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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.

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I

(Acts whose publication is obligatory)

Regulation No 93 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of front underrun protective devices (FUPDs), vehicles with regard to the installation of an FUPD of an approved type, and vehicles with regard to their front underrun protection (FUP) [1]

1. SCOPE

1.1. This Regulation applies to:

1.1.1. PART I: the FUPDs which are intended to be fitted to vehicles of categories N_2 and N_3 [2];

1.1.2. PART II: the installation on vehicles of categories N_2 and N_3 [2] of FUPDs which have been type-approved to Part I of this Regulation;

1.1.3. PART III: vehicles of categories N_2 and N_3 with regard to its front underrun protection (FUP), equipped with an FUPD which has not been separately approved according to Part I of this Regulation or so designed and/or equipped that their component parts can be regarded as fulfilling the function of the FUPD.

1.2. Vehicles of categories N_2 with a maximum mass not exceeding 7,5 tonnes shall comply only with the ground clearance requirement of 400 mm set out in this Regulation.

1.3. The requirements of this Regulation do not apply to:

1.3.1. off-road vehicles of categories N_2G and N_3G [2];

1.3.2. vehicles such that their use is incompatible with the provisions of front underrun protection.

2. PURPOSE

The purpose of this Regulation is to offer effective protection for vehicles of category M_1 or N_1 [2] against underrunning of vehicles mentioned in paragraph 1 of this Regulation in the event of a frontal collision.

3. DEFINITIONS

3.1. For the purpose of this Regulation:

3.1.1. 'maximum mass' of the vehicle means the mass stated by the vehicle manufacturer to be the maximum technically permissible (this may be higher than the 'permissible maximum mass' laid down by the national administration);

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[1] Regulation of the United Nations Economic Commission for Europe published pursuant to the provisions of Article 4(5) of Council Decision 97/836/EC (OJ L 346, 17.12.1997, p. 78).

[2] See Consolidated Resolution on the Construction of Vehicles (R.E.3, Annex 7) (TRANS/SC1/WP29/78/Amend. 3).

3.1.2. 'maximum weight' of the vehicle means the vertical force (in newtons) required to support the same vehicle loaded to its maximum mass;

3.1.3. 'unladen vehicle' means the vehicle in running order unoccupied and unladen but complete with fuel, coolant, lubricant, tools and a spare wheel (if provided as standard equipment by the vehicle manufacturer);

3.1.4. 'approval of an FUPD' means the approval of such a type of FUPD with respect to the requirements laid down in paragraph 7;

3.1.5. 'type of FUPD' means FUPD which do not differ with respect to the essential characteristics such as shape, dimensions, attachment, materials and the markings cited in paragraph 4.2.;

3.1.6. 'front underrun protection (FUP)' means the presence at the front of the vehicle of either:

3.1.6.1. a special device (FUPD); or

3.1.6.2. bodywork, chassis parts or other components, such that by virtue of their shape and characteristics, these elements can be regarded as fulfilling the function of the FUPD;

3.1.7. 'approval of a vehicle' means the approval of a vehicle type:

— for Part II of this Regulation — with regard to the installation of an FUPD of an approved type according to Part I of this Regulation; or

— for Part III of this Regulation — with regard to its FUP;

3.1.8. 'vehicle type' means vehicles which do not essentially differ in such aspects as:

— the width of the foremost axle measured at the outermost part of the tyres excluding the bulging of the tyres close to the ground;

— the structure, the dimensions, the shape and materials of the front part of the vehicle in so far as they have a bearing on the requirements of the relevant Part of this Regulation;

— the approved FUPDs fitted to the vehicle, where the application is pursuant to satisfying Part II of this Regulation;

— the maximum mass of the vehicle type.

4. APPLICATION FOR APPROVAL

4.1. The application for approval to a Part of this Regulation shall be submitted by the manufacturer of the type (vehicle/FUPD) or his duly accredited representative.

4.2. For each type the application shall be accompanied by:

4.2.1. documentation in triplicate giving a description of the technical characteristics of the type (vehicle/FUPD): its dimensions, lines and constituent materials, in so far as required for the purpose of this Regulation.

4.2.2. in case of FUPD sample of the type: the sample shall be clearly and indelibly marked on all its main components, relevant to the front underrun, with the applicant's trade name or mark and the type designation;

4.2.3. a representative of the type of device or vehicle to be approved shall be submitted for each test to the technical service responsible for conducting the approval tests;

4.2.4. for applications pursuant to Parts II or III of this Regulation, a vehicle not comprising all the components proper to the type may be accepted for test provided that they do not adversely affect the front underrun protection;

4.2.5. identification of the positions of the points P_1, P_2 and P_3 as defined in annex 5. For applications pursuant to satisfying Part I of this Regulation these should take into account the requirements of Part II.

4.3. Applications pursuant to satisfying Part II of this Regulation shall be accompanied by:

4.3.1. a list of the FUPDs intended to be fitted to the vehicle type;

4.3.2. at the request of the competent authority the type-approval communication form conforming to annex 1 of this Regulation of each FUPD shall also be supplied.

4.4. Applications pursuant to satisfying Parts II and III of this Regulation shall be accompanied by information on the vehicle type as defined in paragraph 3.1.8.

4.5. The competent authority shall maintain the following administrative procedures according to annex 6 to cover the following:

4.5.1. verification of the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type-approval is granted;

4.5.2. penalties for non-conformity of production;

4.5.3. modification or extension of approval of a type;

4.5.4. production being definitely discontinued.

PART I — APPROVAL OF FRONT UNDERRUN PROTECTIVE DEVICES (FUPDs)

5. APPROVAL OF AN FUPD

5.1. If the FUPD submitted for approval pursuant to this Regulation meets the requirements of paragraph 6, approval of that type of FUPD shall be granted in accordance with the arrangements contained in annex 4.

5.2. Notice of approval, or of extension or of refusal of approval of the type of FUPD 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 this Regulation.

6. REQUIREMENTS FOR FUPDs

6.1. The FUPD shall offer adequate resistance to forces applied parallel to the longitudinal axis of the vehicle and also satisfy certain dimensional requirements. These shall be demonstrated in accordance with the test procedure and conditions specified in annex 5 to this Regulation.

6.2. The section height of the FUPD cross-member shall not be less than 100 mm for category N_2 vehicles and 120 mm for vehicles of category N_3. The lateral extremities of the cross-member shall not bend to the front or have a sharp outer edge; this condition is fulfilled when the lateral extremities of the cross-member are rounded on the outside and have a radius of curvature of not less than 2,5 mm.

6.3. The device may be so designed that its position at the front of the vehicle can be varied. In this event, there shall be a guaranteed method of securing it in the service position so that any unintentional change of position is precluded. It shall be possible for the operator to vary the position of the device by applying a force not exceeding 40 daN;

6.4. The outermost surfaces of every front guard installation shall be essentially smooth or horizontally corrugated save that domed heads of bolts or rivets may protrude beyond the surface to a distance not exceeding 10 mm.

PART II — APPROVAL OF A VEHICLE WITH REGARD TO THE INSTALLATION OF AN FUPD OF AN APPROVED TYPE

7. APPROVAL OF AN INSTALLATION OF AN APPROVED FUPD

7.1. If the vehicle submitted for approval pursuant to this Part of this Regulation is provided with an approved FUPD and meets the requirements of paragraph 8, approval of that vehicle type shall be granted in accordance with the arrangements contained in annex 4.

7.2. Notice of approval, or of extension or of refusal of approval of the 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 2 to this Regulation.

8. REQUIREMENTS FOR INSTALLATION OF AN APPROVED FUPD

8.1. The maximum mass of a vehicle type for which approval is requested shall not exceed the value indicated on the type approval communication form of each approved FUPD intended to be installed on that vehicle.

8.2. The vehicle with the FUPD installed shall satisfy certain dimensional requirements specified in annex 5 taking into account the test conditions and information indicated on the communication document contained in annex 1 issued in respect of the FUPD.

