient chosen produces conservative results.

3.8. All the possible physical contacts between parts of the vehicle shall be taken into account in the mathematical model.

4. EVALUATION OF THE SIMULATION

4.1. When the stated requirements for the simulation program are met, the simulation of the changes in geometry of the interior structure and comparison with the geometrical shape of the residual space can be evaluated as defined in the paragraphs 5.1 and 5.2 of this Regulation.

4.2. If the residual space is not infringed during the rollover simulation, the approval shall be granted.

4.3. If the residual space is infringed during the rollover simulation, the approval shall be refused.

5. DOCUMENTATION

5.1. The report on the simulation shall contain the following information:

5.1.1. all the data and information stated in paragraph 1 of this annex;

5.1.2. a drawing showing the mathematical model of the superstructure;

5.1.3. a statement of the values of angle, velocity, and angular velocity at the unstable equilibrium position of the vehicle and at the position of first contact with the ground;

5.1.4. a table of the value of the total energy and the values of all its components (kinetic energy, internal energy, hourglass energy), at time increments of 1 ms covering, at least, the period from first contact with the ground until the maximum deformation is reached;

5.1.5. the assumed ground friction coefficient;

5.1.6. plots or data which show in an appropriate way that the requirements specified in paragraphs 5.1.1 and 5.1.2 of this Regulation are met. This requirement can be satisfied by the provision of a plot, against time, of the distance between the inside contour of the deformed structure and the periphery of the residual space;

5.1.7. a statement of whether, or not, the requirements specified in paragraphs 5.1.1 and 5.1.2 of this Regulation have been met;

5.1.8. all the data and information necessary for the clear identification of the vehicle type, its superstructure, the mathematical model of the superstructure, and the calculation itself.

5.2. It is recommended that the report also contains plots of the deformed structure at the moment when maximum deformation occurs, giving an overview of the superstructure and regions of large plastic deformation.

5.3. At the request of the technical service, further information shall be provided and included in the report.