8.3. The FUPD shall be so fitted to the vehicle that the horizontal distance measured in the rearward direction from the foremost part of the vehicle to the front of the FUPD does not exceed 400 mm diminished by the recorded deformation (annex 1, item 9) measured at any of the points where the test forces have been applied during the type-approval of the FUPD in conformity with the provisions of Part I of this Regulation and recorded in the type-approval communication form (see figures 1 and 2).

8.4. In measuring these distances, any part of the vehicle which is more than 2 m above the ground shall be excluded.

8.5. The maximum ground clearance with respect to the underside of the FUPD shall be no more than 400 mm, as specified in paragraph 2 of annex 5, between the two points P_1 in the installed condition. Outboard of each point P_1 this height may be greater than 400 mm providing the underside is not above a plane passing through the underside of the FUPD directly below the point P_1 and forming a slope at 15° above the horizontal (see figure 3).

8.6. The height above the ground of the points of application of the test forces applied to the FUPD according to Part I of this Regulation and recorded in the type-approval communication form (annex 1, item 8) shall not exceed 445 mm as specified in paragraph 2 of annex 5.

8.7. The maximum ground clearance with respect to the underside of the FUPD between the two points P_1 shall be no more than 450 mm taking into account their movement during the application of the test load, according to Part I.

8.8. The width of the FUPD shall at no point exceed the width of the mudguards covering the wheels of the foremost axle nor shall it be more than 100 mm shorter on either side than the foremost axle measured at the outermost points of the tyres, excluding the bulging of the tyres close to the ground (see figure 1), or 200 mm shorter on either side, measured from the outermost points of the access steps to the driver's cabin.

PART III — APPROVAL OF A VEHICLE WITH REGARD TO ITS FRONT UNDERRUN PROTECTION (FUP)

9. APPROVAL OF A VEHICLE WITH FUP

9.1. If the vehicle submitted for approval pursuant to this Regulation is provided with FUP that meets the requirements of paragraph 10, approval of that vehicle type shall be granted in accordance with the arrangements contained in annex 4.

9.2. Notice of approval, or of extension or of refusal of approval of the 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 3 to this Regulation.

10. REQUIREMENTS FOR A VEHICLE WITH FUP

10.1. Any vehicle in one of the categories N_2 or N_3 will be deemed to satisfy the condition set out in paragraph 2 provided that the vehicle is equipped with an FUPD which has not been separately approved to Part I of this Regulation or is so designed and/or equipped at the front that, by virtue of their shape and characteristics, its component parts can be regarded as replacing the front underrun protective device. Components whose combined function satisfies the following requirements are considered to form a front underrun protective device.

10.2. The FUP shall offer adequate resistance to forces applied parallel to the longitudinal axis of the vehicle. The FUP shall also satisfy certain dimensional requirements. These shall be demonstrated in accordance with the test procedure and conditions specified in annex 5 to this Regulation.

10.3. For application pursuant to Part III, the section height of the FUPD cross-member (not separately approved to Part I) shall not be less than 100 mm for category N_2 vehicles and not less than 120 mm for category N_3 vehicles.

10.4. The device may be so designed that its position at the front of the vehicle can be varied. In this event, there shall be a guaranteed method of securing it in the service position so that any unintentional change of position is precluded. It shall be possible for the operator to vary the position of the device by applying a force not exceeding 40 daN;

10.5. The FUP shall have sufficient strength that the horizontal distance measured in the rearward direction between the foremost part of the vehicle after the application of the test forces (specified in this annex) and the test ram contact surface on the vehicle does not exceed 400 mm.

10.6. In measuring these distances, any part of the vehicle which is more than 2 m above the ground shall be excluded.

10.7. The maximum ground clearance with respect to the underside of the FUP shall be no more than 400 mm, as specified in paragraph 2 of annex 5, between the two points P_1. Outboard of each point P_1 this height may be greater than 400 mm providing the underside is not above a plane passing through the underside of the FUP directly below the point P_1 and forming a slope at 15° above the horizontal (see Figure 3).

10.8. The maximum ground clearance with respect to the underside of the FUP between the two points P_1 shall be no more than 450 mm taking into account their movement during the application of the test load.

10.9. The width of the FUP shall at no point exceed the width of the mudguards covering the wheels of the foremost axle nor shall it be more than 100 mm shorter on either side than the foremost axle measured at the outermost points of the tyres, excluding the bulging of the tyres close to the ground (see Figure 1), or 200 mm shorter on either side, measured from the outermost points of the access steps to the driver's cabin.

Figure 1

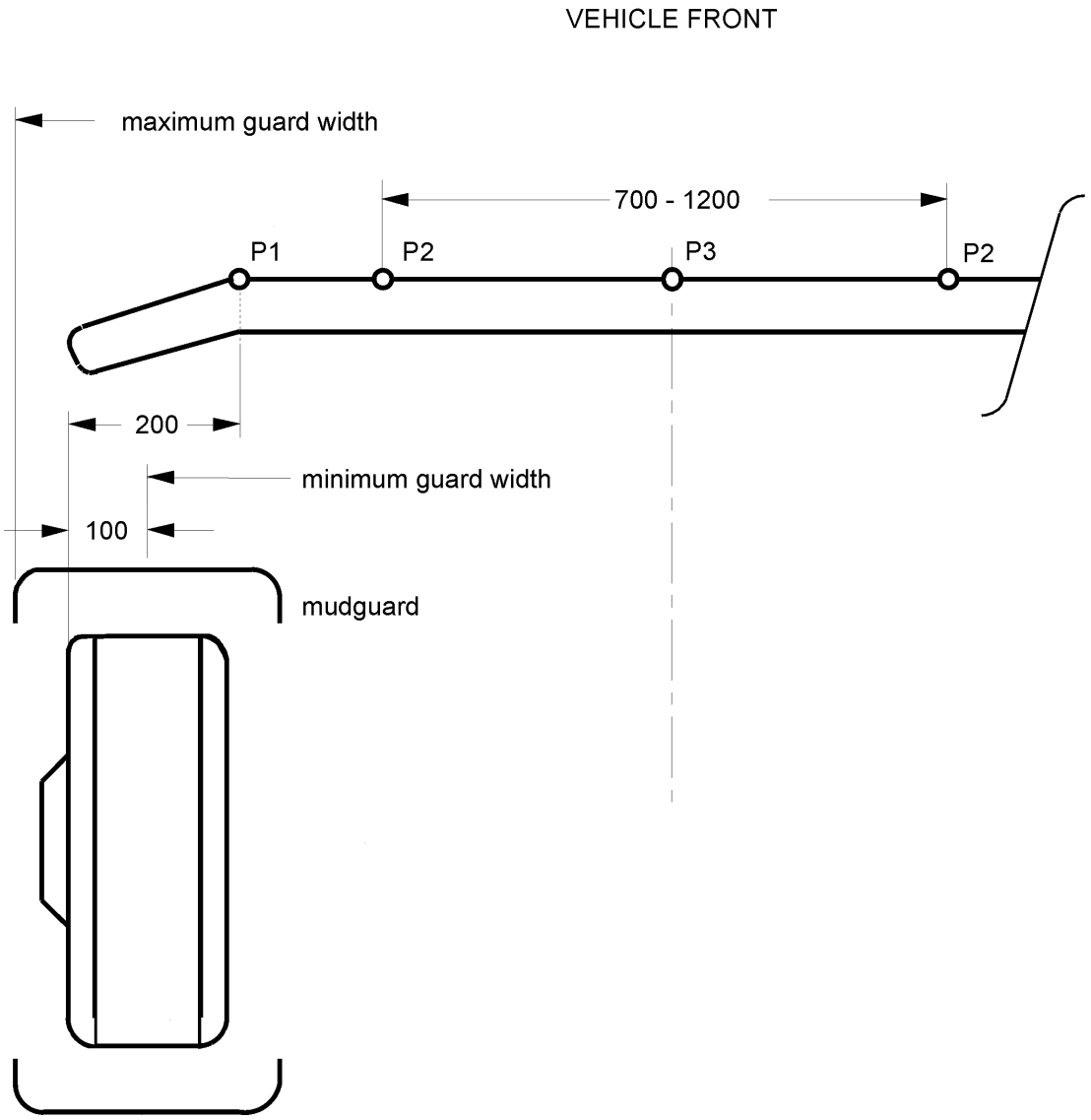

VEHICLE FRONT
maximum guard width
700 - 1200
P1
P2
P3
P2
200
minimum guard width
100
mudguard

Figure 2

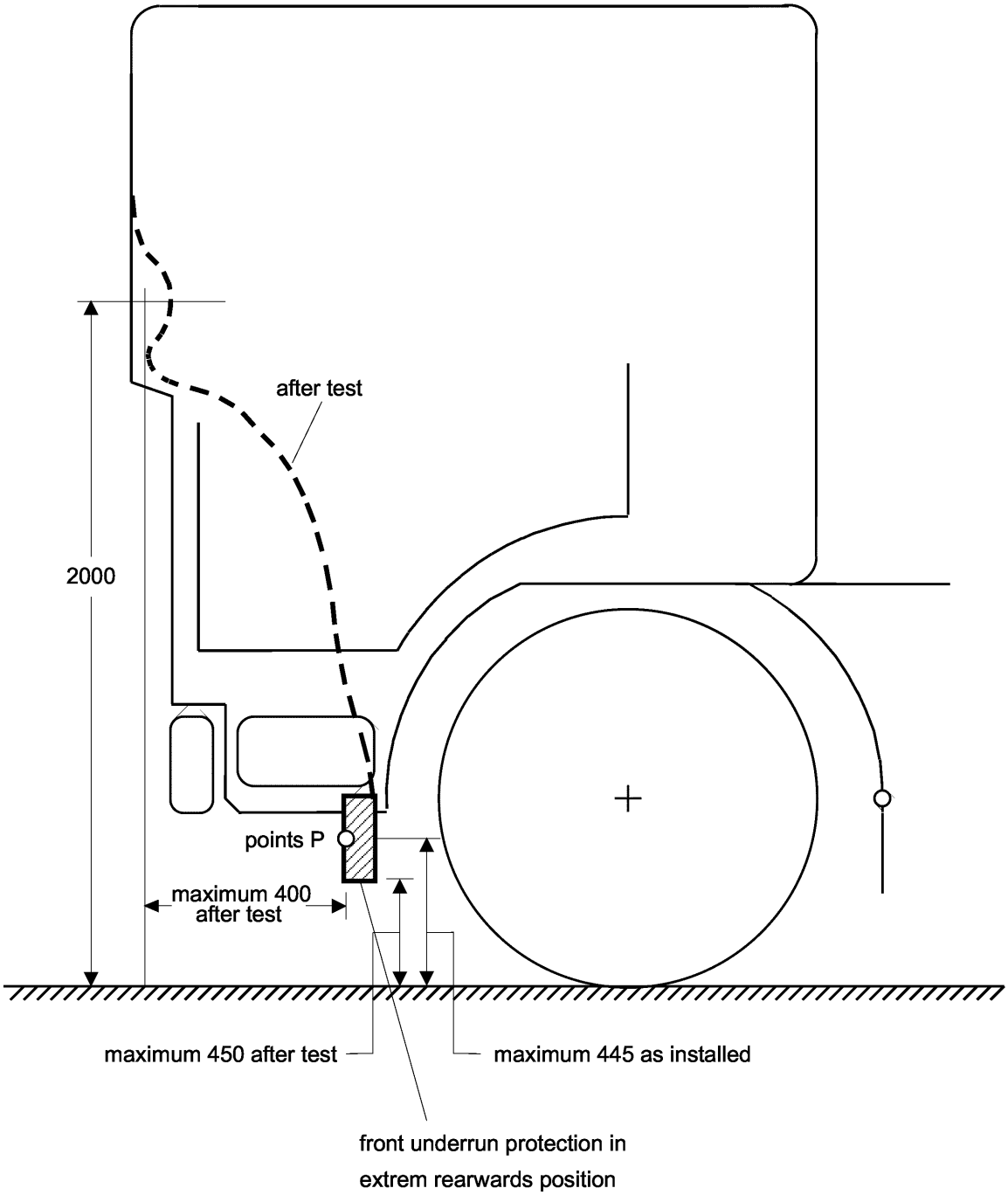
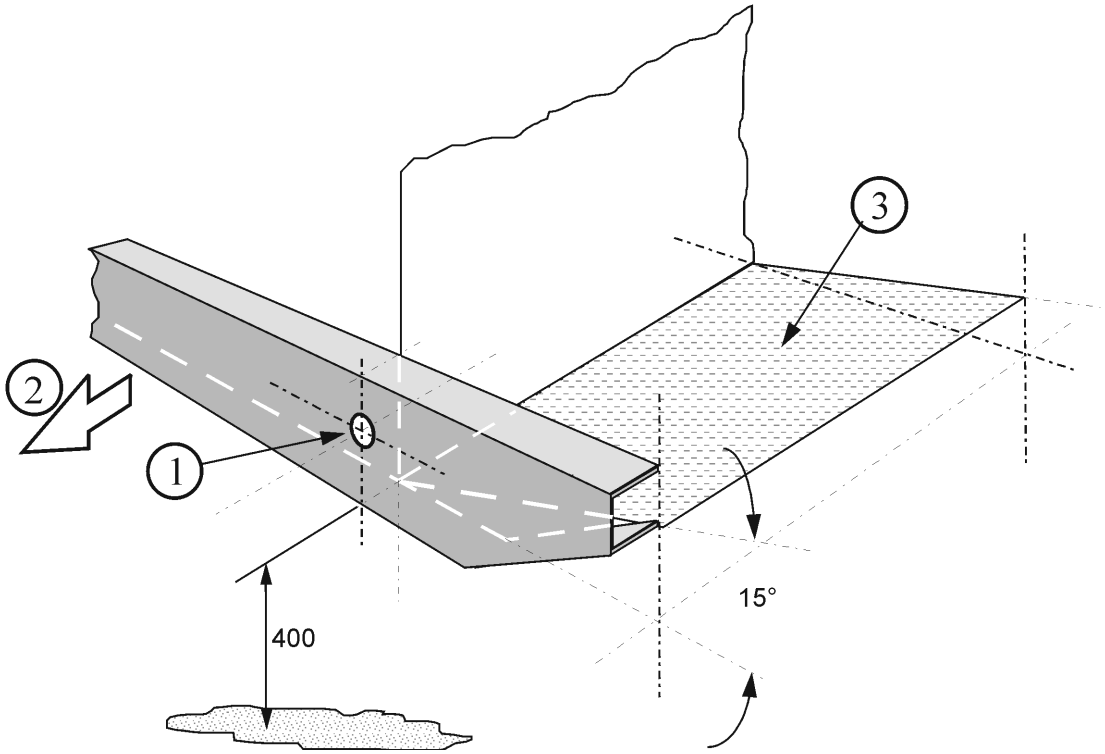

after test
2000
points P
maximum 400
after test
maximum 450 after test
maximum 445 as installed
front underrun protection in
extrem rearwards position

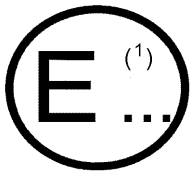
Figure 3



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 type of front underrun protection device (FUPD) pursuant to Regulation No 93 (Part I)

Approval No . . . . . Extension No . . . . . .

1. Trade name or mark of technical unit: . . . . . .

2. If necessary the type of vehicle(s) and category to which it is intended: . . . . . .

3. Maximum mass of vehicle(s) to which FUPD is to be installed: . . . . . .

4. Name and address of manufacturer: . . . . . .

5. Name and address of manufacturer's authorised representative (if any): . . . . . .

6. Characteristics of the technical unit: . . . . . .

7. Restrictions on use and mounting specifications (if any): . . . . . .

8. Position on the device of the points of application of the test forces: . . . . . .

9. Maximum horizontal and vertical deflection during and after the application of the test forces of any test point: . . . . . .

10. Date on which the device was submitted for approval tests: .....

11. Technical service responsible for carrying out the approval tests on devices: .....

12. Date of test report issued by the technical service: .....

13. Number of test report issued by the technical service: .....

14. Approval granted/refused/extended/withdrawn ([2])

15. Reason(s) for the extension of the approval applicable: .....

16. Position of the approval mark: .....

17. Place: .....

18. Date: .....

19. Signature: .....

Name: .....

20. The list of documents filed with the administration which has granted approval, and is available, is annexed to this communication.

21. Remarks (if any): .....

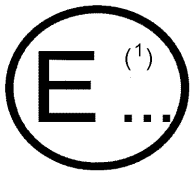
([1]) Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

([2]) Strike out what does not apply.

ANNEX 2

Communication

(Maximum format: A4 (210 × 297 mm))



Issued by: name of administration:

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concerning (2): APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of a vehicle type with regard to the installation of a front underrun protection device (FUPD) of an approved type pursuant to Regulation No 93 (Part II)

Approval No . . . . . Extension No . . . . . .

1. Trade name or mark of the vehicle: . . . . . .

2. Type and category of vehicle(s): . . . . . .

3. Maximum mass of vehicle(s): . . . . . .

4. Name and address of manufacturer: . . . . . .

5. Name and address of manufacturer's authorised representative (if any): . . . . . .

6. Brief description of the vehicle type as regards its dimensions and lines: . . . . . .

7. Trade name or mark of the FUPD(s) and its/their approval number(s): . . . . . .

8. Date on which vehicle was submitted for approval tests: . . . . . .

9. Technical service responsible for carrying out the approval tests on vehicles: . . . . . .

10. Date of test report issued by the technical service: . . . . . .

11. Number of test report issued by the technical service: . . . . . .

12. Approval granted/refused/extended/withdrawn ([2])

13. Reason(s) for the extension of the approval applicable: . . . . . .

14. Position of approval mark on the vehicle: . . . . . .

15. Place: . . . . . .

16. Date: . . . . . .

17. Signature: . . . . . .

Name: . . . . . .

18. Annexed is a list of documents making up the approval file, deposited with the competent authority which granted approval; a copy can be obtained on request.

19. Remarks (if any): . . . . . .

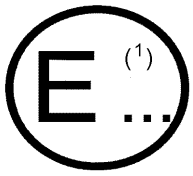
([1]) Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

([2]) Strike out what does not apply.

ANNEX 3

Communication

(Maximum format: A4 (210 × 297 mm))



Issued by: name of administration:

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concerning (2): APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of a vehicle with regard to its front underrun protection (FUP) pursuant to Regulation No 93 (Part III)

Approval No . . . . . Extension No . . . . . .

1. Trade name or mark of the vehicle: . . . . . .

2. Type and category of vehicle(s): . . . . . .

3. Maximum mass of vehicle(s): . . . . . .

4. Name and address of manufacturer: . . . . . .

5. If applicable, name and address of manufacturer's representative: . . . . . .

6. Characteristics of the parts providing frontal protection: . . . . . .

7. Date on which the vehicle was submitted for approval tests: . . . . . .

8. Position on the FUP of the points of application of the test forces: . . . . . .

9. Maximum vertical and horizontal deflection during and after the application of the test forces of any test point: . . . . . .

10. Technical service responsible for carrying out the approval tests on vehicles: . . . . . .

11. Date of test report issued by the technical service: . . . . . .

12. Number of test report issued by the technical service: . . . . . .

13. Approval granted/refused/extended/withdrawn ([2])

14. Reason(s) for the extension of the approval applicable: . . . . . .

15. Position of approval mark on the vehicle: . . . . . .

16. Place: . . . . . .

17. Date: . . . . . .

18. Signature: . . . . . .

Name: . . . . . .

19. Annexed is a list of documents making up the approval file, deposited with the competent authority which granted approval; a copy can be obtained on request.

20. Remarks (if any): . . . . . .

([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 4

Arrangements of approval marks

1. APPROVAL NUMBER

1.1. An approval number shall be assigned to each type approved. Its first two digits (at present 00) 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 type.

1.2. Notice of approval, or of extension or of refusal of approval of a 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 one of the models in annexes 1, 2 or 3 to this Regulation.

1.3. There shall be affixed, conspicuously and in the case of a technical unit in a position where in the installed condition it is readily accessible and specified on the approval form, to every one of series conforming to a type approved under this Regulation an international approval mark consisting of:

1.3.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ([1]);

1.3.2. 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 1.3.1;

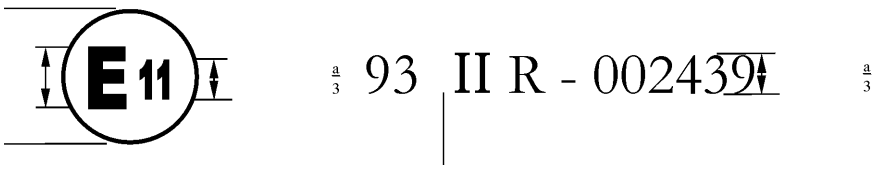
1.3.3. an additional symbol separated from the number of this Regulation by a vertical line and consisting of the Roman numeral(s) for the Part (I, II or III) of the Regulation pursuant to which the device or the vehicle has been approved.

1.4. 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 1.3.1 of this annex need not be repeated; in such a case the Regulation and approval numbers and the additional 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 1.3.1 of this annex.

1.5. The approval mark shall be clearly legible and be indelible.

2. ARRANGEMENTS OF APPROVAL MARKS

2.1. *Model A*

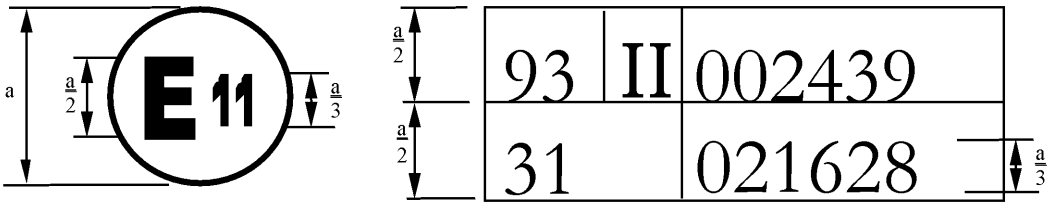


a = min. 8 mm

([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 Yugoslavia, 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, 25 (vacant), 26 for Slovenia and 27 for Slovakia. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement concerning the Recognition of Approval for Motor Vehicle Equipment and Parts, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

2.1.1. The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the front underrun protection in the event of a collision, been approved in the United Kingdom (E11) pursuant to Regulation No 93, Part II (installation of a front underrun protection device (FUPD) of an approved type) under approval number 002439. The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No 93, Part II in its original form.

2.2. *Model B*



a ≥ 8 mm

2.2.1. The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the United Kingdom (E 11) pursuant to Regulation No 93, Part II and Regulation No 31 ([1]). The approval numbers indicate that, at the dates when the respective approvals were given, Regulation No 93 was in its original form and Regulation No 31 included the 02 series of amendments.

([1]) The latter number is given as an example only.

ANNEX 5

Test conditions and procedures

1. TEST CONDITIONS FOR FUPDs

1.1. At the request of the manufacturer the test may be conducted either:

1.1.1. on a vehicle of the type for which FUPD is intended; in that case the conditions set out in paragraph 2 shall be observed; or

1.1.2. on a part of the chassis of the vehicle type for which the FUPD is intended; this part shall be representative of the vehicle type(s) in question; or

1.1.3. on a rigid test bench.

1.2. In the case of paragraphs 1.1.2 and 1.1.3 the parts used to connect the FUPD to part of the vehicle chassis or to the rigid test bench shall be equivalent to those which are used to secure the FUPD when it is installed on the vehicle.

1.3. At the request of the manufacturer and with the consent of the technical service the test procedure described in paragraph 3 may be simulated by calculation or another such method provided that its equivalence is demonstrated.

2. TEST CONDITIONS FOR VEHICLES

2.1. The vehicle may, if necessary to achieve the test forces required in paragraph 3.1, be restrained by any method, this method to be specified by the vehicle manufacturer.

2.2. Dimensions shall be taken as if the vehicle were in the following condition:

2.2.1. the vehicle was unladen;

2.2.2. the vehicle was at rest on a level, flat, rigid and smooth surface;

2.2.3. the front wheels were in the straight-ahead position;

2.2.4. the tyres were inflated to the pressure recommended by the vehicle manufacturer;

2.2.5. vehicles equipped with hydropneumatic, hydraulic or pneumatic suspension or a device for automatic levelling according to load were in their normal running condition specified by the manufacturer.

3. TEST PROCEDURE

3.1. Points P_1 are located up to 200 mm from the longitudinal planes tangential to the outermost points of the tyres on the front axle, excluding the bulging of the tyres close to the ground; points P_2 are symmetrical to the median longitudinal plane of the vehicle at a distance from each other of 700 to 1 200 mm inclusive. The exact positions shall be specified by the manufacturer.

3.2. The height above the ground of points P_1 and P_2 shall be defined by the vehicle manufacturer within the lines that bound the front face of the device. The height shall not, however, exceed 445 mm when the vehicle is unladen. P_3 is in the vertical longitudinal median plane of the vehicle (see Figure 1 of the Regulation).

3.3. The test forces set out below shall be applied to each of the test points in separate tests on the same vehicle or device or, if requested by the manufacturer/agent, on different vehicles or device samples.

3.3.1. If the structure and components of the vehicle relevant to the front underrun protection are located substantially symmetrical to its longitudinal median plane the tests at points P_1 and P_2 shall be carried out only on one side.

3.3.2. When tested the forces shall be applied as rapidly as possible and the device or vehicle shall withstand the forces in the following paragraphs for at least 0,2 seconds.

3.3.3. A horizontal force equal to 50 % of the maximum weight of the vehicle or intended vehicle type(s) but not exceeding 80×10^3 N shall be applied successively to both points P_1.

3.3.4. A horizontal force equal to 100 % of the maximum weight of the vehicle or intended vehicle type(s) but not exceeding 160×10^3 N shall be applied successively to both points P_2. If the device is discontinuous and is reduced in cross-section area between the two points P_2, then the tests shall continue with the application of a horizontal force applied to the point P_3 the same as that to the points P_1.

3.4. The maximum horizontal and vertical displacements of each test point during the application of the above forces shall be recorded and the highest recorded on the communication document.

3.5. Whenever a practical test is performed to verify compliance with the abovementioned requirements, the following conditions shall be fulfilled:

3.5.1. for application pursuant to Part III, an FUPD (not separately approved to Part I) shall be connected to the chassis side members of the vehicle or to whatever replaces them or a structure with demonstrated equivalent performance capabilities;

3.5.2. the specified forces shall be applied by rams which are suitably articulated (e.g. by means of universal joints) and shall be parallel to the median longitudinal plane of the vehicle via a surface not more than 250 mm in height (the exact height and width shall be indicated by the manufacturer) and not more than 400 mm wide, with a radius of curvature of 5 ± 1 mm at the vertical edges; the centre of the surface is placed successively at points P_1, P_2 and P_3.

ANNEX 6

Conformity of production and other administrative procedures

1. CONFORMITY OF PRODUCTION

1.1. FUPDs and vehicles approved to this Regulation shall be so manufactured as to conform to the type-approval by meeting the requirements set forth in this Regulation.

1.2. In order to verify that the requirements of paragraph 1.1 are met, suitable controls of the production shall be carried out.

1.3. The holder of the approval shall in particular:

1.3.1. ensure existence of procedures for the effective control of the quality of the vehicle or the device;

1.3.2. have access to the testing equipment necessary for checking the conformity to each approved type;

1.3.3. record data of test results and annexed documents which shall remain available for a period to be determined in accordance with the administrative service;

1.3.4. analyse the results of each type of test, in order to verify and ensure the stability of the vehicle or the device characteristics making allowance for variations of an industrial production;

1.3.5. ensure that for each type of vehicle or device sufficient checks and tests are carried out regarding the dimensions, materials and performance of the components, which fulfil the function of the FUP and of those for the installation on the vehicle;

1.3.6. ensure that any set of samples or test pieces giving evidence of non-conformity with the type of test considered shall give rise to another sampling and another test. All the necessary steps shall be taken to re-establish the conformity of the corresponding production.

1.4. The competent authority which has granted type-approval may at any time verify the conformity control methods applicable to each production unit.

1.4.1. In every inspection, the test books and production survey records shall be presented to the visiting inspector.

1.4.2. The inspector may take samples at random which will be tested in the manufacturer's laboratory. The minimum number of samples may be determined according to the results of the manufacturer's own verification.

1.4.3. When the quality level appears unsatisfactory or when it seems necessary to verify the validity of the tests carried out in application of paragraph 1.4.2 the inspector may select samples to be sent to the technical service which has conducted the type-approval tests.

1.4.4. The competent authority may carry out any test prescribed in this Regulation.

1.4.5. The normal frequency of inspections authorised by the competent authority shall be one per two years. In the case when negative results are recorded during one of these visits, the competent authority shall ensure that all necessary steps are taken to re-establish the conformity of production as rapidly as possible.

2. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

2.1. The approval granted in respect of a type of FUPD or vehicle pursuant to this Regulation may be withdrawn if the requirements set forth above are not met or if the protective device has failed to pass the test prescribed in this Regulation.

2.2. If a Contracting 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 communication form conforming to the model in annexes 1, 2 or 3 to this Regulation.

3. MODIFICATION AND EXTENSION OF APPROVAL

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

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

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

3.2. Confirmation or refusal of approval, specifying the alterations shall be communicated by means of a form conforming to the model in annexes 1, 2 or 3 to this Regulation to the Parties to the Agreement applying this Regulation.

3.3. The competent authority issuing the extension of approval shall assign a series number to 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 annexes 1, 2 or 3 to this Regulation.

4. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a type of FUPD or vehicle FUP 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 applying this Regulation by means of a communication form conforming to the model in annexes 1, 2 or 3 to this Regulation.

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

The Contracting 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 withdrawal of approval, or production definitely discontinued, issued in other countries, are to be sent.

Regulation No 111 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of tank vehicles of categories N and O with regard to rollover stability ([1])

1. SCOPE

This Regulation applies to the rollover stability of tank vehicles of category N2, N3, O3 and O4 ([2]) intended for the carriage of dangerous goods as defined in the ADR Agreements ([3]).

2. DEFINITIONS

For the purposes of this Regulation:

2.1. 'approval of a vehicle' means approval of a vehicle type with regard to rollover stability;

2.2. 'vehicle type' means a category of vehicle which does not differ in such essential respects as:

2.2.1. vehicle category, (see paragraph 1) and type (truck, full trailer, semi-trailer, centre-axle trailer) ([4]);

2.2.2. maximum mass, as defined in paragraph 2.4;

2.2.3. cross-section profile of the tank (circular, elliptical, maxi-volume);

2.2.4. maximum height of the centre of gravity of the laden vehicle;

2.2.5. distribution of mass among the axles (including fifth wheel);

2.2.6. number and arrangement of the axles (including axle spacing);

2.2.7. suspension arrangements in relation to roll characteristics;

2.2.8. tyre size and structure (radial ply, diagonal ply or bias belted);

2.2.9. track width;

2.2.10. wheel base;

2.3. 'laden vehicle', except where otherwise stated, means a vehicle so laden as to attain its 'maximum mass';

([1]) Regulation of the United Nations Economic Commission for Europe published pursuant to the provisions of Article 4(5) of Council Decision 97/836/EC (OJ L 346, 17.12.1997, p. 78).

([2]) Categories N and O as defined in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev. 1).

([3]) European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

([4]) Type of vehicle as defined in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev. 1).

2.4. 'maximum mass' means the technically permissible maximum mass stated by the vehicle manufacturer (this mass may be higher than the 'permissible maximum mass' laid down by the national administration);

2.5. 'the distribution of mass among the axles' means the proportion of the maximum permissible mass borne by each axle, as declared by the vehicle manufacturer;

2.6. 'suspension trim height' means the distance between the wheel centre and a fixed point on the chassis as declared by the vehicle manufacturer.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to rollover stability shall be submitted by the vehicle manufacturer ([5]) or by his duly accredited representative.

3.2. It shall be accompanied by the undermentioned documents in triplicate and the following particulars:

3.2.1. a detailed description of the vehicle type with regard to the items specified in paragraph 2.2. The numbers and/or symbols identifying the vehicle type shall be specified;

3.2.2. photographs and/or diagrams and drawings of the vehicle showing the vehicle type in front, side, and rear elevation;

3.2.3. particulars of the vehicle's mass as defined by paragraph 2.4.

3.3. A vehicle, representative of the vehicle type to be approved, shall be submitted to the technical service conducting the approval tests.

4. APPROVAL

4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of paragraph 5, approval of that vehicle type shall be granted.

4.2. An approval number shall be assigned to each type approved. Its first two digits (currently 00 for the Regulation in its original form) 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 approval number to another vehicle type.

4.3. Notice of approval or of extension or of refusal or of approval withdrawn or of production definitely discontinued of a vehicle type pursuant to this Regulation shall be communicated by the Parties to the Agreement applying this Regulation by means of a form conforming to the model in annex 1 to this Regulation together with photographs and/or diagrams and drawings supplied by the applicant for approval, in a format not exceeding A4 (210 × 297 mm) or folded to that format and on an appropriate scale.

4.4. There shall be affixed to every vehicle conforming to a vehicle type approved under this Regulation, conspicuously and in a readily accessible place specified on the approval form, an international approval mark consisting of:

([5]) Manufacturer of the base vehicle or the final assembler of the tank vehicle.

4.4.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ([6]), and

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. 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 this case the Regulation and approval numbers and the additional 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.

4.8. Annex 2 to this Regulation gives examples of approval marks.

5. SPECIFICATIONS AND TESTS

5.1. The vehicle shall undergo:

5.1.1. a tilt table test in accordance with annex 3 to this Regulation, which simulates a non-vibratory steady-state turn, or

5.1.2. as an alternative a calculation method in accordance with annex 4 to this Regulation. If there is any doubt or dispute a tilt table test shall be used.

5.2. The result of the tilt table test or the calculation method shall be considered satisfactory if the conditions set out in paragraphs 5.3 and 5.4 are satisfied.

5.3. *Stability criteria*

5.3.1. The criteria, using the corresponding annex (3 or 4) to this Regulation, must fulfil one of the following conditions, subject to paragraph 5.1.2:

5.3.1.1. Tilt table test:

The static rollover stability of the vehicle shall be such that the point at which overturning occurs would not be passed if a tilt table angle of 23° has been reached for all tests in both tilt directions.

If the vehicle fails in one of the three tests for a specific direction (right or left), it is allowed to do one consecutive (re)test.

([6]) 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 Yugoslavia, 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 (vacant), 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32-36 (vacant) and 37 for Turkey. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify the Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, or in which they accede to that Agreement, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

5.3.1.2. Calculation method:

The rollover stability of the vehicle shall be such that the point at which overturning occurs would not be passed if a lateral acceleration of 4 m/s^2 has been reached.

5.4. *Particular requirements*

No contact between parts of the vehicle shall occur which are not intended to come into contact during normal use.

6. MODIFICATION OF THE VEHICLE TYPE AND EXTENSION OF APPROVAL

6.1. Every modification which affects the vehicle type as defined in paragraph 2.2 (for instance the chassis, body, suspension, axle configuration, etc.) shall be notified to the administrative department which approved the vehicle type. The department may then either:

6.1.1. 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

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

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

6.3. The competent authority issuing an extension of approval shall assign a series number to each communication form drawn up for such an extension and inform thereof the other Contracting Parties to the 1958 Agreement by means of a communication form conforming to the model in annex 2 to this Regulation.

7. 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:

7.1. A vehicle approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 5.

7.2. The authority which has granted type-approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be once every two years.

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 requirement laid down in paragraph 7.1 is not complied with, or if the vehicle or vehicles selected have failed to pass the checks prescribed in paragraph 7.2.

8.2. If a Contracting 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 communication form conforming to the model in annex 1 to this Regulation.

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 authority which granted the approval. Upon receiving the relevant communication, that authority shall 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.

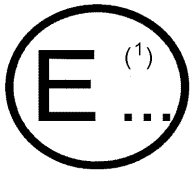
10. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Contracting Parties to the 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 withdrawal of approval, issued in other countries, are to be sent.

ANNEX 1

Communication

(Maximum format: A4 (210 mm × 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 static/steady-state rollover stability pursuant to Regulation No 111

Approval No . . . . . Extension No . . . . . .

1. Trade name or mark of the vehicle: . . . . . .

2. Vehicle category: N2/N3/O3/O4 (2)

3. Vehicle type:

3.1. chassis; make, model, type: . . . . . .

3.2. tank; make, model: . . . . . .

3.3. monocoque tank construction: Yes/No (2)

4. Manufacturer's name and address: . . . . . .

5. If applicable, name and address of manufacturer's representative: . . . . . .

6. Mass of vehicle:

6.1. maximum mass of vehicle: . . . . . .

6.2. mass of laden tank: . . . . . .

6.3. distribution of the maximum mass among the axles: . . . . . .

6.4. in case of a semi-trailer or centre-axle trailer, the static load on the fifth wheel/front coupling: . . . . . .

7. Cross-section of the tank: circular/elliptical/maxi-volume (2)

8. Centre of gravity height of the laden vehicle: . . . . . .

9. Axles:

9.1. number and arrangement of the axles (including axle spacing): .....

9.2. suspension arrangements in relation to roll characteristics: .....

9.3. suspension trim height and datum location ([3]): .....

9.4. tyre size and structure: radial ply/diagonal ply/bias belted ([2])

9.5. track width of each axle: .....

10. Wheel base: .....

11. Test conditions:

11.1. mass of vehicle when tested:

Axle No	Load (kg)
Total	

11.2. load imposed on towing vehicle fifth wheel coupling or centre axle trailer coupling: .....

11.3. filling factor of the test load (% fill of the tank): .....

11.4. test load (water, etc.): .....

12. Vehicle submitted for approval on: .....

13. Technical service responsible for conducting approval tests: .....

14. Date of report issued by that service: .....

15. Number of report issued by that service: .....

16. Tilt table test/calculation method ([2])

17. Approval granted/refused/extended/withdrawn ([2])

18. Position of approval mark on the vehicle: .....

19. Place: .....

20. Date: .....

21. Signature: .....

22. The list of documents deposited with the administrative service which has granted approval is annexed to this communication and may be obtained on request.

([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]) In case of height-levelling devices, please specify.

ANNEX 2

Arrangements of the approval mark

MODEL A

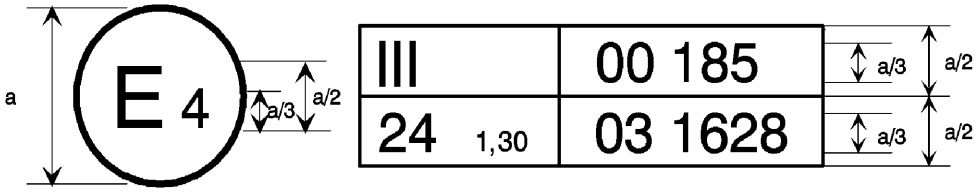
(See paragraph 4.5 of this Regulation)

a ≥ 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the rollover stability, been approved in the Netherlands (E4) pursuant to Regulation No III. The first two digits of the approval number indicate that when the approval was granted Regulation No III was in its original form.

MODEL B

(See paragraph 4.6 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 No III and No 24 ([1]). (In the case of the latter Regulation, the additional symbol which follows the Regulation number indicates that the corrected absorption coefficient is 1,30 m^{-1}). The first two digits of the approval number indicate that, at the date when the respective approvals were granted, Regulation III was in its original form and Regulation No 24 incorporated the 03 series of amendments.

([1]) The latter number is given only as an example.

ANNEX 3

Tilt table test procedure

1. DEFINITIONS

For the purposes of this test:

'rollover threshold' means the instant when all the wheels on one side of the vehicle have lost contact with the tilt table surface.

2. GENERAL CONDITIONS

2.1. *The tilt table*

A rigid surface should be used. The tyres may rest against a safety block or step during the test to prevent sideways slipping, provided that the safety block does not influence the test result.

2.2. *Wind conditions*

If the tilt table test rig is placed outside, the lateral wind velocity shall not exceed 3 m/s and the total wind velocity shall not exceed 5 m/s.

2.3. *Tyres*

The tyres shall be inflated to pressures as specified by the vehicle manufacturer for the test vehicle at the laden condition. The tolerance for the inflation pressure in a cold state is ± 2 %.

2.4. *Operating components*

2.4.1. All operating components likely to influence the results of this test (e.g. condition and setting of springs and other suspension components and suspension geometry) shall be as specified by the manufacturer.

2.4.2. Height-levelling systems should be deactivated (held at static values) during the actual tilt to avoid inflation/deflation of suspension during the tilt. Cross-coupling from side to side may need to be deactivated. An exception can be made for levelling systems with very short response time of less than one second.

3. MEASURING ACCURACY

3.1. The tilt table angle shall be measured with an accuracy of better than 0,3°.

4. NON POWER-DRIVEN VEHICLES

4.1. If the vehicle is a centre-axle trailer, the vehicle may be tested with a power-driven vehicle. Any power-driven vehicle, substitute or support which has the appropriate coupling system and height may be used, as this will not influence the results.

4.2. If the vehicle is a semi-trailer, the vehicle shall be tested with a tractor or a substitute. The tractor/substitute will influence the results and therefore a reference tractor/substitute shall be used.

5. VEHICLE LOADING CONDITION

The standard test condition is the maximum loaded condition: the laden vehicle. In this maximum loading condition, the tank vehicle shall be fully loaded, without exceeding the maximum authorised mass and maximum authorised axle loads.

If the normal load to be carried by the tank vehicle is classified as being of a dangerous type, it may be replaced by water or another non-dangerous test load. If the standard test conditions, (a) fully laden or (b) maximum mass, cannot be fulfilled with this test load then:

(a) a filling factor of the tank between 100 % and 70 % is acceptable. If at the minimum filling factor of 70 % the total mass and/or axle loads still exceed the maximum authorised mass and maximum authorised axle loads, a test load with a lower density shall be used.

The distribution of mass of the tank (including the test load) among the axles shall be proportional to the maximum loaded condition.

Tanks provided with compartments shall be differentially loaded so that the centre of gravity height at each axle or axle group is as close as possible to the real centre of gravity height;

(b) a calculation shall be issued by the vehicle manufacturer ([1]) to provide a new required maximum tilt table angle for the lighter test load.

6. SAFETY

Restraints shall be used to prevent final rollover but these shall be arranged so as not to interfere with the test.

7. TEST PROCEDURE

This procedure consists of a very gradual increase in the tilt table angle up to the required maximum angle or the rollover threshold. The vehicle shall be tested with all units in a straight line parallel to the tilt table axis such that no axle longitudinal centre line is off line by more than 25 mm.

All steerable axles of the vehicle shall be locked to prevent axle lateral movement and/or turning of the wheels in a steering direction. Also the vehicle shall be fixed in the longitudinal direction to prevent forward and rearward movement, provided that the method of fixing does not influence the test result.

The vehicle shall be tilted at very low rates of 0,25°/s or less.

The vehicle shall be gradually tilted three times each to the right and left of the vehicle longitudinal centre line. Due to the influences of stick-slip in the vehicle's suspension systems and coupling components, the vehicle shall be removed from the table between the tests and driven around to 'randomise' and 'equalise' the influences of stick-slip and hysteresis.

([1]) Manufacturer of the base vehicle or the final assembler of the tank vehicle.

ANNEX 4

Lateral stability calculation

1. GENERAL

The lateral stability of tank vehicles is calculated by simulation of a steady state circular test (constant radius, constant speed and consequently constant lateral acceleration). The calculation method take into account the main factors which influence the stability, such as the height of the centre of gravity, the track width and all factors which result in a lateral shift of the centre of gravity (axle roll stiffness, suspension roll stiffness, etc.).

In case of semi-trailers the tractor will be simulated with a reference kingpin roll stiffness.

The specifications of the calculation method are:

1. axle roll centre is at ground level;
2. vehicle structure is assumed to be rigid;
3. vehicle is symmetrical about its centreline;
4. tyre and suspension deflections are linear;
5. lateral deflection of suspensions is zero.

2. DEFINITIONS

For the purposes of this calculation:

'bogie' means an axle group with compensatory load distribution, in which zero load is attained on all wheels on a given side simultaneously.

3. SYMBOLS (see also 1)

i	(-)	=	axle/bogie index (i = 1 - n, front to - axle/bogie; i = T, all axles/bogies; i = M, stiffest axle/bogie; and for semi-trailers only i = K, kingpin)
m_i	(m)	=	nominal suspension roll axis height
A_i	(kN)	=	axle/bogie load
C_{DGi}	(kNm/rad)	=	suspension roll stiffness at axle roll axis
C_{DGMi}	(kNm/rad)	=	equivalent suspension roll stiffness at ground level
C_{CRi}	(kNm/rad)	=	axle/bogie roll stiffness
C_{DRESi}	(kNm/rad)	=	resolved combined suspension roll stiffness at ground level
F_{RVi}	(kN/m)	=	vertical tyre rate for each axle/bogie (inclusive the double effect of twin tyres)
U_i	(kN)	=	unsprung weight
T_{Ni}	(m)	=	nominal track width
T_i	(m)	=	theoretical track width for axle/bogie with twin tyres
F_E	(-)	=	effective mass factor of stiffest axle/bogie
H_G	(m)	=	centre of gravity height of complete vehicle
H_N	(m)	=	centre of gravity height of sprung mass
MA	(m)	=	twin tyre width
q_c	g	=	corrected lateral acceleration at overturn
q_M	g	=	lateral acceleration at first wheel lift
q_T	g	=	maximum optimal lateral acceleration at overturn
g	(m/s^2)	=	acceleration due to gravity; $g = 9{,}81\ m/s^2$
ϑ_i	(rad)	=	pseudo vehicle roll angle at wheel lift
β	(deg)	=	equivalent tilt table angle

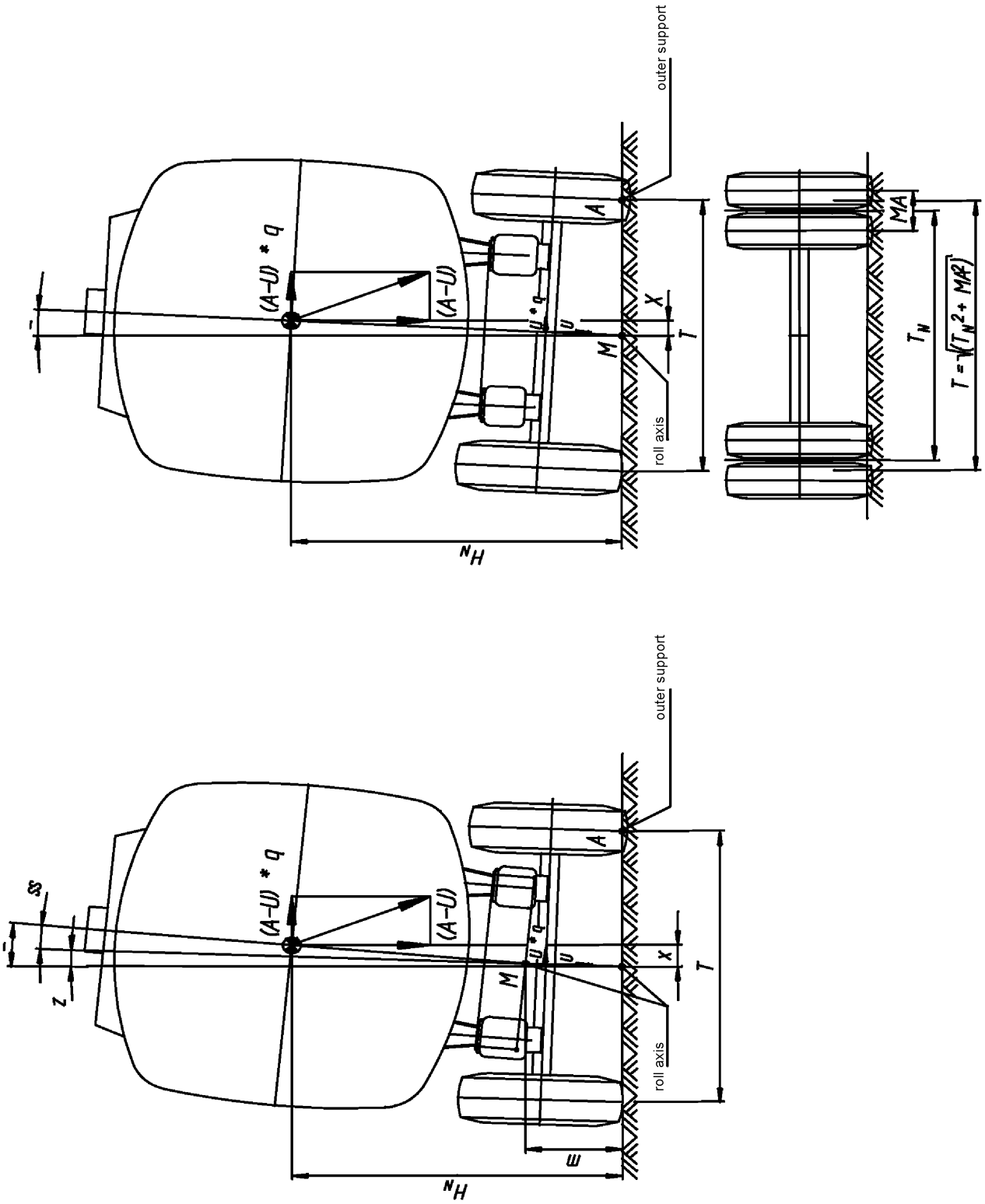


Figure 1: Cross-section of a tank vehicle

4. GENERAL CONDITIONS

Height-levelling systems are not taken into account (held at static values).

5. TRAILERS

5.1. If the trailer is a full trailer or a central axle trailer the calculation does not have to include the coupling with the towing vehicle.

5.2. If the trailer is a semi-trailer, the tractor will be simulated with a reference kingpin roll stiffness, which represents the tractor suspension, tyres, chassis and fifth wheel flexibility at ground level.

6. VEHICLE LOADING CONDITION

The test condition is the maximum loaded condition: laden vehicle. In this maximum loading condition, the tank vehicle shall be fully loaded, without exceeding the maximum authorised mass and maximum authorised wheel loads.

7. CALCULATION METHOD

7.1. Calculation of the combined roll stiffness and the pseudo vehicle roll angle at wheel lift of each axle/bogie with the formulae:

7.1.1. axles/bogie with single tyres:

axle/bogie roll stiffness:

$$C_{DRi} = \frac{F_{RVi} \times T_{Ni}^2}{2}$$

equivalent suspension roll stiffness ground level:

$$C_{DGMi} = C_{DGi} \times \left[\frac{H_N}{H_N - m}\right]^2$$

combined roll stiffness to simulate lateral CG shift:

$$C_{DRESi} = \frac{C_{DGMi} \times C_{DRi}}{C_{DGMi} + C_{DRi}}$$

pseudo vehicle roll angle at wheel lift:

$$\vartheta_i = \frac{A_i \times T_{Ni}}{2 \times C_{DRESi}}$$

7.1.2. axles/bogie with twin tyres:

theoretical track width for twin tyres:

$$T_i = \sqrt{T^2{}_{Ni} + MA^2}$$

axle/bogie roll stiffness:

$$C_{DRi} = \frac{F_{RVi} \times T_i^2}{2}$$

equivalent suspension roll stiffness ground level:

$$C_{DGMi} = C_{DGi} \times \left[\frac{H_N}{H_N - m}\right]^2$$

combined roll stiffness to simulate lateral CG shift:

$$C_{DRESi} = \frac{C_{DGMi} \times C_{DRi}}{C_{DGMi} + C_{DRi}}$$

pseudo vehicle roll angle at wheel lift:

$$\vartheta_i = \frac{A_i \times T_i}{2 \times C_{DRESi}}$$

7.2. In case of semi-trailers, calculation of the kingpin effects with the following formulae:

track width:

$$T_K = \frac{\sum_{i=1}^{n} T_i}{n}$$

roll stiffness:

$$C_{DRESK} = A_K \times 4$$

7.3. After the resolved combined stiffness and pseudo roll angle for each axle/bogie are calculated the totals for the complete vehicle are determined:

total vehicle weight ([1]):

$$A_T = \sum_{i=1}^{n} A_i + A_K$$

total unsprung weight:

$$U_T = \sum_{i=1}^{n} U_i$$

effective track width ([1]):

$$T_T = \frac{\sum_{i=1}^{n} (T_i \times A_i)}{A_T} + \frac{T_K \times A_K}{A_T}$$

total roll stiffness ([1]):

$$C_{DREST} = \sum_{i=1}^{n} C_{DRESi} + C_{DRESK}$$

7.4. Select the axle/bogie with the lowest value of ϑ, for this indicates that first wheel lift will occur. To distinguish this axle/bogie from the other axles/bogies, allocate the following:

A_M = axle load of axle/bogie with lowest ϑ

U_M = unsprung weight of axle/bogie with lowest ϑ

T_M = track width of axle/bogie with lowest ϑ

C_{DRESM} = roll stiffness axle of axle/bogie with lowest ϑ

([1]) Use second part of the formula only for semi-trailers.

7.5. Lateral stability calculation

7.5.1. The effective mass factor of the stiffest axle/bogie F_E:

$$F_E = \frac{C_{DRESM}}{C_{DREST}}$$

7.5.2. The lateral acceleration at first wheel lift q_M:

$$q_M = \frac{A_M \times T_M}{2 \times \left[(F_E \times A_T \times H_G) + \frac{\left((A_T - U_T) \times F_E \times H_N\right)^2}{C_{DRESM} - (A_T \times F_E \times H_N)} \right]}$$

7.5.3. The maximum optimal theoretical lateral acceleration at overturn q_T:

$$q_T = \frac{A_T \times T_T}{2 \times \left[(A_T \times H_G) + \frac{\left((A_T - U_T) \times H_N\right)^2}{C_{DREST} - (A_T \times H_N)} \right]}$$

7.5.4. Linear interpolation between the lateral acceleration at first wheel lift and the maximum theoretical lateral acceleration gives the correlated lateral acceleration at overturn q_c:

$$q_c = q_T - (q_T - q_M) \times \frac{A_M}{A_T}$$

APPENDIX

Calculation report

1. Trade name or mark of the vehicle: . . . . . .
2. Vehicle type: . . . . . .
3. Manufacturer: . . . . . .
4. Height of the centre of gravity of the spring mass: . . . . . .
5. Unsprung weight of all axles: . . . . . .
6. Nominal suspension roll axis height of all axles: . . . . . .
7. Suspension roll stiffness of all axles: . . . . . .
8. Vertical tyre rate (inclusive double effect of twin tyres): . . . . . .
9. In case of twin tyres, the twin tyre width: . . . . . .
10. Calculation result, q_c = ...
11. Technical service which carried out the calculation: . . . . . .
12. Date: . . . . . .
13. Signature: . . . . . .